21st CENTURY SCIENCE & TECHNOLOGY

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THE PHYSICAL STATES OF SPACE

New Vernadsky Translation

- Korea's Ambitious Nuclear Program
- LaRouche on Physical Space-Time

21st CENTURY SCIENCE & TECHNOLOGY

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Features

NOAA's Estuarine Research Reserve Collection

Vernadsky (p. 10) looks at the symmetry of living organisms, compared to crystals. Here a dazzling array of starfish, sea urchins, and mussel shells in the intertidal zone of Kachemak Bay, Alaska.

News

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On the Cover: Korea's Yongwang nuclear complex with six reactors. Photo courtesy of Korea Hydro & Nuclear Power Co., Ltd.; cover design by Alan Yue.

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Reality and the Science of Climate

The looming disaster civilization faces is not "climate change": The world economy is collapsing, food shortages loom, U.S. citizens are losing their homes in record numbers, political hot spots around the globe are being heated up, and a new Dark Age is an increasingly near possibility. In contrast to this economic and political reality, the hysteria about "global warming" has created another bubble, a new industry, where some are profiting from the cap-and-trade carbon proposals-for now.

Here we review what science says about climate, with links to fuller reports:

1. Climate is determined by long-range solar astronomical cycles that are driven by the regular periodicities in the eccentricity (about 90,000 to 100,000 years), tilt (40,000 years), and precession (21,000 years) of the Earth's orbit. Over the past 800,000 years the Earth's climate has gone through eight distinct cycles of about 100,000 year-long ice ages. In each cycle, there is a period of glacial buildup, followed by an interglacial, or relatively warm period, lasting about 10,000 years.

Because the current interglacial period has lasted more than the 10,000-year average, it is expected that a new "ice age" is in the making. We don't know exactly when ice will once again advance to cover a good part of the Northern Hemisphere, including New York City and much of the northern United States, but we do know that man-made carbon dioxide will not stop the march of the astronomical cycles.

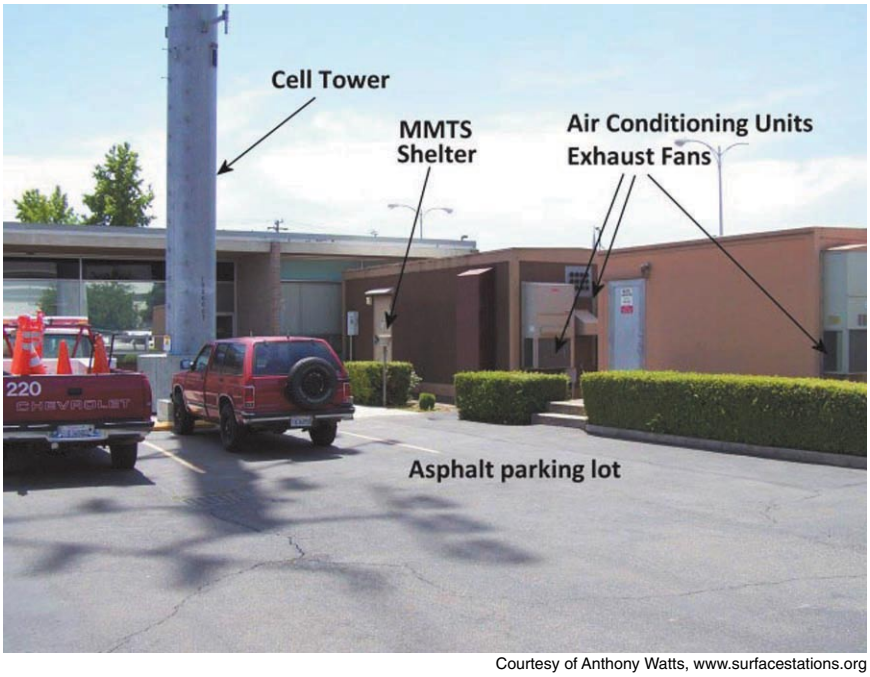
For details, see "The Coming (or Present) Ice Age" by Laurence Hecht, *21st Century Science & Technology*, Winter 1993-1994, available online at: www.21stcenturysciencetech.com/Articles%202005/ComingPresentIceAge.pdf.

2. Carbon dioxide levels have often been higher—much higher, in fact—in the past than they are today. This is documented by Ernst-Georg Beck, who compiled 90,000 carbon dioxide readings going back to the 1800s, by leading scientists. This meticulous record was discarded by the Intergovernmental Panel on Climate Change (IPCC) in order to make its case that carbon dioxide levels today are soaring beyond any past records.

Beck shows that since 1812, the carbon dioxide concentration in the Northern Hemispheric air has fluctuated, exhibiting three high-level maxima around 1825, 1857, and 1942, the latter showing more than 400 parts per million. For more details, see "180 Years of Atmospheric Carbon Dioxide Gas Analysis by Chemical Methods," in *Energy & Environment,* Vol. 18, No. 2, 2007.

3. Carbon dioxide does not cause temperature increase. Increases in carbon dioxide follow temperature increases. If you look at the historical temperature records for the past several million years, there is a 600- to 800-year gap between periods of temperature rise and rising carbon dioxide levels. See the discussion of carbon dioxide in Zbigniew Jaworowski's article "CO_2: The Greatest Scientific Scandal of Our Time," www.21stcenturysciencetech.com/Articles%202007/20_12_CO2_Scandal.pdf.

4. Al Gore dramatically points to 1998 as the hottest year on record. But the temperature data he is using are false. The data come from James Hansen, the director of the Goddard Institute for Space Studies and a leading alarmist on global warming, who had to revise the



Courtesy of Anthony Watts, www.surfacestations.org

U.S. weather stations that monitor temperature and other climate variables are notoriously badly sited and unreliable. This station, for example, at Marysville, Calif., has located its new Min-Max Temperature Station (MMTS Shelter in the photo) near buildings, a cell tower, an asphalt parking lot, and air conditioning exhaust fans, all of which make the temperature readings warmer.

temperature data on the Institute's website because it was shown to be manipulated.

Canadian economist Steven McIntyre pointed out that in the Institute's year 2000 data revision, the model had used a set of data that skewed the results, producing the 1990s as the hottest decade (and 1998 as the hottest year) in history. When this error was removed, it turned out that the 1930s were the warmest decade. All that is left of this 1990s hottest decade claim is hot air. The Institute initially acknowledged McIntyre's correction on its website, but later adjusted this to remove his name.

James Hansen claimed that this was just a "trivial" error, yet U.S. temperature measurements make up 25 percent of his world temperature models—not a trivial amount.

For McIntyre's comments, see http://www.climateaudit.org/?p=1946 and other columns at this website. The Goddard Institute of Space Studies website is http://data.giss.nasa.gov/gistemp/graphs/.

5. Climate models are only models, not all-knowing gods. It is not physically possible to "model" the behavior of clouds, water vapor, and other climate variables because of the nonlinearities involved. It is like deciding that you can "model" the future behavior of a newborn child.

Scientists can get out of climate models what they want, by changing the assumptions of the model and cherry-picking the data used. See "Computer Climate Models: Voodoo for Scientists," http://www.21stcenturysciencetech.com/Articles%20200 7/GW_voodoo.pdf.

6. Temperature data used in models and in the IPCC predictions are not based on physical temperature data, but on model predictions. As one leading climate modeler, Gavin Schmidt of the Goddard Institute of Space Studies, stated, the models "don't use any observed temperature data directly." In addition, the selection process for which weather data are used is not transparent. The end results cannot be replicated, and often the process of data selection is unavailable, because it is considered "proprietary." See Gregory Murphy, "Computer Climate Models: Voodoo for Scientists," http://www.21stcenturysciencetech.com/Articles%202007/GW_voodoo.pdf.

7. The network of U.S. weather stations that monitor temperature and other climate variables is not reliable. The stations, which are monitored by volunteers, are often in disrepair and many are located where they cannot possibly give an accurate reading of temperature (for example, next to an airport runway). For some photos, see http://www.globalwarminghoax.com/e107_plugins/content/content.php?content.7.2

8. A "mean world temperature" is meaningless. Think about having one foot in boiling water and the other frozen in an ice bucket. On average, you would be fine.

9. Ocean levels are not rising. The world's leading sea-level-rise expert, who has observed ocean levels for 35 years, documents that sea levels are not rising and island nations are not endangered, based on actual *observed* sea levels. Climate model scenarios predict often alarming rises, but none has been observed.

See the interview with Dr. Nils-Axel Mörner, just retired head of the Paleogeophysics and Geodynamics Department at Stockholm University in Sweden: www.21stcenturysciencetech.com/Articles%202 007/MornerInterview.pdf.

10. The polar bear, poster child of the global warming scare, have managed to survive several ice ages and interglacials over the past 800,000 years. They must know something that climate alarmists don't know about survival. For this story, see Gregory Murphy, "Polar Bears Are Smarter Than Al Gore," www.21stcenturysciencetech.com/Articles%202007/GW_polarbears.pdf.

11. The IPCC or Intergovernmental Panel on Climate Change advertises its scary pronouncements as a "consensus," but in fact, it has ignored the opposing views of reviewers and many of the scientists listed as members of the IPCC. For example, see the interview with IPCC reviewer Dr. Paul Reiter, head

Continued on page 48

Courtesy of Toshiba

The high-temperature sodium test loop at Toshiba's new Yokohama nuclear facility. Japan has chosen the fast reactor as its standard nuclear plant.

RENEWABLE FUEL: TOSHIBA OPENS BREEDER REACTOR TEST FACILITY

A test loop for research in fast reactors, a type of nuclear power plant that can produce more new fuel than it uses up in power production, is part of Japan's new nuclear facility in Yokohama. The high-temperature liquid sodium test loop will simulate sodium coolant behavior at actual operating conditions and flow.

The fast reactor, also known as a breeder reactor, is slated to be the workhorse of Japan's nuclear program in the future, and a few fast reactors are under design. In a fast reactor, neutrons from the fission process are directed to strike a blanket of unenriched uranium or thorium surrounding the reactor core. The neutrons transmute the nonfissionable ores into usable nuclear fuel. In addition, Toshiba intends to commercialize the 4S reactor, Super-Safe, Small, and Simple, in the late 2010s. The modular 4S reactor uses sodium as a coolant.

The Bush Administration closed down its only sodium-cooled fast reactor, the Fast Flux Test Facility in Washington State, in 2005. A U.S. program for a new facility remains in the talk stage. (See GNEP article, *21st Century*, Fall 2007.)

THE HUMAN VOICE SHAPES WIND INSTRUMENT'S SOUND

Measurements with miniaturized sensors showed that the sound production of a tenor saxophone is dependent on the coupling of the vocal tract to the sounding pitch of the instrument, thus confirming a hypothesis demonstrated by bassoonist Mindy Pechenuk at a Schiller Institute conference seven years ago.

Researchers at the University of New South Wales in Sydney, Australia, designed sensors that could be placed in the relatively large mouthpiece of a tenor saxophone, to measure the acoustic impedance (ratio of sound pressure to air particle velocity) of the sound produced by the voice. This measurement was compared to a similar one taken for the air flow within the instrument. A graph of the acoustic impedance for the instrument, plotted against the frequency, would show peaks at the fundamental tone and its harmonics (integral multiples of the fundamental frequency). A similar plot for the acoustic impedance of the voice showed a peak at the fundamental, but not necessarily elsewhere.

Most compelling, the experimenters noted that in the high range of the instrument, known as {altissimo}, it was necessary that the voice produce a resonance at the fundamental tone, or no tone could be produced at all, as was the case for less-accomplished amateur players. Unfortunately, the instrumental measurements can only provide a crude approximation of the sound heard by the developed ear. Despite these drawbacks, the experiments, as reported in the Feb. 8 issue of *Science*, provide a physical confirmation of the more developed thesis presented by Pechenuk some years ago. (See Jer Ming Chen, John Smith, Joe Wolfe, ``Experienced Saxophonists Learn to Tune Their Vocal Tracts,'' p. 776.)

Courtesy of AMIC

The new accelerator can be located near the medical facilities that provide treatment and diagnostic services using short-lived and specialized isotopes.

PROTON LINEAR ACCELERATOR TO MAKE ISOTOPES FOR PET SCANS

The first compact linear accelerator for isotope production in North America was installed in Kennewick, Washington, near the Hanford nuclear site, in early March. The accelerator will produce specialty isotopes used in Positron Emission Tomography (PET) imaging. Isotopes such as fluorine-18, nitrogen-13, carbon-11, and oxygen-15 decay by emitting a positron (an anti-matter particle with the same mass as an electron, but positive charge), which can then be detected by a scanner. The accelerator will also produce other longer lived isotopes for diagnostic and therapeutic uses, including actinium-225, iodine-123, and indium-111.

The United States now imports more than 90 percent of its medical isotopes. (See article, p. 52). According to the Advanced Medical Isotope Corporation, which will operate the new accelerator, its production system integrates compact accelerator technology with high production yield targets and advanced chemistry process units, making it a more reliable and more compact alternative to cyclotrons.

HYDROGEN COULD REPLACE GASOLINE, USING ALUMINUM-RICH ALLOY

An economical method of separating hydrogen from water, using a new aluminum-rich alloy, has been developed at the electrical engineering department of Purdue University in Indiana.

Hydrogen can serve as a substitute for gasoline in motor vehicles, by burning the gas in an internal combustion engine, or by powering a fuel cell. New, fourth-generation nuclear power plants operate at high enough temperatures to permit the economical separation of hydrogen from water by electrolysis or chemical methods. However, to carry sufficient amounts of the gas for long trips in a car or truck, requires extremely high pressure fuel tanks which are expensive. Therefore, proposals for using the hydrogen as a gasoline substitute often involve combining it with carbon, from coal for example, to form more manageable liquid hydrocarbon fuels.

The Purdue breakthrough would allow production of the hydrogen on demand from a tank of water carried in the vehicle, and could use the abundant electricity generated by nuclear power to recycle the aluminum oxide by-product.

Aluminum in its liquid form easily combines with the oxygen in water, releasing hydrogen and heat. However, the surface of the aluminum quickly becomes oxidized, stopping the reaction. The Purdue scientists, working with Professor Jerry Woodall, have developed a new alloy which consists of 95 percent aluminum, and 5 percent an inert alloy of the elements gallium, indium, and tin. When the combined alloy is heated and then cooled, the constituents separate into two phases. The gallium-indium-tin alloy remains in a liquid phase which is not homogeneously incorporated into the solid aluminum.

This two-phase composition enables the aluminum alloy to react with water to produce hydrogen, but at the same time to be free of the surface oxidation which would stop the reaction.

Introduction of the technology would require a large-scale industrial infrastructure for recycling the aluminum oxide by-product back into aluminum and recovery of the gallium-indium-tin alloy, in addition to motor vehicles adapted to the new fuel. With onsite electricity for the aluminum recycler at 2 cents per kilowatt-hour, such as could be obtained at a nuclear power plant, Woodall calculated last year that the process would be competitive with gasoline at about $3.19 per gallon. Based on new discoveries with the alloy, Woodall now believes his method for producing hydrogen and heat could eventually become an efficient source of energy, as well.

Courtesy of Jerry Woodall/Purdue University

Lumps of gallium-aluminum alloy (GaAl28), used to make hydrogen in reaction with water.

RESEARCHERS FIND REGULATOR FOR ZEBRAFISH REGENERATION

The zebrafish, a ubiquitous aquarium fish used as a model organism by biologists studying developmental mechanisms, has the remarkable ability to regenerate complex tissues and organs, including the heart and whole fins.

Now a Duke University research team has discovered a potent regulator for zebrafish regeneration. Drs. Kenneth Poss and Viravuth Yin reported in the March 15 edition of *Genes & Development* that a tiny RNA molecule called microRNA acts as a regulator. They surveyed mature and regenerating tissue for microRNAs, and found a high prevalence of a particular microRNA named MiR-133 in mature fins, but a low prevalence of it in regenerating fins.

Using genetically modified fish whose regeneration signaling pathway could be blocked during regeneration, they observed MiR-133 to drop during regeneration, then spike to normal levels when the regeneration signal was blocked experimentally.

In fact, the regeneration rate was later found to inversely correlate closely with MiR-133 quantity in regenerating fins.

MicroRNA and similar tiny versions of RNA with less than 25 subunits were virtually unknown until the last decade, hidden behind prevailing axioms of genetic expression regulation mechanisms. Now they are ubiquitous, powerfully regulating at many levels, and are implicated in regulating tumor growth, blocking viral infection, and other complex functions throughout cells.

National Science Foundation

Zebrafish: Will we be able to learn from them how to regenerate human tissue?

Fake Chinese Records Used to Back Warming

Scientific truth struck back against Al Gore's genocidal global warming fraud in January 2008, as record snows and cold weather blanketed much of the northern hemisphere. China, which last year was forced to close 553 coal-fired power stations to placate the carbon dioxide mafia, found itself suffering under blizzard conditions not seen in 50 years. Nearly half a million soliders had to be mobilized to rescue freezing residents and clear transportation corridors in large parts of east, central, and southern China.

As it turns out, a falsified record of Chinese temperature stations also plays a central role in the global warming fraud. As was revealed last year, the Inter-Governmental Panel on Climate Change (IPCC), the coordinating body for the global warming fraud, had employed a falsified record of Chinese temperature readings to help support its claim that global temperature has been increasing as a result of man-made carbon dioxide emissions. The story is as follows:

In May 2007, Canadian economist Stephen McIntyre and Douglas Keenan of Great Britain exposed as fraudulent the IPCC's claim that urban heat island effect—the increase in historical temperature record, due to monitoring stations being located in urban areas—played only a minor role in the temperature data. The IPCC's claim was based on a landmark 1990 paper, "Assessment of Urbanization Effects in Time Series of Surface Air Temperature Over Land," by Phil Jones, director of the Climate Research Unit at the University of East Anglia, and co-author Wei-Chyung Wang, professor at the State University of New York in Albany.

Fought to Keep Station List Secret

But McIntyre and Keenan showed that Jones and his co-author had knowingly falsified data from the 84 Chinese temperature stations used in their study. Jones and his co-author had claimed to have chosen stations "with few, if any, changes in instrumentation, location or observation times." However, after Jones was forced by a protracted Freedom of Information Act fight to release his station list, it was compared to a joint study conducted by the Chinese Academy of Science and the Oak Ridge National Laboratory's Carbon Dioxide Program, which had assessed the state of repair and history of the temperature stations in China.

That study showed that only 60 stations of the 84 used by Jones et al. had even limited station histories. Forty-two of the stations, which Jones listed as rural, had no station history at all. Of the other 42 stations used by Jones, there had been major relocations, in some cases moves of up to 41 kilometers, and most from rural to urban locations.

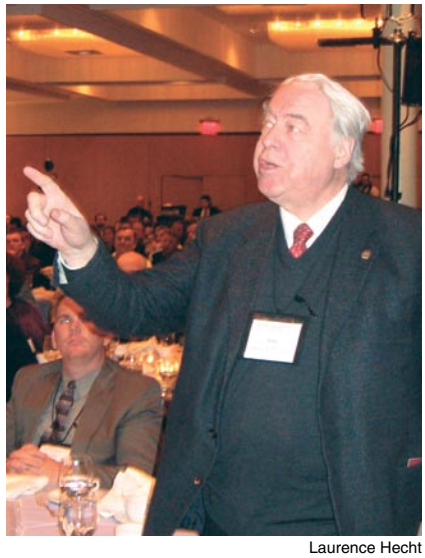
Interestingly, Jones's time frame for his study was 1945 to 1983, which includes the periods of the "Great Cultural Revolution" and the "Great Leap Forward." The joint study by the Chinese Academy of Sciences and the U.S. Oak Ridge National Laboratory had found serious doubts as to the level of accuracy of this temperature data, and that there was a real possibility that station history data had been changed or lost during this time period.

From the time it was first cooked up in 1975, at a conference of population control fanatics, "global warming" was never anything but a hoax to provide justification for denying the fruits of modern industrial society to the poor, and mostly non-white, populations of the world. The case of the falsified data on Chinese temperature stations once again shows Gore's fraudulent claims about global warming to be as solid as an igloo in Miami.

—Gregory Murphy

Russian Academician Proposes New Methods to Stop Global Warming—or Cooling

Yuri Izrael, vice chairman of the Intergovernmental Panel on Climate Change (IPCC) and member of the Russian Academy of Sciences, called for an international conference to address methods other than carbon dioxide reduction for dealing with the effects on civilization of climatic warming, or of the greater danger of cooling. Izrael, who directs the Research Institute for Global Climate and Ecology in Moscow, launched his diplomatic initiative March 2, in a presentation before a climate conference in New York City.



Laurence Hecht

Izrael: Cooling is the more dangerous possibility.

Izrael reported on new research showing the feasibility of injecting aerosol particles into the lower stratosphere, which can reduce the solar radiation by 1 percent. This, he said, is more than sufficient to stem any possible warming.

Similarly, he stated, the use of other aerosols would make it possible to reduce the effects of global cooling, a more dangerous possibility. Solar reflectors in space and other novel technical means might also be used.

Izrael stressed the importance of such a conference being international, to be sure that all affected countries are in agreement on such countermeasures. He said that such an international body should work in parallel with the Kyoto Protocol. While reduction of carbon dixoide emissions to deal with a possible warming

might take 100 years to have an effect, he said, the sorts of measures his institute proposes could take effect within a year or two.

He spoke at the 2008 International Conference on Climate Change sponsored by the Heartland Institute.

Later, in an interview for cable television, Izrael stressed the importance for industry and for the life of both nations, of cooperation between the United States and Russia in the construction of a Bering Strait tunnel joining Alaska with Chukotka. He pointed out that this project had first been proposed 100 years ago.

—Laurence Hecht

Rockefeller's Judith Rodin Urges AAAS to Dark Age

How easily a population, including scientists, can fall into step behind fascist policies, was proven at the February meeting of the American Association for the Advancement of Science in Boston. There, Judith Rodin, president of the Rockefeller Foundation, gave a Feb. 15 plenary address in true sophist fashion about "smart globalization."

"The poor" (eugenics-speak for "those we want to kill"), Rodin said, will suffer the most if we *don't* deal with climate change, since they rely on nature so much!

"There are currently 50 million climate refugees," Judith pleaded, full of emotion, hoping no one had the brains, or guts, to challenge her, reported two LaRouche Youth Movement members, attending the conference as press for *21st Century*.

In reporting on the meeting, LYM member Meghan Rouillard described Rodin's role in "Building America's Future," a coalition led by New York Mayor Michael Bloomberg and California Governor Arnold Schwarzenegger. Rodin appeared with these two "soul mates" at a California press conference earlier this year, putting the Rockefeller's money behind the project to loot public infrastructure for the benefit of the private sector.

Sadly, Rouillard reported, most of the thousands of scientists attending fawned over Rodin's address to the conference, after a day of seminars mostly pushing the Global Warming hoax.

Rockefeller's Rodin: Let them eat tourism? Tourism was her idea of "development" for Africa.

Rouillard and Alexandra Perebikovsky approached Rodin after her speech. Perebikovsky asked Rodin to clarify the following paradoxical point: "LaRouche PAC wants to know why the Rockefeller Foundation doesn't call for a debt moratorium and the development of nuclear power for these poor countries if it's concerned about the situation there?… Your plan, as stated, won't work."

Rodin became visibly disturbed, claiming that the Foundation is prevented by stringent laws from "lobbying," so they can't take a position on these things. The LYM challenged her again on why nothing less than nuclear technology will develop our human economy, at which point she hastily left the discussion.

The oligarchy's world outlook was elaborated the next evening in a sophistical presentation on "One Laptop per Child," another thinly disguised prescription for mass-death, in a world where children die of famine and disease.

Rouillard and Perebikovsky conclude: "It would be wise for the AAAS to disassociate itself from Rodin and company. No scientist with any shred of humanity would want to be labeled as a collaborator in their plot to reduce the world population to less than 1 billion persons."

Atmospheric CO_2: 'It's the Oceans, Stupid'

A retired civil engineer and former dean of engineering at Monash University in Australia has dramatically demonstrated the close dependence of atmospheric carbon dioxide levels on sea surface temperatures.

Prof. Lance Endersbee's curve of the relationship of the measured level of CO_2 over the past 21 years to the global ocean surface temperature pretty well blows away the claim, which has been at the center of the genocidal drive to curb industrial development, that human economic activity is responsible for a significant increase in atmospheric carbon dioxide.

Competent climatologists who are not on the payroll of the British-run global warming propaganda machine, already know that the Sun, not carbon dioxide, is the driver of climate change. What Endersbee's dramatic graph demonstrates is that the small addition of carbon dioxide contributed by man's economic acitivity (less than 3 percent per year of the atmospheric content of the gas) is dwarfed by the changes in atmospheric carbon dioxide due to absorption and outgassing by the oceans.

More than two thirds of the Earth's surface is covered by oceans, which serve as the world's largest storehouse for carbon dioxide gas. The cooler the seawater, the more carbon dioxide gas it can absorb, but when the water warms, the absorbed gas is driven back into the atmosphere. Seawater at 59 degrees F and atmospheric pressure can absorb a volume of CO_2 equal to its own volume. At a temperature of 50 degrees F, the sea water can absorb 19 percent more, while at 68 degrees F it absorbs 12 percent less than its own volume. In other words, most of the change in atmospheric CO_2 level results from changes in the temperature of the ocean.

Comparing satellite temperature data over the past 21 years to the measured level of CO_2 at the state-of-the-art laboratory at Mauna Loa, Endersbee shows an almost perfect correlation of atmospheric

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VIEWPOINT

Malaysia's Role In Defying the Coming Ice Age

by Mohd Peter Davis

Scientists in Malaysia live in one of the warmest climates on Earth, where the maximum daily temperature is usually 32°C (89.6°F) and rarely drops below 28°C. We are therefore well qualified to report on the beneficial effects of global warming and add our voice of reason to the growing list of scientists who are publicly distancing themselves from the global warming hysteria. This scientifically fraudulent campaign, bureaucratically conducted by the United Nations Intergovernmental Panel on Climate Change, is discrediting the United Nations, misusing the names of scientists, and withholding the latest scientific evidence that global warming is a perfectly natural cyclical phenomenon that has been occurring on planet Earth for billions of years.

The time has come to put a stop to the IPPC's dangerous nonsense. Global warming does not threaten life on Earth. Quite the contrary: 1,000 years ago the Earth was 2°C warmer and Arctic Greenland was indeed green.

The global warming fearmongers, led by the scientifically ignorant Al Gore, would be well advised to pay a biology visit to Malaysia where plentiful solar radiation, constantly warm climate ranging between 25 to 34°C, high rainfall, humidity between 50 and 95 percent, and abundant carbon dioxide (regarded by generations of scientists over the last 300 years as the "gas of life") all combine with the chlorophyll in plants and trees to produce *10 to 20 times more biomass per hectare per year* compared to cooler, dryer climates.

This celebration of life has a long history totally ignored by the green environmentalist groups and the British-based government agencies. Mankind has nothing to fear from global warming. Instead, we need to prepare for the next fast approaching Ice Age. See the accompanying map of what the Earth looked like 21,000 years ago, as mankind was struggling to survive an Ice Age where nearly all the landmass was extreme desert or covered in hundreds of meters of ice.

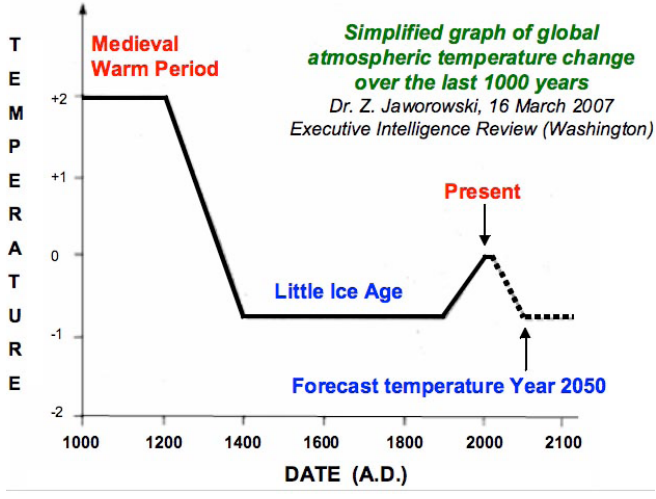
For the past 100 million years, the Malaysian rainforests, supporting perhaps half of the Earth's estimated 20-50 million species, have survived every natural disaster (such as meteorites and Earthquakes) and every climate change. These include frequent Ice Ages, which for the past 2 million years have each lasted around 100,000 years. During Ice Ages, there is a mass extermination of living matter. Life on most of the Earth's landmass becomes buried under hundreds of meters of ice or perishes in the extreme deserts caused by the great reduction in oceanic evaporation and rainfall in the colder climate.

Earth's 'Noah's Ark'

But small pockets of equatorial rainforests survive and serve as the Earth's "Noah's Ark," preserving the huge diversity of plants, insects, animals, and microorganisms. As the Earth again warms up, in much shorter global warming periods generally lasting around 10,000 years, the species crowded into the equatorial rainforest then re-colonize the barren Eurasian landmass in a glorious springtime for Earth.

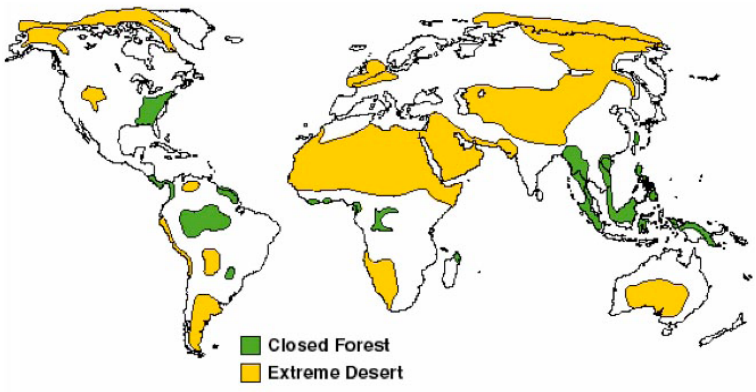
Mankind, perhaps only a few million strong coming out of the last Ice Age, took full advantage of this global warming and developed new technologies such as agriculture and inland cities with flowering Egyptian, and then Greek culture, allowing the human population to expand to 300 million by the time of Jesus.

The rediscovery of Greek and Egyptian science in the 15th Century European Renaissance, with its development



THE EARTH WAS 2° WARMER 1,000 YEARS AGO

This is a simplified version of a graph of global atmospheric temperature change over the last 1,000 years, which was compiled by Dr. Zbigniew Jaworowski, in "CO_2: The Greatest Scientific Scandal of Our Time," 21st Century, Spring-Summer 2007, p. 26. www.21stcenturysciencetech.com/Articles%202007/20_1-2_CO2_Scandal.pdf.



LAST GLACIAL MAXIMUM (21,000 YEARS AGO)

We need to prepare now for the next Ice Age, when nearly all the landmass will be desert or covered in ice.

of the scientific principles governing the universe, opened the way for industrialization, modern health and sanitation, and advanced agriculture which supported a great leap in human population to the 6.5 billion we have today.

After a beautiful 10,000-year historical period of global warming the Earth is again entering a perfectly natural and unstoppable Ice Age with a mini-Ice Age expected by 2050, followed by spreading glaciations expected next century.

The "global warming" fear campaigners, demanding carbon dioxide reduction and a return to the non-industrial Middle Ages, have got it so completely and idiotically wrong that we are entitled to suspect their motives. The whole global warming campaign only makes sense as new twist to an old lie that the Earth is overpopulated. We are back to glory days of the British Empire, where proponents of Malthusian genocide and Hitler's eugenics drooled over the prospect of reducing the world population to a more manageable 1 or 2 billion. But they have chosen a campaign that is inherently stupid.

Climate warming, if it were true, would be a cause for happiness not fear since it creates the conditions for life on Earth to flourish. Alas, we are entering another Ice Age and must summon all our scientific and technological creativity to sustain 6.5 billion and hopefully billions more human beings on Earth. We should be doing all be can to lessen the impact of the approaching Ice Age on the Earth's human population and all other species in the Biosphere.

The Earth's greenhouse gases comprise only 2 percent carbon dioxide, of which no more than 0.2 percent is caused by man's industrial activities, whilst the remaining 98 percent greenhouse gas is water vapor, hardly an environmental poison. Scientists are looking for better artificial greenhouse gases to be released into the stratosphere to keep the Earth warmer during the next unstoppable Ice Age.

Above all, the world population needs orders of magnitude more energy to withstand an Ice Age. This means an urgent return to nuclear fission power plants (6,000 are required by 2050), and accelerating the development of fusion power from universally abundant hydrogen isotopes to replace uranium as it runs out over the next few hundred years.

With nuclear power comes an abundant quantity of desalinated water to artificially green the deserts. This is a welcome return to the Atoms for Peace program launched by President Eisenhower in 1953 but closed down by the anti-nuclear anti-technology green environmental movements over the past 40 years.

Greening the World

Now Malaysia with its biologically perfect year-round warm climate can gear up to become the nursery of the world by mass producing not million but billions of sapling trees for replanting in the arid cities and deserts of the world. Our calculations show that Malaysia has the capacity to produce sufficient trees to green all of the world's deserts within 100 years. A stunningly simple new tree cloning invention by a Malaysian scientist allows 1,000 trees to be cloned from a single juvenile tree in one year. These which can then be grown superfast in polybags out in the open with minimal attention, because of Malaysia's natural greenhouse climate. This invention, which bypasses propagation by hard-to-collect seeds, is the missing link for efficient and economical mass production of trees with optimum genetics.

Live tree production for export is 20 times more profitable per acre compared to palm oil, Malaysia's post-independence golden crop, which freed the population from subsistence farming and opened the way for urbanization and industrialization. Supplying the trees to green the deserts promises to be the next wave of agriculture for Malaysia, greatly eclipsing the 19th Century British-style rubber and oil palm plantations based on cheap labor (and tying up 12 million acres of prime Malaysian land.) This can propel Malaysia into a wealthy modern nation based on 21st Century science and technology.

What a remarkable sight it will be from outer space: A green Earth so far from its Sun, defying an Ice Age and teeming with human beings engaged in scientifically reconstructing the biosphere to support more life. The optimistic, humanity-loving Vernadsky (1865-1945), pioneer scientist of the Biosphere and the Human Noösphere, would rejoice.

Mohd Peter Davis is Visiting Scientist at University Putra Malaysia in Kuala Lumpur.

On the States of Physical Space

by Vladimir Ivanovich Vernadsky

DOE photo

"In every crystal, we have the manifestation of a particular state of space." These 700-pound fast-growth crystals are produced at Lawrence Livermore National Laboratory for use in the National Ignition Facility laser. Sliced into plates, they convert the infrared laser light beams to ultraviolet, just before the beams strike the laser fusion target.

Fragment I

1. We are currently living through a period in which scientific thought is preeminent in the life of mankind. Presently, in connection with his scientific work, the naturalist quite inevitably turns to a more profound, logical analysis of the very foundations of his knowledge, which it was no trouble for him to leave aside during the last century. The conditions in which he is working in the 20th Century forcibly compel him to do this; it is demanded by his concrete, daily scientific work, and by his methodology of experimentation or observation.

The following circumstances, which are independent of the naturalist's will, require it.

First and foremost among these is a phenomenon, absolutely exceptional in the history of science, which is currently being experienced in the natural sciences—in the broad sense—and is leading to their radical reconstruc-

In this first English translation of a 1938 article draft, Vernadsky proposes that living matter exists as droplets of a Riemannian space, dispersed within the Euclidean space of the inert matter of the biosphere.

tion, opening up for scientific thought completely new pathways of investigation and progress, which science previously lacked.

At present, *scientists,* under the influence of exceptionally important *newly* revealed *facts,* are creating new notions, which go far beyond the limits of all previously existing ideas, beyond the limits of the boldest and most fantastical ideas and constructs of philosophical thought. For the first time in the written history of humanity, science, using new, unprecedented methods, is not merely constructing specific generalizations, founded on and originating from facts. In addition, it is constructing new conceptions of the world, which go far beyond the specific facts, but do not contradict them in the way the facts are contradicted by the scientific and philosophical notions that reigned, unchallenged, during the 19th Century. Those notions were developed by human culture over many centuries, and came into scientific thought as if ready-made. They were honed by the labor of philosophical thought over many centuries. At the present time they are being revised in the course of current scientific work, and are undergoing changes that radically transform our understanding of them. Among such concepts are *time, space, energy, life, geometry,* etc.

In all of this motion that is occurring, *the active source of the change* in basic concepts is not philosophy or religion, but science. Scientific work has barely touched on these concepts before now. It made its way within them, not colliding with them, yet introducing its generalizations into them.

2. This condition of scientific thought has coincided with the absence, in 20th Century philosophy, of any creativity, comparable to what is emerging so clearly in science. Scientific thought is currently influencing philosophy, while the previous belief, that philosophy can fathom reality more deeply than science can, is disappearing.

Philosophy is now living in the past, and it is less and less necessary to take it into account, in the ongoing reconstruction of the fundamental scientific understanding of reality. Science is being deprived of the support, which the philosophical analysis of fundamental scientific concepts provided for it during the past three centuries.

Philosophical thought is now working a great deal on the analysis and criticism of the fundamental propositions of mathematics, including those of mechanics and geometry, and, in the most recent time, also those of theoretical physics pertaining to the atomic nucleus.[1]

The entire, enormous domain of the biological and geological sciences, which is undergoing radical restructuring, remains essentially untouched by philosophical thought, which has offered no independent analysis of the newly revealed phenomena. In certain instances, even within new currents like the realistic philosophies of holism and organicism (Whitehead), for example, philosophical thought is essentially standing on 17th Century ground, failing to realize the impossibility of pouring new phenomena into "old wineskins." Unfortunately, dialectical materialism has also closed its eyes to those new developments, which do not fit the framework of the philosophical conceptions of the 1840s through 1880s, where it lives. With the passage of time, it seems to me, this discrepancy will increase, and dialectical materialism's ability to grasp what is observed, or what is scientifically created, will diminish. New, vital, and creative work is needed, smashing the very foundations of philo-

1. The text included in *Filosofskie knigi naturalista* (The Philosophical Books of a Naturalist), Moscow: Nauka, 1988, inserts here two sentences, typed by Vernadsky on a separate piece of paper, without any indication of where they should go: "But I can omit consideration of this area of physics, which encompasses our most profound notions about the universe, just as it is practically ignored by current scientific work in physics and chemistry, and not only in descriptive natural science. It is at a crossroads, and is changing almost daily."

EDITOR'S NOTE

This article is a sequel to V.I. Vernadsky's 1938 work, "Problems of Biogeochemistry II: On the Fundamental Material-Energetic Distinction Between Living and Non-living Natural Bodies of the Biosphere," which was published in the Winter 2000-2001 issue of *21st Century Science & Technology*. In that work, Vernadsky developed the distinction among the three domains of non-living, living, and noetic, the latter referring to the human mind which, he noted, was capable by its innate power of creativity of becoming a geological force.

In his foreword to that 1938 work, Vernadsky promised "a third issue now in preparation for publication," which "poses the still more general question of the 'states of physical space.'" This promised "third issue" was never completed for publication. However, the article presented here is a translation of two fragments from 1938, both bearing the given title.

It was translated from Russian by Peter Martinson and Sky Shields of the LaRouche Youth Movement, and Rachel Douglas, William C. Jones, and Laurence Hecht. It was dedicated to Lyndon LaRouche on his 85th birthday, Sept. 8, 2007.

The text which we have used as a source is from the work *Filosofskie knigi naturalista* (The Philosophical Books of a Naturalist), Moscow: Nauka, 1988. That text, as reported by the Russian editors on p. 442, is based on the copy held in the USSR Academy of Sciences Archive, f. 518, op. 1, item 152. The Russian editors add:

"The work exists as two fragments with the same title, the first of which is evidently an initial draft. This version was later set aside by the author, which explains its brevity [*sic*; in fact, it is longer] and obvious unfinished character. The second fragment is rather fuller and, together with the notes V.I. Vernadsky made at the Uzkoye Sanatorium in the Summer of 1938, treats the problem fairly comprehensively."

The reference to 1938 writings from Uzkoye Sanatorium refers to the essay published in our Winter 2000-2001 issue.

sophical thought, as is now taking place in creative scientific work. Bold and free searching is required. There must be a shift from interpretation of the old, and adaptation of the old to the new, towards a critical examination of fundamental propositions.

3. Among the new general concepts, prompted by the facts of descriptive natural science, it seems to me that two, in particular, ought to be given attention at this time: [first of all,] the state of space, and, secondly, right-handedness and left-handedness. They are closely connected, and the fundamental one is the state of space.

The first person to touch upon this, in a profound synthetic way, but without giving it an in-depth analytic treatment, was L. Pasteur, not long before his death, in the 1880s. Pierre Curie attempted to approach it later and more deeply, but never yet, as far as I know, has this concept become the object of the systematic thought of both the naturalist and the philosopher.

Space that can be investigated empirically is distinct from the space of geometry. That is a consequence of the inadequate depth of geometrical analysis.

Geometrical space is isotropic; for example, it lacks any manifestation of right-handedness and left-handedness.

This does not flow from how things essentially are, but is a consequence of the insufficiently deep analysis of reality by geometrical thought.

When speaking about space, the naturalist can make only partial use of the achievements of geometry; more and more, he goes beyond its limits in his judgments. This must be borne in mind. Geometric space does not now embrace all of empirically studied space—what Helmholtz called physical space.

In discussing the state of space, I will be dealing with the state of empirical or physical space, which has only in part been assimilated by geometry. Grasping it geometrically is a task for the future.

The state of space is closely connected with the concept of a physical field, which plays such an important role in contemporary theoretical physics. The concept of a physical field is distinguished from the concept of a state of space essentially by its being clearly manifested in three dimensions; that is, it coincides with geometric space. It is also the case, however, that a physical field is not a field in the ordinary sense, since it often has curvature and, in a great number of phenomena, physical fields in which lines of force are distributed—electrical, magnetic, heat, gravitational, and electromagnetic fields—clearly are a part of geometric space that is delimited in an acutely different way. We see dramatic manifestations of such fields on a large scale, in the structure of our planet. Among these are the Earth's electrical and magnetic fields, and the vacuum of the ionosphere, which are delimited by two spherical surfaces of different diameters; another is the magnetic field of the Sun, which encompasses the entire orbit of the Earth, its atmosphere, and the Earth itself.

In all of these cases, we are dealing with states of space, whose properties are manifested not materially, but energetically. In the cases encompassed by the thoughts of Pasteur and Curie, however, we are dealing with a state of space, which is manifested primarily *in matter.*

In essence, we have been dealing with such cases at every step in natural science for a long time, even before Pasteur and Curie. Pasteur began to speak in terms of states of space. Helmholtz distinguished physical space from geometric, as possessing its own properties, such as right-handedness and left-handedness. As far as I know, this idea was not further developed.

4. Crystallographers have been encountering this phenomenon for a long time. In every crystal, in every inert natural body, we have the manifestation of a particular state of space. Inside a crystal we have a three-dimensional physical field, the properties and state of which are determined by the phenomena of crystallization. This is a homogeneous space, filled continuously by pent-up crystalline forces (the chemical forces of matter in the solid state), or atom points, which fill it completely and regularly. The distribution of these forces can very well be grasped as a particular case of the lines of force in a physical field. In essence, in homogeneous crystalline matter—in systems of points or parallelepipeds, continuously, uniformly embracing an entire three-dimensional space without violating its homogeneity—we have the case of a special, *anisotropic state of space,* sharply

Yevgraf Fyodorov (1853-1919)

Arthur Schoenflies (1853-1928)

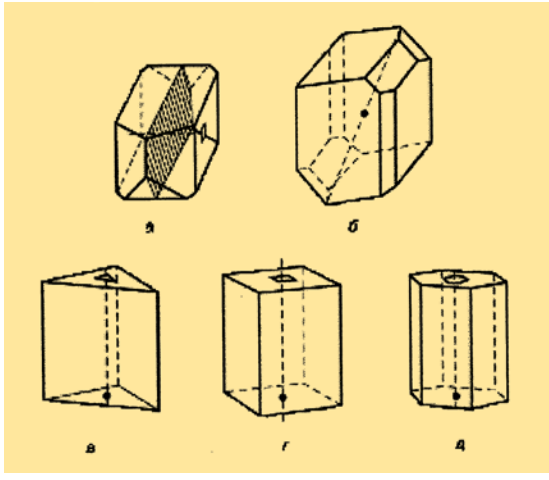
Fyodorov and Schoenflies encompassed "all uniquely possible forms of an anisotropic geometric state of space, manifested in matter," in their studies of crystallography.

distinct from the usual isotropic state of geometric space. Innumerable instances of different such states of space, which are dispersedly[2] expressed in matter, are known and conceivable in geometry.

The geometry of these special states of space is entirely determined by the laws of three-dimensional Euclidean geometry. What is more, it can be said that in these spatial point systems, in their bounded polyhedra—crystals—the laws of geometry emerge for us with the greatest clarity. A. Poincaré expressed this thought very clearly, when he observed that geometry could not have been developed without solids. In crystallographic phenomena, we are located entirely within the bounds of three-dimensional Euclidean geometry. In precisely the same way, we do not go outside of its bounds in physical fields such as magnetic, electromagnetic, and electrical fields.

In reality, in the profound constructions of Fyodorov and Schoenflies, we have a geometric expression of the structures of space, in which the atomic manifestation of the organization of matter can uniquely exist. This is the only geometrically possible expression of the atomic structure of matter, which it expresses clearly, definitively, and precisely. In this solid structure, in its primary manifestation, there is no motion of atoms, such as characterizes the gaseous and liquid states of matter. Taking the general form of this phenomenon, and taking into account that any chemical compound can be manifested in the solid state in our space, we should see, in these great, geometrically expressed generalizations of Fyodorov and Schoenflies, a total encompassment of all uniquely possible forms of an anisotropic geometric state of space, manifested in matter.

"Within the boundaries of the biosphere, which I deal with, in its inert matter, nowhere do we have to go beyond the boundaries of Euclidean geometry."



Some examples of crystalline symmetry.

Eric Hunt

A sulfur crystal from Argent, Sicily.

5. But, in elucidating the more complex processes of the inert natural bodies of the biosphere, it is entirely possible (and fruitful) to use multidimensional space to express the regular patterns that are observed when drawing correlations between matter and its chemical composition (as demonstrated in the works of N.S. Kurnakov and his school, chiefly N.I. Stepanov, et al.). But, even here we do not go outside of Euclidean geometry.

All of these are phenomena, associated with the biosphere or the terrestrial crust.

It appears that Euclidean space may turn out to be insufficient for the geometric expression of phenomena, associated with cosmic space. At the very least, it was necessary to look at those phenomena, when analyzing Einstein's theoretical premises. (Eddington, for example, turned to them—to a certain form of Riemannian space.) But, within the boundaries of the biosphere, which I deal with, in its inert matter, nowhere do we have to go beyond the boundaries of Euclidean geometry.

6. Before continuing, it is necessary to distinguish in what follows, whether we will be dealing in space *with material processes, or with energetic ones*. From the standpoint of the geometric properties of space, it is clearly inevitable that they are manifested differently in space.

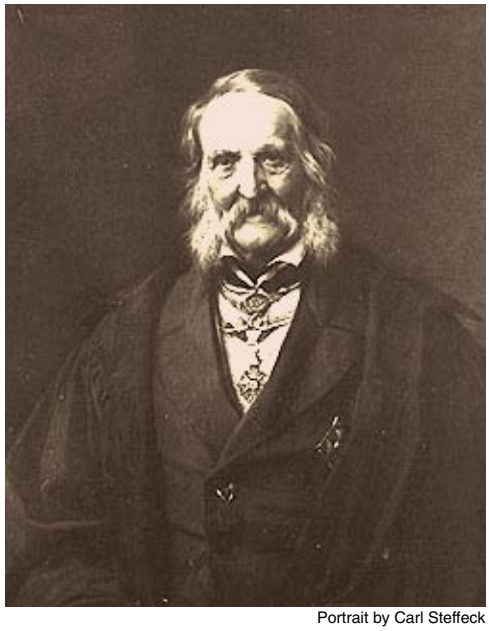
Geometry is not a manifestation of *a priori* human reason. But, it clearly—beyond any doubt, it seems to me—follows from a study of the history of geometry, that it grew out of the investi-

2. Vernadsky uses the terms *"dispersny"* and *"dispersno"* throughout this essay in a sense that is analogous to the chemist's "disperse phase," where particles (as colloidal particles) or droplets of one substance are distributed through another substance, a condition that is also called the "discontinuous phase." We have opted to write "dispersed," rather than possible alternatives such as "quantized" or "discrete," which have their own special connotations.

gation, by scientific thought, of manifestations of solid matter in the biosphere surrounding man. The extension of the laws of the biosphere to energetic phenomena came as a consequence. Such an extension cannot shake this fundamental feature of geometry.

Therefore we ought to view the geometric reflection of the solid state of matter, shown by Schoenflies and Fyodorov in the most profound and general form, as the most profound expression of real three-dimensional Euclidean geometry.

Scientific experimentation and observation have shown that all energetic manifestations of the solid state of matter in space fail to reveal the geometric properties of space as deeply as the atomic structure of matter does. This is a statement, in the language of modern science, of the so-called Neumann principle, named for the noted Königsberg crystallographer, physicist, and mathematician [Franz Ernst Neumann].



Portrait by Carl Steffeck

Franz Ernst Neumann (1798-1895), German crystallographer, physicist, and mathematician, developed the principle that "neither the liquid nor the gaseous state of matter is sensitive enough for detecting the structure of space in its geometric, rather than its dynamic manifestation."

According to this principle, neither the liquid nor the gaseous state of matter is sensitive enough for detecting the structure of space in its geometric, rather than its dynamic manifestation.[3] Not even the weightless fluids, to which the great physicists and philosophers of the 17th Century reduced energetic phenomena—in some cases quite conveniently, from a scientific standpoint—are sufficiently sensitive.

As we are constantly saying, liquids and gases assume the forms of the vessels which contain them, remaining inert with respect to the space of the body. This is another expression of the primacy of solid material bodies for ascertaining the geometry of an environment.

In talking about space in general, we need to broaden Neumann's crystallographic principle. Geometrically, only the study of material phenomena—metamorphic or crystalline—can give us a concept of the structure of space. Energetic phenomena or phenomena occurring in liquids or gases penetrate the geometry of space less deeply, and cannot be used to shed light on this geometry.

Pasteur did not recognize this, when he supposed that it were possible to create a space, characteristic of a living body, by means of circular radiation or electric light. Pasteur proposed to conduct an experiment on abiogenesis in a medium, illuminated by radiation from circular or elliptically polarized light. This experiment was done later, after Pasteur. It reveals the action of these rays upon living phenomena, but, in accordance with Neumann's principle, it in no way alters the structure of space.

The exposition that follows will be based on this geometric nature of material and energetic phenomena in geometric space. *Material phenomena provide a more profound concept of the geometric structure of space than energetic ones do.*

7. Now, we turn our attention to phenomena of right-handedness and left-handedness, as they relate to the laws of symmetry.

We saw that, in three-dimensional Euclidean geometric space, right- and left-handedness are geometrically and physically equivalent in material processes. This equivalence shows itself in the fact that the numbers of crystallographically right- and left-handed polyhedra that are formed during crystallization are identical (in the absence of living organisms in the medium). This number corresponds to the laws of the theory of probability. When there are a sufficient number of cases, the ratio between the quantities of right- and left-handed polyhedra will be equal to unity. The greater the number of cases, the more closely it will approach unity.

The observations done on quartzes by Lemmleyn in our Biogeochemical Laboratory, and an even greater number of cases by Trommsdorf in Göttingen, completely corroborate this.

Pasteur's great discovery showed that this never occurs during crystallization phenomena in living organisms, nor, even more profoundly, during the biochemical formation of right- and left-handed molecules in living organisms.

I fully recognize Pasteur's idea of a connection between this phenomenon and the geometrical space of living organisms, as an ingenious intuition. But, failing to distinguish between the material and the energetic properties of space, Pasteur erroneously supposed that life originated on our planet in some past period of geological history, when the Solar System passed through left cosmic space. He furthermore supposed that, in cosmic space, right- and left-handed spaces are separate. As we see, for three-dimensional Euclidean space, and for Euclidean space in general, this cannot be the case with respect to matter. Energetic manifestations in space do not give us the possibility to judge. The division into right and left, corresponding to life, i.e., the inequalities of right-handedness and left-handedness,

3. The text in *Filosofskie knigi naturalista, op. cit.*, here reads *"v vyiavlenii"* (its detection), but the sense and context require *"v proiavlenii'"* (its manifestation).

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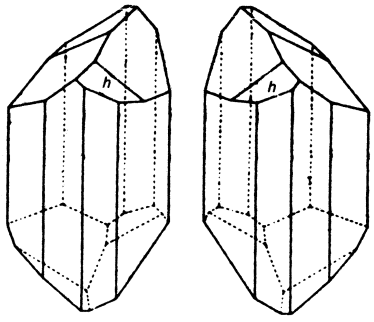
"It can be clearly seen that between the symmetry of crystalline polyhedra and the symmetry of living organisms, there exists a fundamental, deep distinction."



Louis Pasteur (1822-1895) discovered left- and right-handed isomers of tartaric acid crystals. (These are his sketches at left.) He found that only the left-handed form is produced in biological processes, such as fermentation, while in laboratory synthesis of the compound, equal quantities of left- and right-handed forms occur.

have to be established not in the energetic, but in the material properties of space.

8. Geometric laws of symmetry were constructed for Euclidean geometry and were expressed with regard to space in a definitive form at the end of the last century by Ye. S. Fyodorov in St. Petersburg and A. Schoenflies in Göttingen. They had many predecessors, such as Frankenhelm, Bravais, and Sohnke, but they were the first to solve the problem definitively: Schoenflies with the aid of group theory, and Fyodorov geometrically, by the continuous displacement of space uniformly, without empty gaps, by parallelohedra. The crystalline polyhedron was discarded, and replaced geometrically by a system of points at the vertices of parallelohedra situated in a lawful way, but not uniformly, within the unbounded space of three-dimensional Euclidean geometry.

Soon thereafter, Paul von Groth in Munich was the first to point out that it flows logically from the work of Fyodorov, that crystals are characterized in their internal structure not by molecules, as crystallographers had thought, but by atoms. Earlier, this had been clearly understood by Gaudin in the first half of the 19th Century. The discovery of X-ray crystallography in 1911, by M. von Laue, Knipping, and Friedrich in Munich, working with Groth, proved it definitively.

From this we must conclude that in physical space, the atomic state of solid matter inevitably requires, firstly, the inseparability of right-handedness and left-handedness and, secondly, their physical and, consequently, chemical equivalence. The existence of atoms in physical space is, for us, an incontestable fact, upon which our entire scientific conception of reality is constructed. In a solid medium there can be no distinction between right-handedness and left-handedness; moreover, the differences associated with vectors in the direction of the Sun's motion across the sky, and against the Sun, are identical in every other respect. This is *an inevitable logical consequence of the atomic structure of matter* and of three-dimensional Euclidean geometry.

9. This conclusion requires additional consideration. It is again useful to consider the fact that we are dealing here not merely with the properties of crystals, but with the distribution of atoms in spatial lattices. From this it follows geometrically that certain elements of symmetry cannot be manifested in atomic processes. The first crystallographers already pointed out that of the five regular Pythagorean polyhedra, the regular dodecahedron is not encountered among crystals, and a century ago Bravais proved that, accordingly, the axis of five-fold symmetry, which characterizes the dodecahedron, could not occur, because if it were allowed, then the law of rational indices, which has been empirically established for crystals, would have to be recognized as incorrect. This is expressed clearly in the fact that a body composed of atoms, which possesses such an axis of five-fold symmetry, does not allow the possibility of any arbitrary finite distance between two atom points. They will always approach each other to a distance less than the given distance. Physically, we would have to be dealing here with a continuous, non-dispersed state of solid matter. At the same time, we can easily obtain or make a regular dodecahedron out of any solid material. But what's more, from this same fundamental proposition, from the

structure of solid matter, from the homogeneous spatial distribution of atoms having fixed finite dimensions (or possessing forces which do not permit the penetration into their region of the influence of the radius, strictly defined, of another atom)—from all this it follows, on the same basis, that the number of elements of symmetry manifested in crystalline solids is strictly limited. No axes of symmetry greater than six are possible in them, and none is observed. Of the innumerable multitude of the regular polyhedra of geometry, relatively few are encountered in natural bodies, and those consist of homogeneously and regularly distributed atoms in three-dimensional Euclidean space.

10. This is not only a manifestation of the atomic structure of matter, but is also a manifestation of the three-dimensional Euclidean space in which the bodies are located.

From this standpoint, it becomes profoundly significant that such a distribution of atoms is always possible in this space, but then two physically identical varieties of helical spiral distributions of atoms are inevitably formed—right and left. These helical spiral distributions of atoms inevitably should be manifested in crystalline structures, in the absence of elements of complex symmetry, such as a center of symmetry, planes of symmetry, or an axis of four-fold complex symmetry. In ordinary crystallization, the quantity of such differently oriented helical spiral atoms will always be identical, and will be randomly determined.

The violation of this principle in living natural bodies, discovered by Pasteur, poses the question of what the cause of this phenomenon might be.

It cannot, of course, contradict the atomic structure of matter, which is so sharply and definitely manifested in living natural bodies, where, perhaps, atomic properties are manifested even more profoundly than in inert natural bodies.

The cause may lie either in special manifestations of symmetry in living organisms, or in special properties of the space, occupied by bodies of living matter.

These are the theoretically possible premises, which are really associated with the concept of living matter as the totality of living organisms. Thus, I avoid the slippery terrain of the properties of "life." In reality, in the biosphere, this is precisely how we study the phenomena and manifestations of life—only as "living matter."

11. Before going further, it is necessary to pause and consider the phenomena of symmetry as related to the living organism. The very concept of symmetry took shape in the course of studying living organisms. Several centuries B.C., according to tradition, Pythagoras of Rhegium created the concept and the word "symmetry" to express the beauty of the human body, and beauty in general. Here the ancient Greeks had already found lawful numerical patterns, which thereafter, and to this day, have not yielded to the grasp of a generalization in mathematical thought.

When, in the first half of the 19th Century, Bravais approached the concept of symmetry, he proceeded simultaneously from the symmetry of crystals and the symmetry of living organisms. He achieved brilliant results for crystals, thus beginning the discipline of crystalline symmetry, which led, at the end of the century, to a well-formed system of spatial atom points and to the complete description of their geometry.

Illness cut short his work on the symmetry of living organisms. Nobody afterwards investigated it as deeply as Bravais had done, and it has remained in a state of chaos to the present time.

It can be clearly seen, however, that between the symmetry of crystalline polyhedra and the symmetry of living organisms, there exists a fundamental, deep distinction. In the first case, we are dealing with the expression of the atomic structure of solid matter, while the second involves a striving towards organization on the part of living matter, which exists in an isolated and separate way within the alien, inert environment of the biosphere.

Symmetry here is expressed in the external form of that eternally mobile, dispersed element of living matter—a large or a negligibly small living organism—which is created and maintained by the biogenic migration of atoms, and is revealed as a body that is sharply distinct from the nature surrounding it. Symmetry is expressed also in its internal structure, its organization, and its macroscopic and microscopic cross-sections.

12. The laws of this symmetry are completely unknown to us. But, its existence, the existence of morphological regularity, is beyond any doubt. It is clear that this symmetry obeys entirely different laws than those that crystalline symmetry obeys.

Geometrically, two phenomena are immediately striking. First of all, living organisms exhibit five-fold or higher than six-fold axes of symmetry. This indicates that we are not dealing here with the symmetry, or the atomic structure, of a homogeneous solid. The homogeneity of internal structure, which is so characteristic of crystals, is absent here. The inside of a living organism is distinctly heterogeneous, its atoms being in continuous motion, never returning to the same points where they were, unlike crystals, where the atoms do not shift for billions of years, unless external forces cause that to happen. [Secondly,] inside a living organism, we are dealing with an ongoing sequence of dynamic, stable equilibria, regulated by the biogenic migration of atoms. In the symmetry of a living organism, we thus have to consider a new element, motion, which is absent in crystalline symmetry, because the atoms in crystals do not shift, and thus they ideally manifest a solid. It is characteristic, that the biogenic migration of the atoms that create a living organism's form of dynamic equilibrium occurs in a liquid or gaseous medium—in that medium, which is the least pronounced in expressing the geometry of the space occupied by the body of living matter.

Finally, a third, extremely typical feature should be emphasized here, one which is absent in crystals, and is a primary element in the morphological form of a living organism. In the morphology of living organisms, *curved lines and curved surfaces* reign as the

Spirals in mollusk shells. Vernadsky notes the inequality of left and right spirals, and the inadequacy of explanations of the phenomenon.

primary manifestations of their symmetry. In crystalline polyhedra, essentially in the "droplets" corresponding to crystalline spatial lattices, curved surfaces and curved planes are secondary phenomena. They are connected with the action of surface forces during crystallization and in manifestations (of forces) within the space of liquids. Among these are the phenomena of dissolving, and the related dissolution surfaces of crystals. These curved surfaces are even more pronounced in all of the energetic properties of crystals, where the polyhedron disappears and is replaced by a sphere, a hyperboloid, an ellipsoid, etc. These are cases, where, in these phenomena, Neumann's principle states that the geometric structure of space is reflected the least.

13. In the symmetry of living organisms, right-handedness and left-handedness are extremely pronounced, while in crystals they are a special case, whose occurrence is associated with the absence of complex symmetry.

But there is a fundamental distinction, as I have already indicated, between the manifestation of right-handedness and left-handedness, with respect to symmetry, in organisms and its manifestation in crystals. This distinction consists in the physical-chemical equivalence of right-handedness and left-handedness in crystals, which is manifested in their occurrence in equal numbers during the crystallization of right and left forms. This always happens and, as I indicated in Section 8, may be viewed as a manifestation of the atomic structure of matter in the solid state in three-dimensional Euclidean space. *This is as much a property of symmetry, as it is a property of three-dimensional Euclidean space.*

We observe something else entirely, in living matter.

Here *the inequality of right-handedness and left-handedness* is acutely manifested. There is an enormous accumulation of material that has still not been worked through critically, but it seems to me that it can be firmly established on the basis of this material, that in organisms—in living matter—this inequality is extremely pronounced for a whole range of diverse properties. It is transmitted hereditarily and is a species marker. All proteins exhibit a left rotation of the plane of light, both in animals and in plants. This means that, in the complex matter of living bodies, only left isomers in protein bodies—the principle component of protoplasm—are stable. Right isomers are absent. As Pasteur demonstrated, all crystalline compounds—alkaloids, glucoses, sugars, etc., which make up eggs or grains, i.e., which are the most essential for life—are left-handed. This last assertion would require more detailed discussion, which I cannot go into in this short article. But, in general, it seems to me to be true, and sometimes difficulties may occur only because the complex organic compounds in bodies of living matter have right and left complexes simultaneously as their components. This situation requires verification, beginning with the critical processing of all the material.

No less pronounced is the chemical distinction of the action of right and left isomers upon cell protoplasm.

A series of precise experiments in this area, designed by G.F. Gause partly in connection with the work of our laboratory, has recently demonstrated this beyond the shadow of a doubt. Right and left chemical compounds act here in an identical setting and under identical conditions, in the complex thermodynamic environment of living matter, as bodies that are *chemically* acutely different. They point to a unique geometric structure, which is dynamically manifested differently for right and left [isomers] in a living organism, and in a

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Radiolaria are single-celled marine organisms with intricately detailed glass-like exoskeletons. These mixed radiolaria were microphotographed with darkfield illumination.

cell, in particular.

The inequality of right-handedness and left-handedness is expressed not only in their chemical and physical manifestations. It embraces the entire morphology of the organism and, moreover, its dynamics. Extraordinarily characteristic is the significance of spirals in the form of organisms, and the inequality of right and left *spirals*. This is expressed in the inequality of the right and left coils in shells, bacteria, seeds, plant tendrils, etc. It is seen in the rare occurrence of "left-handed" organisms although, for certain organisms, they predominate and can be taken as a species marker.

I am leaving completely aside the numerous and various explanations of this general phenomenon. They are formulated from case to case and, in general, it seems to me that they explain nothing.

Fragment II

1. The state of space is closely associated with the concept of a *physical field,* but is distinguished from the latter, in that it is clearly manifested in three dimensions. But a physical field, too, for example an electromagnetic field, actually has curvature, and phenomena within it do not occur on a plane. In the ionosphere, we have a very pronounced, peculiar state of the space of this terrestrial envelope, a special physical field—the field of a physical vacuum in the form of a three-dimensional space, bounded by spherical surfaces of different radii.

In reality, we encounter different *states of space* at every step. Thus, inside a crystal we have a three-dimensional physical field, whose properties are determined by the phenomena of crystallization. This is a homogeneous space, filled continuously by pent-up crystalline forces (the chemical forces of matter in the solid state), by atom points, which fill it completely and regularly. In essence, in homogeneous crystalline matter—in systems of points or parallelepipeds, continuously, uniformly embracing an entire three-dimensional space without violating its homogeneity—we have the case of a special, *anisotropic state of space,* sharply distinct from the usual isotropic state of geometric space. Hundreds of such different states of space, expressed in different ways in dispersed matter, can be distinguished geometrically. But the geometry of these special states of space is entirely determined by the laws of Euclidean geometry. Likewise, in magnetic, electrical, and electromagnetic fields we do not go outside the boundaries of Euclidean geometry, and remain in three-dimensional space.

But with more complex phenomena, it is convenient and possible to use geometrical representations of multidimensional spaces in Euclidean geometry.[4]

It can be stated that in all of these phenomena, we never go beyond the limits of the inert natural bodies of the biosphere. In this domain of phenomena, we are located entirely within Euclidean geometries. These Euclidean geometries are expressed in three-dimensional geometry in the anisotropic spaces of crystallography, while in expressions of the correlation of chemical properties and matter in the conceptions of Kurnakov, they are expressed in three-dimensional, four-dimensional, five-dimensional, and more complex geometries.

One might think, that nowhere within the limits of the inert natural bodies and phenomena of the biosphere do we currently go outside the domain of Euclidean geometry. We do not go beyond it, until we touch upon planetary phenomena.

Evidently, these conceptions are insufficient, when we go beyond the limits of our planetary world into cosmic space.

But these phenomena, which are associated with Einstein's ideas, lie outside of my purview, insofar as I am dealing with the inert and living natural bodies of the biosphere, which is one small envelope of our planet.

4. Author's note: This current of thought has been applied with great success for correlating chemical compounds in the work of N.S. Kurnakov, N.I. Stepanov, and the school of N.S. Kurnakov.

2. Yet, as soon as we approach living natural bodies, we encounter a fundamental change in the geometric phenomena, which, it seems to me, does not fit into the confines of Euclidean geometry of any number of dimensions.

Basic here is the marked violation of, firstly, *symmetry,* and, secondly, the manifestations of *right-handedness* and *left-handedness*.

Geometrically, the laws of symmetry were constructed for Euclidean geometry, and they were expressed not only geometrically, but also algebraically, in the theory of groups, and the same results were obtained by these two independent logical paths. Geometrically, they came out of the distribution of the points of space, where these points always had a certain parameter, a certain interval, closer than which they could never approach each other. In the phenomena around us, which can be reduced to points, i.e., to the atoms which comprise matter, nowhere do we encounter any violation of the laws of symmetry.

Auguste Bravais (1811-1863), a geometer and naturalist, studied the question of symmetry from the perspective of biology, but illness cut short his life and work. "It seems to me that nobody has gone beyond Bravais," Vernadsky writes.

These laws are violated within the boundaries of the space occupied by *living matter,* where by "living matter" I mean the totality of all living organisms. This violation is most vividly expressed by the acutely different manifestation, inside the bodies of living organisms, of right-handed and left-handed crystal lattices (having right-handed and left-handed internal atomic structure) for one and the same chemical compound, and these turn out to be chemically very different.

3. Unfortunately, these phenomena of symmetry and the phenomena of right-handedness and left-handedness—the former encompassing all of the basic geometric and physical patterns of solid matter, and the latter characterizing the bodies of living organisms—remained for a long time, and in part still do remain, outside the purview of mathematicians and philosophers.

One might say that there has been no philosophical analysis. But, mathematical analysis (both geometric and algebraic) of dispersed regular systems of atom points was done brilliantly, one might say definitively, in the work of Ye. S. Fyodorov in St. Petersburg and A. Schoenflies in Göttingen at the end of the 19th Century. In the course of this work, incidentally, it was determined that far from all of the geometrically conceivable polyhedra are encountered among the inert natural bodies of our planet. In particular, one of the five Pythagorean solids, the regular dodecahedron, is not and cannot be observed among the inert natural bodies of the Earth's crust. This is a consequence of the dispersed structure of solid chemical compounds: they are composed of atoms which can never approach one another to a distance less than a given magnitude, which is different for each isotope. Another geometric consequence of that same basic phenomenon is that in the geometric structures of matter—in crystals and molecules—five-fold, seven-fold, and higher-order axes of rotational symmetry cannot exist.

The phenomenon of symmetry, which has only partly been grasped by mathematical thought, came into science in connection with the sense of beauty that developed in humanity many thousands of years ago. This concept was a creation of Hellenic thought in the first millennium B.C. Tradition has preserved the name of Pythagoras of Rhegium, who first identified it. But in science, the concept of symmetry arose in the 17th Century and, in a more general form, in the 18th and 19th centuries. It had two roots. On the one side, it emerged from the observation of inert natural bodies of the biosphere—snowflakes and crystals—and, on the other side, chiefly with Bravais in the middle of the 19th Century, from observation of the forms of living organisms. Bravais, who approached the study of crystals from the standpoint of his primary scientific interest in biology, laid the basis for the geometric study of crystalline symmetry, and, at the same time, demonstrated the essentially different character of the symmetry of organisms, compared with crystals. But his work, the work of a profound geometer and naturalist, was interrupted in its prime by an incurable illness. The thread that he let go was not picked up by anyone. As far as geometry is concerned, the symmetry of living organisms is in a state of chaos. The assembled facts have not been embraced by geometric thought. It seems to me that nobody has gone beyond Bravais.

Amazingly, the concept of symmetry has remained outside the reach of philosophical thought, and it seems to me that its significance has been insufficiently deeply considered in science, despite its fundamental significance being clear to many, and despite the obvious possibility of further mathematical investigation.

4. Matters are even worse with the concept of right-handedness and left-handedness, whose enormous significance and very different manifestation in living and inert natural bodies were clearly brought out in the middle of the last century by Louis Pasteur. Essentially, no one has gone deeper than he did. Geometers

have ignored this concept. Crystallographers ascertained that it is expressed in the right-handed and left-handed helical spirals, in which the isotopes [sic] are distributed in crystalline structures. Pasteur was the first to prove that the same phenomenon must be observed in certain chemical compounds in molecules. From his observations, he drew the correct conclusion that there is a pronounced difference in how these phenomena are expressed in living and inert natural bodies. The laws of symmetry, derived on the basis of the study of crystals, are sharply violated in living natural bodies.

Pasteur, like Bechamps somewhat before him, understood the significance of right- and left-handedness, based on the observations made by technicians in Alsace, who had obtained left tartaric acid and its salts through the action of living mold on racemic acid and its salts. Most likely Pasteur was right (unfortunately, this has not yet been conclusively verified), that, contrary to the laws of symmetry, all of the main compounds necessary for life, when crystallized (compounds that are components of seeds, eggs, spores, and so forth), are observed only in the form of left isomers. Non-crystalline—colloidal or mesomorphic—proteins are always left-handed. To date, right-handed isomers of proteins and the main crystalline products of their decomposition have been obtained only in the laboratory. In the plant and animal worlds, only the left isomers are observed.

This is expressed in the special characteristic of living organisms, namely, feeding on, and converting into their bodies, right-handed isomers. Only left-handed isomers enter into the composition of a living body. This explanation is a simple statement of fact and, essentially, cannot be considered an explanation. It is just as incomprehensible to us as the fact itself.

5. Since the right-handedness and left-handedness of crystalline solids in three-dimensional Euclidean space are chemically identical, the question inevitably arises of whether or not the fact, grasped by Bechamps and Pasteur, and independently demonstrated earlier by Bechamps, is explained by assuming that living organisms have a special, poorly understood property, by which they violate the equivalence of right-handedness and left-handedness, and construct their bodies from left isomers of the basic molecules necessary for life. Isn't that a tautology? And would it not be more correct to turn, as Pasteur did, to the properties of the spaces, in which life takes place and in which it originated?

Certainly *right-handedness* and *left-handedness* in Euclidean space are a geometric property of that space. That is evident from the geometrical finding, shown long ago, that right-handedness and left-handedness are not manifested in the fourth dimension of Euclidean space. Kant already studied this phenomenon, and he emphasized that right and left hands coincide in four-dimensional Euclidean space. It is clear that right-handedness and left-handedness are characteristic of *Euclidean spaces of odd-numbered dimensionality.*

It is clear from the properties of symmetry mentioned earlier, that it is not only a physical-chemical property, since the equivalence of right-handedness and left-handedness in all of their manifestations, whether those be geometric or physical-chemical, is found for a homogeneous system of points, continuously filling all of three-dimensional Euclidean space. This follows inevitably from the constructions of Schoenflies and Fyodorov. Pasteur did not know this. But with the intuition of genius, he understood the profundity of the phenomenon he was dealing with. And he looked for a way out, in the properties of cosmic space. He suggested that in some past period of geological history, the Solar System had passed through left cosmic space, and that life had originated at that time, and reflected this phenomenon. But Pasteur did not know the geometrical consequences, which follow from the work of Schoenflies and Fyodorov—the geometrical equivalence of right-handedness and left-handedness in three-dimensional Euclidean space—and which are geometrically expressed in spatial lattices of atom points. From this it follows that *the equivalence of right-handedness and left-handedness* may be considered to be a geometrical property of three-dimensional Euclidean space.

6. In order to explain the inequality of right-handedness and left-handedness and the pronounced manifestation of left-handedness in chemical compounds within the bodies of living organisms, we have to suppose either that we are not dealing with Euclidean space in this case, or that organisms possess a special ability to utilize[5] right isomers when constructing their bodies, while left isomers are deposited inside the bodies of living organisms.

It seems to me to be simpler, before assuming the existence of a phenomenon we don't understand and looking for it among the properties of "life," to be persuaded of the possibility of there existing a space, in which geometrically right isomers would be chemically stable, while left isomers could agglomerate in chemical processes.

L. Pasteur supposed the existence of such a space. Essentially he supposed, that in this instance there exist *separately* two analogous spaces—two isomers, in a sense—in the Cosmos: right, and left. He took this space to be Euclidean.

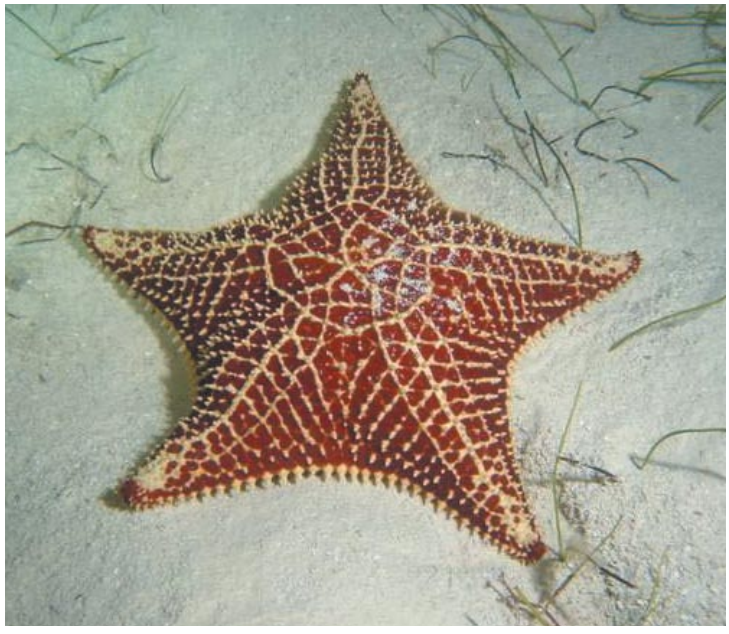
But, right-handedness and left-handedness are inevitably geometrically equivalent in Euclidean space. There would have to be some cause for the division of space into right and left as two independent spaces. Pasteur proceeded empirically, beginning with how racemic crystals and molecules break down into optical isomers. But, to this day, we know of this phenomenon only within living organisms or in their presence. Indeed, in his last work, Pasteur attributed the spontaneous breakdown of racemic acid into right and left tartaric acid during crystallization, to the presence of invisible organisms in the solution. He thought that experiments, such as no one had yet done, needed to be designed to resolve this question.

The notion of such a thing being possible in Euclidean space of an odd number of dimensions seems improbable, for reasons

5. One of the editions we consulted changes "utilize" to "ignore," but Vernadsky's manuscript says *"ispol'zovat,"* which means "to use."

that follow, if we assume that the identity of right-handedness and left-handedness is a geometric property of three-dimensional space. This is demonstrated by the identical stability of structures of matter made from the same chemical compound, with either right or left helical spirals of homologous atom points, completely filling the space. As long as right-handedness and left-handedness have not been studied as a geometric property of three-dimensional Euclidean space, I believe I may take this proposition as a premise in my reasoning.

But for radiation of a non-material nature, we have instances of three-dimensional space, in which such a division of right and left spaces easily occurs. Pasteur already drew attention to them, and thought that they could be used to create a medium for abiogenesis. A gaseous medium or a vacuum, illuminated by light with right or left elliptical or circular polarization, would be such a state of space. Here we are dealing with two separate media—right, or left. But living beings involve a material medium, not an energetic one. Only experiment can resolve the matter. Unfortunately, these relatively easily accessible phenomena have not been studied experimentally at all.



The five-fold symmetry of the starfish Ophiuroidea. *This photo was taken on the sea floor with an underwater camera.*

This being the state of our knowledge, it seems to me to be logically more correct, in geometric problems that have been basically empirically validated throughout the entire existence of humanity, and were constructed by humanity, not to equate, for solids, the material and energetic states of space with respect to their logical consequences.

Thus, I shall proceed from the assumption that the equivalent manifestation of right-handedness and left-handedness for natural bodies in the space they occupy is a geometric property of three-dimensional Euclidean space.

The absence of this equivalence, and the pronounced manifestation of left-handedness in the material substrate of living matter and of right-handedness in its functions, indicate that the space occupied by living matter may not correspond to Euclidean geometry.

Before taking up this subject, we must discuss the problem of the symmetry, characteristic of living matter.

7. The problem of the symmetry, characteristic of living organisms, absolutely cannot be solved within the bounds of the symmetry that was developed for crystalline bodies. This symmetry, which is so striking, must be expressed essentially in some other way.

The point is that in the morphology of living organisms, we do not see straight lines. Where we do encounter them, for example, in sponges or *Radiolaria,* it is when crystallization phenomena are involved. At the same time, we encounter here instances of five-fold symmetry, such as in starfish or *Ophiuroidea*.

This entire domain of phenomena, which clearly involves geometry and symmetry, remains at a standstill, and we have not found ways to express it mathematically.

All investigators interested in the form of living organisms have turned their attention to two extraordinarily characteristic phenomena. The first is their dispersedness, meaning their sharp delimitation from their environment, in which they seem to represent bodies that are independent, constantly moving, and set sharply apart from their surroundings. It is as if they were special little alien worlds. Their sizes range from 10^{-6} centimeters to 10^{3} centimeters. Their delimitation from their environment is unusually pronounced, and is beyond any doubt. The states of space, occupied by the bodies of living organisms, differ fundamentally from the states of space of the inert natural bodies of the biosphere around them. Living organisms are created in the biosphere only from living organisms. Never from inert bodies of the biosphere.

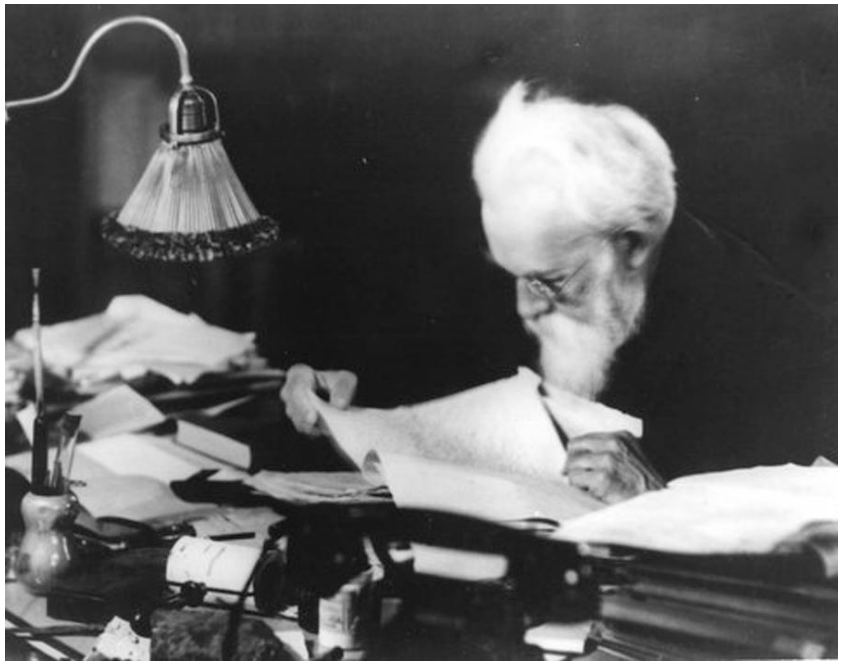
The form of their delimitation is clearly regular and symmetrical, and they are always delimited by curved surfaces. There have been attempts to explain this form as a manifestation of particle forces, developing at the boundary of the gaseous and liquid medium in which the organisms exist and with which they are connected by the continuously occurring biogenic migration of atoms. Their form is unusually constant, extremely stable over historical time and unchanging in the course of geological time; for some living matter, it has remained unchanged for hundreds of millions of years.

This stability of form, which essentially expresses for us, in living matter, the continuous motion of atoms, and the dynamic equilibrium of atoms that is continuously maintained by that motion—in the form of an organism, rather than a mechanism—cannot be entirely determined, in a fundamental respect, by surface forces, but, rather, depends fundamentally upon deeper

properties of matter (at the level of atoms or even isotopes). The general similarity with the way in which particle forces are manifested has to do with the fact that the matter of a living organism, in which liquid water predominates, is in a colloidal or mesomorphic state; only a portion of the dispersed particles within it are composed of crystalline matter, though these may play a very great role.

The symmetry that is observed, and the stability of minute morphological peculiarities over geological time, which is unusual in our experimental work, clearly show that deeper phenomena than particle forces are fundamental here.

It is therefore entirely legitimate to think that we are dealing here with a manifestation of deeper properties of matter, or, rather, with a form of manifestation of matter, other than the properties of atoms and isotopes, or physical-chemical properties in general.



Vernadsky in his office in Moscow in 1940.

It is also legitimate to advance and investigate the working hypothesis, that bodies of living matter are fundamentally determined by the geometric state of the space they occupy, which differs from the Euclidean space of the inert natural bodies of the biosphere.

This space cannot be Euclidean, if only because it lacks the equivalence between right-handedness and left-handedness that is inevitable for Euclidean three-dimensional space.

8. We may try to detect the geometric properties of this space. The following properties of Riemannian space suggest that it will correspond to one or several of the states of this space. Firstly, the fact that an infinite number of Riemannian spaces can exist. Secondly, that any Riemannian space is as if closed, but appears to be unbounded. In three-dimensional Euclidean space, it will appear as a sphere. Thus, it has no straight lines nor plane surfaces, but only curved lines and curved surfaces can exist.

As we know, the symmetry of living matter reveals itself geometrically in exactly this way within the inert three-dimensional Euclidean space of the biosphere.

The dispersedness of living matter, and the widespread occurrence of closed curved surfaces that are nearly spherical or geometrically related forms, entirely support the hypothesis.

But we can deepen the geometric representation of these Riemannian spaces that are characteristic of living matter.

9. Their characteristics must be:

(1) In forms corresponding to this geometry of bodies, straight lines and plane surfaces are relegated to a secondary level. At the fore are curved surfaces and curved lines. Obviously, in the simplest cases in three-dimensional Euclidean space, it is convenient to proceed from lines on the surface of a sphere and, instead of plane surfaces, sections of its curved surface.

(2) Vectors in this space must be polar and enantiomorphous.

(3) Right-handedness and left-handedness must be pronounced, and they are not equivalent geometrically or physical-chemically. Evidently, left-handedness predominates in the internal structure of living bodies.

(4) In such a space, time—just as much as physical-chemical processes—must be expressed geometrically by a polar vector.

(5) A number of very important consequences follow, which sharply distinguish the substrate of living matter, i.e., the state of its space, from the state of space of inert bodies. Expressed by a polar vector, time is irreversible in the physical-chemical and biological processes of this space; it does not go backwards. Consequently, entropy will not occur in matter here.

(6) But a vector in this space must not only be polar, since it is expressed in the physical-chemical and biological properties associated with matter. It must also be enantiomorphous, or else right-handedness and left-handedness would be impossible.

(7) This enantiomorphism is markedly different in phenomena that are "in the direction of the Sun's motion or against the Sun, which is connected to the inequality of right-handedness and left-handedness.

(8) The biosphere represents an envelope of the Earth, in which innumerable minute Riemannian spaces of living matter are included, in a dispersed way and a dispersed form, in the states of space of inert natural bodies with their three-dimensional Euclidean geometry. The connection between them is maintained only by the continuous biogenic flow of atoms.

ON VERNADSKY'S SPACE
More on Physical Space-Time

by Lyndon H. LaRouche, Jr.

September 13, 2007

My receipt of the translation of Academician V.I. Vernadsky's On the States of Physical Space as a Festschrift for the occasion of my 85th birthday, prompts the following remarks: as this effect upon me was probably intended by my relevant dear friends.

One may wonder: how well did Carl F. Gauss know the orbit of the asteroid Ceres? The orbit, as Gauss defined it correctly at that time, is known; but, the universe in which Gauss's thinking was located, remains poorly understood, even among professionals, still today.

The time came, when I was to meet with that LaRouche Youth Movement (LYM) team of volunteers which had been chosen by others, and then assembled, with me, for beginning its mission of reliving of the actuality of the process of Gauss's discovery of that orbit. That was the occasion on which I first challenged the LYM to discover the often overlooked difficulty which confronts any student of Gauss's relatively successful result in this matter.

The problem, I emphasized, then, as now, is that Gauss, then, after the death of Abraham Kästner in 1800, as still later, was working within that hostile environment for European science which had been created by a succession of adverse circum-

The author (top row, third from right) with LaRouche Youth Movement members from the "basement team." A birthday gift in September 2007 of the first English translation of Vernadsky's "On the States of Physical Space" (see p. 10) inspired LaRouche to write this work, in which he locates the crucial discoveries of the great Russian scientist in the tradition of the Pythagoreans and Plato.

Carl Friedrich Gauss (1777-1855). Conditions imposed by the Napoleonic wars and the regime of Prince Metternich, impelled Gauss, "often, out of an understandable sense of discretion, to hold back some amount the significant, controversial features underlying many among his leading discoveries." The challenge LaRouche posed to a LYM team was to discover those hidden features.

stances. These were conditions shaped by both the Napoleonic wars and, under the regime of Prince Metternich and his like from the period of 1815 onwards.[1] Under those special, menacing political conditions, which were widespread in the science-environment of that time, prudence impelled Gauss, often, out of an understandable sense of discretion, to hold back some among the most significant, controversial features underlying many among his leading discoveries: where my native, outwardly militant disposition would not have permitted me to do so.

I warned those assembled for this mission, that they must ask themselves: *What were those hidden features, and why was Gauss committed to suppressing certain among the relevant, underlying facts about his own discoveries? What is the difference between the method Gauss employed for his discoveries, and his method of presenting the proof of that which he had achieved with such justified pride? Why is there such a difference?*

The source of the problem lay not in Gauss himself, but in the state of mind of most among the audience to which virtually all of his discoveries were presented for publication in those times.

That fact of the matter is illustrated by the exemplary case of Gauss's reference to his own earlier discovery of an anti-Euclidean mode in physical geometry.[2] The Gauss living under the political conditions menacing early Nineteenth Century science, often chose to present his discoveries *without taking the political risk* of fully uncovering the actual method by which he had achieved them; this is the case even for some among his most notable discoveries. In such cases, his explanation of the discovery, which, although an accurate description of the result itself, often differed significantly from the means which he had actually employed for those publicly reported achievements.[3] The sometimes heated quality of the correspondence between Gauss and Jónas and Farkas Bolyai, son and father (and others), on the subject of non-Euclidean geometry, typifies the kind of challenge which those who would be serious students of Gauss, must face and resolve.[4]

That kind of challenge to today's student, was not manifest in that problematic form, in the written reports of their own work by predecessors of Gauss such as Kepler and Leibniz. It is also notable, that Gauss's follower Bernhard Riemann, was to be much franker about the method of his own discovery, where Gauss had often been cautious on this point.[5]

On that occasion, I cautioned the LYM team, that, therefore, before jumping, prematurely, to what might appear to be obvious conclusions, they must concentrate on digging deeply into the virtual map of the way in which Gauss's mind actually worked on the Ceres project, and, also, in work on other subjects treated by him at later times. I warned the LYM team that their special challenge in this case would be, that although Gauss provided his readers with a description of the results of his discoveries, such as the Ceres orbit, their task would be to

1. The period from Napoleon Bonaparte's installation as Emperor onward was a time of a deep and widespread cultural decadence, called Romanticism. Romanticism's influence as a form of corruption infecting newborn generations of prominent figures of science and artistic composition and its performance, is typified by the influence of the corrupt Augustin Cauchy in physical science, and Liszt and Richard Wagner in music. See Heinrich Heine on the subject of the Romantic School, for an example of the problem.

2. C.F. Gauss to C.L. Gerling Feb. 14, 1832: in Kurt-R. Biermann, *Carl Friedrich Gauss: Der "Fürst der Mathematiker" in Briefen und Gesprächen* (Munich: Verlag C.H. Beck, 1990), pp. 27, 137.

3. Typical is Gauss's treatments of his argument against the empiricists in the matter of the Fundamental Theorem of Algebra, and the related matter of quadratic reciprocity. See note, below.

4. Loc. cit. There was, and remains, a fundamental difference in principle between the Riemannian *anti-Euclidean* geometry which was the impulse of Gauss's teacher Abraham Kästner, and the modified form of Euclidean geometry typified by the work of Lobatchevski and Jónas Bolyai. As Albert Einstein was to emphasize, Riemannian physical geometry was already implicit in the principal discoveries of Kepler, and also, as Einstein would probably have concurred, in Cardinal Nicholas of Cusa's *De Docta Ignorantia.*

5. As in the opening two paragraphs of Riemann's 1854 habilitation dissertation.

seek out the pattern of evidence which underlies the actual outlook and method which Gauss had employed for the actual process employed in certain among his crucial discoveries, such as, already, in the case of the discovery of the orbit of Ceres.

So, in a comparable sort of case, there is often a crucial difference between the acceptable quality of the honest explanation which a manufacturer might provide the professional employing that manufacturer's product, and the different, deeper nature of the scientist's duty of informing both his colleagues, and future generations, of the method by which the discovery had been actually generated. The requirement of reports on discovery of principles of science, is providing other scientists, or students in science, with *the act of experiencing* that relevant quality of experience which corresponds to an exact description of the actual quality of experienced mental process by which the product's crucially relevant features had been discovered.

In science: if you, as student, for example, have not replicated what I shall clarify here, as the relevant act of specifying the parameters of design required for the relevant proof-of-principle experiment, you, like most who have been trained scientifically in the empiricist or positivist schools, do not actually know, yet, what you are talking about.

In the 20th Century, Kurt Gödel (shown here at left with Albert Einstein) carried forward the anti-Euclidean approach in his exposé of the fallacies permeating Bertrand Russell's Principia Mathematica.

'Quadratic Reciprocity'

This set of considerations obliges us to turn our attention to the most profound of the issues of the method required for scientific progress in general.

From the work of the ancient Pythagoreans and Plato, through the crucial discoveries, as by Nicholas of Cusa, Leonardo da Vinci, Kepler, and Leibniz, as capped, thus far, by that of Riemann, Einstein, and Vernadsky, all actually competent science is always to be rooted in the subject of astrophysics. There is nothing merely coincidental in that choice. For those among us who are thinking clearly today, those relevant, better-known ancients, such as the Pythagoreans and Plato, used the concept of the "universal" to signify either the notion of the entire existence of the known, stellar universe, or a physical principle which could be implicitly attributed, pervasively, to be characteristic of the whole interior of the domain of that universe, so defined.

At first impression, the starry universe appears to be spherical. Why is that so? Does that appearance not imply that a quality of "sphericalness" bounds the universe? If so, does something else, of a still higher authority, bound that apparently spherical quality of boundedness? These are not merely coincidental questions; these questions imply a different question of deadly seriousness: How was this stubbornly persistent appearance of spherical boundedness generated for the mind of man?

Two great questions are implied in that set of questions. *The first of these questions*, is expressed in the form of the elementary notion of an anti-Euclidean geometry of the type underlying the physical science of the Pythagoreans and the related circles of Socrates and Plato. *The second, deeper question, which is also implied in certain features of their work, as also the famous argument of Heracleitus,* is, *to what degree is the way in which we acquire reliable scientific knowledge, itself a reflection of the "architecture" of what appear to be the specifically biological conditions under which all valid human knowledge of the universe is organized?*

Kepler's uniquely irreplaceable, original discovery of the principle of universal gravitation, has continued, in fact, to typify the proper modern use of the term "universal" to the present time.

In the course of time, one member of the team working on Gauss's discovery of the Ceres orbit brought up the matter of Gauss's ominous remarks on the subject of *quadratic reciprocity*. Gauss's emphasis on that matter should have startled the reflective scientist; it startled the LYM team. Thinking, hours later, of the discussion which that question had provoked, I was delighted! At the next opportunity to present my case, on the following morning, I presented the team my thoughts in

Laurence Hecht / *21st Century*

Larouche Youth Movement members (from left) Sky Shields, Michael Kirsch, and Peter Martinson, with Rachel Douglas. LaRouche challenged a group of LYM members, including those pictured here, to probe the actual (but hidden) method that Gauss used in making some of his discoveries.

explanation of Gauss's remarks. I also presented them with a footnote I had prepared the previous evening for intended publication in a major paper of mine in progress of completion at that time. This bears on a crucial feature of Vernadsky's *On the States of Physical Space*.[6]

That observation, on quadratic reciprocity, typifies, exactly, the distinction to be made between Gauss's actual method of discovery, and the frequent manner in which he not only presented, but defended his actual discovery later. I am as gratified as a "proud papa" by what that LYM team itself has done, actually independently of my explicit direction, to that effect.

Kurt Gödel's Paradox

As I emphasized in the referenced location, the general implication of Gauss's famous remark on quadratic reciprocity, is a reference to the fact that we humans are a very special type of species among living processes; this implication points attention to the underlying fact of the way in which we must envision the means by which our living physical organization carries within each of us, a certain set of what might be regarded, for purposes of pedagogical exercises, as a set of deep, quasi-axiomatic-like characteristics; these characteristics express, in themselves, the conceptual powers associated with our ability to form experimentally validated conceptions of the lawful characteristics of our universe. This, for example, is a relevant, much deeper implication of Kurt Gödel's famous work exposing the systemic fallacies permeating Bertrand Russell's *Principia Mathematica*.[7]

As a matter of a relevant bit of my own autobiography, I had always despised the customary form of secondary education in Euclidean geometry. That is to say, from about the first moment, during my adolescence, I had encountered it. That dislike, with its accompanying theological implications, turned out to be, later, over the years, one of my most important, most crucial personal achievements, respecting the benefits this would produce in my progress during that and later decades of my life's work. *A priori* presumptions, as typified by the disgusting hoax known as the definitions, axioms, and postulates of a so-called Euclidean geometry, are to be recognized by the attentive mind, as the very essence of formalist types of the school of Sophistry to which Euclid himself adhered. Whoever clings to Euclidean or kindred assumptions, has thus crippled, if not ruined, what would have been, otherwise, his or her ability to think clearly about the most crucial qualities of scientific and other matters.

A valid form of primitive scientific method, rejects the notion of the functionally ontological existence of a Euclidean, or Cartesian, "four-square" space. All competent mathematical thinking proceeds, initially, primarily, from spherical functions such as those familiar from the work of the Pythagoreans, Plato, et al. Physical space-time is then located "outside" a spherical universe, but in a special way. Spherical space is the virtual screen on which our notion of events in physical space are projected.

However, there are certain crucial complications.

First, as I have emphasized in my August 29, 2007 "Music & Statecraft: How Space Is Organized,"[8] human mental sense-perception is usually defined primarily in terms of the contradictory experience of vision and hearing, as Kepler's discovery of the general principle of Solar gravitation illustrates the point. In fact, the mutually contradictory of all of the relevant senses employed in a particular experience, define the "dimensionality" of the relatively immediate experience of physical space-time. The

6. See Section I:13 of this Vernadsky work itself; also the entirety of Section II. A provisional English translation of this 1938 Vernadsky paper was presented as part of the Festschrift for my 85th birthday.

7. Lyndon H. LaRouche, Jr., "The State of Our Union: The End of Our Delusion," *EIR*, August 31, 2007. See note 42, p. 37.

8. *EIR*, Sept. 14, 2007.

universal physical principles expressed within that framework of sense-experience, rather than either visual or auditory space, define the proximate reality of knowledge relevant to sensory experience.

Thus, although we must reference experience to that notion of sensory interactions, rather than a single quality of sense-perception, it is the product of that multi-sensed view of our experience which informs our useful view of events within the frame of reference of functional spherical space. That provides us the general perspective on the notion of physical space-time.

However, that is not the end of the matter. As man's ability to discover and employ universal physical principles informs us, we do not live within a fixed ordering of the universe. The universe which we human beings know, is *anti-entropic*. Not only do discovered universal physical principles exist; the human aptitude for more advanced discoveries, is an active principle of the universe which we occupy, and which we, thus, to a large degree of approximation, may define.

Here lies the deepest implication of Kurt Gödel's exposure of the hoax in not only Bertrand Russell's *Principia Mathematica,* but the incompetence of all devotees of Russell's argument, such as Professor Norbert Wiener, John von Neumann, and their neo-Malthusian and other followers today.

That refutation of Russell's argument, is the implicit principle of Riemannian physical space-time.

The virtually *a priori* universe we inhabit, is defined for us by what we are, functionally, in our universe. This pertains to both the way the paradoxical juxtaposition of our sense-organs' functioning defines a real world distinct from that of crude sense-certainty. However, since the human individual contains a manifest, principled form of power over "nature" lacking in all animal species, it is not sufficient to recognize the way in which our biological organization determines the axiomatic features which define physical science, and related matters. We are also distinct from all other living creatures in respect to the creative powers which separate us from the beasts.

There, in those higher powers which distinguish us as a species, lies the faculty of the true scientific method through which we are uniquely equipped, differing thus from other living species. Our knowledge of scientific principles lies in that special quality we express as members of a human species. There, precisely here, lies the essence of scientific method.

In short, it is the prescience of an individual mind's original discovery of a new (anti-entropic) physical principle of the universe, which must be included as both a supplement to, and as superior to the function of the interaction of the senses. It is the whole nature of mankind, including that principle of creativity which is absent in the beasts, which defines the organism man, and, in this way, defines the principled properties which the creative individual human expresses as mankind's power in, and over the universe.

International Condensed Matter Nuclear Science Conference

Aug. 10-15, 2008.

Information and papers on LENR can be found at:

http://www.lenr.org
http://www.newenergytimes.com
http://world.std.com/~mica/cftsci.html
http://www.infinite-energy.com

For information on the ICCF series of conferences, search on ICCF-X, where X can be any integer from 1 through 13.

To obtain more information on the conference hotel, see **http://washingtonregency.hyatt.com/hyatt/hotels/services/maps/index.jsp**

The 14th International Conference on Condensed Matter Nuclear Science (ICCF-14) will be held from August 10-15, 2008 at the Hyatt Regency Hotel on Capitol Hill in Washington, D.C. The purpose of this scientific conference is to present and discuss new results on low energy nuclear reactions (LENR), which originally went by the name "cold fusion." The production of unexpectedly large amounts of excess heat in metals heavily loaded with hydrogen is also called the Fleischmann-Pons Effect.

LENR have been studied by hundreds of scientists globally since the field began in 1989. At this time, the experimental evidence for the existence of LENR is strong. Further, many of the characteristics of LENR are already known. Measurement techniques and results obtained with them have been published in more than 1,000 scientific papers.

The mechanisms for such reactions are not yet understood theoretically. Nevertheless, the empirical information shows that LENR produce energy with harmless helium as the primary by-product. In most experiments, there is neither significant immediate radiation nor residual radioactivity.

Several start-up companies and other organizations are working on the science of LENR. The emerging results might provide the basis for green energy sources with many applications, such as the production of clean water.

The series of ICCF conferences, which began in 1990, has been held alternatively in North America, Europe, and Asia. It is the primary venue for the international community of involved and interested scientists to give and critique papers that describe what was done and found. The papers are then published in the proceedings of the conference.

The conference website will be hosted by the International Society for Condensed Matter Nuclear Science (www.iscmns.org). The site will have registration, program and other information, with the initial postings in February 2008.

David J. Nagel, Research Professor at George Washington University, is chairman and Michael E. Melich, Professor at the U.S. Naval Postgraduate School, is co-chairman of the conference.

Korea's Nuclear Past, Present, and Future

by Dr. Chang Kun Lee

Courtesy of Korea Hydro & Nuclear Power Co., Ltd.

Korea's Yongwang nuclear complex with six reactors.

A founder of Korea's nuclear program tells how Korea began nuclear research as a Third World nation after World War II, and within 50 years developed into an industrial powerhouse, supplying 27 percent of the nation's electricity by nuclear power.

One day in 1958, Mr. Walker Lee Cisler made a courtesy call on Dr. Syngman Rhee, the Korean President. Mr. Cisler, one-time CEO and Chairman of the Chicago-based Commonwealth Edison Company, had helped to rehabilitate the electric grids of Europe in the post-war period, under General Dwight Eisenhower, the Allied Forces Commander.

The meeting between the two men was reported in the press, and we

As the chairman of KEPIC, the Korea Electric Power Industry Code Committee, for the past 15 years, C.K. Lee has mobilized and managed 350 engineering professors and professional engineers dispatched from six engineering-related academic societies. KEPIC's 2005 edition consists of five parts contained in 83 volumes or some 27,000 pages, about 3.2 meters thick. Dr. Lee is also a former Commissioner on the Atomic Energy Commission of South Korea, and a former chairman of the International Nuclear Societies Council.

This article is adapted from Dr. Lee's book-length presentation at the Summer Institute of the World Nuclear University, held in Korea in August 2007. A previous article, "A Nuclear Perspective from Asia," appeared in the Winter 2002-2003 21st Century.

The author can be reached at changkunlee@gmail.com

Walker Lee Cisler, the Atoms for Peace ambassador, helped Korea and other nations move into the nuclear age.

Dr. Syngman Rhee, the first Korean President (right), at the groundbreaking for the first nuclear reactor in Korea, a research reactor. Rhee pursued an Atoms for Peace program, to take his nation into the 21st Century.

can imagine the conversation as having proceeded along the following lines:

President Rhee asked if any radical measures were available that could be undertaken to address the problem of chronic power shortage in Korea. Mr. Cisler answered:

"Well, there is a way, Mr. President. It's a somewhat difficult option perhaps, but nevertheless worth trying."

"And the option is?"

Mr. Cisler took out a wooden box from his brief bag. "An energy box of this small a size with uranium fuel can, under the right conditions, undergo a fission reaction, and generate an energy equivalent of 100 freight cars loaded with coal or a big tanker filled with petroleum."

"Wow!," marveled the Princeton Ph.D. President who, admittedly, was not a physicist. "How is that possible?"

"You see, Mr. President, uranium atoms when split will release energy some 3 million times more than what fossil fuel can in terms of weight. We are talking about nuclear energy here."

"Is this something that we Koreans can harness to resolve our energy problems?"

"Of course," Mr. Cisler said emphatically.

"What would be involved for us to get started?"

"Well, this energy source would not be easily extracted from the ground like coal or oil but, rather, it will be squeezed from the human brain, insofar as it involves technological manipulation and prowess. It's new technology-based energy for which you will need many high-quality scientists and engineers. Nurturing capable, dedicated manpower will be key for the task."

"Thank you, Walker! And when do you suppose Korean people will start benefiting from this thing you call nuclear energy?"

"Probably in two decades," was Mr. Cisler's prediction.

True to Mr. Cisler's prediction, the Korean nuclear industry began supplying nuclear-based electricity to the nation as of July 20, 1978, exactly 20 years after the Rhee-Cisler meeting. And another 20 years later, Korean nuclear power plants, accounting for some 20 percent of total power-generating facilities, were supplying roughly 40 percent of the nation's power needs at very low-priced rates.

The Nuclear Sector and How It Began

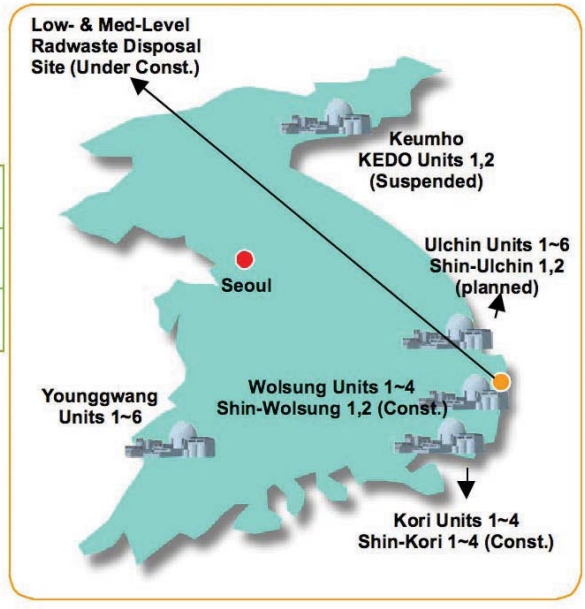
Korea has 20 operating nuclear power reactors deployed at four sites, with a total capacity amounting to 17,716 megawatts, which is 27 percent of the total generating capacity (65,560 MW), supplying 39 percent of the nation's power need in 2006. Six additional units (6,800 MW) are under construction, and two others (2,800+ MW) are currently in the planning stage.

We believe that the nuclear share in the fuel structure of total power generation will gradually increase in the forthcoming years. To be precise, today's 27 percent nuclear share will increase to 29 percent by 2020.

The cost of electricity generated from the Korea Electric Power Corporation's coal-fired plants, hydro-plants, oil-fired plants, and LNG-fired plants was 1.42, 2.19, 3.0, and 3.45 times thanthat from nuclear power plants in 2006 (Figure 2).

Figure 1
STATUS OF NUCLEAR POWER STATIONS IN KOREA

In Operation	20 Units 17,716 MW
Under	6 Units 6,800 MW
Under Plan.	2 Units 2,800 MW



Under the framework of KEDO, the Korea Energy Development Organization, the Republic of Korea started to construct two Korea Standard Nuclear Power Plant, 1,000 MW-class pressurized water reactor units in North Korea, but the construction of these reactors was suspended for politico-diplomatic reasons, especially the reckless nuclear bomb development and its test by North Korea.

When World War II ended, the installed capacity of power generation facilities on the Korean peninsula totalled 1,921 megawatts. Of this, North Korea accounted for 88.5 percent, while the south, with twice the population, had merely the remaining 11.5 percent of capacity, comprising mostly small, inefficient facilities.

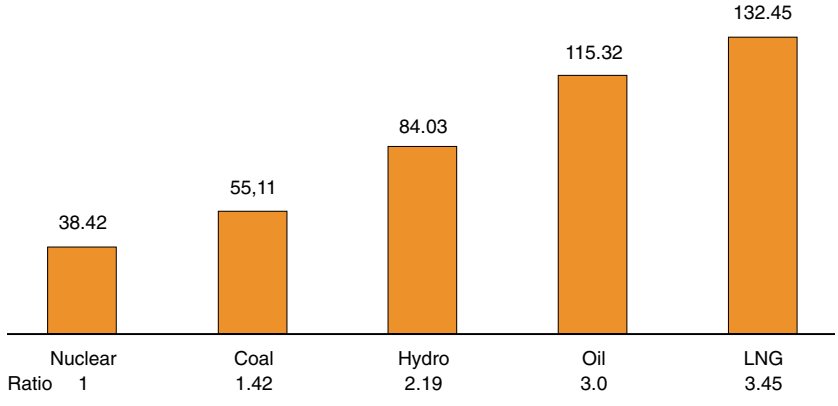
The legacy of Japanese colonialism meant that until 1945, there were only 205 Korean university graduates in the entire country who had been educated at four-year-course institutes of higher learning in Japan and elsewhere. In fact, regular universities were not established in Korea until the end of World War II, except for one (the predecessor of Seoul National University), which was newly founded in Seoul primarily for the education of Japanese students.

There was a handful of graduates of European and American colleges. Korea's Third World status at this juncture in history can be seen in the fact that South Korea could claim fewer than 100 college graduates with science and engineering degrees in the immediate years following World War II. These engineers and science professionals would soon become pivotal technocrats for running the country. Such intellectual manpower shortage was the result of Japan's obscurant policy for the colonial Korea.

The state of underdevelopment was so dire that the U.S. military deputy governor, Charles Helmick, was led to comment in 1948: "Korea can never attain a high standard of living. There are virtually no Koreans with technical training and experience required to take advantage of Korea's resources and effect an improvement over its recent rice economy status." Amplifying this view, Helmick added, "When the U.S. occupation forces withdrew and stopped sending in supplies that south Korea needed, it would be reduced to a bull-cart economy and some 9 million non-food producers will face starvation."

After World War II, the southern part of Korea, which had embraced millions of refugees from the north, Japan, Manchuria, and China, had only 11.5 percent of the nation's power-generation facilities and was able to supply no more than 4 percent of its electricity requirements. So, the south was at the total mercy of the north for power supply.

Figure 2
RELATIVE COST OF ELECTRICITY BY FUEL
(Based on rates paid by KEPCO in 2006)



Nuclear is the least expensive fuel. The most expensive, liquid natural gas, is 3.45 times the price KEPCO paid for nuclear. Costs are shown in won, the Korean currency.

Electricity Demand in Korea

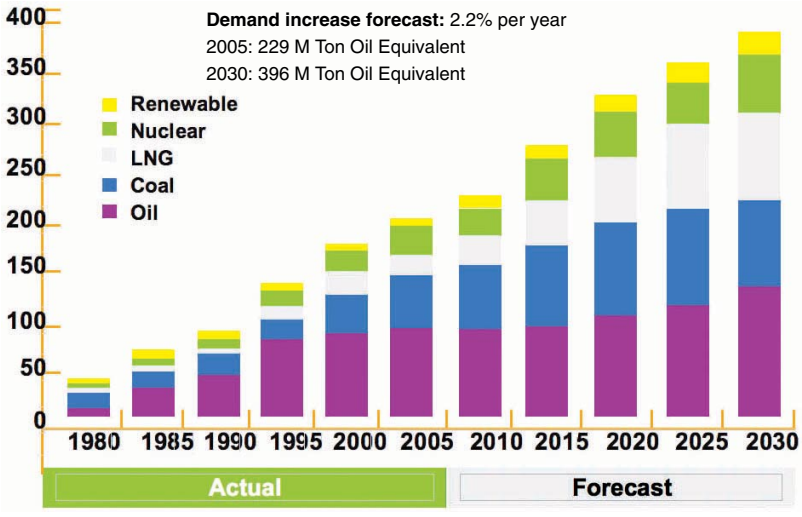
The growth rate of electricity supply in the past was extremely high: 23.2 percent per annum in the 1960s, 15.5 percent in the 1970s, and 11.2 percent in the 1980s, which were good indications of rapid industrialization in those periods, the so-called the Economic Miracle Era. In current years, it has been 4.6 percent per annum, but it will decrease to 1.8 percent in 2011-2015, and then to 1.0 percent in 2016-2020. This downhill trend will be attributed to the rapid shift of GDP's main contributor from heavy industry to the commercial sector, *inter alia*, the service industry, that is now skyrocketing in Korea.

It is estimated that the electricity demand in 2020 will amount to 478,555 million kWh, which will be 1.4 times the consumption in 2006 (248,719 million kWh). The electricity share out of the total amount of energy consumption in Korea will gradually increase with time, in such a way that it will increase to 19.4 percent in 2020 compared to 16.6 percent in 2005.

The total primary energy demand in 2005 was 229 million Ton Oil Equivalent (TOE), and it is estimated to be 396 million TOE in 2030. In the years up to 2030, demand increase forecast is presumed to be about 2.2 percent per annum. The increase in demand for petroleum and coal will be low, but that for liquid natural gas, nuclear, and renewable energy will be relatively high because of environmental concerns.

In terms of energy demand by sectors, the industrial and transportation sectors will show slow increase, while that of the commercial sector will make a rapid increase, because of the mushrooming growth of the service industry.

The annual growth rate of electricity in Korea was always higher than the nation's annual GDP growth rate, in the period of 1999 through 2006. For instance, the annual electricity growth rate in 2005 was about 6.5 percent against 4.2 percent GDP growth rate in the same year. But the two growth rates levelled off, to be the same, 4.5 percent, in 2006.



PRIMARY ENERGY DEMAND FORECAST IN KOREA

North Korea brought the south to its knees by abruptly cutting off the power supply to the south on May 14, 1948, causing crippling blackouts and widespread brownouts throughout the nation. The U.S. Military Administration brought in power supply barges—*Jacona* (20 megawatts) and *Electra* (6.9 MW), and later *Impedance*, to the South Korean ports, to meet the urgent need.

That abrupt power cutoff was actually a prelude to the main knockout punch: The north struck on June 25, 1950, beginning the Korean War.

Under the pretext of homeland unification, the northern regime attacked the south, and the result was a total destruction of all cities and towns in every nook and cranny of the Korean peninsula. What industrial plants and factories that had been there, were laid to waste, and the northern regime's kidnappings and selective killings, especially of educated Koreans, further bled the nation. The war exacted a terrible toll from the already impoverished population, and further scarred the national psyche, which was already hurting from 35 years of colonial subjugation under Japan.

However, where once ashes smoldered, now stands a vibrant and dynamic nation, with aspirations toward becoming an important player in the global economy. Where war once raged, now stands a thriving economic engine putting out state-of-the-art high-tech software and hardware products, including those in the nuclear sector. And out of the detritus of war was born the Korean nuclear industry. Over the years, the Korean nuclear community has had to face many challenges. And yet, it has thrived. I will summarize here Korea's nuclear power projects in view of the past and present perspectives, and a hopeful future.

The Early Days

President Rhee would have been heartened by the sight of some 15 engineers and scientists, mostly in their late 20s and garbed in military uniforms, voluntarily putting their noses to the grindstone at weekend seminars on nuclear technology, from 1955 onward. The textbook we used was Raymond Murray's *Introduction to Nuclear Engineering,* which was copied for the seminar participants by a typewriter and manual printing kit, and these seminars, conducted in a warehouse-like room, were begun some four years before Mr. Cisler admonished the Presi-

dent in the Blue House about the importance of manpower training for developing nuclear energy.

For about 10 years, beginning in the 1950s, college graduates were dispatched abroad to receive basic training in nuclear technologies, including radioisotope applications. The main incubator was the U.S. government-funded Atoms for Peace program. Of the young trainees, 127, representing 57 percent of 237 total, were sent overseas and many went to the United Kingdom through funding from the Korean government. Given the penurious conditions of the time, with so many Koreans still going hungry and in tattered clothes, city streets pullulating with war-wounded and orphans, and government coffers perennially empty, the commitment to spend the scarce foreign exchange resources on educating these young Koreans was an extraordinary step, and reflected the Korean nation's eagerness for new technological know-how and its wish to quickly rehabilitate the war-ravaged country.

These foreign-trained technical personnel later became the core of the Korean nuclear community, and preached the nuclear gospel all through the early, empty, wilderness years. Of course, many, perhaps a third of the total, were lost through leakage as they opted to remain in the countries where they had received training, to work there either in industry or in academia. This was a phenomenon experienced by many other less-developed countries at the time, and much discussed later under the rubric of the "brain drain."

The brain drain turned out in retrospect to be really a blessing in disguise, because these professionals kept on sharpening their expertise in the host countries only to be tapped later on, when they returned home to join the nuclear projects in full swing, bringing with them much-needed cutting-edge technological skills. Where earlier appeals to patriotism and homesickness had insufficient drawing power, a tangible project commensurate with a suitable posting could pull these ex-pats back home, and thus reverse the brain drain. The material conditions had to be right for the natural reversal of the brain drain.

It goes without saying that those trained in Britain favored a gas-cooled reactor, while the beneficiaries of Uncle Sam's largesse agitated for a light water reactor. Since U.K.-produced gas-cooled reactors were already deployed in Italy and Japan at that time, the British model enjoyed a winning edge at first. A dogfight ensued, pitting the one competing model against the other and involving financial, technical, political, and diplomatic interventions. Ultimately, though, the pro-American camp prevailed, and delivered a coup-de-grâce to the efforts of the allied European consortium. In hindsight and from a long-term

National Archives and Records Administration

Left: After years of Japanese occupation and then a brutal war, Korea was a devastated country in the early 1950s. Here, civilians in flight during the Korean War.
Below: A recent night scene of Seoul City, with illuminated buildings, the sports facility, and city streets.

perspective, this was a fortunate development, I must say.

Later, it was adjudged, however, that the light water reactor was too light for us, so a decision was made to add more weight to our overall nuclear system by supplementing it with a heavy water nuclear machine. Thus, we became the only nation in the world with a mix of light and heavy water reactor types—that is, until China came along and followed our footsteps.

These days, four pressurized heavy water reactors are in full operation at the Wolsung site. The name Wolsung, literally meaning Moon Castle or Lunar Citadel, has a poetic and romantic resonance. When the CANDU reactor was introduced to Korea, some wits were commenting that whereas the PWR was akin to an unexciting *de jure* wife, the CANDU at Wolsung was surely like a beloved concubine with whom one could discuss high art and literature and write lofty poetry together under the moon-lit castle.

With the introduction of CANDU, the 2+1 nuclear reactor strategy was developed in Korea under the direction of Dr. Kyung Ho Hyun, the former president of KAERI, the Korea Atomic Energy Research Institute. This called for twin units of the PWR, plus one CANDU, in that combination. Intensive R&D work led later to the DUPIC (Direct Use of PWR spent fuel In a CANDU reactor) concept, for simultaneously saving natural resources and reducing radiation waste volume. On the other side of the coin, it can be nothing but a spread-too-thin drawback of a nation's technological potential if a small country like Korea should launch into the pursuit of two reactor types from the beginning.

After long pondering and in-depth study, the Korean nuclear community decided to pursue a one-reactor-type strategy, that is, the PWR alone. The deployment of CANDU reactors was terminated with the fourth CANDU unit at the Wolsung site. This CANDU site is scheduled to have new family members bearing different nomenclature: the Westinghouse APR 1400 (Advanced PWR Reactor 1,400-MW-class) and a radioactive waste management center.

To the great collective relief of the Korean nuclear community, Wolsung also has finally been selected as the disposal site for low- and medium-level radiation waste, after some 18 years of contentious bickering over several different possible locations. At least, we were fortunate to avoid a Yucca Mountain-type debacle seen in the United States over site selection.

The Hare and the Turtle

The Western nuclear hares sprinted way ahead, just as the Korean turtle was crawling to the starting line. Over the decades, the world witnessed a successful transformation of nuclear energy applications from swords to plowshares, that is, from bombs to power-generating plants such as CANDU in Canada, LWRs in the United States, and gas-cooled reactors in Europe. Even when it owned zero hardware, the Korean turtle still assiduously prepped for the future by learning the basic software. We were fortunate in that the cream of the Korean academe and industry came knocking at our door: Probably, many were muttering "open sesame" and hoping for a quantum leap both in their status and in the country's industrial clout.

The recent scenery looks like that depicted in the cartoon, where the Western hare is taking a nap and snoring loudly under a big tree on the hillside, and just coming within the range of the turtle's sight. Yet the Korean turtle still keeps crawling toward the high mountain.

It is common knowledge that a turtle enjoys a longer life than a hare, although the turtle's pace is slow. So far, we have pursued a step-by-step route in nuclear technology development. The most important knowledge we had at the very beginning was the self-knowledge that we did not have anything and we knew nothing. We started, indeed, from scratch.

Period	Projects	Main contractor	Implementation method
1960s	Research reactor	Foreign suppliers	Cradle, spoon-feeding, technology learning by eyes and ears
1970s	Kori #1,2 Wolsung #1,2,3,4	Foreign suppliers	Turn-key contract
1980s	Kori #3,4 Younggwang #1,2 Ulchin #1,2	Foreign suppliers	Non-turnkey and component approach
1990s	Younggwang #3,4 OPR1000	Domestic suppliers	Component approach, but foreign firm responsible for design, supply, and performance
2000s	Ulchin #3,4 Younggwang #5,6 Ulchin #5,6	Domestic suppliers	Component approach, domestic firm responsible for design, supply, and performance
2000s	Shin-Kori #3,4 (APR1400) and henceforth	Domestic suppliers	System upgrading; looking for foreign markets

Table 1

NUCLEAR POWER PROJECTS VS. TIME

Table 1 (p. 33) shows in chronological order our development path with respect to nuclear projects.

Training and Work Performance

The Korean nuclear sector has long regarded manpower training as priority Number 1. The training (and subsequent retraining) of a top-notch nuclear engineer in Korea usually costs an amount equivalent to his body weight in gold. The amount comes to about 50 percent of the cost incurred in training a full-fledged pilot in the Air Force and in the aviation industry, and much less than that for an astronaut training, yet it is a big burden on the project director, especially insofar as most of the training must be undertaken far in advance.

Because of this, we sometimes jokingly refer to a good nuclear engineer as "Mr. Gold." And, as you know, the most common last name in Korea is Kim which means gold. We deploy many "Mr. Golds" in planning, design, manufacture, construction, operation, maintenance, inspection and safety analysis for nuclear projects, along with many more "Mr. Silvers" and "Mr. Coppers" in supporting roles who man our laboratories, offices, and plant sites.

Many of our "Mr. Golds" and their supporting cast put in 12-hour workdays and seven-day work weeks. It has been carried out in a pattern of Monday-Monday-Tuesday-Wednesday-Thursday-Friday-Friday work. Senior members in our nuclear sector have a sort of intimate feeling toward a convenience store entitled Seven-Eleven, which connotes from 7 o'clock in the morning to 11 o'clock at night.

Our plant managers sometimes resort to non-traditional methods to focus the minds of their staffs. A manager by the name of Young Suk Huh, for example, packed off his men to a Marine Corps training camp to toughen their physical and mental endurance. Even those who were initially reluctant to join the camp later expressed their great satisfaction at having completed the tough training, saying that they are now better prepared for difficult tasks and challenges at work.

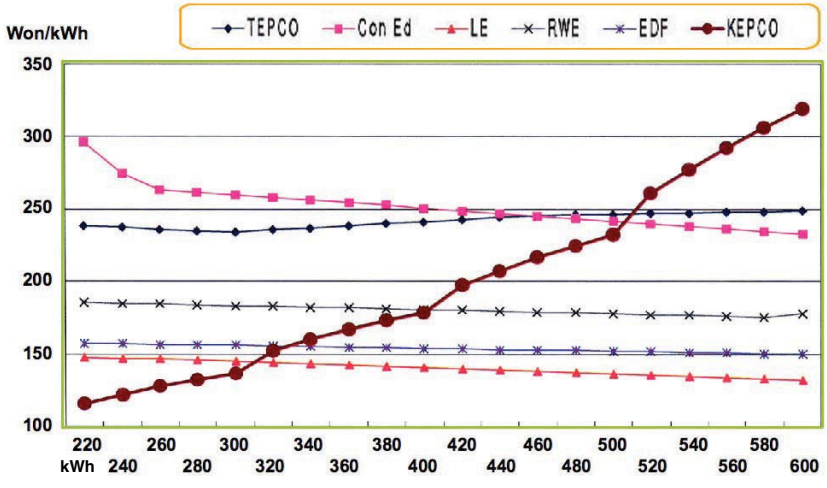
In January 2007, 29 of KOPEC's new recruits were sent straight to a Marine Corps camp to put them in tiptop shape (KOPEC stands for Korea Power Engineering Co.). All the new recruits of KAERI, the Korea Atomic Energy Research Institute, headed by Dr. Chang Kyu Park, were also sent to a Marine Corps training camp for tough drill.

Another unique training procedure had reactor operators and technical crew at a Buddhist temple for meditation sessions and

A Fair System of Electricity Rates

Unit electricity rates in Korea are lower for the poor and higher for the wealthy—the opposite of the rates in many other places. The figure shows the unit electricity rate (in won) imposed on residential customers at six selective electric utilities in the world. Two utilities show distinctive features: One is Con Ed, where the unit electricity rate is 295 won/kWh when its consumption is 220 kWh, while the rate goes down to 240 won/kWh if the consumption is 600 kWh. This means that a high unit rate is imposed on smaller consumers, while there is a low rate on larger consumers.

The other is the Korean case, where the unit electricity rates are opposite to Con Ed: There are low unit rates to smaller users (poor people), and high rates to larger customers (rich people).



UNIT ELECTRICITY RATES IMPOSED ON RESIDENTIAL CONSUMERS PER kWh AT SELECTED UTILITIES

Two singularities are evident: KEPCO's rates are the lowest for the small users and highest for the large consumers, while Con Edison's rates are the highest for the small consumers, and lower for large consumers.

For instance, the electricity rate imposed on rich people living in deluxe houses consuming much electricity is about 2.8 times the unit electricity rate imposed on lesser users of electricity, who may be poor people. Please bear in mind that the electric bill to the high-income bracket may be insignificant, but it can be a financial burden to the poor and needy.

Therefore, I strongly recommend this Korean system to the Electricity Commission (Board) or government authorities of other countries, which may thus suppress electricity consumption by self-regulated mechanisms in the luxurious residential sector, as well as indirectly mitigating the financial burden of poor families, whose purses are now squeezed by the electricity bill.

for open-minded discussions with the reverend monks. This idea was also strongly opposed by employees at first, for many reasons, but especially on religious grounds. However, Mr. Suk Chun Suh, the director of the Wolsung plant site, who introduced this training methodology, was able to assuage the initial skepticism and persuade the employees to give it a try. The success of his persuasion was attributed to his non-religious attitude and atheistic inclination. The meditation training had a good effect, and made these employees sharper mentally to tackle work, especially in stressful emergency situations.

Such intensive and extraordinary training has resulted in a good harvest, that is, in the tangible form of operating performance of power reactors, that has been above a 90 percent capacity factor over the past seven consecutive years, and a 15 percent better capacity factor than the world average over the past two decades In comparative terms of investment and return, pre-investment for manpower training in timely manner can be a lucrative venture.

The improved revenue as the result of having achieved a better capacity factor of our 20 power reactors can be calculated as $9 billion in 2004, $8 billion in 2005, and $8 billion in 2006.

The physical protection of nuclear facilities has long been a focal point of concern for the Korean nuclear community. Our sense of vulnerability was driven home especially hard in the aftermath of North Korea's bloody acts of rampaging terrorism during the 1970s. Just to mention two cases: There was the massacre of 17 dignitaries, such as several cabinet members of the Korean government in Rangoon, Myanmar (Burma). (The terrorists were targetting the President and nearly got him, too.) And, there was the blowing-up of the Korean Airlines plane carrying some 120 Korean workers who were returning home from construction sites in the Middle East, simply to jeopardize the 1988 Seoul Olympiad.

Because of the terrorist behavior of the North Korean regime, we in the south have had to strengthen and constantly upgrade the protection features for our national security assets, including nuclear facilities. Long before the Sept. 11 disaster, North Korean threats made us sensitive to a possible Al Qaeda-type attack on our critical installations, including nuclear power plants. In response, we have had to put in place extra-security shields and monitoring, and we are confident that our nuclear installations can be run safely and efficiently, free from these external menaces.

From 1984 to the end of 2004, the price index of general commodities in Korea saw a rise of 184.8 percent. During this same period, the electricity price index rose by only 5.4 percent. The availability of relatively cheap electricity in Korea, which is the result in large part of the excellent performance in power generation, especially from nuclear reactors, is the main contributive factor to this benefit. Korea's electricity sector has managed to maintain a top-class standard in power supply quality, both in voltage and in frequency stability terms, meeting 99.99 percent of requirements.

However, we do not bask in self-congratulatory complacency with this high performance; we think that there is still room for further improvement. We should be able to squeeze out even better productivity, for example, by working on our relatively long overhaul and maintenance periods.

Table 2

ACTUAL CONSTRUCTION PERIODS AND TARGETS
(In months)

Project	Target	Record
YGN* Units 3, 4	64	63, 67
Ulchin 3, 4	62	61, 73
YGN 5, 6	58	59, 61
Ulchin 5, 6	56	58,55
Shin-Kori 1, 2	53	
Shin-Wolsung 1, 2	53	
Shin-Kori 3, 4	58	

*YGN = Younggwang Units

Construction Innovations

When it comes to construction periods, Korea still lags behind those of the nuclear hares. The construction repetition of the same reactor capacity with identical design has always resulted in shortening the construction period by a few months per project. The construction periods for the ongoing Shin-Kori and Shin-Wolsung projects are presumed to be 3 months less than that of the previous project (Ulchin No. 5,6); that is, from 56 to 53 months. All the reactors listed in Table 2 are 1,000-MW pressurized water reactors, except for Shin-Kori 3 and 4, which are of the PWR 1,400-MW-class, or the so-called APR 1400 type.

One thing we are satisfied with is the improving trend in this area. As we climb the learning curve with ever more projects under our belt, the construction periods are getting shortened: for instance, from 64 months for the YGN (Younggwang) 3,4 project, to 56 months for the more recent Ulchin 5,6 project (Table 2). Through further performance-enabling incremental breakthroughs, we think that in time we can reach the construction period target of under 4 years per project.

Korean shipbuilders have been able to develop an innovation that has meant great savings in time, manpower, cost, and space at the job site. The novel procedure involved fabricating modules offsite, and then bringing them together for assembly at the dock site, whose availability was at a premium. This modularization technique was a straight borrowing from the construction experience at one of our nuclear plants, where the calandria (reactor core) of the CANDU reactor was fabricated nearby in advance and then transported by rail track into the containment building.

And Korean shipbuilders are now using such modularization technology on land to assemble container ships that are 200 meters long and 15 stories high, before towing them out to sea on rail tracks. Korean shipbuilders use the word "block" instead

of "module," which is the terminology used in our nuclear community. The shipbuilders have steadily stepped up the size of the block unit from a 500-ton block to more than 2,000-ton gigablock so as to optimize shipbuilding work and to shorten the construction time.

A friend of mine, Dr. D.S. Shin, who is known as the godfather of the Korean shipbuilding community, has been involved in this block-assembly project as a naval architect. He said the other day that a dozen pieces of gigablocks for a 300,000-ton oil tanker are now assembled at dock in 26 days—the world-record in shipbuilding history.

Because of these assembly techniques, a 300,000-ton oil tanker is built at a Korean shipyard within seven months from the first cutting of steel plate to the final launching of the tanker out to the sea. He said further improvement in block unit system, assembly work, and construction time is being pursued. The construction time of the same tonnage tanker at the shipyards in other countries is said to be in the range of 1 to 2 years, but it is becoming shorter each year.

Another time-saving technique can be learned from steel structure assembly work at the construction site of high-rise buildings. The conventional method has been to first dig out the ground, fabricate the underground steel structure, and then start assembling the steel structure above ground.

My kid brother, a structural engineer, was the first to adopt a new technique in this area, the so-called "Top-Down" method, wherein steel frame assembly work proceeds above ground and below ground simultaneously. By relying on this simultaneous assembly work, he usually saves 20 percent of the steel structure assembly time.

I think it is now time for the nuclear sector to benchmark the above shipbuilding technology and steel-frame assembly techniques so as to shorten the construction time of nuclear power plants. In a nuclear power plant, a one-day delay in the construction stage now equals more than a $1 million dollar loss to its operator.

Key Issues in Nuclear Project Development

In my view, the main lessons learned from Korea's nuclear project development experience can be summarized as follows:

- **Long-term Planning and Its Implementation**

In Korea, the long-term nuclear power development program was drawn up in the early 1960s, when electric power was in short supply, and the nation's total electric grid was too small to accommodate even the smallest nuclear power plant unit. But there was a consensus among the ruling elite, as well as among the public, that the dire power shortage problem had to be tackled by whatever measure necessary, and nuclear power was considered a breakthough solution.

Over the years, the original development plan was modified a number of times to be consonant with the progress of reactor commercialization in advanced countries. In time, Korea's role flipped from that of a recipient to one of a supplier of nuclear technology. The remarkable transformation took three decades of toil, sweat, brainpower, and the mobilization of many dedicated people in the industry.

- **Continued Training of Good-Quality Manpower**

When our nuclear power development program was in the conception stage in the late 1950s, Korea was just emerging from a devastating civil war. People were in tattered clothes and hungry, the government coffers were near-empty, and the streets were full of begging orphans, destitute widows, and limbless ex-soldiers.

Yet there were young Koreans whose audacious dream for the nation involved nuclear power, those who looked to nuclear energy to rehabilitate the war-torn nation, as well as to nurture their careers. It was with the recruiting of these people (most of them had just completed their mandatory military conscription duties) that the Office of Atomic Energy and KAERI were established.

In order to attract and retain the best-quality manpower, KAERI kept its salaries at an extraordinarily generous level of 300 percent of that for ordinary government officials. Through government and U.S. funding aid, a number of young scientists and engineers had already been sent abroad to receive basic training in nuclear technology. These foreign-trained cadre constituted the original core of KAERI's personnel.

New recruits to KAERI were given basic training. After that, many were sent abroad for additional training, which, on average, lasted one year. In accordance with the old adage, "strike while the iron is hot," new trainees were constantly sent to seminars and workshops, in addition to participating in the in-house training courses organized by the seniors.

The oldest and the most active nuclear training center is the one that was established at KAERI, and it has been the delivery clinic, incubator, nursery, kindergarten, and school for Korean nuclear personnel as well as for those from abroad. In the year 2005, KAERI's Nuclear Training Center (KAERI-NTC) offered 36 domestic courses to 1,580 persons and 9 international courses to 116 foreign individuals, and it managed one international seminar attended by 122 participants. The courses conducted in the year 2005 include: Radioisotope Utilization Technology, Radiation-Hazards Protection, IAEA/KOICA Training Course on Nuclear Power Policy, Planning and Project Management.

Since the NTC's dormitory capacity can accommodate 48 trainees at maximum, participants in larger courses must be lodged in outside hotels. The Nuclear Training Center of KHNP is better furnished and well equipped, and it is sometimes open to international courses.

In addition, each power station has its own training center furnished with respective simulators and experienced faculty members. KOPEC, the Korea Power Engineering Company, an architect-engineering firm responsible for the design of nuclear power plants; KEPOS, a power plant maintenance company; KINS, the nuclear regulatory and licensing agency; and other

The Korean King, his cabinet members, and subjects witnessing the first electric light lit at his majesty's Royal Palace on March 6, 1887. William McKay, an American engineer, installed the electric bulbs at the royal palace in Seoul, 7 years and 5 months after Thomas Edison's invention of the electric bulb. The bulbs arrived some 2 1/2 years after the order for them had been placed. Nevertheless, April 10 was later promulgated as the official Electricity Day in Korea in recognition that the general populace began benefitting from electricity as of that day in 1890.

outfits operate these training centers.

- **Technical Backup by R&D**

Because the nuclear sector is a knowledge-based industry, the technical problems encountered usually call for technical expertise for resolution. When problems arise, the quickest solution is to resort to foreign consultants and engineering companies. This approach, however, can be costly, time-consuming and, above all, it will not engender the local accumulation and accretion of technical expertise that should result from working on various problems and issues.

Given all this, it is best to adopt a do-it-yourself approach wherein a technical group is empowered to tackle the various problems that will inevitably arise. This technical group, however, can only succeed if there is an effective R&D backup that can be called in to help address the most intractable of problems.

Again, dedicated and high-quality research manpower is a prerequisite for the success of the local go-it-alone approach. The nuclear-related organizations in Korea operate in-house training centers and research centers for the technical upkeep and innovation of their employees and new recruits. Some organizations offer evening classes on specific topics to their members, either by inviting outside experts or professors and/or in-house professional seniors. In the case of reactor operators, one of six shifts is always sent to a training center, while another shift is deployed to a technical evaluation & maintenance group at the site.

Securing top-notch expertise is the prime measure for bringing forth the vitality of our industry and eventually bringing about the next nuclear renaissance. To this end, continued changes toward innovation and betterment will be the key words that describe the nuclear community of today. It is the growth engine that powers our future technology, keeping our caliber always at the competitive edge.

- **Step-by-Step Development of a Technological Self-Reliance Capability**

In the sciences, we sometimes see quantum leaps in understanding and radical shifts in paradigms; for example, the revolutionary shift from Newtonian science to quantum physics. The philosopher of science Thomas Kuhn wrote about such paradigm shifts. In engineering, however, advancement tends to be incremental in nature, and the gradualist *modus operandi* is the way to go. Here, the persistence of a turtle, moving at what appears to be a glacial pace, is often the guarantor of sure success. It is the small details and constant improvement in all areas, like developing capable and experienced personnel and honing in-house engineering and R&D capability, which will make or break a nuclear power project. And such capability cannot be willed into existence overnight; it has to be the result of years of gradual accumulation and accrual of know-how, and constant training and re-training of personnel.

Our experience tells us that the most cost- and technology-effective way of implementing the first one or two nuclear power projects is to rely on a turn-key contract, structured in such a way as to ensure maximum deployment of local input (ensuring on-the-job training for locals and transfers of know-how), while the supplier still shoulders all the responsibility from alpha to omega. The other side of the coin is that the recipient must keep

his eyes wide open to the work progress and completion and, through surveillance, inspection, and testing, must confirm that the supplier's work conforms to the expected level. The recipient must be a constant watchdog.

Once on the learning curve, the interactive and on-the-job aspects of the projects pushed us quickly up the admittedly steep learning curve, as this chronology shows:

1970-1986: Acquisition of basic technology

1986-1995: Buildup of technological self-reliance capability through project repetitions

1992-2001: Development of next-generation reactors

1999-2006: Enhancement of nuclear power technology with emphasis on core technology development

2007: Basic buildup for nuclear technology advancement and preparations for plant export.

- **Construction Management**

No manual or textbook on construction management and project scheduling can hope to match the direct tutorial and hands-on involvement of an experienced project manager or a professional project scheduler from offshore, and this is especially true for the very first nuclear power plant construction projects. The experienced foreign professionals can guide the locals on the well-trodden path of power plant construction, saving the locals from having to reinvent the wheel every so often. Repetitive trials and errors can be avoided, and the project can be finished on a timely basis and on budget.

When it comes to hiring outside help, we recommend top-notch consultants, even if it means bigger outlays in fees and salaries. Pennywise and pound foolish is an apt maxim to hearken to here, and we all know how bad consulting advice can lead to millions of dollars in problems to fix down the road.

Korea's first and second nuclear power projects were undertaken on a turn-key contract basis. The suppliers were fully responsible from design to test operation, and the projects were completed within schedule and budget. Korean engineers and technicians were involved in every step of the process, and they were eager to learn and absorb the tangible know-how from the foreign suppliers. The deployment of Korean personnel in every aspect of the project meant, too, that the suppliers could realize a saving in their personnel expenses.

In short, it was a win-win situation for both parties: The supplier could save in personnel deployment, while the buyers' personnel could become proficient in the new technology through on-the-project participation. This on-the-job learning gave us not only new knowledge but also fomented within us a determined self-confidence necessary for confronting the subsequent projects which we, for the most part, carried out on our own.

After the completion of first two turn-key projects of the nuclear power plants in Korea, the construction company dispatched many of its engineers to KAERI for training in nuclear basics and the concept of quality control and quality assurance systems. Needless to say, this construction company has been the most successful bidder in the public bidding for many subsequent nuclear power plant construction projects. And this particular firm has grown to be one of the top-notch construction-engineering companies in the world market in terms of work progress, quality, and amount of contracts.

When I was an engineering student, I was very impressed with the following lecture from a much experienced professor: It was something to do with the reshuffling scheme of plant managers along with the progress of construction and operation phases of thermal power plants:

CONSTRUCTION PHASES AND THE PREFERABLE CORRESPONDING PLANT MANAGERS

Phase	Plant manager
Site preparation, building	Civil engineer
Equipment installation	Mechanical engineer
From test operation to initial operation for some years	Electrical engineer
After some years of initial operation to the end of plant life	Chemist

The professor stressed the importance of water chemistry and corrosion control of the materials in a power plant time and again, saying that the availability of the power plant is greatly dependent on the control of water quality and the preventive measures against material corrosion. I think that this point is not only limited to a thermal power plant but also to a nuclear power plant as well.

- **Measures for Winning Public Acceptance**

In any society, one finds ardent supporters for national nuclear projects as well as activists agitating against them. The general public, for the most part, remains unperturbed, neutral, and non-biased. The proportions of each group tend to fall in place in a bell curve.

Professional anti-nuclear people are bold, quick to act, and internationally well-connected. They do not shirk from aggressive tactics. Above all, they are clever with presenting nonsensical data in plausible terms, and they seek to provoke. It is difficult to win a public debate against them since they are quick to counter our arguments with unfounded facts and data. The long and strenuous efforts of the Korean nuclear community to engage and win over these radical anti-nuclear activists through rational discourse have not borne any fruit. All our sincere and time-consuming face-to-face discussions with them have failed totally.

What we have learned is that in order to win wide public acceptance of nuclear power, we must focus on the unthinking general public in the middle: the housewives, students, children and, especially, those in the mass-media, rather than waste our time wrestling *mano-a-mano* with incorrigible anti-nuke activists. A winning campaign will require our total commitment for the long haul, with lots of patience, sincerity, and, of course, uncontestable facts and data with

which to present our claims.

Using straightforward and simple language, we must appeal to reason and common sense, and make a case for how nuclear technology can ensure environmental conservation and at the same time provide a stable energy supply for now and for future generations. Hearts and minds must be won over from an early age and one of our long-term strategies is to encode the concept of nuclear energy benefitting human civilization and kindling electric candles for our offspring in textbooks at all levels.

Technological Self-Reliance Capability

In retrospect, Korea's pace toward a self-reliance capability for developing nuclear technology has been slow but persistent over the years. It was fortunate that continued efforts have been dauntlessly employed in step-by-step fashion.

First was the learning process of practical know-how from the mentors, either in the form of training courses at home and abroad or on-the-job training at the sites, and second was the endeavor for developing basic software and hardware technologies. This was followed by the third step, which is the tangible realization of design-engineering-manufacturing as well as system analysis of necessary systems. Here are some of the major footprints regarding the technological development of domestic capability in the nuclear sector.

- **CANDU Fuel Development**

Technological self-reliance, or so-called technical localization, has been a magic word in the Korean nuclear community. First of the all-out endeavors for the localization commenced with the development of CANDU fuel at Korea Atomic Energy Research Institute in the late 1970s. Our researchers and engineers employed their utmost efforts at this, working 12 hours per day and 7 days a week, around the year.

As the result of their endeavor at home and in Canada, KAERI people succeeded in designing CANDU fuel bundles, and then approached AECL (Atomic Energy of Canada Limited) for the use of CANDU fuel technology. AECL, the Atomic Energy of Canada, Ltd., claimed $26 million of it.

There were lengthy *vis-à-vis* negotiations between KAERI researchers and AECL staff involving the proprietary information issue. During the negotiation process, Canadians recognized that the very fact that KAERI researchers possessed sufficient CANDU fuel design know-why and know-how, almost everything from its alpha to omega, meant that there was nothing much to be transferred to the technology recipient. As a symbol, however, AECL requested $1.00 from KAERI for the use of the CANDU fuel design technology.

We still feel extremely grateful to our AECL partners for their generosity in this regard. It was our first step toward the nuclear technology self-reliance avenue.

The second step was the actual fabrication and test-proof of the CANDU fuel bundles. Because it was mandatory for the KAERI-made fuel bundles to be test-proven under the actual operating conditions for their integrity before being loaded into a CANDU reactor, KAERI was obliged to ask AECL for help.

The Korean-made fuel bundles had to be tested at NRU, a materials-testing reactor in Canada. The test fee quoted from Canada was $3 million, which was, however, far more than what KAERI had in its coffers. In fact, KAERI had only $0.4 million for it. Eventually, the three-day negotiation between AECL and KAERI was broken off, and the KAERI delegation went out to Montreal Airport to return home in despondency.

But while the Korean delegates were waiting for the boarding announcement, they were abruptly visited by AECL's vice president, who graciously conveyed the word that the Canadian government had authorized AECL to sign the contract for the irradiation of KAERI-made fuel bundles at NRU at $400,000.

Thus the contract was signed at Montreal Airport on Oct. 5, 1982.

Canada's favor was not limited only to the exceptional reduction of the contract amount but also extended to invisible support for R&D activities in this regard: Under the positive cooperation of Canadian colleagues, three Korean-made fuel bundles were loaded in the NRU reactor for a seven-month test period. During the test period, all kinds of test data were obtained by the measuring instruments of the Canadian laboratory, with the help of Canadian colleagues.

In June 1984, the fully tested fuel bundles were discharged from the NRU reactor, and the result was more than satisfactory.

Our track record attests to the fact that CANDU fuel development was Korea's major march toward the lengthy technological self-reliance path for the development of nuclear software and hardware. The expenditure KAERI put up for CANDU fuel development was merely 0.3 percent of what the Canadian developer had initially invested for this fuel development.

- **PWR Fuel Development**

Of the operating power reactor fleet, 16 out of 20 reactors in Korea belong to PWR type, purchased from two different countries, the U.S.A. and France. Since PWR fuel is made of enriched uranium, the related technical specifications are complex and more stringent compared to other types of fuel. In particular, its design technology is one that cannot be easily mastered. Furthermore, codes and standards applicable to the design, manufacture, inspection, tests, and surveillance of the fuel in these two countries are different in the U.S. and French programs.

In order to jump over this hurdle and to achieve the localization objective at the earliest possible period, with the least amount of expenditure, KAERI ended up with the following conditions for importing technology from abroad:

(1) KAERI should be fully empowered, including in its selection of technology providers. Priority will be given to the degree and contents of the provider's technology-transfer terms from KAERIs perspective.

(2) The contract form will be a joint design between technol-

ogy provider and recipient. However, the responsibility for the integrity of the output will be borne by the recipient.

(3) The construction cost for the fuel fabrication plant to be built at home will be financed by domestic (Korean) sources.

As the result of public bidding, the German firm KWU (Siemens) was selected, because its terms and conditions for technology transfer were most favorable among all bidders. It was agreed in the contract that the training for recipient party's engineers will be carried by on-the-job participation; that is, to deploy trainees at each specialty group and every job site from the beginning. This new training concept was considered plausible and workable because most of the trainees had already been exposed to the fundamental technologies, and the majority of them had a few years of a post-doctorate career. In addition, the Korean trainees at KWU worked more than 60 hours per week with tenacious effort.

At last, the PWR fuel fabrication plant was constructed at KAERI within the budget and time frame. At the same time, the nuclear fuel group became legally independent from KAERI in 1989, and it was named KNFC, Korea Nuclear Fuel Company. At present, KNFC supplies all the necessary CANDU and PWR fuel in Korea. KNFC also fabricates the zircaloy tubing, which accounts for more than one-third of the nuclear fuel fabrication cost.

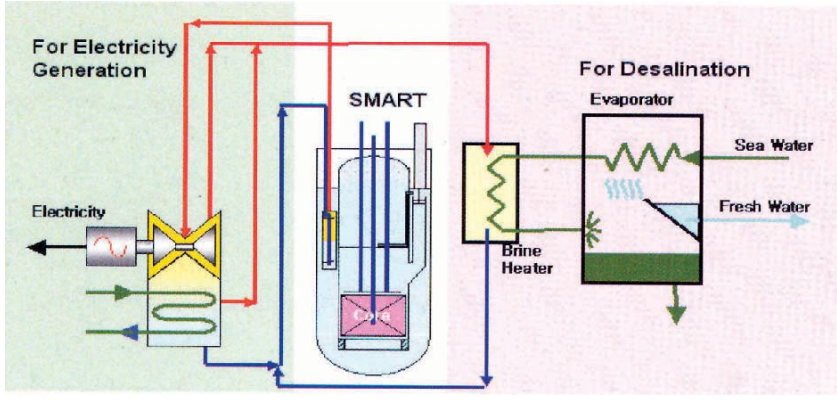
Korea's Changing Status and Role

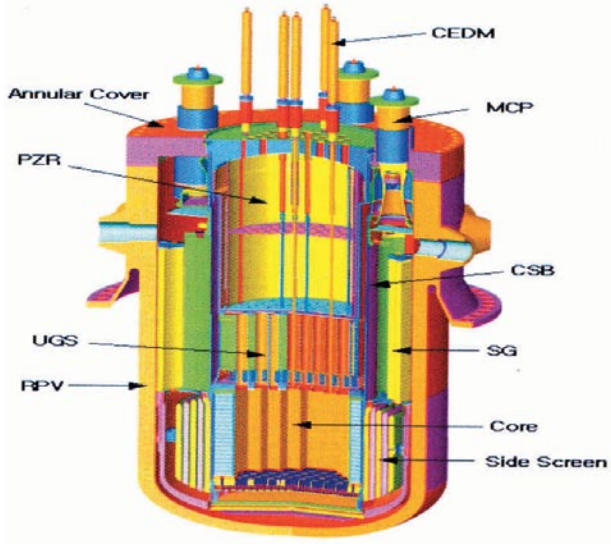
Korea has gone through thick and thin, with many challenges, and is the only country in the world, that has transformed its status from an LDC (least-developed country) to a nuclear-developed nation in the past 50 years.

When my generation was young, in the 1950s and 1960s, we were stricken with hunger and cold, clad in tattered clothes, and we usually slept in naturally well air-conditioned rooms without

Figure 3

KOREA'S SMART: A DUAL PURPOSE REACTOR FOR POWER GENERATION AND DESALINATION





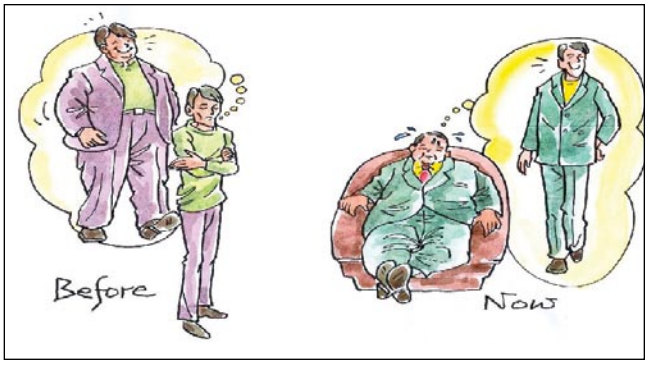
SMART stands for System-integrated Modular Advanced ReacTor, designed by the Korea Atomic Energy Research Institute as a 110 MW electric power reactor, enough to meet the demand for electricity and water for 100,000 inhabitants.

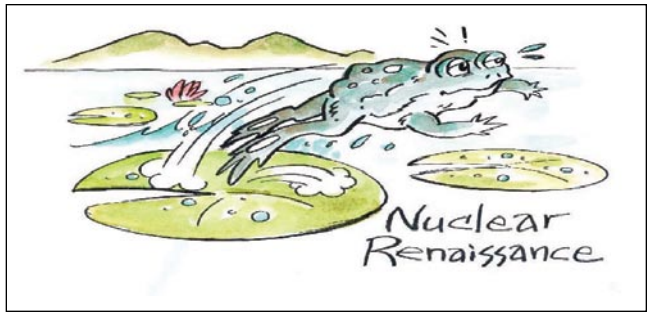
Human history is entering a new era, wherein a severe shortage of water is presumed to occur in many parts of the world, as a result of climate changes, rapid population increase, and industrialization. To cope with this problem, KAERI developed SMART, with the blessing of the IAEA and in consultation with a few water-thirsty countries.

SMART is an integral type reactor with new innovative design features and proven technologies, aimed at achieving enhanced safety and improved economics, by incorporating inherent safety improvement features and reliable passive systems. The improved economics is achieved by means of system simplification, component modularization, construction time reduction by in-shop fabrication and site installation, and increased operating availability.

The low power-density design has a core fueled by uranium oxide, and is proven to provide a thermal margin of more than 15 percent to accommodate design basis transients associated with critical heat flux. The soluble boron-free design provides a strong negative moderator coefficient over the entire fuel cycle and therefore improves reactor transients and load-following capacity. A modular type once-through steam generator has an innovative design feature with helically coiled tubes to produce superheated steam at normal operating conditions.

All major primary components are contained in a single pressurized vessel. The system pressure is passively adjusted by partial pressure of steam and nitrogen gas filled in the pressurizer in accordance with variation in pressure and temperature of the primary coolant.





beds in the winter seasons. At that time, our hope was how to become affluent, and, in other words, it meant to be fat, preferably being full of nutrition storage under the skin.

These days, in the 21st Century, people desire not to be obese, but to become slim and thin, even wearing intentionally tattered blue-jeans. Thus, people's hopes change with time, and the utmost desire of mankind in the present era is sustainable development along with environmental conservation, and nuclear energy can be one of the major contributors in this equation.

The Republic of Korea joined the Organization for Economic Cooperation and Development in 1997, and also the Geneva Group in 2006. Until last year, Korea's United Nations Base Rate Share had been 1.73 percent, but it was increased to 2.17 percent as of this year, thus becoming the 11th highest among nearly 200 U.N. member states; it corresponds to our GDP or GNP. (The U.N. Base Rate Share of the economic giants, the United States and Japan, is 25 percent and 12.5 percent, respectively.)

IAEA's case study report published recently pointed out that nuclear energy in Korea played a crucial role in realizing Korea's "Economic Miracle." The main contents of the report are:

- Korea's nuclear energy (including RI and radiation) constitutes 2.2 percent added value to its GDP.
- Nuclear technology self-reliance has been demonstrated by the development and deployment of the KSNP, the Korea Standard Nuclear Power Plant, PWR-1000 MW, which is unique in the world.
- Korea is a successful example of national development from an agro-society to a high-tech state that is enjoying several top world commodities in the global market.
- Korea was a "recipient country" when the IAEA was established, but is now a representative "donor country."

In this regard, I have a say: As far as nuclear training is concerned, I was a technology recipient from the IAEA and the United States on many occasions in the 1950s to 1970s. After that, people started calling me a nuclear engineer. In the 1980s-1990s, I was often recruited by the IAEA as a consultant for technical projects, and I presided over many technical meetings as chairman.

Several years ago, the IAEA dispatched me and Dr. John Rundo of the United States to Africa to evaluate the IAEA-supported projects, to interview former IAEA trainees, and to help the member states in drawing up their national nuclear development program if necessary.

In this connection, it has been customary for the host country to provide the IAEA Mission with a car and chauffeur. Nevertheless, one of the member states did not do it for us. So we had to rely on taxicabs and a rental car. Upon their request one day, Dr. Rundo and I gave a one-hour lecture each to a few hundred participants. At the end of my lecture, I wrote the following words on the blackboard : "We like Africa. We love Africa."

I read it such that we like Africa because of many reasons, and we love Africa from the bottom of our hearts. Then I added the third line : "We need Africa in terms of ah-free-cah."

To this expression, a dignitary sitting at the first line of the audience stood up gently and shook hands with me, saying, "Sorry, we will send car and driver to you from tomorrow."

Research and Development

R&D stands for Research and Development. The scope of R&D has been extended to R&DDD by the addition of Demonstration and Deployment.

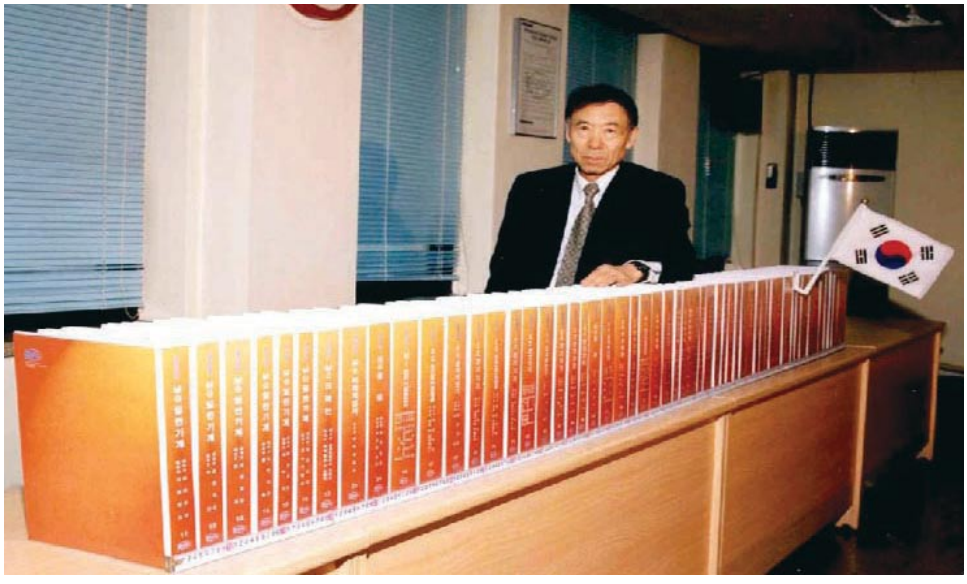
I'd like to introduce a new vocabulary, under the acronym of R&Penta-D, or R&DDDDD, that is supplemented with Driving (Operation & Maintenance) and Decommissioning. In our business, nuclear personnel must be responsible for carrying out a lifelong caretaker role of facilities, up to the end of their life, that is, until plant decommissioning. That is why I'm proposing to add two more "D"s to R&DDD.

Here are the critical items for our R&D activities:

- Fuel cell and hydrogen production by a nuclear reactor, as well as hydrogen storage and distribution. The high-temperture gas-cooled reactor, HTGR, must be further upgraded and improved in this regard.
- The development of superconductor and electricity storage technologies.
- Wireless transmission of electricity.

At present, Korean researchers announced that they have succeeded in transmitting electricity without a conductor for a distance of 1 centimeter, and NASA researchers have announced that they have accomplished a wireless transmission of electricity between a 1-kilometer gap.

- The development of a fusion reactor. As the international tokamak ITER stands for "way" in Latin, it will yet be a steep



Dr. Lee with the 2005 edition (in 83 volumes), of the Korea Electric Power Industry Code, whose publication he organized and oversaw

and thorny way with lots of engineering and material problems, and such problems must be solved by "Tinkers" rather than "Thinkers."

- Once I was deeply engaged in the submarine transmission line connection project between Korea and Japan, which spans 200 kilometers. To this end, my friend recruited a cable manufacturer, bank, engineering company, and so on; and actually there was consensus or agreement between the two parties for the implementation of this project, considering the merit that the electricity price in Korea is 45 percent of that in Japan, and that electricity quality in Korea is superb.

Conclusion

As of the end of 2006, the number of operating nuclear power plants in the world was 435 units or 370 gigawatts, plus 26 additional units (21 GW) that are under construction. By 2030, global nuclear power generation capacity will increase to 640 GW, that is 1.73 times the present capacity (370 GW). This means we will have 270 additional gigawatts about 270 more units than now during the forthcoming 23 years, and the nuclear share out of the total installed capacity will augment from the present 16 percent to 27 percent by that time.

Most of the currently operating nuclear units will be either refurbished, life-extended, shut-down or decommissioned by 2030, and all such works will have to be carried out by nuclear professionals. In this context, today's nuclear students will be called upon to implement these projects, which constitute a tremendous volume of work.

In fact, there are many people and at the same time, there are only a few people. Here "many people" means the general public, who are waiting for the supply of reliable, safe, and cheap electricity; while "few people" connotes the capable and dedicated manpower who can be deployed to meet these requirements from the general public. To make a long story short, the future will hold lots of nuclear projects.

Nuclear projects require long lead and construction times, lots of preparatory work, huge capital cost, a variety of numerous dedicated specialists, and, in particular, public acceptance. However, nuclear technology is younger than those of the computer, television, airplanes, and others. It is, therefore, worth participating in its challenges in consideration of the significant potential benefits in the future, looming on the horizon.

One day, Albert Einstein was asked by a newspaper reporter: "Why can't we get rid of the nuclear war threat?"

"Because politics is more complicated and difficult than physics," was his answer. So, I'll not touch upon these tricky politics here. I'll wrap up this lecture with the following solicitation: To those who are from countries or organizations without an operating nuclear reactor and with relatively underdeveloped industrial or institutional infrastructures, my message is to go and preach the nuclear gospel even in the wilderness, and win converts and public mandates—that is, carry light to the darkness with nuclear light bulbs

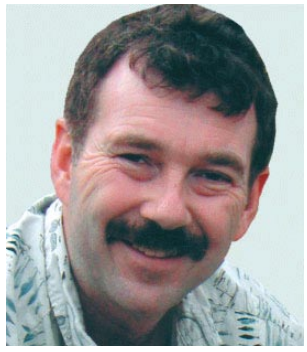
To those who are from countries with aging nuclear facilities and whose nuclear program has been inert for decades, my message is that the Nuclear Renaissance is never a free gift from a merciful and generous Santa Claus, but can only come from unending do-it-yourself efforts and perspiration. Your forebears have already gone down the steep learning curves, and you are already blessed with a font of native original insight for the challenges ahead.

To those who are from countries having steady ongoing nuclear projects and whose operational record has been satisfactory, my message is that your first enemy is the self-complacency that lurks within you. What you desperately need is not complacence but continued complaisance in your daily work! Always be vigilant and innovative. In addition, you have to pay heed to the catch-phrase from the Japanese industry: "Wring your dry rag further and once more, for that last drop."

In conclusion, you are cordially invited to display your caliber as a robust "Nuclear Stallion" here, there, and everywhere, all the time from now on. In order for me to see your Earth-saving activities and also to clap my hands in applause for your success, I'm going to apply to the Absolute Being for my "Life Extension."

INTERVIEW: DR. R. TIMOTHY PATTERSON

There's No Correlation Between CO_2 and Climate Change



Timothy Patterson, Ph.D., is a Carleton University Professor of Geology, Director of the Ottawa-Carleton Geo-Science Center in Ottawa, Canada, and a chief collaborator with Martin Durkin in the 2007 documentary for Britain's independent Channel 4 TV, "The Great Global Warming Swindle." He describes himself as "half a biologist, half a geologist, sort of in between. But luckily a biologist with a long view, looking at deep time, which is what you need if you're looking at this problem."

Gregory Murphy interviewed him on Dec. 28, 2007.

Question: We are interested in interviewing people like yourself who have done research, and who may at one time have thought that CO_2 drove climate, but after doing research, found that this was not the case.

Well, to be truthful, I didn't think about it all that much, because it's not really what my research was about; I worked on paleo-oceanographic projects.

How it all started was, I got a pretty large grant from the Natural Sciences and Engineering Research Council of Canada. The reason I got this grant, was that British Columbia hasn't been settled all that long, like lots of places in North America, and there are major fisheries out there—not just the salmon that you always hear about from the West Coast, but they had anchovy fisheries, sardine fisheries, herring fisheries, and so on. Their problem was that periodically, these fisheries would just crash. They'd have a great fleet one year, going after these fish, and the next year, nothing! And so, fisheries managers were pulling their hair out; but the problem was, their records were very, very short, so they had nothing to go on. They just didn't really understand what was going on with the system.

"You think we know everything about climate, but here we are understanding major, major parts of the climate system that nobody even recognized until the late 1990s!"

So I got this funding, to go in and try to assess fish records over thousands of years, because the sort of research I was doing allows me to track that. We knew that there were certain inlets in the West Coast that didn't have any oxygen in them, so that various sorts of fish remains, like their scales, would be very, very well preserved. Our idea was to look at very high resolution, to see if there was any pattern with the fish, to see if we could figure out what was going on.

We started to do that in 1998. We looked at the fish records, and the microfossils, and the sediments themselves—they were beautiful sediments. What goes on in these inlets, is that basically there's no oxygen; anything that falls into these inlets, just stays there, preserved. The Aleutian Low dominates climate in the wintertime, and results in a lot of rain, and you end up with a lot of sloughing off of material into inlets, and that forms a dark layer. Then in the summertime, there's upwelling going on, which is related to the North Pacific High at this time of year, and you get sink layers and phytoplankton, and so on. The fish like that, and so you get a layer of these things. So you get a light layer and a dark layer.

And so, we were able to go in and get something like a 6,000-year record of these laminated sediments, year-in, year-out. And when you start to pull the cores out, after you X-ray them, right away you see patterns: Some years are thick; you can see it's a great year for upwelling, because the light layer will be thicker, and then other years the dark layers will be thicker.

And so, we deployed computers that would go in, and we X-rayed the samples, and then we scanned them, and we began to pull patterns out, using "time-series analysis," various sorts of techniques. And we started to look at the fish records with very high resolution, which resolves phytoplankton and everything else there [Figures 1 and 2].

The Impact of Sunspot Cycles

The interesting thing that was starting to pop out for us, was that we began to see sunspot cycles. There are different "flavors" of sunspot cycles: There are the 11-year sunspot cycles, and the 88-year sunspot cycles, and the 200-year cycles, called the Gleissberg Cycle. And we were also recognizing, that no one big climate event was popping up. That was kind of causing us to pull our hair out, because, looking at the literature, there is a correlation between sunspots and climate, but no one had a driver for it, because there's not enough energy across the sunspot cycle.

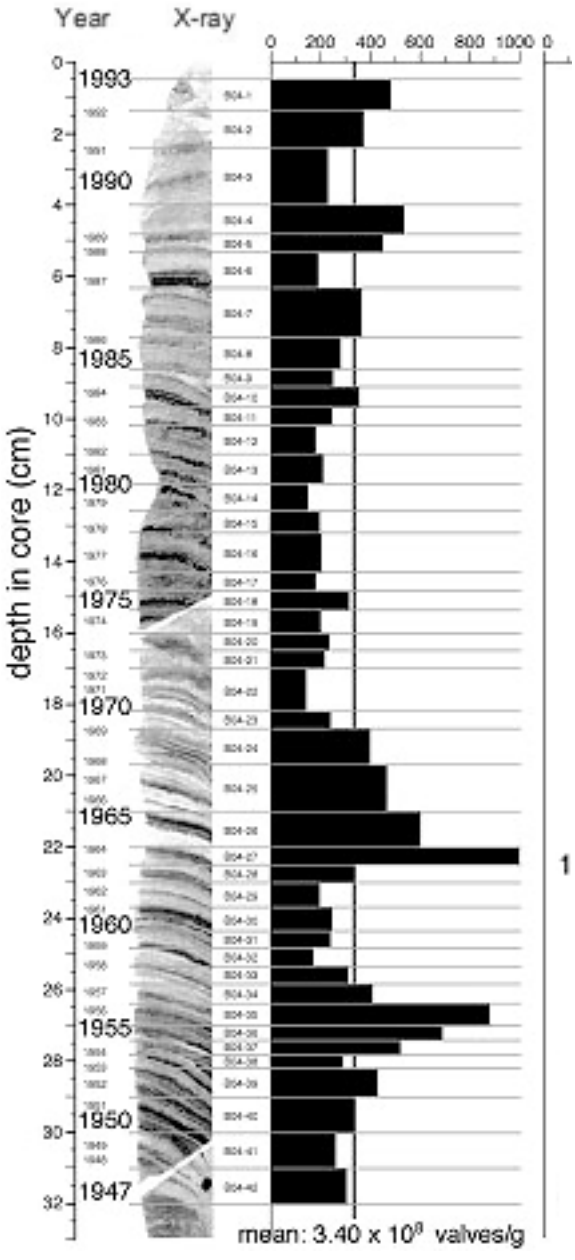
But luckily, as a lot of this work was coming to fruition, Jan Veizer from Ottawa and Nir Shaviv from Israel published their paper.[1] Since Jan Veizer is right here in Ottawa, I went to a couple of talks that

1. N. Shaviv and J. Veizer, "Celestial Driver of Phanerozoic Climate?" *GSA Today*, July 2003.

Figure 1

DIATOM CONCENTRATION
(millions of valves/g)

The dark layers are formed in cold, rainy weather, when mud falls into the basin; the light layers are formed in the Summer, when there is greater upwelling of nutrients form the sea floor, and hnce a greater growth of the diatom population.



Source: R.T. Patterson, A. Prokoph, C. Wright, A.S.. Chang, R.E. Thomson, D.M. Ware, "Holocene Solar Variability and Pelagic Fish Productivity in the NE Pacific," *Palaeontolgia Electronica*, Vol. 6, No. 1, 2004.

he was giving, and the light bulbs began to go off. He explained about cosmic ray amplifiers, and how that could amplify the solar effect, with the clouds and so on. And that gave us our amplifier.

And so, I began to look more closely at it, and our model is much, much more mature now—we've looked at more inlets, we've got more data—and we know now that on the West Coast, it's this combination of the clouds that Jan Veizer and [Henrik] Svensmark [at the Danish Space Research Center] and some of these people talk about; but there's also an impact, across the sunspot cycle, of changes in UV radiation at low latitudes: There's something like a 0.4 percent variation. And that has an impact upon the jet stream; the jet stream is like a rope that whips around the world, and causes the movement of the North Pacific High and the Aleutian Low. And they move according to the 11-year sunspot cycle as well—move north and south, east and west. And, that movement controls the upwelling and the winds, and so on, in the region, and that is what impacts the upwelling and the rainfall, and so on, in my inlets. That's what I see.

It's a perfect match! And it's not just the inlets we started on, in the southwestern part of British Columbia; but the ones in the north now, show the same sorts of patterns.

It's been very exciting to see this sort of thing. This is how I got really interested in looking at the sunspots, because the impact upon climate in the West Coast is very, very clear, and it shows in our records, right up to the present time.

So, at that point you have to say, "Well, it's not really my area of research," but you start to think about carbon dioxide. And this is again due very heavily to Jan Veizer at the University of Ottawa. He won a top science award from Germany in the 1990s, and he got something like $2 million that he could spend any way he wanted to. So he wanted to look at the record of carbon dioxide through all the Phanerozoic, at very, very high resolution. And this is where the work he did with Shaviv came in, and they found that *there was no statistical correlation between CO_2 and climate*.

And in my research, I didn't really see any CO_2 impact at all; there was nothing changing in more recent times that didn't correlate well with the sunspot cycle. So, that's how I got where I am.

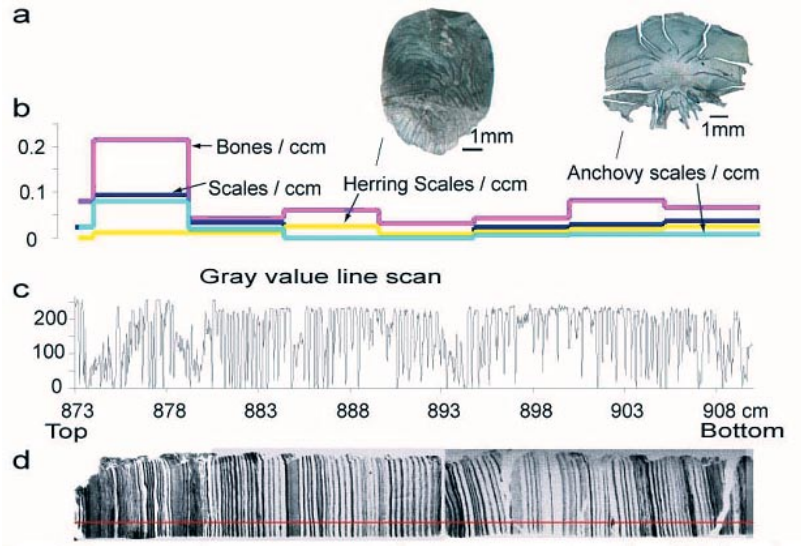
Paradoxes Ignored by Al Gore

Question: When you testified at the Commons Committee on Environment and Sustainability [in Canada in 2005], you pointed out the real paradox in geological time, is that CO_2 hasn't driven climate at all.

Yes, it doesn't correlate, on any scale that you want to look at. Again, that's not my research; that was based on a literature survey. It's very, very clear, when you go through any of the literature—not just looking at Veizer's, but any of the research that's done on carbon dioxide—there's not a good correlation. And the ice core records that Al Gore shows up in his "An Inconvenient Truth," he misconstrues, in that, *the CO_2 lags behind the temperature*—that's just objective! That's just what is reported in the literature. To claim otherwise, is ridiculous.

And what gets me, is that when people can see this sort of data out there, why would they think that today, carbon dioxide would behave any differently than it

Figure 2
FISH SCALES AND BONES FROM SAMPLE



Source: Patterson et al., op cit.

Herring (light bands) thrive during the Summer, when there is greater upwelling of nutrients, and the diatoms that they eat are plentiful; anchovies (dark bands) prefer colder, rainier weather, when there is more mud at the sea bottom.

did in the geologic past? Which is 99.999 percent of the time? When carbon dioxide has been up to 16 times higher than it is at the present time, the temperatures—the Earth was once, in the Ordovician, in an Ice Age! And through most of geologic time, except for in the Permian, the CO_2 levels have always been much, much higher than the present time. So, there's just really no correlation between climate and carbon dioxide.

That's basically what I testified, and I showed them some graphs and so on, and everybody nodded appreciatively. And we all had a little bowl of soup after—they serve nice lunches at these Commons hearings—and chatted about it, and everybody said platitudes about that wasn't going to change anything, so thanks for coming, and that was it!

Question: What you said at the Commons hearing really highlighted the paradox, that 450 million years ago, CO_2 was 10 times higher—

More like 16 times higher, which is way higher! But anyway, no matter whether it was 10 or 16, it was an Ice Age, and so that's some of the paradox. But again, as you move on up into the glacial—you know, we're an icehouse world right now. CO_2 levels are low for a reason, and they are low, geologically speaking, mainly because we have hardly any time to warm up between glacials. The way it runs right now, you get about a 15,000-year interglacial, which we're in right now, we're near the end of it, and then you go into about 100,000 years of glaciation. And the problem with that is, a lot of CO_2 gets sequestered in the oceans, and it gets very cold, and the CO_2 just gets sequestered in these oceans, and then, when it warms up again, it really doesn't start to come out again until it's time to go back into the next Ice Age! So, just in the last couple million years, CO_2 levels have been really, really low for just that reason: It's cold most of the time, and because the oceans are deep and wide, and they sequester an enormous amount of carbon dioxide.

Why would you say that a correlation in temperature and CO_2 has occurred since the late 1980s, why would you throw out the correlation with the solar cycles, which match not only now, since the 1980s, but all the way back through the records that we have? I think it's a very, very clear case.

I just can't see how people who have jumped on this bandwagon have stayed there! Because from a geological perspective, there's really no reason for them to be there. Maybe that's why, in the geological community, you don't have nearly the same majority of people claiming that human-generated carbon dioxide is driving climate, because we look at a longer record. And if you go to geological meetings, it's a much more interesting debate, because I think the majority of the people are on my side. It's funny how this whole debate has been hijacked, I think, by biologists and geographers.

Models and Understanding Climate

Question: You said that you got started looking at this, by looking at the effects on fisheries. A lot of the work that was done on studying the Pacific Decadal Oscillation had to do with the salmon fisheries.

Yes. And the funny thing was, it shows how little we understand about the climate system. They didn't even recognize the Pacific Decadal Oscillation until 1996. And now, that is recognized to be a key component of what drives this 22-year drought cycle, in the experience in the western part of North America, and it sometimes reaches even farther afield. Some people are suggesting that is closely linked to sunspot cycles as well.

So, there's all kinds of interesting work. And what I find, and I tell my students often: You think we know everything about climate, but here we are understanding major, major parts of the climate system that nobody even recognized until the late 1990s! And we're still discovering lots of things. So the claims that we understand everything, and that the models are perfect and so on, are just ridiculous. (I'm not a great model fan, either!)

Question: I can see that.

There tends to be a commonality within the geological community, too. They tend to use computers for doing the studies, like breaking down core samples, and showing the layers and how you do time series analysis off that—yes. I interviewed Nils-Axel Mörner,[2] and he told me, they don't understand sea level rise, because they sit there—a bunch of meteorologists sit around their computers, playing games, and they don't go out and

2. www.21stcenturysciencetech.com/Articles%202007/MornerInterview.pdf

actually muck around and look at things. He identified people who actually do the physical research, as tending to be more on the skeptical side on this whole climate change issue.

I would think that's entirely true. And the modelling community, they're very smart with math and so on. But I think, at this stage of the game, trying to use these things as predictive tools is very difficult, mainly because there are major, major parts of the climate system that we just don't quite understand yet. And the models have to be so complex, that basically, I think some of the huge ones spiral out of control, that there are things going on within the models that fall outside all bounds of scientific understanding. And no one who uses these models, understands how they work.

They don't deal with clouds, for example. And so, if you like this galactic-cosmic-ray-driving climate idea, that basically they're causing changes in clouds and that's the amplifier, well, here you have models that can't really even deal with clouds! And the issue, too, of not being able to reproduce climate over the last 60 years; they basically can't reproduce what's happened! So, you're supposed to use that as a predictive tool? I find that that's a real problem.

They're great tools, I think, for understanding a process, if you could look at some little part of it; but the work that's been done, using them as a predictive tool, I think is ridiculous.

I even saw that William Ruddiman wrote a textbook a couple years ago: He's at the University of Virginia, a carbon dioxide guy, who came out with a silly paper a couple of years ago that suggested that early Indians and early Western Europeans lighting campfires, was what staved off the next Ice Age.[3] He basically made a claim that because the population was growing—it would still be pretty small, several thousand years ago—that they would clear woods, and light fires, and so on, and that basically that's why we aren't in an Ice Age, because of the carbon dioxide released from the burning of wood. I just thought, "One good forest fire in a dry year would probably add up to everything these people would do altogether."

Anyway, he wrote this textbook, and he said, basically, here's the way the process works: The geologists collect data, and then they provide some interpretation, and the modellers take the data, and they run the model. But if the model doesn't correspond to the geology for which it was supposed to be a predictive tool, if it couldn't reproduce it, then perhaps the geologist had collected the data wrong! I was reviewing this textbook, and I made the guy take it out, because it was the silliest statement that was ever made. That basically, if you have real physical data, and someone does a model of it to predict the future, and the model doesn't correspond to the actual collected data, *then there's a problem with the actual collected data!* It's not the data you throw out, it's the model.

This is the sort of mindset that's in that community. And so, again, they're mathematicians, these people, they're not regular guys, that go around and get their hands dirty.

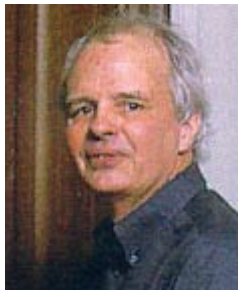
But the funny thing is, it's the IPCC [Intergovernmental Panel on Climate Change], and every time they come out with these sorts of model projections, that's what they jump on. If you watch the news: "Here's a new model out—this is what it says, it's gonna be even worse than it was before"—and that's what the media reports, and it's just fantasies.

And you know how it all got started: In 1988, [James] Hansen [NASA climatologist and propagandist for anthropogenic global warming] came out with his model, which predicted, what was it?—a 10° celsius increase in the next 50 years or so? It was like the super-computer equivalent of a Nintendo 64 or something; it was ridiculous! His model was so simplistic, it would be a *joke* today! The grid sizes were huge! Who could put any credence in it? But everybody jumped on it, and they said, "This is it, this is it!"

Question: Did you hear the story about the stagecraft when Al Gore called Hansen to testify to the Senate? Gore, when he was a Senator, brought Hansen to the Senate to testify. It was hot weather, and

3. William F. Ruddiman, "The Anthropogenic Greenhouse Era Began Thousands of Years Ago," *Climatic Change*, Vol. 61, No. 3, December 2003.

Malthusian Claims Pandemic Disease Will Stop Warming



William F. Ruddiman of the University of Virginia argues that man-made global warming began thousands of years ago, as a result of the production of CO_2 caused by the discovery of agriculture and subsequent technological innovations in the practice of farming.

The other main source of CO_2, Ruddiman claims, was the cutting of forests and burning of wood and peat to heat homes in Eurasia and North America, which he maintains is why glaciers didn't advance farther south from the Arctic, as they did in previous glacial advances. Ruddiman bases this bizarre hypothesis on fraudulent ice core data and computer modelling of the extent of deforestation in Europe and North America over the past 8,000 years.

Ruddiman is a neo-Malthusian and a follower of "population bomb" hoaxster Paul Ehrlich. Ruddiman repeatedly asserts that man created climate problems by developing new technologies which caused a slight rise in CO_2 . (The amount of emissions is barely above the level of natural variation from outgassing from the oceans.)

One might laugh at the notion that early Europeans burning wood staved off the worst effects of the last Ice Age which was the response among most scientists to Ruddiman's paper. But his more important point is more blood-curdling: he says that pandemic diseases such as the Black Death of the 14th Century cause a decrease in CO_2 and a decrease in temperature. In other words, such diseases will reduce the population, thereby creating a cooler world. —*Gregory Murphy*

they turned the air conditioning off in the room, opened the windows, let the hot air in; Hansen is sweating, and he's wiping the sweat off his brow, as he's saying that it's going to rise 10°C in the next 50 years—

So you think it's hot in here now, just wait till then!

I think parliamentarians and congressmen should be all told that story, and learn a bit of humility around here.

I was reading somewhere, suggestions that this is sort of a Baby Boomer thing, too, that you have control over everything: The Baby Boomers never age, the Baby Boomers never do this, that, and the other thing. So, the Baby Boomers can control the climate. I think it's ridiculous: How can you possibly legislate that "Climate shall not change 2°C"?

And when I teach my climate class to 500 students next semester, that's the first thing I'll talk about, on Day 1, is that the only constant about climate is change. Because the general public, for the most part, has no inkling that climate has ever been really much different from now. They basically think this is the way the world has been forever!

Canadian Department of Fisheries and Oceans

Canadian researchers lower a scientific monitoring device into the ocean. Dr. Patterson studied the fossils and sediments of British Columbia's coast to try to determine what caused fish populations to flourish some years and crash the next.

The Next Solar Cycle

Question: You talk about how the next solar cycle, cycle 25, or after cycle 24, is supposed to be very, very weak. Some of the solar people I talked to are saying that some of this temperature drop will start a little sooner than you're saying, but around the same time frame.

Yes, I just read that the first inkling of a sunspot of this cycle may have appeared—no sunspot yet, but there was a magnetic reversal the other day. I haven't followed up on that closely, but it's quite interesting, that we've been sitting around with nothing. I guess that every day it gets delayed, shortens it a little bit, and it will make the cycle a bit weaker. So it's going to be interesting to see what happens as we get through this supposedly "big one," and then on to the smaller one after that.

But from a strategic point of view, from this country's point of view—because there's a very good match-up between climate and these solar cycles. If the pattern holds, the last time that there was a cycle like what cycle 25 is supposedly going to be, was during the Dalton Minimum. And during that time, a lot of wheat agriculture was affected. As you know, the Canadian breadbasket is an enormous producer of wheat. In Saskatchewan alone, I think it's something like 22 million bushels of grain every year. You look at what the impact might be, not only of a delayed harvest, but also early frost, and lower temperatures out there, which influences how the wheat heads. I was talking to somebody who suggested that wheat production could fall from 22 million bushels down to 10 million bushels, if you had like a 1-2°C drop in temperature in that region. Agriculture will be very, very seriously curtailed out there.

So from a strategic point of view, that's bad news! And North America is a relatively small continent; you think of Eurasia, which has vast areas that are in grain production—if it's bad here, it's magnified when you get to those places. So, there could be very, very serious agricultural issues when we arrive at the 20-teens.

Question: I've talked to scientists who believe that an increase in CO_2 will actually be beneficial to agriculture. If you look at an increase in CO_2, in, say, an area that has more drought conditions, like in Australia, the wheat would actually benefit from a higher CO_2, because they would use less water, and they wouldn't be so water-stressed.

That's right, but I refer to it from the Canadian perspective, where basically it's a frost issue in the West. And so, if the seasons are shorter and it's not very warm, the CO_2 fertilization certainly is going to help some, but it's not going to offset things all that much. Maybe in parts of the U.S.—okay, the U.S. has great climate variation, all the way from like what it would be in Saskatchewan, in northern North Dakota and so on, right down to places where they'd love it probably a little bit cooler! So, it would probably be better production for them....

The Challenge for Scientists

I think that the biggest problem, is that there's a *real* lack of communication amongst the various sorts of disciplines and sub-disciplines. I wasn't kidding when I said, you go to the earth science community, and you'll find that the overall consensus in our community is much different than you'd see in the biological community, and for some reason, we don't speak out too much, in the earth science community.

And so, I think that people don't quite appreciate that scientists in this community are not quite as excited about the global warming doom, as some of the other community, like the modelers, who are able to somehow get their point across much more effectively. And my hat's off to them, in that regard, I guess. Because we've been failures in the earth science community. Maybe we would not have been in this mess, if we had been more vocal earlier on.

Editorial

Continued from page 3

of the Insects and Infectious Disease division of the Pasteur Institute: www.larouchepub.com/eiw/public/2007/2007_10-19/200 7-14/pdf/52_714_scienv.pdf.

12. There is no "consensus" that the globe is warming. A review of 539 papers on global climate change on the ISI Web of Science database from January 2004 to mid-February 2007, conducted by medical researcher Dr. Klaus-Martin Schulte, found that only 7 percent explicitly endorse the "consensus" that warming is anthropogenic, and only 45 percent agree in some degree with the consensus. The largest category of papers, 48 percent, were neutral on the subject. The ISI Web of Science database covers 8,700 journals and publications, including every leading scientific journal.

13. Global warming from its beginning was devised as a population control policy. It was created as an alarmist way to get people to cut back on their living standards and to curb black and brown populations. For documentation, including damning quotes from 1975 by today's leading global warming enthusiasts, see this author's"1975 Endangered Atmosphere Conference: Where the Global Warming Hoax Was Born," www.21stcenturysciencetech.com/Articles%20200 7/GWHoaxBorn.pdf.

14. "Carbon offsets" and other mechanisms to relieve the "carbon footprint" of the industrialized sector are simply new ways to keep the Third World poor and in the dark, with no access to advanced technology. For example, Climate Care, the carbon-offsetting company features on its website (www.climatecare.org/projects) a cartoon illustration of happy little natives peddling a treadle-pump to get water, and burning a lone solar-powered light bulb, while heating their stove with dung. All this to "offset" the air travel of a guilty emissions-consuming Westerner.

For details, see Gregory Murphy, "Carbon Offsets Are Genocide," www.21stcenturysciencetech.com/Articles%20200 7/GW_genocide.pdf.

Mörner being interviewed in the Maldives in 2001 by MaleTV. His good news that the sea level was not rising there, was apparently too good, and the government censored it.

Global Warming Update

Continued from page 7

CO_2 to sea surface temperature. As the activity of the Sun had caused a warming of the ocean surface over that period, it was no surprise that atmospheric CO_2 tended to increase. A period of reduced solar activity, which we appear to be entering, will allow the oceans to cool, causing a reduction in atmospheric carbon dioxide.

However, in either case the CO_2 level has nothing to do with the climate. Historical readings from the 19th Century have shown carbon dioxide levels much greater than those we see now. But these and other anomalies were systematically removed from the measurement record, as Dr. Ernst-Georg Beck extensively demonstrated (www.21stcenturysciencetech.com/Articles%202007/ True_CO_2_Record.pdf).

One caveat: Despite the close correlation demonstrated in Professor Endersbee's curve, it is also possible that the CO_2 levels reported from the Mauna Loa, Hawaii observatory are themselves part of the gigantic global warming fraud. Mauna Loa is the world's largest volcano, and an active one. The measuring apparatus for CO_2 is set right by one of the vents where the volcano outgasses. To the north, on the big island, is the world's most active volcano, Kilauea.

The full text of Professor Endersbee's article is at: LINK

—Laurence Hecht

Sea-level Expert Publishes New Pamphlet on Climate Lie

"The Greatest Lie Ever Told" is the title of a new booklet on global warming by Nils-Axel Mörner, who recently retired as director of the Paleogeophysics and Geodynamics Department at Stockholm University. Mörner describes his hypothesis that the global warming "horror scenario" came out of the 1970s oil crisis, and the collaboration between Swedish meterologist Bert Bolin and his old school friend Olof Palme, Sweden's Prime Minister. Palme was an initiator of the global climate organization that led to the Intergovernmental Panel on Climate Change.

Mörner then reviews the science and observations of sea level changes, in which he is an acknowledged world expert.

Copies of the 20-page, four-color booklet are $15 and can be obtained by writing to the author, morner@pog.nu. An interview with Mörner and an article by him appear in the Fall 2007 *21st Century,* www.21stcenturysciencetech.com/Articles%202007/MornerInterview.pdf.

Russia's Nuclear Energy Plan For the Next 50 Years

by Marsha Freeman

While the United States wastes precious time, trying to come to a political "consensus" on what kind and how much Federal support should be provided for the revival of nuclear energy development, Russia has decided to deploy all of the necessary resources—human, industrial, and financial—to create a fundamental shift in energy policy. Russia is going nuclear.

The annual conference of the American Nuclear Society, held Nov. 12-15 in Washington, D.C., provided a contrast between the Russian approach, of a national commitment to create the nuclear energy infrastructure for the next 50 years, and the straitjacket of the "free market" in the United States, which is stalling the revival of nuclear power. At that event, Dr. Alexander Chebeskov, from the Institute for Physics and Power Engineering in Obninsk, laid out the systematic multi-decade plan of new nuclear technologies to take Russia into the next century.

One of the first questions from his American audience was, who will pay for this program? The Federal program, to build 20 or so new nuclear power plants in the near term "was accepted," he replied, and will be "financed from the Federal budget, using money from the export of oil." No comparable Federal commitment has been made in the United States.

A follow-on question was asked, about the degree of "public acceptance" of nuclear power. The "public attitude is rather good," Dr. Chebeskov replied. Twenty years ago, during the earthquake in Armenia, "people had to burn trees, books, and furniture" when the power plants had to be shut down. "In the [Russian] Far East, we have the same situation" of a severe shortage of power. "People need electricity at home, and this is their first priority." Three or four people out of five are in favor of nuclear power, he reported.

With the decision by the Federal government to pursue this course, the Russian scientific and engineering community is formulating the progression of nuclear technologies needed to meet Russia's energy requirements through the middle of this century. The goal is to make nuclear fission a renewable, virtually limitless resource for the Russian economy, based on the highest energy-dense technologies.

Alexander Chebeskov, Viktor Dekusar

This photograph of the construction site of the BN-800 fast-breeder reactor was taken in August 2007. The scheduled date of completion is 2012. The BN-800 is a technology demonstration plant, whose design will inform the deployment of half a dozen breeders over the next 20 years.

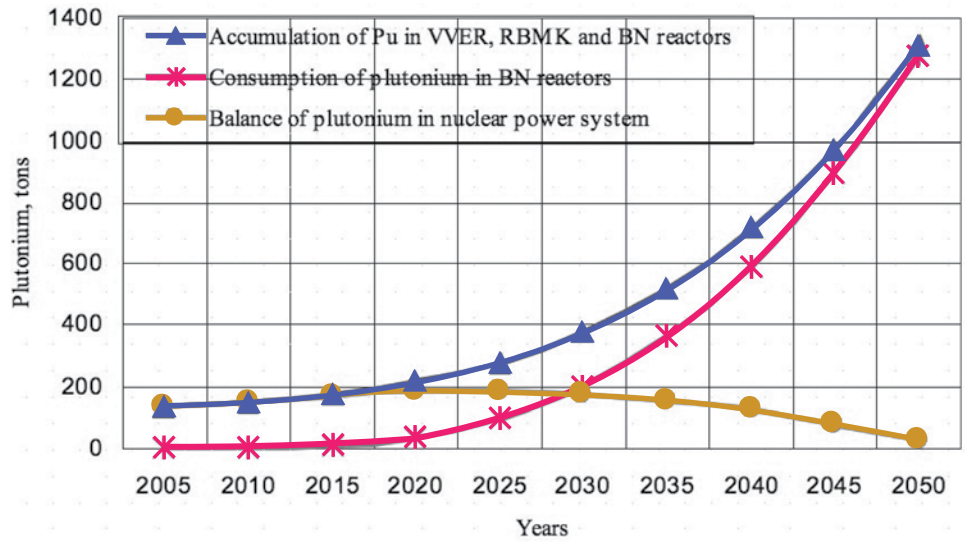
The First Phase

Time is of the essence, Dr. Chebeskov stated. Russia's economic growth has been accelerating since 2000, and there has been a sharp increase in demand for electricity, which has exceeded projections twofold.

Burning fossil fuels entails many problems, as they are finite, dirty, and becoming more and more expensive, he said. In Russia, fossil fuel plants are also very old and inefficient, and must be replaced. By 2030, he said, Russia will be short of oil, and export of oil and natural gas abroad is "more attractive." The goal is to look forward at least a half century, and create a "stable kernel" of technologies in the energy sector. This will be based on nuclear power.

Russia's nuclear development will occur in two phases: from now to 2030, and from 2030 to 2050. Between 2007 and 2020, Russia plans to increase the share of nuclear energy production for electricity from the current 16 percent of the total, represented by 23.2 gigawatts of nuclear capacity, to at least 25 percent, or at least 40 GW. By 2030, 60 GW of nuclear capacity are planned to be on line. The near-term deployment of new reactors will be based mainly on upgraded VVER pressurized water reactor designs.

The two main problems of contemporary nuclear systems, Dr. Chebeskov explained, are first, that they cannot effectively use the plentiful, but not fissile, mined natural uranium. Second, today's



CONSUMPTION OF PLUTONIUM BY FAST-BREEDER REACTORS

By 2020, Russia plans to introduce the first small series of BN fast-breeder reactors, which will use plutonium in their mix of fuel. By mid-century, the pace of breeder introduction will allow the full use of plutonium stocks from power reactor spent fuel and from the breeders themselves, as plutonium consumption matches production.

Source: Alexander Chebeskov and Viktor Dekusar, "Valuation of the Scenario for Innovative Russian Nuclear Power Development."

open cycle, where fuel is used only once, necessitates long-term storage of spent fuel, along with the storage of tailings left over from the uranium enrichment process to make fuel, and of the plutonium that is separated from spent fuel. Both of these "problems" will be solved with new technologies, he said.

To meet the goals for 2030, Russia will add new capacity at the rate of 2 to 3 GW of new nuclear power per year, in order to replace decommissioned units and add new capacity. Next-generation VVER units will be larger, to increase the rate of growth of capacity. Also, "grid-appropriate" units—meaning smaller-scale reactors—to "meet remote regional demands and to export to developing countries," will be deployed. Last Spring, the keel was laid for the barge that will be the platform for Russia's first 70-MW floating nuclear power plant, for the energy-short city of Severodvinsk, in the Arkhangelsk region, producing both electricity and heat.

The plan is to "match exports" to the number of units and amount of fabricated nuclear fuel deployed domestically. This will require creating a broad technical base, and completing the consolidation of the previously separate branches of the Russian nuclear industry, which is under way. The Russian nuclear agency Rosatom has already secured contracts to construct new nuclear power plants in Eastern Europe and India, and is in the process of bidding on units that will be built in new nuclear nations.

At an international nuclear conference in Moscow in November, Russian nuclear official Alexander Glukhov described the construction opportunities abroad that are of interest to Russia, including in Vietnam, Indonesia, and Morocco. "But central and Eastern European countries, particularly the Czech Republic, Bulgaria, and Slovakia, are the most interesting markets," in the near term, in addition to Ukraine and Belarus, he said.

This plan for new nuclear power plants must be assured a reliable supply of fuel. Dr. Chebeskov estimated that, assuming a 50-year operating life for existing and new VVER reactors, with a total installed capacity of 100 GW by mid-century, up to 1 million tons of natural uranium would be needed, to extract enough fissile fuel for the reactors. The total natural uranium resources in Russia, he reported, are currently assessed to be from 600,000 to 1 million tons. Clearly, other sources of nuclear fuel will be required.

For the near term, Russia has instituted a new program, called "Uranium for Russia," based on exploration for new deposits within the Russian Federation. Agreements and contracts for the import of resources are also being put into place, notably with resource-rich Kazakstan. In September, Russia and Australia signed a bilateral agreement, under which Russia will buy uranium at the rate of 4,000 tons per year, and at the end of November, Russia and Canada agreed to jointly prospect for uranium on their territories, and establish joint ventures for extraction.

But in the medium to long term, it will be the application of new technologies that will provide the resources to expand the use of nuclear fission energy, providing the bridge to nuclear fusion power.

By 2030, at the end of the first phase, seven fast breeder reactors, which create new fuel, are planned to be commissioned, reaching 60 GW of capacity. After 2031, fast breeder reactors will replace conventional VVERs for new capacity, and some of the operating VVERs may be converted to the thorium-uranium fuel cycle, using uranium-233 produced in fast reactors.

Creating New Resources

Dr. Chebeskov proudly reported that work has been under way in Russia for more than 50 years on scientific, design, and technology development for nuclear power plants and the nuclear fuel cycle. In 1954, the 5-MW Obninsk reactor became the first in the world to produce electricity, at the institute where Dr. Chebeskov works.

This heritage is the foundation for the second phase, 2030-2050, for nuclear technology development. It is a plan which requires that a "fuel resource must last for an historically meaningful period (hundreds of years)." The objective is to "use innovative technology to switch to a new energy resource—plentiful uranium-238—by the middle of the 21st Century." This will re-

quire the "transition to a new technological platform, with the total closure of the fuel cycle, based on fast reactors," he explained. The advanced nuclear research and development program to implement this plan is already substantially under way.

By 2012, Russia will complete construction of the BN-800 demonstration fast reactor, a follow-on to its BN-600 sodium-cooled fast reactor, which operated for 27 years. Fast breeder reactors provide a number of advantages over conventional reactors. The BN-800 will use mixed oxide, or MOX, fuel. MOX fuel is made up of 5-9 percent plutonium, using a material now considered as "waste," from conventional power plants and nuclear weapons production. In the near term (to 2030), the plan is to construct a small number of fast breeder reactors, based on the operating experience of the BN series, which will use recycled plutonium as a fuel.

Russian fast reactors not only create a "new" resource by using recycled plutonium, but are also designed to breed at least as much fuel as they use. By placing a blanket of plentiful fertile but not fissile material—such as uranium-238 or thorium-232—around the reactor core, the energetic neutrons produced in the fission process will create fissile isotopes, such as plutonium-239, in the blanket, which can then be used as fuel in other reactors.

When the BN-800 is completed in 2012, it will demonstrate fast reactor technology on an industrial scale. During the first phase to 2030, a small number of industrial-scale breeder reactors will be deployed. A new design for a sodium-cooled fast reactor, the BN-1800, which is more efficient than water-cooled designs, and designs using other liquid metal coolants, are being developed, and are at varying levels of maturity.

When natural uranium (U-238) is enriched, to concentrate the fissile isotope, U-235 to a few percent, only a small percentage of the natural uranium is used. As an example, for the 23.2 GW of current nuclear capacity in Russia, 3,800 tons of natural uranium must be mined or taken out of stocks per year. After enrichment, a little more than 600 tons of fuel are created, with the remaining 3,200 tons left as "enrichment tails," or depleted uranium. In Russia, uranium enrichment tails are accumulating at a rate of about 4,000 tons per year. These tailings can be enriched, as an additional source of reactor fuel.

International Nuclear Safety, Pacific Northwest National Laboratory

The BN-350 fast breeder, located at Aktau, Kazakstan, on the Caspian Sea, generated electricity and desalinated water for Aktau residents. It was commissioned in 1972 and operated until 1999.

In terms of reprocessing reactor spent fuel, to extract the more than 95 percent of the material that can be recycled and reused, the Russian RT-1 plant has been operating since 1971, reprocessing spent fuel from VVER-440 reactors and the BN-600 fast reactor. In addition to creating a new resource, reprocessing also helps to eliminate the need for large-scale spent fuel storage. Reprocessing 1,000 tons of spent fuel from conventional reactors, such as the VVER, reduces the spent fuel tenfold, to 100 tons.

The decision has not yet been made to reprocess the spent fuel from the graphite-moderated RBMK reactors, Dr. Chebeskov reported. In order to manage the spent fuel from the 50 gigawatts of VVER reactors expected to be operating in the near term—or more than double current online capacity—it is estimated that a reprocessing plant with a capacity up to 1,000 tons per year is required, and will be built.

In this transition to a full, closed nuclear fuel cycle economy, a small series of fast-breeder reactors is planned, with 5 GW capacity each. A fuel-manufacturing facility, that can produce about 100 tons of MOX fuel per year for the breeders, is also required. At an experimental level, the fabrication of MOX fuel for fast reactors has already been demonstrated.

Long-Term Nuclear Plans

For the long term, Russia plans to develop the technology to efficiently use its reserves of natural uranium itself as a fuel, not just as a feedstock to extract a tiny percentage of fissile U-235. Fast-breeder reactors will be introduced with breeding ratios greater than 1, meaning they will produce more fuel than they consume. Both uranium-238 and thorium-232 will be used in the breeder blanket as fertile material, to be irradiated and transmuted into fissile isotopes. Russia is estimated to have about 3 percent of world thorium resources, or 75,000 tons.

Nuclear power technologies being developed in Russia also include follow-on advanced-generation fast reactors, and the Gas Turbine-Modular Helium Reactor, based on a design by General Atomics, to burn plutonium from nuclear weapons, and to produce hydrogen. General Atomics has been working with Russian engineers on the design specifications for this GT-MHR.

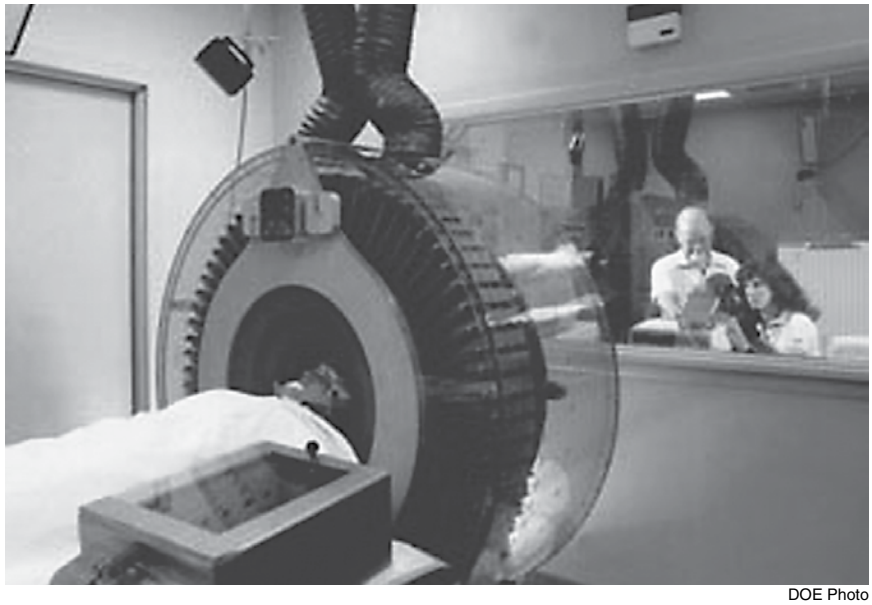
For Russia, the next 50 years will used to build the bridge to a nuclear future. With or without the United States, other countries will soon be following suit.

Medical Isotopes in the 21st Century

by Robert E. Schenter, Ph.D.

Radioactive isotopes should and will play a major role in the advancement of 21st Century medicine. These medical isotopes are currently showing outstanding results in both diagnostic and therapeutic medical applications, which should continue to expand for application for essentially all the major diseases (cancer, heart, Alzheimer's, arthritis, etc.) for the rest of this century. There have also been promising research results in killing the HIV virus with medical isotopes.

This paper briefly presents examples of these developments and their future promise for two forms of cancer (breast and liver), Alzheimer's disease, and HIV. The promise of treatment with radioactive isotopes can be seen from one patient who was told, "You have three months to live" four years ago. Now, as a result of treatment with the medical isotope yttrium-90, applied using what are called Y90 microspheres, the patient not only is alive, but works out with a personal trainer every other day, and is living life to the fullest.

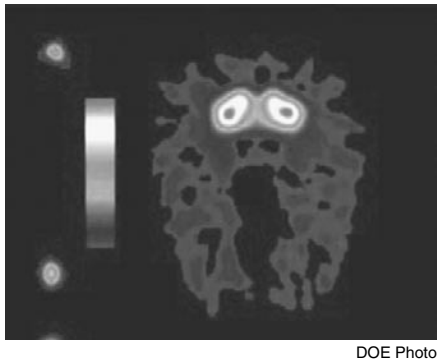


DOE Photo

Brookhaven National Laboratory scientists preparing for a Positron Emission Tomography (PET) scan of a patient. The PET technology uses the radioisotope fluorine-18 in combination with glucose (together called FDG or fluorodeoxyglucose). Cancer tumors overutilize glucose, and the PET scan identifies the metabolic difference between normal tissue and the tumor, thus identifying tumors.

Introduction

Diagnostic and therapeutic medical isotope applications have made major advances for the past 50 years, and these advances should accelerate as we continue through the 21st Century. In the United States, and probably in the rest of the world, the aging of the World War II Baby Boomers will create an exponentially increasing demand for the medical application of these isotopes, as people live longer and acquire the diseases of aging.



DOE Photo

This PET scan shows the chemical uptake in a monkey's brain, to test the effectiveness of a Parkinson's disease treatment. The research is being carried out by the Lawrence Berkeley National Laboratory in collaboration with Somatix Therapy Corporation. By restoring levels of important brain chemicals in animals, the hope is to develop a similar treatment for human Parkinson's patients.

Dr. Robert E. Schenter is one of the leading U.S. experts on fission reactor production of isotopes. Based on his 39 years as an expert on neutron cross-section and decay data information, he has become a world authority on isotope production. Now the chief science officer of the Advanced Medical Isotope Corporation, Schenter previously worked as the site director and deputy site director in the Isotope Program Office at the Westinghouse Hanford Company (WHC) and the Pacific Northwest National Laboratory (PNNL). In 1991, he was responsible for the relief of a world shortage of gadolinium-153, which is used in instruments for early detection of osteoporosis. He also defined the project and directed the production in the Fast Flux Test Facility (FFTF) in Richland, Washington.

This paper, which appeared in Executive Intelligence Review, *Jan. 1, 2008, was prepared for the Schiller Institute conference on "Making the Eurasian Land-Bridge a Reality," Sept. 15-16, 2007.*

MAJOR PET ISOTOPES AND THEIR APPLICATIONS

Isotope	Half-Life	Diagnostic Applications
Bromine-76	16.0h	Anti-Carcinoembryonic Antigens, Anti-CEA Antibodies, DNA Studies, Nerves of the Heart, Quantitative Imaging
Carbon-11	20.3m	Cancers: Chest, Chronic Lymphocytic, Glioblastoma, Liver, Multiple Myeloma, Prostate, Urinary Tract
		Diseases: Alzheimer's, Brain, Epilepsy, Heart, Parkinson's
		Alcohol Addiction, Amphetamine Release, Drug Addiction, Neuropsychiatric, Nicotine Dependence, Pain Processing, Schizophrenia, Small Animal Imaging, Tobacco Addiction
Copper-62	9.74m	Cerebral and Myocardial Perfusion, Colorectal Cancer, Human Biodistribution, Liver Cancer, Renal Blood Flow, Renal Injury
Copper-64	12.70h	Cancers: Cervical, Colon, Colorectal, Lymphoma, Melanoma, Pancreatic, Prostate
		Diseases: Angiogeneses, Brain, Hypoxia, Parkinson's, Wilson's
		Stem Cell Research
Fluorine-18	1.83h	Cancers: Adrenal Gland, Anal, Bone, Bone Marrow Transplants, Bowel, Breast, Cervical, Chest, Colorectal, Esophageal, Gastric, Head and Neck, Hodgkin's Disease, Laryngeal, Leukemia, Liver, Lung (NSCLC), Lung(SCLC), Melanoma, Multiple Myeloma, non-Hodgkin's Lymphoma, Osseous, Ovarian, Pancreatic, Prostate, Rectal, Rhabdomjo Sarcoma, Squamous Cell, Thyroid, Urinary, Vocal Cord
		Diseases: Alcohol Addiction, Alzheimer's, Anorexia, Atherosclerosis, Brain, Depression, Diabetes, Heart, Herpes, HIV, Hypoxia, Infection, Liver, Muscle, Kennedy's Narcolepsy, Lung Inflammation, Osteomyelitis, Parkinson's, Pneumonia, Ulcerative Colitis, Schizophrenia, Tourette's Syndrome
		Infection: Pen-Prosthetic, Hip-Prosthetic, Joint-Prosthetic
		Small Animal Imaging, Chemotherapy Research
Gallium-68	1.13h	Breast Cancer, Heart Imaging, Immunoscintigraphy, Molecular Imaging, Neuroendrocrine Tumors, Pancreatic Cancer
Iodine-124	4.18d	Apoptosis, Cancer Biotherapy, Glioma, Heart Disease, Mediastinal Micrometastates, Scouting of Therapeutic Radioimmunoconjugates, Thyroid Cancer
Iron-52	8.28h	Anemia, Human Bone Marrow
Nitrogen-13	9.97m	Ammonia Dog Studies, Coronary Artery Disease, Diabetes, Gamma Camera, Heart Disease, Imaging of Heart, Pancreas and Liver, Lupus Erythematosus, Myocardial Perfusion, Pulmonary Ventilation
Oxygen-15	122.s	Acute Brain Injury, Arterial Blood Flow, Brain Cancer, Oxygen Utilization, Brain Studies, Cerebral Blood Volume, Cerebral Responses, Coronary Artery Vasospasm, Coronary Reserve, Heart Disease, Ischemic Stroke Disease, Kinetics of Oxygen, Liver Cancer, Myocardial Viability, Oxygen Metabolism, Pain Control, Venous Ulceration
Rubidium-82	1.26m	Heart Disease, Myocardial Perfusion, Sarcoidosis
Yttrium-86	14.74h	Distribution of Y90, Lung Cancer, Melanoma, Renal Cell Carcinoma
Zirconium-89	3.27d	Brain Tumors, Head and Neck Cancers, non-Hodgkin's Lymphoma

Source: Dr. Robert E. Schenter, Ph.D.

A good example of this increase in demand is the explosion in the diagnostic application of Positron Emission Tomography (PET) for essentially all major diseases.

The PET application uses several radioisotopes, which have a whole range of half-lives, predominantly led by fluorine-18. The list of isotopes used with PET and their half-lives and applications is given in the Table.[1]

In the area of therapy, the isotopes of iodine-131 and yttrium-90 are applied very effectively in treating follicular non-Hodgkin's lymphoma. They are used in Food and Drug Administration-approved radiopharmaceuticals called BEXXAR (I-131) and Zevalin (Y-90). This procedure is called radioimmunotherapy, or RIT, where the goal is to kill all the cancer cells without harming the healthy cells. This is also known as cell-directed therapy.

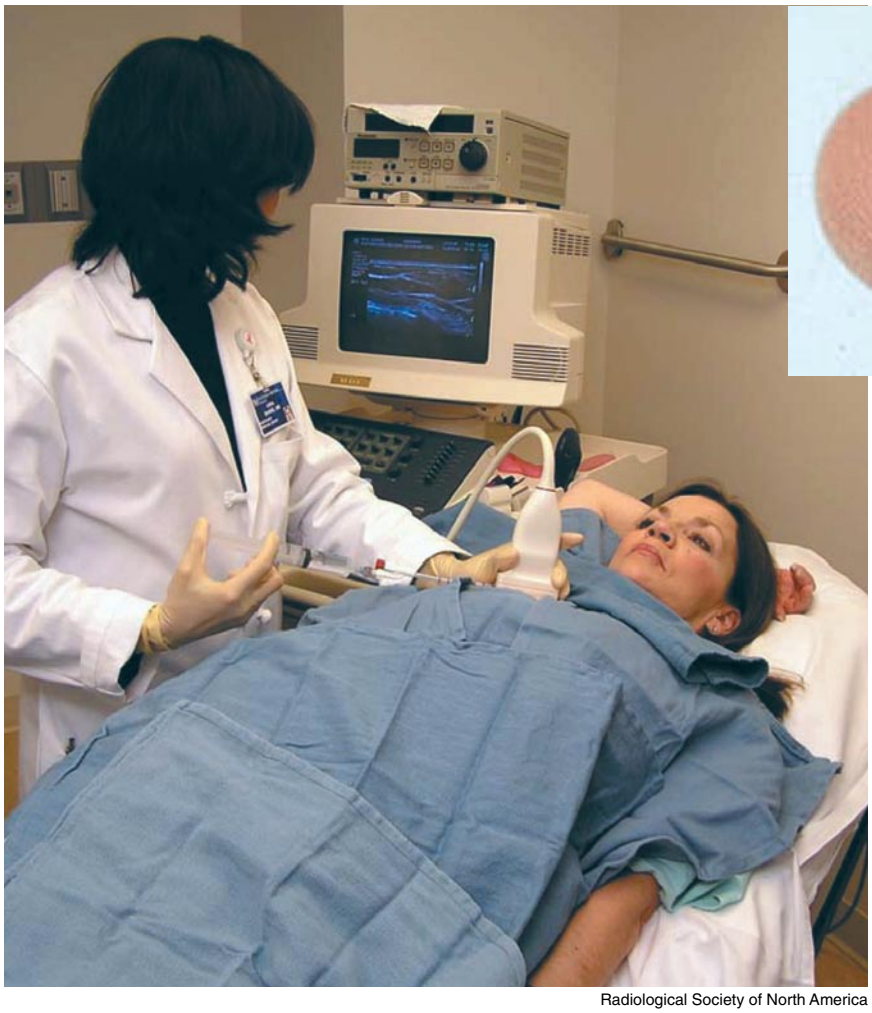
Four additional examples of medical isotope application for both diagnostic and therapeutic procedures are presented below, for two types of cancer (breast and liver), Alzheimer's disease, and HIV.

Examples of Medical Isotope Applications

- *Breast Cancer*

Currently, 40,000 women in the United States die each year as a result of breast cancer. That number could double as the Baby Boomers age. Consequently, better treatments for this devastating disease should be aggressively pursued.

An important method of treating breast cancer is the application of brachytherapy. This procedure involves placing a tiny radioactive seed inside the breast, up against tissues harboring the breast cancer. The radiation is focussed on the breast tumor



Radiological Society of North America

An ultrasound-guided breast brachytherapy procedure, in which a radioactive "seed" is inserted into a tiny balloon, placed at the site of the surgically removed tumor. The seed delivers the prescribed dose of radiation directly to the site where cancer recurrence is most likely, minimizing exposure to healthy tissue in the breast, skin, ribs, lungs, and heart. This outpatient treatment can be for one to five days. No source of radiation remains in the patient's body between treatments or after the procedure is completed.

area, which significantly reduces the destruction of the healthy breast cells.

The isotopes irridium-192 and iodine-125 are used for this application.

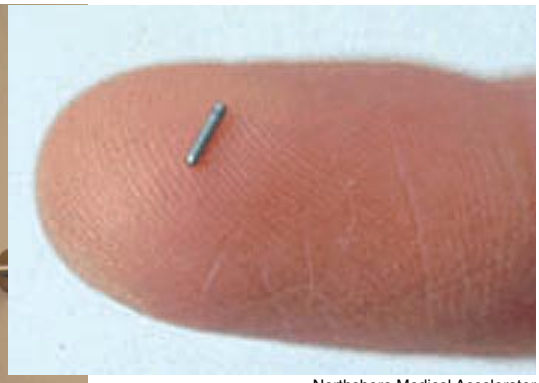
Robert R. Kuske, M.D., a radiation oncologist with Arizona Oncology Services, discussed advantages of Accelerated Partial Breast Irradiation (APBI) at the July 2004 meeting of the Radiological Society of North America (RSNA).[2] APBI combines surgery with brachytherapy as a breast conservation therapy.

- *Liver Cancer*

A medical breakthrough called microsphere brachytherapy is giving new hope to patients with liver cancer.[3] This therapy works by delivering radiation from the medical isotope yttrium-90 through a catheter tube, directly to tumors inside the liver. The yttrium-90 is contained in tiny glass bead microspheres. Several million of these Y-90 microspheres are used in a single treatment.

According to Dr. Andrew Kennedy of Raleigh, N.C., the Y-90 microspheres are delivered into the liver, where they reside permanently in the tumors; and the radiation is designed to penetrate only about one-quarter of an inch into the tissue. So, as the tumor is being destroyed, the nearby normal liver tissue is not being affected. The outpatient procedure takes about one hour.

- *Alzheimer's Disease*



Northshore Medical Accelerator

A similar radioactive treatment is used for prostate cancer. This shows the actual size of a prostate seed implant.

Currently, more than 5 million Americans have Alzheimer's disease. Symptoms vary considerably, but usually begin with a tendency to forget, which becomes so severe that it affects the patient's social life, family life, work, and recreational hobbies. Alzheimer's is the most common form of dementia, and is the result of brain aging.

The two major methods of diagnosing Alzheimer's disease both use medical isotopes: Single Photon Emission Tomography (SPECT) and Positron Emission Tomography (PET).

With SPECT, a small amount of gamma-ray-emitting isotope (for example, technetium-99m or thallium-201) is bound to neuro-specific pharmaceuticals and then injected into a patient's vein, from where it is taken into the brain tissue. The isotope fixes itself onto the brain with proportional flow, emitting a gamma ray which is picked up and detected by a SPECT gamma camera.

PET is a way of getting three-dimensional images or maps of functional processes of the body (see box). For Alzheimer's disease, PET scan images use the isotopes carbon-11 or fluorine-18, to compare normal brain activity to reduced brain activity. A PET scan can show the brain's biological changes attributable to Alzheimer's disease earlier than any other diagnostic test can provide this information. Alzheimer's disease can even be detected several years earlier than the onset of symptoms.[4]

The application of PET for Alzheimer's disease is rapidly spreading in use at medical clinics and hospitals all over the

world. There were 25 papers on this presented at the 2006 Society of Nuclear Medicine meeting in San Diego.

• *HIV*

Twenty-five years from the start of the epidemic, HIV is still an incurable disease. It is clear that something completely different needs to be done to eradicate it, commented Dr. Ekaterina Dadachova of the Albert Einstein College of Medicine in New York City.[5]

Using radioactive antibodies, as is done in many successful cancer treatments, Dr. Dadachova and her colleagues have been doing research directed towards killing HIV-infected cells. This involves treating mice infected with HIV and has been reported in the online journal *PLoS Med*.[6]

Dadachova's team linked radioactive bismuth-213 and rhenium-188 to antibodies designed to stick to two HIV proteins (gp4) and (gp20), displaced on the surface of the infected cells. The initial results reported showed significant killing of HIV cells in the mice, providing support to the concept that radioimmunotherapy could work against HIV/AIDS.

Conclusions

Major medical advances in the 21st Century should occur through the application of medical isotopes. This paper presented several examples of the diagnostic and therapeutic applications of essentially current results and indicate promise for future significant developments.

For more information on the medical isotope/disease connection for the examples presented here and several other examples, please contact the author at 2521 SW Luradel St., Portland, Ore., U.S.A. 97219, or via e-mail: reschenter@comcast.net.

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NUCLEAR MEDICINE

Technologies We Can't Afford to Ignore

by Marjorie Mazel Hecht

Nuclear medicine, the use of radioactive isotopes in diagnosing and treating disease, has a proven track record of saving lives, and saving money, by providing faster and better diagnostic results and cancer treatment with no unpleasant or dangerous side-effects. But although many nuclear medicine techniques were pioneered in the United States, today this country lags behind in research, development, training, and treatment.

In Europe, where nuclear medicine is overtaking standard chemotherapy treatment for certain types of cancer, a patient is more likely to find the most advanced treatment, using radioisotopes.

Every aspect of nuclear medicine is underfunded and underdeveloped here. Most striking is the fact that the United States must import more than 90 percent of the medical radioisotopes used. When you consider that 20 million diagnostic and treatment procedures are performed annually here with radioisotopes, this level of "outsourcing" is staggering.

Eighty percent of the medical radioisotopes used in the United States come from Canada, with the rest coming from Europe and Russia. When Canada's Chalk River reactor, which is dedicated to isotope production, was shut down for a safety upgrade in November 2007, it meant that patients in Canada and elsewhere would have to go without their needed tests and treatment for several weeks. The situation was so dire, that the Canadian Parliament met in an unprecedented special session to mandate the reopening of the reactor and the postponement of the upgrade. The Parliament judged, correctly, that the immediate risk to human lives was far greater than the hypothetical risk for which the reactor was being upgraded. On Dec. 16, 2007, the 50-year-old Chalk River reactor, which supplies half of the world's radioisotopes, went back on line.

The Chalk River event points up the frustrating situation of nuclear medicine in the United States. Both the Congress and the Executive for years have ignored the many government reports advising more Federal funding for nuclear medicine research and facilities for isotope production. Perhaps as the generation of Baby Boomers ages, and suffers from the diseases of aging, their desire for advanced medical treatment will overrule their knee-jerk opposition to anything nuclear, and these programs will get the support they need.

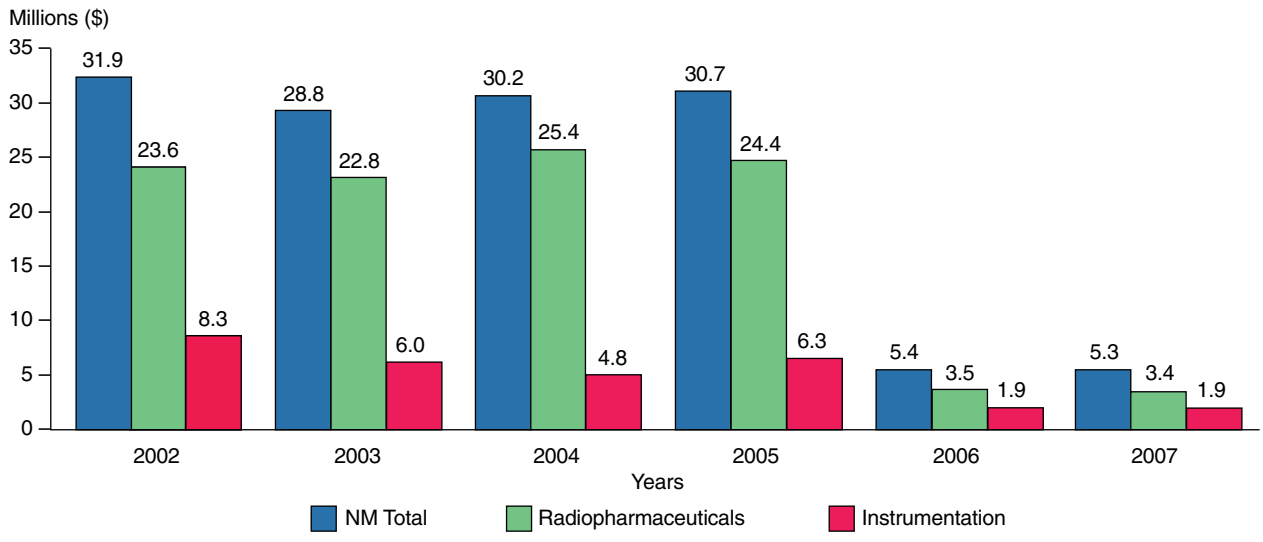
NAS: More Funding Needed

The most recent of a series of scientific reviews of the nuclear medicine situation is a National Academy of Sciences (NAS) report "Advancing Nuclear Medicine Through Innovation," issued in September 2007.[1] This report comprehensively describes the promise of nuclear medicine and concludes: "In spite of these exciting possibilities, deteriorating infrastructure and loss of federal research support are jeopardizing the advancement of nuclear medicine. It is critical to revitalize the field to realize its potential."

But although the NAS report accurately characterizes the present dismal state of U.S. infrastructure in nuclear medicine, its recommendations for isotope production are far too modest. It recommends merely that "a dedicated accelerator and an upgrade to a nuclear reactor should be considered."

The glaring omission in the NAS review is that it never mentions the Fast Flux Test Reactor (FFTF) at Hanford, Washington. This 400-megawatt sodium-cooled fast reactor was designed to test fusion and fission materials, and to produce isotopes. Yet, for no good reason, and despite a lack

1. Committee on State of the Science of Nuclear Medicine, National Research Council, "Advancing Nuclear Medicine Through Innovation" (Washington, D.C.: National Academy Press, September 2007).



FUNDING FOR NUCLEAR MEDICINE RESEARCH (2002-2007)

Declining funds, dramatically visible in this graphic, translates into declining research progress.

Source: National Academy of Sciences, *Advancing Nuclear Medicine Through Innovation.*

of domestic facilities to produce large amounts of medical isotopes, the Department of Energy (DOE) decided to shut it down in 1993, and deactivate it in 2001. In 2005, the DOE made a decision to disable the reactor, just months before the same Department announced its new Global Nuclear Energy Partnership (GNEP) program, which calls for a sodium-cooled fast reactor facility.

Fortunately, the FFTF could be reactivated, faster and at a lower expense than building a new facility. According to Dennis Spurgeon, DOE Assistant Secretary for Nuclear Energy, the FFTF "continues to be a potential option" for the GNEP program (see interview with Spurgeon in EIR, Nov. 23, 2007). Restarting the FFTF to produce isotopes would be a step toward meeting the current demand domestically, but an even greater capability is needed.

One of the U.S. suppliers of radioisotopes is the Advanced Test Reactor (ATR) at the Idaho National Laboratory. This is the largest research reactor in the United States, but it was not designed to produce isotopes with short half-lives. As the NAS report notes, there is a plan to upgrade it next year.

Other sources are the High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory; the Brookhaven Linac Isotope Producer (BLIP), at Brookhaven National Laboratory; and the Isotope Production Facility, at Los Alamos Nuclear Science Center (LANSCE), at Los Alamos National Laboratory. All of these machines date back to the 1960s and 1970s, and were designed primarily for physics and materials science. According to the NAS report, they cannot "meet the demands of the research community for regular and continuous availability of these radionuclides," and they are limited by "age-related degradation of the facilities and extended shutdowns for facility maintenance."

There are a few research reactors at universities, which have helped in the supply of medical isotopes for research, most prominently the Missouri University Research Reactor (MURR). But many university research reactors have been shut down since the anti-nuclear decade of the 1970s, and those remaining have a limited capability for isotope production.

Without an increase in the domestic supply of radioisotopes, the United States will continue to be dependent on other countries and the vagaries of transporting short-lived isotopes over long distances.

Other Resources Lacking

The deterioration in the field of nuclear medicine is not limited to domestic production of isotopes. The nation also lacks the reservoir of students in the necessary fields and the infrastructure to ensure that there will be trained personnel in the future. The report states: "[T]here has been a substantial loss of support for the physical sciences and engineering basic to nuclear medicine. There is now no specific programmatic long-term commitment by any federal agency for maintaining high-technology infrastructure (e.g., accelerators, research reactors) or centers for instrumentation and chemistry research and training, which are at the heart of nuclear medicine research and development."

The NAS report spells out how the isotope program is "not now meeting the needs of the research community." Public Law 101-101, the report says, "requires full-cost recovery for DOE-supplied isotopes, whether for clinical use or research [and] [t]he lack of new commercially available radiotracers over the past decade may be due in part to this legislation." In addition, the report notes, the lack of appropriate guidelines of the U.S. Food and Drug Administration for manufacturing radiopharmaceuticals hinders the development and use of new radionuclides.

The NAS report describes the research areas in need of upgrading, stressing the obvious: that there must be long-term financial commitments in order to reap the assured benefits. The report states: "There is an urgent need for the further development of highly specific technology and of targeted radiopharmaceuticals for disease diagnosis

and treatment. Improvements in detector technology, image reconstruction algorithms, and advanced data processing techniques, as well as development of lower cost radionuclide production technologies (e.g., a versatile, compact, short-lived radionuclide production source), are among the research areas that should be explored for effective translation into the clinic. Such technology development frequently needs long incubation periods and cannot be carried out in standard 3- to 5-year funding cycles."

In summary, the NAS report aptly states, "We have arrived at a crossroads in nuclear medicine." The question now is whether the nuclear medicine program will take the high road to expansion, or whether it will continue to devolve, costing America both lives and money.

What Are Radioisotopes?

Radioisotopes or radionuclides are artificially produced, unstable atoms of a chemical element, which have a different number of neutrons in the nucleus, but the same number of protons and the same chemical properties. Many live for only minutes. Their existence is measured in "half-lives," how long it takes for half of the isotope to disappear.

To produce radioisotopes, a stable isotope is bombarded with fast neutrons that are produced in a nuclear reactor or a particle accelerator. The stable isotope is transmuted into an unstable isotope of the same or a different element.

Smaller proton linear accelerators (linacs), which can be located near a medical facility are also under development, such as that of the Advanced Medical Isotope Corporation in Washington State. The fusion program of the University of Wisconsin at Madison is investigating a new method of producing isotopes in a small fusion reactor. A 1-watt fusion source has already demonstrated that it could provide very short-lived radioisotope doses for use with a PET (positron emission tomography) scanner.

From the time of the Manhattan Project, scientists had realized that nuclear fission would provide an unlimited amount of "tracer and therapeutic radioisotopes."[1] The first major use of a radioisotope was iodine-131, for diagnosis and treatment of thyroid disease. It was found that the thyroid specifically absorbs iodine.

Now, five decades later, isotope technology has developed to a high degree, defining which unique properties of radioisotopes are best at particular tasks. There are now about 200 radioisotopes in use.

Diagnostics and Treatment

Radioisotopes which emit radiation are used today in medical diagnostics, to provide information about how certain organs—the thyroid, bones, heart, liver, and so on—are functioning, without surgery. Radioisotopes can also be used to image the progress of certain treatments, such as shrinking tumors. The radiation does not stay in the body, and there are no side-effects.

The most frequently used radioisotope in medicine today is technetium-99m, which has a half-life of six hours. It is supplied to hospitals in a lead container of its more stable precursor, molybdenum-99, which has a half-life of 66 hours and decays to technetium-99m. The hospital extracts the technetium-99m as needed, and the container is replaced as needed.

Radioisotopes are also used in disease treatment, especially cancer, where radiation-emitting isotopes are attached to some kind of carrier, such as a monoclonal antibody, which targets particular cancer cells. The carrier delivers the radioisotope to the cancer site, where the radiation destroys the cancerous cells, with minimal damage to surrounding tissue.

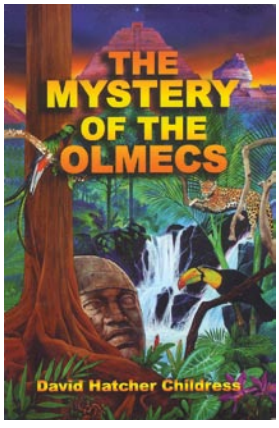
As noted in the accompanying article, research is ongoing into the use of radioisotopes in treating AIDS and other diseases.

1. Committee on State of the Science of Nuclear Medicine, National Research Council, "Advancing Nuclear Medicine Through Innovation" (Washington, D.C.: National Academy Press, September 2007).

America's Most Controversial Civilization

by Charles Hughes

The Mystery of the Olmecs
David Hatcher Childress
Kempton, Ill.: Adventures Unlimited Press, 2007
Paperback, 262 pp., $20.00



Author David H. Childress has travelled around the world several times and written at least 12 books on exploration, lost cities, and ancient civilizations. But he says that one of the strangest and most fascinating mysteries is located right here in North America: the ancient Olmec civilization, which was only recognized as a separate entity in the 1940s. And ever since, the Olmec culture has been a constant source of disagreement and controversy.

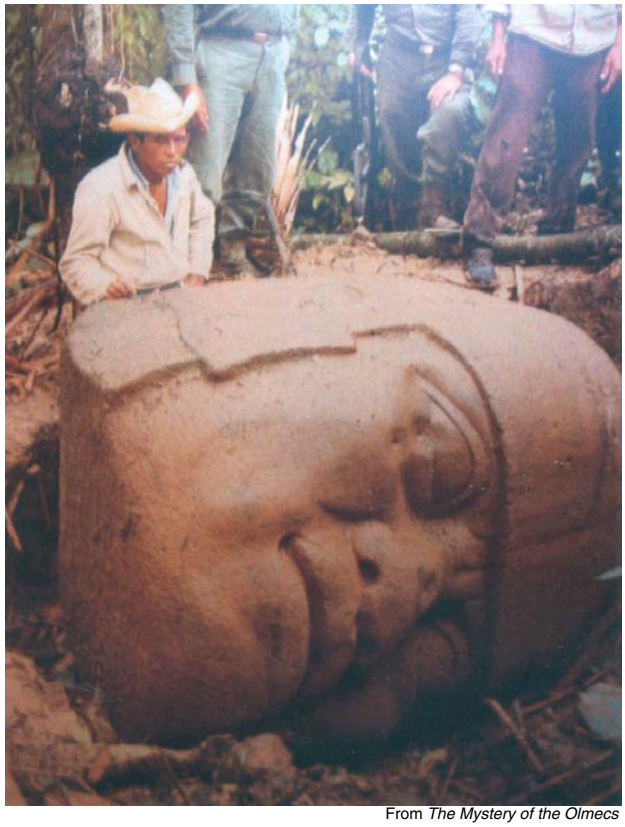
Prior to the 1940s, establishment archaeologists believed that the oldest civilization in Mesoamerica was the Maya, which flourished in Yucatan, Guatamala, and the Gulf Coast of Mexico.

Then, beginning in the 1930s and continuing to the present, it was noticed that some of the Mayan artifacts were unlike the rest, in peculiar ways. Large heads, carved in very hard basalt rock, resembled people from Africa, or wore masks with feline features such as those of a jaguar, the large tiger-like beast of the area.

These strange artifacts were found mainly in the area of the southern Mexican regions of Tabasco and Veracruz. This is a swampy jungle region noted for the production of rubber from ancient times. The name Olmec derives from the Aztec Nuatal language, and means rubber.

The Mexican archaeologist Ignacio Bernal relates that Olmec-type art first turned up as early as 1869, but the designation of Olmec to describe this culture was not used until 1927.

Explorations and excavations in the late 1930s at Tres Zapotes, and La Venta by the Smithsonian and by the National Geographic Society uncovered artifacts and large inscribed stone tablets, called stella.



From *The Mystery of the Olmecs*

An early color photo of the colossal head discovered at La Venta, Mexico, in the late 1940s.

There was resistance to recognizing the Olmecs as a culture older than the Mayan, and which most likely preceded and gave birth to the Mayan culture, by such old timers of Mexican archaeology as Eric Thompson, who had helped decipher the Mayan calendar. At a special archaeology meeting in Mexico City in 1942, it was largely settled among Mexican archaeologists that the Olmecs predated the Maya, although the date of the beginning of Olmec civilization continued to be hotly debated.

The controversy over which culture was primary, Maya or Olmec, was settled in the 1950s by the use of radiocarbon dating. Artifacts found at San Lorenzo were given a radiocarbon date of 1200 B.C. So, here was a culture preceding the Maya, which featured very strange art, with depictions of bearded men, massive Negroid stone heads, and hieroglyphic writing. Subsequently it was found that the carbon dates determined in the 1950s were erroneously too recent, and that the Olmecs are probably older than 1200 B.C.

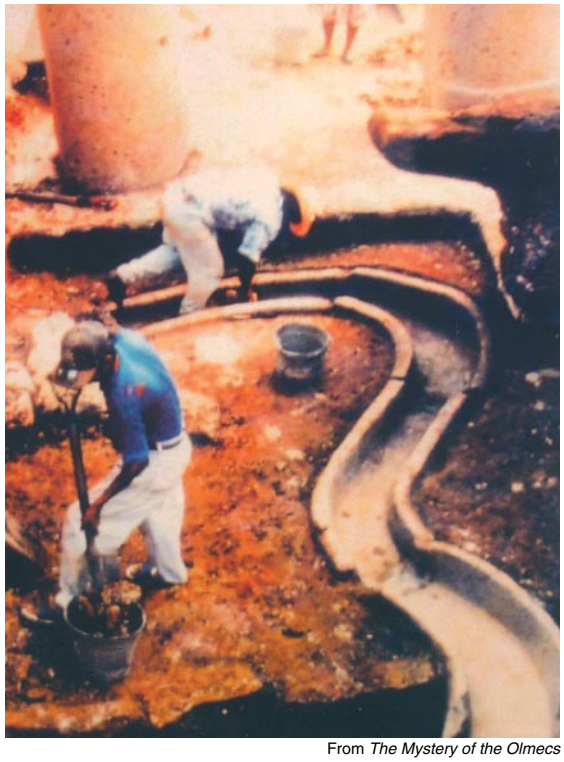
A Chinese Link

Childress's large-size book is well illustrated, with photographs in black and white and color, as well as maps and bibliographical footnotes. The reader may see photos of the huge, multi-ton Negroid heads in stone, statues carved in jade of strange looking people with elongated heads, weird feline-like humanoid statues, and carvings of Caucasian-appearing men with beards. Many

statues are of figures in a seated position, apparently praying, in a very similar fashion to what the Chinese call the stance *Qhizuo*.

A good deal of Olmec art, in fact, closely resembles that of the Shang Dynasty, and Childress says that Olmec writing has been examined by Chinese scholars, who claim that it is derived from early Chinese pictographs, found on Shang oracle bones (see *U.S. News and World Report,* Nov. 4, 1996).

Chinese scholar Han Ping Chen, one of the few experts on Shang inscriptions, stated that this is plainly Chinese writing. His statement apparently upset Mesoamerican specialist Michael Coe of Yale University, who said that such an implication of Chinese influence on the Olmecs is insulting to the indigenous people of Mexico! Such comments reveal the attitude of the mainstream archaeologists to the concept of Universal History.



From *The Mystery of the Olmecs*

Excavations at La Venta, Mexico, uncovered sophisticated water systems.

Here is a civilization, right next door to us, who were the inventors of the number and writing system of the Mayas, ballgames with rubber balls, monumental architecture, and the wheel (as evidenced in wheeled toys). Author Childress asks, "So who were these weirdos?" We seem to have here a vast, unusual culture, which flourished from central Mexico to Costa Rica, and possibly into Colombia. Its cities ranged from the Gulf to the Pacific, very likely being the recipients of trade by sea from Europe, across Mexico, to the Pacific, where goods arrived from Asia and Oceania.

This is an excellent book, as the author focusses on the singularities, and points out to the reader what the archaeological mafia would rather you not see, much less think about. Childress spent almost a year visiting Olmec areas, as well as museums. For those interested in our ancient predecessors, I recommend this book on the Olmecs, America's most controversial civilization.

In This Issue

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FIRST ENGLISH TRANSLATION: VERNADSKY ON THE STATES OF PHYSICAL SPACE

This 1938 article draft continues Vernadsky's discussion of the relationship of living and non-living natural bodies, examining their states of space. In particular, he probes the difference between the material and the energetic properties of space, proposing that living-matter exists as droplets in a Riemannian space, dispersed within the Euclidean space of the inert matter of the biosphere.

Every crystal manifests a particular state of space, Vernadsky writes. Here, one of the largest monocrystals in the world, grown by Saint-Gobain for use in the French laser fusion program.

Doctors at the University of Washington Medical Center perform a radioisotope treatment for prostate cancer. Inset are tiny radioactive "seeds" of cesium-131, which are implanted near or in a tumor. The X-ray emitting seeds kill the cancer cells without serious side-effects.

NUCLEAR MEDICINE SAVES LIVES; WILL THE U.S. CATCH UP?

Radioactive isotopes that precisely target cancerous tumors without damage to surrounding cells are just one of the nuclear medicine technologies that can save lives. An expert on medical isotope production, Dr. Robert E. Schenter, discusses the exciting developments in the field, including the use of radioisotopes to kill the HIV virus. In an accompanying article, Marjorie Mazel Hecht reviews the languishing state of the U.S. nuclear medicine program.

Pacific Northwest National Laboratory