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Environmental Management

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ABSTRACT

Approaches toward solving current and future environmental problems require intelligible inputs from the disciplines of management and economics, as well as those from the physical and biological sciences. Appropriate cost and benefit considerations must be taken into account in both the short and long runs. Any environmental problem which can be defined can be studied as a system, and alternatives proposed with a proper mix to enhance optimum and realistic solutions.

Introduction

This monograph summarizes a longer study attempting to bring into focus the major disciplines involved inescapably in any efforts to evaluate and execute plans or programs to improve the relationships between mankind and the physical environment, and thereby enhance the favorable qualities of life. The approach to any problem of human ecology necessarily unites economics, management, engineering, and social goals which may require the most realistic, practical, and effective choices of action possible to be even partially successful.

The consideration of methods to improve general or specific environmental conditions must bring into play the sharpest economic analysis, the best management techniques, and the clearest definitions of objectives that can be employed.

The economic theme which runs throughout the entire system of natural

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and social phenomena related to man is the ratio of benefits and costs resulting from the myriad economic choices he makes as they affect the viability of his environment and his capacity to live within it.

Choices On Earth

Viewing this "island earth" from outer space, American astronauts on their way to the moon saw a blue planet. The National Aeronautics and Space Administration in its remarkable series of photographs issued in 1971 emphasized the relative isolation of man's planetary home in the solar system.

Physically, with the exception of its continuous bombardment by various forms of energy emanating from the sun and deep space, the earth is a closed system. It has a thin atmospheric covering. Some 70 per cent of its surface is water. Its land area, excepting at the poles, provides the physical framework in which all human industry is located, including ocean and air transport.

Subsurface and surface supplies of fresh water, the saline oceans, and the nebulous atmosphere constitute the functional constraints within which human life has developed and is pursued.

Relatively minor changes, such as a swing of 10° to 15° in the mean temperature of the earth's surface could spell the end of man. Within fragile limits, easily disturbed, all man's efforts and aspirations must be achieved as long as he calls earth home. His great civilizations, his technologies, his history, and his goals are all dependent upon delicate balances established initially by nature, and alterable only marginally at his will. Yet, like Robinson Crusoe on his island, man must make a continuous series of hard economic choices—choices which are cumulative in their effects upon resources, the quality of his environment, his available supplies of economic goods, and even his continued existence.

Nature as a whole, as older economists have remarked, seems relatively indifferent to man—providing the conditions of his existence, yet niggardly in all quantities in accessible forms of the materials which he requires for sustenance. Moreover, in the natural processes and cycles of which he is a part, man is compelled at every step to balance benefits and costs, to array priorities in the allocation of his labor, and to observe at his peril both the obvious and more subtle conditions his environment imposes upon him.

The context of this paper relates to the ensuing issues: that is, the environment, the management (leadership), the economics, the costs, and initiation of the alternative approaches toward solution. The definition of ecology used herein is: *the total environment studied in its relationship to human society, and in particular to industrial and economic activity.*

Improving the Quality of Life [1]

Almost everyone now agrees that tremendous efforts are required to improve our quality of life. Public concern has hit a peak, and various bodies are actively engaged in the processes of improving the environment. Legislators, businessmen, corporations, educational systems, government agencies, community action groups, and the public at large are all—with various degrees of success—working for improvement.

Most important in this concentration of effort on pollution is the need for a series of carefully-studied and fully-evaluated plans which will insure at least partial acceptable solutions, and not greater deleterious byproduct effects. Haste not only makes waste, but can become extremely costly in both the short and long runs.

Thus, the starting point, as it is in all problem-solving issues, is to gain a complete understanding of the problem then list, study, and evaluate alternative solutions.

The environmental problems with which we are currently beset have been building up for a long time, although many have asked why and how they cropped up so suddenly. The absorption capabilities of both air and water are tremendous, but not limitless, and can purify and restore (essentially) themselves to near-original states. Most people have either performed or witnessed a chemistry experiment in titration to determine the acid-base relationship, using phenolphthalein as the indicator. Drop after drop of the titrating liquid into the beaker solution will not change the color of the overall solution, although a pink spot will appear from time to time. By shaking the beaker, the pink will disappear. Eventually, there comes a drop which will turn the entire solution pink.

This pattern is an example of the natural law which states that matter does not disappear; it changes into some other form. Another law states that changing the form of matter can create a disruptive change in the balance of nature which, if unchecked, can start a reaction which may be irreversible.

The two main causes of the saturation effects of our air and water are increases in economic growth and population. By stopping continued increases in both, the rate of increase in pollution would slow down. Although discussed as solutions, neither is really practical. Zero population growth and zero economic growth could cause disastrous side effects and, in any case, would take at least another 30 years to show beneficial results.

We must support economic growth, and return part of the funds into improving the quality of life by inventing and creating new and better methods of combating pollution.

Pollution and congestion are very closely correlated. Two-thirds of our total population is contained in only 9 per cent of our land area. To support this large segment of people, industrial plants, disposal units, and transportation units must concentrate. Thus, if there were a way to redistribute the population, pollution could be decreased in the large cities. While studies are being made in this area, i.e., new cities, and the satellite proposals, these are long range concepts. People will continue to move into the cities, or to a suburban locality, to be close to where they work.

We must not only be concerned with short run results, but always keep in mind the long run interest of the nation. There must be a series of balanced determinations; for example, considerations of costs, and benefits, as well as technological approaches must be integrated.

Although we started late in recognizing and confronting pollution problems, many positive and productive measures are being effected. The technology required to solve the problems is becoming vastly improved, and *realistic* standards are being enforced. Although the costs have been estimated in the billions, the resultant benefits should be worth the sacrifice.

The writers are convinced that one of the necessary tools to use in solving the environmental problems before us must be effective leadership in applying the full spectrum of sound management practices and techniques developed by the private enterprise system, particularly through corporate administration.

Managing the Environment

Many writers on the environment advocate that good and effective management techniques, processes, and procedures must be applied judiciously if we are to accomplish the massive task before us. These writers contend that a good basic understanding of the principles–those of the formal and traditional nature–constitute a floor to build upon in developing any managerial philosophy. The philosophy can then establish the framework for the specific issues at hand.

One must keep in mind that the material presented here has universal application in solving a wide range of problems–including those of pollution.

Through cooperative efforts, a manager wants to obtain the maximum of goal satisfaction with the minimum expenditures of time, money, unpleasantness, or other unsought consequences.[2] Let's break the above sentence down and examine each of its parts. "Through cooperative efforts" indicates good leadership–which instills confidence in employees. It implies group participation, and teamwork in accomplishing a common objective–a way of effectively getting the job done. "The maximum of goal satisfaction" implies that the group's goals are integrated with the company's goals, and are motivated toward superb performance (a goal in itself).

"Minimum expenditures of time, money, unpleasantness, and other unsought consequences" refers not only to accomplishing the job, but performing it in a most efficient mode of operation. This criterion can be achieved by following the sequence of steps outlined:

1. Establish the desired objectives.
2. Plan the resulting ways to accomplish these objectives.
3. Organize the required resources.
4. Evaluate the possible outcomes.
5. Implement the plan.
6. Follow it through by measuring the results at critical steps along the way.

"The overall job of management is to create within the enterprise the environment which will facilitate the accomplishment of its objective."[3] This relationship may be portrayed as shown in Figure 1.

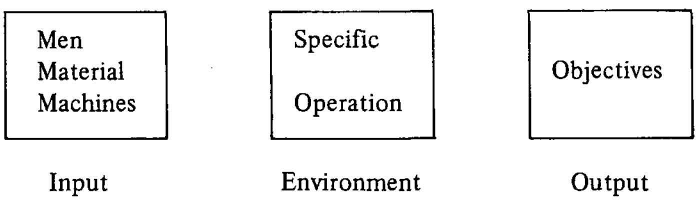

Figure 1.

Authority is the focal instrument which a manager uses to insure task accomplishment. It is the power to command and to act in a manner prescribed by the possessor of the authority. It is an invested right, and delegated. At the same time, responsibility is assumed by the recipient of the authority, and is an obligation.

Planning

Although planning is of extreme importance, too often it is left to chance. Planning sometimes comes about after the fact—called *replanning,* where prior events fail to work out satisfactorily. (This lapse is the crux of the current environmental deterioration problem.) Planning implies thinking about future events and then deciding the best available course of action to implement, that is, the what, how, when, and who, with respect to the job under study.

Plans should be flexible so that changes can be made, as required during their implementation. The heart of planning is the decision-making process.

The number of steps in the decision-making process varies from four to nine, depending upon the complexity of the problem and the capabilities of the problem solver. The four-step approach is generally written as follows:

1. Defining the problem.
2. Identifying alternative courses of action.
3. Evaluating alternative courses of action.
4. Choice of best alternative (the decision).

Planning in action is essentially control, as depicted, in Figure 2.

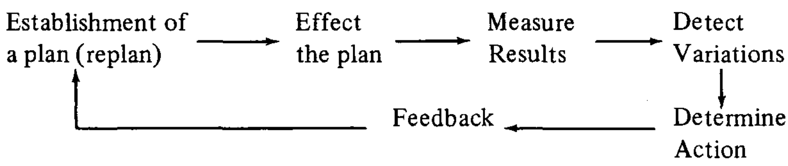

Figure 2.

The best planning occurs when everyone has access to accurate information affecting the area of planning responsibility.

Control

Control is the measurement and correction of the performance of subordinates to make sure that enterprise objectives and the plans devised to attain them are accomplished. It is the function that makes sure that what is done is what is intended.[4]

Control is the extension of planning (planning in action); thus, the two functions become more and more difficult to separate. It is becoming apparent that planning and controlling should be called *plantrol.*

The control system used by managers must be designed for the task it is intended to perform. Controls should be designed as tools of environmental management, instead of replacing managerial decision-making.

In approaching solutions to environmental problems, several other considerations become of great importance.

1. Benefits of improving the environment versus the cost of doing so. In addition to performing benefit-cost analysis, consideration must be given to where the money really comes from, as well as what we must give up to accomplish our objective.
2. With respect to proposed new projects, consideration must be given not only to the potential of "harming" the environment, but also to the potential of *not* creating new and useful benefits to man. In assessing the

benefits and costs of pollution-control projects (both new and improvements to existing conditions), those who have to pay the brunt of the bill tend to inflate costs and deflate benefits. Those who take the opposing position, tend to deflate costs and inflate benefits.[5] Thus, it becomes important to assess carefully both sides of the "what if" concept.

3. In addition to an objective benefit-cost analysis, applications of the value analysis and value engineering approaches can be beneficial in environmental planning and replanning. Briefly, using the value analysis approach application to environmental replanning means improving the environment after deterioration has already begun; the value engineering approach to environmental planning means minimizing any environmental deterioration through preventive implementation. Although both approaches are good, the value engineering concept is clearly the better of the two.

Value Analysis

Value Analysis is an organized cost reduction program with a systematic or scientific approach. This technique has been used quite successfully in many companies, both large and small. Essentially, value analysis says—*find a better way to do something, all factors considered.* Value engineering is involved with a better way before the fact (in planning and design stages), whereas value analysis is an "after-the-fact" approach. Both have applicability in environmental planning and improvement.

These concepts really enhance a philosophy; that is, everything an organization does costs money (and time), and anything that costs money can cost less.

Alternatives

As the result of benefit-cost analysis studies, it frequently can be shown that there are advantages and disadvantages of a specific project. This indication in turn will help with the economics of "where the money really comes from," and will minimize the "what if" concept, that is, the approach used by those who continue to say what if this happens, or what if this goes wrong, or what if the world comes to an end, or what if earthquakes hit, or what if it never rains again. Sometimes probability techniques can be used (risk analysis).

Environmental Management Economics

Definitions, concepts, and the multiple significance of the word *cost* can often be both confusing and misleading. For example, the statement, "How much does it cost?," has several meanings. Initially, one must know who is asking the question and in what context. If it is a consumer asking a sales clerk, he probably is asking the selling price of an item. If it is a manufacturing manager asking an industrial engineer, he probably is asking the costs of labor and material to fabricate the item. If it is the president of the company asking the finance manager, he is probably asking for the cost of labor, material, overhead, general, and administrative, and all other costs that may be involved in both manufacturing and dispensing the product to a customer with a resultant return to the company. This approach also will include pricing strategy, for the alternative use of capital is also a cost.

Although mathematical equations are neat, clear, and concise, costs, in the "real world" sense, remain quite complex. The first portion of this section will explore cost concepts, cost philosophies, and cost developments. The reader is advised to keep in mind that speeches by well-meaning politicians and stands taken by constructive ecological organizations must be supported by money if we are to solve our environmental problems. This requirement implies the efficient allocation of this scarce commodity (money), and in order to evaluate the benefits to be derived from any venture, we must also know the costs to be incurred.

There are many adjectives that modify the meaning of cost. Without specific definition or description, some will be mentioned herewith. (It is suggested that the reader review the meanings of these terms in texts on accounting and economics.)

Incremental costs
Marginal costs
Future costs
Traceable costs
Direct costs
Overhead costs
Indirect costs
Burden costs
Replaceable costs
Sunk costs
Fixed costs
Historical costs
Social costs (including depletion)
Alternative costs
Joint costs
Market costs
Comparative costs
Scalar costs

Common costs
Opportunity costs
Alternative costs
Controllable costs
Reducible costs
Uncontrollable costs
Escapable costs
Postponable costs
Cash costs
Book costs
Variable costs
Standard costs
Physical costs
Functional costs
Original costs (public utility)
Residual costs
Life-cycle costs
Unit costs

Concept of Real or Physical Costs

Physical Costs are associated with both long and short range costs. For example, the effects of oil on the seabed involve both energy expenditure and transformation of material, which in turn can cause an additional international cost.

These physical costs involve a real-time cost, where there is an increase of skill and efficiency in the use of material and energy with respect to time. They are likened to a learning curve which reaches a plateau, or flattens out.

Entropy, the second law of thermodynamics, states in one form that mechanical energy can be converted completely into heat, but heat cannot be converted completely into mechanical energy. Thus, entropy is that portion of lost energy, a way of saying that in using energy, entropy always increases and never decreases.

From a long term standpoint, we can think of the entropy concept as a depletion factor, which causes capital and labor inputs to increase over a period of time. Thus the total of materials available and accessible diminishes.

Because real costs are a problem of both scarcity and accessibility of physical assets, as affluence increases capital inputs increase over a period of time. Therefore, the real costs, in consonance with the increases of capital costs, rises as materials decrease, which implies the entropy function.

Examples of the relationship described above are mines and land—top soil, and high-grade, easily-accessible ores decrease, as does good land. Therefore, by increasing the quantum of capital and labor, skills and efficiency must be improved to maintain productivity. (See Figure 3.) Even so, limits may be reached, as in the ghostly mining towns of the world which once yielded riches, but can no longer be worked economically.

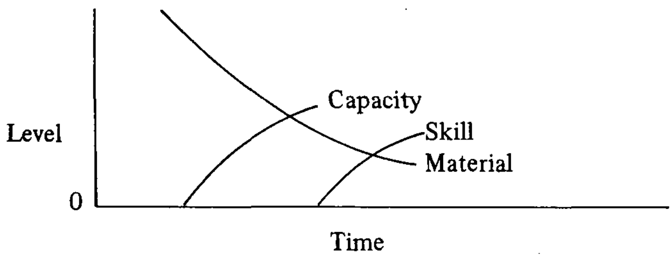

Figure 3.

By hypothesis: A law of irreversibility of total real costs resulting from depletion or deterioration exists for industry in general, as well as for specific raw material production. The concepts of diminishing returns and economic rent, central theorems in classical economics have, in short, a set of long-run cost implications which underlie many of the industrial, resource, and environmental problems of the modern world.

Social Costs and Psychic Costs

In contrast to physical costs, social and psychic costs must be taken into account. Although social and psychic costs overlap somewhat, there are some differences between the two.

Social costs are the external costs, for example, of an objective such as feeding everyone a particular kind of meat. Thus, to achieve this objective certain resources must be diverted to make the venture successful. This diversion in turn may cause a disutility function.

Psychic costs have both individual and social implications. They are primarily subjective and relative in nature, and may have no compensation. This aspect of costs, where applicable, involves both goal setting and the establishment of priorities according to implicit or explicit ideas of value. Psychic costs involve expectancy–sometimes called futurity. The market scales the psychic and social benefits–excepting the individual psychic costs, which are totally subjective.

The accountant can take psychic costs into consideration only through an approximate subsequent evaluation and appraisal process–which means a post, or after the fact, cost. The economist can often impute a psychic cost, which aids in decision-making.

Psychic costs at the individual level may include such elements as the demanding personal effort made by an author, artist, or musician to achieve the perfect expression of his creative ability in a chosen medium. At a group or social level, some may consider as an aesthetic cost the loss of a scenic vista displaced by a building (however necessary), or the cutting of a road through a forest. In such instances the social cost contains an element of psychic cost, but may have long-run physical or resource effects as well, which will add concretely to future costs by decreasing total resources, or increasing their scarcity, or reducing the alternative use–choices of land.

Some economists maintain that many kinds of psychic costs and nearly all conceivable types of social costs can be directly or indirectly quantified, or if not susceptible to numerical translation, may be ordered in terms of preference and indifference.[6]

Such social costs, as far as they can be measured directly, or indirectly become legitimate factors in computing total real economic costs, especially if over time they compel substitution of resources, or induce invention as the response to necessity, or if they result in such changes (e.g., decline of population, migration, or uninhibited population increase) that the total equilibrium of the economy is altered.

Philosophy of Economic Costs

Whereas accounting costs are of a predominantly historical nature, economic costs are those more concerned with imputing future costs for managerial decision-making; i.e., determining the present value, or the net worth, of alternatives. This difference does not affect the necessary significant use of accounting costs, but rather makes it imperative to examine them, to determine how they have evolved, and then to modify cost estimates appropriately for the specific decision. For example, a sunk cost is a past cost, and may be irrelevant with respect to future decisions.

Cost Ratios

In setting up cost ratios, one must scale each benefit and scale each cost as well as defining carefully the units and relationships involved. Both should be functional elements or components within a system, and by assumption, within any project must have at least 1:1 benefit cost ratio, to be economically worth consideration. Public works generally require a ratio of 1.5:1 as a standard minimum in justifying government projects.

Throughout the discussion of costs, benefits, and ratios as they are applied in practice, it is essential to distinguish between what is implied in two often-confused terms: *economy* and *efficiency.* Economy should be interpreted as a ratio of values (e.g., benefits to costs) which must be at least 1:1, or if it is less it becomes a ratio of diseconomy (uneconomic choice).

Efficiency is always a physical energy concept, a ratio of total energy output to total energy input in a mechanical, electrical, or chemical process. The efficiency ratio is always less than 1:1, by the law of entropy. Thus, an automobile engine is usually about 35 per cent efficient or less, a transformer may be as high as 95-98 per cent efficient, or a chemical unit operation may vary from low to high efficiency–but less than 100 per cent.

The key to the validity of any cost analysis involves both errors of omission and errors of observation. In errors of omission, we ignore or leave costs out (benefits also) that, if included, could markedly change the ratio–thus changing the decision. Errors of observation imply inadequate cost data, or not enough study and evaluation. Rarely will errors of omission and observation be entirely eliminated. The important precaution is to minimize these errors in so far as is practicable, yet to recognize that the ratio must include a random variable, which is a statistical concept relating to probability.

Social Costs (Zero Returns?)

As stated in a previous section, social costs are the external costs incurred by having an objective of, say, cleaning up the environment. Consideration must be given to both slowing down and stopping present environmental deterioration and planning to enhance the future quality of life.

President Nixon made the following point in his State of the Union address to the Congress in January, 1971: "In the next 10 years we will increase our wealth by 50 per cent; the profound question is, does this mean that we will be 50 per cent richer in any real sense, 50 per cent better off, 50 per cent happier?"

The President has made a profound statement–one dealing with social costs and social benefits.

Of Scarce Means and Multidimensional Ends

"We learn and learn, but never know all, about the smallest humblest thing."[7] So it is that in seeking to state conclusions, as they emerge from inquiry, it is vital to consider that even the most "scientific" or "objective" inferences are partial, finite, and tentative.

These limits apply especially to the disciplines which converge in environmental problems. Economics, management, and our modern models of nature are inseparable elements of decisions and policies affecting the ecological systems of human society. Recognition of their interrelationships, and the combined and many-sided effects of their interaction, is perhaps the principal and most useful inference to be drawn from the study.

An equally significant conclusion, however, is that although public interest and discussion of many aspects of environmental problems have grown rapidly within recent years, much of the emphasis has been on a selective, *ad hoc* basis. These characteristics are perhaps inherent in social efforts which simultaneously cleave through many cross sections of society and yet unite many diverse interest groups on seemingly common ground.

Clearly, it would appear that the measured response to environmental problems is continued improvement of scientific analysis and data, more persistent and probing review of economic alternatives by all concerned, and the application of the best management know-how of which we are capable to the resolution of environmental issues. Hasty, drastic, and "flat-rule" legislation tends to be neither scientific nor economic.

In particular, it is desirable to consider that the mutual interest of the public, government, and industry far outweigh and outnumber the dramatically-posed and relatively few direct conflicts of interest on which so much attention has been concentrated. Long before current hue and cry became fashionable, numerous industries, their engineers, their economists and their managers were devoting concerned study to the maintenance and improvement of air quality, water quality, effective disposal and recycling of waste, and the development of superior alternative extraction and production processes. Industry, government agencies, scientific societies, private conservation groups all have contributed to the long-term solutions of environmental problems.

Environmental change, in a global sense, can be classified, and must be treated in accordance with degrees of feasibility as well as priority. Geological evolution (such as an Ice Age) has played a major role in determining what species of life may exist and what courses their adaptation or mutation may take. Successful predictions of earthquakes would prevent many disasters; better knowledge of volcanic activities is important in several geographic areas of the world. There is as yet very little positive action that can be taken to alter the course of geological events. Men and their technologies at best can only offset or adapt better to such massive shifts in the behavior of nature.

Industrial and technological activity and development cover several thousands of years of human history. Hunting, agriculture, the mining of metals, the development of cities and the spread of the species to all habitable areas of the globe have produced some irreversible changes in surface, air, and water composition, as in the variety and quantity of animal life, while yet leaving many options open to present day society.

It should be equally understood that there is no single panacea. The earth is a dynamic, changing entity, possessed of great inherent stability, yet with evolving and mutating conditions. It is limited in its capacity to react favorably, from the human standpoint, to all the contingencies which can occur automatically or which can follow from human activity. Man himself is the greater variable in the equation and has still an immense range of alternative choices open to him. Economic history would indicate that his long-run choices tend to be rational or at least realistic despite short-sighted or opportunistic, immediate errors, If this inference seems either unduly Darwinian or unduly optimistic, it is also self-limiting. If man does not choose wisely, in the long run he is confronted by higher real costs which may indeed become prohibitive. By exercising his powers of economic choice on an average rational balance, man may avoid not only the worst effects of his follies but may enjoy fuller realization of harmonious adaptation to nature, a genuine symbiosis, and thus improve the total quality of human life.

It should not be assumed, however, that the growth of pollution is either directly linear or exponential on a completely one-sided basis. Existing technical know-how and foreseeable innovation promise not only more efficient and more economical, but "cleaner" industrial processes, waste disposal, general sanitation, and similar developments. At the same time curative and corrective technology are advancing and will continue to do so.

"What is past is prologue." At no time in future will it be possible to eliminate all environmental problems or to resolve them without the use of the best knowledge in science, engineering, management, and economics.

On the practical level, it is perhaps best to remember that the changes wrought by industry, far from being mainly detrimental, have been chiefly favorable to man. The logic of economic choice manifested in the growth of enterprise assures the achievement of long-run environmental well-being and beneficial control. The price system equates all other major forces of demand and supply by those competitive checks and balances which are an inherent part of both the natural and social environment in which human life evolves. In its barter with nature, mankind must bargain carefully.

In conclusion, any environmental problem which can be defined, can be studied as a system. Its scientific, its economic, and its managerial components can be arrayed, the cost of alternative measures determined, and an empirical decision can be reached on an optimum, rather than an absolute basis. Realistic policy can then be developed through the correct use of a carefully designed appropriate model which embodies favorable and economic benefit-cost ratios, and policies which enlarge, rather than diminish, economic initiative.

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