

Environmental Pollution and Our Future

by Kevin Rolfe *

(When I presented a course in Environmental Pollution Control to final year Industrial Engineering students during the second semester of the 1975-76 academic year, I was pleasantly surprised with the level of interest. Several lecturers have also demonstrated an interest in environmental studies. Because of this, I have converted my lecture notes into manuscript form for formal publication. The book, Environmental Pollution Control, is currently being translated into Thai by Archarn Chaturong Boontanjai and is being edited by Dr. Kasem Prabritputaloong. It specifically deals with the engineering aspects of environmental science. The following article, which forms an epilogue to the book, is more philosophical in nature. Although less specific - and hence possibly less relevant to Thailand - than the rest of the book, it is written with the intention of promoting general discussion. In particular, some of the latter sections on nuclear power plant safety and depletion of the atmospheric ozone layer should be of interest to some Engineers.)

1. Pessimists and Optimists

Environmental pollution, along with peace, population, and resources, is one of the variables whose unsatisfactory management threatens our future. Views about this threat tend to be pessimistic or optimistic, depending on the extent to which they focus on the magnitude and ecological complexity of the problems. Another factor in the polarization of views on environmental matters is the differing opinions on the likelihood of our technological capabilities to be able to correct the problems.

The opposing views of the 'pessimists' and 'optimists' are succinctly described by the following analogy: "Two cars are travelling along a smog shrouded highway, which as everyone knows ends in a precipice. One car is a large American sedan - the other, an English Mini. The Welshman driving the Mini is confident that ahead he will find a turning which will eventually take him to a sunlit land on the other side of the gorge. He is, however, unhappy about the other car whose occupants are stridently proclaiming imminent disaster. He is worried that they will panic everyone into doing the wrong thing or, possibly worse, doing nothing at all" (1).

* A biographical note on the author appeared with the paper: "Development of the Salt Deposits of North East Thailand", published in a recent issue of the KKU Engineering Quarterly.

The occupants of the American sedan include Rachel Carson (2), Barry Commoner (3), Paul and Anne Ehrlich (4), and some British friends — such as Edward Goldsmith (5), while the Welshman is John Maddox. Maddox feels so strongly about the opinions of the 'prophets of doom' that he has written a book (6) attacking them. He believes that it is misleading to compare the earth to a spaceship and to argue that the world and its occupants are travelling towards disaster.

My opinion with regard to this debate is a compromise blend of both. I agree with Maddox when he says that the pessimism of extreme environmentalists is defeatist. However, I also feel that authors such as Rachel Carson have had a tremendous positive influence by exposing environmental degradation to the general public. A considerable amount of discussion and control legislation has resulted from this. The discussion reached a high-point in 1972 with the United Nations Conference on the Human Environment held in Stockholm. Social and administrative controls and technical improvements can be utilised to reduce the pollution burden, but they will only be implemented if the general public is aware of the possible consequences of inaction.

The 'honeymoon' period of media exposure of environmental problems is now finished in many countries. The environment is beginning to take its place alongside education and defence as a normal item on the political agenda. Therefore, it is important that scientists such as Carson, Ehrlich, and Commoner continue to jolt politicians into action. Nowhere is this more important than in the 'developing countries'. Although there are many important differences in perspective and priority between the environmental problems of the industrialised countries and those of the developing countries, it is important that leaders of the developing countries consider the environmental issue as an integral aspect of development. The Founex Report (7) discusses this topic at length, and stresses that incorporation of environmental issues and goals in the development of the developing countries requires astute planning and policy making.

2. World Models and their Critics

In April 1968 a group of 30 individuals, experts in environmental and agricultural sciences, met under the instigation of Dr. Aurelio Peccei to form the 'Club of Rome'. None of the group speaks from an official position but all share a common concern that traditional institutions can no longer even come to grips with environmental and population problems. The first report of the group, 'The limits to growth' (8), came from a small team at the Massachusetts Institute of Technology under the direction of Dr. Meadows. The team, using a global computer model developed by Professor Forrester, also of MIT, examined

in detail five factors determining growth : population, agricultural production, natural resources, industrial production and pollution. Their conclusions were that, even if the most optimistic assumptions are made about advances in technology, the world cannot support present rates of economic and population growth for more than a few decades, but that, if the problems are seriously attacked now, a stable, sustainable equilibrium may be reached. Quite naturally, the publication caused a widespread debate.

Professor Beckerman in his Inaugural Lecture at University College, London, called 'limits to growth' a "brazen, impudent piece of nonsense that nobody could possibly take seriously" (9). Despite this, many people in important positions have taken it seriously. Then, in 1973, a group from the Science Policy Research Unit (SPRU) at Sussex University published a technical report (10) criticising many aspects of 'limits to growth'.

Because of its approach, 'limits to growth' has been a more influential document than, for example, 'blueprint for survival' (5). Its statements are based on figures that may be challenged openly. Although the debate about the book has been extremely interesting from an academic point of view, somehow the full extent of the debate has not been appreciated by policy makers. Instead, many important people throughout the world accepted the conclusions of 'limits' without question. I feel this may have been damaging. I have heard Dr. Peccei say that 'limits to growth' only set out to establish that in principle there were limits to growth (11). This is not the way I interpreted the message of the book. The model used was too simplistic, and the criticism of it on the basis of the 'first law of computers' - garbage in, garbage out - was completely justified. A more recent publication of the Club of Rome corrects some of the criticism. 'Mankind at the turning point' (12) divides the world into 10 regions according to differences in culture and economic development. Although it repeats the collapse assertion of 'limits', it does put forward a different solution. Rather than 'no growth', 'organic growth' - a planning and separation of growth for the benefit of the whole world - is suggested.

3. Population Control

Of all the topics of environmental studies, the one that is most often discussed - frequently in highly emotional terms - is population control. It has been the subject of countless papers, dozens of prestigious symposia, and a growing avalanche of books. The number of people in the world is currently about 4,000 million and, if things go on as they are, there will probably be over 7,000 million by the year 2000, and 13,000 million by 2050. These statistics are a source of concern to many people, so much so that 1974 was United Nations World Population Year (WPY). The most important single WPY activity was the World Population Conference, held in Bucharest in August 1974. The conference clearly demonstrated the unfortunate polarisation of views on the magnitude of, and solutions to, world overpopulation.

The developing nations, generally supported by the communist bloc, were impatient and resentful of suggestions that the solution to the problems facing a largely undernourished and often starving species lay in attempts to restrict population growth. They were particularly upset by the simplistic approach of the wholesale distribution of the Pill, the condom and the coil to the 'ignorant' natives of poverty stricken and backward countries. The real solution to poverty, malnutrition, and high infant mortality rates was better exploitation and distribution of the world's resources. In particular, they argued that exploitation by the poorer nations of their own lands and minerals and other natural riches would solve many of the problems. For this, several of the developing countries felt that they would require more rather than fewer hands to man the ploughs and tractors, and to build and work the factories. The catch phrase of the conference became not 'curbing population growth', but 'social and economic development' (13).

Many people argue in favour of the 'theory of demographic transition'. This theory proposes that the motivation for large families is the peasant's fear of poverty in old age. High child mortality means that a couple must produce seven or eight babies in order that one or two should grow up to work the land and look after their aged parents. Supporters of demographic transition argue that in the more developed countries the birth rate fell historically as the standard of living rose, and point to a few areas like the Indian Punjab where rapid economic development in the last few years has been associated with lowered fertility (14).

The proposing view to the demographic transition theory is voluntary, or even compulsory, birth control programmes. Measures include contraceptive devices, sterilisation, and (thankfully yet only a suggestion) the putting of anti-fertility agents in water supplies. One of the major difficulties of birth control is that it cuts across religious beliefs and social customs. In Hindu India, for example, a son is a ritual necessity. A son must light his father's funeral pyre and perform other last rites or his parent will be denied a life in the hereafter. In his father's earthly life, a son is not just another mouth to feed; rather he is a pair of hands capable of doing work. A daughter marries and goes to her in-laws; a son stays with his own family, eventually to feed and clothe his father when he is too feeble to work in the paddies.

I believe that at present family planning efforts in developing countries are frustrated by the social and economic complexities of under development. Also, the simple arithmetic of dividing the total reproductive-age population by the number of doctors and health workers available, demonstrates there are not enough medical personnel for an effective birth control programme. Clearly, the developed countries must take significant measures to effect some

redistribution of the wealth of the world. Two eminent scientists, Lord C.P. Snow of Great Britain and Andrei Sakharov of USSR have made similar proposals along these lines. They recommend that the rich nations devote 20 per cent of their GNP for 10-15 years to the task of population control and development of the poor countries. I support this suggestion in principle, but I foresee massive administrative problems.

Demographic transition has been highly successful in Europe, especially in Catholic countries where the family planning movement has had relatively little influence. Nevertheless, I think it is quite incorrect to expect it to produce demographic stability in the developing world. In the first place, the population growth rates in the developing countries are far larger than those which today's rich countries had to cope with during their development. Secondly, a decline in birth rates historically has followed industrialisation only after a substantial time lag.

Therefore, although massive development programmes are highly desirable, they are not a panacea to global overpopulation. Economic development may be completely negated by a rapidly rising population. On the other hand, as the World Population Conference demonstrated, a birth control programme may be unsuccessful because it cannot resolve motivations which are essentially economic. Obviously, a balance has to be set between the two, and it will vary from place to place. I feel most strongly that birth control programmes should not contravene the basic principle of freedom of choice. For this reason, I disagree with the 'forcible persuasion' approach of Mrs Gandhi in India and Lee Kuan Yew in Singapore. In some states of India bills have been drafted stipulating fines, imprisonment, and compulsory sterilisation for couples having more than three children. For the last couple of years Singapore has had tax relief, paid maternity leave and free hospital delivery for the first three children only, and last year compulsory sterilisation was introduced. I believe the Chinese use of 'persuasion by propaganda' is more desirable than, for example, compulsory sterilisation. In mainland China, the most populous country in the world, social education has been able to reduce the annual population growth to around 1.6%, considerably less than the Asian average of 2.3%. Marriage is discouraged until at least 28 years, and any girl that gets Pregnant is despised by society.

4. Nuclear Power Plant Safety

Popular scientific journals (for example, 'Science' in USA and 'Nature and New Scientist' in Great Britain) frequently publish articles on topical environmental issues. Two that are currently in vogue are nuclear-power safety and depletion of the atmospheric ozone layer. The nuclear power plant debate, highlighted by the recent increase in oil prices, has been particularly heated.

In the United States, eminent scientists are being matched against each other in a 'war of words', with a regular flow of petitions from each camp being presented to the White House and Congress.

The pro-nuclear power group see nuclear fission as the saviour of the growing energy supply problem, brought about by the depletion of conventional fuels. Although only a few extreme members of this group state that nuclear power is entirely safe, they all feel that the nuclear industry has sufficient data and experience to operate at less societal risk and environmental impact than other energy sources commonly used for the generation of electricity. To support their claims, the two-year nuclear safety study conducted for the US Atomic Energy Commission is frequently quoted. The 3,549 page report of the study (15) — commonly called the Rasmussen report — calculates that the risk of a fatality in the United States from a nuclear accident (based on 100 plants) is 1 in 300 million. Comparable figures given (for 1969) include motor vehicles 1 in 4,000 and lightning 1 in 2 million.

The Rasmussen report has been criticised by many people (in particular, Dr Henry Kendall, Professor Rasmussen's colleague at MIT) on account of its use of the now discarded 'Fault Tree—Event Tree' evaluation technique. One serious drawback of this technique is that it assumes design adequacy of the equipment. The critics point out that design mistakes occasionally do occur and that they were the major cause of serious accidents in the Apollo space programme. Kendall's group also feel that it is impossible to allow for human error by plant operators or the likelihood of sabotage mathematical equations.

The anti-nuclear lobby quote the fire in March 1975 at the Tennessee Valley Authority plant at Browns Ferry in the United States as an example of the type of accident that can occur. A technician, using a candle to search for air leaks in an area where electric cables converge beneath the control room, ignited some polyurethane foam surrounding the cables. As the blaze spread, the power plant's electrical system went haywire: instruments that had been shut off clicked back on; some that had been turned on, turned off. Many of the safety systems were disabled. There was no 'meltdown' or release of radioactivity — a tribute to the ingenuity of the plant's operators—but it was a close call.

Two further aspects of nuclear power that make it entirely unsatisfactory to many people are the yet unresolved problem of long-term storage of radioactive wastes and the possible use of these wastes as weapons by political extremist groups. A reactor's wastes, mainly the depleted uranium fuel, are so highly radioactive that they pose serious risks to humans. Much of the waste remains dangerous for centuries, and nuclear power critics argue

that it is not fair to produce lethal garbage that could endanger future generations. The counter argument to this is that the total volume of waste is extremely small and, although a satisfactory long-term storage system has yet to be found, the temporary storage has been satisfactory through careful management. The well-published leaks in the United States, where an estimated 430,000 US gallons of high level wastes have leaked from drums since the early 1940s — the most serious being a leakage of 115,000 gallons in 1973 that went undetected for 48 days—refutes the claims of careful management.

Many people feel that the possible use of nuclear wastes, in particular plutonium, as weapons by extremist groups is the most dangerous aspect of all. Plutonium is the prime ingredient of atomic bombs; as little as 22 lbs. is all that is required for a crude fission bomb with the explosive force of 100 tons of TNT. Tight security regulations are needed to ensure the material does not fall into the hands of terrorists and blackmailers. Although the critics doubt such security measures could be achieved, if they were enforced the resulting infrastructure would take on the form of a 'garrison state' with civil liberties suppressed. The often-quoted response to these claims is that it requires considerable technical skill to manufacture a nuclear weapon from plutonium waste, skills not expected to be available to terrorist groups. However, this view recently suffered a considerable blow when a Chemistry undergraduate student from MIT designed a bomb from reactor-grade plutonium in five weeks. The student was allowed access only to public books and documents. It took him about three weeks to master the elements of nuclear engineering to his own satisfaction, and he actually designed in only two weeks a bomb that the Swedish assessor gave a fair chance of exploding with a low yield (16).

My opinion with regard to this debate is that, because of the considerable risks involved, nuclear fission should only be introduced in a particular location after all possible alternatives have been discarded. I accept that, despite its drawbacks, nuclear power is a necessity in many countries. However, I also believe there is considerable scope for energy conservation, and for the introduction of some of the alternative energy sources—sunshine, wind, tides, earth's heat, etc. In particular, I very much disagree with the current trend of introducing western-type reticulation networks to all areas of developing countries. This practice results in a necessity to then construct large generation plants—with the preferred option more frequently being nuclear fission—to supply the electricity.

Instead, with an estimated 800 million of the world's people living in villages, I see tremendous scope for the introduction of 'energy centres' in rural areas. This, idea, which has been enthusiastically promoted by Dr. Ishrat

Usmani of the UN Environment Programme, has discrete centres for energy production powered by a mixture of sources, depending on what is already available locally. For example, many poor countries are abundantly endowed with wind (especially in the trade wind areas of the Caribbean, the Pacific and the Indian Ocean), and sunlight is plentiful in most energy-poor countries. Another interesting possibility is the use of axial-flow turbines, originally developed for the Rance tidal power barrage in France, to harness the flow of the high-flow, low-gradient rivers which abound in many of the densely-populated parts of SE Asia, South America and Africa. Usmani would like to see the village energy centre function-oriented-wind energy is good for water pumping, solar energy is ideal for heating, methane from a bio-gas unit is useful for cooking, and a small-scale hydro plant is best-suited for electric power generation (17).

Returning to nuclear, it is ironic that economics may accomplish what the critics have failed to do with their safety campaign: to put a halt to the construction of new power plants. In the early days of nuclear power, scientists forecast that electricity from nuclear power plants would be extremely cheap. It now appears that the economic advantage has turned out to be an illusion. In fact, the euphoria about cheap nuclear power after the five-fold rise in oil prices was based on a simplistic, and wrong, assumption that generating costs for nuclear power would be half what they are for oil-fired stations. That cost comparison might be true for a power station completed today, but current costs are based on capital costs incurred in the early 1960s, fuel contracts made at the same time, and the bulk of research and development costs being shouldered by governments, not industry. Nuclear power plants are more complicated to build than other types of power plants; they take about 10 years to complete, while coal-burning plants can be built in 7 years. The extra time is money—lots of it—because the costs of building and borrowing are skyrocketing. For example, the cost of a nuclear power plant planned for Midland in the United States, in 1968 was estimated to be \$260 million; the Plant, not yet finished, is now expected to cost \$1,400 million. It has recently been estimated that the cost of building a nuclear power plant, per kilowatt of installed capacity, is now 50-70% higher than for fossil-fuel plants (18).

5. Depletion of the atmospheric Ozone layer

The possible depletion of the atmospheric ozone layer is another interesting environmental debate. Since the early days of atmospheric science, aerochemists have been particularly interested in the layer of ozone that surrounds the earth, at an average altitude of about 25 kilometres. This layer shields the earth from a certain amount of ultra-violet radiation, in the 200 to 310

nanometre wavelengthrange A reduction in the ozone layer could pose dangers for human life, for example, an increase in the incidence of skin cancer. Chemists therefore express concern when they find a chemical substance produced by man's activities, likely to reach the upper atmosphere, that reacts with ozone. About 5 years ago, there began to appear in scientific journals articles on the possible damage to the ozone layer by super-sonic transport (SSTs). It is postulated that the nitrogen oxides in the exhaust of these high-flying aircraft will reduce the ozone concentration by chemical reaction. Recently the concern for this possibility has waned, mainly because the exorbitant manufacturing costs of super-sonic aircraft have meant that it is now unlikely there will be the huge fleets of SSTs originally feared. However, concern for the ozone layer has received new attention by the recent discovery of another chemical produced in large quantities that reacts with ozone.

Less than 2 years ago, Professor Sherry Rowland of the University of California, Irvine, told the annual meeting of the American Chemical Society that the atmospheric concentrations of propellants used in aerosols (mainly chlorofluoromethanes) are rising so rapidly as to present a real threat to the ozone layer. He postulates that chlorofluoromethanes rise into the stratosphere, where they are photodissociated by ultra-violet light. The chlorine released is said to catalytically destroy ozone through reactions similar to nitrogen oxides and ozone. In many countries the aerosol spray can has in the last 3 decades become an ever-increasing part of everyday life. Normally an environmental 'scare' involving a widely used product is investigated for a long time before any action is taken. This did not happen in this case. Less than 10 months after Rowland first suggested that chlorofluoromethanes may seriously disturb the ozone layer, a high-level US 'taskforce' (representing 14 Federal agencies) recommended a ban on the use of fluorocarbon propellants for aerosols within 3 years. Almost immediately, various US states introduced bills banning aerosol cans containing fluorocarbons. In Oregon, for example, the bill is to take effect in February next year.

The major point of disagreement in the aerosol can debate is whether or not a ban is warranted at this time. Professor Richard Scorer of Imperial College, London, has labelled the situation a "bad case of environmental jitters" (19). He feels the scientific evidence is far from complete, and contends that laboratory experiments cannot satisfactorily model something as complex and unstable as the upper atmosphere. Dr. Jim Lovelock, the scientist who first detected fluorocarbons in the atmosphere in 1971, agrees with Scorer. He interprets the American reaction to mean "scientific arguments no longer count" (20). Lovelock believes that man-made halocarbons are swamped by naturally produced halocarbons. He estimates that man-made halocarbons account for no more than 2% of the total entering the atmosphere.

One of the reported side-effects of the proposed US ban of fluorocarbon propelled aerosol cans is that it could cost "billions of dollars and adversely affect the jobs of millions of workers" (21). Despite this, and despite the lack of scientific evidence, it appears that the ban will go ahead. I find this difficult to understand. I believe environmentalists have over-reacted on this issue; the ban they have succeeded in forcing may prove to be counter-productive to the environmental cause. There are many other more depressing examples of environmental degradation, for which we have concrete evidence, that require urgent attention. No adequate medical evidence exists to support the belief that higher levels of ultraviolet radiation necessarily leads to higher incidences of skin cancer. In fact, it has been proposed that "genetic factors, skin pigmentation, behavioural characteristics, medical facilities, broad straw hats, and suntan lotion all have some influence on skin cancer fatalities" (22). Obviously, a considerable amount of further research is needed before our knowledge of the link between the ozone layer and human health is complete.

6. Environmentalists

Anthony Crosland, now British Foreign Secretary, once wrote the following about environmentalists; "Their approach is indifferent to the needs of ordinary people. It has a manifest class bias.....they are little concerned with the far more desperate problem of the urban environment" (23). I concede that this criticism is, to a large extent, true. In western countries it is mainly middle class people that form such groups as 'Ecology Action' and the 'Society for Social Responsibility in Science'. Often their interests clash with those of ordinary, working class people. This was made very clear to me when I lived in Carlton, an inner city suburb of Melbourne, Australia, during 1973. Disagreements arose between the new, 'trendy' middle class and the old, working class residents of the suburb over such things as the forced relocation of industry outside the area. The 'trendies' were treated as invaders, taking over the area and arranging the local environment to suit their tastes for reduced noise and traffic, clean air, aesthetically appealing buildings, parks, etc. All this was at the expense of accessible factory jobs for their working class neighbours. The sincere claim of the middle class group that they are improving the local environment for all, working class residents included, became even more suspect when the improved middle class environmental conditions encouraged more of that kind to move into the suburb, forcing property prices, rents and rates to rise and forcing the working class out in search of cheaper accommodation. It is an unfortunate truism that concern for the environment is usually a luxury item of most interest to the comfortable middle class.

There are, thankfully, a few exceptions to this rule. Using another example from Australia, the 'green bans' imposed by Jack Mundy and his New South Wales Builders' Labourers Federation have been successful in preserving some historical buildings in Sydney. The bans were imposed despite the potential loss of jobs for members of the labourers union. In this case the conflict between personal interest and the self-perceived interpretation of the 'public good' was resolved in favour of the latter. Another interesting exception comes from the Himalayan states of Northern India. A group of village people in a small hamlet in the Chamoli-Garhwal area decided that it was time to stop the clearing of forests by developers and contractors. They formed a movement called the Chipko Andolan, which literally means the 'movement to embrace'; the strategy being, should nobody try to fell a tree, the Chipko agitator threatens to hug it. This threat has turned out to be so potent that in almost every confrontation with forest officials and contractors the Chipko agitators have been able to get their way by merely stating their threat (24).

Environmental concern has a definite class bias, but does it have a racial bias? It is true that of the experts in the various pollution fields (air pollution, water pollution, etc.) come from the developed countries, especially the US and Europe. However, there are several very capable scholars of the natural sciences from the developing countries that are currently having an important influence on environmental matters. For example, Dr. Boonsong Lekagul of Thailand, a hunter-turned-naturalist, is well-known for his attempts to save the remaining animal and plant life in the rapidly disappearing forest areas of South East Asia. Another leading natural scientist from a developing country is Mustaphia Tolba of Egypt. It is encouraging to see that he was recently appointed to the position of Director-General of the UN Environment Programme, based in Nairobi, Kenya.

If nowhere else, decision-making in the field of development and environment must involve leaders of developing countries. To a considerable extent, it does. Dr Gamani Corea of Sri Lanka was chairman of the 1972 Founex Conference on Development and Environment (7), and has played a leading role in more recent advancements in this very important field. At a more local level, the views of mochtar Lubis, Indonesia's leading environmentalist, are worth recording. Mochtar Lubis is the editor of Jakarta's main daily newspapers, and has been particularly outspoken on environmental issues concerning his country; He is highly critical of the type of foreign aid Indonesia is receiving. He feels that most UN advisers orientate their advice towards developed country technology and have very little knowledge of local conditions. He believes that one of the problems with the 'Green Revolution'

was that the people who designed the techniques of applying fertilisers and pesticides were western agricultural experts, and not people whose roots were in peasant farming. "It never occurred to them, for example, that in a rice paddy you not only grow rice but you also grow fish. In addition to the fish killed in the fields, the pesticide drained back to streams and lakes" (25).

7. Conclusions

Despite all of the foregoing, at this time I am mildly optimistic about the future. I believe that environmental pollution is not necessarily a 'price of progress'. Much of the technology exists to control it. All that is required is the will to implement this technology. I also believe that the international co-operation necessary to effect the redistribution of the wealth of the world can be achieved. This leaves us then with the problem of finding enlightened leaders. Our future depends on it. Is it too much to hope for?

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