

BETTER WORLD ENVIRONMENT THROUGH ENGINEERING EDUCATION AND MANAGEMENT

DR. M. NARAYANA RAO

1.0 INTRODUCTION :

The word 'environment' is derived from an old French word 'Environ' meaning 'Encircle'. In our limited human existence, we are encircled right from the time of our birth. We are surrounded by people, animals, plants and physical objects which are part of our environment. According to the Stockholm declaration in June 1972, 'Man is both creature and moulder of his environment, which gives him physical sustenance and affords him opportunity for intellectual, moral, social and spiritual growth'. Environment is thus the sum of all social, biological, physical and chemical factors which compose the surroundings of man. What we make of our life depends upon how we interact with the environment.

During the 1950's and 1960's people all over the world became more concerned about the quality of their environment. Well-known environmental tragedies, like the case of mercury poisoning in Minamata, Japan, severe smoke-pollution episodes in London

and the massive oil spill caused by the Tarrey Canyon accident reinforced in people's mind, the sense that the quality of air, water and a wide range of other natural resources was being seriously degraded. This sense of the deterioration of the natural resources on which human life itself depended was heightened by the fact that the human population grew from 2.5 billion in 1950 to nearly 5.5 billion in 1994. Demographers predicted that by the year 2000, global ecosystem would have to provide enough fresh air, potable water, arable land, minerals and other natural resources and provide a decent standard of living for over 6 billion people. Thus it became apparent to individuals and Governments around the world that the past approaches of economic growth, the past methods of natural resources exploitation, and the past rate of population growth had to be reduced or modified, if the well-being of future generations is to be assured. There has been wide recognition that economic and social development can only be sustained

Principal, TTTI, Chennai.

if the environmental concerns are integrated with the development process.

2.0 INTEGRATION OF ENVIRONMENTAL CONSIDERATIONS INTO THE DEVELOPMENT PROCESS :

The United Nation's Conference on the Human Environment, held at Stockholm, Sweden, in June 1972 was the first comprehensive international attempt to articulate the inter-relationship between the quality of environment, growing world population, and the world economic growth needed to sustain it. What was even most important was that this conference recognized the need for specific national and international actions to ensure that economic growth is planned in full appreciation of the long term value of environmental protection and natural resources conservation. The Conference proclaimed, 'A point has reached in history when we must shape our actions throughout the world with a more prudent care for their environmental consequences. Through ignorance or indifference we can do massive and irreversible harm to earthly environment on which our life and well-being depend.'

It is now generally recognized that population, resources, environment and development are inextricably linked and the relationship is extremely complex. These inter-relationships need to be understood for proper appreciation of the issues involved in the integration of environment with development. Furthermore, if the impact of technology for production on the environment in the past is any indication of its potential adverse implications, technology plan-

ning with considerations to environmental aspects should be carried out carefully.

When offered a choice of 2 desirable things said Oscar Wilde with his usual wit 'I choose both'. The most recent response to the false alternative 'ENVIRONMENT or DEVELOPMENT' has been the Rio Conference on Environment and Development, namely, urgent advocacy of environmentally sound, sustainable development. Sustainable development is development that meets the needs of the present without comprising the ability of future generations to meet their own needs. This calls for proper engineering, relevant education and efficient management of resources.

3.0 CONCEPT OF SUSTAINABLE DEVELOPMENT :

Sustainable development is a process in which the exploitation of resources, the direction of investments and institutional changes are all made consistent with future as well as with present needs. The concept of sustainable development has the following underlying premises (a) symbiotic relationship between consumer human race and producer natural systems and (b) compatibility between ecology and economics. The concept of sustainable development is closely linked to the carrying capacities of eco-systems.

Sustainable development planning needs,

- (a) carrying capacity based development planning process
- (b) structural changes in economic sectors
- (c) preventive environmental policy

and

- (d) Environment Impact Assessment (E.I.A.). E.I.A. is a preventive approach adopted to minimise adverse environmental impact and it is an aid to environmental planning of new developmental projects.

It differs from technical and economic planning techniques in that it deals with the utilization of common source i.e., the environment. The developmental planning process based on regional carrying capacity takes cognizance of the fact that the environment with its biotic and abiotic components provides the basic resources that support production-consumption activities and assimilates the residue produced during the course of these activities.

Structural changes in economic sectors relates to increased ecological harmony and economic efficiency through non-waste technology of production, utilization of renewable rather than non-renewable resource base in sectors like agriculture, energy, industry, mining, transport and construction.

4.0 SOCIAL ASPECTS OF ECONOMIC DEVELOPMENT :

Aristotle, the fountain head of western economic thinking, stressed the need of a natural limit to the needs of individuals as dictated by the ultimate welfare. He has said that human beings if unchecked by good sense would be insatiable and the beginning of reform would be training the nobler traits of human nature not to desire more.

Mahatma Gandhi stated that nature has sufficient material to satisfy the needs of the people but not their greed.

Men resorted to the following methods to modify or exploit natural resources to forcibly take out of nature more than what it is willing to part with. In this quest of increasing productivity, he eliminated complex eco-systems and replaced them with the following :

- (a) Monocultures (i.e., simplified single eco-system),
- (b) Shortened food chains (i.e. selective breeding),
- (c) High levels of fertilization,
- (d) Increased exploitation of minerals and fossile fuel,
- (e) Specialized and concentrated productive activities
- (f) Newer energy sources with more and more complex processes to utilize stored energy, and
- (g) Changing the natural contours of topography by the creation of man made lakes, irrigation projects, canals, etc.

The more man was able to utilize science, technology and management, the more, he was able to make the above methods productive. Obvious result is the extra-ordinary increase in the availability of goods and services and the capacity of earth to sustain a very large number of individuals. In return the valuable and irreplaceable biosphere inherited by him is spoiled and destroyed.

Human and hence economic production processes interact with economic systems in three ways :

- (a) materials are extracted from the biosphere,
- (b) they are transferred by physical and chemical means, and

- (c) after use, the arterial products are disposed off in the biosphere.

Human societies thus take out materials, causing depletion and add materials, causing pollution in the biosphere. They withdraw things from one place where they are found naturally in a diffused harmless state and deposit them in a transformed, often concentrated state in another place where it is harmful to the proper functioning of the biosphere. Ecological degradation according to the plant physiologist, Barry Commoner is a "process which stresses an ecosystem so much as to reduce its capability for self adjustment and which, therefore, if continued can impose an irreversible stress on the system and cause it to collapse."

The trends of resource degradation can be observed from the extent of desertification, deforestation, indiscriminate use energy, mineral and marine resources. Depletion of forest resources, soil erosion, increase in the recurrence of floods and loss of wild life and genetic resources rank as the major consequences of deforestation.

5.0 ENVIRONMENT AND POLLUTION :

The burden of excessive human claims on the earth's biological system is aggravated by yet another human excess the generation of waste. When waste is excessive, it becomes a pollutant. Pollution is more than a nuisance. It can impair and even destroy the productivity of local biological systems. It can ruin forests, crops, fisheries, fresh water lakes and streams, destroy whole species of plants and animals, impair human

health, deplete ozone layer, impede the exchange of oxygen and carbon dioxide between the oceans and atmosphere, and even damage clothing, buildings and monuments. Synthesis of new chemical compounds that are not readily biodegradable and the introduction into the ecosystem of heavy metals extracted from beneath the earth's surface have posed spacial threats. The current scale of pollution, the long-lived nature of synthetic chemicals and radioactive wastes and the indestructibility of heavy metals make it a formidable problem.

According to Chester Bowles, approximately a million tonnes of oil seep into the seas from freighters, tankers and off shore drilling rigs every year. Several million more tonnes of crude oil products in the form of gasoline, solvents and waste crank case oil also pollute the oceans. Both the quantity and variety of oceanic pollutants are multiplying so fast that their individual and combined effects on the marine biosphere cannot be precisely gauged. But it is clear that oceanic pollution which has reached alarming proportions is global in scale and is a growing threat to oceanic food resources.

While the pollution caused by domestic and industrial wastes is more readily apparent, the pollution caused by run-off from agricultural fields draining pesticide and insecticide residues, fertilizers and nutrients is only less apparent but nevertheless formidable.

There are several global issues related to atmospheric eco-systems. Three most important ones are acid rain, stratospheric ozone depletion and carbon dioxide build-up. The term "acid

rain" is rapidly becoming a part of our daily vocabulary. Acid rain kills fish and other aquatic life, corrodes buildings and monuments, damages forests and croplands and poses a special threat to human health. The stratospheric ozone forms a protective shield, that absorbs much of sun's ultra violet radiation. Ozone induced changes in ultra violet radiation are predicted to influence the evolution of life on earth, to modify the weather and cause ecological disturbance in the life support systems. Green house gases causing global warming is resulting in the melting of snow in Polar caps.

Global food production may be affected due to changes in rainfall patterns and desertification of the delicately balanced marginal lands now use for agriculture. Habitat destruction is now recognized as the most important cause of species extinction. It comes in two forms, a direct habitat destruction due to felling of forest-trees, shifting cultivation, construction of transport corridors etc. and indirect habitat destruction which is usually in the form of the pollution by chemicals, solid wastes and air pollution.

Solid wastes generated from industrial sources are heterogeneous ranging from inorganics such as those produced in mining, collieries, to organics produced in basic consumer product industries and may include even hazardous wastes as in the nuclear industry. These wastes can be grouped as biodegradable, nonbiodegradable and hazardous. Hazardous wastes are grouped into five categories namely.

(a) chemical,

- (b) biological,
- (c) flammable,
- (d) explosive and
- (e) radioactive wastes.

Disposal of these wastes is posing a formidable problem.

6.0 ENVIRONMENTAL POLLUTION AND HUMAN HEALTH

Inadequate water supplies for drinking and other uses and inefficient or non-existent sanitation facilities are responsible for many environmental health problems. Dr. Mahler, Ex-Director General of the WHO sated, "the number of water taps per thousand persons will become a better indication of health than the number of hospital beds". The statement is all the more true because inadequate water supplies almost always imply inadequate sanitation facilities. Furthermore, 80% of the diseases in the developing world are directly traceable to unsafe water and poor sanitation. The magnitude of water and sanitation inadequacies in the developing countries is staggering. The diseases caused by lack of water and sanitation can be classified into five categories.

- (a) water-borne diseases such as typhoid, cholera, dysentery, gastroenteritis and infectious hepatitis,
- (b) water washed infections of the skin and eyes such as trachoma, scabies, etc., due to inadequate water supply,
- (c) water based diseases such as schistosomiasis and guinea worm,
- (d) diseases with water related insect

- vectors (mosquitoes and back flies) which need water for breeding, and
- (e) infections that are primarily caused because of defective sanitation such as hook worm etc.

The factors contributing to the resurgence of malaria between 1960 and 1980 are lax surveillance, immunity of mosquitoes to DDT and increase irrigation facilities leading to stagnant pools of water. The widespread use of toxic chemicals and metals, application of pesticides in the control of malaria, filariasis and other vector-borne diseases and pest control is causing concern for environment and human health in recent years. The intensity of danger from chemicals can be gauged from the fact that the leakage of methyl isocyanate from a pesticide factory in Bhopal in December, 1984 killed over 3000 people, blinded several thousands and affected over 150,000 people.

In recent years there is a significant increase in the use of nuclear energy. Safe methods of discharge of nuclear wastes have not yet been discovered. Plutonium has a half life period of 25,000 year. Steel drums and other containers in which low-level wastes are stores become radioactive and pose problems of safe disposal. The cost of decommissioning a typical nuclear power plant is estimated at US \$1 billion. Nuclear wastes are important while power is mortal.

Uncontrolled urbanization is resulting in urban areas suffering from squatter settlements, lack of sanitation and water supply, congestion, overcrowding and pollution. The large cities

in Asia like Bangkok, Mumbai, Calcutta, Jakarta, Manila face addition environmental problems such as lack of sanitation, chronic shortage of services, polluted air and water, lack of open spaces and recreational areas, traffic congestion etc.

In general, the greater the extent, spread and intensity of poverty, the shorter is the life expectancy. UNICEF has ranked countries in regard to their development statues by magnitude of their infant mortality rates. Just as the symptomatic treatment of diseases does not cure disease, treating disease as they occur or even undertaking prophylactic measure do not have a long term ameliorative effect of the health conditions of the society, unless the nutritional status and water supply are improved.

7.0 ENVIRONMENTAL MANAGEMENT TOOLS

Mounting environmental liability costs, increased mass awareness and consumer movements lead to environmental audit. Word "Environmental Audit" was first used by British Petroleum (BP) international group in 1972. In Europe, Ciba-geigy was the first corporation to adopt environmental audit in 1981. Environmental audit became popular in USA from 1980.

The primary and obvious advantage of Environmental Auditing is to help safeguard the environment and the assist with and substantiate compliance with local, regional and national laws and regulations and with company policy and standards.

Environmental Audit is now being

followed in all countries. It highlights process inefficiencies and areas of poor management, helps to improve process efficiency, operation and maintenance of treatment plants and reduces waste generation.

Waste audit is a technical tool meant for waste reduction from all possible sources and is carried out in 20 steps. Waste as well as environmental audit serve as management information systems (MIS) by collecting, organizing and analysing data and transmitting information to management.

8.0 CLEAN TECHNOLOGIES :

The emergence of the concept of clean technologies can be traced back to the UN Conference on Human Settlement in 1972 that proclaimed resources conservation as a basic principal for environmental management.

In 1976, the Economic Commission for Europe (ECE) defined Non-waste Technology (NWT) as the practical application of knowledge, methods and means so as (within the needs of the man) to provide the most rational uses of natural resources and energy and to protect the environment.

The concept was broadened by ECE by coining the term "clean technologies" of production, which means less pollution discharge into environment, less waste generation and less demand for natural resources.

Clean technologies use minimum resources with maximum efficiency to achieve twin benefits of resource conservation and environmental protection. They include (a) Recycle technologies designed to recover raw materials, en-

ergy, water etc. (b) Waste utilization technologies and (c) Low or non waste technologies aiming at waste minimization through process changes, good house-keeping, recycle and reuse equipment redesign and product reformulation.

The United Nations Environmental Programmes (UNEP) established an International Cleaner Production Information Clearing (ICPIC) house with computer based information exchange systems. ECE has set up a Network of Environmental Technology Transfer (NETT) in 1988 and provides exchange of information of cost-effective abatement methods and waste treatment technologies.

The United States Environmental Protection Agency (USEPA) has recently changed the focus of its activities from end-of-pipe treatment to pollution prevention. In addition, many developments are made in physical, chemical and biological treatment of sewage, sludges and industrial wastes.

Waste utilization policies and programmes have resulted in 40-60% recovery rates in countries like Japan, Netherlands, United Kingdom and Sweden in the paper and aluminium industries.

9.0 EARTH SUMMIT IN RIO DE JANEIRO :

The year 1992 is virtually the year of the environmentalists when as many as 110 heads of Governments of various nations, congregated at the picturesque Rio de Janeiro in Brazil to shape the future destiny of a pollution ravaged world.

The United Nations conference on Environment and Development (UNCED) which took place two decades after the Stockholm meet was the first serious global attempt to tackle environmental issues like depletion of ozone layer, global warming, climate change and dangers of greenhouse gases.

More than 40,000 people and over 10,000 journalists, arrived at Rio de Janeiro to debate and decide on how to tackle these vexing issues under the aegis of the world body. It became not only a media event of the century but also a major political event of the decade. For 12 days, Ministers and Bureaucrats negotiated to bring forth momentous documents like the Rio Declaration 21, convention on climate change, biodiversity and statement of principles of forestry.

Climate change convention signed by 160 nations prescribed limits for carbon emissions to minimise climate changes caused by green house gases and global warming. UNCED estimated that it would cost at least \$650 billion to clean up environmental mess in the world. The convention called upon the developed countries to transfer environmental protection technology to the developing world at no cost.

1992 saw many countries acceding to the Montreal Protocol on phasing out substances like chloroflorocarbons that punch holes in the protective ozone layer in the atmosphere.

A large number of countries signed the Biodeversity convention with the exception of USA and other countries. This convention sought to preserve the flora and fauna of the planet as a part of

the world wide conservation strategy to minimise effects of pollution.

Thus the Rio-declaration broadly outlined the rights and obligations of member nations of U.N. toward protecting the environment.

10. STRATEGY FOR SUSTAINABLE LIVING :

The World Conservation Union, UNEP and the World Wide Fund for Nature defined a sustainable society as one based on :

- respect and care for the community of life;
- improvement in the quality of human life;
- conservation of the Earth's vitality and diversity;
- living within the Earth's carrying capacity;
- improving individual attitudes and practices;

Development ought not be at the expense of other groups or later generations, nor threaten the survival of other species. But, when development does occur, both benefits and costs should be shred fairly among different communities and peoples. These changes involve a new set of ethics to act as a guide to future decision making.

To signal this ethical shift to their citizens, nations should adopt a universal declaration and covenant on sustainability. Incorporation of such a declaration into national legislation would make the declaration more effective.

Improving the Quality of Human Life :

The universally accepted goals for

human life are : a long healthy life; education, political freedom, a guarantee of basic human rights, and freedom from violence. If development improves all these aspects of life then it is real development.

In lower-income countries, economic growth is needed urgently to improve the quality of life by allowing people access to sufficient food and safe water, and to educational facilities.

Higher-income countries need to reduce resource consumption, energy use and environmental degradation. In all countries, the immunization of all school children will be necessary to improve the quality of life.

Conservation of the Earth's Vitality and Diversity :

Future development must conserve life support systems the physical and ecological interactions that shape climate, cleanse water, recycle essential elements, create and regenerate soil, and enable ecosystems to renew themselves.

This will mean having to preserve both the diversity of species and of the ecosystems in which different species co-exist. To achieve this, renewable resources must not be used at a greater rate than can replenish themselves. This applies to wild animals, fish, forests, cultivated and grazed lands and fresh and marine water systems.

To achieve these goals, governments must adopt a precautionary approach to pollution : minimizing and, if possible preventing the discharge of harmful substances into air and waterways, and the dispersal of such substances on coastlines or on land. This will entail factory redesign to produce

less dangerous waste, and changes in consumer spending patterns, particularly in affluent countries. Economic incentives, taxes and regulations all have their place in bringing about these changes.

Of particular importance will be a reduction, by higher-income countries, of emissions of sulphur dioxide nitrogen oxides, carbon monoxide and hydrocarbons. These emissions cause acid rain and smog. Industrial and economic growth in developing countries will result in a rise in carbon dioxide emissions, the major cause of the greenhouse effect. They will need assistance in reducing these emissions and their emissions of ozone-destroying chlorofluorocarbons.

Where deforestation occurs, it should be matched by regeneration of forests but it will also be necessary to preserve biodiversity by the establishment of specially protected areas. To ensure the effectiveness of protected areas in preserving a diversity of habitats, it will be necessary to enlist the support of local communities. Their support for these areas will be more likely if they benefit from them.

Living within the Earth's carrying capacity :

The depletion of non-renewable resources like minerals, oil, gas and coal must be minimized. While such resources can not be used 'sustainably', their life can be significantly extended by recycling, by using the resource more efficiently – whether it is a mineral or fossil fuel – and by substituting the use of renewable resources.

To achieve this goal it will be neces-

sary to stabilize both population growth and resource consumption. New taxes and economic incentives will be important tools in fulfilling this aim.

It will be necessary to at least double the global provision of family planning services if population growth is to be stabilized. Both the health of mothers and infant mortality will be crucial factors to be considered in population stabilization. The aim for countries should be to have total fertility rates of 2.1 (stable replacement level) by 2010.

Improving Individual Attitudes and Practices :

With the encouragement of governments and aid agencies, and leadership from the non-governmental organizations, individual attitudes and behaviour will change. To do this, crucial target groups will have to be targeted for information campaigns, including farmers and those in the fishing industry, forestry, workers, artisans, the urban and rural poor, and industrial and investment managers and controllers. Environmental teaching will have to be incorporated in school and college curricula.

11.0 ENVIRONMENTAL ISSUES IN INDUSTRIES :

Some people believe that environmental issues are a curse on business establishments. Others believe that when it comes to the environment, it simply is the right thing to do. Both are wrong ! Small companies can turn environmental costs into profits. Environment is not cost-it can be an asset. In the 1990s, environment management is not something that we should do. It is not

the ethical thing to do. It is only to do if we are to maintain a competitive advantage. Environmental issues are no more a fad than quality was in the 1980s. It is a strategic advantage; it is a series of operational initiatives that enhance competitiveness.

Some of the most innovative and far-sighted companies in the world are turning environmental considerations into a competitive edge. Unless we incorporate environmental decision-making into routine managerial and employee activities, we are likely to lose perhaps the last competitive battleground. Signs of an ever quickening recognition of the strategic advantage of good environmental management are everywhere.

According to conservative estimates, American companies are producing five times as much waste per dollar of revenue as their Japanese counterparts, and double the level of Germany. There are notable American exceptions including 3M's Pollution Prevention Pays (3P) programme that has saved the company over \$400 million since its inception in 1975.

Dow Chemical, Allied-Signal, Chrysler, Upjohn, Quad/Graphics, ARCO and others are on the cutting edge of being able to turn the environment into something more than simply a marketing strategy.

Challenging the ways things are done often produces new solutions. This happened in a division of Quad. The company was under pressure from employees who were questioning the use of styrofoam in its cafes. Many wondered why the company didn't wash dishes

instead of tossing them. Using china and silverware provided to be practical in some plants. Others have implemented styrofoam recycling programs.

Upjohn was also to improve waste management by challenging old assumption about the way business had been in the past. By working with the purchasing and office service's departments, it was able to find a recycled paper almost identical to what it had been using. The new paper eliminated the need for a new virgin material and the company discovered the recycled paper was actually less expensive.

TECHNOLOGICAL SOLUTIONS :

Environmental operational strategies simply involve investing in new equipment and technologies rather than using obsolete ones. For example, studies have shown that the newest lighting fixtures, air conditioners, furnaces, and refrigeration units are several times more efficient than older models. The International Energy Agency in Paris estimates that industrial countries could cut energy demand by 20 percent by the year 2000. Upjohn saved \$123,000 on its electric bill by simply replacing light fixtures and bulbs with more efficient alternatives such as mirrored reflectors that increase reflectivity by 94 percent and reduce the number of bulbs required to light a room. Technological solutions are also the reason why new herbicide plants are producing 90 percent less pollution than ones already in service.

Equipment and technological solutions can also prevent pollution. By modifying equipment to perform better or by optimizing its performance we can

reduce by - products and waste. Some technological solutions are high tech, others are simply good common sense. On the high end, would be Merck's use of an experimental expert computer system called Environmental Assessment System (EASY). It gives Merck a systematic way of evaluating manufacturing process concepts in advance for the amount and type of waste and emissions.

There are control technologies that physically trap substances before they are released into the environment. Waste can then be recycled, destroyed, or landfilled. Minimization technologies improve the design or equipment used in the manufacturing process so that waste can be eliminated or reduced. As part of its constant Performance System, Goodyear created the first "smart tires" for the trucking industry. A tiny integrated circuit or "chip" imbedded in medium commercial truck tires enables them to "report" by radio frequency such information as tire pressure, temperature, and revolutions. The technology helps truckers to maximize fleet fuel economy and extend tire life, keeping them from premature entry into the waste stream. The objective is to have a high yield, a small volume of benign waste using the fewest control technologies.

Prevention technologies seek to avoid waste. A good example can be seen in Quad/Graphic's use of electronic page and image processing instead of the older photochemical, film-based technology. The growth of electronic page and image processing, like many paperless systems, is enviro-friendly.

Publishers who use electronic page design and production now skip intermediate steps such as issue of art boards and galley stages that consumed paper and other resources. When the design is complete, it is sent on diskette over phone lines to Quad/Imaging and processed into final films directly.

Aircraft manufacturer Northrop found the same positive results from its film processing when it converted its photography department from conventional chemical photography to electronic photography. It reduced its waste, decreased hazardous waste water, and eliminated film purchases.

There seems to be no end to the emerging environmental technology. Already researchers have developed a new method for processing pulpwood that may reduce the energy and production cost at paper mills 80 percent. It may double yields and cause virtually no air or water pollution. Scientists have also developed a new approach to pesticide waste disposal that sees ultraviolet irradiation and ozone to break up the pesticide molecule so that it can be metabolized by microorganisms.

These examples might give us the impression that technological solutions to pollution must be high-tech and a high-investment cost. Technological solutions can be low-tech and low cost. Sometimes it just takes a little creativity.

RESOURCE RECOVERY :

The last option in this hierarchy of pollution prevention choices is resource recovery. It is the least desirable choice because you are in a reactive rather than proactive mode. Naturally, prevention

rather than control is always the preferred method. Recycling should never be the goal of waste management, because it's not the last choice ! It would be better to recycle less because you waste less, The goal is waste reduction, not recycling, which means the focus should be on efficient use of all resources including energy, and landfill space. Sometimes people and government lose site of the goal of pollution management. As a result, recycling and collection efforts often end up costing more than the recyclables are worth. Despite its drawbacks recycling by products for sale still can remain a viable and economic alternative.

Needles to say, while resource recovery and in particular recycling may not be the first choice, it is an essential one. In 1960, Americans produced 88 million tons of trash. By 1988 that amount had risen to 180 million tons or roughly 4.5 pounds per person per year. To give a better sense of how much garbage that is consider this perspective. If you were to put all that garbage each year into garbage trucks and put them end to end, it would stretch more than halfway of the moon ! If this trend continues, America will generate 216 million tons of trash annually by the year 2000.

RECYCLING :

Recycling is obviously going to be part of the solution. One ton of recycled paper saves about 17 trees; 7,000 gallons of water and 4,000 kilowatt hours of electricity, not to mention keeping three cubic yards of landfill space while keeping 60 pounds of pollutants from the air.

Additionally, recycling programme reduces energy consumption as well as avoids incurring landfill cost.

Even modest environmental initiatives like recycling paper products can pay big dividends. The Upjohn Company reported that in 1990 it recycled 910 tons of waste paper, carton board, loose-corrugated and corrugated bales. Not only did this paper recycling effort help the community by saving an estimated 2,992 cubic yards of landfill space, preventing 54,413 pounds of air pollution and saving 15,420 trees, it also helped the company's bottom line. Because of the recycling effort it was also able to save 3,809,033 kilowatt/hours of electricity and 6,348,388 gallons of water.

Any recycling efforts are valuable. For example, recycling packaging can have a dramatic economic impact. Valvoline packaging plants have recycled more than one million pounds of plastics, corrugated stretch wrap, banding and paper, thereby reducing the amount of landfill material by nearly 3.4 million pounds. Likewise the Disneyland Resort recycling efforts produced impressive numbers. They collect over two million pounds of cardboard, 24,000 pounds of aluminium cans, over 133,000 pounds of glass and 302,000 pounds of paper. Their paper efforts alone saved 2,571 trees and 4,000 kilowatt hours of electricity.

12.0 ENVIRONMENTAL MANAGEMENT ISSUES :

The preamble to the "National Conservation Strategy and Policy Statement on the Environment and Development"

Government of India, June 1992 states that "The survival and well-being of a nation depends on sustainable development. To this end we must ensure that the demands on the environment form which we derive our substance, does not exceed its carrying capacity for the present as well as future generations".

A good and stable environment is a harmonious combination of several elements, which include sunshine, air, water, land, biomass and biodiversity. These elements sustain life on this planet earth, Any environmental policy shall have to aim at protection, preservation and conservation of sunshine, air, water and land. Nurturing and careful handling of biomass and biodiversity is the core of environmental management.

Needless to mention that all these elements are mutually dependent. Biomass and biodiversity survives because of the sunshine, air, water and land. On the other hand, biomass and biodiversity protect and enrich them. Biomass and biodiversity

- purifies air and supplies oxygen to it
- makes the land fertile by fixing nitrogen and creating humus
- regulates water movement and thus reduces erosion and sedimentation
- regulates water movement, maximizes infiltration and recharge.

Any environmental management, policy and programme should contribute towards maintenance and regulation of harmonious combination of proper quality and quantity of land, biomass and water. On the contrary, environ-

mental mismanagement would regret in increased aberration in the environment in terms of drought, flood, landslide and cyclone.

13.0 SCOPE OF ENVIRONMENTAL MANAGEMENT :

Environment management promotes due regard for physical, social and economic environment of the enterprise or project. It encourages planned investment at the start of the production chain rather than forced investment in cleaning up at the end. It seeks to develop integrated systems rather than unrelated bits and pieces and provides for a good relationship with and concern for the local community rather than paying expensive legal fees to fight it.

Some business houses have long understood that environmental protection and economic progress can go hand in hand, for example.

- (a) a chemical company (Europe) with minimal capital investment for recycling its water solvents, eliminated 50 percent pollution from its operations and saved US \$400,000 per year.
- (b) a manufacturing company (Asia) introduced waste recovery for atactic polypropylene production to improve annual profits by US \$500,000;
- (c) an oil refinery (Europe) turned its hydro-carbon pollution into by-products that produced profits of US \$1 million per year;
- (d) a chemical company (America) reduced its annual pollutant load by 75 percent and achieved cost savings of US \$2 million per year.

Yet, in many countries, industries failed to train and provide for reasonable environmental management. The unfortunate results have received international publicity and seriously threatened the profitability, growth and even survival of these enterprises.

The dimensions of environmental management are increasing each year, as governments become aware of the political priority of reasonable environmental protection and its links to economic development and technological progress.

Environmental management covers such general areas as environment and enterprise objectives, scope and structure of the environment, interaction of nature, society and the enterprise, environmental impact assessment, economics of pollution prevention etc., such project areas as projected development, implementation, monitoring and evaluation; and such production areas as production management and the environment product design, technology choice waste management and production systems.

14.0 GOVERNMENTS INITIATIVE :

Ministry of Environment and Forests, Government of India Department of Environment and Forests of each State Government have been deeply engaged in the protection, preservation and conservation of environment. Several possible policies, programmes and implementation strategies have been evolved from time to time by these Governmental Organizations towards their effort for better environmental management. The programmes and activities

are directed towards all aspects of environment and ecology with the purpose of protection and conservation of environment and ecology. With the purpose of protection and conservation of nature and natural resources, these departments are fully aware about the environment and major environmental problems that the country is facing today. Their missions include

- Developing a good and stable environment through land and water management.
- Conservation and restoration of the ecological heritage.
- Development and propagation of eco-friendly technologies for sustainable development
- Involving NGO's and women in all environmental related activities.
- Help Government to formulate laws and regulation.
- Undertake special measures in afforestation and vegetative propagation.
- Supporting environmental education in educational institutions.

ENVIRONMENTAL MANAGEMENT AND THE LAW :

Between 1974 Water (Prevention and Control of Pollution) Act to 1997 National Environment Appellate Authority Act, about two dozen acts have been enacted in India exclusively for environmental pollution control. According to Ministry of Environment and Forests, Govt. of India 6624 cases have been filed by the Central Pollution Control Board, State Pollution Control Boards and the Pollution Control Committee of

the Union Territories as on 31.10.1997 under the water and air acts. 3677 cases are still pending in various courts. The loopholes in environmental laws make it easier for the lawyer to support the cause of the polluter. These laws if implemented properly can contribute to a large extent at this end.

Various Government agencies and NGO's in their effort towards environmental protection and law organize seminars and workshops involving the judiciary, advocates, academicians and students. These seminars and workshops discuss and suggest strategies on various aspects and issues involving problems and contraventions of environmental laws.

15.0 ENVIRONMENTAL EDUCATION :

Education has a very important role to play in dealing with this global issue. Education has been used by mankind not only as a conserving agency and a mechanism of social control but also as a creative and regenerative influence to bring about positive changes in existing modes of thinking and living in beliefs, values, attitudes and customs. In a crisis of the kind we are witnessing vis-a-vis environmental problems, there are greater demands on education to take a more active part and make purposeful contributions in the form of developing an awareness and sensitizing in the first place, of the challenges and consequences of manhandling of the environment, a proper understanding and appreciation of the phenomenon of better living and the formation and sustaining of desired values and attitudes through it.

Environmental Education is an integral process which deals with man's interrelationship with his natural and man made surroundings, including the relation of population growth, pollution, resource allocation and depletion, conservation, technology and urban and rural planning to the total human environment. Environmental Education is a study of the factors influencing ecosystems, mental and physical health, living and working conditions, decaying cities and population pressures. Environmental Education is intended to promote among citizens the awareness and understanding of the environment, our relationship to it, and the concern and responsible action necessary to assure our survival and to improve the quality of life. By Environmental Education is meant a set of organized curricular and cocurricular experiences designed to bring about the needed changes in knowledge, understanding, attitudes, and skills pertaining to environment, conservation, ecological balance and sustaining it. However, education must not be considered as a solution for all environmental problems. It must be strengthened and supplemented by corresponding social and political action.

Education, by its nature and content is considered a strong and effective process of bringing about behavioural modifications. It aims at influencing on the values, attitudes and beliefs of individuals. Most of the problems of environment are problems of the human mind. It is therefore imperative that education is eminently suitable as a strategy to deal with environmental problems. Education aims at developing a peaceful

and happy world order and supports individuals in their quest for solving problems and attempts at working towards a better living. The goal of environmental education should be to improve and enhance the quality of life.

A nation may take pride in its industrial and economic growth. While investment in a large scale in these sectors would result in increased products, unchecked erosion of environment will nullify the effects of industrial growth. It will create an imbalance in the ecosystem, notwithstanding scientific and industrial progress, making life on this planet miserable.

More specifically, the objectives of Environmental Education are :

- **Awareness** – to help individuals and social groups acquire an awareness of and sensitivity to the total environment and its allied problems.
- **Knowledge** – to help individual and social groups acquire basic understanding of the total environment, its associated problems and humanity's critically responsible presence and role in it.
- **Attitude** – to help individuals and social groups acquire social values, strong feelings of concern for the environment and the motivation for active participating in its protection and improvement.
- **Skills** – to help individuals and social groups acquire the skills for solving environmental problems.
- **Evaluation Ability** – to help individuals and social groups evaluate environmental measures and edu-

cation programmes in terms of ecological, political, economic, social aesthetic and educational factors.

- **Participation** – to help individuals and social groups develop a sense of responsibility and urgency regarding environmental problems to ensure appropriate action to solve those problems.

Education must attempt to imbibe in learners a value oriented thought to take care of the environment. The success of Environmental Education would depend on internalizing the following principles.

- Environmental Education considers environment in its totality.
- Environmental Education is not a one shot learning approach. It is a life long process encompassing all levels of education.
- Environmental Education is a challenging area requiring both disciplinary and interdisciplinary approach. This calls for a holistic rather than a piece meal subject oriented approach.
- Environmental hazards are controllable and every citizen has a moral obligation and responsibility towards this.
- Concerns of environment are concerns of several agencies. Formal and nonformal educational system and programmes must work in unison.
- Education must cater to all sections of society - the general public, and non specialists, socio professional groups and technologists as well.

- Promote the value and necessity of local, national and interpersonal cooperation in the prevention and solution of environmental problems.
- Help learners discover the symptoms and causes of environmental problems.

The importance of environment has long been recognized in our country. Article 51 A (g) of the constitution states "It shall be the duty of every citizen to protect and improve the natural environment, including forests, lakes, rivers and wildlife and to have compassion for living creatures". The National Policy on Education 1986 reiterated the need for education to play a more proactive role in regard to educating learners 'about' the environment 'for' the environment. There is a paramount need to create a consciousness of the environment. It must permeate all ages and all sections of society beginning with child and 'in' the environment. Environment consciousness should be included in schools and colleges.

- (a) Education about environment provides learners with know how on environment.
- (b) Education for environment will be concerned about conservation, preservation and upgradation.
- (c) Education in Environment would result in using environment as a medium of learning. Positive attitude towards it could be developed and integration with learning activities become possible.

Formal Education system by its very nature and reach has an important

role to play in regard to Environmental education. It must aim at developing in students knowledge, awareness and understanding. While these may provide knowledge to students about environment, it is the concerns about environmental problems that is more vital. The secret of success lies in development of correct values and attitudes towards environment. Curriculum of courses and programmes at all levels of education need to reflect this concern. The absence of environmental issues in the existing curricula has resulted in an inadequate understanding and appreciation of the virtue of environment. Educationalists are concerned about introducing study of environment as a separate subject or by integrating it with the other subjects. The infusion approach where environmental issues are introduced into the traditional subjects is tried out at the primary and secondary levels. At the tertiary and higher levels the need to integrate environmental education has been felt for a long time. While environmental concepts in areas such as Sciences, Geography and Applied Science, Social Sciences. Medicines are felt necessary for inclusion, the courses must aim at developing sensitivity and awareness to environmental issues, developing skills to analyse and solve environmental problems. While planning Environmental Engineering courses for technical and vocational levels the stress must be on inclusion of ecology, natural resources, dynamics of ecosystem, clean technology, use of resources and working environment. The technician must have a basic knowledge of and a special sensitivity and responsibility towards

environmental problems. Different approaches could be tried out for building in environmental education into the curricula of courses.

A classical approach would be to introduce a new subject namely Environmental Engineering Education.

A second approach would be to group topics under broad themes drawn from various disciplines and inclusion of these themes in the different subjects.

A third approach would be to plan and implement learning experiences in the form of extra curricular programmes by inclusion of environment or environment related topics. Each one of the approaches has merits and any specific approach needs to take into consideration several factors which are specific to curriculum designing.

16.0 TEACHER TRAINING :

The question of education depends upon the quality of teachers. The effectiveness of the curriculum depends upon how well teachers are equipped to implement it, their bearing and attitude towards it. To expect all teachers to have the know how and 'do how' of environment is too much. There are some institutions in our country which have introduced Environmental Education in preservice training programmes. These are meant to cover teachers at secondary school level. In the absence of preservice training for technical and vocational teachers Environmental Education needs to be provided through inservice

training programmes, induction programmes/orientation programmes for young and freshly recruited teachers. However, certain problems are seen in this regard.

- Environmental Education is interdisciplinary in nature. Teaching this requires specific skills.
- At present there are very few teachers with competencies to handle environmental education as an interdisciplinary subject.
- Environmental Education is viewed by a large majority of teachers as a borrowed discipline.
- Teaching/training kits and materials are not readily available in this area for teachers to depend upon.

The very nature of Environmental Engineering suggests the requirement of participatory-oriented, activity - based teaching methods. Conventional teacher-centered approaches such as Lecture can not be expected to be effective in teaching environmental engineering. Case studies, Simulation, Problem Solving and Project methods need to be used so that learners can be provided with a variety of direct experiences making use of the local environmental issues.

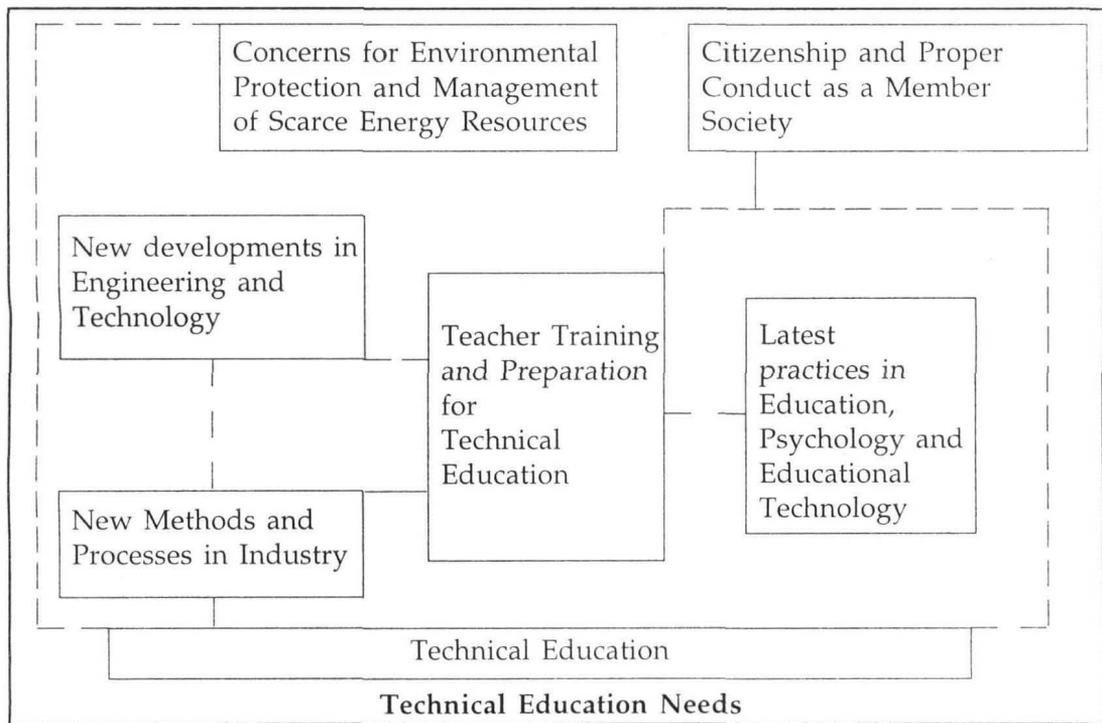
Environmental Education must be addressed to all sections of the community. Continuing Education programmes in Environmental Education using interdisciplinary approaches targeted to various groups is essential. Continuing education units need to be set up in institu-

tions and entrusted with the responsibilities of designing, implementing and monitoring Environmental Education programmes.

Environmental Education must enlist the cooperation and involvement of all people concerned. Environmental Education must get the status of a discipline like any other discipline. Institutions should be encouraged to establish Environmental Education Centres. These centres may be entrusted with the responsibility of training teachers, designing awareness programmes designing curricula and undertake research in the area of Environmental Education.

The successful incorporation of Environmental Education into the curricula of technical schools and training institutions depends upon the competencies, knowledge, skills, abilities, attitudes and values of the teacher. There is now a felt need for exposing all teachers in training institutions to a teacher training programme which builds in them the competencies needed for teaching environmental subjects. The general analysis of the needs of technical teacher education is shown in the Figure below. This indicates how the curricula in teacher education are largely influenced by various factors relating to technology, industry, pedagogy and general social and community needs. Environmental concerns and needs are the new factors now introduced. The competencies to be sought in an effective environmental teacher are listed below.

Area	Environmental Aspects Needed for Teacher Training
1. Awareness	Impact of Environment on life. <ul style="list-style-type: none">• Impact of social and group habits.• Causes of pollution.• Need to protect environment.• Renewable sources of energy.
2. Knowledge	Health and hygiene standards <ul style="list-style-type: none">• Pollutants and their characteristics.• Mechanics of pollution.• Sources of energy.• Wastes of energy.• Methods of conservation.
3. Skills	Location of areas of pollution. <ul style="list-style-type: none">• Measuring extent of pollution.• Applying techniques to control pollution to acceptable levels.• Applying soil conservation methods.• Applying water and sewage treatment methods.• Rotation of crops.• Disease prevention for cattle and poultry.
4. Attitudes	Appreciation of hazards of pollution. <ul style="list-style-type: none">• Value health standards.• Value personal health.• Accept and use national pollution standards.



17.0 CONCLUSION :

Environment is a partner to development and not an impediment. In order to maintain essential ecological process, to ensure genetic diversity, sustain species and ecosystems, prevent environmental degradation, governments should

- (a) adopt a natural resource conservation strategy;
- (b) incorporate environmental considerations into all public and private sector developmental planning,
- (c) adopt a national policy on sustainable economic development,
- (d) enact and enforce national legislation to protect and enhance national resources,
- (e) strengthen national organizations that have environmental informa-

tion and statistic,

- (f) strengthen programmes for environmental manpower development,
- (g) improve environmental education and training programmes
- (h) broaden public information and participation programmes, and
- (i) develop and implement projects dealing with environmental management.

Only through fuller knowledge and wiser action, we can achieve for ourselves and our posterity a better life in an environment in keeping with human needs and hopes.

Pollution is created by everyone; every one is affected by it and therefore every one should participate in controlling it.

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