

GREEN TECHNOLOGY BY DESIGN: A NEW PARADIGM
FOR ENGINEERING EDUCATION FOR SUSTAINABLE DEVELOPMENT

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by

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In this paper I explore some aspects of the challenge we face in changing the culture and perspective of engineering education in the United States and also around the world so as to achieve a holistic and integrated systems approach to design that includes design for resource conservation and environmental elegance or “Green Technology By Design” (GTBD) as a necessary part of our futures for sustainable development. Engineering education for the environment has grown up in the USA, and perhaps elsewhere in the developed world, in departments of environmental engineering, often housed in civil engineering and with an “end-of-pipe,” “pollution control” philosophy and mind-set that mirrors the pollution control regulatory philosophy of government. Today we are beginning to recognize that while “pollution control” is very important and probably always will be, perhaps we also need to think more expansively and creatively than just from a “control” perspective to one of “prevention” – from “pollution control” to “pollution prevention.” In this paper I address this transition from a philosophy of “control” to one of “prevention” in the environmental education of engineers.

Design is the leverage point for resource conservation and pollution prevention because, by the time the basic product or production system has cleared preliminary design, the designers have already fixed some 90 percent of all life-cycle costs, benefits, and consequences. Resource conservation and environmental concerns must become “design criteria” of equal importance to other traditional engineering design criteria. Unfortunately, with relatively rare exceptions, that is not the way our industrialized system presently works, either in practice or in the engineering academic world.

Civil engineers working with excellence in outstanding academic departments of environmental engineering with a “pollution control” philosophy are but a small proportion of the engineers who design and create the products and industrial manufacturing processes that ultimately consume resources and pollute. The vast majority of engineers who do this important work are all the other types -- mechanical, electrical, industrial, chemical etc., etc., etc. “Green Technology By Design” ideas must become an integral part of all engineering education in regular engineering design courses and laboratories. I will suggest a non-coercive model for achieving these needed changes – namely the model of “quality by design” that has played such a major role in improving the quality and reliability of products and processes designed and produced by major economic world powers in recent years. Quality and reliability enter a product or process at the very beginning of the design process as a consequence of concrete design criteria for Q & R – and not primarily through manufacturing “quality control,” important as that also is.

In this paper I will also illustrate parallels and explore the limitations that are inherent in “end-of-pipe” and “control” philosophies in both of the domains that we call “pollution control” and “quality control.”

Unless we in the “first world” are able to achieve orders of magnitude more resource conserving and non-polluting technologies, FOR OURSELVES, and most importantly as MORE APPROPRIATE MODELS for the “developing world” to emulate than the wasteful ones we contemporarily demonstrate to them – I see our collective future in the 21st century as one of “resource wars” and unbelievable entropic environmental degradation as people all over this globe seek the “goods-life.” We saw a dominantly “oil resource” war in the 1991 Gulf War. Had it not been for oil under their sands we would most likely have ignored that region. Sustainable development is likely not possible without “green technology by design,” along with essential reductions in population growth and also a few other important things.

The essence of this paper became a chapter in, Freeman, Puskas, & Olbina, *Cleaner Technologies and Cleaner Products for Sustainable Development*, Springer-Verlag, New York 1995.

SELECTED EXCERPTS FROM OUR BOOK

Overby, Charles (text) Kunihiro, Masao (translator) & Momoi, Kazuma (photo artist), *A Call For Peace: The Implications of Japan's War-Renouncing Constitution*, Kodansha International, Tokyo 1997, paperback 2001. Republished with a 45 page new preface and update, Tachibana Publishing Inc., 2-17-8, Nishiogiminani, Suginami-ku, Tokyo, 2005 (Bilingual English and Japanese)

Founding of the Article 9 Society -- pages 57-67

"In mid March, 1991, shortly after America's Persian Gulf "oil resource" war, with the encouragement of like-minded persons in our Unitarian Fellowship in Athens Ohio, I founded The Article 9 Society (A9S), an organization dedicated to the long term goal of having all nations adopt in their constitutions the principles expressed in Article 9 of the Japanese Constitution."

"The Article 9 Society was born ... out of a mixture of hope and hopelessness. Threads of hope came from the almost unbelievable transformations taking place in Eastern Europe, the USSR, and in South Africa -- with far less violence than could ever have been anticipated ... Hopelessness came from a litany of recent unfortunate American involvements with military violence ... the Persian Gulf ... the Panama invasion ... the Reagan years of subversion of the Nicaraguan revolution ... and our Vietnam disaster ..."

"President Bush, during the Gulf War spoke of "A New World Order." It occurred to me that indeed we do need a new world order, but not the militaristic one of violence demonstrated in the Gulf. The new world order we need is one modeled on the war-renouncing principles in Article 9 of the Japanese Constitution, which imply that we use war prevention, and non-military, non-violent approaches to international conflict resolution. Thus was born our Article 9 Society."

Article 9 of the Japanese Constitution

Aspiring sincerely to an international peace based on justice and order, the Japanese people forever renounce war as a sovereign right of the nation and the threat or use of force as means of settling international disputes.

In order to accomplish the aim of the preceding paragraph, land, sea, and air forces, as well as other war potential, will never be maintained. The right of belligerency of the state will not be recognized.

Why I call the Gulf War an "oil resource" war -- page 65

"We know that resource scarcity is one of the reasons why nations engage in war. Having wastefully consumed much of our own virgin oil resources, we in the United States now import over 50 percent of the oil that we consume. In mid September 1990, six weeks after our protégé Saddam Hussein, invaded Kuwait, our US Senate rejected S-1224, a bill that would have required automobiles manufactured and sold in America to have 40 miles-per-gallon (17 kilometers-per-liter) fleet average fuel economy by the year 2001. This is well within the realm of contemporary engineering capability. The Union of Concerned Scientists calculated that had we encouraged this kind of 'green technology by design', by the year 2005 we in America would have been saving more than double the entire Kuwaiti annual oil production, every year on into the future. We had a choice of protecting our long-term interests by (1) cleaning up our own house and becoming a less wasteful nation or (2) using our military fist to protect "our" oil supply in the Gulf. Unfortunately we chose the latter."

In 1975 the US Congress passed a "Green Technology By Design" law (EPCA, PL-163) precipitated by the Middle East oil shut off after the 1973 Arab-Israeli war. US auto companies sent their attorneys to Washington to vigorously fight PL-163 as inappropriate and even unconstitutional. Japanese and European auto companies sent their engineers and scientist to Washington saying – yes, we can do this. Finally Ford, Chrysler, and General Motors got the message. As Japanese and European car sales began to overwhelm US models, US auto companies withdrew their attorneys and asked their engineers and scientists to get to work with a new design criterion, fuel efficiency, at the very beginning of the engineering design process. EPCA worked beautifully from 1976 to 1985 to double US automobile fleet-average-fuel-economy from 13 miles/per/gallon in 1972 to 26 mpg in 1985.

The Half-Life of the Earth -- page 175

In the late 1970s I spent a year of sabbatical leave with the U.S. Congress Office of Technology Assessment working on resource conservation and pollution issues. This experience with ever increasing consumption and growing waste-streams stimulated me to wonder how long this growth phenomenon could go on if all humans on Earth were to over-consume and pollute, as do we in the developed countries. To get an answer, I made a "back of the envelope" "engineering calculation" to estimate the "half-life of the Earth." How long, I asked, would it take to consume half the weight of the earth and turn it into high entropy irretrievable wastes, if Earth's entire population were to begin, today, to consume the Earth's resources at the same rate, as did the USA in 1972? Using 1972 USA per capita consumption of resources (minerals, both fuel and non-fuel, metals and non-food fibers) of 52 kilograms/person/per/day, assuming that the entire globe were composed of suitably consumable materials, and assuming a 5 percent compound growth rate (population and demand), it would take only about 430 years for Earth's people to consume half the weight of the Earth and reduce it to high entropy irretrievable wastes. From this we might conclude that it is likely not possible for the teeming billions on Earth to enjoy the lifestyle of we, "the rich" -- and yet that is exactly what these teeming billions seek.