

THE ROLE OF ENGINEERS AND ARCHITECTS IN CONTROLLING THE ENVIRONMENT OF DEVELOPING COUNTRIES

by

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I. INTRODUCTION

Perhaps the most significant realisation of man in recent times is that our environment is not limitless. The more crowded our planet becomes, the more urgent is the need to understand human ecology and to control our developing environment in our own long-term interest.

In the developing countries, the problem is not so much population density and environmental pollution, as it is one of population indifference and environmental deficiencies. Therefore, there is time to devise and establish a balanced socio-economic philosophy that safeguards against inevitable environmental deficiencies without undercutting the invaluable economic development essential to all nation-building.

While this is a task for many disciplines in government and in the private sector, the engineers and architects have an understandably special place in development programmes. With this goes the responsibility to provide the engineering and architectural expertise needed for a controlled development of the traditional sectors of our environment — air, water, food and shelter.

II. TECHNOLOGY AND THE ENVIRONMENT IN DEVELOPING COUNTRIES

Technology and development

In simple terms, engineers and architects serve mankind by utilizing the resources of nature and by designing buildings. In practice however, the industrial revolution and the proliferation of communities throughout the world have given them a more direct influence on day-to-day modern living. Indeed, "the history of development of the common man and his physical comfort and material welfare are inseparable from the history of development of technology."¹

1. B.G. Singh: "Professional Engineer" Role in Technological Development in Small Transitional Societies" (Journal of Assoc. of Prof. Engineers of Trinidad & Tobago — Vol. 8 No. 1 of 1968).

But the technologist must offer his society more than the technological competence of basic knowledge and disciplined mind. He can no longer function without an awareness of and interest in the socio-economic implications of his work. He cannot engineer in a vacuum. To optimize his impact on his society he must understand social design as much as the science that underlies his more mechanistic designs. In other words, he must not accept a purely technical role.

Secondly, technologists tend to feel that new technological discoveries will solve all our problems, like those of environmental pollution (e.g. cleaner fuels for automobiles, or recycling industrial wastes — gaseous, liquid or solid). But often these solutions have a way of creating new environmental problems of their own (e.g. nuclear power plants avoid smoke pollution of the air but introduce heat pollution to streams). So technology alone is not enough. It must be the product of social attitudes from which the technologist cannot continue to disassociate himself.

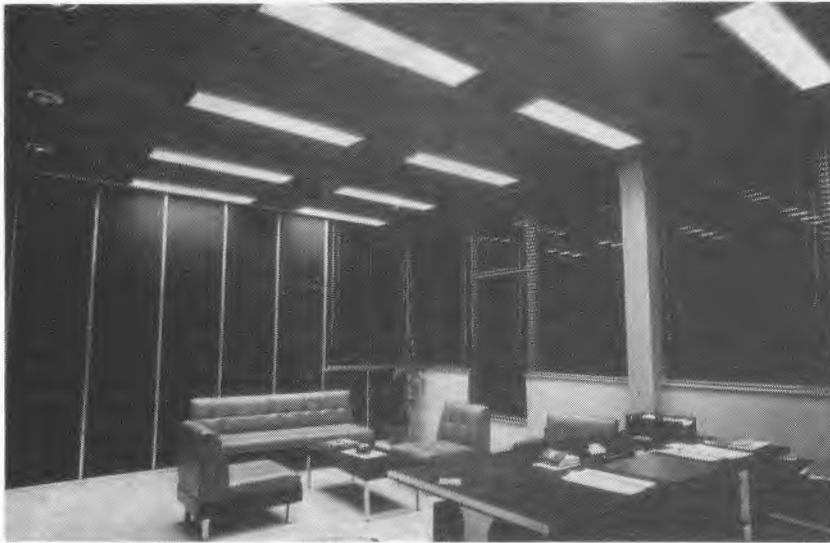
A third point is that technology has outstripped human development. Perhaps the best example of this is the laser beam that is often referred to as the solution waiting for a problem. Another example is our ability to provide a perfect human environment for man to go to the moon, before we are convinced of the need to provide the best environment for man to live in here on earth.

What we need is a maturing of mankind to keep pace with our galloping technology. Nowhere is this more obvious than in the developing countries where modern technology is importable in a matter of weeks or months, but where the availability of adequate numbers of indigenous technologists, supported by enlightened and disciplined societies, is a long way off.

In these countries the role of the technologist is different because:

- (a) By and large, the young graduate has a higher status, but less opportunity for professional in-service training, and a limited choice of employment. This is not in the interest of full professional development.
- (b) The grounds of efficiency for technological operations have been developed in the advanced countries to suit a different set of conditions and circumstances; and they therefore cannot be copied exactly by the new technologists of the developing countries.

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- (c) For comprehensive national development, technologists must discriminate in favour of local labour and materials, which is often difficult in view of the requirement of donor countries (where aid is involved) for use of their goods and services. This suggests the need for making special arrangements so that young technologists, for instance, can get suitable experience at home.
- (d) The technologist is a member of a small group of senior citizens and his field is vital in the nation's development, so he is inevitably involved in policy-making. His concern for the social purpose of his work must therefore be greater; and in such fields as environmental control he may have the initial responsibility of laying national foundations for the future.
- (e) This concern is doubly needed because investment is often from abroad and such investors are interested in quick and high monetary returns which naturally puts a low ceiling on any accompanying social development. It usually takes a special effort to win social benefits from such foreign investment.
- (f) Thinking in compartments is a big obstacle facing developing countries. The technologist must solve the coordination problem if he is to maximize his efforts in an age that demands an overlapping of interests.
- (g) Developing country governments are either very changeable or very permanent, which provides either an insecure and inconsistent atmosphere or the unchallenging mood of the dictatorial. In either case the prevailing atmosphere is almost always one of political expediency, which seems to generate a hopelessness among many technologists.

The environment and its control

The state of the environment today in most developing countries is one of undiscovered and undeveloped natural resources, of scattered communities with limited modern facilities, and of original lands unserved but unpolluted by man's activities. In the midst of this, capital cities display a broad spectrum of environmental problems from the lack of basic sanitation to the occupational hazards of the modern industrial environment.

Prevailing social and economic conditions lend certain natural difficulties to the situation. The undeveloped society is not so aware of environmental controls or of the need to implement them; and the inevitable social inertia is an obstacle to change. Coupled with this is the regrettable money scarcity and manpower shortage that make the job of catching up with the 20th century an almost impossible task.

The environment has always been suspected of playing an important role in the life of man, and now we recognize three distinct and inerrelated areas:

- (1) Environmental deficiencies — The environment plays a direct role in the spread of certain communicable diseases and in the causation of certain health problems when controls are not enforced —
 - (a) Water-and food-borne diseases (e.g. typhoid), because both water and food are common and agreeable vehicles for the transmission of some diseases;
 - (b) Water-related diseases (e.g. schistosomiasis), whose vectors have a larval or adult aquatic stage;
 - (c) Other diseases that are soil-borne (hookworm), the result of bad sanitation (trachoma), or sewage-borne (poliomyelitis) and
 - (d) Accidents and problems such as sight, hearing etc. resulting from bad design and lack of protection.
- (2) Environmental pollution — As a result of industrial development and urbanization, especially in the developed areas, attention has recently been drawn to the economic, health and esthetic costs of air, water and soil pollution as a result of man's waste disposal practices on his crowded planet. Occupational dangers and emotional stresses are also accompanying modern development.
- (3) Environmental influences — The environment has a direct effect on the development of human characteristics, in health as well as in disease. The long term consequences of various types of biological and social deprivation to man are not known, but we do know that they are not in our best interests.

This important role of the environment has led to the field known as "environmental sanitation" which is "the control of all those factors in man's physical environment which exercise or may exercise a deleterious effect on his physical, mental or social well-being."²

Responsible for leadership in the field of environmental control is the environmental engineer who is usually a civil engineer with post-graduate training in environmental engineering. Such a person applies "engineering principles to the control, modification, or adaptation of the physical, chemical, and biological factors of the environment in the interest of man's health, comfort, and social well-being."³

But nowadays the environment and its control is the responsibility of many, because it is now being viewed in an expanded context. Environmental

2. World Hlth Org. techn. Rep. Ser. 1952, 47 (Expert Committee on Environmental Sanitation, 2nd Report).

3. Wld Hlth Org. techn. Rep. Ser. 1957, 376 (The Education of Engineers in Environmental Health" — WHO Expert Committee).

problems are no longer considered as individual, isolated ones. They are vastly complex and interacting requiring the systems approach. Characteristics of the environmental system are:

- (a) It is formed from many components, involving many variables.
- (b) The interactions of its components are more important than their individual components.
- (c) The system behaves like an organism - - it is adaptive and capable of being controlled.
- (d) Its interlinking problems require fresh combinations of analyses using engineering, economics, medicine, sociology, biology and other disciplines.

Therefore, all engineers and architects, not only the environmental specialist, will become increasingly associated with or involved in the control of the environment. In developing countries much of this will be aimed at proper planning "so as to avoid lowering the quality of the environment and prevent environmental hazards" from developing.

III. ROLE IN THE AIR SECTOR OF THE ENVIRONMENT

The oxygen-filled atmosphere of man is essential for his survival. It must be fresh and pure at home, at work, during travel, and during recreation. Not only should air in such enclosed places meet man's vital needs, but also should outdoor air in cities and in rural areas.

Yet we know that in the presence of natural phenomena and manmade activities there can be no environmental purity. Dust, fog, smoke and chemical discharges are part of man's modern automotive and industrial atmosphere. These may affect respiration, cause odour nuisance, irritate the exposed mucous membranes of the human body, and even cause illness and death. They may also rot crops, crack rubber, blot out the sun, and discolour paint. Although air pollution is not a major problem in the developing countries, it can be a localised problem of some magnitude in urban and industrializing areas.

The environmental engineer "seeks the cause, particularly the manmade causes of such pollutants and assists in cleaning it up. He devises or adapts instruments — filters, exposure meters, and densitometers, for example - - for the purpose of measuring, analyzing, identifying, and then eliminating offensive odours and particles. He sets up air sampling stations to gather the evidence. He chemically analyses the pollutants from automobile exhausts, factory smoke stacks, incinerators and other sources — and looks for ways of curbing the production of those pollutants."⁴

Meanwhile the architect's role is to provide for adequate and sanitary air capacity in buildings at all times.

4. "Toward a Healthier World: Your Career in Sanitary Engineering", US Public Health Service Publication No. 579.

IV. ROLE IN THE WATER SECTOR OF THE ENVIRONMENT

The water phase of environmental control "includes consideration of the quantity, quality, and safety aspects of water from the stages of planning, development, transportation, storage, treatment distribution and use; on through the stages of treatment disposal; or conservation, reclamation and reuse of waste water (or sewage)."⁵

Water resources and supplies

The environmental engineer works with other professional specialists in locating and exploiting sources of clean water for growing towns, new agricultural communities, and industries. He is responsible for chemical and other means of treatment for purifying water, which substantially means the removal of turbidity as well as any pathogenic micro-organisms. But it may also mean the softening of water, the removal of such harmful chemicals as iron or fluorides, or the finding and employing of an inexpensive method of water desalination.

The environmental engineer designs and constructs water treatment plants and distribution systems for swimming pools, small communities, or big cities. As a member of a municipal or national Authority he would operate such community systems; and in the national government he would be concerned with water quality control, the utilization of water equipment, and the enforcement of a plumbing code.

In the development of surface-water sources for large scale agricultural purposes, the environmental engineer has the additional responsibility of ensuring that such programmes do not lead to the proliferation of vectors of water-related diseases, e.g. the snail and schistosomiasis, the mosquito and malaria (or yellow fever), and so on.

Waste water disposal and pollution control

A large percentage of the water collected and used by any community becomes waste water requiring treatment before disposal into a water body. The environmental engineer designs, constructs and operates sewer (or drainage) systems and treatment plants for such waste water. He also advises industry in determining ways of treating, controlling or eliminating the waste products of a growing number of manufacturing processes that may find their way into streams and contaminate them. This is a field of increasing complexity for new developments in industrial technology are introducing new chemical substances whose effects to receiving streams may be toxic and cumulative.

The treatment of domestic sewage and industrial wastes is no doubt the vital step in preventing the costly diminishing of water resources by pollution; but such measures must be part of an overall water

5. F.H. Stead — "Levels in environmental health", Amer. J. publ. Hlth vol. 50, No. 3.

pollution control programme for respective river

basins and marine areas. The programme includes the development of physical, chemical and biological records of river water quality; assistance in the treatment of waste waters; the enforcement of standards and legislation to control deliberate or accidental discharges into rivers. Lakes should be almost wholly protected.

V. ROLE IN THE FOOD SECTOR OF THE ENVIRONMENT

"Food sanitation encompasses the entire chain of events from production of food on land or sea, its processing, distribution, storage, and marketing down to the actual preparation and serving of meals and the disposal of wastes. It includes the effects of heat, irradiation, freezing, and other methods of treatment; contamination by dirt, micorganisms, insects or rodents; chemical additives, including radioactive substances, at any stage, both advertent and inadvertent and the effects of all of these on the structure, safety, nutritional value, wholesomeness, and palatability of the food or beverage."⁶

There are two main areas of activity for the environmental specialist. Food plants such as milk pasteurization, meat packing, shellfish canning, or bottling plants, must be carefully designed and provided with adequate water and sanitary facilities, in addition to the controls necessary to prevent food contamination during processing. Food processing is becoming relatively commonplace in the developing countries to meet increasing demands at home and for the export market. Government controls are essential.

The other area of activity is the manufacture or importation of food equipment. The rise in food processing and the sale of pre-cooked food meant a steady increase in the demand for food equipment. Such equipment and machines are needed for the processing, canning, storing, and selling of food. In developing countries these machines are normally imported rather than manufactured, but it still requires that they be carefully examined to ensure that their functioning under local conditions is safe and sanitary.

VI. ROLE IN THE SHELTER SECTOR OF THE ENVIRONMENT

In the shelter phase of man's relationship with his environment the architect plays an essential role.

Community planning and facilities

All communities should enjoy "a physical environment free from pollution and noise, aesthetically pleasing, and allowing each individual to live a comfortable, enjoyable, and productive life".⁷

To accomplish this requires professional town planning, viz community siting for the best environ-

ment; establishment of residential, industrial etc. zones; availability of healthful housing; adequate streets and parking spaces; well distributed park areas; and adequate community services.

This planning must also be supported by the provision of such community engineering facilities as water supply, sewage disposal drainage, and refuse disposal.

Building design and control

The design of dwelling units, apartments, hotels, public buildings and so on are exclusively the domain of the architect, usually the privately employed. However, such buildings as schools, hospitals and other common institutions are usually the work of a specialist, requiring special design considerations. In such buildings the health authorities have a particular interest.

The provision of a safe and healthful environment for residential living is fairly routine. For the industrial environment however, a knowledge of occupational diseases and other health problems, as well as accident hazards, demand the attention of the environmental engineer.

The initiation of housing projects, the rehabilitation of substandard housing, and enforcement of building controls are important responsibilities of the municipal engineer and architect. The state of a community depends very largely on the enthusiasm and competence of its government.

VII. MAJOR CAREER OPPORTUNITIES FOR ENVIRONMENT SPECIALISTS

The level of attainment in modern community life in the advanced countries is a clear testimony to the contributions of engineers and architects in environmental control. Despite the growing concern for environmental pollution, advances in community health over the years do reflect the success of these contributions in government services and in private enterprise.

Government services

Most of the career opportunities for environmental specialists in the developing countries exist in the provision of one government service or another; although this is not necessarily common knowledge even in civil service circles.

Public Health: In basic health services "an engineering unit should be established at the central level and should be in the charge of a qualified professional public health engineer. Its functions will be:

- (a) to provide technical guidance and supervise the environmental health activities which often involve engineering work of considerable complexity;
- (b) consult with and provide advice to other ministries and departments on the health

6. F.M. Stead — "Levels in environmental health", Amer. J. publ. Hlth vol. 50, No. 3.

7. "Urbanization and public health" in WHO Chronicle of October 1967 Vol. 21 No. 10.

aspects of public works such as irrigation and agriculture programmes, and other water resource development projects."⁸

This is a multifaceted, broad spectrum field of application existing at the national and provincial levels, and supervising the local level. Also included is the architecture of medical care facilities, e.g. hospitals, health centers and health stations, and also such special programmes as malaria eradication, training, and so on.

Municipal Government: This is another big field of activity at two basic levels. For the municipalities with water supply and sewerage drainage systems, a national Water and Sewerage Authority is normally responsible for design, construction, operation and maintenance of such essential community facilities. In advance of such an authority, a ministry (e.g. Interior) has the responsibility for assisting the various municipalities in town planning and other related engineering fields. For the bigger and more independent municipalities (population over 75,000) a town engineer and architect would attend to the environment in building control, town development, refuse disposal, and supervising sanitation services.

Water Resources: National development automatically includes the development of water resources, and this is best carried out under one multi-ministerial head Water Resources Council to ensure the most efficient, effective and economical use of the essential commodity of water. Through its executive agency such a Council would "collect data; make river basin surveys; prepare feasibility studies; design and construct rural water supplies; control water pollution, administer water rights and supervise legislation, co-operate collection and publication of hydrologic, meteorologic and related data."⁹ These responsibilities clearly depend on the employment of environmental engineers.

Armed Services: This is an undeveloped area of application in the developing countries. However, the airforce, army and naval bases are all military communities with the same community needs of civil areas, viz. town planning, building control, water supply, sewage disposal, drainage, refuse disposal and so on. In the interest of national security these services should have their own environmental engineers and architects to ensure that the environment at military camps and installations does not allow the development of environmental diseases and nuisances.

Research: This is another under developed area that needs attention. It is not always possible for developing countries to import methods and man-

power to solve environmental problems; and certainly their ultimate eradication will require the development of indigenous research in environmental engineering, either nationally or regionally. This would develop on a large scale:

- (a) suitable inexpensive methods, equipment and materials for local environmental control, and
- (b) on-the-spot expertise on these locally employed methods, equipment and materials.

An example of this is the work being done by the Central Public Health Engineering Research Institute of India at Nagpur to provide basic data that can be used by public health authorities, industry and other private or public agencies for the design of more efficient and more economical sanitary processes and health installations in urban and rural areas, with particular emphasis on water supplies, waste water treatment, and the control of water and air pollution."¹⁰

Other Services: Other opportunities in government are expected, in the planning and coordination of large scale programmes involving environmental control works and services (Planning Commission); in the development of such facilities for small communities (Community Development); in river basin and other agricultural development schemes (Agriculture and Valley Development Authorities); in teaching and training programmes (University and Technical School); in housing development (Public Works); and indeed wherever government services or their coordination require environmental control expertise.

Private enterprise

Any development of environmental control works and services, which are essential to all national development programmes, requires the participation of private enterprise in two prime areas of activity — private consultation and industry.

Private Consultation: Any engineer or architect engaging in individual or group consulting practice may be retained by private industry, municipalities or government agencies. In such a role he would usually design, supervise construction and advise on the operation or maintenance of such environmental engineering works as: community water supplies, industrial waste and domestic sewage disposal systems, and refuse disposal system. He would also engage in town planning, industrial building layout, swimming pools, housing projects, and so on, all of which are essential to developing countries. Certainly the lack of such consulting services in any country places an unfair burden on government staff, and in the long run, on the standard and quality of living.

8. "Basic Health Services", WHO/PHA/69.39 (World Health Organization).

9. 3rd Five Year Development Plan (1961-1965 F.C.), Imperial Ethiopian Government.

10. "Promoting Public Health Engineering in India" in WHO Chronicle of October 1969, Vol. 23 No. 10.

Industry: Although consultants usually provide industry with the necessary expertise for setting up environmental control works and services, and designing building and process layouts, salaried opportunities are growing in industry in the operational fields of occupational hygiene, accident prevention, water supply and waste disposal. The best working environment must be maintained for employees, and the sanitary and economic operation of industrial water supply and waste disposal systems must be ensured at all times. Special opportunities occur in the food industry where environmental and process control are necessary for the sanitary quality of their products. And still others occur in the manufacture of piping and other supplies and equipment for later employment in one phase of environmental control or another.

VIII. CONCLUSION

The importance of the role of technology in realizing the full potential of the natural and human resources of the developing countries is generally

understood by all, although the full extent of this role is not always appreciated.

In the developing countries the technologist engrossed in development programmes must also recognize the importance of the social aspects of his participation. One prominent aspect is the accompanying responsibility to control the environment for man's collective benefit.

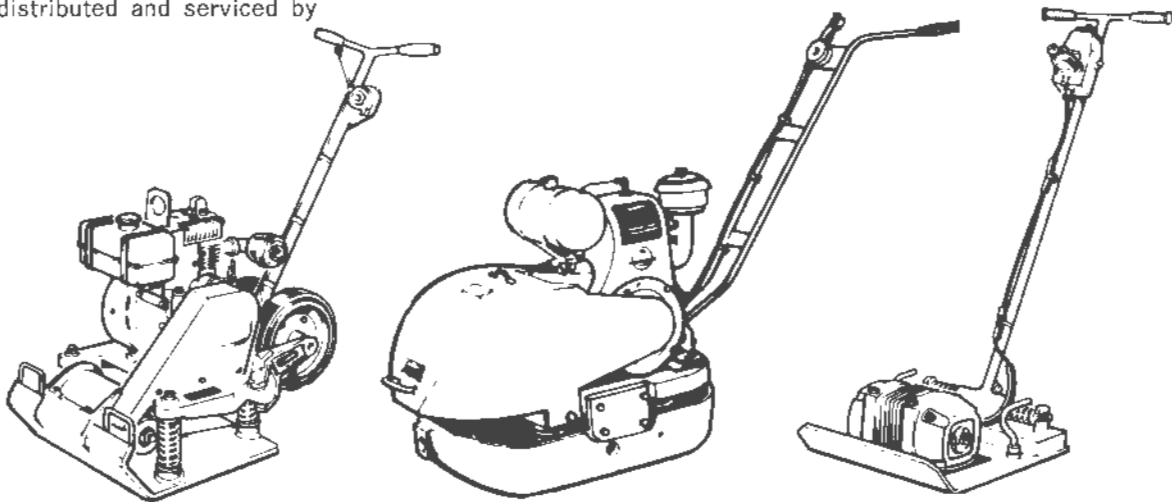
So although engineers and architects must continue to ensure that their countries share in the 20th century technological revolution, they must agree "to master the forces of technological change and given those forces a sense of constructive, creative, and responsible direction, so that we can increase our material affluence without corrupting and destroying our living environment."¹¹

This, I believe, is the great challenge of facing our professions in the developing countries at this time and in the years ahead.

¹¹ Walter P. Reuthen in "The Revolution of Human Fulfillment" (Journal — Water Pollution Control Federation Jan. 69 Vol. 41).

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