ADMINISTRATION OF ENVIRONMENTAL HEALTH PROGRAMMES
A Systems View

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CONTENTS

Preface .................................................. 9
Introduction ............................................. 11

PART 1. GENERAL CONCEPTS AND APPLICATIONS

CHAPTER 1. THE EVOLUTION OF NEOCLASSICAL ADMINISTRATIVE THEORY ............................................. 17
1. Purpose and scope of the chapter ............................................. 17
2. Traditional administrative theory ............................................. 18
3. Modifications of traditional theory ............................................. 22
4. Further development of administrative theory ............................................. 30

CHAPTER 2. CONCEPTS OF GENERAL SYSTEMS THEORY APPLIED TO ADMINISTRATION ............................................. 33
1. Meanings of "systems analysis" ............................................. 33
2. Traditional "scientific method" and its impact on administration ............................................. 34
3. Systems in general ............................................. 36
4. Basic properties of systems ............................................. 38
5. Open and closed systems ............................................. 41
6. Summary of basic systems concepts ............................................. 44
7. Social systems and administrative systems ............................................. 45
8. General components of administrative systems ............................................. 49
9. System functions ............................................. 52
10. Classification of system outputs ............................................. 57
11. Summary of administrative system concepts ............................................. 59
12. Systems theory and administrative theory ............................................. 59

CHAPTER 3. A SYSTEMS VIEW OF ENVIRONMENTAL HEALTH ............................................. 63
1. Applicability of the systems approach ............................................. 63
2. Environmental health relationships and problems ............................................. 67
3. Environmental health interventions ............................................. 77
4. Time and distance factors ............................................. 83
5. Implications of a systems view of environmental health ............................................. 85
PART 2. THE ADMINISTRATIVE PROCESS IN ENVIRONMENTAL HEALTH

CHAPTER 4. OVERVIEW OF THE ADMINISTRATIVE PROCESS
1. Administration as problem solving
2. Problem definition and goal setting
3. Policy and programme planning
4. Management planning, implementation, and programme operation: cycles, feedback, and constraints
5. Elaboration of the administrative process: programme development
6. Programme results in environmental health
7. A guide to detailed study of the administrative process

CHAPTER 5. PLANNING, DECISION MAKING, AND EVALUATION
1. Decision making and evaluation in the administrative process
2. Health planning: definitions, characteristics, and outcomes

CHAPTER 6. PROGRAMME PLANNING
1. Problem analysis
2. Role analysis
3. Objective setting
4. Constraint analysis in relation to objectives
5. Programme selection: factors in choosing priorities and strategies
6. Preparation of the programme plan and evaluation base
7. Budget formulation

CHAPTER 7. MANAGEMENT PLANNING: DESIGN AND IMPLEMENTATION
1. The conduct of management planning
2. General management norms
3. Operational objectives and other norms
4. Specification of programme activities
5. Projecting programme implementation
6. Transition to management operations
Annex. Network analysis and PERT method

CHAPTER 8. MANAGEMENT OPERATIONS: COMMUNICATION AND INFORMATION
1. Administrative communication: basic concepts
2. Communication to the system's operators: the administrative procedure
3. Information for service and control: the form
4. Records, reports, and information systems

6
The effectiveness of environmental health programmes depends in no small measure on the skills of those who administer them. Until recently, environmental health programme administrators wishing to improve their understanding of and skills in administration could find little of direct relevance to their field in the administrative literature. Despite the many articles and books devoted to the art of administration, there have been few descriptions of administrative concepts related specifically to environmental health. One reason is that environmental health programme administration is particularly complex—to describe as well as to carry out—owing to the complexity of the sociopolitical and institutional settings in which the programmes are implemented and the multiplicity and diversity of the physical, biological, and social factors that they must take into account. Another difficulty is that administrative theory is not a well established, fixed entity but rather a continuously evolving body of concepts that does not readily lend itself to codification or formulation. This explains the lack of unified, coherent formulations of the basic concepts of environmental health administration, particularly formulations incorporating the insights derived from recent developments in systems theory.

The aim of the present volume is to formulate within a unified framework the concepts of planning, management, and evaluation that are relevant to environmental health programmes and to apply these concepts directly to the special problems and circumstances encountered by the administrators of such programmes. The author, Professor Morris Schaefer, combines a background of training in public administration with broad experience in health planning and management and a knowledge of systems theory enabling him to bring together seemingly disparate administrative concepts into a coherent "systems approach".
This book is addressed primarily to students and practitioners of environmental health administration, although it should be found useful by other health administrators as well. It is hoped that it will help fill the need, to which more than one WHO expert group has drawn attention, for an exposition of administrative concepts suitable for use by health programme administrators at the country level.
Man, like all other species, is dependent on his relationships with the environment for his safety, health, and very survival. However, the human environment consists not only of natural factors but also of man-made alterations and additions to nature: the social environment. Over the centuries, such developments as population growth, industrialization, and urbanization have made man's environment progressively more complex and more important as a determinant of his health status.

Environmental health programmes are organized community efforts to monitor and modify man-environment relationships in the interests of better health. Such efforts may be directed towards the modification of environmental factors themselves or towards the modification of human behaviour in relation to the environment.

In order for environmental health programmes to be effective, they must be well administered. *Administration* is the process by which knowledge, energies, and social structures are systematically meshed to achieve agreed upon goals. Its *planning function* involves analysing the problems to be dealt with, deciding on the appropriate solutions, determining the intervention technology—whether in the form of services or physical changes—, fixing programme objectives, and projecting future actions. Its *management function* consists in procuring, arranging, and applying human, material, and informational resources according to priorities derived from planning. Administrators, in both their planning and their management functions, make use of the processes of communication and decision making, the latter being highly dependent on evaluation.

Since environmental health programmes are among the most useful and expensive investments a community can make in the safety and wellbeing of its members, their expert administration is properly a matter of social concern. Inadequacies in programme administration can be detrimental to the community interest. In all countries, there-
fore, there are certain requirements that need to be met by all environmental health programmes. Their administrators must ensure that the programme:

1. receives acceptance and support;
2. achieves the desired objectives and results;
3. links its efforts with those of other health and socioeconomic development programmes; and
4. accomplishes its work economically, with a minimum waste of money and other scarce resources.¹

Unfortunately, environmental health programmes all too often fail to meet these administrative requirements. Such failures are associated with three factors: the backgrounds of many administrators, the complexity of contemporary social systems, and the present state of administrative theory and technology.

First, environmental health programmes are frequently administered by leaders who are trained to high levels of technical competence but who have minimal training in administration.

Second, especially great administrative expertise is needed by those who plan and manage environmental health programmes because of the intricate ways in which such programmes relate to the complex social and political systems of the communities in which they are carried out.² Environmental health interventions intersect and interact with the full spectrum of the community's political, economic, social, and cultural values. As a consequence, environmental health administrators are called on to deal not only with problems of engineering and management in a restricted sense but with social issues and political decision making as well.

Third, administration is a developing discipline and its theory has not been completely defined or agreed upon. Moreover, while the traditional theories of organization and management embodied in most governmental systems appear to be adequate for the administration of relatively limited social intervention programmes, they have distinct shortcomings when applied to broad problems of socioeconomic development whose solution requires action that cuts across established organizational boundaries. Certain new approaches and methods

² Throughout this volume the term community is used in its most general sense and not merely as the equivalent of locality. It stands for a group of people, of whatever size and geographical distribution, who share interests and values. Thus, “community” can pertain to the neighbourhood, the locality, the province, the nation, or the world, so long as common interests and values exist among the people referred to.
have emerged but these have achieved limited success and even more limited acceptance, often having been rejected as "foreign bodies" incompatible with established patterns of administration.

In view of these three factors, the present volume has three corresponding goals:

(1) To provide practising environmental health administrators with a coherent statement of administrative theory and practice within the context of environmental health programmes. In addition to practitioners, the volume is addressed to students in environmental health training programmes in institutes and professional schools.

(2) To deal with environmental health programme administration within the framework of the complex sociopolitical settings in which such programmes are planned and executed.

(3) To set forth the ways in which newer so-called "systems" approaches to administration can be integrated with present patterns of administration. These approaches are proposed not as alternative or substitute theories but as a major step forward in the continuing evolution of administrative concepts and practices.

The volume is divided into two parts, the first dealing with certain fundamental concerns and concepts of administration, and the second weaving these concepts into a pattern of application that leads the administrator through the various stages of planning into the management of programme implementation and operation.

In Chapter 1, the tenets of traditional administrative theory and the evolution of that theory over the past half century into its present "neoclassical" form are reviewed. This chapter also indicates how general systems theory points to the direction for the next promising step in the evolution of administration.

Chapter 2 sets forth the concepts of general systems theory and applies them to the components and functioning of administrative systems.

Chapter 3 contains an application of systems theory to environmental health, showing both how the field of environmental health can be viewed in comprehensive terms and how interventions on behalf of environmental health can be approached in a broad community context.

Part 2 of the book begins with Chapter 4, which presents an overview of the administrative process oriented to environmental health programmes. The succeeding chapters examine the various phases of the administrative process in greater detail, giving major emphasis to methods of planning, evaluation, and management.
Part 1

GENERAL CONCEPTS AND APPLICATIONS
THE EVOLUTION OF NEOCLASSICAL ADMINISTRATIVE THEORY

1. PURPOSE AND SCOPE OF THE CHAPTER

A major thesis of this volume is that general systems theory, as it has developed over the last 30 years, provides new insights, ideas, and methods whose application can make contemporary administrative organizations more effective in solving problems of community environmental health. It will become apparent, particularly in the course of Chapter 2, that some systems concepts imply ways of defining problems and solutions that differ from the methods associated with more traditional administrative theories.

Yet these differing concepts and the methods that derive from them are not altogether incompatible with the key ideas of prevailing administrative theories and are in fact usable by existing organizations. Hence, it is a modified way of analysing problems and finding solutions that is being proposed rather than a wholly new theory of administration. This approach is justified on both scientific and social grounds: first, the development of systems theory and technology is still incomplete, and, second, existing institutions are more likely to respond to an invitation to broaden their arsenal of methods than to accept the advice that they should disband altogether and give way to a new order of things.

To see how systems ideas complement, extend, and depart from current administrative theory and practice, it is necessary first to understand the concepts that have guided the administrators of past and present institutions. Retracing the evolution of administrative thought, this chapter will deal with three subjects:

1. Traditional theory in its classical form (section 2).

2. The ways in which that theory has been modified in some organizational settings over the past 50 years into the form called "neoclassical" (sections 3 and 4.1).
(3) Certain inadequacies of this theory in its current form for guiding administrators in dealing with present and emerging social problems.

At the outset of this chapter, it is necessary to define the relationship between theory and practice in administration. The position taken here is that, while the administrator’s set of beliefs and premises may be either obvious to him or below his level of awareness, every administrator does in fact function on the basis of some “theory”, if only in the sense of a rationale that determines his view of how work is to be done and how people relate to one another in the work situation. Whether this theory is acquired by conscious study, by induction from experience, or simply by unconscious absorption from the organizational setting in which the administrator works, it shapes the decisions and actions that constitute visible administrative practice. In other words, administrative behaviour rests on administrative beliefs.

Such beliefs can be expressed in a concrete form only when one is considering a specific single situation. If one attempts to theorize about more than one administrative situation, one’s concepts become less concrete; and statements about administration in general are necessarily highly abstract.

A certain abstractness also results from the fundamental nature of administrative organizations, which are after all sets of arrangements that are not detectable by the five senses. While it is often possible to see the organization of a simple machine, either in the form of plans or as an actual object, an administrative organization is essentially invisible: even assembling the entire staff in a single room would reveal little about the pattern of their relationships over time, which is the essence of organization.

Finally, it is necessary to recognize that many abstract concepts concerning administration, although formulated in scientific terms, rest to some degree on cultural substructures that may be metaphysical in nature. This is particularly true, as we shall see, of such concepts in traditional administrative theory as order, authority, responsibility, loyalty, and leadership, whose roots extend deep into the religious and philosophical systems of certain parts of the world and whose viability is more likely due to cultural learning than scientific reasoning.

2. TRADITIONAL ADMINISTRATIVE THEORY

By traditional administrative theory, we mean the conception of administration that has developed over the last 200 years in Western
countries and that has spread, often in modified form, to most parts of the world. Described as "classical", "traditional", or "scientific management", it has been this type of theory that has been associated with the rise of mass production and distribution in the course of industrial and commercial development.

While there are a host of concepts connected with theories of formal organization, these concepts all stem from two fundamental ideas: the division of labour and its reciprocal, the coordination of labour.

2.1. Division of labour

Labour is divided among human beings for a variety of reasons; even in so simple a group as the family, different tasks are usually assumed by male and female members and by those in different age groups. In primitive settings, this serves the purpose of equalizing or otherwise distributing the work to be done by the members of a group. In more complex settings, division of labour leads to specialization, which in turn generates (a) expertness (by narrowing what one has to learn or to become skilled in), (b) increased productivity through greater dexterity, and (c) economy in the training of workers and the use of resources. The neurosurgeon and radiological technician acquire expertise by narrowing their vocational concerns to a limited field. Workers on production lines perform one small task on each of the many items being produced and, in combination with their fellows, can turn out many more finished articles than if an equal number of men each fabricated the entire article. By dividing the work done by engineers, clerks, and cooks, one reduces the amount of time required to train each for their work; this is less time-consuming than training every man for all three vocations. When work is divided, training costs less and can be done relatively quickly, for the tasks are of small scope; rather than craftsmen, one trains specialized operators. Division of labour implies more, better, and —over the long term—cheaper.

2.2. Coordination

However, division of labour by itself is not sufficient, for it is a centrifugal force. Left to themselves, specialized workers would produce fragments that could be combined, if at all, only at considerable cost and with great difficulty. Hence, there must also be coordination of labour (and of product) if the enterprise is to succeed in its mission. This involves the meshing of labour in a framework of time and the bringing together of parts at the right moments in order
to produce meaningful wholes. The absence of such coordination leads to failure and waste, either of which can cause the death of the enterprise. Coordination implies not only relating the pieces but reconciling differences in values and intentions. It is the coordination of labour, in traditional administrative theory, that is seen as the principal function of management.

2.3. *Work rationalization*

The coordination of divided labour, further, implies *rationalization*, i.e., the calculated planning of work, the identification of the component tasks, the assignment of those tasks, and the seeing to it that the tasks are done when necessary and as prescribed. *Planning, organizing, and control* are essential for rationalized administration. Planning means the making of reasoned decisions about what is to be done (objectives) and the prescription of how the work is to be done (methods). Organizing refers to the detailed specification of the statuses and interrelationships of staff and the channels and conventions for formal communication among them: the structure resulting from these relationships constitutes the *organization*.¹ In traditional administrative theory, the meaning of control is limited to the systematic monitoring and evaluation of work activities to ensure that the work is done in accordance with the plans.

2.4. *Hierarchy and authority*

Coordination entails two other conditions: first, the organization contains two types of member, those who coordinate and those who are coordinated; second, those who are coordinated are expected to obey the instructions of their coordinators. These two conditions are related respectively to the concepts of *hierarchy* and *authority*. Hierarchy denotes a rank order of coordinators on a vertical scale, each coordinating a number of subordinates, culminating at the top of the pyramid in the head of the organization. Authority means the power vested in the organization head to coordinate by making decisions and distributing rewards and punishments. It implies that this power is legitimate, whether sanctioned by law, by custom, or by acceptance.

The justification for granting authority is twofold: first, that such authority is necessary for the achievement and maintenance of social

¹ It is well to note the usage of three terms in this discussion that contain the root "organize". *Organization* in the general sense means the deliberate assignment of elements into some orderly pattern. *Organizing* is the process of planning and bringing into actuality a patterned relationship of persons or things. *The organization, or an organization*, refers to a concrete social entity such as a corporation or a government ministry.
order and, second, that the power is needed by its holder to fulfil his responsibility, the tasks and functions he is bound to perform for the organization and for which he is accountable to the organization's sponsors. These sponsors are seen as external to the organization, as they grant the authority and define the responsibility to be held by the head of the organization. Authority may come from such sources as the deity, the monarch, the constitution, the electorate (directly or through representative legislative bodies) or, in business organizations, from the owners. The head of the organization (usually a single person) may then delegate or distribute the authority and responsibility vested in him to subordinates, according to the organization's policies and hierarchy.

2.5. Propositions of traditional administrative theory

Traditional theory, based on these major concepts and with its strong orientation to the structure of the formal organization, may be summarized in the following set of propositions:

1. The organization is a formal structure of relationships that corresponds to the authorized network of communications channels.

2. It is a hierarchical structure, characterized by levels of authority and responsibility.

3. The chief purpose of this structure is to make possible the coordination of decisions and work actions.

4. The head of the structure is responsible for and has authority to accomplish all the work of the organization.

5. Authority and responsibility are commensurate at the head and at each lower hierarchical level.

6. The head accomplishes the work by delegating authority, responsibilities, and resources to sub-heads, who make further sub-delegations. The hierarchy of decision makers is commonly called the “line”.

7. Such delegations are administrative in character and do not relieve the responsibility-holder of his ultimate accountability. According to this concept of ultimate responsibility, the head cannot legally make final delegations of either authority or responsibility.

8. Delegations can be made only to “line” officers. “Staff” personnel advise, counsel, and provide technical expertise in various parts of the organization but do not receive delegations of authority and responsibility as such. Although they may assist the head or other line officers in their responsibilities and may be permitted to speak with their authority, this is not true delegation in the strict sense.
9. By making this distinction between "line" and "staff", the organization achieves *unity of command*—no one receives conflicting authoritative orders, as each person has one superior to whom he is responsible: one man, one boss.

10. No head or sub-head should be in charge of so many subordinates as to diminish his ability to coordinate. This is the "span of control" concept, often stated: no superior should have fewer than 3 or more than 7 subordinates.

11. Proper delegation involves specification of the functions to be executed; at each lower level of the structure, the specification is more detailed until the basic level of the job specification is reached. (Thus, the authority hierarchy is complemented by a hierarchy of functional specification.)

12. Similar tasks, activities, and functions are grouped in jobs, units, and departments; similarity may be based on the purpose of the programme, the processes used, the clients served (or material processed), or the place of processing.

13. In the interests of efficiency, the grouping should be specific and exclusive: there should be no overlapping or duplication.

14. Orders are communicated by the superior to his subordinates; subordinates report results or actions on the orders to their superior.

15. Reporting upward is the basic element of control; one accounts to his superior for results in terms of orders received from that superior. At each level, reports summarize information received from the subordinate level.

16. Work should be planned and then executed according to the authorized methods and procedures. The procedures are assumed to be "the one best way" of doing the work.

17. The performance of organizational units and individual organization members is appraised by superiors for effectiveness and conformity with prescribed methods, and rewards and punishments—customarily economic—are then assigned on the basis of the appraisal.

### 3. MODIFICATIONS OF TRADITIONAL THEORY

From this summary, the main propositions of traditional theory can be seen to be almost entirely concerned with how the organization structures the accomplishment of work. Little attention is given to human or resource factors. Also, it will be noted that these proposi-
tions, based upon notions of complete obedience to and conformity with the decisions of hierarchical superiors, have a highly mechanistic or militaristic flavour. Indeed, some of the earliest critiques of this administrative approach condemned it precisely because it conceived of organizations as machines made up of humans, or perceived men as the extensions of machines, manipulated by higher-level managers. Such criticisms were founded both on the contention that people did not or could not behave in these ways and on the contention that they should not. The attack thus was based on both empirical and normative grounds.

Hundreds of books and thousands of articles have been devoted to this critique of traditional administrative theory and the effort to modify it. While a complete summary is not possible, it is feasible to identify certain key ideas that have had the effect of changing administrative practice from the strict application of the traditional propositions into an approach that is somewhat more oriented to human factors and less concerned with rigid patterns of decision making. Such modifications have produced what is now the prevailing administrative theory in many countries, generally labelled “neoclassical”.

3.1. Informal organization

The concept of informal organization emerged early in the 1930s. Two definitions of the term appear in the literature, referring respectively to different behaviours in the formal organization. One connotes the various adjustments and departures from strict hierarchical relationships and communication rules that almost every organization develops in order to facilitate its work. Encompassed within this definition are such behaviours as horizontal communication to various specialized units that bypass the formal, vertical channels; the exertion of influence by staff units such as the finance and legal offices; and the force of personalities in decision making.

In its second sense, informal organization refers to the existence of small groups within the formal organization that are bound together by friendship and the perception of mutual benefits and interests rather than by the formal boundaries of organizational units. Such groups not only differ in composition from the formal units of the organization but may have leaders that differ from the official heads of the formal units. The various informal groups and clusters that emerge usually establish links with each other—most often through persons who associate with more than one group—and the resulting network constitutes a kind of “shadow organization” superimposed on the formal organization.
3.2. Motivation

Traditional theory is based almost entirely on the concept of economic motivation of employees: good service is rewarded by payments and advancement to higher paying positions; poor service results in lowered income or separation from the position. While both “the carrot” and “the stick” are used, the incentives are invariably economic or material ones. Critics of this concept have pointed out that these incentives assume a shortage of jobs and are much less effective if there is a shortage of workers. They also consider them as unnecessarily limited, since social benefits, prestige, pride in work, and internalized drives for satisfaction through achieving organizational goals also motivate employees and may in fact operate as more powerful incentives than wages and salaries. Such motives need not be idealistic or complex: they may be as simple and selfish as using employment to avoid loneliness or a sense of guilt over being idle; on the other hand, the individual may have objectives that transcend those of the organization and use his job as a vehicle to advance those broader goals. Unless the administrator is aware of and understands the full range of forces motivating organization members, he may use ineffective or unnecessarily limited means to harness their energies in the service of organizational objectives.

3.3. Professionalism

In organizations that include significant numbers of professionally trained personnel, motivational factors are apt to be even more complex. Unlike the industrial worker whose norms are usually restricted to those established by the organization’s managers, the behaviour of professionals is in addition influenced by norms and values they have acquired from sources outside the organization. Successful integration of professionals into the organization’s work therefore requires some modification of the strict superior-subordinate relationships prescribed by traditional theory; decision-making processes must be adjusted to permit the exercise of professional judgement and the application of outside values. Additional problems arise when an organization employs persons from many different professions, as health agencies frequently do. Interprofessional rivalries, difficulties in communication, and differences in values can strongly affect the planning and conduct of its work.

3.4. The sources of policy

Implicit in traditional theory is that the organization’s mission is to achieve efficiently the objectives set by its owners or by political bodies
outside the organization, be they goals of production or of social change. As seen by traditional theory, then, the task of administration is simply to plan out the details of the work required to achieve these externally determined goals. The administrative organization is a neutral, even passive instrument that does the bidding of its masters, who are assumed to know best.

These ideas came under challenge in business in the 1930s and in public administration a decade later. The challenge was based on two observations. First, organizations by nature are concentrations of power that soon tend to develop directions and momentum of their own, some aimed at their own survival and growth; organization leaders come to hold their own ideas about what is good for the organization and for the community. The second observation was that, in their own areas of responsibility, full-time technical staffs quickly become better informed than organization owners and outside politicians about needs, markets, limitations, and operating conditions. It is difficult to ignore such information when setting objectives and policies. As a result, whatever the formalized policy-setting protocols may appear to dictate, administrative staffs inevitably become important, sometimes decisive participants in the process of policy formulation. If the organization has a number of different programmes, with distinctive objectives and staffs—which is, again, frequently the case in health agencies—then administrators at the middle as well as the top levels will become involved in setting policy.

Thus, even if the formal policy decisions are made by political bodies, it was realized that the premises for these decisions come from the administrative agencies under their supervision. The implications of this realization for the conception of administration were enormous. No longer was it possible to view the manager as simply the one who coordinates work operations and makes sure that the organization has the capacity to produce the goods or services desired. Administrators were now seen as contributing influentially to the formulation of policies—decisions about what the organization is to do and about the conditions and restrictions under which the work is to be done.

Complementing this line of thought was the recognition that to decide about programme details and to make choices about the use of resources is in fact to determine the actual specifics of policy. Since the objectives set by outside bodies are invariably formulated in general terms, as in the form of legislation, it remains to the administrators of the organization to work out the detailed sub-objectives. In the process, important decisions must be made about relative emphases and priorities, about methods, and about resource factors. Many of these decisions have political and economic consequences, deter-
mining, for example, whether policies are effectively carried out and who receives the resulting benefits and disbenefits.

Thus, it came to be appreciated that administration is deeply and continuously involved with questions of policy and that effective administrators need to have proficiencies that extend beyond skill in managing work operations.

3.5 Organizational decision making

A major target in the critique of traditional theory is the manner in which it views authority and decision making within the organization. The traditional concept of a single, all-powerful, all-knowing decision maker at the head of the organization has been challenged as unrealistic. The view now prevailing is that organizations are networks of decision-making roles; workers and supervisors at the lowest levels of hierarchy make decisions under the guidance of organizational policies and rules, and higher-level specialists receive information from these and other organization members to make judgmental decisions at their levels. In this and related conceptions, organizations are viewed as large information-processing entities, the information concerning the organization's external environment as well as its internal operations. Programme plans serve as broad, guiding statements of objectives and strategies and are decided upon by those in the upper level of the hierarchy. Plans for implementing and executing the strategies are made at lower levels; these plans are in effect decisions that define how operations will be conducted. In most situations, decisions on alternatives involved in individual cases (e.g., does this X-ray machine meet the safety standards?) are made at the level of direct services. For organizational effectiveness, communications must move throughout the organization—and not just from the top downward—so as to inform decision makers at all levels.

3.6 Reciprocal basis of authority

In view of the implications of the critiques summarized in the preceding sections, the concept that authority derives only from outside sources was judged inadequate. One line of criticism, based on the observation that those in whom authority is supposedly vested often do not elicit obedience, claimed that it was more realistic to view authority as depending on its acceptance by organization members. In this view, authority that is not accepted is ineffective; moreover, determined subordinates who do not accept the authority of their hierarchical superiors can undercut the organization's efforts to achieve its goals. The conception of organizational authority as resting
on reciprocal relationships between the leaders and the led was thus asserted to be more accurate and useful than the traditional view.

3.7 Leadership styles

Such alternative views of decision making in organizations and of the reciprocal nature of organizational authority have also led to the development of different concepts of leadership and "leadership style". In addition to the rather autocratic leadership style characteristic of traditional administrative theory (according to which, it will be recalled, the superior gives orders and the subordinates report on how well they have complied), at least two other models of leadership have evolved, the democratic and the participative.

Democratic management stands at the opposite extreme from autocratic management. It is based on the notion that, since all organizational members have an interest in the success or failure of the organization's work, all of them should participate in decisions concerning policy. Democratic management models usually stop short of calling for all decision making to be done through organization-wide plebiscites, as this might paralyse administration and make it inconsistent. Most such models advocate democratic decision making in the immediate work unit on questions within its area of responsibility, as well as representation of such units in decision making at higher levels. In contrast to traditional theories, such models imply that authority is vested in the workers rather than in the managers.

Between the autocratic and democratic extremes stands the model of participative management. In this formulation, the decision-making responsibility of the managers at each level is preserved. Unlike the traditional model, however, participative management requires that prospective decisions first be considered by those organization members who are affected by them, before the decision is actually made by the responsible official.

Research into organizational behaviour indicates that certain situational and psychological conditions must be satisfied for participative management to succeed. First, there has to be consistency in the practice of this management style. In addition, those who participate must feel that the subject of the decision is important and that it falls within their competence.

A number of benefits are claimed for the participative management model. A greater range of ideas and information is brought to bear on decisions. It has also been observed that, once the decision is made, there will be greater moral commitment to it even if the option selected by the responsible decision maker is not the one favoured by the
majority of participants. Participative decision making is also seen as an antidote to apathy among organization members.

Since participative decision making emphasizes the early involvement and consultation of those affected by the decisions, it has been suggested that the model can be useful for involving affected consumers and other community members in decision making about social action programmes.

3.8. **Summary; additional challenges**

Because the challenges to traditional theory described above have been scattered and diversified, it is not possible to give a set of propositions on the resulting modifications of that theory that would be as complete, coherent, and logical as the set of traditional propositions listed in section 2.5. However, a summary of the main points of section 3 may help to clarify the way in which neoclassical administrative theory has evolved.

1. To function effectively, organizations must modify their formal communications channels by authorizing bypasses for certain types of message. This is one aspect of informal organization.

2. The existence of a network of small groups, defined mainly by shared social values, is another aspect of informal organization. This network is a "shadow organization" that may both support and conflict with the formal organization.

3. In addition to economic incentives, administrators work with a broad array of motivating forces, many of them intangible. Often, however, the manipulation of such non-material rewards may be more effective than the distribution of economic rewards and punishments.

4. Professionalism, which is prevalent in health agencies, acts to modify the functioning of the authority hierarchy. The exercise of professional judgement and the professional's importation of outside value systems into the organization may strongly affect the actual processes of decision making.

5. The inclusion of a broad variety of professionals in an organization makes it more complex and more difficult to manage, as it requires the resolution of value differences and the control of rivalries.

6. To view organizations as neutral instruments merely carrying out the wishes of external sponsors is to misjudge the policy-setting process and the nature of administration. A more realistic view is that organizations themselves help to develop and decide on policies, influencing over time the goals selected for fulfilment. One of the
important tools of administration for contributing towards policy making is its function of elaborating the details of broadly stated policies. It also influences policy by making operational choices on the use of resources.

7. In organizations having a number of distinct programme missions, policy making will involve a large number of administrators and their programme staffs.

8. Decision-making functions are widely distributed among organization members rather than being concentrated at the top levels.

9. The effectiveness of organizational authority rests more on its acceptance by organization members than on its being vested by an external sponsor. Reciprocity in the relationships between the leaders and the led is a key to understanding the effective exercise of authority.

10. Autocratic management, which is the leadership style implied by traditional theory, may not be as effective in achieving the necessary reciprocity of relationships as the alternative of democratic management or, more plausibly, participative management.

Beyond these key ideas, several other concepts of traditional administrative theory have been challenged and modified in recent decades. Some will be elaborated in subsequent chapters; the others, while interesting and relevant, are deemed of secondary importance for the purposes of this volume. The additional critiques include the following:

11. It is recognized that it is impossible to have authority and responsibility commensurate in complex agencies and governments, in view of the many participants and organizational levels involved in decision making.

12. There is a need for a more elastic view of the “span of control”. Instead of being determined by rigid rules that a supervisor should have no fewer than 3 or more than 7 subordinates, supervisory load must be adjusted to such factors as the character of the work, distance or proximity between supervisor and subordinates, mechanisms for communication, and the objective of developing more responsible subordinates. The inherent desirability of close supervision has itself often been challenged.

13. The traditional guides to internal organization (summarized in proposition 12, section 2.5) are seen to be inadequate for determining how to set up and group units, since the general criterion of similarity of tasks permits of several alternative organizational patterns in any given situation. For example, this criterion does not help in deciding
whether sanitarians (who use similar methods) should be grouped together in a single unit that provides sanitarian services to a number of programmes (i.e., organization by process), or whether they should instead be distributed to different programme units where the basis of similarity is the unit's objectives, regardless of the professions of the individual unit members (i.e., organization by purpose).

14. The idea has evolved that in every organization there is a bureaucratic subculture that contains values and customs so strong as to affect and shape the manner in which a programme can be carried out by the organization. This concept will be discussed in systems terms as "internal constraints" (Chapter 2).

4. FURTHER DEVELOPMENT OF ADMINISTRATIVE THEORY

4.1. Impact of the critiques

What has been the outcome of the challenges to the validity and utility of traditional theory, as briefly examined in the preceding sections? The key to the answer lies in remembering that, with a few academic exceptions, the critiques have been aimed at particular aspects of traditional theory, not at traditional theory as a whole.

Basically, the outcome has been not the development of a new, rival theory to replace the old but rather a subtle, evolutionary modification of administrative practice and theoretical formulations. A few examples may make clear the degree to which the underlying concepts of traditional theory, as opposed to its superstructure, still persist.

While there has been substantial criticism—particularly in industrial enterprises (and, interestingly enough, in the field of medicine)—that division of labour and specialization have been carried too far, there is no rejection of the basic idea of the division of labour. Similarly, while elaborate research has been devoted to the idea of informal organization, as both conflicting with and supplementing the formal organizational structure, the concept and existence of formal organization remain viable in most enterprises. Ideas about formal organization have been enriched, but not replaced, by the view that the organization is a subculture functioning within the culture of its society.

To take another example, the economic view of motivation, that people work in order to seek their material good, has been decried as incomplete, and notions of intangible rewards, social benefits, and self-fulfilment have been added. Thus, although economic motivation may now be considered as an oversimplified explanation of why people work in organizations, it has not been cast out. Instead, the know-
A knowledgeable administrator works with an enlarged view of the incentives he can manipulate so as to induce organization members to strive for the achievement of organizational objectives.

Another outcome of the long critique has been a change in the way the persisting concepts of traditional theory are regarded and used by many administrators. Instead of treating them as "principles" to be followed blindly or slavishly, the knowledgeable administrator uses them as general guides to be applied as his particular situation permits. This more flexible approach stems from a recognition that local factors require different responses to similar problems.

This attitude toward administration, together with certain expanded and enriched concepts that have emerged from behavioural and policy research, is generally termed neoclassical administrative theory. The name connotes both the persistence of the fundamental ideas and the accretion of newer insights. There are, however, few books on management and administration that consciously identify these changes or provide a coherent assessment of them. For the most part, current books and articles in the field represent the individual integration of the ideas and experience of each writer at the time of writing.

It is important to note in this connexion that the evolution of traditional theory into its neoclassical form has not proceeded at a uniform pace in all locales. Changes in administrative practice have varied with the particulars of the training, experience, and theoretical concepts to which various administrators have been exposed, as well as with the setting in which they work. As a result of the play of historical circumstances, there are notable differences among countries, among governments, and among individual agencies and industrial enterprises in the administrative theory currently being used.

This lack of uniformity, which in itself is by no means undesirable, probably also reflects the general orientation of administrators and politicians towards solving practical problems rather than serving academic ideologies. In other words, theory supports rather than dominates experience and practice; and practice serves as the source from which theory is drawn.

4.2. Administrative evolution and the needs of environmental health

Considering the evolutionary and practice-oriented character of administrative theory, how adequate is this theory in its present form for dealing with the types of problem that communities are now seeking to solve? The answer to this question must consider both the

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1 One exception to this is the work of the eminent teacher-historian of management thought, Edward Dale (Theory and practice of management, New York, McGraw-Hill, 1969).
nature of present-day problems and the characteristics of the existing mechanisms for solution.

Throughout the world there is an increasing awareness that social problems—notably those involving man's social and physical environment—are highly complex and interrelated. Yet all too often these problems have been defined and dealt with in overly fragmented ways, sometimes with unfortunate consequences. For example, the solution of one problem, or even an unsuccessful attempt to solve it, has sometimes led to the emergence of still other problems.

The causes of this fragmented approach will be discussed at greater length in Chapter 2. Suffice it to say here that the dilemma confronting environmental health administrators—like administrators in other fields of social intervention—is that administrative technology in the form developed up to the present time is a technology of specialization, which fosters efficiency, whereas the technology needed for comprehensiveness and hence social effectiveness is still underdeveloped.

Of the various lines that contemporary theoretical research has taken to develop this needed technology, the approach identified with the application of general systems theory to administration has come increasingly to the forefront as the best hope for mounting more comprehensive attacks on social problems. This is not to say that the needed technology should be developed only in academe. On the contrary, its development must take place through actual administrative practice. However, universities and other research entities can contribute by providing practising administrators with the basic concepts and vocabulary of a comprehensive approach so that the practitioners can in turn proceed to develop specific methods of solving concrete problems. The academicians can then observe, analyse, generalize, and codify the results obtained in order to advance further the body of theory.

It is the provision of the basic concepts and vocabulary of the systems approach to administration that is the aim of this book. The outlines of general systems theory and its application to administration will be discussed in the following chapter. While later sections of this volume will identify certain conflicts between the concepts of the neoclassical and systems theories, it bears repeating here that the latter group of concepts is presented not as an alternative or replacement for existing administrative theory but as its complement—as a necessary next step in the long evolution of administration.
Chapter 2

CONCEPTS OF GENERAL SYSTEMS THEORY
APPLIED TO ADMINISTRATION

1. MEANINGS OF "SYSTEMS ANALYSIS"

In recent years governments and other organizations have turned increasingly to "systems" as a way of thinking and problem solving. This is largely because they have been confronted with problems for which the concepts and tools of systems analysis, for reasons to be discussed in section 2, have been judged more appropriate and useful than those of more traditional analytical methods.

Despite the growing use of systems analysis, its introduction into various fields has often been accompanied by misunderstanding and hostility. One source of misunderstanding is the fact that the term "systems analysis" is used to describe different, although usually related, methods and processes. Three current meanings of the term are noted below.

1. "Systems analysis" may refer to a general process of analysing and explaining interrelated elements that constitute systemic wholes, a process that does not necessarily involve mathematics or quantification. In this sense, "systems analysis" means using the concepts and conventions of a type of thinking referred to as general systems theory\(^1\) to acquire an understanding of how the structures and processes of a programme, organization, or even a larger system are composed and interrelated. The insights gained from this process of analysis may then be used to decide which of a large variety of methods and techniques would be useful in solving related problems.

2. "Systems analysis" may refer to a group of methods of solving operational problems by means of a variety of quantitative techniques, including those of Operations Research and economic analysis. A more appropriate label for this group of methods is "management

\(^1\) The classic work is von Bertalanffy, L. (1968) General systems theory, New York, Braziller.
science". Many of these methods have grown out of more specialized
theories (games, network, queuing), and they usually involve the use
of mathematical models. While their application may constitute a
logical progression from the preceding type of analysis, in the present
state of knowledge there are major practical difficulties involved in
using them to solve problems of large systems as a whole, although
one or another analytical method can usually be applied to a sub-
system or to a carefully limited operational problem. The methods of
management science are presently inadequate to solve system-wide
problems that are large, complex, and fraught with uncertainties, as
is the case with many health problems and systems.

3. "Systems analysis" in its most restricted and pernicious sense
refers to the use of one of a variety of techniques, often derived from
computerization models, that are indiscriminately applied to problems
regardless of their nature. If the claims made for such a technique
within an organization raise expectations that are not fulfilled—which
is especially likely to happen if there is no rigorous problem analysis
—hostility and misunderstanding are generated, leading to the re-
jection of any approach that carries the "systems" label. Similar
antipathy may also be expected when there is disenchantment with
the limited results achieved with the more versatile methods of
management science.

Since this volume is concerned more with the concepts and pro-
cesses of programme administration than with techniques, its emphasis
will be upon the first of these interpretations of systems analysis: the
use of general systems theory as a way of thinking, organizing infor-
mation, and communicating. We seek general rules that would be
useful to administrators rather than standardized solutions to problems,
which in any case inevitably vary with the situation in which they
are found.

2. TRADITIONAL "SCIENTIFIC METHOD"
AND ITS IMPACT ON ADMINISTRATION

To understand why systems thinking is needed in programme ad-
ministration, one must compare it with the prevalent type of thinking,
namely the reductionist approach—or, more accurately, the partitionist
approach—of the so-called "scientific method". Over the last 500 years,
Western science has accumulated a rich store of basic and applied know-
ledge whose effects have changed the course of history in most of the
world. The major tool used to acquire this knowledge has been a
particular type of analytical method now so basic to thinking in most scientific circles that it is referred to as "the scientific method". It proceeds by breaking problems into ever smaller parts and studying these intensively.

While the partitionist approach has led to an explosive growth of knowledge and technology, particularly in medicine and engineering, in the process it has also had far-reaching social repercussions. As Western science itself has become ever more highly specialized and fragmented, this fragmentation and specialization has been mirrored and even magnified in the professions and technologies whose task it is to apply science to individual and social problems. And just as few mechanisms exist to bring the separate bodies of scientific knowledge together, it has become increasingly difficult for specialists in different fields to understand or work with one another. Thus, the vast increase in knowledge and skills derived from the partitionist approach—and from its administrative application through the division of labour and specialization—has been bought at the cost of engendering differences in terminology, in ways of looking at the world, and in value systems.

Over the centuries, partitionist ideas and processes, as well as specialists themselves, have been absorbed into administrative organizations. It is now being realized what a high price such organizations have had to pay for this increase in expertise. As almost anyone with even superficial experience in health agencies or comparable organizations knows, when different professionals and technicians are brought together to work on a common problem or "as a team" what usually happens is that different patterns of thinking emerge. Communications are not understood—or are misunderstood; the problem to be solved is perceived differently; its key features are disputed; each specialized group sees the problem and possible solutions from its own frame of reference. Sometimes, basic hostilities and suspicions among disciplines are aggravated by each new effort to communicate.

A major function of administration is to synthesize various elements so as to create and pursue effective programmes, but rampant specialization has led to increasingly severe strains on administrators by frustrating their attempts at synthesis. In health agencies, staffed by personnel from a profusion of scientific, professional, and technical disciplines and concerned with myriad health and disease problems, the difficulties have been especially troublesome. It is no exaggeration to say that increasing specialization, together with the emergence of ever more complex social problems and political demands for coordination, have brought many health agencies into a state of recurring crisis. Not only does the agency encounter massive difficulties in communi-
cating with political and social leaders and others outside its boundaries, but it is frequently impossible to obtain coherent communication within the organization itself. Often, the result is a suspension of all attempts at effective communication and a withdrawal of specialists into their respective bureaucratic fortresses. Some of the difficulties in overcoming fragmentation in community health agencies may stem from the fact that their scientifically trained leadership has its intellectual roots in the partitionist approach.

The problem of intraorganizational stress is compounded by interorganizational fragmentation: programmes that are interrelated are assigned to different specialized agencies. Monumental problems of achieving programme coordination seem to exist in most countries, regardless of the relative sizes of the governmental and private sectors.

The utility of the systems approach would seem to lie in its inherent ability to define relationships among separated parts. Since it is assumed that labour must continue to be divided and specialized responsibilities assigned, one can readily perceive the usefulness of a method that is able to relate to each other (for working purposes) a number of entities that are formally distinct in structure. When specialized workers can themselves be brought to see their interrelationships, to improve their communications, and to pool their efforts more effectively in programme planning and execution, giant steps will have been taken toward overcoming fragmentation.

3. SYSTEMS IN GENERAL

Although general systems theory has had a short life as a self-conscious science, its precursors run back to antiquity. One line of Greek philosophy (the work of Heraclitus, for example)—although, as it turned out, not the dominant or enduring line—was formulated in systems terms. Some of the Eastern philosophies and religions are based on ideas with which systems theorists can be comfortable. More recently, such towering figures in the natural and social sciences as the physiologist Harvey, the economists Adam Smith, Marx, and Keynes, and the biologist Darwin dealt with their subjects in systems

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1 As an example of these problems, a WHO Expert Committee on Health Statistics in 1970 noted 10 sources of inadequate linkages between two types of specialist (health planners and health statisticians) in carrying out planning and evaluation work, including lack of a feeling of common purpose, distincctions of hierarchical status, inadequate resource supports, ignorance of each others' methods and skills, differences in background and personal status, inadequate communication on goals and their interpretation, lack of appreciation of time factors bearing on each discipline, inflexibility in respective work systems and lack of imagination to adapt them, basic differences in work methods, and improper perceptions of power relationships (World Health Organization, Technical Report Series, No. 472).
terms, although they did not use the vocabulary of present-day systems analysis.

The scope of these examples suggests that much of the work and social organization of mankind can be viewed as systems. That they can be viewed as such is the key idea here, since what distinguishes systems analysis from partitionist analysis is the difference in the way these two analytical approaches perceive and think about the relationship of wholes and parts.

As a way of thinking, the power of systems theory derives from its ability to describe, analyse, and discuss the nature of things in comparatively few general terms. The “things” may be as different as a machine, a geographical area, a body cell, a government ministry, a forest, a human being, or an animal population. Not only does this make possible a common basic language among people working in many different fields, but it permits people to use analogies in their reasoning with a high probability that the analogies will be valid for their own particular situation. As we shall see, especially with regard to administrative systems, systems theory enables one to cut through arbitrary ideas about organizational structure in order to deal with the world from the standpoint of process—how things actually work.

As a young science, systems theory has generated many definitions of the term “system”. While these definitions may differ in their wording, the basic ideas they are trying to convey are similar.

A classic definition of a system, given by L. von Bertalanffy, is terse but suggestive. It states that a system consists of “elements standing in interaction”. This brief statement suggests that a system is a whole made up of parts, that the parts have relationships to each other (interactions), and that the continuing (“standing”) interactions imply pattern or organization. The definition also implies that any perceived elements that are found not to interact with the others are not part of the system being considered.

This idea can be made somewhat more explicit by defining a system as a set of elements so related that a change in the state of any element induces changes in the state of other elements. This definition, besides containing all the ideas of the preceding definition, also supplies a working guide or criterion to help determine whether a given element is actually part of the system in question. This is vital for stating what the system consists of. For example, if we posit that a family occupying the same household is a system, we may test the truth of the assumption by thinking about (or actually effecting) changes in the state of one or more of its elements, i.e., the family members. We know from experience that a change in the state of one member of a family (e.g., one of them falling ill or becoming un-
employed) induces changes—minor or severe, depending upon the position and functions of that family member—in the other members of the household. When a member of the family dies or moves far away, it provokes a marked or even drastic change in the system. If the system is to continue as such, its remaining members (elements) will have to adjust their interactions and find a new “steady state”. Short of such major disruptions, the interactions among family members undergo regular changes at certain times of the week or day as different members go about their activities: working, playing, eating, and sleeping. In addition, marked or minor changes occur in such states as individual members’ moods and feelings, with repercussions on other members of the household. Thus, the family forms a system because—or to the extent that—a change in the state of any member of the household causes changes in the states of others.

An analogous example can be given for a machine, taking the bicycle as a simple illustration. Loosened bolts, a broken chain, low air pressure or the puncture of a tire, a broken or bent wheel—any such change in the state of these elements will affect, more or less directly, other parts of the bicycle “system” as well as its operation as a whole.

4. BASIC PROPERTIES OF SYSTEMS

1. The crucial characteristic of a system, as noted in the preceding discussion of definitions, is that of interaction, or interdependence. If an element does not interact with the rest of a system, it is not part of that system and has no true relationship to it. More than that, to the extent that a group of parts are not in a state of interaction or interdependence, they constitute only an array of elements and not a system. When a living organism—plant or animal—dies, it ceases to be a system and becomes merely a collection of cells, tissues, and organs, which will decay sooner or later and, usually, be transformed into elements of other quite different systems.

This implies that any system is more than the simple sum of its parts. It becomes a system when the parts are brought into a state of interaction or interdependence. Three strangers placed in a room do not constitute a social system. If they do not communicate they will never become a system; if they do, their interaction begins to form them into a system that we would call a group. Should they come to depend on each other through their interactions, a strong social system might develop. Similarly, a water source plus a heap of items such as pipes, connectors, valves, taps, pumps, chlorinators, etc., is no more than a collection of parts; it does not become a water
supply system until these parts are brought into an interactive or interdependent relationship with each other—in this instance, a planned pattern of interdependence.

Paradoxically, some systems may be—or appear to be—less than the sum of their parts. Mechanical and macro-botanical systems may have interchangeable elements, but at any given time each element belongs to only one system. This, however, is seldom the case with social systems (human and animal), in which the individual plays roles in a number of different groups, i.e., is an element in a number of systems. Thus, each such system seems smaller because it “shares” some of its elements with other systems. As we shall see, this fact is of considerable significance since the way a person (element) functions in one system may be strongly conditioned by his membership and role in another system. For example, membership in a religious or political system may condition one’s behaviour in the family and at work, or family stresses may condition one’s performance as a member of the work organization. The implications of these interactions for administrative systems—considered as a type of social system—are obvious.

2. Another characteristic of systems is that the state of a system is not merely dependent on the presence or absence of its parts but is also contingent upon the state of the parts. A complete, fueled automobile (a system) will not function at all—although it will still constitute a system—if there is a block in the fuel supply line or if the energy level of the battery is too low to activate the starting mechanism; when it does operate, how much less than optimally it functions depends upon the condition or state of its pistons, cylinders, spark plugs, brakes, tires, etc.

3. It is obvious from the world around us that systems are almost invariably parts of ever larger systems. To start at the upper end of the scale, we readily perceive that everything on our planet is part of the enormous system that we call earth, a system that is itself made up of numerous subsystems—geographical, climatic, political, economic, etc. Starting from the other end of the scale, we can see that the bicycle and automobile of our preceding examples are, when functioning, parts of man-machine systems and that these man-machine systems are elements in traffic systems in which they are related to roads, traffic signals, other vehicles, police surveillance, and the like. Local traffic systems are in turn linked together into larger traffic systems of the same type. Various traffic systems—road, pedestrian, rail, air, water navigation—are part of a still larger system we call transportation. To take another example, the immediate family is a subsystem of an ever larger hierarchy of more inclusive systems, such as the extended family, the neigh-
bourhood, the religious congregation, the municipality, district, province, nation, and mankind.

4. Systems are complex and of different types. As indicated in the preceding paragraph, any system (above the level of quanta of energy) consists of subsystems usually arranged in descending order. This is but one dimension of complexity. Even an entity of such "low" level as a single muscle cell in the human body is a fairly complex system that usually includes a nucleus, cytoplasm, and an enclosing membrane; each of these elements is in turn interrelated with its constituent sub-systems, down to the smallest unit of energy. As we shall see later, some of these inter-level relationships grow out of natural processes, evolutionary ones in the case of life forms. Others are man-made and can be further divided into (a) relatively stable man-made systems, such as machines, and (b) dynamic man-made systems, such as various forms of social organization.

An important corollary consideration is that there is no predetermined level of magnitude at which a system is denoted "the system", with everything within it called a "subsystem" and everything larger a "supersystem". In other words, one is not limited by any absolute, predetermined hierarchy of system levels. Instead, anyone describing, analysing, or working with a system is free to set the level of "the system" to suit the problem he is attempting to solve. Thus, in medicine, the cytologist defines his system at the level of the cell, the cardiologist studying the cardiovascular system is concerned with the level of organ or body, as his interests dictate, and the medical sociologist is concerned with a system involving the sick person and his social environment. When we come to consider administrative systems, we will see how useful it is to be able to set the level of system according to the problem that is to be solved. Whatever the analyst's ultimate decision, it is most important that he state explicitly the level and boundaries of the system he chooses to analyse.

5. Not only is there no absolute hierarchy of system levels, but—as the preceding examples illustrate—the elements contained in the system under analysis are also not predetermined. The system's composition depends on the problem to be solved, on the objectives of the analysis. For example, if an analyst were concerned with understanding the financial processes involved in an environmental health programme, he would have to define the system's composition not only on the basis of the presence or absence of certain elements but on the basis of their behaviour. If he should find that an accounting unit in the Ministry of Treasury interacted frequently and intimately with the programme, checking, approving, and perhaps modifying every proposed expenditure before
it were made, the analyst would necessarily include it as part of the programme’s decision-making system. On the other hand, he would not include the accounting unit in the system, but would rather consider it as an external force, if the unit simply set accounting norms with which the programme had to comply, and did not interact frequently with programme staff.

6. It follows from the preceding points that, whatever their level or composition, systems of the type that concern us function in relation to an environment. Usually, the system’s environment is complex, especially in the case of social systems of the administrative type. To remain for the moment with simple examples, however, the “immediate family system” is not only part of an environment consisting of the larger social groupings mentioned in paragraph 3 above (extended family, neighbourhood, religious congregation, etc.), but also exists and functions in relation to other types of system, such as its dwelling, which is part of an urban or rural system, which is then part of a larger physical environment, a cultural system, an economic system, etc. Whenever a system has an environment with which it interacts, we consider it to be an open system. This concept is explored more fully in the following section.

5. OPEN AND CLOSED SYSTEMS

As stated above, when a system is in a state of interaction or interdependence with factors in its environment, it is considered to be an open system. Where such interactions and interdependent relations do not exist, the system is considered to be closed.

5.1 Closed systems

In nature, there are no rigidly closed systems. Each component of the environment inevitably interacts with other components; even man’s philosophical systems and religious ideas affect his relationship with the environment and are in turn affected by it. Thus, the “closed system” is, in the strict sense of the term, a purely theoretical concept.

Sometimes, in order to simplify and stabilize the analysis of a system, it is convenient to “close” the system arbitrarily by making certain explicit assumptions. For example, the functioning of our planet as a system is dependent upon certain environmental factors: one of these is the maintenance of the gravitational relationships in our solar system and galaxy; another is the flow of energy from the sun, 150 million kilometers away. However, ecologists concerned with comprehensive life systems on the earth simplify their analyses by (a) disregarding the first
dependent relationship and (b) arbitrarily declaring that the flow of solar energy is *within* the boundary of the planetary biosphere system rather than in its environment. Considering the ecologists’ purposes, these assumptions are both reasonable and useful.

In general, the experimental research method consists in arbitrarily “closing” the system, assuming or ensuring that all remains constant except the variable under study.

Comparable assumptions, but arrived at implicitly from culturally derived notions rather than by explicit reasoning, are made by administrators who think of their organization as a closed system existing within the boundaries defined by the formal organization chart.

From these examples, it may be concluded that the arbitrary “closing” of a system for purposes of analysis may be useful and valid. However, sound analytical procedure in such circumstances would require that the rationale and the assumptions be explicitly stated.

### 5.2 Open systems

More practically, we live in a universe of open systems, which do interact with their environments. All systems require certain inputs and supports from their environments, such as resources, information, work to be done, endorsement, and recognition. To the ecologist, all of these inputs constitute energy in some form: the cell requires nutrients, the automobile requires fuel, the administrative organization requires money, manpower, materials, authorizations, clients, and information.

Open systems not only depend on the environment for inputs but frequently exist precisely in order to produce outputs for consumers or target populations in the environment. Thus, there is system-environment interaction on both the input and the output sides. Often, the environment depends on the system for valuable outputs such as crops, industrial products, medical services, safe water supplies, and so on. Of significance to environmentalists is the fact that, aside from producing outputs that are positively valued, systems also produce outputs that are negatively valued—generally called wastes—whether they be human excreta, slag, rubbish, extracted toxins, or crime and delinquency.

### 5.3 Constraints

A “constraint” is a general systems term that refers to an expectation or condition that is imposed on a system by its environment. More precisely, this is the definition of an external constraint, for constraints can also come from within the system itself.

42
External constraints may be natural or man-made forces. A community inhabiting a tiny island is mainly constrained by natural processes; availability of arable land, water conditions, types of vegetation, conditions of transportation to other places, etc., will all serve to determine what that community system is and may become. An administrative system is shaped in addition by man-made forces: what external political leaders expect it to do and to produce, the funds available to it, its legal rights and responsibilities, the availability of technology, and a multitude of similar factors.

Internal constraints are those behaviours and forces within a system that either limit how well the system can respond to changes desired by its leadership or that present expectations that the leaders have to meet. An important type of internal constraint is the “steady state” of the system, to be discussed in the next section.

The word “constraint” itself seems to produce a tendency to consider such forces as restrictive or negative. It is more accurate to consider them simply as conditioning forces, from the environment or from within the system, without imputing to them any absolute positive or negative character. This is not to say that values cannot be assigned to a given constraint. However, these will vary with the values of the system participants as well as with circumstances. For example, the constraint stemming from a political decision that domestic refuse must be collected three times weekly may be valued differently by various members of the sanitation agency. Some may regard it as an opportunity to demonstrate their orientation to public service or as a more desirable way to reduce the population of insects and rodents, while others may consider it to be a misuse of resources that could be better employed for other services and programmes of the agency.

For the analyst, therefore, it is more useful to think of constraints as forces to be identified, whose significance is to be measured in terms of how they condition the system and set its parameters, than as inherently good or bad, positive or negative. Over time, it should be remembered, constraints may change, sometimes in response to the operation of the system.

Constraints also serve to define the nature and boundaries of the system being analysed, a concept that will be considered further in the discussion of administrative systems.

5.4 The steady state (homeostasis)

To say that systems are conditioned by external constraints is to say, also, that systems must adapt to any conditions that they are
unable to change. The degree and form of such adaptation in living systems appear to be limited from within by the system's need to maintain a *steady state* (the alternative term is *homoeostasis*). If the steady state cannot be maintained, the system breaks down, deteriorates, or dies.

A normal state of health in which a person is resistant to certain disease-causing organisms is an example of a steady state. Should that state be altered by excessive fatigue, a change in diet, or some other stress, the person might fall ill of a disease that had been kept latent by his resistance. If then the normal limits of body temperature—still another aspect of his steady state—were exceeded for too long, he would probably die.

Rather than being conceived as a fixed equilibrium, a steady state can best be thought of as a range of tolerance for change, or the range within which adaptation can take place without essential deterioration occurring in the system. Living systems—whether organisms or organizations—differ in their steady state requirements, both among species and among individuals. They vary, for example, as to how long they can survive in a waterless environment or how much psychological stress they can endure.

Over longer periods of time, steady states themselves can change as the system gradually adapts to changed conditions. In genetic terms, this concept is at the base of the theory of evolution. It also is related to the processes of growth, maturation, and education. The notion of steady states and their ability to evolve slowly over time has clear implications for those interested in community or organizational change. Social systems are more likely to respond to—and remain viable in the face of—gradual or progressive change than radical change. This assumes, of course, that those who are interested in effecting the change desire the continuation of the system and its primary parts. In contrast, the aims of revolutionaries are to change social systems drastically or destroy them altogether by disrupting their steady states.

6. SUMMARY OF BASIC SYSTEMS CONCEPTS

On the basis of the preceding discussion, certain fundamental concepts of systems can now be summarized.

1. Interactions (interdependent relationships) must exist (or be hypothesized) for a system to exist (or be hypothesized).

2. A system is greater than the sum of its parts, since it consists of interactions among its elements as well as the elements themselves.
3. In a somewhat different sense, a system may appear to be less than the sum of its parts if some of the latter belong simultaneously to another system.

4. When an element belongs to more than one system, its state in one system may be altered by a change in its state in another system.

5. The state of the system is a function of the states of its elements and of the states of their interaction with each other and the system's environment. Systems containing similar elements may thus be in different states.

6. Any system that is in interchange with its environment is an open system.

7. The primary forms of interchange between a system and its environment are the receipt of inputs and the provision of outputs; the latter may be positively valued goods and services or negatively valued side effects (such as wastes).

8. Forces from the environment that condition the system—its inputs, the way it functions, and the way its outputs are treated—are called external constraints.

9. The capacity of a system to adapt to changes in its environment is limited by its need to maintain a steady state (homoeostasis), defined as the system's range of tolerance for a particular change at any given moment. The steady state accounts for many of the system's internal constraints.

10. An open system may be artificially and arbitrarily "closed" for purposes of analysis. If this is done, it is desirable that the assumptions relating to the closing should be made explicit. They should also be reasonable from the standpoint of the problem under study.

11. The level and composition of the system (or "subsystem" or "supersystem") to be studied are selected by the analyst to suit the problem at hand rather than on the basis of an arbitrary, predetermined ranking.

7. SOCIAL SYSTEMS AND ADMINISTRATIVE SYSTEMS

7.1 Social systems defined

Social systems are those based on interactions and interdependent relations among members of a population, either human or animal. The most complex social systems are those developed by human beings. In
addition to people, these systems may include mechanical elements as well, forming man-machine systems.

A community water supply system illustrates how a social system can include both people and things. Customarily, when one thinks of a community water supply system, one considers only its physical elements: the water source, conduits, storage facilities, and treatment and distribution equipment. But the picture changes if one thinks of a community water supply system in general systems terms. From this standpoint the elements mentioned above can be seen to form only the physical subsystem, and it becomes apparent that the system as a whole also includes the interactions among that subsystem and its users, operators, sponsors, and controllers. It is crucially important, when studying the administration of environmental health programmes, to see not only the engineered or physical components but also the social components as part of the system. Indeed, in programmes to combat environmental pollution, social system relationships involving politics, economics, and values and behaviour connected with production and consumption are often more critical to achieving a solution than the engineering component. The same is often true of sanitation programmes.

Human social systems range in size, formality, and complexity from relatively simple primary groups—e.g., the family, other kinship groups, and informal social entities—to highly differentiated systems, such as organizations, governments, communities, and societies. As noted earlier, individual persons and families themselves each belong to a number of social systems.

Social systems are always open systems, being in a state of interdependence with their environments. These environments usually consist of other social systems as well as natural systems. In most analyses at the community level, man-made physical systems (housing, transportation, industrial plants) are best analysed as subsystems of social systems.

7.2 Administrative systems and administrative organizations

Administrative systems are among the most complex and sophisticated of human social systems. Their complexity is due to the high degree of differentiation among the roles played by members and groups within the system (specialization), the degree to which they formalize the relationships and communications among such roles, and the complicated nature of the work that they accomplish. Their sophistication derives from their degree of rationalization (Chapter 1, section 2.3).
Unlike such primary social systems as families and tribes that evolve slowly and intuitively over many generations, administrative systems are created quickly and purposefully. Their missions, goals, structures, and processes are almost always the product of deliberate mental activity and purposeful communication.

It is important to stress from the outset that administrative systems seldom overlap completely with formal administrative organizations, or agencies; it is thus dangerous to assume in any given case that they will be identical. They differ in several respects.

1. Administrative systems are usually “extended open systems” in that, as they function, they transcend the boundaries of the formal organizations (or parts thereof) that form their core. (The concept of the extended open system applies, for example, when we speak of a hospital or a public water supply system or a local pollution control programme.) Thus, the interrelationships of administrative systems may include groups of elements that are not found in the organization chart, among them the clients and recipients of services, sponsors, legislators, community leaders, and suppliers of resources. It is obvious from this that if an analysis of an environmental health programme is limited to what is done by the administrative agency involved (i.e., the formal administrative organization), the analysis is likely to fail to include the full range of system participants and their relationships or to assess the programme’s true strengths and liabilities.

2. Conversely, the administrative system of an environmental health programme may involve less than the whole formal administrative organization if the organization happens to be one that operates a large number of programmes. If the purposes and instrumentalities of the agency’s various programmes differ widely—in other words, if they do not pass the test of interaction or interdependence—it is probably hazardous to assume that the entire formal organization is involved in the particular administrative system being analysed.

In many health agencies, such gaps in communication exist between medically oriented programmes and environmental control programmes. A similar lack of interaction may also exist between one environmental programme and another. Thus, even though there may be a preconceived notion that such programmes should interact, the analyst will usually find it wiser to begin on the assumption that there are no interactions and then investigate whether any do in fact exist.

To express this caution in terms of our earlier discussion of closed and open systems, it is perilous for the analyst to make the assumption
that the administrative system he is studying is one whose boundaries are identical to those of the administrative organization. In analysing the administrative system of almost any environmental health programme, he is likely to find that some elements outside the formal organization are parts of the system, whereas some elements within it do not pass the test of interaction or interdependence and thus cannot be considered to belong to the system.

7.3 Health systems

National or community health systems are invariably extended open systems. Even in societies with highly centralized governmental sectors, an analyst working with any reasonably broad definition of health will find that the boundaries of the health system extend far beyond those of the official ministry of health.

When one thinks at the level of "health system", one is clearly at the supraorganizational or interorganizational level. As discussed in section 2, specialization and the partitionist approach have led in all societies to the fragmentation of health and health-related functions and to their distribution among a number of agencies and governmental levels. Fragmentation is even more marked in pluralistic societies, with a substantial nongovernmental sector in which private entrepreneurs function, than in highly centralized systems.

In the case of societies where the private sector is large, the health system may take the rather loose form of a "market" in which there is little governmental regulation beyond certification to participate. The "coordination" of such a health system results from the way in which each essentially independent subsystem reacts to the actions of other subsystems. In centralized societies, all health subsystems may be under the control of a unitary authority and subject to its policies. Between these two extremes, the health subsystems may be autonomous (i.e., semi-independent) and organized into either "federations" or "confederations". In federations, certain specified functions are distributed to a central regulating unit and others are assigned to autonomous subsystems. In confederations, the subsystems have greater autonomy and the central entity functions more as a secretariat or clearing house than as an authority.

7.4 Homoeostasis in administrative systems

As they develop and age, administrative systems tend to generate better defined and more stable steady states (section 5.4). This means that administrative systems expend energy in adjusting themselves so as to function more or less in the same way as they have been functioning. It will be recalled, however, that a steady state is not a
frozen state: over a relatively long period of time, an administrative system may come to function quite differently from the way it worked at an earlier time, but the changes tend to take place slowly, by incremental adjustments. Over a period of one month, a war-making system (particularly during peace time) will undergo imperceptible changes; over a period of twenty years, a succession of steady state adjustments may make the system visibly different from what it was two decades earlier.

Besides being conditioned by internal development, changes in the steady states of administrative systems depend to varying degrees on interactions with the system's environment. Drastic changes in the policies or economy of the government of which the programme is a part will exert effects on the system. No generalization can be made about whether these impacts will be major or minor, because of variations among communities, circumstances, and bureaucracies.

Thus, the study of administrative systems in "systems" terms must involve an analysis of both external and internal constraints.

7.5 Learning and adaptation in administrative systems

Administrative systems, particularly those successful at surviving, are learning systems, in the sense that they learn from their experience (utilizing the vehicle of "feedback", which will be discussed below). The learning process in such a system is closely linked to its adaptation. Whether the intent of those who manage the system is to maintain the current state of affairs or to bring about gradual change, experiential learning and adjustment are the key processes in determining maintenance or alteration of the system's steady state. Learning usually implies growth, in the sense of qualitative improvement in the system, if not necessarily in its size or quantity. The improved skills, dexterity, or insights acquired by a staff member from his experiences in the course of system operations are one example of growth through learning. Another example is the evaluation of the operations and impacts of a system in order to learn how it should be adapted so as to be more relevant and effective. The key difference between these two examples is that an increase in individual dexterity is likely to occur spontaneously "in the course of events", while the learning derived from evaluation requires deliberate, systematic efforts on the part of those who manage the system.

8. GENERAL COMPONENTS OF ADMINISTRATIVE SYSTEMS

Like other open systems that have production objectives,
administrative systems can be conceived as consisting of the following "general components": inputs, outputs, processor (including control), and feedback loops.

General components must be distinguished from elements. The latter are the parts specific to a particular system; the elements of one system may thus be of different types than the elements of another system. A component is an entity into which certain elements of a system can be grouped and organized. General components are those that are common to all open systems. It is important to keep this distinction in mind: the elements of administrative system A may be mainly manpower while those of administrative system B may be mainly machines, but both systems have the same general components, enumerated in the preceding paragraph.\(^1\)

Before considering how these general components are related to each other in making up a system, let us first define each term and give examples.

1. The *inputs* to a system are defined as those elements that are transformed by the system into outputs.\(^2\) The input may be water or sewage to be moved and treated, householders and food handlers to be educated, or dust to be filtered. A very common form of input in administrative systems is information—information about environmental demands, about technology, about operating criteria, and about the processes and outputs of the operating system. Information about the needs of individual persons and groups is another frequent and important class of input. When, as in the case of health services, the system uses up various materials (reagents, precipitants) in the process of transformation or conversion, such supplies are also a type of input.

2. *Outputs* are the products of the system. They are presumed to embody the purposes and goals for which the system functions (to be elaborated in section 9). Examples of useful direct outputs in environmental health programmes are people educated, safe water supplied, pollution abated, wastes disposed of, and hazards shielded against.\(^3\) The definition of outputs is arbitrarily simplified at this point in the discussion. As will be explained in section 10, the term output refers

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\(^2\) The reader should also be alert to the tendency in casual discussions to speak of "system components" in the sense of subsystems that constitute or compose the system, e.g., the "collection component" (subsystem) of a solid wastes disposal system. For this reason, the term general component is used in this text to refer to those entities common to all systems.

\(^3\) The manpower, equipment, and facilities of an administrative system, i.e., its resources, do not fit this definition since they function as elements of the processor. Although they are not converted into the production type of output, the next section will identify them as input to those subsystems that have to do with the ability of the system to function. (A special exception to the definition is the system whose primary purpose is to duplicate itself, as when the system is a cadre that is to be split to form the nucleus of a number of identical systems.)

\(^9\) Another systems term in use, which is not mentioned in this discussion, is "throughput", most simply defined as "input in the process of becoming output".
not only to the goods or services produced by the system but also to their impacts or outcomes and to the way these impacts contribute to the system’s broad goals. In its general sense, “outputs” is equivalent to the effects and results of the system.

3. The processor is the “mechanism” that transforms input elements into outputs, inducing changes in persons, materials, and information. The processor of an administrative system may be large or small but is usually complex. Depending upon the system, the processor customarily consists of (a) persons and machines, who may be called operators in the sense that they perform operations on the inputs; (b) the pattern of distributed responsibilities and communications channels among the operators; (c) the processes and procedures carried out by these operators; and (d) the facilities in which processing takes place.

4. The control component, viewed in this discussion as an integral part of the processor, functions as the “brain” of the system. The control component defines the goals of the system and the relationships among its elements. Through the mechanisms of the feedback component, it monitors the operations of the system and the effects achieved. In addition, it both monitors and performs many of the cross-boundary transactions between the system and its environment, particularly transactions with “higher” systems. As control is roughly equivalent to system administration, it will be given major attention in this volume.1

5. Feedback may most simply be conceived of as information describing the condition of the operating system, including information on the outputs produced (quantitative and qualitative), their acceptability to the system’s environment, and the adequacy of the processes and procedures used. Formal feedback is data generated by the operation of the system, such as the information that “hazard x has not yet been reduced to a tolerable level”. As explained above, such information can then serve as input to the system. The feedback loops of the system are the channels and directions in which feedback moves. If the control unit of the processor is the system’s brain, then the feedback loops constitute its peripheral nervous system, collecting and channelling information to the “brain” for evaluation.

Fig. 1 depicts schematically the way in which these general components can be conceived as relating to each other in most administrative

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1 When the administrative process is discussed in Part 2, it will be useful to keep in mind the distinction between the control component, which is a conceptual construct in systems theory approximately equivalent to the broad concept of administration, and the control function of management, which is an operational administrative task of more limited scope.
systems. Most of the information shown is straightforward, particularly the flow of inputs through the processor to become outputs. Note that the control component\(^1\) is seen as part of the system processor and that the depiction of feedback loops is simplified to show only the main relationships discussed in the text and omits several implied relationships.

The figure also indicates the relationships of external constraints to the system's general components, emphasizing that they affect mainly the inputs (determining, for example, which clients will be eligible to receive services) and the processor (e.g., authorizing only certain types of worker to carry out specified activities).

This schema has been reduced to its simplest possible form in keeping with the deliberate restriction of this phase of the discussion to the general components of systems and how they are related to each other in such a way as to achieve the system's objectives. Additional details on the system's functions—some of them aimed at producing goods or services, others at maintaining the system itself—have been reserved for the next section. As we shall see, such additional information can be depicted by adding only a modest amount of graphical "language" to express the greater complexity.

9. SYSTEM FUNCTIONS

Administrative systems operate to produce goods and services in order to achieve their respective missions, to justify their reason for being.

\(^1\) In interpreting Fig. 1 and 2 (page 57), the reader should bear in mind that these are process models, not organization charts. The "Control" rectangle symbolizes a function, not a hierarchical position.
This “production function”, while it constitutes the overt mission, is only one of several functions that must be carried out for the system to be viable and effective. The other functions can be classified into two groups. One is the group we call “para-production” (beside or beyond production). The other group consists of the system’s “regulatory” functions, which manage both production and para-production functions (although most of the management literature concerns the regulation of production functions). While these three functions are common to all types of social system, in this discussion we shall emphasize their features in administrative systems. All these functions require planning if the system is to operate efficiently and effectively.

It is important to remember that this is a discussion of functions and not of persons; that is, we are considering what is done in the system rather than the people or positions that might carry out these operations. In small systems, certain persons may be responsible for both production and para-production functions; in large systems, specialization of functions is more likely to occur.

The system functions in the three groups are:

1. Production functions
   (a) Direct or “final” production of goods and services
   (b) Indirect production (usually the production of services contributing to “final” production)

2. Para-production functions
   (a) Procurement
   (b) Continuity
   (c) Adjustment
   (d) Development

3. Regulatory functions
   (a) Managed regulation
   (b) Informal regulation

These functions will now be explained in greater detail.

1. Production functions, which include distribution activities, can be divided into those that lead directly to turning out the goods and services delivered to the population (safe water, controlled pollution, health education of the public, reduced vector populations) and those that essentially support or contribute to such direct production (technical advice, information processing, transportation, laboratory tests, legal services), which we call indirect production functions. Alternative terms would be final production and intermediate production. Direct production usually consists of series or chains of activities, as when water is collected, conducted to treatment plants, treated, and distribu-
ed. Indirect production, as described above, may be applied at various points in the chain of direct production activities.

2. *Para-production functions* are those that enable the system to survive and maintain its capability for carrying out production functions.

   (a) *Procurement functions* are those that serve to bring into the system from its environment the tangible or intangible elements needed for the system to accomplish its mission. In this sense, procurement refers to the obtaining of funds, the formation and maintenance of favourable attitudes among sponsors (or perhaps in the entire community), the recruitment and training of personnel, and the making of arrangements for obtaining goods and services from other systems, such as chemicals, equipment, or building construction. In most instances, procurement functions operate across the system’s boundaries rather than within the system itself. If a system services clients or patients, then recruitment of these persons would be one of the procurement functions.

   (b) *Continuity functions* are those that enable the system to maintain itself in a steady state (section 5.4). These functions are exemplified by keeping records, ensuring that equipment remains in running order, paying debts, maintaining supply inventories, replacing personnel or facilities, and keeping morale sufficiently high so that production functions will be carried out.

   (c) *Adjustment functions* are those that harmonize the operation of the system with the constraints of the environment, particularly if those constraints should change. Any changes in demand, in the population to be served, in financial support, in technology, in the general social situation—e.g., war, revolution, or economic depression—or in the state of the problem to be solved (a massive discharge of pollutants, a rapid increase or decrease in a vector population, a change in the exposure or susceptibility of the target population) call for adjustments in the way the system functions. The personnel involved in sensing needs for these adjustments are usually those who occupy so-called “boundary positions”, such as the director who maintains communication with political authorities or those in direct contact with clients. Many others—supervisors, trainers—may be involved in effecting the adjustments. A major aspect of adjustment is, of course, replanning.

   (d) *Development functions* are those that effect quantitative or, more usually, qualitative changes in the skills of system personnel or otherwise enhance the capability of the system to carry out its other
functions. An improved understanding of the problem to be solved, a
greater capacity to use new technology, and increased skill gained
through experience all represent development of the system.

The four types of para-production function are related to one
another as well as being related to the production functions proper.
Improvement or growth in the capacity of the organization (develop-
ment) is dependent on the quality of personnel recruited (procurement)
and upon the state of staff morale (continuity); it in turn determines
the ability of the system to adapt to changes in the environment
(adjustment). Maintaining the continuity of the system is linked to the
procurement of funds and personnel and to the responsiveness of the
system in adjusting to external constraints.

Now that the distinction between production and para-production
functions has been explained, the concept of inputs and outputs in
administrative systems can be clarified further. The implication of this
distinction is that such systems require two corresponding types of
input and generate two types of output. Production inputs, or operands,
are those defined in the preceding section as the persons, information,
and things (water, air, food) that are to be transformed into production
outputs by the system’s processor, in accordance with its stated
mission. Para-production inputs are the various resources that make
up the system’s processor: staff, facilities, equipment, procedures,
standards, and technology. When, through the operation of the system,
there is a transformation of the states of these resources (as, for
example, when staff become more competent), the system has pro-
duced a para-production output.

3. Regulatory functions are those that serve to determine, organize,
direct, monitor, and correct the production and para-production
functions already described. Regulatory functions are associated with
the control part of the processor component, discussed on page 51.
Since these functions are obviously of particular relevance and interest
to those systems members having administrative responsibilities, they
will be elaborated further here and throughout Part 2 of this volume.

In order to survive and operate effectively, all open administrative
systems need regulation of their functions, both production and para-
production, to enable them to work within the desired limits and
maintain a high degree of harmony or balance among their parts while
achieving their objectives. The necessity for such regulation is recog-
nized by systems theory no less than it is by traditional administrative
theory. Just as the unregulated production of hormones by a living
organism or its uncontrolled exposure to physical stress may result in
damage or death, so the unregulated behaviour of an administrative
system can lead to its weakening and dissolution. Just as the human body may be disabled or killed if its sensory organs fail to communicate about hazards, administrative systems will break down if they receive inadequate feedback from their environments and become unable to adjust appropriately to changed environmental conditions. In administrative systems, the establishment and operation of mechanisms to carry out regulatory functions is pre-eminently (but not exclusively) the responsibility of the system's managers.

As in the human body, but to different degrees, regulation in administrative systems depends upon both subconscious and deliberate behaviours. Two types of regulatory function can thus be specified:

(a) Managed regulatory functions are those formally organized to establish objectives and other norms, to collect and process information on system operations, and to take corrective and adaptive action. Once established and learned, regulatory procedures may become habitual behaviours—and hard to change. Managed regulation ensures that the work is planned, that goals and other norms are set, communication patterns and content specified, and operating procedures established. These functions require flows of feedback on the basis of which the operating system can be evaluated and changed as necessary. Such planned feedback arrangements may be referred to as the management information system.

(b) Informal regulation consists of those behaviours and activities that fall outside the sphere of management but that also serve to adjust the functioning of the system. In this category, group and professional norms, social values, informal communications, and interpersonal relations are important elements. Informal regulation thus refers to those determinants of behaviour in a system that management does not deal with, either intentionally or through neglect.

Managed and informal regulation may overlap in several ways. Informal regulatory mechanisms may use some of the organized feedback provided for management, and managers may use informal feedback information ("the grapevine") in their regulatory activities. To the degree that managers behave in ways inconsistent with the formal arrangements they may be said to be regulating informally, as when formalized norms for the promotion of personnel are ignored or when targets are changed to conform to the preferences of the staff. While managed and informal regulation complement each other, it should not be assumed that they are always harmonious. Certain aspects of informal regulation may not be compatible—and may come into conflict—with managed regulation.

When such incompatibility or conflict appears, it points to a dis-
crepancy between management planning and operating realities. One prime source of such a discrepancy may be the inability of management to immediately reconcile planned change with the system's steady state. Homoeostasis, as pointed out earlier, is an important internal constraint on the system. Inability to effect immediate change may result from management's ignorance of internal constraints or from apathy or lack of concern with them; unwillingness to effect change, however, may stem from a decision that the disadvantages of change would outweigh the advantages or from a recognition that no acceptable alternative to the status quo is available.

The introduction of the main points of this discussion of system functions into the schematic diagram presented in the preceding section (page 52) greatly increases the complexity of the model, as can be seen from Fig. 2. The main source of increased complexity is the larger number of feedback loops that must be specified in order to describe, even in general terms, the interactions involved.

Fig. 2. System functions in relation to general components

10. CLASSIFICATION OF SYSTEM OUTPUTS

For a variety of administrative purposes, notably planning and evaluation, it is useful to think of system outputs in terms of three levels or stages: direct outputs, intermediate effects (or impacts), and
ultimate effects (or benefits). The differences between them can be explained as follows, using production functions as an example:

(a) **Direct outputs** are those goods and services that are produced by the system, irrespective of how they affect or are used by the target population. For example, the provision of a safe water supply to the consumer, the containment of airborne particles, and the correction of violations of sanitary standards in a restaurant are all direct outputs produced by environmental health programme systems.

(b) **Intermediate effects, or impacts**, are the changes made in the problem being solved or in the persons served by the direct outputs. To use the examples given in the preceding paragraph, the reduction of disease achieved through the provision of safe water and its use for domestic and hygienic purposes constitutes the impact of the safe water supply upon the population served by the system; reduced air pollution has favourable impacts on the health states of men, animals, and plants, as well as slowing the deterioration of exposed surfaces and substances; improved restaurant sanitation has as its impact increased protection against and reduction of foodborne diseases. Some impacts may, however, be negative side effects.

(c) **Ultimate effects, or benefits**, are defined as personal or social advantages—or disadvantages (disbenefits)—deriving from the system’s impacts. Avoidance of disability has the benefit or ultimate effect of maintaining man’s capacity to function economically and socially. Social benefits may be limited (e.g., increased tourism) or far-reaching (such as a higher level of economic development). The ultimate effects of disease reduction are felt at the demographic and economic levels and in the capacity of people to enjoy life. In general, the ultimate effects or benefits of environmental health programme systems can be thought of in terms of longer survival, maintenance of people’s social and economic functioning, enhancement of their opportunities for enjoyment and self-fulfilment, and better realization of community values and goals.

The same three-level classification is conceptually applicable to the para-production outputs. Usually, however, such outputs turn inward to modify the system, becoming a type of feedback whose impact is an improved capacity of the system to accomplish its goals. They may also have some favourable impacts on the larger societal or community environment, for example, by strengthening its institutional base (infrastructure) or by “developing” certain system employees so that they

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1 There are other ways, of course, of classifying results. A common classification is by time: immediate, medium-term, and long-term.
become economically and emotionally more self-sufficient and able to contribute more richly to the functioning of the community.

That effects may be positive or negative reminds us that systems may generate unintended or side effects in the course of their operations. Because these external effects tend to vary so greatly from one system to the next, their discussion is deferred to the following chapter where environmental health systems are examined in greater detail.

11. SUMMARY OF ADMINISTRATIVE SYSTEM CONCEPTS

1. Administrative systems are complex and sophisticated social systems distinguished by role differentiation, formalization, and deliberate structuring.

2. In that they transcend the boundaries of their formal core organizations, administrative systems are “extended open systems” involving key elements in other organizations and in the community.

3. Administrative systems need not have central hierarchical management but may be coordinated through various other patterns.

4. Administrative systems tend to develop steady states, often requiring changes to be brought about in small increments rather than by drastic measures.

5. As behaviour in administrative systems is modified on the basis of experience (perceived through feedback), such systems may be considered to be learning systems.

6. The general components of administrative systems are inputs, outputs, processor (including control), and feedback.

7. System functions may be conceptualized in three groups: production, para-production, and regulatory, the second group including procurement, continuity, adjustment, and development functions.

8. System outputs may usefully be classified into direct outputs, impacts (or intermediate effects), and ultimate effects (or benefits), in order of increasing involvement with the system’s environment.

12. SYSTEMS THEORY AND ADMINISTRATIVE THEORY

Having reviewed the basic concepts of systems theory as they relate both to systems in general and to administrative systems, we may pick up the question left at the close of Chapter 1: What are the implications and uses of that theory for the administration of social intervention programmes?
Obviously, there are differences between traditional and systems vocabulary. Systems theory introduces us to words (and concepts) like input and output, constraints and controls, processors and feedback, homeostasis and environment, interdependence and boundaries.

Beyond the words themselves, however, systems theory presents in a number of ways a different view of administration and organization, how work is divided and coordinated. The following statements summarize the ways in which the systems view differs from more traditional views.

1. An analysis of programmes and their organization should start from an examination of how processes are carried out rather than from a priori ideas about status, role, and departmentalization.

2. The full range of participants in a programme should be identified and their relationships assessed without limiting the analysis to the boundaries of the formal organization. This often means an expansion of the scope of analysis. Further, the criterion of whether elements are parts of the system is whether they interact, not whether they have a legal status or an asserted role in the programme.

3. Various alternatives to the hierarchical organization and management of social intervention programmes already exist in practice. The concept of non-hierarchical organization not only implies viewing programmes as extended open systems but also suggests the possibility of interorganizational systems. The latter are especially important in the field of environmental health because of the number of organizations involved in solving these problems and the wide distribution of environmental health responsibilities among different governmental and other community agencies.

4. When working on problems, organizations are not closed systems without dependence on their environment. External constraints and the interactions between organizations and their environment set limits to the scope of their activities, present them with expectations, provide purposes, and suggest goals. It is therefore essential for programme planners and managers to analyse not only factors internal to the formal organization but also factors in its environment, so as to understand the systems of which it is a part.

5. The steady states of systems, of their organizational as well as their non-organizational elements, impose limitations on the degree and pace of change that can be tolerated. On the other hand, analysts armed with an understanding of the steady state of a particular system will be able to identify the stable factors that can serve as a base from which to move forward with modifications.
6. Systems, including the elements within formal organizations, have needs and functions in addition to those related to the achievement of programme goals. These are strong needs and important functions that neither the analyst nor the administrator can afford to ignore, for they determine to a considerable degree the effectiveness of the administrative system and its potential for survival.

7. Planning and management need to be based on a view that looks beyond the production of direct outputs to the impacts of the system (intermediate effects) and their social benefits (ultimate effects), as well as the full range of operating factors in the system.

8. For administrators dealing with major social problems that involve multiple causes and require multi-pronged programme actions for solution, systems analysis provides a more flexible methodology for manipulating administrative and health problem information than the alternative approach that would handle it on the basis of formal organization units.

Systems theory does not reject the basic goals of classical administrative theory—order, rationality, and coordination—but rather provides a number of supplements and substitutes. It is not incompatible, for example, with recognizing formal organizations as core elements of programme systems but stresses that the actual interactions in such organizations be analysed and demonstrated rather than merely assumed to exist.

Like the gradual incorporation of ideas from human relations and behavioural research into administrative theory and practice over the years, it may be expected that there will be not a revolution but an encroachment and absorption of systems concepts into the thinking and practice of administrators. Indeed, many practitioners may have experienced moments of recognition on reading the preceding pages and may remember having thought and acted along much the same lines. The hope held out by the development and use of administrative systems theory is the progressive substitution of rule and disciplined method for instinct and guesswork.

What is needed is a closer parallel between good practice in sanitary engineering and good practice in programme administration. No competent water supply engineer would neglect the hydrological factors in the locale in which he is designing a community water system; he would consider sources of water, flows, pressures, distances, and factors relating to the disposal of used or surplus water. Contemporary systems analysis can already help him to do this work more accurately and more comprehensively. Analogously, environmental
health programme administrators can look to systems analysis to help them deal with combinations of physical and social factors involved in programme planning, execution, and evaluation. To be sure, social elements—in particular, individual and group behaviour—are less well understood and less quantifiable than are elements of the physical environment. Similarly, systems analysis methods for dealing with social systems are more primitive than the methods available for analysing physical systems. But even without precise measurements, a systems approach can identify the existence of relationships and indicate the direction in which they tend. This can help to avoid many errors and harness energies for the achievement of programme objectives.

The specification of current applications of the systems approach in planning and management is the task attempted in Part 2 of this book. To lay additional groundwork for that effort, the following chapter applies the systems approach to an analysis of the nature and possibilities of the field of environmental health itself.
Chapter 3

A SYSTEMS VIEW OF ENVIRONMENTAL HEALTH

1. APPLICABILITY OF THE SYSTEMS APPROACH

As a professional field and as a form of social action, environmental health is in a state of change throughout most of the world. Traditional approaches are being challenged and new approaches sought in response to a number of converging developments:

— There is major concern in the developed countries over the ecological effects of production and consumption processes.

— The developing countries are feeling the untoward effects of some aspects of these same processes and of environmental deterioration from rapid urbanization, resource abuse, and inadequate environmental control services.

— In the less developed countries, there is increasing appreciation of the linkages between improved health and socioeconomic development, and a consequent renewed emphasis on extending basic sanitation as a contribution to developing and improving the quality of life.

— There are increased expectations that disease and disability prevention through environmental control can help to reduce the rapidly mounting costs of medical care.

— New but incomplete insights are being gained into the relationships between social and physical environmental factors and human ailments, and there is a growing awareness of the broad array of problems involved and of the multiplicity of disciplines that can contribute to their solution.

— It is becoming recognized that better scientific knowledge of cause-effect relationships and firmer measurement criteria are needed to solve the problems stemming from pollution of the environment.
— At the same time, it is recognized that the knowledge already available needs to be codified in order to improve the provision of organized environmental health services.

— Challenges are being made, in some countries and among international agencies, to the leadership of health services in the field of the environment; these challenges are taking the form of the assignment of environmental control responsibilities to agencies that are primarily oriented to economic development and resource conservation rather than to health.

1.1 Need for comprehensive approaches

Such social and political trends, quite aside from any academic or scientific rationales, provide sufficient justification for a comprehensive approach to the conceptualization and planning of environmental health interventions that differs from traditional segmented approaches. Not only does the field called environmental health embrace far more than its historical predecessor, sanitation, but it also operates in a context charged with political and economic conflict. In any such context there is always a danger that the goals of health may receive secondary or minor attention. Under present circumstances, several tendencies may be increasing the danger.

First, among professionals and politicians alike there is a tendency to neglect or overlook the interactions among environmental forces and hence among programmes designed for their control. Often, the field of environmental health is defined as a list of separate topics: water supply, water pollution, air pollution, occupational safety, radiological health, food and milk hygiene, restaurant sanitation, housing sanitation, and so forth, with 20 or more distinct categories. In some countries, this view of environmental health has led to the organization of categorical programmes in virtual independence of one other and their administrative assignment to different agencies. Under such conditions a coherent attack upon the community’s environmental health problems becomes both difficult and improbable. Environmental health agencies may be entirely separate from agencies providing personal health services even though the latter have certain resources necessary for environmental health programmes, such as experts in epidemiology and health education.

Further, many environmental health programmes lack the resources to work with the behavioural factors that often determine programme impact and effectiveness. Sometimes, such factors are entirely neglected. This stems from the tendency of environmental health professionals in both their education and their everyday practice to
concentrate on the scientific and technological aspects of the field—most frequently the engineering technology—with the result that little or no attention is given to political, social, and economic factors or to the theory and practice of administration. Yet expertise in these areas may be critical to success.

To identify these tendencies is not to condemn technical competence or the concept of programme organization. It is precisely because organized efforts on behalf of environmental health must be set up in programmes of manageable scope and size that arrangements are required for communication and coordination among the separate parts.

Therefore, there are two sets of forces that make an imperative case for the application of the systems approach to environmental health. First, the changes in the sociopolitical context of these programmes (pages 63-64) demand attention. Problems seen in isolation from one another, and organizations operating without needed coordination, have to be better related to each other. Second, in order to foster these interrelationships, the perceptions, education, and practices of environmental health professionals have to be fortified with a more comprehensive view of health problems.

While this volume is concerned with administration, it should be emphasized that systems concepts are useful in dealing not only with the planning and management of environmental health programmes but with their substance and purposes as well. Moreover, effective administration is not an end in itself, and it is useful for there to be some compatibility between ways of thinking about problems and technology in environmental health and ways of planning and executing solutions to those problems. In this chapter, therefore, we will consider environmental health problems and interventions from the systems viewpoint.

1.2 Available systems-oriented models and theories relevant to environmental health

The application of the systems approach to various aspects of the social and physical environment has already led to the formulation of several theories and models that are relevant to environmental health. The most prominent of these is the ecological view of the environment, with its important concept of the multiple interactions of human, animal, and plant populations within the biosphere. The systems view of the balance of nature holds that it is an equilibrium among the elements of a natural system that is supportive of desired relationships between man and his environment. The "energy model" of earth, in which all phenomena are expressed in units of energy
use and flow, is a related systems concept that seeks to explain the relationships among people, economies, and nature.\(^1\)

A systems approach of more restricted scope and greater specificity is the mathematical modelling of natural systems. This approach has been perhaps most successful so far in the modelling of river systems, in which the characteristics of entire drainage basins—including significant relationships among natural and man-made elements (such as industries, agricultural enterprises, and communities)—are expressed in mathematical terms. Reduced to a form that enables manipulation with the digital computer, such analytical models permit the simulation of the consequences of introducing various alternative combinations of changes into the system, such as the erection of dams, diversion of flows for agricultural and industrial water uses, increased urbanization, and pollution abatement. Among other uses, such simulations enable one to predict, in crude terms at least, the effects of alternative interventions on public water supplies and other human uses of surfaces waters, as well as any productive yields to the human economy. This approach will become increasingly feasible for analysing other natural systems, such as air regions, terrestrial regions, and oceans, as models of those systems are progressively refined.\(^2\)

Still another line of systems research is that being done on urban areas (i.e., cities and their surrounding suburbs) viewed as systems for purposes of concurrent planning of land use, transportation, industrial and residential development, recreation, sanitation, and other public services.\(^3\)

Borrowing from these sources and others, this chapter will present systems formulations deemed to be especially useful to planners and administrators of environmental health programmes. In these formulations the view is taken that man, both as an individual and as a community member, is the focal point for consideration in such programmes, since environmental health is most directly concerned with the wellbeing of humans living in communities.

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2. ENVIRONMENTAL HEALTH RELATIONSHIPS AND PROBLEMS

2.1 The general system

Environmental health programmes are undertaken to prevent or limit disease and disability and to promote conditions for good health. In contemporary terms, disease, disability, and health, as related to environmental factors, are concerned with complex physical, mental, and social states. A systems model of environmental health must, however, be developed by beginning with a high degree of generality and a broad content and by adding progressively finer detail. To start, Fig. 1 sets forth in gross terms certain general relationships, consistent with epidemiological concepts, among the main subsystems.

![Diagram of general relationships in environmental health]

On the basis of Fig. 1 we can make a number of general assertions about the environmental health system.

1. Man (or mankind) functions in a natural and social environment that contains agents affecting his health.

2. Impressed as agents are all types of environmental factor (biological, chemical, physical, or social) that induce stress. The majority of such stress-inducers (stresses) are potentially both beneficial and harmful to man; that is, health problems may result from either too much or too little exposure or involvement with the factor, e.g., food, exercise, noise, and social contact. However, a few stressors, such as snake venom and poisonous gases, are always harmful or at least never beneficial.

3. These stressors may reach man through various pathways and interactions; that is, he may be exposed to them directly or affected indirectly through many media (e.g., insects, water, food, air, job, automobile, television).

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1. For the main lines of thought and some of the detail in sections 2-4, the author is indebted to an internal study group that met in 1971 in the Division of Environmental Health, World Health Organization, Geneva, Switzerland.
4. The effect of exposure on a given human being depends on an intervening variable, "host factors," representing his relative resistance, susceptibility, or adaptability to environmental agents. Thus, there are biological and sociocultural differences among human beings that cause them to experience different effects upon exposure to the same stressor.

5. The state of the host factors may depend on the host's previous or current interactions with the environment (represented by the rising arrow in Fig. 1) as well as on his congenital traits. Thus, an experienced, trained worker can avoid hazards on the job better than a casual employee; a person remaining well in an environment rife with tubercle bacilli has probably developed an immunity to tuberculosis not possessed by a person living in an environment in which that agent is rare; the witnessing of a prolonged sanitation strike in a city with a normally efficient wastes disposal system may cause a sense of depression unimaginable among people who live in settings where accumulated garbage is a "natural" feature of life and who have developed a type of psychological immunity to it.

If it is to be more specific, a systems model of environmental health must identify agents and factors in the physical and social environments, respectively, and indicate their relationships. This is done in broad outline on the left side of Fig. 2. The right side of the figure depicts the "effects" subsystem in more specific terms than in Fig. 1. (At this point, the reader may also wish to look ahead to Fig. 6, page 77, which presents the same diagram in far greater detail.)

Fig. 2. Major conceptual subsystems of an environmental health system

The additional information provided by this diagram—directly or by implication—can be summarized as follows, continuing the list of narrative statements started above:

68
6. Man's health not only is affected by the environment but, especially at the group level, itself exerts effects on the environment.

7. The physical environment (1) can be classified into physical, chemical, and biological sets of elements.1

8. Societal factors (2) can be classified into social (including political), economic, and cultural elements.

9. Factors of the physical and social environments interact (Link (1)-(2)) to produce environmental health problems and benefits. For example, the availability of water has to be accompanied by favourable attitudes toward its use in order to result in personal and domestic cleanliness; adequate nutrition and housing depend on both the productive capabilities and the folkways of individuals and communities.

10. Social and physical environmental factors produce significant ecological, economic, and aesthetic effects (3) in addition to direct effects on human health (4C).

11. Such "other" effects interact with and reinforce exposures and effects on human health (Link (3)-(4A,B,C)) in both directions. Living in slums affects man's health adversely; sick people cannot clean up slums but healthy people may be able to do so.

12. The concept of total effects (5), from the vantage point of environmental health, represents the combination of effects on human health and "other" effects (Link (3),(4)-(5)).

13. Environmental factors and their interactions (as noted in statement 2, page 67) may have either health-promoting effects or health-threatening effects. Further, a particular factor may be both beneficial and harmful in varying proportions to the same or different segments of the population at the same or different times. Pesticides serve to increase food supply but may also be toxic to man and other life. Flush toilets reduce disease hazards in community A but, if they channel raw sewage into watercourses, increase disease hazards in community B downstream. Air carrying oxygen is essential to life yet air can be the pathway by which toxic substances and pathogenic microorganisms reach man. Housing is necessary to protect man from inclement weather yet poor housing is conjectured to increase his exposure and susceptibility to disease. The culture of his community supports him and may strengthen his emotional life but his "way of life" may contain features and elements that are damaging to his health.

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1 The italicized numbers between brackets refer to the correspondingly numbered subsystems in Fig. 2, later to be broken down into their respective elements (Fig. 3, 4, 5, and 6).
This is true in developed countries (e.g., where the “way of life” often involves increased exposure to deleterious factors such as over-powered automobiles) as well as in developing countries (e.g., where a culturally implanted belief that the only suitable food for man is corn may lead to malnutrition).

14. The total effects of these various systemic relationships exert a force (a feedback not necessarily limited to information) upon the environmental factors themselves (Link (5)-(1),(2)), as when overintensive use of land, housing, and urban space results in social and physiological stresses, or when a socially based reaction against environmental deterioration leads to government regulation of practices that degrade the environment. It is well to make clear that in Fig. 2 we have an imprecise, simplified construct of feedback. In reality, such feedbacks are occurring all the time throughout the system, and there is no single mobilization of energy at the “total effects” point to deliver substantial jolts of feedback to the physical and social environment.

2.2 Physical, chemical, and biological factors

These generalized concepts will now be examined more closely in the succeeding figures, beginning with the factors of the physical environment that may affect man’s health. Fig. 3 shows the elements involved in this subsystem and includes other subsystems only to indicate their general relationships with it. In interpreting this and the following figures, one should bear in mind that the broken lines surrounding certain elements (such as (1A1), (1A2), (1A3), and (1A4)) are meant to indicate interactions among those elements, even though arrows are lacking.

The growing list of narrative statements developed from the last two figures can now be advanced as follows:

15. Humans may be exposed to stresses directly at their sources (1A,1E), or the stress may reach them through various media (1B) along pathways that can be long, complicated, and relatively indirect. (The diagram simplifies such complications.)

16. Sources are distinguished from media and pathways for two reasons. (a) Some stresses manifest themselves differently and present different degrees of community benefit or hazard depending on the medium in which they are found (e.g., radioactivity in air and in oysters; heat in the form of thermal pollution of a river from a factory versus heat from a fire in a burning building in which one is trapped). (b) Identifying the chains through which stresses affect
Fig. 3. Details of physical, chemical, and biological factors in the environment

(A full diagram of the environmental health system — of which this figure shows only one subsystem in detail — will be found in Fig. 6, page 77.)

* See footnote 1, page 72.
man implies that there is a choice as to the links where the chain can best be cut by individual or organized intervention; this point will be discussed further in section 3.

17. The biological element-set includes "other humans", in the sense that man can be a reservoir, carrier, and source of biological agents (e.g., pathogenic microorganisms) as well as a "carrier" of potentially hazardous chemical (narcotics peddling) and physical (automobile driving) environmental agents.\(^1\) (See statement 9, page 69, for other relationships.) A special set of such stresses—diseases, defects, and other pathophysiological states—is transmitted, genetically or otherwise, from humans to their offspring (Link (1A4)-(4)). In a sense, this is a heritage from the offspring's "past" environment and serves as a reminder that all of the environment has a history. It should be noted, also, that the effects of transmission from parents to children are determined in part by what the former have experienced from their own environment (e.g., nutritional deficiencies, ingestion of mutagenic drugs, lack of protection against diseases during pregnancy).

18. Food, including potable water and milk, represents a key pathway through which environmental factors—positive and negative—reach man. This is because the ingestion of food is a systems necessity, i.e., the human system needs to take in certain inputs from the environment if it is to survive.

2.3 Social, economic, and cultural factors

In considering the social environment as it bears on human health, one finds that the concepts involved are both less clear and less sharply delimited than those describing the physical environment. The factors and relationships shown in Fig. 4 hence are not as accurately defined or as complete as those shown in Fig. 3. This probably reflects the stage of development of the social sciences as compared with the natural sciences. The natural sciences are comparatively well mapped, even though current concern over environmental pollution has uncovered many gaps in our knowledge. The social sciences, however, are still in the early stages of exploration, with the explorers being familiar mainly with local landmarks and unsure of the shape

\(^1\) As a result, it is necessary to conceptualize "target populations"—those that receive exposure and effects—when distinguishing in environmental health programmes between (a) humans who have a need for or are to benefit from the programme and (b) humans who act as agents or carriers of environmental hazards. This distinction is not difficult to make when we identify polluters and those exposed to pollution, or farmers using chemicals and consumers ingesting chemically treated food. Making a distinction is more difficult in a programme field like traffic accidents or communicable disease, where the same persons may be in different elements of the same equation at different times.
Fig. 4. Details of social, economic, and cultural factors in the environment
(A full diagram of the environmental health system — of which this figure shows only one subsystem in detail — will be found in Fig. 6, page 77.)

PHYSICAL, CHEMICAL, AND BIOLOGICAL FACTORS

SOCIAL, ECONOMIC, AND CULTURAL FACTORS

General Factors (2A)
- Size, Composition, and Distribution of Population (2A1)
- Level and Distribution of Income (2A2)
- Education and Information (2A3)
- Customs and Behaviour (2A4)
- Social Organization (2A5)

Derived Factors (2B)
- Occupation (2B1)
- Health Care (2B2)
- Nutrition (2B3)
- Housing, Goods, Amenities (2B4)
- Mobility, Migration (2B5)
- Leisure, Recreation (2B6)

Social Adaptation (2C)
- Psychological Stress (2D)

ECOLOGICAL, ECONOMIC, AND AESTHETIC EFFECTS (3)

INDIVIDUAL HUMAN SYSTEM (EFFECTS) (4)
of the world; even the exploratory effort itself is lacking in coordination. While legitimate issue may be taken with the details shown in Fig. 4, it appears justifiable to posit certain general ideas about the social environment subsystem. These may be formulated as follows:

19. The social environment may be conceptualized as being composed of general factors (2A) such as demography, economics, education, social organization, and culture, on which depend derived factors (2B) such as the occupational and nutritional stresses to which the people of the community will be subject and the types of medical care and recreation that will be available to them.

20. Factors in the social environment lead to direct exposure of people to psychological and other stresses (Link 2D)-(4)) and to potentially health-promoting forces (Link 2B3)-(4)), as well as to the modulation of such exposures through processes of social adaptation (Link 2C)-(4)), such as police protection, welfare programmes, attitude changes, risk-sharing policies, norm formation, and group ideologies, which serve as communal shields and filters against certain stresses. Also, as communities and their technology develop, more and more stresses from the physical environment are channelled through the social environment; consider, for example, the differences in how farm children and city children receive their milk supply.

21. Social stresses (like forces in the physical environment — see statement 13, pages 69-70) may either enhance or endanger health, depending on the state of the elements, for example, good or poor nutrition (2B3). As a result, the set of social stresses affecting an individual or community at a given time will be a combination of positive and negative forces upon health.¹

22. Forces in the social environment bear indirectly on health by producing effects on the ecology, economy, and aesthetic milieu (Link 2)-(3)). Such forces act either on the immediate environment (for example, by inducing changes in housing policies) or on the more distant environment (e.g., by controlling water pollution), all of which may result in various effects on health.

2.4 Effects on human health

Turning now from the consideration of interacting environmental forces to the reactions of the individual human being, let us use Fig. 5 as a model of this important subsystem. In the interests of

¹ Variations in individual tolerance and resistance to environmental stress are discussed below, in statement 25.
Fig. 5. Details of human reactions to environmental forces
(A full diagram of the environmental health system — of which this figure shows only one subsystem in detail —
will be found in Fig. 6, page 77.)
clarity, previously discussed details of sources, agents, and pathways to man have been consolidated and symbolized in the linkages between the physical and social environment subsystems and the major component of the diagram, the "individual human system" (4). In addition, this component is itself shown in simplified form, a simplification justified by the prior inclusion in Fig. 4 of the element-set "social organization" (2A5) implying the influences of such factors as family and peer groups upon the individual's reactions to environmental forces. Also noted in Fig. 5 are the relationships between human health effects and the "total effect on man and his welfare."

The list of statements on the environmental health system may be continued as follows:

23. The state of the individual is affected not only by such host factors (4B) as natural or induced immunity, nutritional status, and education, but also by his continuing exposures to the environment (Link (1),(2)-(4A)). His psychological and somatic reactions (4C) may be stimulated and strengthened, or dulled and atrophied, by combinations of these factors and experiences.

24. Exposure to environmental forces may trigger reactions (Link (4A)-(4C)) in the form of evasive or protective behaviour (withdrawing from a source of heat, moving away from noise, wearing safety goggles) that serves to avoid, reduce, or terminate exposure (Link (4C)-(4A)).

25. The effects of exposure depend on the relationship between the exposure and the individual's tolerance and adaptability (4D). The latter represents the combination of the state of his host factors (4B) and his reactive capacity (4C).

26. Effects may produce feedbacks in the individual by modifying somatic and psychological host factors (Link (4E1,2)-(4B)), with or without any clinical signs or symptoms being apparent.

27. The results of exposure may not be limited to psychological and somatic effects on the individual exposed but may extend to genetic and other effects ((4E3), placed at the boundary of the "individual human system") felt only by "future generations".

28. Effects upon individuals contribute to the "total effect on man and his welfare" (5), changing the state of that element-set and stimulating feedbacks to other parts of the environmental health system.

A composite of the preceding figures, summarizing this system's discussion of environmental health, appears as Fig. 6.

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1 How these reactions may be fortified by environmental health interventions is discussed in section 3.
3. ENVIRONMENTAL HEALTH INTERVENTIONS

How can the preceding description of environmental health in systems terms assist one in thinking about intervention programmes
to protect and promote human health? Clearly, this systems view has certain broad implications:

— Since environmental health problems often arise from intricate and complex interactions between man (as an individual and a member of society) and stressors in his environment, including other humans, effective interventions to deal with these problems require detailed knowledge of the interactions and pathways involved, as well as knowledge of the various control technologies. This suggests that it is essential to draw on a wide variety of sciences and disciplines when designing and carrying out environmental health programmes.

— The choice and design of environmental health programmes must take into account the fact that interplays between physical and social factors may be decisive in determining the success or failure of such interventions.

— Inasmuch as interventions can deal with the environmental stresses themselves, with individual and social behaviour in response to these stresses, or with both, a rational choice needs to be made among the alternative intervention points so as to solve or control problems most effectively and efficiently.

More concretely, the preceding systems formulation of environmental health relationships can be used as a basis for cataloguing the alternative possibilities for intervention open to communities. By taking up in turn the various subsystems and element-sets of the environmental health system as summarized in Fig. 6, one can systematically explore the interventions and intervention points potentially available for the control of environmental health problems. This is done in the following "catalogue" of interventions.

To be comprehensive, the catalogue includes many logical alternatives that may not be feasible in practice. It does not, however, include certain possibilities having to do with war and genocide; although logical, these alternatives have been excluded on the basis of the value judgement that such interventions are by their very nature incompatible with the goals of health. It should also be kept in mind that the objective of this catalogue is not to describe specific intervention programmes but to illustrate the many ways in which a community can conceivably control man-environment relationships in the interests of health, however defined. These include (a) interventions to induce behavioural changes in community members, (b) interventions in the form of control and preventive services, and (c) interventions to alter or eliminate environmental factors. Thus, the
listing goes far beyond what is generally done by environmental health workers.

The catalogue is illustrated schematically in summary form in Fig. 7, which shows that one can intervene by controlling hazards at their source, by blocking or modifying pathways, by interposing barriers to exposure, by modifying human behaviours and tolerances, and by treating adverse health effects.

Fig. 7. General schema of environmental health interventions

1. Interventions in the physical environment

1A. Control chemicals, biological agents, teratogenic and mutagenic factors, and physical hazards at their sources.

1A1. Affect natural processes and conditions: e.g., dam streams and otherwise change watercourses; reclaim wasteland; clear forests; reforest; reduce, replenish, and transplant animal species.

1A2. Regulate production, consumption, and transportation.
   - Regulate production processes so as to reduce (a) hazards to workers, (b) waste discharges of a polluting character, (c) misproduction of goods, (d) output of nondegradable products and containers, (e) use of polluting, radioactive, and toxic chemicals in industry and agriculture, (f) planned

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*The italicised numbers and letters refer to the correspondingly numbered subsystems and element-sets in Fig 8.*
obsolescence, (g) energy use, and (h) aesthetic insults; and regulate these processes so as to increase production of goods and services considered socially desirable (see 2. Interventions in the social environment, page 81).

- Regulate consumption processes so as to control (a) demand for goods and services inconsistent with policies described in the preceding paragraph, (b) utilization of energy from fossil and nuclear sources, (c) planned obsolescence, and (d) accessibility of dangerous products.

- Regulate transportation processes so as to reduce (a) energy demands, (b) hazardous features and uses of vehicles and routes, (c) emission of pollutants, and (d) noise.

1A3. Control animal populations in contact with man so as to (a) reduce populations of harmful species, (b) reduce diseases transmissible from animals to man, and (c) increase populations of useful species and create and maintain barriers against their infection.

1A4. Control human sources of infection, genetic defects, and physical hazards by (a) isolating, quarantining, or imprisoning persons who pose a threat to others, (b) influencing reproductive behaviour, (c) restricting certain "potentially dangerous functions (such as driving automobiles), (d) providing health education and counselling, and (e) curing and restoring deviants and disease carriers to a non-hazardous state.

1B. Maintain or restore environmental media (air, water, and land) to a health-promotive state by (a) limiting the discharge and introduction of hazardous agents into such media, (b) removing, destroying, and neutralizing any hazardous agents present, (c) fostering better distribution and utilization of water and land, and (d) recycling wastes.

1C. Control hazards transmitted through terrestrial and aquatic life, beyond preventing or limiting contamination at the source, by (a) destroying contaminated animals and plants and (b) finding and developing alternative sources of needed animals and plants.

1D. Control diseases transmitted through insect vectors by (a) reducing harmful insect populations (e.g., by introducing sterile males) and (b) interposing barriers between insect and man.

1E. Counteract weather and climatic factors by (a) taking emergency relief and sanitary control measures in case of disrup-
tions and disasters, (b) locating and constructing human settlements so as to avoid or withstand stresses, (c) protecting goods and facilities from spoilage, contamination, or destruction, and (d) using available technology to induce favourable meteorological changes.

IF. Protect against infection, infestation, and poisoning through food by preventing contamination in (a) production, (b) processing, (c) transportation, (d) storage, (e) distribution, (f) preparation, and (g) serving, by means of methods of education, surveillance, and law enforcement (e.g., destruction of contaminated food, official approval of equipment designs, sanctions against violators of standards).

2. Interventions in the social environment

2A. Modify "general" social factors.

2A1. Influence population factors by using incentives, sanctions, and services to (a) delay, encourage, or discourage births, (b) encourage or restrict relocation, (c) regulate entry into and separation from the labour force, and (d) accelerate or slow population movements.

2A2. Modify income factors by (a) increasing gross national income through economic development policies and programmes, (b) instituting policies for income redistribution so as to achieve socially valued income patterns (e.g., egalitarianism, or assurance of acceptable minimum income, or acceleration of capital accumulation), and (c) influencing family size.

2A3. Modify educational and information factors by (a) controlling the provision of educational resources, (b) regulating access to and availability of those resources, (c) stimulating or limiting the development and availability of information resources (books, films, libraries, mass media), and (d) expanding the use of mass communications media for educational and informational purposes.

2A4. Modify customs and behaviour through such means as (a) indoctrination, education, and training, (b) changes in laws and economic activity patterns, and (c) influencing family life patterns.

2A5. Modify social organization by changing (a) decision-making patterns, (b) access to positions of power, (c) income distribu-
tion, (d) domestic and community roles, (e) residential factors, (f) eligibility criteria for governmental benefits, and (g) availability of education.

2B. Modify “derived” social factors.

2B1. Regulate occupations in the interests of health by (a) fostering safety engineering and industrial hygiene, (b) using place of work to deliver preventive medical care and first aid services, and (c) encouraging occupations that lead to improved income, education, information, and nutrition.

2B2. Manipulate the availability, accessibility, and quality of health care by (a) improving resources and organization and (b) developing strategies for allocating these resources productively among activities of health promotion, disease prevention, early detection and diagnosis, therapy, and rehabilitation at the individual, family, and community levels.

2B3. Alter the nutritional status of the population through manipulation of (a) food supply, processing, and storage, (b) merchandising, (c) fashions, (d) education and information, (e) distribution, and (f) pricing policies.

2B4. Control housing, goods, and other amenities to promote and maintain health.
- Modify conditions of shelter through housing policies that regulate (a) land use, (b) occupancy standards, (c) housing supply, (d) quality criteria (including sanitary aspects), (e) pricing, and (f) maintenance, renewal, and rehabilitation.
- Control the availability, accessibility, and utilization of goods and other amenities through the regulation of production and consumption (see 1A2, above, which is complementary) in consonance with policy goals connected with the quality of life, economic development, pollution control, etc.

2B5. Control the mobility and migration of people by means of economic incentives, legal sanctions, and manipulation of transportation factors.

2B6. Control leisure and recreation through the manipulation of (a) social, economic, and occupational values and standards, (b) accessibility and availability of entertainment, cultural, and other recreational services and facilities, and (c) scheduling of vacation time and other holidays.

2C. Modify social adaptation processes by controlling how quickly or slowly change takes place and through the direct manipulation of information and opinion.
3. **Evaluation of ecological, economic, and aesthetic effects of existing and proposed policies**

The objective of such evaluation is to generate feedback information concerning changes in the community system needed for the promotion of health.

4. **Interventions in the individual human system**

4A. [Exposure is assumed to be the effect of policies—or the lack thereof—that modulate forces from the physical and social environment. Thus, exposure resulting in undesirable stress represents a deficiency in environmental protection.]

4B. Modify *host factors* on an individual basis through such processes as health education, immunization, and development of health-promoting attitudes and habits (in addition to the internalized modifications resulting from the various policies of environmental control already mentioned).

4C. Modify the individual *capacity to react* to existing and anticipated exposures through information, education, and advice.

4D. [Tolerance or biological adaptation, being the result of 4B and 4C, is affected by actions taken in regard to those factors.]

4E. Correct, whenever possible, failures of environmental control appearing as mental, physical, and genetic diseases and disabilities through programmes of case-finding, treatment, rehabilitation, and after-care.

4. **TIME AND DISTANCE FACTORS**

Up to this point, environmental health factors have been discussed as if in a vacuum, without regard to the specifics of when or where they occur. System relationships and the "catalogue" of interventions have been formulated in the present tense and in general terms as if everything could happen anytime and anywhere. To this general picture of systems relationships must now be added considerations of how the system is affected by time and distance factors.

Hazards and other forces in the environment occur in different places, at different times, and for different durations. Such differences condition not only the resulting problems but also the possible solutions. The nature of these differences is illustrated in Fig. 8, which shows the time-distance configurations of several specific environ-
mental health problems. The ordinate is a time scale, the abscissa a distance scale showing geographical extension.

Analyses of immediate, local environmental health problems—domestic and neighbourhood sanitation, occupational and transportation hazards, food and water supply—naturally focus on the typical day-to-day activities of people as they move about their homes and certain areas of their locality. The time and distance spanned by such problems is illustrated by the rectangle in the lower left-hand corner of Fig. 8.

Fig. 8. Effects of time and distance on environmental health hazards

But the people and locales in that restricted time-distance framework are seldom beyond the reach of potential hazards arising in other places and sources. Certain examples of such threats, shown in the middle and on the right side of the figure, can be seen to impinge upon the rectangle of "the locality today". (Implied, of course, is that similar hazards may arise within the rectangle itself and extend outward to other times and places.) Some hazards move more rapidly than others, some extend over a greater geographical distance (and affect more communities) than others. But all have significance for environmental health planning and control.

The processes of movement and accumulation over time and distance often act to increase health hazards. As people travel from one environment to another—whether by bullock cart or jet airliner—they carry with them potentially hazardous substances and ideas and, conversely, increase their own risk of exposure to new hazards. Goods and wastes, including toxic substances, move among nations and communities, borne by natural and artificial media of transportation. With the possible exception of remote, primitive settlements, no locality can be said to be isolated. All are linked by movements
in and out of immediate environments, although the pattern of linkages varies greatly from situation to situation. The implication of this fact is that there is a need for environmental health monitoring and action programmes at many levels, ranging from the coordination of the behaviour of householders and farmers at the local level to collaborative arrangements among national governments on bilateral, multilateral, and international bases.

Many such programmes already exist. Some are well coordinated and mutually reinforcing. More frequently there is overlapping and duplication in some activities, while others are covered by no agency at all. For many hazards, even simple monitoring and control programmes are lacking. Nor is this true only of the poorer, developing countries. Uncontrolled dumping of wastes and sales of hazardous goods from community to community occur in a variety of forms in almost all countries. Through the media of streams and oceans, the atmosphere, and channels of commerce, environmental degradation and threats to health can still be introduced from one locality to another throughout the world.

On the other hand, it must be remembered that distance and time can also act (or be used) to reduce, contain, and restrict the spread of hazards among communities. Whether the danger be from flood waters, microorganisms causing epidemic diseases, nuclear fallout, or oil spills in the seas, actions may be taken to shield against such hazards, interrupt them, or confine them spatially. In some instances, dilution over time and distance in conjunction with natural processes may even lessen the degree of danger, as with nuclear fallout. In any event, effective action to contain or neutralize spreading hazards requires information, organization, solution technology, and other resources. While these are the essentials of any programme, their availability on a standby or prompt basis may be crucial to success in controlling intercommunity threats to health.

5. IMPLICATIONS OF A SYSTEMS VIEW OF ENVIRONMENTAL HEALTH

The systems view of environmental health presented in this chapter—briefly and sketchily—will carry different implications for the citizen, the political leader, the epidemiologist, the ecologist, and the administrator of environmental health programmes. We are primarily concerned here with its implications for the administrator. Certain of these implications have already been presented. The social and political trends that require a reconsideration and rethinking of environmental health problems and programmes were listed
at the head of section 1. The implications of a systems view of environmental health relationships were summarized in the beginning of section 3. We shall now examine the implications of our discussion in sections 3 and 4 of alternative possibilities for intervention and time-distance factors in environmental health.

1. Just as man-environment relationships encompass practically all aspects of man's biological and social life, interventions to promote health can conceivably involve a multitude of different actions to be undertaken by the community. Intervention possibilities go far beyond conventional views of the scope of environmental health programming and are conterminous with the scope of social organization.

2. To varying degrees, the solution of environmental health problems requires intercommunity cooperation at all levels from the neighbourhood to the international community.

3. In view of the incompleteness of scientific knowledge concerning cause-effect relationships in health and the low probability that health will become the ultimate, paramount goal of governments and enterprises, environmental health objectives must necessarily continue to be assessed relative to other social goals and to situational factors, and cannot be treated as fixed, absolute, or universal.

4. However, in order to optimize the health-promotive aspects of social policies and programmes, environmental health leaders need to pursue a dual strategy aimed at (a) increasing the appropriateness and effectiveness of programmes for which they are responsible, and (b) influencing the policy decisions and programmes of other agencies so as to minimize any health risks involved and maximize their favourable effects on health.

5. In order to pursue this dual strategy, environmental health administrators will have to increase their ability to:
(a) carry out comprehensive analyses of man-environment problems and alternative solutions;
(b) obtain accurate and adequate information on environmental health problems and intervention programmes in local and national communities;
(c) effectively link fragmented environmental health activities into comprehensive programmes, both within health agencies and with other agencies;
(d) evaluate and advise other governmental and nongovernmental sectors on the health effects of existing and proposed programmes;
(e) develop networks of cooperation among communities at various levels of government in order to work more effectively at reducing
adverse health effects and to pool the environmental health resources available in the various communities;

(f) engage in effective communication with political and economic decision makers; and

(g) alter individual and social behaviours of significance in environmental health, as well as altering the environment itself through engineering.

While the utopian character of these suggestions is recognized, and while such capabilities obviously cannot be developed rapidly or perhaps even fully, this outline can point to the directions in which environmental health administration needs to move.

Even at the present time, however, it is suggested that administrators in all countries and communities can pursue the dual strategy outlined in paragraph 4, above, more vigorously and effectively than is currently being done.

It is further proposed that better use can and should be made of existing administrative technology for solving current environmental health problems as well as for developing the capabilities summarized above.

If this last proposal is to be realized, then the key requirement is that those entrusted with administrative responsibilities in the field of environmental health should acquire a better understanding of administrative theory and technology and its application to environmental health practice. To provide the basis of such an understanding is the aim of Part 2 of this volume.
Part 2
THE ADMINISTRATIVE PROCESS
IN ENVIRONMENTAL HEALTH
The mission of public health is to improve and protect the health of human communities. As pointed out earlier in this volume, the environmental health part of that mission includes planned activities (interventions or intervention programmes) that attempt to modify favourably the environment itself and to modify the interactions of human beings (and sometimes other animal species) with the environment.

Broadly speaking, intervention programmes are concerned with a variety of problems and may use a variety of methods. Whatever their goals and form, however, the administrative aspects of such programmes can be seen to have certain elements in common. Together, these elements constitute what is called the administrative process. In this chapter, the administrative process will be described through several models that will serve as the basis for more detailed examinations of the various phases of this process in the following chapters. As the discussion proceeds, the main concepts will be illustrated with hypothetical but representative examples of environmental health programmes.

In the course of the present chapter, and indeed throughout Part 2 of this volume, the concepts of general systems theory will be emphasized and applied. The rationale for the applicability of this theory is that intervention programmes, as asserted in Chapter 2, can usefully be considered as administrative systems. However, it is important to make clear from the outset that our focus in this chapter will be fundamentally different from that of Chapters 2 and 3. The aim of the earlier discussions was to explain how administrative and other social systems can be conceptually understood; and for this reason such systems were described as already established and functioning: their existence was taken for granted. In the present chapter, we shall approach the subject from the standpoint of how an administrative system comes into existence. The starting point is the perception of
a problem to be solved, in the form of an unsatisfactory health condition, and the discussion focuses on how an intervention programme to solve this problem is brought into being.

1. ADMINISTRATION AS PROBLEM SOLVING

Programme administration may be defined as a process for solving social problems, usually over extended periods of time, through the organization of resources and their regulated application to the problem at hand. In some instances, as when the problem demands the construction of facilities, the solution has a defined endpoint, such as completion of a community incinerator or water treatment plant. Once that is accomplished, the problem-solving organization may disband or move on to another problem of the same type. More frequently, however, the solution of social problems requires continuing actions in the form of services, as in restaurant sanitation, air pollution control, and public water supply programmes. In many such programmes, the first type of problem solving—the accomplishment of an engineering task—is only a part or subsystem of the service programme; for example, an incinerator, once constructed, would be a subsystem of a solid wastes management programme.

Effectiveness in programme administration is measured by the progress made toward objectives (i.e., progress in solving the assigned problem). Such a criterion places the problem and its solution at the centre of the administrator’s universe. It may seem unnecessary to state that the problem is the most important focus for a problem-solving apparatus, i.e., an intervention programme. All too frequently, however, programme administrators and staffs become more oriented to carrying out procedures and activities than to monitoring the problem and the progress being made in solving it. In other words, programme services become ends unto themselves rather than means to solve the problems for which they were organized. To avoid such pitfalls, the problem should properly be considered as the starting point for an administered programme, its point of orientation, and the criterion by which its usefulness and effectiveness are measured.

2. PROBLEM DEFINITION AND GOAL SETTING

The example to be developed in the course of sections 2-4 concerns

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2 A problem, in general, is a difficulty to be overcome. In public health jargon, the difficulty may be perceived as (and expressed in terms of) an undesirable condition, such as a high incidence of waterborne diseases in a population; in effect, the existence of the condition is seen as a difficulty to be overcome to achieve the goal of improved health. This definition implies that a given set of data may or may not be seen as a problem by different persons; data may also be selected and interpreted differently to produce different conceptions of the problem.
a hypothetical intervention programme developed in response to the perception of a social problem. In the present case, the problem will be expressed in terms of the values of the political leaders of the country concerned. It is important to state this from the outset, for when identifying a problem one must also identify the point of view from which it is perceived. Different individuals and interest groups may perceive a problem differently, as will become clear in the present example.

The political leaders of a nation seeking to promote economic development through accelerated industrialization and agricultural mechanization observed that skilled workers were being lost from their jobs. An ad hoc group of technicians from the Ministries of Health, Finance, Labour, and Agriculture was set up to consider the problem.

Like most social problems, this loss of trained manpower was not completely understood at the beginning. Data were incomplete and the causes of the loss were somewhat obscure. However, such information as was available indicated that a substantial part of the manpower loss—temporary and permanent—was due to a high rate of occupational accidents. It was observed that such accidents not only interfered with the progress of development and the attainment of production goals but also imposed an additional burden on the health services, entailed extra expenses for training replacements, and strained the financial reserves of the social security system, which had to support disabled ex-workers. For these reasons, the study group decided to state the problem in terms of an unacceptable rate of occupational accidents, which directly led to considering a reduction in the number of such accidents as a goal.1 It was conjectured, furthermore, that solving the problem might well require a combination of services, including setting and enforcing standards for industrial plants and mechanized farms, controlling and correcting machine designs, ensuring the safety education of workers, and possibly improving the medical treatment and rehabilitation of accident victims. After reporting to the Prime Minister's chief of economic planning, the study group was instructed to continue its work along these lines.

A number of concepts and general principles can be inferred from the example thus far.

1. An administrative study group approaches problems as rationally as its resources—in this instance, primarily information—permit. Although the information was recognized as incomplete, a working hypothesis was formed linking part of the manpower loss to occupational accidents. Additional implications of this problem for the community system were identified.

2. The way a problem is identified determines the nature of its

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1 A goal is a general term signifying a desired end, which may be the change or maintenance of a given condition. The term objective is used to denote stated ends that can be stated more specifically than goals and that contribute to broad goals. In the literature, the terms objectives, aims, targets, and goals are used interchangeably—and, unfortunately, inconsistently.
solution. In the example, stating the problem in terms of manpower loss shaped the approach taken by the administrative study group. In turn, once the factor of occupational accidents was perceived as being of major importance, the statement of the problem suggested what the solution (goal) might be. The goals then suggested several types of intervention strategy known to the members of the study group, who were presumably selected because of their ministries' interests and expertise. Had the original problem been stated differently—say, to return injured workers to their jobs more quickly—a different study group might have been selected and a different problem definition, goal, and initial strategy might well have been formulated.

3. Frequently, interventions in the health field do not solve problems directly but rather enable the individuals and groups concerned to solve them. In the example, the services and activities thought to be necessary to reduce occupational accidents were directed mainly at altering human behaviour in relation to environmental factors (ensuring better safety standards, providing worker education). As a generality, it has been found that health services often improve states of health not directly but rather indirectly, by influencing the biological and behavioural processes of people, whether singly or in groups. In effect, physicians do not cure patients but help patients to cure themselves; if an ill person lacks the biological capacity to heal or to tolerate an antibiotic, or lacks the psychological capacity to cooperate with a treatment regimen, then the most skillful efforts of the physician will fail. Similarly, behavioural processes are often critical to the success of environmental health programmes. Dangerous driving, the misuse or non-use of safe water, poor domestic sanitation, or, in our example, disregard of safety precautions can make even superb environmental engineering and control services worthless.

4. It follows from this that success in influencing biological and behavioural processes in the interests of better health often requires programme activities that seek to modify both the human environment and the biology and behaviour of people. This is as true in personal health care as in environmental health, as for example when the physician manipulates the patient's surroundings to influence such factors as family support and the sick room environment. The relationships involved are depicted schematically in Fig. 1.

5. Environmental health and personal health services are often

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1 We will find, of course, that behavioural changes often need to be made part of the programme process itself. An analytical laboratory in a public water supply system is worthless if the staff do not use it as they should.
interrelated, although there is all too frequently a failure to have them linked administratively. In the example, this interrelationship is illustrated by the concern that accident cases were overburdening personal health service resources and possibly requiring their expansion. Other common examples can be cited: people must be treated medically for diseases and disabilities arising from poor environmental control; immunization requirements are not absolute, but are related to the degree to which a population's exposure to environmental hazards can be reduced (as with BCG vaccination against tuberculosis); and medical measures may be relatively ineffective in the presence of environmental conditions such as inadequate food supply, illiteracy, contaminated drinking water, and unsanitary domestic conditions. Conversely, if time and money to effect environmental changes are lacking, the use of prophylactic medical measures may be necessary in the short run.

6. Whether coordinated or not, organized personal and environmental health services are only a part, and usually a small part, of the factors influencing the biological and behaviour processes of individuals and communities. Other influences from the environment — symbolized by the large arrow in Fig. 1 — may be pervasive, powerful, and multiple. Geographical and climatic factors, urban and rural situations, local customs and beliefs, socioeconomic conditions, and stage of development not only are often more powerful determinants of biology and behaviour than organized health services but frequently constrain what health services are provided, how they work, and the effects they can achieve.

The relationships described in the above statements strongly condition the character of health administration. To repeat, adequate administration of environmental health programmes requires constant attention to the results that are being sought in relation to the community's needs. In systems language, programme administration has
to be output-oriented, i.e., oriented to solving the social problem at hand.\textsuperscript{1}

3. POLICY AND PROGRAMME PLANNING

To return to our example, the work of the ad hoc study group led to a decision by the Prime Minister that further planning efforts should indeed focus on the reduction of occupational accidents. The work was turned over to a staff of specialists in analysis and planning, with the original group serving in an advisory and liaison role.

The initial work of the analyst-planners was directed to obtaining a better understanding of the problem. Once the pertinent information available from various ministries' statistical units had been collated and analysed, the analysts concluded that there was presumptive evidence of the importance of the problem but inadequate information as to what the direct and indirect causes were, what the most effective solutions might be, and how such solutions would compare with one another in terms of cost and effectiveness. Additional information was needed. Thus, the analysts, working with the liaison group, designed a study to investigate the causal factors and review the technology available for solution. Even though it was planned to use manpower from a number of the ministries concerned to gather and assess the needed information for the study, time pressures made it impossible to examine all the ideas and hypotheses that had already been generated. It was decided that the study would concentrate on such factors as workers' safety behaviour, general and specific hazard control in workplaces, stress factors arising from scheduling and task specialization, and protective clothing and equipment, and would deal only incidentally with such factors as alcohol consumption, educational level, customs and attitudes, and family background.

The outcome of the study, which included both sample surveys of the target population and a review of scientific information on intervention technologies from within and outside the country, was not as conclusive as desired. Nevertheless, the study suggested the general lines that an intervention strategy might take and permitted the initial formulation of programme objectives. The main lines of the strategy included the filling of important gaps in occupational safety standards, the education of equipment manufacturers, managers, and workers in standards and practices, and the enforcement of standards. Special emphasis on general safety of the workplace and greater use of protective clothing and equipment seemed justified.

With these preliminary proposals in hand, the planners began consultations with a number of groups, starting with representatives of workers and managers, and including equipment suppliers, architects, and builders. After certain modifications had been made in the proposals on the basis of advice and reactions from these interest groups, the preliminary plan, including alternative strategies and their costs, was taken to the political leaders of the country and their economic and development planning advisers. Out of these discussions emerged a decision on the occupational accident control programme to be developed.

A programme plan was then written recapitulating the problem analysis, the selected strategy, the general time schedule for inaugurating the various parts

\textsuperscript{1} As opposed to being "resource-oriented" (i.e., input-oriented) or "process-oriented".
Again, a number of concepts can be inferred from the example.

1. The administrative process can be seen to be a linked series of subprocesses, working from the general and conjectural toward the specific and determined. From the example thus far, we can identify the first two of the major subprocesses or phases of administration:
   (a) Problem and solution analysis: investigating and explicitly defining the problem and considering the various solutions available.
   (b) Policy and programme planning: determining what is to be done and writing a programme plan.

2. While the sequence of subprocesses in administration is conceptually straightforward, in practice a considerable amount of cycling is required, that is, looping back to rework earlier phases of programme development as information improves and as constraints from the programme’s environment make themselves felt. This concept will be further elaborated in section 4.

3. Preformulated concepts of the problem and technical solutions (illustrated in the example by the review of solution technologies by technical experts and consultants) require adaptation to actual conditions in the community. Adaptation depends on how the problem is manifested in the community and what actions are feasible under community constraints.

4. Provided there is a strong orientation toward problem solution, programme development can take place within a systems framework. In other words, the planners or administrators can cut across organizational boundaries and analyse the various groups and interests involved in the problem and proposed solutions. (An analysis of the roles of the participants in this particular example will be undertaken in a later chapter.)

Fig. 2 summarizes most of the concepts formulated thus far on the basis of the example. The area within the square represents the “programme system” and the inner border of the square indicates the boundary between the system and its social environment. The diagram shows the cyclical nature of the administrative process operating through its various phases, of which the remainder will now be elaborated.
4. MANAGEMENT PLANNING, IMPLEMENTATION, AND PROGRAMME OPERATION: CYCLES, FEEDBACK, AND CONSTRAINTS

After its approval, the programme plan became the basis for management planning, consisting in the development of operating plans and their subsequent implementation. These plans included specifications of resource needs, budget allotments, operating policies and procedures, records, and reports. Each component of the plan that required a phase of resource mobilization and development (implementation) was denoted a project, and a schedule in network form was worked out for it. The project plans were linked in a master project plan so as to keep the projects in a logical time relationship with one another. Through such planning, various elements of the programme were put into operation as soon as their preparation was sufficiently advanced for services to begin.

The various services of the occupational accident prevention programme were inaugurated more or less on schedule, although not without difficulties. Unanticipated events and factors overlooked in planning contributed to such difficulties and required special efforts and shifting of resources in order to have each component subsystem ready on time. Had there not been detailed management planning of the projects and their close monitoring and control,
many difficulties would not have been detected early enough; as it was, early identification of difficulties permitted replanning (cycling back) of the affected projects.

As the programme continued to provide its services, the control system—also developed in the course of management planning—served likewise to anticipate or quickly detect operating problems. Certain of these problems proved possible to solve in a manner that kept services in conformity with the programme and operating plans. Others required the adjustment of plans but, owing to the earlier detailed work, it was feasible to assess the implications of each change for the other aspects of the programme.

As the programme continued, certain developments cast doubt on some of the basic assumptions about the problem as it had originally been analysed. Again, because of the explicitness of the programme plan, it was possible to interpret the significance of these developments and to bring them under study.

The fact that such studies were in progress made the comprehensive annual evaluation studies called for in the programme plan even more fruitful than anticipated. As a result, a change in the allocation of funds to various activities of the programme was made early in its second year. In the third year, it became possible to provide advice to the management of various industrial and agricultural enterprises on possible economies in the conduct of safety activities and to arrange for greater participation by the staffs of trade unions in educational activities.

The responsiveness of the programme to actual needs, in solving problems and exploiting opportunities as they arose, was attributable not only to the clarity and thoroughness of its planning and the readiness of its administrators to make revisions, but to the excellence of its feedback arrangements and the progressive improvement of its records and reports (management information) subsystem. Effective monitoring and control depended on careful selection of the types of data that would be the best indicators of how the programme was functioning. Most of the feedback data selected indeed proved helpful to administration. Because of continuing insistence on timely receipt of reports and other forms of feedback data, the programme system was continually monitored and control led to prompt correction. Responsible administrators at all levels of the programme were willing (or persuaded) to use feedback information consistently to make adjustments in operations and resources, which meant that the programme operated with relative stability and adjustments could be accomplished without erratic oscillations in policies or disrup-

tions of continuity and morale.

Beyond the diligent use of feedbacks as planned, these devices served to make staff generally alert to changes in conditions within and without the programme system. This helped them to identify both obstacles and opportunities, including promising improvements in programme technology.

While the programme progressed more or less as planned and many problems were handled effectively, several difficulties were too great to overcome and had long-term effects. There was continuing tension, sometimes open conflict, between those devoted to the objectives of the programme and those who were hostile to it, mainly on the grounds that it drained time and money away from production growth. While this problem was most troublesome during the early years of the programme, when major reliance had to be placed on foreign sources for certain protective devices and acceptable machinery, it was only slightly eased as the country's own capacity to fill these
requirements was developed. The hostility of employers was aroused against what was interpreted as rigidity in the safety standards set by various government ministries and in their mode of enforcement. As the programme entered its fifth year, these and other opposition groups had made their opinions well known among the political and economic leaders of the country. At the same time, in other sectors of the community, particularly among employee groups, strong expectations had developed as to the continuation and expanded coverage of the programme.

During the fifth year a full-scale evaluation covering all aspects of the programme was carried out, including a review of the occupational accident problem itself. The evaluation report showed that there had been an absolute reduction in industrial accidents, even when account was taken of the increased employment over the five years. The programme had been more effective in industry than in agriculture, where it had fallen short of its quantified objectives. On the average, 85% of the projected annual decrease in the accident rate had been achieved, and the original cost estimates had been exceeded by about 14%. The evaluation also ascertained that the programme had helped to generate certain characteristics in the industrial-agricultural economy, especially in worker and management attitudes, that gave promise of continued progress on the problem without requiring the same high level of activity on the part of the government as during the first five years. Certain programme activities were asserted to be less productive than others, although the evaluators felt that the information supportive of such assertions was uncertain.

Decisions made on the basis of the evaluation resulted in the replanning of the programme at several levels. At the level of the national government, it was decided to transfer a large part of the programme services to nongovernmental entities headed by committees representative of workers, managements, and government. Governmental activities and resources were, however, expanded and monitoring the operation of the reconstituted system. Activities directed at improving the medical treatment and rehabilitation of accident victims in the areas of standard setting, technical assistance to various other agencies, were added to the programme.

The following conclusions can be drawn from this final portion of the account of our hypothetical intervention programme.

1. The main phases of the administrative process (see Fig. 2) are as follows:

   (a) Problem and solution analysis: investigating and explicitly defining the problem and considering the various solutions available.

   (b) Policy and programme planning: determining what is to be done and writing a programme plan.

   (c) Management planning: determining how the programme is to be carried out.

   (d) Implementation: assembling and organizing the resources necessary for programme operation.

   (e) Programme operation: providing goods and/or services under controlled conditions.
To return to the basic definition of administration given in the Introduction, phases (a) and (b) would correspond to the planning function of administration while phases (c) through (e) would correspond to the management function. This will be elaborated further in section 7.

2. Although the main phases can be listed in sequence and indeed are often carried out in this order, it bears repeating that the administrative process has a cyclical character. This is true not only during the initial planning and implementation of a programme but throughout its duration and at various levels. Cycling in order to correct the system may take place rapidly and repeatedly at the level at which ongoing services are controlled, and it also may operate once every few years at a higher level of review in order to modify objectives, policies, or resource allocations, or otherwise replan the programme.

3. One purpose of cycling is to keep the programme under control, i.e., to use feedback to maintain programme actions in conformity with programme objectives and other norms. Since a programme has many levels of norms (e.g., community values, programme effectiveness, and service efficiency), one finds a multiplicity of cyclings.

4. The cardinal process of administration that helps keep the programme under control is evaluation, which will be discussed in some detail in Chapter 5, section 1.2. To illustrate the types of question that evaluation is used to answer, the following general examples are offered.

(a) Evaluation of effectiveness: Is the programme having the effects that were set forth in the goals? If not, why not and what is to be done?

(b) Evaluation of value to the community: Is the programme needed as much as, or less, or more than when it was begun or last examined? Have community needs changed, either because of the success of the programme or because of changes external to it? Should it be continued, changed, halted?

(c) Evaluation of efficiency: Are there better ways of carrying out the programme? Have new technology and knowledge become available? Are there more productive ways of using the resources available to the programme?

5. Although this point was not illustrated in our hypothetical example, most governments and enterprises establish arbitrary cycles

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1 See Chapter 5, section 2.1 for a discussion of this and related terms.
for certain processes. An almost universal cycle in administration is that of the budget, which is usually an annual cycle. Often, the basis for a cycle is provided by the periodic meetings of legislative bodies who pass on authorizations and general norms and on appropriations of funds for budgets. In countries that work under 4-year and 5-year plans, each planning period constitutes a cycle, usually with annual subcycles within it. Like other cycles in administration, these arbitrary arrangements also have a control purpose, in this case to review simultaneously objectives and resource allocations throughout the government.

6. Programme control, as it is served by the evaluation process, depends for its quality and timeliness on the nature and calibre of feedback in the system. Feedback can be of two types within administrative systems. One type, emphasized in the occupational accident prevention example, is the movement of information to various decision makers on how well the system is working and what adjustments are needed. A second type, which is of greater significance for delivering services than for managing them, is the reuse of information or material that is generated or transformed in the service process (e.g., laboratory test reports, recycled physical material).

7. Another type of feedback data that may be of critical importance to the survival and potency of the system concerns what is happening in its environment. Such information may be gathered at a wide range of points along the system's boundary, from the highest level of political dialogue to the opinions and attitudes expressed by recipients of programme services.

8. Forces outside of health programmes—external constraints—not only influence the problem the programme is trying to solve but strongly affect the state and very existence of the health system itself. For example, an outside decision may be made that a programme will be begun or continued (which is just as much a constraint as a decision to terminate or reduce it, although the two decisions may be valued differently by different system participants). Fig. 3, which adds to the information in Fig. 2, shows that external constraints, represented by the large arrows driving inward from the system's boundary, affect all the components of the system. The general point being made here is that administration is obliged to deal with constraints in one way or another. Machine systems can deal with constraints only by accepting them, by functioning within the limits they set. In social systems, many—perhaps most—constraints also have to be accepted, but some may be able to be modified, gradually if
not immediately. Although external constraints are forces from the system's environment that it cannot alter at that particular moment, at a later time a given constraint may change in character and intensity, perhaps in response to the behaviour of the system itself.

9. Fig. 3 also identifies the internal constraints of the system, which are factors in the system's state that permit, facilitate, or retard change and affect the functioning of the administrative process. An example of an internal constraint is the existence or absence of information on which to base evaluations, and its quality. Other examples would be the quantity and quality of programme staff; resistance or willingness to change customary procedures; existing organizational structures; and other factors of the system's steady state. As with external constraints, internal constraints must either be accepted as limitations on the system or be changed over time.

Fig. 3. Constraints on the administrative process in a programme system
5. ELABORATION OF THE ADMINISTRATIVE PROCESS: PROGRAMME DEVELOPMENT

The concepts developed in sections 2, 3, and 4 can now be elaborated by means of a somewhat different model. Fig. 4 illustrates the various steps in programme development, from the stage of someone's becoming aware of a problem through the development and implementation of an intervention programme to the achievement of results in the form of the reduction or elimination of the problem. Instead of emphasizing the cyclical character of the administrative process, as in Fig. 2 and 3, the broad phases of that process now move from left to right. (In order to clarify the relationship between the earlier diagrams and Fig. 4, the major phases shown in the former diagrams are indicated below the flow diagram.) Breaking the circle shown in the earlier figures and making it into a straight line permits the addition of more detail. Another advantage of the left-to-right depiction is that it makes it possible to illustrate how the several phases of the administrative process overlap, with each beginning before the preceding step has been completed. The significance of such overlapping is that it makes for continuity of effort and permits information flows between successive phases.

Except for the interactions represented by arrows with two heads, the reader will have to imagine the many feedbacks involved and the cycling back from later to earlier steps that would certainly take place.

To help explain the steps of programme development as depicted in Fig. 4, a different and simpler illustration from the field of occupational health will be used. In this example, the problem concerns respiratory illness among workers in industrial and mining enterprises.

5.1 Problem and solution analysis

This phase—and the programme development process itself—begins with awareness of the existence of a problem in the community. Such awareness may arise from direct observation of signs representing a deviation from what is expected or desired (the norm) or it may grow out of the comparison of a pre-existing general concept or model of the problem with the conditions in a particular community. In the first instance, one becomes concerned because one senses that something is amiss in the community, without necessarily having clear or well organized ideas of what the problem consists of, how it is caused, how it may be solved, or how important it may be. In the second instance, i.e., when a general model is applied to a specific situation, the problem is somewhat better identified and understood.
and there is some knowledge of whether and how it might be solved. In this second case, the model is being drawn from a body of scientific and technological information that may come out of the observer's own education or from technical communications, such as conference reports, publications, or inputs from specialized agencies.

Fig. 4. Programme development model
The major elements of such bodies of knowledge about problems and their solution are shown in that part of Fig. 4 enclosed by a broken line and labelled "Science and Technology". Within this box are represented the relationships between an overall conception or model of the problem, the signs by which it may be recognized and measured (problem criteria), knowledge or assumptions of how it may be caused (and the cause-effect relationships involved in its solution), and the relevant body of scientific and technological information about causation and solution. The sum of these elements may be conceived as constituting an intervention hypothesis. Such a hypothesis is a general statement about the problem that is not specific to any particular community but presumably applicable to any community in which the problem exists. An intervention hypothesis usually contains the following information:

- the terminology associated with the problem;
- how the problem may be recognized and measured;
- how, under stated conditions, it is caused and propagated;
- how, under stated conditions, one or another method may be used to solve it; and
- how the solution of the problem may be measured and assessed.

Such information can be found in textbooks covering the traditional areas of sanitation and preventive medicine, particularly for categorical disease problems. Comparable materials are also available for problems of air pollution, traffic accidents, and substandard housing. Intervention hypotheses have also been formulated for certain of the technical assistance efforts of international organizations and, in some countries, by national-level ministries for the guidance of their political subdivisions.

To illustrate this initial step of programme development with our example of respiratory disease in industrial workers and miners, it might well be that the initial awareness of the problem would not come at all from identifying respiratory illness but rather from observing (and being concerned about) increased work absences, unusual numbers of deaths, symptoms of discomfort and pain in workers, low productivity, or poor worker morale. To have the concept that there is an unusual amount of respiratory illness associated with the observed phenomena already represents a fairly well advanced stage of problem identification.

Problem conception is of prime importance, for the way the problem is perceived will determine which problem criteria are considered to be significant. The criteria in turn will help to select the appropriate solution strategy and will determine the measurement units to be
used in planning the intervention and evaluating its effectiveness. While the general problem conceptions or models and intervention hypotheses available in the scientific and technical literature are powerful weapons in the armamentarium of the public health worker, administrators need to be alert to the danger that such models may not fit their own community situation as well as they might certain others—and, indeed, the danger that the problem, as it exists in their particular community, may be considerably different from the general technical formulation. In other words, preconceptions about problems that are derived from technical models may cause administrators to look at their own problems with “tunnel vision”.

Because of such perils, we distinguish in Fig. 4 between the intervention hypothesis, which is not specific to any community, and the programme hypotheses that emerge from epidemiological and other analyses of the problem in the actual community in which the programme is to be developed. If, in our hypothetical example, the problem is indeed one of respiratory illness affecting workers in certain enterprises, the intervention hypothesis can aptly furnish the criteria of problem recognition (definition of the respiratory syndrome, measurements and standards of incidence and prevalence, signs and symptoms of morbidity and mortality), criteria of causation (based on knowledge of the “natural history” of the disease and associating prolonged breathing of certain types of particulate matter in enclosed spaces with disease symptoms), and criteria of solution (associating reduced disease incidence with a reduction in concentration of or exposure to the irritant particles). It is only when such criteria and other elements of the intervention hypothesis are applied to the community in question, are modified in the light of specific community conditions, and are then expressed in relevant terms, that what is here termed a programme hypothesis will have been developed. However, planning usually requires not only a general programme hypothesis that deals with the relationship between exposure and the disease but also more specific hypotheses that estimate the outcomes of various solution technologies (in this example, the filtering, precipitation, or dilution of particles) that are presumed to be feasible in the community.

5.2 Policy and programme planning

Problem analyses and the formulation of programme hypotheses for the solution of the problem in the community are important inputs

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4 Both biological research (based on autopsies, for example) and epidemiological research are required to develop the criteria for intervention hypotheses. Such research can help transform assumptions into knowledge over time, making the criteria more specific, objective, and valid.
into the programme planning phase. Knowledge of the extent and distribution of the problem in the community, the possible causal factors involved, and the nature, effectiveness, and relative costs of available solution technologies constitutes a solid base on which to begin the planning of policies and programmes. It is, however, no more than a base.

Epidemiological and technological information has to be reconciled with information on community values—how important or urgent the problem is felt to be—and with information on community conditions, which might be economic, physical, social, administrative, or political, so as to generate alternative strategies that would be relevant and feasible for the community. Programme planning is the phase in which such alternatives are generated, in which a decision is then made by the appropriate officials or bodies on the preferred alternative (or some combination of them), the chosen strategy is elaborated, and the full body of programme information is then documented for use in the following phases of programme administration.

The programme selection step may take place relatively early or late in the programme planning phase, according the characteristics of the community’s decision-making system (Chapter 5, section 2.3). Depending on how that system handles issues of public concern and questions of resource allocation, programme selection may consist of a number of consultations between planners and decision makers while the alternatives are being studied, or it may be concentrated in a single review for a final decision. It is during the step of programme selection that the developing programme receives its greatest exposure to the influence of various forces and interests in the community, with the extent and variety of exposure, again, being a function of the particular decision-making system.

Once the programme strategy (or configuration of strategies) has been selected, the definitive programme plan is written. Not only should this document outline the strategy, its objectives, and its solution technology in greater detail than previously, but it should also incorporate other pertinent information concerning all of the factors, elements, and decisions accumulated from the start of the analytical process up to that point. Important components of a programme plan are the detailed definition of the problem, the rationale for selecting the strategy that has been adopted, the statement of programme hypotheses, details of the selected strategy, specification of quantified objectives, and technical norms and criteria, the last two being important for the subsequent control and evaluation of the programme. The programme plan should also furnish detailed information about external constraints as they have been measured and
estimated by the planners' analysis, both to make clear why the
strategy was selected and, more practically, to identify the factors
in the community that will condition the programme's future operation.
A careful examination of constraints—for example, incomplete
information about attitudes among the target population or knowledge
about hostile attitudes in some part of this population—will be
especially useful if one objective of the programme is to change adverse
external constraints. In the case of the occupationally-induced
respiratory disease problem, if the provisions of building or industrial
codes would prevent the application of a preferred solution technology,
one objective of the intervention programme might be to seek changes
in existing legal restrictions.

5.3 Management planning; implementation

The next step in the programme development process is to formulate
time-specific operating plans, based on the programme plan, outlining
how the programme is to be set up and setting forth models of how
it is to operate. The operating plans include information on the
relationships of staff members and organizational units, flows of
communications, descriptions of programme activities, specifications of
procedures for accomplishing the activities, and the protocols for
handling information. Of especial importance in the operating plans
is the identification of the types of operators (man and machine),
other resources, and operands (target population or substances) that
are to be recruited and mobilized. Because of the plans' comparative
concreteness and specificity in these matters, their development may
properly be considered the first step in programme implementation.

It is difficult to generalize about the form and content of operating
plans, not only because countries differ as to how they organize their
administrative agencies but also because such plans are extensions
of the programme plan, which itself is specific for the problem as
it exists in the community concerned. Some of the elements often
found in operating plans are descriptions of programme activities,
standing procedures for technical and administrative work, perform-
ance and other operating norms, protocols for reporting and control,
schedules and deadlines, tables of organization, and job and task
descriptions.

Based on provisions of the operating plans, the implementation
phase begins with the actual intake of resources, including recruit-
ment, training, construction, equipment modification and installation, con-
tracting for external support services, and preparation to receive
programme operands. As in all phases of the administrative process,
explicit attention has to be given to the external constraints that affect implementation and future programme operation.

5.4 Programme operation; biological and behavioural processes

Once the programme has been implemented, the major responsibility of administration is to ensure that services are provided or goods produced in accordance with the provisions of the programme and operating plans. The need to conform to those plans—as well as to make orderly adjustments to changing conditions—is the basis for the control function of management. This function consists in the monitoring of programme operations to ascertain the degree of conformity with norms and the making of suitable corrections, either in the operations or in the norms.

In the respiratory disease example, programme services would include the progressive installation of the solution technology, based on the use of air cleaning devices or protective mechanisms, in various industrial and mining settings. In their control function, managers would be concerned with how rapidly and adequately coverage of the hazardous sites was being achieved, the effectiveness of surveillance of the participating factories and mines, the compliance of employers and workers with the safety standards, the quality of work being done by the staff, and the relationships between costs and the effectiveness and efficiency of programme activities. Beyond the level of task and activity performance, however, management would be concerned with the programme's results, certainly with the production of results in the form of direct outputs, but also with impacts and benefits (see Chapter 2, section 10). Because of the importance of programme results, this subject is treated separately below in section 6.

5.5 Other aspects

Three additional comments need to be made before closing this discussion of the programme development process illustrated in Fig. 4.

First, the controlled operation of the programme should be understood to lead to replanning activities, even though these are not identified explicitly in the diagram. During replanning, attention might be limited to changing the programme's way of operating, the resources used, or the procedures employed. Concern might extend, however, to changing the target population, the level set for objectives, or standards of quality. Even broader replanning might include revision of the programme strategy, including its technology and the programme hypotheses. Replanning would of course be influenced by the
effectiveness of the intervention programme in solving the problem: if the problem had been substantially reduced, it would be possible to transform the programme into one for surveillance and maintenance, which would be different from the intervention originally needed to bring the problem under control.

Second, it should be noted that the programme development model contains no specific step labelled "programme evaluation", in keeping with the concept expressed throughout this book that evaluation is a process that pervades administration rather than a discrete function to be carried out some time after the programme has been in operation (see Chapter 5).

Third, it must be remembered that the preceding exposition of the programme development process is idealized: a rational sequence of steps has been set forth in which the output of each step serves as input to the next. Seldom are the events of life so logically arranged, nor does the planner normally start with a clean slate in the sense that the problem is untouched so that he can begin "at the beginning"; usually, one is dropped into the middle of a crisis and the information needed for problem analysis and planning does not become available until later, if at all. Even allowing for this, however, it is asserted that the steps in the rationalized programme process all have to be accomplished at some time, even if the ideal sequence cannot be followed. For example, if service provision begins on the basis of rather vague goals and hit-or-miss activities, then the various planning phases and the establishment of management controls will have to take place later on if the programme is to be effective and viable.

6. PROGRAMME RESULTS IN ENVIRONMENTAL HEALTH

In Chapter 2, section 10, a three-level classification of results in administrative systems was set forth that distinguished between (a) the direct outputs or immediate products of a programme, (b) its intermediate effects, or the impacts of these outputs on reducing the problem, and (c) its ultimate effects, or the social benefits of problem reduction (i.e., the benefits of improved health states). The application of this classification to environmental health, along with a consideration of what is denoted "other effects" in Fig. 4, will now be considered in the context of the respiratory disease example and then, more broadly, for several of the major programme fields of environmental health.

In our respiratory disease example, the direct outputs of the
programme would consist of the measurable reduction in worker exposure to airborne particles through the use of various mechanical devices or the alteration of worker behaviour (e.g., the wearing of filtration masks). The impacts of these direct outputs would be the measured changes in morbidity, disability, mortality, and discomfort over specified periods of time. The ultimate effects, or benefits, would be the improved wellbeing of workers, the contributions of reduced illness to the productivity of the enterprises concerned, and the contributions of increased productivity to economic development.

Since the programme is an open rather than a closed system, however, these results would not be obtained in isolation from other systems, nor could it be assumed that the programme would have no effects on other systems. Factors in other systems (such as trade union organization, price competition in the market, community attitudes toward health, relative availability or scarcity of government funds) might either reinforce or reduce the effectiveness of the programme. In its operations the programme might generate by-products, either positive (e.g., greater yields from raw materials, improved worker-employer relations) or negative (higher production costs, decreased or slower production—to be balanced against increased productivity from reduced absenteeism). The impacts of the programme on other systems might likewise be positive or negative, for example, if control of particles in the work area led to either increased or decreased discharge of particulate matter into the atmosphere outside the factory. We may thus infer from the example that a programme may produce both benefits and disbenefits.

6.1 Interrelations of environmental health programmes

A more inclusive view of possible results in environmental health interventions is presented in Table 1. One purpose of this table is to make concrete for the reader the way in which the concept of three levels of output applies to certain familiar environmental health programmes.

Another point made clear by the table is that, as one moves from direct outputs to intermediate effects, and then from intermediate to ultimate effects, one sees an increase in the interrelationships among the programme results. At the lowest level, the direct outputs of each of the programmes are quite distinctive and differ considerably from the outputs of the other programmes. When we proceed to the intermediate effects column, we find a number of similarities among the impacts of the various programmes on biological, social, and physical factors, as symbolized by the broken lines separating the
<table>
<thead>
<tr>
<th>Programme</th>
<th>Direct Outputs</th>
<th>Intermediate Effects or Impacts</th>
<th>Ultimate Effects or Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Supply</td>
<td>Safe water provided to households in adequate amounts and used efficiently</td>
<td>Reduced disease from waterborne pathogens; support to hygiene, nutrition, and economic activity</td>
<td>Longer survival</td>
</tr>
<tr>
<td>Water Pollution Control</td>
<td>Reduced contamination of (used water returned to) watercourses, seas, soil, and food</td>
<td>Improved water resources for human use; reduced damage to marine life; improved aesthetics</td>
<td>Less disability, suffering, impairment, and pain</td>
</tr>
<tr>
<td>Solid Wastes Management</td>
<td>Wastes confined, removed, and disposed of (treated, recycled)</td>
<td>Reduced disease from vectorborne pathogens and from pathogens and chemicals transferred to air, water, and land; economic gains; improved aesthetics</td>
<td>More efficient personal and social performance</td>
</tr>
<tr>
<td>Air Pollution Control</td>
<td>Reduced introduction of toxic, irritant, and nuisance elements into ambient air</td>
<td>Reduced death, disease, and discomfort; reduced economic losses; improved aesthetics</td>
<td></td>
</tr>
<tr>
<td>Occupational Health</td>
<td>Reduced physical/chemical hazards in work environment, through primary and secondary disease prevention services</td>
<td>Reduced illness, trauma, and poisoning; safer work environment; improved working conditions and productivity</td>
<td>Improved quality of life</td>
</tr>
<tr>
<td>Food Sanitation</td>
<td>Food safeguarded against contamination in production, processing, delivery, preparation, and consumption</td>
<td>Reduced disease and death from pathogens and toxins in food; enlarged markets; improved aesthetics</td>
<td>Socio-economic development</td>
</tr>
</tbody>
</table>

programme categories in that column. At the level of ultimate effects or benefits, the results sought are so completely interrelated that they must be formulated in common for all the programmes. In other
words, from the criterion of how their outputs interact, environmental health programmes can be seen to form a system.

This brings us back to a point made consistently throughout this volume. While communities are obliged to organize programmes and structure activities in categories in order to make them more manageable, all programme administrators should bear in mind that they share the same commitment, namely, to improve human wellbeing. Further, they should recognize that human welfare, whether of the individual or of the community, is inseparable from the totality of environmental conditions. The worker on the job is part of the "target population" not only for occupational health and safety programmes, but also for programmes of water supply, general and food sanitation, air pollution, noise control, wastes disposal, and, perhaps, pesticide control and radiological health—even while he is at his place of work. Personal health services, including those relating to mental health, may also be linked to the work situation. The family in the home, the child in school, city and farm dwellers—all are target populations for a multiplicity of programmes. Man faces complexes of risks in his environment that are seldom satisfactorily divisible into conventional programme categories. While public health workers categorize their efforts in order to reap the benefits of specialization, it should never be forgotten that specialization is best justified by what it contributes to the whole of which it is a part.

6.2 External relations of environmental health programmes

When environmental health programmes are viewed as systems, one tends to become more aware of the relationships that these systems bear to their social and physical environments. In general, we have noted that the programme system receives inputs of resources and demands from the community environment and produces goods, services, or effects in response to the expectations of the community. In addition to this basic property of the system, three types of external relationship are also likely to exist. These apply not only to the outputs but also to the planning and operation of environmental health programmes.

1. Environmental health programmes form part of the environment of other systems. Just as the community and its systems constitute the environment for various health programmes, such programmes correspondingly serve to condition and constrain other systems in the community. Restrictions on commercial and industrial systems are imposed by the educational, inspection, and law enforcement
activities of environmental health programmes. These may act as significant conditioning forces on industries and other employers, restaurants, milk producers and processors, tourism, and other sectors of the economy. The availability and quality of the water supplied to the community, the removal of wastes, and their manner of treatment condition the functioning of families and various commercial enterprises. Similarly, the educational aspects of environmental health programmes can potentially go beyond their immediate objectives and modify the social and economic behaviours of segments of the community and, sometimes, the community as a whole.

2. **Environmental health programmes have side effects.** Beyond the recognized goals and objectives of environmental health programmes, such programme systems will produce other effects, both intended and unintended. In sections 9 and 10 of Chapter 2 we discussed such para-production effects as when environmental control programmes give employment, which yields economic benefits to the community; the people employed by such systems acquire experience, skills, and greater self-sufficiency, thus adding to the community's stock of resources. However, side effects are not always positive. The vesting of managerial authority in programme administrators results in both benefits and disbenefits that may be overlooked: for example, the capacity of the community to deal with social problems through organized interventions is increased, while the possession of such authority by organization heads implies some restriction on individual freedoms. Effective programmes may also have a marked influence on the demographic characteristics of the community, which is a fundamental factor in producing a new configuration of community resources and needs. Thus, both by their operations and by their effects on the health conditions of a community—i.e., by their alteration of the state of the total community system—environmental health programmes can have various other social and economic repercussions.

3. **Goals of environmental health programme systems are advanced or thwarted by the operation of other programme systems.** Various environmental health programmes are usually justified on the grounds that they will result in reduced morbidity, mortality, and disability. When such benefits occur, however, it is frequently difficult to determine whether and to what extent they were brought about by the environmental control programme itself. If they occur simultaneously with improvements in nutrition, disposable income, and knowledge of good health practices in the community, it may reasonably be conjectured that the operations of these other systems
contributed as much or more to the decline of disease as did the environmental health programme. On the other hand, what might otherwise have been a successful environmental health programme may prove to have no significant impact on the health conditions of the community if the programme ignores or is unable to reverse simultaneous deterioration in relevant social conditions, or if other programmes in the community pursue goals that nullify or reduce its impact.

The existence of these external relationships clearly points to the need for environmental health programmes to be planned and executed with the greatest possible communication and interchange with other systems in the community. Too often, the external relations of environmental health programmes are viewed in an oversimplified manner. Administrators see their own programme as competing with other programmes and hence needing more forceful interpreting and “selling” of its virtues to those who control funds and other resources. While such interpretation and promotion may be a necessary and important function of administration, this conception of external relations is inadequate. More effective administration requires that planners and managers take account of the full range of implications of their own programme goals and, further, that they actively seek to participate as consultants and collaborators in the planning and execution of other community programmes that demonstrably or potentially interact with environmental health.

7. A GUIDE TO DETAILED STUDY OF THE ADMINISTRATIVE PROCESS

Having traced the development of the administrative process as a whole, we shall pause briefly to examine some of the characteristics of health planning (Chapter 5). We shall then proceed in Chapters 6–9 to examine the individual steps or phases of administration in detail. To guide the reader through this discussion, Fig. 5 shows the relationships among these phases and indicates the chapters and sections in which each is discussed.

It will be noted that the upper part of the diagram conforms to the definition of administration given in the Introduction, namely, that administration is a process consisting of two major functions—planning (determining the course of action to be followed) and management (seeing to it that the course is followed, as well as making needed corrections and adjusting the system to changing conditions). The phases of the administrative process pertaining to
Fig. 5. General relationship of topics in programme administration, and sections in which they are discussed

**ADMINISTRATION**
(Chapter 4)

**PLANNING FUNCTION**
(Chapters 5 and 6)

**CARDINAL PROCESSES**
- Communication (Chapter 8, sec. 1 and 2)
- Decision making (Chapter 6, sec. 1)
- Evaluation (Chapter 5, sec. 1; Chapter 9, sec. 1 and 2)

**MANAGEMENT FUNCTION**
(Chapters 7, 8, and 9)

**Programme Planning**
(Chapter 6)
- Problem analysis (sec. 1)
- Role analysis (sec. 2)
- Objective setting (sec. 3)
- Constraint analysis (sec. 4)
- Programme selection (sec. 5)
- Programme plan preparation (sec. 6)
- Budget formulation (sec. 7)

**Management Planning**
(Chapter 7)
- Conduct of management planning (sec. 1)
- Setting of norms
  - General (sec. 2)
- Operational (sec. 3)
- Specification of activities (sec. 4)
- Projecting programme implementation
- Implementation scheduling (sec. 5.1)
- Resource planning (sec. 5.2)
- Transition to management operations (sec. 6)
- Administrative communication (Chapter 8)
  - General (sec. 1)
  - Administrative procedures (sec. 2)
  - Forms (sec. 3)
- Information systems (sec. 4)
- System control and evaluation (Chapter 9)
  - General (sec. 1)
  - Types of control (sec. 2)
  - Financial control (sec. 3)
the planning and management functions are shown below these headings. It was also mentioned in the introductory definition that both major functions, as well as their components, are served by the cardinal processes of communication, decision making, and evaluation.

It is recognized that not all readers will be in agreement with the classification shown in the figure or with the arrangement of topics in subsequent chapters. For example, it could reasonably be argued that most of the administrative steps shown under the heading of management planning could be associated with the planning function just as well as with the management function—as indeed they might be in one administrative situation as contrasted with another. Judgements in such matters are necessarily arbitrary, and the classification used here is justified only by the writer’s experience and his estimate of what arrangement will make sense to most readers.

Another part of the difficulty of proposing a valid classification arises from the limitations and character of written media of communication. In print, processes and methods must necessarily be described in some sequence even though in actual practice they may be used simultaneously or parallel with one another. Because this limitation cannot be overcome, the comprehensive overview of administration presented in this chapter should be kept in mind as the various phases of the process are described sequentially. While that sequence will follow the logic of programme development as discussed in the preceding pages, it is well to remark once again that the circumstances and events of administrative practice seldom occur in such a logical order. The wholeness and comprehensiveness of administration stem from concrete administrative situations, and no conceptual treatment of the subject can fully capture that integrity or reflect what is particular to each such situation.