An Application of General Systems Theory to the Determination of the Nature of Accounting.

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TO THE DETERMINATION OF THE NATURE OF
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TO THE DETERMINATION OF THE NATURE OF ACCOUNTING

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Submitted to the Graduate Faculty of the
Louisiana State University and
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in

The Department of Accounting

by

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ABSTRACT

Accounting as a profession and body of knowledge has a long history of service in the conduct of the economic affairs of mankind. In recent years, however, change in all areas of human endeavor has forced accountants to reevaluate the role of their discipline in society and to seek to expand its boundaries in order to maintain and increase its importance as a discipline.

General systems theory is a developing body of concepts which can be quite useful in the effort to describe the nature of accounting. These concepts are based on the assumption that the entire universe can be viewed as a hierarchical structure of systems, a system being any complex of elements in mutual interaction. The purpose of the study here is to identify the basic concepts of general systems theory and to describe the nature of accounting within the systems framework.

The view of human organizations taken in this study is based on the concept of the cybernetic system. Cybernetic systems maintain a state of self-regulation through the feedback process. Human organizations will be most effective if they operate as self-regulating systems with three basic groups of components—management, production, and information. The management components control the system, the production components process inputs into outputs, and the information components measure and communicate feedback information. The role of accounting should be to act as the feedback information component of self-regulating human organizations of all kinds.
The basic elements of the structure of any system are the environment, objective, boundary, inputs and outputs, and components. The environment of accounting includes primarily the organizations in which it functions as information component. The basic objective of any system is considered to be survival, which is achieved through production of output useful to the suprasystem. The objective of accounting then is the production of information output of maximum usefulness to its suprasystem. The boundary of accounting is the state of affairs which identifies it and links it with its environment. In one respect this boundary is determined by tradition or general acceptance, but ideally it should be determined by a structure of accounting theory. Maintenance inputs from the suprasystem sustain accounting, while signal inputs are selected for processing into information output. The output of accounting results from the measurement and communication activities of the two basic production components of accounting—accounting for external users and management accounting.

Accounting ideally should function as a self-regulating system, in specific organizations and in the aggregate as a profession. A system in a condition of maintained self-regulation is said to have achieved a steady state. The steady state of accounting should be that of constant production of useful information output through an adaptive system structure. The process of adaptation inevitably means growth and expansion, and accounting may grow quantitatively by multiplication of usual activities and qualitatively through incorporation within its boundary of other information techniques so as to maintain and improve the usefulness of its output.
Accounting may be defined as the system for the measurement and communication of feedback information on the state and process of human organizations. Accounting is considered to encompass the entire scope of feedback information production. As a body of knowledge, accounting should consist of a framework of general principles based on general systems concepts. As a profession, accounting should be staffed with information specialists capable of functioning in any organization. The responsibility of accounting education should be production of graduates inspired by an understanding of accounting's vital role in human affairs and equipped with the knowledge that will enable them to fulfill that role.
CHAPTER I

INTRODUCTION

Purpose of the Study

Rapid change in all areas of human endeavor has become the basic characteristic of the second half of the twentieth century.\(^1\) The rush of technological advances sweeps away the old technology and makes products, processes, and equipment obsolescent from the moment they are conceived. The development and application of the electronic computer has had a most profound effect in recent years. The vast information storage and processing capabilities of this instrument have either caused or made possible many of the changes and achievements in science, business, government, and other areas.\(^2\)

Change is rampant not only in technology and science but also in the areas of human behavior and social organization. New technology, scientific progress, and rapid change itself have undoubtedly had profound, pervasive, but poorly understood effects on the mores of human society.

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\(^1\)This conclusion has been reached by numerous writers. Max Ways states: "The great new truth about humanity is change, movement." Max Ways, "Gearing U.S. Policy to the World's Great Trends," *Fortune*, LXXIX (May 1, 1969), p. 65.

The accountant of today finds that his area of knowledge has not escaped the effects of technical and social change. Many of the traditional clerical functions that have been thought of as accounting are being automated. Accountants have found that they must expand the horizons of their profession if it is to survive. The authors of *Horizons for a Profession* observed that "the advent of the computer, the development of sophisticated mathematical and statistical tools now applicable to problems in the world of affairs, and the promise of research in behavioral science make increased rigor mandatory if CPAs are to maintain a place in the sun."³

Those persons who are involved in the academic study of accounting and who thus tend to view it as an area of knowledge are particularly concerned with determining more clearly the nature of accounting and its place in human society. Even the practicing accountant, caught up in the details of the work which mainly through expediency has become "accounting," must occasionally have the nagging thought: "What relationship does what I am doing have to something really important?"
The question then is what is the true nature of accounting and what is its place in the realm of human society.

A developing body of knowledge which may aid in the understanding of the nature of accounting is general systems theory. Kenneth Boulding states that general systems theory "aims to provide a framework or structure on which to hang the flesh and blood of particular disciplines and particular subject matters in an orderly and coherent corpus

Accountants need a basic framework which can be used to enable them to better determine and describe the order and coherence of their field of knowledge. General systems theory holds promise as such a framework.

The premise of this thesis then is that general systems theory can be used to determine and describe the nature of accounting. The assumption is that accounting can be viewed as a system and described within the framework of general systems theory.

Approach and Methodology

Any study making use of the ideas of general systems theory must begin with an investigation of the current state of development of the theory and a synthesis of its major points. General systems theory is a developing body of knowledge whose principles are scattered throughout the writings of several disciplines. Only recently have there appeared books attempting to bring together the basic ideas of general systems theory, and these are not complete.

The first part of the research which is the basis of this dissertation involved the study of the literature of general systems theory to determine the nature of theory and to identify the principles which have been suggested up to this time. Secondly, these principles were


examined as to their applicability to the determination of the nature of accounting and then they were used to develop a description of accounting as a system.

The idea of a general systems theory was developed and publicized by the biologist Ludwig von Bertalanffy. His book Problems of Life presents his early conceptions about the nature of a general systems theory. Research into the theory then must begin with the writings of Bertalanffy. Another classic work on general systems theory was that published by the economist Kenneth Boulding in 1956 in which he described a "system of systems." Beyond these basic writings in general systems theory, systems principles in recent years have been described and applied in the fields of management and organization theory, sociology and psychology, operations research, systems


9Kenneth E. Boulding, op. cit.


12For example, Churchman, op. cit.
engineering, cybernetics, information theory, and others. There are also, of course, works in general systems theory as a separate and distinct field. Many of the above-mentioned subject areas, such as cybernetics and information theory, are in reality derivatives or variations of general systems theory. Research into general systems theory involves consideration of the important research and writings of these various fields.

The second aspect of research involved the use basically of deductive reasoning to apply the principles that relate to systems in general (general systems theory) to a specific system, accounting. This line of research involved four steps. First, it was necessary to establish that accounting fits the general definition of a system. Second, since each system consists of certain elements, these elements were identified, where possible, in accounting. Third, an attempt was made to relate the ideas of system behavior to accounting. Finally, the implications of the understanding of accounting as a system were investigated, with particular concern for the future of accounting as a profession and as an academic discipline or body of knowledge.

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14 For example, Stafford Beer, Cybernetics and Management (New York: John Wiley & Sons, Inc., 1959).


Chapter II presents the nature of general systems theory as a body of concepts and Chapter III describes some of the characteristics of systems as set forth in the theory. Chapter IV basically provides the justification for the application of general systems theory to accounting, while Chapters V and VI describe accounting in terms of the elements of systems and the behavior of systems as viewed by general systems theory. Chapter VII suggests some of the implications that the application of systems theory has for accounting.

Limitations of the Study

A study involving general systems theory is limited at the outset by the nature of the theory in its current state of development. Since general systems theory involves principles applicable to all systems, the principles must of necessity be abstract. Berrien, in introducing his book General and Social Systems, states: "... We shall present a version of general systems theory as a set of definitions and postulated relationships. These, we shall argue, are both sufficiently precise and sufficiently abstract to be applicable to systems at various levels of analysis." Kaplan says "systems theory is . . . not a theory. It consists of a set of concepts. . . ." Katz and Kahn, in describing open-system theory, emphasize that "open-system theory is an approach and a conceptual language for understanding and describing many kinds and levels of phenomena." General systems

17 Berrien, op. cit., p. 8.
19 Katz and Kahn, op. cit., p. 152.
theory as presently formulated can best be described as an approach or methodology and a growing body of concepts designed to promote understanding of phenomena which exhibit the characteristics of systems.

General systems theory, as originally envisioned by Bertalanffy, was to be a "logico-mathematical field." He proclaimed that "the principles that hold for systems in general can be defined in mathematical language." Progress in stating the principles in mathematical terms has been slow, however. Berrien, writing in 1968, stated that "at this stage of our understanding most of the concepts in general systems theory lack the precision which permits translation into the formal mathematical statements."22

The point of the preceding discussion is that the view of accounting taken in this study is abstract. The view will be a macro view, since this is the view of general systems theory. The objective is to gain a better understanding of the general nature of accounting and its place in the social system by taking the outlook of general systems theory. It is not proposed that all the detailed procedures, problems, and relationships within accounting can necessarily be explained or improved through use of the principles of general systems theory. The implication is, however, that a better understanding of the nature of accounting will provide part of the basis for the improvement of accounting procedures, the solution of current problems, and the maintenance of an important role for accounting in the future.

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20 Bertalanffy, Problems of Life, p. 199.
21 Ibid.
22 Berrien, op. cit., p. 12.
CHAPTER II

THE NATURE OF GENERAL SYSTEMS THEORY

The Need for General Systems Theory

General systems theory has developed over the past few decades out of a need to provide some unifying general concepts for the massive quantities of information being generated in all fields of knowledge. The theory is an attempt to take a macro view of science and human affairs as opposed to the traditional micro view taken by individual disciplines. Systems theory seeks to overcome the inhibitions to overall knowledge brought on by the somewhat arbitrary divisions of knowledge into academic disciplines. Russell Ackoff put it this way: "We must stop acting as though nature were organized into disciplines in the same way that universities are. The division of labor along disciplinary lines is no longer an efficient one."\(^1\)

The solution to the problem of the increasing amount and complexity of knowledge traditionally has been specialization. As knowledge increased in a general area, such as biology or economics, the tendency was for individuals to limit their work or study to a particular facet of the field. As more and more information was generated

narrower and narrower specialization occurred. "Thus Pavlov examined
with great care the salivary behavior of dogs, Sherrington isolated the
stretch reflex, and Culler studied dogs with functional spinal cords
only."² Wiener stated in 1948 that "today there are few scholars who
can call themselves mathematicians or physicists or biologists without
restriction. A man may be a topologist or an acoustician or a coleopterist.
He will be filled with the jargon of his field, and will know
all its literature and all its ramifications, but, more frequently than
not, he will regard the next subject as something belonging to his col­
league three doors down the corridor, and will consider any interest in
it on his own part as an unwarrantable breach of privacy."³

This micro approach to knowledge, though valuable in some re­
spects,⁴ was an extreme which neglected the relationships among parts.
Bertalanffy, in his early writings on general systems theory, stated:

\[\ldots\text{It is impossible to resolve the phenomena of life comple­}
\text{tely into elementary units; for each individual part and each}
\text{individual event depends not only on conditions within itself,}
\text{but also to a greater or lesser extent on the conditions within}
\text{the whole, or within superordinated units of which it is a part.}
\text{Hence the behavior of an isolated part is, in general, different}
\text{from its behavior within the context of the whole.}\ldots\]

²F. Kenneth Berrien, General and Social Systems (New Brunswick,

³Norbert Wiener, Cybernetics (2nd ed.; Cambridge Massachusetts:

⁴At least one writer considers overspecialization dangerous.
Lord Ritchie-Calder blames the pollution of the earth's environment on
"scientists and decision-makers [acting] out of ignorance and [pretend­
ing] that it is knowledge. \ldots\ Because of overspecialization, most
scientists are disabled from exercising judgments beyond their own
sphere." Lord Ritchie-Calder, "Mortgaging the Old Homestead," Foreign

⁵Ludwig von Bertalanffy, Problems of Life (London: Watts & Co.,
The need then was for a new or complementary area of study—relationships among parts within a whole, or the concept of organization.

General systems theory is an attempt to discover general relationships that exist between the parts of any whole, or "system." As Boulding has indicated, it does not seek "to establish a single, self-contained 'general theory of practically everything' which will replace all the special theories of particular disciplines. Such a theory would be almost without content, for we always pay for generality by sacrificing content, and all we can say about practically everything is almost nothing." Rather, general systems theory seeks a level of generality somewhere "between the specific that has no meaning and the general that has no content."^7

The thesis of general systems theory is that physical and social phenomena can be viewed within the framework of systems and that if generalizations can be made about the nature of systems then these general concepts will lead to a better understanding of particular systems. Bertalanffy's statement about the physical world was: "We find in nature a tremendous architecture, in which subordinate systems are united at successive levels into even higher and larger systems."^8 The generality of this fact led Ellis and Ludwig to conclude that "the properties, circumstances, occurrences, and relationships concerning appropriate phenomena may be related by a common vocabulary and a single set of concepts. These yield sufficient generality to describe widely

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^7Ibid.

^8Bertalanffy, op. cit., p. 23.
diverse systems without reference to their expression in nature or by artifice." This statement by Ellis and Ludwig summarizes the objective of general systems theory.

General systems theory may thus be said to provide a set of general concepts common to many disciplines. That is, it is an interdisciplinary approach to knowledge. Boulding warned that increasing specialization among disciplines could lead to a slowing of the total growth of knowledge because of the lack of communication. He stated that "in the course of specialization the receptors of information themselves become specialized. Hence physicists only talk to physicists, economists to economists.... One wonders sometimes if science will not grind to a stop in an assemblage of walled-in hermits, each mumbling to himself words in a private language that only he can understand." The general systems theorist believes that knowledge growth need not slow down and that science need not grind to a halt if interdisciplinary concepts and models are developed and used. New interdisciplinary fields of study are being developed, and these are the "systems sciences," including general systems theory, along with such related fields as cybernetics, information theory, and game theory.

General systems theory then has developed out of a need for concepts that will facilitate a macro view of science and human affairs and bridge the communication gaps among specialized disciplines. The theory is still embryonic, development having taken place only over the past twenty or thirty years, but it has reached the stage that its

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10Boulding, op. cit., p. 198.
outlook and concepts are valuable to one who seeks to better understand the general nature of one or many areas of knowledge.

The Development of General Systems Theory

General systems theory is a product of the belief by scholars in numerous fields that in addition to a study of the miniatiae of an area of knowledge there must be a study of the organization of the parts into a whole. The immediate popularity of the idea of such a theory or of the "systems approach" after it was proposed around 1950 indicates that scientists in several fields were concerned about the need for a better understanding of the principles of organization. According to Bertalanffy, "workers widely separated geographically, without contact with each other, and in very different fields arrived at essentially similar conceptions--sometimes to the point of almost literal coincidence of expression. In other words: developments emerging from experimental embryology, developmental psychology, cultural anthropology, neo-Kantian philosophy, sociology and other fields, converged into closely similar conceptions of the organism--man and society--developments which only now have come to full fruition."11

Ludwig von Bertalanffy is the creator of the concept of a general systems theory, according to his own claim12 and attribution by others.13


12"The aim and term of general systems theory was first introduced by your lecturer after the War (prior to Wiener's Cybernetics of 1948)." Ibid., p. 40.

13For example, in addition to those sources mentioned in Chapter I of this dissertation, see Boulding, op. cit., p. 197.
Bertalanffy is an Austrian-born biologist, now a citizen of Canada, who is presently serving as Professor of Theoretical Biology at the University of Alberta. His earliest publication regarding the idea for a body of general systems concepts came in 1947. The idea was published in English in 1950 in the British Journal of Philosophical Science. The acceptance of the idea of a general systems theory is attested to by the formation of the Society for General Systems Research, which has published a yearbook, General Systems, since 1956.

The concept of an overall theory of systems developed out of Bertalanffy's belief in "organismic biology." He believed that "the proper study of biology is in the order and organization of parts and processes," rather than in the study of the parts alone. Many physical scientists and behavioral scientists had long ignored principles of organization, believing that relationships among parts were the products of chance events. Bertalanffy and others believed, however, that the physical and social world, rather than being one of unorganized or lawless complexity, was one of organized complexity. "Organization runs right through all levels of reality and science," said Bertalanffy. Physicists must be concerned not only with the nature of elementary particles of matter but also with the laws governing the relationships among these particles. Biologists cannot be concerned only with the


\[16\] Bertalanffy, Organismic Psychology and Systems Theory, p. 35.

\[17\] Ibid., p. 34.
elementary units of life but must also consider the organizational relationships which form these units into higher and higher forms of life (organisms) and which cause and control the growth and evolution of living things. Likewise, sociologists must consider the organizational principles that govern sociocultural systems. Bertalanffy concluded that "the principles of wholeness, of organization, and of the dynamic conception of reality become apparent in all fields of science."\textsuperscript{18}

Thus, it should be possible to identify principles of wholeness, organization, and dynamics that apply to systems (that is, any complex of interacting elements) in general. Such a body of principles would be the content of general systems theory.

Concurrent with and subsequent to Bertalanffy's development of the idea of a general systems theory, other scientists worked on concepts of organization which have since become part of systems theory. Some of these scientists sought laws of organization within the recognized physical and behavioral sciences. Others developed interdisciplinary approaches, creating such new fields as cybernetics, information theory, and operations research. For example, cybernetics, concerned mainly with control of systems, was introduced in 1948 by Norbert Wiener.\textsuperscript{19} These and other areas related to general systems theory are described in more detail later in this chapter.

In recent years there has been an increased recognition of the significance of the systems outlook and of the value of general systems

\textsuperscript{18}Bertalanffy, \textit{Problems of Life}, p. 176.

\textsuperscript{19}Wiener, \textit{op. cit.}
theory. One writer has gone so far as to say that "'system' and 'systems analysis' are already fad terms." There may be an element of truth to this claim, as it appears fashionable now to profess to use the systems approach in attacking all problems, often without a very clear understanding on the part of the solution-seekers of what this "systems approach" involves. If one looks beyond the fad aspects of systems, however, one finds that the careful use of the emerging principles of general systems theory, with recognition of the tentative and abstract nature of these principles, has enabled students of numerous areas of scientific endeavor to gain a better understanding of the relationships which determine the nature of the subject of study. This approach is the one to be followed herein in the effort to gain a better understanding of the nature of accounting.

The Realm of Systems Theory

As a first step in the study of general systems theory, it is necessary to distinguish among the several terms which have been used in describing fields of knowledge that deal with systems. These terms include systems theory, systems science, general systems theory, open-system theory, the systems approach, systems analysis, system engineering, and such specialized terms as computer systems and accounting systems. These terms, while related in that they deal with "systems," actually describe conceptions along a spectrum from the very abstract to the very concrete. There is no real agreement on the specific meanings of these terms, but those presented below seem to be useful.

"Systems theory," or "systems science," is a broad term that encompasses all areas of thought and application involving concepts of "systems." Bertalanffy divides the systems sciences into two categories—the mechanistic trend and the organismic trend. \(^{21}\) The mechanistic trend is connected with technological, industrial, and social developments such as control techniques, automation, computerization, and their application for industrial, military, governmental, etc., purposes. The underlying theory is essentially that of cybernetics, automata, computers, and similar hardware. \(^{22}\) The organismic trend, on the other hand, involves the search for generalizations about systems rather than specific applications. Cybernetics, systems analysis, system engineering, computer systems, and accounting systems are products of the mechanistic branch of systems theory. General systems theory and open-system theory have developed out of the organismic trend.

General systems theory may be considered an overall term covering the conceptual approach to systems. Much of the content of general systems theory has developed out of the concept of the "open" system. Thus, open-system theory is a part of general systems theory, and at present a relatively large part. Also, concepts which have been discovered and elaborated in the more mechanistic areas, such as cybernetics, have been incorporated into general systems theory. General systems theory is concerned with generalizations; cybernetics, systems engineering, and others of the mechanistic branch are concerned with applications. The one is theoretical, the other practical.

\(^{22}\) Ibid.
"The systems approach" is a widely used term which emphasizes the view of systems theory as an outlook or way of thinking. This term describes the approach to problem-solving or situation analysis which involves the application of systems-principles. Operations researchers, for example, say they take the systems approach in designing models to aid in management decision-making. The systems approach then describes the outlook that is the basis for all systems theory—the conception of the system as a whole, as opposed to the analytical approach.

At the very concrete level, systems concepts may be applied in designing a specific accounting system or part of such a system. At a more abstract level, systems concepts may be applied in the attempt to describe the nature of accounting as an area of knowledge. This latter application is the one attempted in this study.

"System" Defined

Definitions of the term "system" have been offered by many writers. A sampling of these definitions is presented below.

Bertalanffy:
"... A complex of elements in mutual interaction."24

Churchman:
"... A set of parts coordinated to accomplish a set of goals."25

Beer:
"... Anything that consists of parts connected together."26

24Bertalanffy, Problems of Life, p. 11.
25Churchman, op. cit., p. 29.
"... Any cohesive collection of items that are dynamically related." 27

Ellis and Ludwig:
"A system is a device, procedure, or scheme which behaves
according to some description, its function being to operate on
information and/or energy and/or matter in a time reference to
yield information and/or energy and/or matter." 28

Berrien:
A structural definition:
"A system is defined as a set of components interacting with
each other and a boundary which possesses the property of filtering
both the kind and rate of flow of inputs and outputs to and from
the system." 29

A functional definition:
"A system processes inputs and expels products which are, in
some detectable characteristic, different from the inputs." 30

Hall and Fagen:
"A system is a set of objects together with relationships
between the objects and between their attributes." 31

The preceding definitions and all the others are of two basic
types, general and special-purpose. Bertalanffy's definition, as an
example, is a general description of a system. Berrien's definition,
on the other hand, even though it is of rather general applicability,
is really designed specifically as the basis for the version of gen-
eral systems theory he develops in his book General and Social Systems. 32
A basic general definition of "system" then should follow the pattern
of those of Bertalanffy, Churchman, and Beer quoted above. A system

27 Ibid.
28 Ellis and Ludwig, op. cit., p. 3.
30 Ibid., p. 15.
31 A. D. Hall and R. E. Fagen, "Definition of System," General
32 Berrien, op. cit.
is any complex of elements in mutual interaction. This basic definition can be extended into detailed descriptions of the structure and behavior of systems. Chapter III of this dissertation presents such a detailed description of the general properties of systems.

Open vs. Closed Systems

Much of the value and general applicability of systems theory originates in the concept of the open system. The older systems concepts of the physical sciences dealt with closed systems, that is, systems isolated from their environment. Living systems are not so isolated, however, and thus the principles of closed systems have only limited applicability in the biological and social sciences. Bertalanffy promulgated a theory of open systems, which became the foundation of general systems theory and which allowed wider application of systems concepts to the social sciences.

Closed systems are those which are "relatively self-contained structures," functioning "within themselves," without interchange with the environment. Open systems, on the other hand, are those in contact with their environment, with input and output across the boundaries of the systems. Buckley emphasizes that "this interchange

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33 Berrien, op. cit., p. 15, reports that Bertalanffy emphasized the open-system concept in a 1932 work, Theoretische Biologie, I, Gebruder Borntraeger, Berlin.


35 Berrien, op. cit., p. 15.

Between the open system and its environment is an essential factor underlying the system's viability, its reproductive ability or continuity, and its ability to change.37

In reality, no true closed systems exist.38 As the definition above states, closed systems are relatively self-contained. Interaction with the environment is limited. A clock is sometimes proposed as an example of a closed system. The clock "maintains a steady level of operation so long as the mainspring tension does not drop below a given point. But periodically, new inputs are necessary to keep the system functioning."39 Thus it is a matter of degree of openness. For all practical purposes, some systems may be analyzed as though they were closed, since the effects of the environment are relatively immaterial. Also, it is sometimes useful to study a system as if it were closed, as is done in the static models of economic theory. Relationships within the system are examined under the ceteris paribus assumption which holds environmental conditions constant at the point of analysis.

Living systems, however, "are acutely dependent upon their external environment and so must be conceived of as open systems."40 Bertalanffy made the point beautifully from the viewpoint of a biologist: "Living forms are not in being, they are happening; they are the expression of a perpetual stream of matter and energy which passes the


38 Chin, op. cit., p. 20.

39 Berrien, op. cit., p. 16.

40 Katz and Kahn, op. cit., p. 18.
organism and at the same time constitutes it. We believe we remain the same being; in truth hardly anything is left of the material components of our body in a few years; new chemical compounds, new cells and tissues have replaced the present ones." Thus, the human body is more a process than a fixed structure. Open systems must be viewed as processes which continually give up matter to the outer world and take in matter from it. Talcott Parsons states that "the system is not the physical organism nor the object of perception, but it is a system of behavior or action."

The distinction between open and closed systems may be expressed through the concept of entropy. The second law of thermodynamics states that "the general direction of ... physical events is towards a decrease of order and organization." According to Scott, entropy is a measure of this tendency for the organization of any closed system to deteriorate. That is, closed systems have increasing entropy and tend to "run down," to take the path of least resistance and finally reach their most probable state, through dissipation of their energy and the progressive destruction of differentiation and order. Open systems, on the other hand, are characterized by negative entropy.

^41^ Bertalanffy, Problems of Life, p. 124.

^42^ Ibid., p. 125.


^44^ Bertalanffy, Problems of Life, p. 112.

Open systems counteract entropy through interchange with the environment which provides energy and resources. Hence, according to Bertalanffy, "the entropy balance in an open system may well be negative, that is, the system may develop toward states of higher improbability, order, and differentiation."\(^46\) Thus, whereas closed systems tend to run down, open systems tend to grow and become more elaborated.

General systems theory then is basically the theory of open systems. The laws of Newtonian physics, which might be called the theory of closed systems, are deemed inadequate in dealing with living systems and social structures. General systems theory involves concepts of the open system, viewing systems as processes and seeking to understand and describe the relationships both within the system and between the system and the environment.

**Variations and Applications of Systems Theory**

Systems theory has been described above as a broad area of thought and knowledge centered around the concept of the system. Many lines of study, research, and application have contributed to the body of the systems concepts. The common objective that binds these rather diverse areas of study together is the search for unifying principles of organization. The discussion which follows in this section presents a brief description of several of the variations and applications of systems theory and concludes with a final look at the nature of general systems theory.

Cybernetics. Cybernetics is the science of system control. In particular, it is concerned with self-regulating systems. The science was promulgated by Norbert Wiener in his 1948 book, *Cybernetics*.\(^7\) Stafford Beer, in his book *Cybernetics and Management*, summarizes the nature of cybernetics as follows:

Cybernetics is the science of communication and control. The applied aspects of this science relate to whatever fields of study one cares to name: engineering, or biology, or physics, or sociology. . . . The formal aspects of this science seek a general theory of control, abstracted from the applied fields, and appropriate to them all.\(^8\)

A major contribution of cybernetics is the description of the significance of feedback in self-regulating systems. Beer calls feedback the key idea that underlies control.\(^9\) Feedback is a basic property of cybernetic systems, since it is feedback that allows for self-regulation of the system.\(^10\) In feedback, output of a system is compared against desired performance and discrepancy information becomes an input to effect changes in the system. A simple cybernetic system with feedback is represented diagramatically in Figure 2-1.

![Figure 2-1. A Simple Cybernetic System](image)

\(^{47}\)Wiener, op. cit.

\(^{48}\)Beer, op. cit., p. 7.

\(^{49}\)Ibid., p. 28.

\(^{50}\)Scott, op. cit., p. 165.
Cybernetics has itself grown into a diverse area of knowledge. It is generally considered the basis for automation, for example. One writer has divided cybernetics into three large subdivisions: (1) theoretical cybernetics, including mathematical and philosophical problems; (2) the cybernetics of control systems and means which includes the problems of collecting, processing, and output of information, and also the means for electronic automation; and (3) the field of the practical application of the methods and means of cybernetics in all fields of human activity. The major contribution of cybernetics to systems theory remains, however, the concept of the self-regulating system with feedback.

**Information theory.** Information theory is directly related to cybernetics. Cybernetic systems require communication or flow of information to achieve self-regulation. In fact, all systems are bound together by flows of information. Information theory defines information in a specific sense and depicts the flow of information as a statistical process which can be described in terms of the mathematics of probability theory. Wiener discussed information in Cybernetics, and the theory was developed fully in Shannon and Weaver’s *The Mathematical Theory of Communication* (1949).

Shannon’s conception of a general communication system is shown in Figure 2-2. It consists of five parts:

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52 Wiener, op. cit.

1. An information source which produces a message or sequence of messages to be communicated to the receiving terminal.

2. A transmitter which operates on the message in some way to produce a signal suitable for the transmission over the channel.

3. The channel is the medium used to transmit the signal from transmitter to receiver. During transmission, or at one of the terminals, the signal may be perturbed by noise.

4. The receiver ordinarily performs the inverse operation of that done by the transmitter, reconstructing the message from the signal.

5. The destination is the person (or thing) for whom the message is intended.

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Figure 2-2. Schematic Diagram of a General Communication System

The concern of the mathematics of information theory is to provide a measure of the amount of information conveyed from any selection or choice among messages from defined sources. Information theory does not consider such factors as the meaning, reasonableness, and

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54 Ibid., pp. 4-6.

55 The details of the mathematics involved in the calculation of this measure may be found in Shannon and Weaver, op. cit. An excellent summary may be found in Buckley, op. cit., pp. 64-89.
personal importance of the message. Thus, in the mathematical sense, information theory is a rather narrow field useful primarily in the technical aspects of information transmission.

Cybernetics and information theory emphasize the significance of communication and information flow in systems. Although the mathematical theory of communication of Shannon has limited direct application, it has provided an impetus and a foundation for extensive study of symbolic intercommunication. This broader area of study is sometimes called "communication theory." Communication is an integral part of systems and thus the study of information and communication has a direct relationship to systems theory.

Game theory and statistical decision theory. Game theory and decision theory are described by Bertalanffy as follows:

Game theory analyzes, in a novel mathematical framework, rational competition between two or more antagonists for maximum gain and minimum loss.

Decision theory similarly analyzes rational choices, within human organizations, based upon examination of a given situation and its possible outcomes.

These two related fields are mathematical and statistical disciplines involving analysis and evaluation of alternative strategies. The systems approach is evident in the design of the games of game theory. "In such games each participant is striving for his greatest


advantage in situations where the outcome depends not only on his actions alone, nor solely on those of nature, but also on those of other participants whose interests are sometimes opposed, sometimes parallel to his own. The mathematics of game theory at present is incomplete, has limited applicability, and relies on numerous initial assumptions. Nevertheless, game theory and statistical decision theory hold the promise of possible valuable contributions to the concepts and methodology of systems theory.

**Organization theory.** Organization theory deals with a specific type of system, the social organization. An organization exists "when explicit procedures are established to coordinate the activities of a group of people in the interest of achieving specified objectives." Organizations thus are social systems and the application of systems concepts is an important part of organization theory.

The behavioral sciences—sociology, psychology, and social psychology—have made much use of systems theory in recent years. Organization theory is a product of this systems approach to the understanding of the behavior of human beings as individuals and in groups. Students of business management have embraced organization theory as an important aid in the understanding of the business organization. All in all, organization theory is a highly significant application of the concepts of systems theory.

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60 Buckley, op. cit., pp. 121-122.

Systems engineering. Systems engineering is the scientific planning, design, evaluation, and construction of man-machine systems. For example, a systems engineering project might involve the design and production of a military weapons system. This field emphasizes the engineering aspects of particular systems, but its general philosophy is that of the systems approach and it involves applications of concepts of systems theory.

Operations research. Operations research is "the scientific control of existing systems of men, machines, materials, money, etc.," according to Bertalanffy. Ackoff states that the essential characteristics of operations research are "its system orientation, its use of interdisciplinary teams, and its methodology. . . . The systems approach to problems is based on the observation that in organized systems the behavior of any part ultimately has some effect on the performance of every other part. . . ." The methodology of operations research involves the identification of the variables in a system or system component and the construction of a representation, or model, of the system that can be manipulated to determine the effect of changes in system variables. "The output of an OR study, then, is usually a set of rules for determining the optimal values of the controlled variables together with a procedure for continuously checking the values of the uncontrolled variables. . . ."

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63 Ibid.
65 Ibid., p. 293.
thus involves the application of the systems approach and systems concepts in the design of models useful in the management of systems.

**Rhocrematics.** Rhocrematics, according to Johnson, Kast, and Rosensweig, is defined as "the science of managing material flow, embracing the basic functions of producing and marketing as an integrated system and involving the selection of the most effective combination of subfunctions such as transporting, processing, handling, storing, and distributing goods." It is the application of the systems approach to the management of production and marketing, with each activity in material flow considered as a segment of a total system. Rhocrematics thus is another of the growing number of applications of systems concepts to various areas of human endeavor.

**General systems theory.** Some writers indicate that general systems theory is not a theory but an outlook or methodology. In the opinion of this writer, however, although general systems theory is not really a theory in any strict sense of the word, it is more than just an outlook or philosophy. An outlook or philosophy is the basis of general systems theory, but it alone is not the theory.

The basis of general systems theory is the idea that various physical and social phenomena can be viewed as systems and that generalizations made about the nature of systems will lead to a better understanding of particular systems and of the relationships among

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67 Ibid., p. 175.

systems. The aim of general systems theory therefore is "the creation of a science of organizational universals . . . using the elements and processes common to all systems as a starting point." These universal characteristics of systems then are the content of general systems theory. There must be a synthesis at a high level of abstraction of such organizational universals. No such complete identification and synthesis has yet occurred, but the work to date toward this goal has produced concepts which provide for a better understanding of the nature of systems. The initial significance of general systems theory was in its outlook, it is true, but its final significance, if and when achieved, will be in a body of concepts which will provide the basis for a macro view of knowledge.

Summary

General systems theory has developed out of the need for concepts to allow a macro view of knowledge and of human affairs and to bridge the communications gaps among specialized disciplines. Its philosophy is that emphasis must be placed on principles of organization within the whole of a system rather than on the nature of the individual parts and events.

The concept of a general systems theory resulted from a convergence of thought in numerous fields around 1948. Ludwig von Bertalanffy first proposed that such a set of general concepts was possible, and workers in many fields have identified principles that have become part of the growing body of general systems theory.

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69 Scott, op. cit., p. 121.
The concept of the "system" has been used in so many areas, in fact, that there has developed a plethora of terms that describe aspects of systems theory. "The systems approach" is the outlook or philosophy of systems theory; "systems theory" or "systems science" is a broad term encompassing the whole realm of systems concepts and applications; general systems theory is the body of concepts relating to systems in general. "Cybernetics," "systems engineering," and "computer systems" identify specialized concepts and applications of systems theory.

A system can be defined in general as any complex of elements in mutual interaction. General systems theory is concerned with open systems, which are systems in contact with their environment, with input and output across the boundaries of the system. Open systems are contrasted with closed systems, which are relatively self-contained, without interchange with the environment.

Numerous variations and applications of systems theory are found today, including cybernetics, information theory, game theory, statistical decision theory, organization theory, systems engineering, operations research, rhocrematics, and others. Each of these areas has a specialized nature of its own, but each involves in some respect the application of the systems approach. Each has also contributed to an understanding of the general systems concepts which form the substance of general systems theory.
CHAPTER III

THE NATURE OF OPEN SYSTEMS

A system may be defined in general as any complex of elements in mutual interaction. An open system is one in contact with its environment, with input and output across the boundary of the system. These fundamental definitions provide the basis for a more detailed description of the nature of systems. Such a description must consider the concept of hierarchical order, the elements of which systems consist, the functional behavior of systems, and the dynamics which determine the state of a system. This chapter follows this outline to present a description of the nature of open systems.

Hierarchical Order

The "tremendous architecture." A fundamental assumption of general systems theory is that the universe may be conceived of as a nesting of systems, with smaller systems embedded in larger systems.¹ Thus Bertalanffy observed in nature a "tremendous architecture" of subordinate systems united at successive levels into higher and larger systems.² The hierarchy of systems in nature runs from atomic particles


through atoms, molecules, crystals, viruses, cells, organs, individuals, small groups, societies, planets, solar systems, and galaxies.\(^3\) The architecture of systems found in nature is, according to Bertalanffy, "typical of a pattern which is of wide occurrence not only in the biological but also in the psychological and sociological fields. It can be called \textit{hierarchical order}..."\(^4\)

The concept of hierarchical order states that every system is a component or subsystem of a suprasystem, with the possible exception of the largest system—the universe.\(^5\) Likewise, each system has subsystems, except for some lowest level of elementary system. Since any whole and its parts are systems, then the whole and the parts behave individually according to the same systems principles. Yet, since any whole consists not only of its parts but also of the relationships or organizational processes which bind the parts together, then the whole has characteristics that the parts taken individually do not have. Thus any system can be studied completely only by examining its components, the relationships among the components or subsystems, and the relationships between the system under study and the other components of its suprasystem.

The means of identification of the lowest level of elementary systems which have no subsystems has not been agreed on. In fact, according to Simon, "it is somewhat arbitrary as to where we leave off


\(^4\)Bertalanffy, \textit{op. cit.}, p. 37.

\(^5\)Miller, \textit{loc. cit.}
the partitioning, and what subsystems we take as elementary." Miller proposes that "if one found a homogeneous distribution of energy in any system, so that no boundary between its subsystems was discoverable, then that system would have no subsystems." He locates a boundary by a measure of energy or information exchange, but the selection of the magnitude of the measure which identifies a boundary is relatively discretionary, so that we still have no concrete description of an elementary system.

Despite some uncertainties about where the hierarchy of systems starts and stops, in general any system can be said to fit into a hierarchy of systems. Each system is part of a suprasystem and is itself made up of subsystems. Hierarchy is the basic characteristic of system structure and is an essential element in general systems theory.

The concept of the "black box." The hierarchical structure of systems requires that, in order to obtain complete knowledge of a system, one must describe all possible relationships within a system and between the system and its environment. Many of the systems that are most worthy of study, however, are so exceedingly complex that such a complete knowledge is impossible. A concept has been proposed which provides the basis for acquiring valuable understanding of the nature of a system without a complete analysis of its workings. This concept is the "black box."

A simple illustration may be used to portray the difficulties involved in describing a system. A system is assumed that has eight


7Miller, op. cit., p. 515.
inputs and one output. Each input and the output may exhibit one of
two states. There are thus $2^8$ possible input states and two possible
output states. With only two possible outputs, the number of possible
internal connecting or not connecting input-output states is $2^n$, where
$n$ is the number of distinguishable input states. The number of possible
arrangements then is $2^{2^8}$ or 2256. The time required to define the pos­
sible states of even this simple system is prohibitive.$^8$

Beer has classified systems into three categories of complexity:

Simple system:
Definition: A system with few components and interrelations.
Examples: Window catch, the tossing of a coin.

Complex system:
Definition: A system that is highly elaborate and richly
interconnected but describable.
Examples: Electronic digital computer, industrial
profitability.

Exceedingly complex system:
Definition: A system that is so complex that it cannot
be described in a precise and detailed fashion.
Examples: The economy, the brain, the company.$^9$

The notion of the black box originated in electrical engineer­
ing. Ashby describes it as follows:

We imagine that the Investigator has before him a Black Box
that, for any reason, cannot be opened. It has various inputs--
switches that he may move up or down, terminals to which he may
apply potentials, photoelectric cells on which he may shine lights,
and so on. Also available are various outputs--terminals on which
a potential may be measured, lights that may flash, pointers that
may move over a graduated scale, and so on. The Investigator's
problem is to do what he pleases to the inputs, and to make such
observations on the outputs as he pleases, and to deduce what he
can of the Box's contents.$^{10}$

$^8$Berrien, op. cit., p. 19.

$^9$Stafford Beer, Cybernetics and Management (New York: John Wiley

$^{10}$W. Ross Ashby, "General Systems Theory as a New Discipline,"
The concept of the black box has wide application, perhaps, says Ashby, "as great as the range of science itself." Berrien states that, essentially, the concept proposes "that when faced with any system which we cannot describe, either because it is inconvenient and tedious or because the internal structure of a system is unknown, we invoke the Black Box." In cybernetics, the box stands for the control mechanism of the system. In general systems theory, the black box becomes a vehicle for the study of systems. Berrien describes this application as follows:

Any subsystem may, for the purposes of explication, be considered solely in terms of inputs from, and outputs to, the suprasystem of which it is a component. As one progresses downward from macro- to microlevels, what was accepted as a black box at one level becomes the central concern at a lower level. We can thus enter the hierarchy of systems at any convenient point. It is not necessary to build up descriptions of all the subsystems lying below that point or trace through several higher layers the consequences of a given system's outputs as they become the inputs for suprasystems lying above them. On the other hand, the systems definition permits one to follow processes in either direction as far as one's interests, time and intellectual capabilities permit him.

A significant characteristic of the black box suggested by Scott is that its behavior should be predictable. "The black box is a system. And all systems have structures which lend them a certain degree of predictability." The idea seems to be that if one assumes

11 Ibid.
12 Berrien, op. cit., p. 17.
14 Berrien, op. cit., p. 18.
that the black box is a system with a structure in a state of equilib-
rium then like inputs should produce like outputs.

The major significance of the concept of the black box in general
systems theory is that it provides a useful vehicle for the study of
particular systems. The black box may be invoked when it is conve-
nient to do so or when it is necessary to do so. A system may con-
sidered a black box when it is expedient in relation to the nature of
the study. A system may also be considered a black box when the time
and effort required to completely describe it would be prohibitive, or
where description is impossible.

A "system of systems." An important function that has been
proposed for general systems theory is that of providing a framework
which can be used as a guide in the description of individual disci-
plines. Kenneth Boulding suggested such a role for general systems
theory in his 1956 article which has become a classic work in the field:

General systems theory7 hopes to develop something like a
"spectrum" of theories--a system of systems which may perform
the function of a "gestalt" in theoretical construction. Such
"gestalts" in special fields have been of great value in direct-
ing research toward the gaps which they reveal. Thus the periodic
table of elements in chemistry directed research for many decades
towards the discovery of unknown elements to fill gaps in the
table until the table was completely filled. Similarly a "system
of systems" might be of value in directing the attention of
theorists towards gaps in theoretical models, and might even be
of value in pointing towards methods of filling them.16

Boulding proposed such a "system of systems" in his article,
describing it as an "arrangement of theoretical systems and constructs
in a hierarchy of complexity,"17 or "a possible arrangement of 'levels'

16Kenneth E. Boulding, "General Systems Theory--The Skeleton of

of theoretical discourse."\textsuperscript{18} Boulding's hierarchy of systems is presented below with a description and discussion of each of the levels.\textsuperscript{19}

1. Static structures

   Description: Frameworks
   Example: Map of the earth

   Boulding, referring to this level of system as "frameworks," says "the accurate description of these frameworks is the beginning of organized theoretical knowledge in almost any field, for without accuracy in this description of static relationships no accurate functional or dynamic theory is possible."\textsuperscript{20} Thus the organization chart of a company, for example, is useful basically as a proposed definition of the fundamental framework within which the organization operates.

2. Simple dynamic systems

   Description: Systems with predetermined, necessary motions
   Example: Clock

   Although this level is called "dynamic," the idea of predetermined motions seems to connote a state more like equilibrium. In fact, Boulding states in connection with this level that "most physical and chemical reactions and most social systems do in fact exhibit a tendency to equilibrium."\textsuperscript{21} Thus, the group of systems at this level includes stochastic dynamic systems. Equilibrium systems are the product or limiting case of a dynamic system. Dynamic systems are the parents of equilibrium systems.

3. Cybernetic systems

   Description: Systems that maintain a given equilibrium
   Example: Heating system with thermostat

\textsuperscript{18}\textit{Ibid.}

\textsuperscript{19}Based on Boulding's discussion, \textit{Ibid.}, pp. 202-204.


\textsuperscript{21}\textit{Ibid.}
The systems at this level have an important added characteristic—self-control through the transmission and interpretation of information. A diagram representing a simple cybernetic system was presented in Chapter II above in Figure 2-1. The cybernetic system maintains a given equilibrium through the feedback mechanism, in which the observed output value of the system is compared with predetermined desired output value. If a discrepancy exists, feedback causes the system to adjust itself to the conditions which will provide the desired output.

4. Simple open systems
   Description: Self-maintaining structures
   Example: Body cells

   The essential characteristic of the open system, according to Boulding, is "the property of self-maintenance of structure in the midst of a throughput of material."\textsuperscript{22} Another characteristic of these systems is self-reproduction. At this level of systems life becomes apparent. "... By the time we have got to systems which both reproduce themselves and maintain themselves in the midst of a throughput of material and energy, we have something to which it would be hard to deny the title of 'life.'"\textsuperscript{23}

5. Genetic-societal systems
   Description: A cell society
   Example: Plants

   This level of systems introduces division of labor among cells, forming a cell society with differentiated parts. Information transmission and reception, however, remains crude.

\textsuperscript{22}\textit{Ibid.}, p. 203.

\textsuperscript{23}\textit{Ibid.}, pp. 203-204.
6. Animal systems
Description: Systems with specialized information receivers with complex nervous systems including a brain.
Example: Sub-human animals

This level of "animal" systems is characterized by increased mobility, purposeful behavior, and self-awareness. At this level are found "specialized information-receptors (eyes, ears, etc.) leading to an enormous increase in the intake of information; we have also a great development of nervous systems, leading ultimately to the brain."

A most striking characteristic suggested by Boulding as emerging at this level is that of knowledge structure or "image." The proposition is that at this and higher levels of systems, behavior is response not to a specific stimulus but to an "image" or knowledge structure or view of the environment as a whole. The process through which this image is built up is quite complex. "It is not a simple piling up or accumulation of information received, although this frequently happens, but a structuring of information into something essentially different from the information itself. After the image structure is well established most information received produces very little change in the image—it goes through the loose structure, as it were, without hitting it." Occasionally, according to Boulding, a bit of information will hit and become part of a slightly altered image, and sometimes a bit of information will strike a particularly responsive nerve and cause a radical change in the knowledge structure and a resulting far reaching change in system behavior. Boulding's conclusion is that prediction

\[2^4\text{Ibid., p. 204.}\]
\[2^5\text{Ibid.}\]
of the behavior of systems at this and higher levels is difficult because of the intervention of the image between stimulus and response.

7. Human systems
   Description: The individual person as a system
   Example: A man

Here the individual human being is considered as a system. Thus are introduced those characteristics which distinguish man from animals. In addition to the characteristics of animal systems, human beings possess self-consciousness and self-reflexiveness—he not only knows, but he knows that he knows. Man's ability to communicate through the symbolism of language clearly sets him apart. "Man is distinguished from the animals also by a much more elaborate image of time and relationship; man is probably the only organization that knows that it dies, that contemplates in its behavior a whole life span, and more than a life span. Man exists not only in time and space but in history, and his behavior is profoundly affected by his view of the time process in which he stands."26

8. Human organizations
   Description: Organizations of two or more persons
   Example: A social club

As men join together into social organizations at this level, systems with great complexity are created. Much of the complexity is produced by the need for communication among the individuals in the organization. Man alone is complex enough. The addition of interaction among men makes for a much more complicated system. "At this level we must concern ourselves with the content and meaning of messages, the nature and dimensions of value systems, the transcription

26 Ibid., p. 205.
of images into a historical record, the subtle symbolizations of art, music, and poetry, and the complex gamut of human emotion. The empirical universe here is human life and society in all its complexity and richness.  

9. Transcendental systems

Description: The ultimates and absolutes and the incapable unknowables that exhibit systematic structure and relationships

Example: A human organization that transcends human selfishness

Transcendental systems are an unknown ideal. In the realm of social systems, the transcendental system might take the form of the "high-synergy" societies described by A. H. Maslow. "Those societies have high synergy in which the social institutions are set up so as to transcend the polarity between selfishness and unselfishness, between self-interest and altruism, in which the person who is simply being selfish necessarily benefits other people, and in which the person who tries to be beneficial to others necessarily reaps rewards for himself. The society with high synergy is one in which virtue pays."  

The absolute transcendental system may seem unknown and unattainable, but men should strive for such systems nevertheless. The prospect is discouraging indeed if the systems of today, whether social systems, economic systems, or even accounting systems, must be accepted as the ultimate in attainability.

Boulding proposed this hierarchy of systems as a framework which would provide a basis for an orderly development of knowledge in any

27 Ibid.

discipline. He believed it would give "some idea of the present gaps in both theoretical and empirical knowledge." According to Boulding, "adequate theoretical models extend up to about the fourth level, and not much beyond. Empirical knowledge is deficient at practically all levels." 

In a 1958 paper, Boulding attached a slightly different but highly important significance to his hierarchy of systems. A system of a lower class may be considered an abstraction of a higher, more complex system. He put it this way:

All the "higher" systems in some sense "enclose" the lower systems—that is, a "lower" system is always a legitimate abstraction of certain aspects of a higher system. Thus the human organism has a geography (anatomy, mechanics of levers and muscles, chemical systems, growth systems, and so on) as well as involving a symbolic and eiconic system of great complexity. Thus it is quite legitimate to abstract from the social system a "price system," as economic theory does, and to postulate a set of equations which "determine" the price system in a rather mechanical way, in spite of the fact that actual prices are quoted or accepted by "people" in the light of highly complex images going far beyond the dimensions of the economic abstraction. 

The importance of this view of Boulding's hierarchy of systems is that another vehicle is provided to aid in the understanding of the nature of exceedingly complex systems. Social systems, at the eighth level in the hierarchy, present profound complexities which hinder understanding. But if certain aspects of social systems can be abstracted into systems of the less complex nature of those lower in the hierarchy, then analysis and understanding are more feasible.

29 Boulding, op. cit., p. 205.
30 Ibid.
The significance of this hierarchy of systems and of general systems theory itself is that it shows how far we have to go in completely understanding and describing the many systems of our world. General systems theory does not primarily answer questions, it forces questions to be asked. At the same time, it is helpful in showing us where to go, and in finding what questions to ask.

Elements of Systems

The term "elements" has no particular special meaning in systems theory. "Elements" is used here as a convenient term to encompass the parts which make up the structure of an open system. The discussion which follows describes in some detail the nature of those "elements" of which systems consist.

Objective. Systems exist to accomplish the purpose for which they were created. The objective of a system then is its purpose. The system objective should thus be the central guiding force in the functioning of a system.

The sentences in the paragraph immediately above may seem, on the surface, to present rather obvious and simple concepts. But, upon reflection, one finds that the ramifications of this idea of system objectives are vast and profound. Systems theory says all that exists is in a nesting of systems. What then is the objective or purpose of the system Earth? If a man is a system, what is his purpose? On a less philosophical level, what is the objective of the governmental system of the United States? The point is that, although the system

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objective should be the guiding force in any system, the identification, verbalization, promulgation, and implementation of the true objective is often very difficult. Perhaps this is why the Earth is so befouled, the human race so befuddled, and governments often so ineffective.

A system's function basically is to process input into output. Berrien states that outputs are of two classes: "products useful to the suprasystem, and wastes or products that are useless."\textsuperscript{33} He further states an assumption about system output that, although not emphasized elsewhere in general systems theory, seems to be of fundamental importance. Berrien believes that "each system must, if it is to survive, deliver products that are acceptable to its environment. If the products are unacceptable, either the producing system itself takes on a different state . . . or the environment operates in such a fashion that the system is destroyed."\textsuperscript{34} Given this characteristic of system relationships, the reasonable conclusion would seem to be that the primary objective of any system should be to deliver output of maximum usefulness to the suprasystem.

The objective of a particular system then should be stated in terms of a relationship with the suprasystem. An objective stated in this way would give the greatest guidance to the operation and health of the system. Take the familiar example of a thermostat-controlled heating system in a building. The objective of this system is not "to produce heat," but is "to maintain a desired temperature in the

\textsuperscript{33}Berrien, \textit{op. cit.}, p. 27.

\textsuperscript{34}Ibid.
building." The former objective is system-oriented, while the latter is suprasystem-oriented. Another example is a medical laboratory. Its real objective is not accuracy, but what accuracy is good for: improving the doctor's diagnosis.35

Churchman warns of the difficulties to be found in connection with the statements of objectives in human organizations.36 Inhabitants of systems often talk of their objectives, but only in vague terms, such as "quality education," "public service," and the like. Churchman states the test of a system's objectives as follows:

The scientist's test of the objective of a system is the determination of whether the system will knowingly sacrifice other goals in order to attain the objective. If a person says that his real objective in life is public service and yet occasionally he seems quite willing to spend time in private service in order to maximize his income, then the scientist would say that his stated objective is not his real objective. He has been willing to sacrifice his stated objective at some time in order to attain some other goal.37

Wherever possible, the objectives of a system should be stated in terms of some precise measure of performance.38 Vague objectives provide no basis for measuring how well the system is doing. The objectives should be such that a specific measure of performance is possible. There is the danger, however, that the measure or score will become the objective rather than the performance it is intended to measure, as in the case of the student who seeks to attain a high grade rather than knowledge.

36 Ibid., pp. 30-32.
37 Ibid., p. 31.
38 Ibid.
In general, the objective of a system is to produce output of maximum usefulness to its suprasystem. The objective of a particular system thus should be stated in terms of a relationship with the suprasystem. Where possible, the objective should be related to a specific measure of performance. Identification of a particular system's true objective is not easy, because real objectives are often hidden beneath stated objectives. The identification of a system's real objectives and the use of them as the guiding force in the system, however, will surely lead to survival and improved performance of the system.

Environment. The concept of system environment is defined by Hall and Fagen as follows:

For a given system, the environment is the set of all objects a change in whose attributes affect the system and also those objects whose attributes are changed by the behavior of the system.39 This definition is quite broad in that it includes in the environment everything that in any way relates to the system but is not within it. Thus, "to specify completely an environment one needs to know all the factors that affect or are affected by the system; this problem is in general as difficult as the complete specification of the system itself."40

A definition of environment presented by Optner is similar to that above, but it seeks to impose a limit on the inclusions in the environment. "Environment is defined as a set of all objects, within some specific limit, that may conceivably have bearing upon the operation

40Ibid.
of the system." Although Optner indicates that a limit must be placed on what is included in the environment, he does not really specify how the limit is determined. The implication seems to be that the system investigator draws the limit so as to make his research manageable. Such a procedure, though probably the most feasible for complex systems, does raise the possibility of an important relationship being overlooked.

Churchman proposes a test that may be used to identify the environmental elements of a system. "We must ask, 'Can I do anything about it?' and 'Does it matter relative to my objectives?' If the answer to the first question is 'No' but to the second is 'Yes,' then 'it' is in the environment." In other words, the environment of a system consists of those things which are outside the system's control, but which affect the performance of the system. "Environment, in effect, makes up the things . . . that are 'fixed' or 'given,' from the system's point of view."

The definitions of environment cited above are all very similar. In general, a system's environment consists of all things outside the system's control which affect the accomplishment of the system objective. In a complex system, it may be possible to identify only those elements in the environment which significantly affect the system's

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42 Ibid.

43 Churchman, op. cit., p. 36.

44 Ibid., p. 35.
performance. The concept of environment is closely related to that of boundary, which is discussed next.

**Boundary.** The idea of the boundary of a system, although seemingly an obvious one, is difficult to delineate. "The notion of a boundary is one of those notions which are difficult to discuss because of their fundamental simplicity," according to Rapoport. Yet, for purposes of description and analysis, the distinction between system and environment and between one system and another may be of considerable importance. In the real world also, the distinction between systems is important, and so identification of boundaries must be made.

The boundary of a system may be physical, such as the skin of a person. Only a few systems have physical boundaries, however, so the concept of boundary must go beyond the physical. Thus Rapoport states this idea:

> If two classes of things are completely distinguishable, they are separated by a boundary. Such a boundary is a notion, not a physical thing. The surface of an ocean is such a boundary, if we assume that we can completely distinguish air from water or vapor, although the surface of the ocean is certainly not a material thing and is not fixed in space. Such a boundary is merely a "state of affairs," where the goings-on on one side of it are markedly different from the goings-on on the other.

The boundaries of other systems are neither physical nor as clear-cut as that of an ocean. Rapoport calls such less-than-exact

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47 Rapoport, op. cit., p. 308.
boundaries statistical boundaries. For example, what is the boundary of a forest? It is at some area where the density of the trees has decreased to a specified level. Or, put another way, the edge of a forest may be considered as that encircling area of land where the probability of tree density being above a certain level is below a specified value.

Berrien describes the boundary of a system as "that region separating one system from another; it can be identified by some differentiation in the relationships existing between the components inside the boundary and those relationships which transcend the boundary." Chin states that the boundary of a system is "the line forming a closed circle around selected variables, where there is less interchange of energy (or communication, etc.) across the line of the circle than within the delimiting circle." These two definitions seem to lead to the conclusion that there is a high level of interchange (of energy, information, etc.) among those components within the boundary of the system. Components which have interchange with the components within the boundary but at a lower level are in the system environment, outside the boundary.

The boundary of a system is considered by Berrien to serve two important functions—coding and decoding, and controlling the rate of input-output flow. The coding and decoding functions refer to the

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48 Ibid.
49 Berrien, op. cit., p. 21.
51 Berrien, op. cit., pp. 21-23.
idea that "the transfer of information, energy, sustenance, or any other form of exchange between one system and another undergoes some modification which is discriminably different in frequency, phase, amount, or quality from exchanges between components within the system."^52 Coding refers to input: "What goes into a system is not what is impressed on it."^53 Decoding refers to the transformation of a product into a form useful to the suprasystem: "What comes out of systems is not what went on within them."^54 In addition, the boundary serves as a gate, controlling the rate of input-output flow.^55

The boundary of a system then is that line or region which separates the components of a system from its environment. Inputs and outputs pass through this region. The boundary codes the inputs for processing by the system and decodes the product into output acceptable to the suprasystem, and also controls the rate of input-output flow.

**Inputs and outputs.** The functional definition of a system proposed by Berrien is: "A system processes inputs and expels products which are, in some detectable characteristic, different from the inputs. That is to say, ... the system does something to the inputs it accepts so that the products are not merely copies of the inputs but different in some identifiable way."^56 Thus a functioning system accepts inputs and expels output, with the mark of the system process being the distinguishable nature of the output.

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^52 Ibid., p. 21.
^53 Ibid., p. 22.
^54 Ibid.
^55 Ibid., p. 23.
^56 Ibid., p. 15.
The inputs to a system consist of the complexes of information and/or energy and/or matter\(^{57}\) introduced into or absorbed by the system. Inputs are assumed to be of two types: maintenance and signal,\(^{58}\) or production.\(^{59}\) "Maintenance inputs are those which energize the system. . . . Signal inputs are those which the system accepts for processing . . . to produce an output delivered to the suprasystem."\(^{60}\)

The outputs of a system consist of the complexes of information and/or energy and/or matter discharged from the system into the suprasystem. Outputs are also of two types, according to Berrien: useful products and wastes.\(^{61}\) As noted previously, these outputs differ in some identifiable way from the inputs, indicating that the system transformed the inputs in some way. For example, the useful product of an electronic computer is the print-out of the results of its computations, while the waste output is heat. Output is described in a more general and perhaps more useful way by Chin as the effect of the system on the environment.\(^{62}\)

A system must, if it is to survive, produce products that are acceptable to the suprasystem. Since outputs are of two types, useful and useless, it would seem that, if the system is to survive, the suprasystem must consider the useful products of sufficient value to


\(58\) Berrien, *op. cit.*, p. 25.


\(62\) Chin, *op. cit.*, p. 20.
offset the uselessness of the waste products. That is, on balance, the total product of the system, useful and waste, must be acceptable to the suprasystem. Otherwise, "either the producing system itself takes on a different state . . . or the environment operates in such a fashion that the system is destroyed."63

Components. The term "component" is used by most writers in general systems theory to refer to the subsystems which compose a system. The concept of components of a system is directly related to the hierarchical structure of systems. Each system consists of subsystems (components) which themselves consist of subsystems (components). The question that arises is where in the hierarchy does a particular unit fit?

Ellis and Ludwig conceive of the hierarchy as system-subsystem-component.64 Berrien's hierarchy is system-component (subsystem)-subcomponent.65 Churchman's hierarchy of system-components-resources66 is slightly different conceptually, but seems basically similar to the others.

Ellis and Ludwig, writing in the area of systems engineering applications of systems theory, state, "In any given discussion of larger systems, the lowest level of a system is traditionally distinguished by being called a component. It should be emphasized that the terms subsystem and component are purely relative to some established

63Berrien, op. cit., p. 28.
64Ellis and Ludwig, op. cit., p. 11.
65Berrien, op. cit., p. 19.
66Churchman, op. cit., pp. 37-44.
Thus, to these writers, in any particular hierarchy of subsystems of subsystems of subsystems, etc., the lowest system level is the level of the component, the next higher levels in order being subsystems and systems.

Churchman writes from the viewpoint of the management scientist. To him, the components of an organization are not the traditional departments, divisions, or offices, but are the distinguishable missions (objectives) or tasks the system must perform. Thus he seems to be saying that the components of a system are its basic subsystems. These components accomplish their mission through the use of the resources of the system. "Resources are the general reservoir out of which the specific actions of the system can be shaped." These resources then would be the next level of subsystems in the hierarchy system-components-resources.

Berrien defines a component of a system as "a unit that in combination with other system units (subsystems) functions to combine, separate, or compare the inputs to produce the outputs. . . . The feature that defines a component of a system is whether or not it interacts with another component within the boundary to produce a product that is distinguishable from the interactions themselves and the inputs." Thus subsystems which have a distinguishable objective that contributes to the production of the system output are components.

67 Ellis and Ludwig, op. cit., p. 11.
69 Ibid., p. 39.
70 Berrien, op. cit., p. 17.
Those units which contribute to the achievement of the separate objectives of the components are called subcomponents.

Berrien's concept of component and subcomponent is one of relative hierarchical position, as is that of the other writers. He goes further, however, and attempts to delineate the distinction between components and subcomponents in a system. He uses the facts of the nature of the chemical bonds which determine molecular structure to reach this conclusion about systems in general: "Forces of mutual attraction exist among components within a system that are balanced or nearly balanced by repelling forces. The forces of mutual attraction are those which permit the components to function together; the repelling forces are those which preserve the identity of the components. If the repelling forces are absent or are over-balanced by the attractive forces, the separate components merge into a subsystem in which their original identities are lost." Thus those subsystems (subcomponents) which have much in common, that is, among which there are strong attractive forces and weak repelling forces or none, join together as a separate component of a system. The separate components have strong attractive forces in that they must interact to produce system output, but they have strong counter-balancing repelling forces based on distinguishable subsystem objectives, keeping the components separated.

Berrien's ideas about the nature of components are similar to those used by Simon in describing "nearly decomposable" systems.

71Ibid., pp. 19-20.  
72Ibid., p. 20.  
In a nearly decomposable system, the interactions among the components are weak, as compared to the interactions among the subcomponents. According to Simon, "in a nearly decomposable system, the short-run behavior of each of the component subsystems is approximately independent of the short-run behavior of the other components; in the long run, the behavior of any one of the components depends in only an aggregate way on the behavior of the other components."\textsuperscript{74} Simon summarizes: "Intra-component linkages are generally stronger than intercomponent linkages. This fact has the effect of separating the high-frequency dynamics of a hierarchy—involving the internal structure of the components—from the low-frequency dynamics—involving interaction among components."\textsuperscript{75}

The components of a particular system then are the basic subsystems which compose the system. These components are separately identifiable as having distinguishable objectives that contribute to the production of the system output, although the components must interact to achieve the overall system objective. Each component is made up of subcomponents that interact to meet the component objective. Linkages among subcomponents within the components are stronger than those among the components.

\textbf{Management.} The term "management" is used here rather than the more commonly used term "control," because "control" has meanings and connotations to most people that are inappropriate to the concept of system control. Beer put it this way: "The fact is that our whole concept of control is naive, primitive, and ridden with an almost

\textsuperscript{74}\textit{Ibid.}, p. 69.

\textsuperscript{75}\textit{Ibid.}, p. 72.
retributive idea of causality. Control to most people . . . is a crude process of coercion." The concept of system control or management refers to the element of a system which regulates the system toward the achievement of the system objective.

The control of a system is probably best viewed as being achieved by a management subsystem, a component of the system. System control concepts are based on the idea of the cybernetic system with feedback. The management component of a system identifies system objectives, plans for the achievement of the objectives, and sets standards for evaluation of system performance and output. It evaluates feedback data and adjusts system process as necessary.

The concept of system management, along with related notions of feedback and system state, are discussed in considerable detail in subsequent sections in this chapter on system process and dynamics.

Relationships. A system is composed of the elements described above—objective, environment, boundary, inputs and outputs, components, management. A particular system is identifiable by the nature of the elements and particularly by the relationships that exist among the elements.

The relationships in a system are the things that tie the system together. The concept of a given set of relationships among given elements is at the heart of the whole system approach. Optner defines relationships as "the bonds that link objects and attributes in the system process. Relationships are postulated among all system

76Beer, op. cit., p. 21.

77Hall and Fagen, op. cit., p. 18.
elements, among systems and subsystems, and between two or more subsystems."\(^{78}\)

In lower level systems, relationships are mainly of the nature of physical arrangements and material and energy flow. Of considerable significance, however, is the concept that in higher level systems relationships consist mainly of communication or information flow. Buckley states: "Whereas the relations among components of mechanical systems are a function primarily of spatial and temporal considerations and the transmission of energy from one component to another, the interrelationships characterizing higher levels come to depend more and more on the transmission of information—a principle fundamental to modern complex system analysis. . . ."\(^{79}\)

Relationships among system components pertain more to system functioning or behavior than to system elements. Characteristics of system behavior are considered in detail in the next section of this chapter.

**Characteristics of System Behavior**

*Process vs. structure.* A system has been defined previously as a complex of elements in mutual interaction. This definition indicates that a system consists of a structure (complex of elements) and a process (mutual interaction). There is no complete agreement among writers in general systems theory as to which view of a system is more important—structure or process. Structure is relatively stable and thus

\(^{78}\)Optner, op. cit., p. 27.

of major significance perhaps in lower-level, simple systems. In higher-level systems, particularly living systems, structure is generally seen as more fluid, and process becomes the important aspect of a system.

Berrien is one writer who stresses structure as more important, so perhaps his view should be considered first, since it is somewhat at odds with the views of the other writers presented below. He offers a structural definition of a system: "A system is ... a set of components interacting with each other and a boundary which possesses the property of filtering both the kind and rate of flow of inputs and outputs to and from the system;" and a functional definition: "A system processes inputs and expels products which are, in some detectable characteristic, different from the inputs." Berrien then states that "we set as an axiom that the structure of a thing determines its functions and, hence, the structural definition takes primacy over the functional definition. Without structure, function is impossible." Bertalanffy argues from the viewpoint of biology that, whereas a crystal, for example, is built up of unchanging components that persist indefinitely, living organisms only appear to be persistent and invariable when in truth they are the manifestations of a perpetual flow. Parsons, a behavioral scientist, states: "The system is not the physical organism nor the object of physical perception, but it is

81 Ibid., p. 15.
82 Ibid.
83 Bertalanffy, Problems of Life, p. 124.
a system of behavior or action." Beer concludes that systems "can be pointed out as aggregates of bits and pieces; but they begin to be understood only when the connections between the bits and pieces, the dynamic interactions of the whole organism, are made the object of study."  

Each of these writers is emphasizing the idea that complex systems must be viewed as open systems. If a system is assumed to be closed, the system interactions are fixed and predictable, based on an unchanging structure of components. Open systems, however, maintain a constant exchange with their environment, and thus are dynamic rather than stationary, never in equilibrium, but possibly maintaining or approaching what will be described below as a steady state. Thus knowledge of the interactions among components which are the process of the system provides greater understanding of the system.

Knowledge of both the structure and the process of a system is obviously necessary to gain a maximum understanding of the nature of the system. Berrien's conclusion that structure determines function is based on the idea that the components have limited functional capabilities determined by their structure and thus the system's functioning is limited by the structure of the components. This idea seems axiomatic enough, but since the components of a system do have a range of functional capabilities, the true nature of the system at a point in time must be determined by the particular interactions that are taking

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85 Beer, op. cit., p. 9.
place among the elements of the system at that time. Likewise, the potential of the system may be determined by its structure, but reaching the potential will likely require an altered set of interactions among the elements. Obviously, a system is both structure and process, but it is interaction that makes the structure a system, so process would seem to be the more significant characteristic, particularly in systems at higher levels. This conclusion follows the idea of synergism that, from the systems viewpoint, the whole is greater than the sum of its parts.

Probabilistic nature of systems. The distinction between deterministic and probabilistic systems has been explained as follows:

A deterministic system is one in which the parts interact in a perfectly predictable way. There is never any room for doubt: given a last state of the system and the programme of information by defining its dynamic network, it is always possible to predict, without any risk of error, its succeeding state. A probabilistic system, on the other hand, is one about which no precisely detailed prediction can be given. The system may be studied intently, and it may become more and more possible to say what it is likely to do in any given circumstances. But the system simply is not predetermined, and a prediction affecting it can never escape from the logical limitations of the probabilities in which terms alone its behaviour can be described.86

Open systems are dynamic, thus the reasonable conclusion must be that all open systems are probabilistic. Berrien states: "We cannot determine precisely at any given instant, armed with knowledge of the inputs and components, what the internal arrangements will be, or what the outputs will be except within certain limits."87 Although the functioning of all open systems is probabilistic, the probabilities

86 Ibid., p. 12.
87 Berrien, op. cit., p. 49.
of some systems functioning in a near-deterministic manner are higher than for other systems. Thus Berrien concludes that although all system outputs are basically probabilistic, some are more rigidly determined by their inputs and components than others.⁸⁸

The idea that system behavior is probabilistic means that events are to some extent determined by chance.⁸⁹ This conclusion may seem to be directly contrary to the thesis of general systems theory that system behavior is determined by certain general principles of organization. Beer has these comments which seem to relate to this apparent contradiction: "... It is obviously quite possible that a complete knowledge of the physical universe would do away with probabilistic systems, since everything would be fully predictable in terms of understood causes and effects... The status of the distinction being drawn is empirical: we accept as a matter of experimental fact that whereas we are able to describe some systems as if they were deterministic, we are able to describe others only as if they were probabilistic."⁹⁰ Rapoport replies to the seeming contradiction along two lines:

First, the distinction between deterministic and probabilistic contingencies is not sharp. Probabilities tend toward certainty as the probability of one of the possible events approaches one. Therefore a probabilistic system theory provides a useful intermediate theoretical framework between chaos and organization. Indeed, the degree of organization of a system can be conveniently defined in terms of the departure of the observed behavior from a

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⁸⁸Ibid., p. 50.

base line, determined by purely chance events. Second, in a large population of systems, probabilities become frequencies, and so determinism is in a sense re-established in the observed distributions of system characteristics.\(^9\)

Rapoport also makes the point that there are general concepts that may be applied to probabilistic systems—the entire conceptual apparatus of the theory of stochastic processes.\(^9\) These statistical concepts are applicable to all systems that are considered probabilistic in nature and thus is provided a general system concept.

In the present incomplete understanding of systems, then, they must be considered fundamentally probabilistic in behavior. This conclusion seems particularly appropriate with respect to human organizations. General concepts about system behavior must therefore be considered tentative and subject to exception. At the same time, the theory of stochastic processes provides a mathematical framework to facilitate the understanding of probabilistic systems.

**Cycle of events.** The basic pattern of the functioning of a system is input\-transformation\-output or input\-process\-output.\(^9\) That is, the cycle of events in a system includes "the importation of energy from the environment, the through-put or transformation of the imported energy into some product form which is characteristic of the system, the exporting of that product into the environment, and the reenergizing of the system from sources in the environment."\(^9\)

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\(^9\)Ibid.


\(^9\)Optner, *op. cit.*, p. 36.

\(^9\)Katz and Kahn, *loc. cit.*
Inputs to a system have been described previously as consisting of information and/or energy and/or matter, some of which are used to maintain the system and some of which are processed into system output. The process of through-put of the system transforms input into output which differs from the input. That is, the system does some specific work on the input to produce an output product which is clearly distinguishable from the input. This product, which again may be information and/or energy and/or matter, is exported into the environment as output.

Katz and Kahn emphasize the cyclic character of system functioning as follows:

The pattern of activities of the energy exchange has a cyclic character. The product exported into the environment furnishes the sources of energy for the repetition of the cycle of activities. The energy reinforcing the cycle of activities can derive from some exchange of the product in the external world or from the activity itself. In the former instance, the industrial concern utilizes raw materials and human labor to turn out a product which is marketed, and the monetary return is used to obtain more raw materials and labor to perpetuate the cycle of activities. In the latter instance, the voluntary organization can provide expressive satisfaction to its members so that the energy renewal comes directly from the organizational activity itself.96

The boundary of a system has been described previously as performing a coding function with respect to inputs. This coding relates to the idea that a system is selective in the reception of inputs. According to Katz and Kahn, "through the coding process the 'blooming, buzzing confusion' of the world is simplified into a few meaningful and simplified categories for a system."97 A system must select inputs on the basis of their relevance to its functions and objectives.

96Ibid., p. 20.
97Ibid., p. 22.
Feedback. The concept of feedback has been called "one of the central and most important concepts in general systems theory." Beer refers to the "ubiquity of feedback." This concept of feedback, a contribution of cybernetics to general systems theory, is a key idea relative to the control of system behavior and to the dynamics of systems.

Feedback is a mechanism which provides for the control of purposive or goal-directed systems. "Control" in this context means "self-regulation" as opposed to repression. Since the system is purposive or goal-directed, control is aimed toward the desired goal or objective. The objective of a system has been previously described in general as the production of output useful to the suprasystem. Thus feedback compares actual output with the desired output standard and feeds information back so that, if a discrepancy exists, the system can adjust itself to correct the output deviations.

A distinction is sometimes made between negative feedback and positive feedback. In general, if the deviation of output from standard is positive, the control mechanism reacts negatively to counteract this deviation, thus negative feedback. In positive feedback, if output is below standard, control acts positively to adjust the system output.

The traditional examples of a feedback-controlled system are the Watts steam engine and the thermostat-controlled furnace. In fact, the

98 Berrien, op. cit., p. 34.
99 Beer, op. cit., p. 28.
100 Buckley, op. cit., pp. 52-53.
101 Beer, loc. cit.
idea of feedback seems most commonly associated with simple closed-loop systems such as these and such as the one previously represented diagramatically in Figure 2-1. However, for applications to the higher-level complex systems, a more elaborate conception of feedback seems required.

Buckley conceives of feedback as "a principle underlying the goal-seeking behavior of complex systems."\textsuperscript{102} Thus, he says, feedback applies to open systems:

1. Whose characteristic features depend on certain internal parameters or criterion variables remaining within certain limits;
2. Whose organization has developed a selective sensitivity, or mapped relationship, to environmental things or events of relevance to these criterion variables;
3. Whose sensory apparatus is able to distinguish any deviations of the system's internal states and/or overt behavior from goal-states defined in terms of the criterion variables;
4. Such that feedback of this "mismatch" information into the system's behavior-directing centers reduces (in the case of negative feedback) or increases (in the case of positive feedback) the deviation of the system from its goal-states or criterion limits.\textsuperscript{103}

Karl W. Deutsch has stated that "by feedback is meant a communications network which produces action in response to an input of information and includes the results of its own action in the new information by which it modifies its subsequent behavior."\textsuperscript{104} This notion of feedback, according to Deutsch, "is a more sophisticated notion than the simple mechanical notion of equilibrium, and it promises to become

\textsuperscript{102}Buckley, \textit{op. cit.}, p. 52.
\textsuperscript{103}\textit{Ibid.}, p. 53.
Buckley, referring to Deutsch's article, summarizes as follows:

For effective "self-direction" a sociocultural system must continue to receive a full flow of three kinds of information: 1) information on the world outside; 2) information from the past, with a wide range of recall and recombination; and 3) information about itself and its own parts. Three kinds of feedback, which make use of these types of information, include: 1) goal-seeking--feedback of new external data into the system net whose operational channels remain unchanged; 2) learning--feedback of new external data for the changing of these operating channels themselves, that is, a change in the structure of the system; and 3) consciousness, or "self-awareness"--feedback of new internal data via secondary messages, messages about changes in the state of parts of the system itself. These secondary messages serve as symbols or internal labels for changes of state within the net.106

The most useful concept of feedback, particularly in relation to complex higher-level systems, thus would seem to include the use by the system of all available pertinent information to achieve self-regulation. This information would consist of all data relating to the functioning of the system in the meeting of its objective, such as output evaluation data, information on environmental conditions, and information about its own structure, functions, and goals. Feedback-control would include not only adjustments to maintain a given structure and process but also adjustments to change system structure, process, and objective, leading to growth and elaboration of the system.

System state. Feedback as described above acts to maintain a system's state or to effect a change in that state. Ellis and Ludwig say simply that a system's states are the "possible conditions of the

105ibid., p. 198.

106Buckley, op. cit., p. 56.
system. "107 Berrien's definition of system state is slightly more explicit: "A system may exist in various states. A state of the system is a particular pattern of relationships existing among the components and the particular filtering condition of the boundary."108 It seems apparent then that system behavior at any point in time is determined partly by the state of the system at that time. The concept of system state is discussed in more detail in the section below on the dynamics of systems.

Dynamics of Systems

The state of a system. The concept of entropy states that a closed system "tends to run down, that is, its differentiated structures tend to move toward dissolution as the elements composing them become arranged in random disorder."109 Scott has proposed a simple example to illustrate the basic idea:

Vizualize a tank of water divided by a removable partition. On one side of the divider the water is colored with blue ink, the other side with red ink. If the partition separating the different colors of water is raised, the colors merge into an overall purple hue. The entropy of the system has increased. Before the removal of the partition, a form of order existed with the red-ink molecules separated from the blue. But after the change, the molecules distributed themselves evenly throughout the tank, resulting in a single color.110

This example illustrates the general principle that "systems tend to approach their highest probability, which is greater randomness as opposed to greater organization."111

107Ellis and Ludwig, op. cit., p. 3.
110Scott, op. cit., p. 178. 111Ibid.
Closed systems thus move toward states of equilibrium, that is, most probable states with maximum entropy and progressive destruction of differentiation and order.\textsuperscript{112} Equilibrium is the state of the most probable distribution of the system's elements and thus is static. Equilibrium is the state toward which the system inexorably moves and, once in this state, returns if disturbed.

Open systems, on the other hand, do not run down. Bertalanffy states that living systems "are maintained in a state of fantastic improbability . . . [and] develop towards more improbable states, towards increase of differentiation and higher order of matter."\textsuperscript{113} Thus open systems, according to Katz and Kahn, become more elaborated rather than less differentiated, as "the operation of entropy is counteracted by the importation of energy and the living system is characterized by negative rather than positive entropy."\textsuperscript{114}

The law of negative entropy states that "systems survive and maintain their characteristic internal order only so long as they import from the environment more energy than they expend in the process of transformation and exportation."\textsuperscript{115} Bertalanffy's conception is similar: "In open systems, we have not only entropy production owing to irreversible processes taking place in the system; we also have entropy transport, by way of introduction of material which may carry high free energy or 'negative entropy.'"\textsuperscript{116} Thus open systems can

\textsuperscript{113}Ibid. \textsuperscript{114}Katz and Kahn, \textit{loc. cit.}
\textsuperscript{115}Ibid., p. 28.
overcome the tendency to lose organization because they are open and can receive inputs of energy from the environment.

The state of dynamic equilibrium toward which open systems move is called homeostasis or steady state. The concept of equilibrium relates to a fixed state toward which the system moves, whereas the concept of steady state relates to a self-regulated open system which maintains a balance but not at any particular fixed point or level. Homeostasis refers to the process in which the system regulates itself, using the process of feedback. The system reacts to disturbances by adjusting so as to minimize the disturbance and return to a steady state as modified by required changes.

Adaptation and growth. An open system has been described previously as a system in contact with its environment, with inputs and outputs across the boundary of the system. In fact, it is this interchange with the environment that provides the "negative entropy" that is essential to the viability of the system. The open system tends to maintain a steady state of self-regulation and reacts to disturbances by modifying its steady state so as to minimize the disturbance. According to Buckley, "the typical response of open systems to environmental intrusions is elaboration or change of their structure to a higher and more complex level." Thus, adaptation and growth seem to be the mechanisms by which a system insures its survival.

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117 The distinction between the static concept of equilibrium and the dynamic concept of steady state in open systems was offered in the early writings of Bertalanffy. See Bertalanffy, Problems of Life, p. 125.

118 Chin, op. cit., p. 19.
119 Berrien, op. cit., pp. 36-37.
120 Buckley, op. cit., p. 50.
Adaptation, according to Berrien, "refers to those behavioral and structural modifications within the life span of a system . . . which are survival-extending."\(^{121}\) Katz and Kahn state that "the basic principle is the preservation of the character of the system,"\(^{122}\) and thus the system will tend to import more energy from the environment than is required for its output, so as to maintain a high negative entropy balance.\(^{123}\)

Growth may consist of an increase in quantity rather than quality\(^{124}\) or, as Ellis and Ludwig put it, "the system . . . becomes larger without becoming better."\(^{125}\) Katz and Kahn suggest that a system may seek a margin of safety of input energy to maintain its negative entropy. "The body will store fat, the social organization will build up reserves, the society will increase its technological and cultural base."\(^{126}\) Or, "in adapting to their environment, systems will attempt to cope with external forces by ingesting them or acquiring control over them."\(^{127}\)

Growth may be qualitative rather than just quantitative, however. Boulding, in an article in which he proposes five general principles of growth, suggests that significant structural growth may occur because of the introduction of some core element (nucleus) into the system

\(^{121}\)Berrien, op. cit., p. 74.
\(^{122}\)Katz and Kahn, op. cit., p. 24.
\(^{123}\)Ibid. \(^{124}\)Ibid.
\(^{125}\)Ellis and Ludwig, op. cit., p. 39.
\(^{126}\)Katz and Kahn, loc. cit.
\(^{127}\)Ibid.
that triggers a growth process. Katz and Kahn suggest that qualitative change may occur when quantitative growth requires specialized subsystems not required when the system was smaller.

A System Model

A complex, high-level system may be portrayed abstractly as in Figure 3-1. This diagram suggests that a system consists of three basic groups of components—management, production, and information. Each of these groups is made up of one or more subsystems. Each of these subsystems has a distinguishable objective which contributes to the production of the system output, and each is in turn composed of subcomponents that interact to meet the component objective.

Figure 3-1. A Self-Regulating System

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129 Katz and Kahn, loc. cit.
The boundary of the system consists of a recognizable state of affairs which identifies the system and separates it from the environment. The environment is everything outside the system that affects the system. Consider the example of a university. The boundary of this system is a generally recognized state of affairs delineated by laws, regulations, rules, and customs. This boundary identifies what is part of the system and what is not; selects and codes (makes ready) inputs for processing, through such things as admissions regulations, funds requests, and perhaps even the student registration procedure; decodes the output (makes it recognizable and acceptable to the environment) through the granting of degrees, for example; and controls the rate of flow of input and output.

The function of the management component or components is to give life to the system and to direct it toward a state of self-regulation. These functions are likely to be carried out by a single management subsystem. This component identifies system objectives, plans for the attainment of those objectives, and sets standards to measure system performance; evaluates feedback; and adjusts system structure, process, plans, and standards as required. The production components are likely to be several subsystems, and their function is to perform aspects of the physical processing of the input into the output. The suggestion is that all physical effort that is related basically to the production of the primary output is carried on by these subsystems. The information components, one or more, collect, measure, analyze, synthesize, and communicate feedback information. Feedback information here is considered in the broad sense as all
data relating to the functioning of the system in the meeting of its objective.

The diagram indicates that there are interrelationships among all the components. These relationships may be considered basically communication links. For example, the management subsystem communicates control inputs to the production and information subsystems. Any required structural and process changes are then carried out within or among the subsystems.

Each of the components of the system is itself made up, at least conceptually, of subcomponents in three groups—management, production, and information. Physically, an information component, for example, may at the same time be functioning as a component of the system and as a subcomponent of one of the production components. The possible dual nature of any subsystem, however, seems to present no conceptual difficulties in the analysis of a system as a hierarchical structure.

The abstract model may be applied to a business firm as an illustration. Suppose the firm is a manufacturer. Inputs, consisting of information, materials, money, energy, and so on, are admitted to the system through the boundary, that state of affairs which identifies the system. The boundaries of the components then select the inputs, either from the environment or other components, that are required in the functioning of each component. The management component would consist of the top policy-making management of the firm and the control processes they devise. The production component group would consist of several subsystems, such as a finance subsystem
in which all activities involving the flow of cash take place, a manu-
ufacturing subsystem in which all activities involving the transforma-
tion of materials into finished product occur, and a marketing subsys-
tem which prepares the product and facilitates its discharge into the
environment. The information group would consist of such subsystems
as accounting, statistical reporting, operations research, and the
like. Each of these subsystems would consist of management, produc-
tion, and information subcomponents, in a continuation of the hierar-
chical structure.

This model seems descriptive of most, and probably all, self-
regulating systems. It is quite abstract, but it provides a very
useful basis for analyzing any system or component. It points out
the basic functions in a system and emphasizes the hierarchical struc-
ture of systems and the fundamental relationships which are system
process. The investigator of a particular system may evaluate the
state of his system within a framework of the components and relation-
ships depicted by this model.

Summary

General systems theory views the universe as consisting of a
tremendous architecture of nested systems. Each system is a part of
a suprasystem and is itself made up of subsystems. To completely
describe any system, it is necessary to delineate all relationships
within the system, its subsystems, and its suprasystem. Since for
many complex systems such a description is either impossible or
impractical, a system may be considered a "black box" when necessary
or advisable and described solely in terms of inputs from, and outputs to, the suprasystem of which it is a component.

Kenneth Boulding has proposed a general hierarchy of systems that may serve as a framework upon which to build an orderly presentation of the knowledge of any particular discipline. His hierarchy is one of systems of increasing complexity: static structures, simple dynamic systems, cybernetic systems, simple open systems, genetic-societal systems, animal systems, human systems, human organizations, and transcendental systems.

The elements of a system are those units which form its structure. The objective or purpose of a system should be stated as the production of output of maximum usefulness to its suprasystem. The environment of a system consists of all things outside the system's control which affect the accomplishment of the system objective. The boundary of a system is the line or region that separates the components of a system from its environment. The inputs to a system are the complexes of information and/or energy and/or matter introduced into or absorbed by the system, while the outputs of a system are the complexes of information and/or energy and/or matter discharged from the system into the suprasystem. The components of a system are its basic subsystems, which themselves consist of subcomponents. Management of a system is achieved by the control subsystem, which regulates the system toward achievement of the system objective. The relationships in a system are those bonds that tie the system together.

The elements of a system form its structure, but the exact nature of a system is determined by its process, the particular interactions
among the elements. With our present incomplete knowledge of systems, these interactions must be considered probabilistic in nature, particularly in open systems.

The functional pattern of system behavior is input-transformation-output, as the system selects inputs pertinent to its functions and objectives and processes these inputs into outputs having a nature clearly distinguishable from the inputs. The system achieves control of its functioning through feedback, the use of all available pertinent information to achieve self-regulation.

Systems achieve self-regulation through feedback to maintain a state of dynamic equilibrium, called the steady state. Survival is achieved through the mechanisms of adaptation and growth. Open systems respond to disturbances with growth, elaboration, or change of their structure to a higher and more complex level.

A self-regulating system may be depicted by the simple abstract model of Figure 3-1. Of particular significance is the suggestion in this model that a system consists of three basic groups of components—management, production, and information. Relationships among these components are basically communications links. The model suggests a framework which can be applied in the investigation of any particular system.
CHAPTER IV

THE APPLICATION OF GENERAL SYSTEMS THEORY TO ACCOUNTING

The Problem of the Nature of Accounting

Accounting is a discipline with a long history, having been a part of the world of commerce for many centuries. The double-entry basis of bookkeeping was presented in the fifteenth century by Pacioli in his mathematical treatise Summa de Arithmetica, Geometria, Proportioni et Proportionalita. Researchers have traced financial record-keeping back to the ancient Babylonians.¹ Yet today, despite this long history, the question is being asked, "What is accounting?" As recently as January, 1970, Wheeler stated: "Indeed, one useful piece of research might be a study of the nature of accounting."²

The current questioning of the nature of accounting is perhaps best described as a call for a reevaluation of its nature, brought on by the rapid pace of change in the world today, in business and elsewhere. Wheeler, asks, "Accounting, like many a dignified lady, has a past, but does it have a future?"³ Will the computer usurp most of what has been known as accounting? Will accounting lose its identity?

³Ibid., p. 1.
in an all-encompassing total information system? Is accounting obsolete in the face of the newer quantitative techniques of management science? Is accounting too tradition-bound to provide information relevant to the needs of today? Does accounting really have a role to play in the world of human affairs? Nagging questions such as these have caused thoughtful accountants to stop and consider and reassess the nature of their profession and area of knowledge, and contemplate its role in the future.

If accountants are to have a future role to play in human affairs, they need to get busy and make it. Accounting has the potential, as a body of knowledge backed by practitioners with recognized professional standing, to play a vital role in human organizations of all kinds. If it is to do this, accountants must take a new perspective on their function, renovate and add to their techniques, and proceed to apply their knowledge in new areas. Accountants have collected for themselves certain traditional functions, some of which have been recognized and required by law. But if accounting is to consist only of its traditional, legalized functions, its practitioners will become mere legal clerks. Accountants surely have a more vital, pervasive function than that to perform in the future. Thus they must get busy and identify that function and assert their competence to perform it.

The view afforded by an application of concepts from general systems theory may well provide a better understanding of the nature of accounting. By viewing as systems the entities within which accounting functions, a clearer view of accounting's role in human affairs may be achieved. Then, by viewing accounting itself as a
system, perhaps a framework will be provided for a better understanding of the discipline's inherent characteristics.

Ways of viewing accounting. The image conjured up by the word "accounting" surely differs drastically among people, both accountants and non-accountants. The fact seems to be that accounting is viewed differently by various people. The view of accounting taken by a particular person is undoubtedly influenced by his contacts with the subject—his education, work experience, and the like. These many views of accounting point up the need for a more careful study of the nature of accounting.

Various definitions of accounting have been proposed over the years. These definitions seem to indicate an evolutionary trend toward an expansion of the scope of accounting. A definition by Brett (1928) was:

Accountancy is the science of classifying and recording business transactions and of analyzing their effects upon a business concern so as to reveal the true condition of the business, and also to indicate any changes of policy of the management that would improve these results and benefit the status of the business.

Later definitions by accounting writers are similar:

Accounting embraces numerous activities, chief among which are the following:
(1) Recording business transactions—or bookkeeping.
(2) Verifying the accounting records—or auditing.
(3) Preparing statements of various kinds, which summarize and interpret the data shown by the accounting records.

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4Or, accountancy. No distinction is made in meaning between these terms in this dissertation.


Accounting may be defined as a body of principles and procedures designed to act as a guide in recording and reporting those affairs and activities of an economic unit that are capable of expression in monetary values.  

Accounting is the art of recording and summarizing business transactions and of interpreting their effects on the affairs and activities of an economic unit.

The American Institute of Certified Public Accountants (AICPA) formulated a definition in 1941 that emphasized the traditional viewpoint of accounting as financial record-keeping:

Accounting is the art of recording, classifying, and summarizing in a significant manner and in terms of money, transactions and events which are, in part at least, of a financial character, and interpreting the results thereof.

In October, 1966, the Council of the AICPA adopted an official statement of policy which seems to prescribe an expanded concept of the nature of accounting:

Accounting is a discipline which provides financial and other information essential to the efficient conduct and evaluation of the activities of any organization.

... Accounting includes the development and analysis of data, the testing of their validity and relevance, and the interpretation and communication of the resulting information to intended users. The data may be expressed in monetary or other quantitative terms, or in symbolic or verbal forms.

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The American Accounting Association in its 1966 statement on accounting theory emphasized a broad scope for accounting:

The committee defines accounting as the process of identifying, measuring, and communicating economic information to permit informed judgments and decisions by users of the information. . . .

This definition of accounting is broader than that expressed in other statements of accounting theory. There is no implication that accounting information is necessarily based only on transactional data, and it will be shown that information based on various types of non-transactional data meet the standards for accounting information. Although measurements of assets and periodic earnings qualify as accounting information, our definition of accounting is not limited to these measurements, nor is the concept limited to those entities in which earning periodic profits is a primary objective.

Definitions of accounting provide a concise statement of the thinking of leaders in the field, but the view of accounting taken by most individuals, accountants included, is probably much less definite and of less scope than is the view suggested by the latest definitions. A survey of some of the possible different ways of viewing accounting suggests the scope of the problem of defining the nature of accounting.

To many persons, particularly non-accountants, accounting is equated with bookkeeping, that is, record-keeping activities such as payroll preparation, maintenance of customer accounts, "paying the bills," and the like, and "keeping the books," some vague notion of an activity in which all businesses seem to engage. To others, perhaps, accounting is connected with the work of auditors, and involves the view of accounting as a verification procedure. Many persons probably consider the main activity of accountants to be the preparation of income tax returns.

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The view of accounting also differs among accountants. There is a clear distinction made between public and private accounting. Public accountants, principally certified public accountants, are those who offer their services to the public as professional experts in the practice of accounting, and thus render services to various persons and organizations, or clients. A private accountant, who may also hold a certificate as a certified public accountant, works as an employee for a single organization. In fact, of course, both public and private accountants do basically the same things, in terms of the profession or discipline of accounting. The significant difference is that at present the attest function is performed only by certified public accountants in public practice.

As the scope of accounting has broadened in recent years, there has developed a distinction between financial accounting and management (managerial) accounting. Financial accounting is considered to be those accounting activities whose information output is directed mainly toward users outside of the entity. The basic output of financial accounting consists of the traditional financial statements—balance sheet, income statement, and possibly the retained earnings statement. Management accounting is directed toward the presentation of information to users inside the entity as an aid in decision-making. This aspect of accounting consists of the measurement, analysis, and communication of data as information to aid in the management functions of planning and control. The interest of the public accountant in financial accounting is mainly in the attest function. Public accountants have, on the other hand, entered a broad field called "management
services," consisting of the presentation of information as a direct aid to the functioning of management.

Accounting may be viewed as a profession. On the other hand, it may be viewed as a body of knowledge or an academic discipline. Accounting has traditionally been associated with the business firm, with only limited applications in entities not organized for financial profit. A more modern view of accounting is that it should be considered a universal system applicable equally well to any human organization. David Linowes states: "Now we find important leaders of academia equating accounting with the entire measurement concept. Some even suggest that consideration should be given for accounting to be established in a separate school of measurement, thereby divorcing accounting from the business environment."

The view of accounting in a system framework taken in this dissertation may seem to be just another viewpoint to add to all the others, and in some respects it may be. The big difference and advantage of the systems approach, however, is that there is thus provided a general framework of principles which allows an overall view of the field. General systems theory, as a body of concepts applicable to all systems, may well provide a means for a view of accounting which could eventually reconcile many of the varying views of accounting, supersede others, and perhaps provide a perspective that will lead to a more useful role for accounting in human affairs.

Historical evolution of accounting. "The accountant has a proud heritage and may lay claim, along with the attorney, to being a member

of the first recognized professional group."\(^{13}\) Thus Willard Stone introduces his article on the antecedents of the accounting profession. "Systems of accounting are believed to have existed as early as 4500 B.C., in the ancient civilizations of Babylonia and Assyria,"\(^{14}\) according to Albert Newgarden. Thus in antiquity are found the beginnings of what has evolved into the present-day discipline of accounting.

Fra Luca Pacioli published his famous treatise on double-entry bookkeeping in 1494. Newgarden states that "most of the accounting methods described in this treatise are considered to be as applicable today as they were in the fifteenth century."\(^{15}\) He goes on to say, however, that "accountancy may have been born and bred in Italy, but it was in England, Ireland, and particularly in Scotland that it grew to full stature as a mature and respected profession. In the seventeenth, eighteenth, and nineteenth centuries, hundreds of treatises on bookkeeping and accounting were published in English."\(^{16}\) As far as the United States is concerned, however, "the history of the accounting profession . . . dates back no further than the 1880s and 1890s, when accountants from Scotland, England, and Ireland began to emigrate to these shores."\(^{17}\)

Two major forces in the early decades of the twentieth century did much to shape the evolution of accounting to a place of importance

\(^{13}\)Stone, *loc. cit.*


\(^{15}\)Ibid., p. 51.  \(^{16}\)Ibid., p. 54.

\(^{17}\)Ibid., p. 55.
in American life. The first of these was the federal income tax law and its requirement of business record-keeping in a generally accepted form. The second force was the 1929 stock market crash and its aftermath, the Great Depression. A searching examination of business practices led to the various federal securities acts of the 1930s and the resultant required disclosure of financial data. The Securities and Exchange Commission hearings in the late 1930s in the matter of McKesson & Robbins, Inc., had a significant impact on auditing procedures.

The period of the 1950s saw the development of the managerial accounting approach. This approach is based on the premise that accounting techniques can provide information useful in management decision-making, and it is a forward-looking approach as opposed to the historical approach of financial accounting and the requirements of tax and securities laws.

The evolution of accounting did not stop in the 1960s. Perhaps it has now (1970) reached a pace more appropriately labeled revolutionary. The pressures of the 1960s and 1970s, some of which are discussed below, will undoubtedly have a profound effect on the future of accounting.

Current pressures. A swelling tide of rapid change—social, political, economic, technological, and otherwise—has shaped the events of the years since World War II. The decade of the sixties was particularly marked by almost explosive change. The profession and discipline of accounting is feeling the pressure, and its future

18 Securities and Exchange Commission, Accounting Series Release No. 19, December 5, 1940.
may well depend on how it copes with the changing needs and demands of society.¹⁹

Social change has been profound in recent years. The racial crisis, the college uprisings, the mushrooming drug problem, and the outcry against environmental pollution are all symptoms of a basic questioning of social institutions and traditions. Among the traditions that are no longer universally accepted are the virtue of hard work, the primacy of the profit motive in business, and a limited role for government in human affairs. Many of the traditions and institutions that are being questioned and that are changing as a result are those upon which traditional accounting has been based.

Many people are contending that business has social responsibilities to its employees, to consumers, and to the community and nation in general.²⁰ The responsibility to make a profit is not the only obligation of business management, and perhaps not even the most important. How then can these other responsibilities of business be considered in the measurements and reports of accounting?

There has been a vast expansion of governmental social programs in recent years. A significant deficiency in many of these programs has been the inability to determine their effectiveness in meeting their objective. In some cases little or no attempt has been made to evaluate the operations and results of the programs, and where attempts

¹⁹ An excellent discussion of the changing environment as it was seen in 1965 is found in John L. Carey, The CPA Plans for the Future (New York: American Institute of Certified Public Accountants, 1965), pp. 1-112. This book was written with the collaboration of the Committee on Long-Range Objectives of the AICPA.

²⁰ Ibid., p. 22.
have been made, they have been handicapped by a lack of concepts and techniques by which to make such evaluations. The traditional profit-oriented principles of accounting were not applicable because the objectives of the programs were not directly related to dollars-and-cents profits. Yet an "accounting" is what is required of many of these programs. Why cannot accounting have a scope broad enough to be applicable to any organization, system, or program?

The United States and the world are faced with rapid population growth, declining quality of life, depleted resources, and polluted environments. If mankind is to survive and maintain or improve his standard of living, physical and spiritual, he must make more efficient and wiser use of his resources and his organizations. Accounting as a tool for more effective decision-making should be able to play a vital role in this area.

Economic events have brought pressure to bear on accounting and accountants. Of primary significance is the fact that the unprecedented economic growth of the 1960s has culminated in serious inflation at the end of the decade. The accountant has thus faced a need for providing more and more information about a rapidly changing economy in the face of the impairment of the usefulness of his basic unit of measure, the dollar.

The vast merger movement of recent years has presented problems for the accountant. In particular, the growth of large conglomerate firms, in many cases through unusual, uncertain, and even devious financial arrangements, has brought a clamor for information which accounting has not traditionally provided. Accounting techniques
that lack the sophistication to adequately deal with these mergers may provide inadequate, and perhaps even misleading, information.

An outcry has also come against what is described as a lack of uniformity in accounting principles and in their application to actual situations. The clamor has stirred the Accounting Principles Board of the AICPA to considerable effort to attempt to clear up areas of uncertainty, but they have been hard pressed to stay ahead of the tide of trouble spots.

The automation of data-processing with the electronic computer has certainly had an impact on accounting. Also, the greatly increased analytical capabilities provided by the computer have greatly expanded the boundaries of information processing. As the technology has been provided, concepts from mathematics, statistics, and the behavioral sciences have been applied and have revolutionized management information systems. Some fear accounting may become only an insignificant component of a massive, computerized total information system in organizations and in the economy as a whole. The more optimistic and far-sighted among accountants see accounting evolving into such a system.

These and other pressures are those which have forced accountants to reassess the nature of their profession and area of knowledge. To many, the conclusion has been that accounting must meet the challenge of change by expanding its scope, or else lose its importance. Meeting the challenge of change is surely the most important problem facing accountants today.

The outlook for the future of accounting. The rapid pace of change today could be the element that triggers a rapid expansion in
the role of accounting in human affairs. John Lawler recently pointed out that "problems are often merely opportunities in disguise." If accountants will take the initiative and use their knowledge and experience to meet the challenge, the future for the profession will be bright.

The pressures described above surely do present opportunities for service by accounting. The area of social accounting, designed to provide information relative to organization objectives other than profit-making, has the potential of being a broad, extremely useful extension of accounting techniques. Feedback information of many kinds is essential to greater efficiency in the use by man of his resources and organizations. Sound economic growth requires much reliable, timely information of the type accounting can provide. There is certainly no shortage of opportunities for service for accounting. If anything, they are greater than can be met.

John Wheeler states: "No period in history has provided such challenges and opportunities to the accounting scholar, but to take advantage of these opportunities he must be prepared to work outside the narrow confines of traditional accounting and to utilize sophisticated research tools which have been developed in a variety of other disciplines." Accountants have been somewhat bewildered by change because of the narrowness of their field of specialization. Thus, if accounting is to meet the challenge of the future, a special burden

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22 Wheeler, op. cit., p. 10.
must be assumed by accounting educators. There must be injected into
the profession persons with the interdisciplinary knowledge that seems
to be required for an expansion of the boundaries of accounting.

Accounting may well be at a crossroads in its history. Lawler
warns: "Buffeted by winds of change, some practitioners seem to me to
be descending to the storm cellars—retreating to the comfort of old
ruts of routine—adopting . . . a 'business-as-usual' attitude. This,
surely, is a fatal approach." The alternative is to face up to the
challenge of change, revamp the techniques of accounting by incorpo­
rating developments in the behavioral sciences, economics, and mathe­
matics, and thus assure a vital role for accounting in the future.

Accounting as a System

Any significant expansion of the scope of accounting requires
a breaking away from the limitations of traditional accounting theory.
Such a departure, however, may leave accounting without a foundation
upon which to base the development of its new, expanded role. Wheeler
states: "Accounting theory . . . has lost its shackles, but in the
process it has also lost bases for theory development and research
which have been of inestimable value; so far little of substance has
been found to replace them." The proposal made in this dissertation
is that general systems theory may provide some guidance in the formu­
lation of the role of accounting in the future.

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23Lawler, op. cit., p. 16.

The concept of "system" applied to accounting. A system has been defined as any complex of elements in mutual interaction. This definition is general enough to allow anything to be considered as a system. In fact, the hypothesis of general systems theory is that the entire universe may be considered a nesting of systems arranged in hierarchical order. If accounting has a place in the universe, then it must be considered a system in a hierarchical structure of systems.

At the highest conceptual level, accounting should be considered part of a social system and, a social system itself. Accounting is essentially people—people measuring and communicating information to people who use the information. Thus accounting must be viewed within the framework of the nature of social systems as developed in the behavioral sciences.

Berrien defines a social group as "a set of two or more individuals interacting with each other in a manner different from their interactions with other individuals." Exchanges within the group will show somewhat greater confidence, greater intimacy, and greater detail than will exchanges between the group and its surroundings. Social groups or systems exist in hierarchical structures. "A work group in a factory is a component within a department that is part of the manufacturing division of a corporation, existing within a competitive industry making up a segment of the economic system within a nation having political, economic, military and other relationships


26Ibid.
with other nations, some of which may be bound together by treaty ties in opposition to other nations similarly bound."27

Miller distinguishes between concrete systems and abstracted systems.28 A concrete system is a real system, or, as defined more formally by Miller, is "a nonrandom accumulation of matter-energy in a region in physical space-time, which is nonrandomly organized into coacting, interrelated subsystems or components."29 Abstracted systems, on the other hand, are "sets of formal relationships within or among concrete subsystems. Their relationships exist as concepts in the minds of scientific observers."30 The units of abstracted systems are "relationships abstracted or selected by an observer in the light of his interests, theoretical viewpoint, or philosophical bias. Some relationships may be empirically determinable by some operation carried out by the observer, but others are not, being only his concepts."31

A particular concrete social system consists of particular persons performing roles. Social systems may also be considered apart from specific individuals by considering the system in terms of functional roles.32 Such an approach seems similar to Miller's conception of abstracted systems.

27 Ibid., p. 91.


32 Berrien, loc. cit.
Accounting may be considered in terms of a concrete system within a specific organization. It might be regarded as a single concrete system made up of all those persons who function in the profession or vocation of accounting in all organizations. Accounting may also be considered abstractly as a set of relationships, roles, or functions. Both views of accounting, concrete and abstract, are significant in determining its nature. In concrete terms, accounting is a social system, people communicating with people. Behavioral considerations cannot be overlooked. From this concrete system, relationships may be abstracted by observers so that they may be considered directly. These relationships may be based on empirical observation or they may be more of a normative nature, based on someone's conception of relationships that "ought to be." The study of accounting as an abstracted system is important in that it allows a macro view and permits investigation of the fundamental nature of the system. Such a study can lose much of its value, however, if the realities of the concrete systems involved are neglected.

Boulding suggests, as previously noted, that his "system of systems" may be used as a vehicle for abstraction of certain aspects of higher level systems. "... A 'lower' system is always a legitimate abstraction of certain aspects of a higher system." Thus there is the possibility that some abstractions about accounting may fit the characteristics of some of the lower level systems in Boulding's hierarchy.

Hierarchical order of human organizations. Level eight of Boulding's "system of systems" was the level of social organizations. Most of the activities of mankind are carried on within the framework of these systems. Human organizations exist in a hierarchy of subsystems of subsystems of subsystems, and so on. A business firm, for example, is a subsystem of an industry which is a subsystem of an economic system which is a subsystem of the nation. A social club may be a subsystem of a local society system which is a subsystem of a national society system which is a subsystem of the nation.

Any human organization may be considered a self-regulating system of the type depicted previously in Figure 3-1. The system consists of three basic groups of components—management, production, and information. The boundary of the system identifies it, and codes input, decodes output, and regulates input-output flow. Self-regulation of some degree is achieved by the feedback process.

This concept of a self-regulating system is, admittedly, a normative model. The model is basically that of a cybernetic system, about which Beer states: "It is hard to detect a system in industry or society which answers to all ... the basic cybernetic criteria. ... The case for industrial cybernetics is, quite simply, that industrial systems should (to be properly effective) be designed as cybernetic systems." The proposition here is that human organizations will be more effective if they function as self-regulating systems.

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The management, production, and information components of the system are subsystems, that is, systems themselves, and thus likewise consist of management, production, and information components. Consider, for example, the management component of a system. The function of this component is to energize and control the system through use of feedback information relative to the system's performance in meeting its objective in relation to the environment. The management subsystem itself is controlled by a management subsystem using feedback information relative to the subsystem's objective in relation to its environment, the system. The management subsystem produces its output through production components that do the actual work of identifying objectives, planning, setting standards, and so on. The management subsystem should also have information components that provide feedback information relating to the subsystem objective.

The thing being emphasized here again is hierarchical structure—systems within systems within systems. Whatever human organization is the focus of study, it must be considered part of a hierarchy of systems, a subsystem itself and consisting itself of subsystems. A complex system can be most meaningfully described as a self-regulating system.

The place of accounting in the hierarchy. A study of human organizations as they are today may well reveal that the state of the information components within the system is generally the weakest link in the chain of self-regulation. If this is true, the reason may be the lack of understanding of the role of these components in the achievement of self-regulation. In fact, feedback is the essence of
self-regulation, and it is the information components that provide the feedback data.

The role of accounting should be that of an information component in a system. Traditionally, it has played this role, but in a rather limited way. Accounting has measured and communicated information, but within a severely limited framework, and often without consideration of the usefulness of the information relative to the system objective.

Baladouni aptly describes the accounting universe as "a grand behavioral process." Accounting must be considered in light of the fact that its information output will affect the user's state of mind and thus his behavior. In a system, then, accounting should have as its objective the output of information that will be most useful in directing behavior toward system self-regulation.

The control of a system is directed toward assuring that the system meets its objective. Speaking of business organizations, Caplan says, "To the extent that any truly over-all objective might be identified, the objective is probably organization survival." The basic objective of almost any system may reasonably be assumed to be survival. General systems theory indicates, as discussed above in Chapter III, that the survival of a system is assured by its providing output useful to its suprasystem. Therefore, the role of the information component in a system should be to communicate

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37 Ibid., p. 219.

information relative to the system's performance in meeting its objective, with the objective being stated in terms of relationships with the suprasystem or environment.

The role of accounting as an information component in a system is to provide feedback information in the process of self-regulation. Feedback information is considered here, as described previously, as consisting of all data relating to the functioning of the system, past, present, and future, in the meeting of its objective. Much of this information is of interest only to the internal functioning of the system. Outsiders have a legitimate interest in some of it, however, and such information may be made available to the suprasystem.

Hierarchical order within accounting. Accounting itself may be described as a system, either as a concrete system or an abstracted system. As a system, accounting should consist of management, production, and information components.

The management component of accounting as a system has the function of controlling accounting toward the meeting of its objective. A traditional hindrance in this respect has been the disagreement as to what accounting's objective is. In a systems framework, the objective of accounting, as will be presented in detail in Chapter V, is, as with any system, the production of output of maximum usefulness to its suprasystem.

The production components of accounting produce the output of the system. In considering the nature of accounting in the future, the basic problem is to identify the systems which interact in the production of feedback information relative to suprasystem performance
in relation to its objective. If the objective of accounting is defined broadly to encompass all feedback information, as has been the tendency in recent years, then accounting is the information system, consisting of various components. If accounting is to be considered as involving only limited financial information, then it must be considered only a component of a larger information system.

Of urgent importance in accounting is the development of feedback information components. If accounting is to survive, it must provide output useful to its environment. That is, accounting must achieve self-regulation toward this objective. Self-regulation requires feedback information relative to the success of the system in meeting its objective. Feedback information in accounting does exist today and is heeded to some extent, but the need is for this information to be an integral part of a system that is self-regulating. The designing of the accounting of the future with such information components is an immense challenge, but it seems essential to the well-being of the system.

Summary

Accounting has a long, distinguished history as a profession and body of knowledge, and yet, today, there is considerable questioning of its fundamental nature and role in human affairs. To many people, the situation seems to be that accounting must take on an expanded role or be eclipsed by newer quantitative information techniques.

A survey of the definitions of accounting presented by various authorities in the field over the years seems to reveal an evolution
toward an expanded scope for the discipline. This enlarged range of accounting activities is particularly evident in the definitions offered by the American Institute of Certified Public Accountants (1966) and the American Accounting Association (1966).

Concepts of the nature of accounting as viewed by various persons range from that of it as the limited field of financial record-keeping to that of it as a universal information system applicable to all human organizations. The concepts of general systems theory may provide a better macro view of accounting that will lead to a more useful role for the discipline.

Accounting has evolved over the centuries and has been basically oriented toward business entities. Rapid environmental changes in the 1950s and 1960s, however, have suggested that accounting, if it adapts to the changes, may well be able to play a more pervasive role in the future. In the general environment, social, political, and economic change has been profound. In the more immediate environment, pressures have been exerted on accounting by the automation of data-processing, the growth of new forms of business organization, and a clamor for more uniformity in accounting principles. If accountants seize the pressures of change as opportunities for the improvement and expansion of their profession and body of knowledge, accounting should have a significant, vital role in the future.

Concepts of general systems theory may provide a useful basis for the reevaluation of the nature of accounting. Accounting must be considered and studied as a system, and, at the highest level, as a social system. Within human organizations as self-regulating systems,
accounting may be considered as an information component providing feedback information for the purpose of system control. This information should be useful to the system in assessing its performance in meeting its objective and in adjusting itself to meet its objective.

Accounting itself may be considered as a concrete system or as an abstracted system. Either way, it also should consist of management, production, and information components. This system framework seems most promising as a basis for the well-being of accounting in the future.
CHAPTER V

THE ELEMENTS OF ACCOUNTING AS A SYSTEM

Environment

The environment of a system consists, in general, of all things outside the system's control which affect the accomplishment of the system objective. The immediate environment of a system consists of its suprasystem, the system immediately above in the hierarchical structure. The total environment of a system includes all factors that affect or are affected by the system.

In the study of any particular system, the immediate environment, the suprasystem, is of greatest significance. A system receives input from its suprasystem, and expels output into the suprasystem. The boundary of the system selects, filters, and codes the input from the immediate suprasystem. Factors from outside the immediate suprasystem are filtered by the boundary of the suprasystem. Likewise, system output is filtered and coded by the system boundary and is discharged into the suprasystem. Before this system output affects any other system, it is again filtered and coded, and perhaps processed, by the suprasystem and its boundary. This hierarchical structure is represented graphically in Figure 5-1. Each lower level system will likely consist of several subsystems, but only one at each level is depicted in the diagram.
The function of any system is to contribute to the production of the suprasystem output, which, in turn, is a contribution to the output of the next higher system. The environment which primarily affects the system and is affected by it is the immediate suprasystem. In the case of accounting, the environment of a particular concrete system of accounting is the organization or entity of which it is a subsystem. The general environment of accounting then consists of the human organizations in which accounting functions. The environment of these organizations, in turn, consists of the economic, social, and political systems of which they are subsystems.

The expanded scope seen for accounting in the future is to function as an information component in entities of all kinds.
Traditionally, however, accounting's primary role has been in business firms, and this role will continue to be of great significance in the future. Therefore, the influences on accounting from the business environment may be considered first. Entire volumes could be written on business and its environment.¹ The discussion below therefore is a very selective summary.

The business firm has been and will likely continue to be the type of entity in which accounting plays its most significant role. In a private enterprise economy, business is the medium for most of the economic activity. Today, as an environment for accounting, business firms themselves are changing, and the environment in which they operate is changing. These changes are of considerable significance in the consideration of the nature of accounting.

The forms of business organization have undergone major modification in recent years. The merger movement of the 1960s saw the formation of many large firms, called conglomerates, that carried on a wide diversity of activities. At the same time, the large non-diversified corporations continued to grow in size, a natural result of their wealth and industry dominance. Yet, small businesses have not disappeared. The franchise phenomenon of the late 1960s in the basically service-oriented fields was centered around small, local businesses operating under license from franchisers. Thus, the business entities in which accounting functions are and will likely continue to be a

diverse assortment, from giant industry-leading corporations and giant diversified conglomerates to small localized firms.

The process of management of business firms, large and small, has reached a level of increased sophistication and effectiveness in recent years. Significant strides have been made in the science of business management with increased emphasis on systematic planning and control, made possible by contributions from the behavioral sciences, mathematics, and accounting. Management accounting has made important contributions to the improvement in business management effectiveness, and it is this area that offers great opportunities for service by accounting in the future.

The production activities of business firms have undergone change also, particularly as a result of automation. Firms that produce physical products have been characterized by increasing investments in capital equipment and reduced dependence on human labor. Increased leisure in society, on the other hand, has caused a large increase in the number of firms producing a service, and these firms rely heavily on human labor. The long-range impact of automation, probably including a significant restructuring of business and employment, is an important consideration in the environment of accounting.

The information activities of business firms also have been affected by automation. In particular, information can now be made available and used that previously was beyond the capabilities of manual methods. The monumental computational effort required in many

statistical analyses has been reduced to a fraction of a minute of computer time. The complex simulation models of the management scientist have become feasible through the computer. Accounting now must evaluate its role in an environment of vastly expanded information capabilities of business firms.

The environment of business consists of those systems that expect to receive output from business. This desired output is of varying types, depending on the nature of the receiving system. Since system survival is based on its output being useful to its suprasystem, then business firms must adapt to the needs of its environment. The state of accounting's environment, the business firm, is thus related directly to the state of the firm's environment. A significant function of accounting is to act as an information component to facilitate a firm's adaptation to the needs of its suprasystem.

The owners of a business firm make up one of the groups that expect output from the firm. Whether these are the stockholder-owners of a large corporation or the sole owner of a proprietorship who is also its manager, owners in the ownership role expect useful output from the firm. The output desired by owners probably is the largest possible return on their investment and maximization of the value of their investment in the firm.

The National Labor Relations (Wagner) Act of 1935 put the federal government on the side of labor in its long fight to claim a significant benefit.}

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3Davis and Blomstrom, op. cit., p. 207.

interest in the operations of business firms. The law forced firms to recognize labor unions and to bargain collectively with them.

Since the passage of the act, labor unions have grown to a position of power in business, and American labor is now a recognized social institution\textsuperscript{5} with power equal to, and sometimes greater than, that of business. The fundamental right to a job was stated in the extraordinary Employment Act of 1946, in which the federal government stated a policy of promoting conditions "under which there will be afforded useful employment opportunities, including self-employment, for those able, willing, and seeking work, and to promote maximum employment, production, and purchasing power."\textsuperscript{6}

Identification of the output desired by workers from business is difficult, being hindered by the uncertainty of human motivation. Labor unions traditionally have emphasized "bread-and-butter" demands for improved wages, hours, and working conditions. More recently, emphasis has been placed also on worker economic security issues such as supplemental unemployment benefits and job security in cases of automation of production. Perhaps the interests of workers would be better served if the desired output were stated in terms of maximizing worker purchasing power or standard of living, since this output would include not only secure wages, but also price stability, product quality, and other less tangible aspects of business output.

\textsuperscript{5}Davis and Blomstrom, op. cit., p. 246.

Government expects certain outputs from the business community. At the national level, government expects business to produce goods and services so as to support a generally high standard of living for all citizens and to produce goods and services for use by the government itself. The aggregate of business firms is expected to produce a stable but growing general economy.

The federal government, over the years, as real or imagined defects in the performance of business firms appeared, has stepped in to seek to shape business toward the desired performance. Such intervention activities are numerous: regulation of transportation, trade, and securities exchanges; anti-trust activities; management of the money supply and interest rates; minimum wage laws; and others. State and local governments are also quite active in regulating the activities of business. Some persons even suggest that the real need in the United States is national economic planning.

Another important output expected by government from business is tax revenue, both directly from business firms and from firms as agents in collecting consumer taxes. The federal income tax and state and local income taxes are the most significant tax revenue output of business. The collection of taxes whose incidence is more clearly on the consumer, however, is also facilitated by the designation of business firms as collection agents. Federal, state, and local government is increasingly dependent on business firms as primary and indirect sources of tax revenue.

7Carey, The CPA Plans for the Future, p. 77.
In 1882, in response to a reporter's question as to whether a certain train was run for the public benefit, William H. Vanderbilt replied: "The public be damned... I don't take any stock in this silly nonsense about working for anybody's good but our own, because we are not..."8 Despite Vanderbilt's outspoken statement, the public interest in the railroads was affirmed in the Interstate Commerce Act of 1887. A "public-be-damned" attitude on the part of a business firm has never been amenable to its long-term success, and it certainly is not today. Business is more and more being forced to accept a responsibility for the effects of its output on society in general. Consumers and the public at large have a significant interest in the output of business firms.

The primary environment of accounting is the business firm. Other human organizations, however, also function most effectively as self-regulating systems, thus requiring an information component producing feedback data. Accounting should be able to fill this need in any system. Thus, the environment of accounting may include not only business firms but also organizations of all types—governmental units and programs, universities, churches, social clubs, and the like. Even an individual's affairs may be conceived of as a self-regulating system, and accounting has a legitimate role here.

The principal point of this discussion of the environment of accounting is that this environment consists of the systems in which accounting functions as an information component. Accounting's role in general is to measure and communicate information to facilitate

the meeting of the systems' objectives as related to their environment. Thus accounting in any particular system must be shaped by the output objective of the particular system, which objective is in turn shaped by the needs of the system's environment. Accounting in general functions in an environment consisting of a variety of entities requiring feedback information components in order to achieve self-regulation.

Objective

The objective of any system, in general, is to produce output of maximum usefulness to its suprasystem. The objective of accounting then should be the output of information of maximum usefulness to its suprasystem or environment, the entities in which it functions as an information component.

The idea that the basic objective of accounting is usefulness is certainly not new, but neither is it the subject of full agreement. A sampling of articles in The Accounting Review provides the following statements in favor of usefulness as the objective of accounting:

- The criterion of usefulness occupies the highest level of the accounting information criteria hierarchy.\(^9\)
- Any significant exposition of accounting theory must start with the recognition that the purpose of accounting is usefulness.\(^10\)
- Accounting is utilitarian. . . . Underlying accounting standards represent the concept of usefulness.\(^11\)

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Accounting reports are not an end in themselves but exist to be used.\textsuperscript{12}

Other accounting writers, however, reject usefulness as the basic accounting objective. In Accounting Research Study No. 1, Moonitz excludes usefulness from his list of accounting postulates, on the grounds that it is vague and perhaps dangerous:

But anyone who stresses "usefulness" as a criterion, in accounting or elsewhere, must answer the two pointed questions—useful to whom? and for what purpose? And herein lies the danger. We could easily be trapped into defining accounting and formulating its postulates, principles, and rules in terms of some special interest. ...\textsuperscript{13}

Leonard Spacek argues that utility means nothing unless the utility sought is clearly defined. "... The word 'utilitarian' is not used in everyday accounting work because it is meaningless."\textsuperscript{14}

Usefulness is certainly not a valid objective of accounting if it is considered as license to passively produce traditional output without question unless and until it is rejected by the recipients as useless. Such an objective may well be fatal, as noted previously in this quotation from Berrien: "If the products are unacceptable, either the producing system itself takes on a different state ... or the environment operates in such a fashion that the system is destroyed."\textsuperscript{15} Instead, usefulness must be the active motivating force


which shapes the output of accounting at all times. Bedford states: "Accountants will have to assume the responsibility of determining what should be reported rather than merely reporting that which someone else has requested. Thus, accounting will become more of a normative science in the future."¹⁶

"Usefulness" standing alone is too vague to be of value as the objective of accounting, as Spacek warns. General systems theory, however, provides a standard which gives usefulness the substance required for its use as the objective of accounting. In the systems framework, accounting must provide output useful in directing its suprasystem toward self-regulation to the meeting of its objective, the objective in turn being stated in terms of output to the next higher systems.

Accounting as an abstract system has the general objective of providing information of maximum usefulness to the process of system self-regulation toward the meeting of system objectives stated in terms of output to the environment. Accounting in a particular concrete system has the objective of providing information of maximum usefulness to the self-regulation of that particular system toward the meeting of its particular objectives. Accounting thus should be based on principles relating to the measurement and communication of information in general, principles relating to the measurement and communication of information in systems of a particular general type (business firms, governmental units, etc.), and principles relating to the measurement and communication of information in each particular concrete system (a specific firm, governmental agency, etc.).

The case of business firms as a class of systems may be considered as an illustration of accounting's objective of usefulness. The objective of business firms is the production of output of usefulness to its environment, which, as discussed above, includes owners, labor, government, consumers, and the general public. This output is achieved by systems consisting of management, production, and information components.

The output of accounting as an information component of a business firm is to its suprasystem, the business firm, and particularly to the management and production components of that system. The significance of the objective of usefulness is that maximum usefulness of accounting's output will be achieved if the information measured and communicated is related to the desired system (business firm) output. Maximum system efficiency will be achieved through self-regulation, which requires constant adjustment of the system by the management components toward the meeting of the system objective stated in terms of output useful to the environment, which in turn will be most effectively achieved if feedback information provided is presented in terms of the system output.

What is the output desired of business firms by the various elements of the environment—owners, employees, government, consumers, and the general public? The truth may well be that the desires are not always clear and are often conflicting. A business firm generally has not a single objective but several objectives. The management component has the responsibility of resolving or assigning priorities to conflicting objectives, but it should have information available
relative to the several objectives so as to facilitate decision-making. Accounting's reports must therefore be multi-dimensional. Bedford, reporting on the deliberations of the 1965-66 Committee on Basic Accounting Theory of the American Accounting Association, states:

The Committee foresaw a future need for multi-dimensional reporting as well as multiple valuations. For example, the goal of high employee morale may require entirely different measurements than will a goal of income maximization. The fact is that different information is needed for different purposes and different measurements are appropriate for different purposes. That is, measurements appropriate for one objective may be inappropriate for another. This concept has at times been expressed in elementary form as the need for different measurements for different purposes and situations.17

The traditional financial statements, balance sheet and income statement, are directed, if anywhere, toward the objective of output to the owner, that is, return on investment and maximization of investment value. Information relative to the present value of the firm and its operating performance should relate directly to these owner-oriented objectives. Such information is apparently provided by the balance sheet and income statement, but do they really provide the best measurement and presentation? The most significant figure for owners would seem to be the present value of the firm, but the value shown on cost-based balance sheets can hardly be of much usefulness to owners. Net income as presently measured is a summarization of transactions and only as an afterthought is it related to the increase in value of the firm. A more useful concept of income from the view of owners might well be the increase in value of the firm during a period resulting from all factors--transactions, holding

gains, and others. R. J. Chambers in his book *Accounting, Evaluation and Economic Behavior*\(^{18}\) presents a system of financial measurement and reporting which follows a viewpoint similar to the approach suggested in this paragraph.

The basic objective of accounting then is the production of information output of maximum usefulness to its suprasystem, organizations of all kinds. The standard by which usefulness is judged is this: Is the information related to a suprasystem output objective and is it measured and communicated in a way to facilitate decision-making relative to the suprasystem's state of self-regulation? Accounting as a system oriented toward meeting this objective can be of maximum value to organizations of all kinds in their performance at maximum efficiency as self-regulating systems.

**Boundary**

The boundary of a system may best be described as that state of affairs which identifies a system and separates it from its environment. The boundary functions as a component of the system by selecting and coding input and output and regulating the rate of their flow. There is a higher level of interchange (of energy, information, etc.) among components within the boundary than there is between these components and systems outside the boundary.

The boundary of accounting is not physical but is conceptual. It is a state of affairs determined in one respect by tradition, acceptance, reputation, competence, professional status, and other such

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intangible marks of a profession and body of knowledge. Since this boundary which identifies accounting is neither physical nor fixed, it should be subject to modification, expansion, or contraction. The boundary might be expanded, for example, if there is demand from the suprasystem and/or pressure from expanding capabilities within the system, accounting.

Evidence of an extension of the boundaries of accounting can be found in the rapid growth of the field of "management accounting" or, in public accounting practice, "management services." These areas include the entire span of information measurement and communication. The question of whether all of this is "accounting" or not is not really relevant. The important point is that a system which before had a rather narrow scope is now producing or being called on to produce information of much greater variety.

This potential for expansion of the boundary of accounting is the result of two forces. First, those who needed additional information turned to the traditional source of information, accounting, and demanded data of different types more relevant to their needs. The traditional competence of accounting and the unquestioned professional status of certified public accountants surely caused managers, investors, and others to turn to this source for needed information. Secondly, accountants themselves have taken the initiative, broadened their areas of competence, and offered their services in providing information beyond the traditional financial statements. The result has been an apparent extension of the boundary of accounting to identify a system with an expanded scope.
The idea of "social accounting," proposed mainly by social scientists, presents a challenge which accounting should seek to meet. Social accounting is based basically on general systems concepts and relates closely to the description of the nature of accounting developed in this dissertation.

Bertram M. Gross, in a 1967 article in *Human Relations*, described the nature of social accounting in a general systems framework. Social accounting has been fostered by the data needs of the Planning-Programming-Budgeting-System (PPBS) of the federal government. According to Gross:

The new benefit-output-input synthesis requires that government budgeting be "based upon an appraisal of (a) the direct and indirect benefits likely to be obtained from (b) identifiable outputs (or services) to be provided by (c) the use of realistically estimated inputs (costs)."

The relation between (b) and (c) is the traditional field of cost accounting. Here the cold-eyed analyst will have a field day. But with (a) we enter the complex realm of "What does it all mean to people? What is the result as measured not only in income and savings, but in health, security, opportunity, and self-development?"

Gross further distinguishes among micro social accounting, macro-residual social accounting, and social system analysis. Micro social accounting takes a broader view of single organizations or projects. "These broader ways usually consist of identifying inputs that do not appear on the cost accounts of an organization—whether these inputs are extracted from, or contributed by, the organization's members or

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by other organizations (including government agencies) in the immediate environment. "Macro-residual social accounting emphasizes a view of an entire society or nation and would measure and communicate information on the state of such matters as art and culture, health, education, research and development, civil rights, and the reduction of poverty, crime, and delinquency."

Social system analysis covers both micro and macro views of a society. Gross states:

In this sense social system accounting may be either micro or macro. At the micro level it provides a way of ordering complex information concerning the changing state of an organization, its component parts, and its environmental relations. This involves a truly "managerial" style of "managerial accounting"—as distinguished from the various approaches to "managerial accounting" whereby either accountants or economists try to interpret specialized accounting or economic information to managers. At the macro level social systems accounting provides a way of ordering complex information on the changing state of a nation, its major subsystems and its relations with other nations and the world environment.

The boundary of accounting then has already been expanded somewhat by the concepts of management accounting and management services. This expansion has opened the door to vastly greater extensions of accounting, even, perhaps, to include eventually the sphere of social accounting.

The logical role of accounting, from the systems standpoint, is that of the information component of self-regulating systems. The objective of accounting, as described previously, is the production of

22 Ibid., p. 367.
23 Ibid., p. 368.
24 Ibid., pp. 368-369.
information output to facilitate system self-regulation, and thus accounting would consist of all components which contribute to this objective. The boundary of the system would separate those subcomponents whose primary objective relates to feedback information output from those with other output objectives.

The boundary of a system not only identifies it and separates it from other systems but also serves as a coding-decoding filter and input-output flow regulator. The boundary of accounting should provide for the selection, from the mass of data likely to be available in a system, of that data which is relevant to the production of system feedback information. The boundary should also perform a decoding function relative to output. Berrien has made the point that what comes out of systems is not what went on within them.²⁵ Thus, users of accounting output need information in a form relating to their needs, not in a form relating to the needs of the internal processes of accounting. The boundary of accounting should provide for the presentation of accounting information in a user-oriented form. The boundary of accounting also determines when input is required and when output is desirable or possible, thus acting as a regulator of the input-output flow.

Ideally, the boundary of accounting should be clearly and carefully defined by accounting theory. Prince states that the theoretical structure of a discipline should consist of a complete statement of the purpose and function of the discipline and all other disciplines,

²⁵Berrien, op. cit., p. 22.
thus setting the limits or boundaries of the discipline.\textsuperscript{26} Hendriksen defines accounting theory as "logical reasoning in the form of a set of broad principles that (1) provide a general frame of reference by which accounting practice can be evaluated and (2) guide the development of new practices and procedures."\textsuperscript{27}

Accounting theory thus should be a general framework of principles that define the nature of accounting and demarcate its boundaries. A view of accounting in the framework of general systems theory seems to provide an excellent basis for the statement of principles to form the nucleus of accounting theory. The function, objective, or boundary of accounting can best be stated in terms of its role as a component of a self-regulating system. Accounting's role is that of an information component in the process of feedback. Thus, as stated previously, accounting theory should be made up of, in levels of decreasing abstraction: (1) General principles relating to the measurement and communication of information in general and to the role of information in the process of system self-regulation; (2) Principles relating to the measurement and communication of information in systems of a particular type; and (3) Principles relating to the measurement and communication of information in each particular system. Level three may well be described as accounting practice or procedures rather than theory.

Accounting theory at the highest level would have to be based on or related to such considerations as general systems principles,

\textsuperscript{26}Thomas R. Prince, \textit{Extension of the Boundaries of Accounting Theory} (Cincinnati, Ohio: South-Western Publishing Co., 1963), p. 34.

the nature of information, measurement theory, communication theory, the nature of the decision-making process, and logic. Thus at this level accounting theory would involve such disciplines as general systems theory itself, the behavioral sciences, mathematics, and organization theory. At the second level, accounting theory would be shaped by considerations relative to particular types of organizations, and would thus be influenced by economic theory, principles of business management, political science, and other disciplines that give insight into specific types of systems. At the third level accounting theory would be further delimited by the nature and needs of the particular system in which it functions.

The boundary of accounting defines its nature, identifying it as a system with a distinguishable purpose or objective. This boundary should be determined by the principles of accounting theory. Since accounting is an open system, however, the system and its boundary are subject to change in adaptation to the changing requirements of its suprasystem. Thus, at the present time, accounting is facing the potentiality of a significant extension of its boundary.

**Inputs and Outputs**

The inputs to a system consist of the complexes of information and/or energy and/or matter introduced into or absorbed by the system, and the outputs consist of the complexes discharged from the system into the suprasystem. The function of the system is to process the inputs into outputs that are distinguishable in nature from the inputs. If a system is to survive, its outputs must be acceptable, that is, useful to its suprasystem.
Inputs to a system are of two types, maintenance and production (or signal). Maintenance inputs energize and sustain the system, whereas production inputs are processed into output. Output may be useful or waste. A viable system produces useful output whose value offsets the worthlessness of the wastes.

The maintenance inputs to accounting come from its suprasystem, allocated by the management component. Accounting’s performance of the role of information component in system self-regulation allows the suprasystem to achieve efficiency of operation in producing output, which in the cyclic functioning of the system furnishes energy for input back into the system. Accounting’s maintenance inputs thus also result from the cycle of events—accounting’s output promotes suprasystem efficiency, maximizing useful output, which provides energy renewal inputs to the suprasystem, which allocates inputs to its information component. Thus the health of the system and of its subsystem, accounting, is related directly to the usefulness of accounting’s information output in achieving system self-regulation.

Signal inputs are selected by accounting from the vast quantity of data available. The data selected is chosen for its applicability to the generation of feedback information relative to suprasystem self-regulation. As described in Chapter III, three kinds of information are required by the suprasystem in achieving self-direction: (1) information on the world outside; (2) information from the past; and (3) information about the system itself, its parts, and its performance. The boundary of accounting selects data relevant to its production of these three kinds of information. In addition, accounting
receives input from its own feedback network relative to its performance in meeting its objective.

A true system processes the inputs into output different in some detectable characteristic from the inputs. Inputs are not merely transported, they are transformed. According to Berrien, "the system does something to the inputs it accepts so that the products are not merely copies of the inputs but different in some identifiable way." Accounting therefore does not just report data as collected, it transforms the data into useful feedback information. This transformation is accomplished through activities such as identification, measurement, testing validity and relevance, summarizing, interpretation, and communication. If raw data were readily usable to management in achieving system self-regulation, there would be no need for accounting or any information component in a system. The fact is, however, that the activities of accounting are requisite to the provision of feedback information in a system.

The output of a system may be partly useful and partly waste. If a system is to survive, the useful output must exceed the waste, and the system's survival time increases as the ratio of useful to useless production increases. Since all systems are selective in receiving inputs, and since a subsystem's survival is dependent on its output being useful to its suprasystem, then it seems apparent that a system should design its output to meet the requirements of its suprasystem.

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28 Berrien, op. cit., p. 15.

29 Ibid., p. 29.
The input the suprasystem will accept is determined by the structure of its receiving system\textsuperscript{30} or its boundary. If a system continually receives from a subsystem output which must be rejected as unacceptable to the system, there is the possibility that the system's receiving system or boundary will eventually be modified to accommodate the subsystem output. The more likely occurrence, however, is that the subsystem will either adapt itself to the suprasystem's needs or be abandoned. Berrien proposes that the evolution of systems takes the form of a gradual improvement in the matching of systems to their suprasystems.\textsuperscript{31} Mismatched subsystems "produce too much, too little, or the unacceptable kind of output for the suprasystem."\textsuperscript{32} Matching occurs when the subsystem output meets the requirements of the suprasystem.

The applicability of the preceding concepts to accounting seems clear and direct. Accounting is a subsystem of organizations seeking to attain self-regulation. The output required of accounting then is feedback information relative to the performance of the organization in meeting its objective. If the output of accounting is not attuned to the receiving system of the suprasystem or of the management component of the suprasystem or is not useful to it in achieving goal-directed behavior, it will be rejected. If the output of accounting is useless and the suprasystem does not get adequate feedback information from other sources, the suprasystem may deteriorate and die. If the output of accounting is of minimum usefulness, the suprasystem may

\textsuperscript{30}\textit{Ibid.}, p. 28.  
\textsuperscript{31}\textit{Ibid.}, p. 41.  
\textsuperscript{32}\textit{Ibid.}.  
continue to function but slowly deteriorate, or there may be evolution
toward a closer matching of accounting to the suprasystem's needs.
Maximum efficiency of the operation of the suprasystem will come when
it can function as a self-regulating system through the receipt of
output from accounting that is designed specifically to meet its in-
formation needs.

Some systems possess the property of storing inputs or their
derivatives. Some systems surely is such a system. Some of the po-
tential output of accounting may be useless to the suprasystem be-
cause of a mismatch in timing between output and the need. Storage
of this information by the accounting system will allow it to be
drawn on when required by the suprasystem. Likewise, storage of in-
puts and accounting process production is essential to the output of
feedback information relative to the past. Storage of inputs may be
required when processing is not possible or advisable at a particular
point in time. The storage capability of a system and of accounting
facilitates the process of adaptation. According to Berrien, "those
systems which are so constructed that storage is possible are thereby
better equipped to survive."^4

Production Components

The components of a system are the basic subsystems which com-
pose the system. System output is achieved through interaction among
these components. System components are identifiable by the following

^33Ibid., p. 40.

^4Ibid., p. 41.
characteristics: (1) A component of a system interacts with other components in the production of system output. (2) A component has a distinguishable objective that contributes to the production of system output. If components have attractive forces based on similarity of objectives that are not counterbalanced by repelling forces based on the distinguishable characteristics of their objectives, the components will merge into a single component. Surviving components will have clearly distinguishable roles in the production of system output. (3) Intracomponent linkages are stronger than intercomponent linkages. The dynamics involving the internal structure of the components is high-frequency as compared to the dynamics of interaction among components.

In the study of a particular system, components may be identified by first defining the objective of the system and then delineating those subsystems that make a distinguishable contribution to the meeting of that objective. These components will be of the three basic types—management, production, and information. The focus of the following discussion of the components of accounting is particularly on the production components.

The basic objective of accounting has already been presented as the production of information output of maximum usefulness to its suprasystem, organizations of all kinds. The information output should be designed to be useful in the achievement of self-regulation by the suprasystem. Thus, the components of accounting should each make a distinguishable contribution to that objective.

"Financial accounting" is the term generally used to describe that part of accounting whose activities are directed mainly toward
the production of information for external users. The basic products of financial accounting are a measure of net income and a presentation of financial condition, presented in an income statement and balance sheet. These statements have apparently been intended to relate basically to the information needs of investors in business firms, owners and creditors. Does financial accounting qualify as a component of accounting viewed in the systems framework?

An organization is expected to provide information on its performance and state to those elements in the environment that have a vital interest in the output of the organization. For a business firm, for example, external users would thus include owners, creditors, workers, customers, government, and the general public. The present narrow scope of financial accounting provides information of some value to owners and creditors but of little or no value to the other external parties.

The scope of financial accounting, from a systems viewpoint, should include the presentation of various types of information which indicate the performance of an organization in producing the output desired by the different interested parties in the environment. Financial accounting then should produce multi-dimensional reports or several different reports directed toward different users. These reports would likely include information other than dollars-and-cents measurements. Thus, this component of accounting should be called something other than financial accounting. Perhaps "accounting for external users" would be appropriate.

This view of accounting for external users is compatible with the view of accounting as the feedback information component in a
system. The information provided for external users is a basic type of feedback on the performance of the system. Although system management is interested in this information as a macro measure of system performance, the information should be presented in a form particularly suited to the needs of the external users. The information presented to the external users is an output of the suprasystem, not directly of the accounting system, following the hierarchical structure. This information output is basic to the cyclical input-output functioning of the system, since the environmental elements expect and require it in evaluating the system and their contributions to its functioning.

The emphasis of this information for external users is on summarized, overall measures of system performance and state. In the present state of affairs for many organizations, the information will be mainly historical and subject to attestation. Information on expectations would also be of considerable usefulness to external parties, however, and accounting for external users will likely include such information, clearly labeled, in its output more and more in the future.

Accounting for external users qualifies as a component of accounting because it makes a distinctive contribution to the output of accounting, information useful to the suprasystem in achieving self-regulation. The contribution is in the form of summarized, macro measures of system performance and state, prepared in a form specifically suited to the needs of those in the environment who contribute input to the suprasystem and receive output from it. The cyclical input-output functioning of an open system is dependent on interchange
with the environment, and this interchange requires and is facilitated by the information output of the suprasystem made possible by the functioning of accounting for external users.

The activities that are generally called "management accounting," in contrast to accounting for external users, are directed toward the production of information useful internally by management at all levels in the control of a system. The American Accounting Association definition is:

Management accounting is the application of appropriate techniques and concepts in processing the historical and projected economic data of an entity to assist management in establishing plans for reasonable economic objectives and in the making of rational decisions with a view toward achieving these objectives.35

From the systems standpoint, management accounting produces feedback information designed especially to be useful internally by management in achieving system self-regulation toward the most efficient meeting of the system objectives. This information should be useful in all phases of management activity, including the identification of system objectives, the planning for the attainment of the objectives, the facilitation of system functioning, the evaluation of system performance, and the adjustment of the system as required. This is feedback information, and thus includes, as previously discussed, all available pertinent information. Much of the information is likely to be detailed, rather than highly summarized as in the case of accounting for external users.

This view of management accounting is broad and includes the measurement and communication of all types of information useful in

system control. Thus is included both historical and projected information, financial and statistical data, verbal and quantitative presentations. The view is so broad, in fact, that it seems to indicate that there are only two basic production components in accounting—accounting for external users and accounting for internal users. These two components have distinctive objectives in the production of accounting output. Each specific accounting area—such as financial statement preparation, income taxes, attestation, statistical analysis, capital project evaluation, cost accounting, social cost-benefit analysis, and any and all others—would be considered as basically a subcomponent of these two basic components, contributing primarily to either external or internal information. Yet, as is the nature of components, there are interrelationships and interactions between the components and among the subcomponents in the achievement of the system (accounting) output. The separation between components is based on the difference in principal objectives, information for internal or external users.

The incredible complexities of income tax laws, particularly the federal Internal Revenue Code, and the fact that income taxes are levied on an income figure calculated in a manner similar to that of accounting, have combined to make income taxes a principal concern of many accountants. How does the preparation of income tax returns fit into the system view of accounting?

The basic output of the income tax activities of accounting is information for the government to use as a basis for assessing the taxes. Thus the principal objective of tax accounting is information to meet the needs of an external user, the government. Thus tax accounting is a subcomponent of accounting for external users.
The attest function in accounting is also directed toward external users, and it thus would seem to be a subcomponent of accounting for external users. It is a part of accounting because certain outside parties have required it. The output of the attest function at present is an opinion on the "fairness" of the basic financial statements. The attestation is not to the usefulness of the statement information. Usefulness must be the criterion underlying the design of the methods of measurement and presentation. The opinion relates to the application of the accounting methods in a particular organization.

The view of the attest function as a subcomponent of accounting for external users, when accounting is viewed in the abstract, seems to present no particular difficulties. But can the attest function in a particular organization be so viewed, when it must be performed by public accountants who are "independent" of the organization? The answer would seem to be yes, since this independent opinion is the distinctive contribution of the subcomponent. The fact that the functioning of the subcomponent involves persons other than organization employees does not upset the system structure. While performing the attest function, the public accountant is filling a role in the system.

The broad view of accounting as the information component of self-regulating systems means that any activity which provides a distinctive contribution to the production of information useful to either external or internal users in evaluating system performance and state can be considered a subcomponent of accounting. Many of the newer techniques that provide information to facilitate management
decision-making thus could be regarded as subcomponents of management accounting.

Could one be so presumptuous as to say that management science or operations research is a subcomponent of accounting? Churchman, after a careful exposition of management science as a grand example of the systems approach, says of the management scientist: "... He doesn't really understand how he himself is a component of the system he observes."36 Perhaps this observation pinpoints a major deficiency of management science. In its aloofness it may sometimes fail to appreciate the fact that it must be a part of a system itself. What is the role of management science in a system? Churchman states that its role is distinct from that of the decision-makers, being strictly advisory in nature.37 The proposition here is that it is a subcomponent of management accounting. The objective of management accounting is to provide information useful to management in achieving system self-regulation. Surely an essential element of this information should be an overall view of the system and the potential effect of decisions on the system. Operations research models can be of value in providing this information. To be of greatest value, however, management science must take its place as a part of the information components of systems.

Thus the basic production components of accounting are (1) accounting for external users, and (2) accounting for internal users, or management accounting. Each of these components consists of subsystems

37 Ibid.
that contribute to the production of information for external and internal users. Accounting for external users consists of the systems that contribute information useful in the evaluation by outsiders of the system's state and performance, and includes the balance sheet and income statement system, the tax return system, the attest system, and eventually, systems for the measurement and communication of information for external users such as workers, consumers, and the public.

Management accounting consists of the systems that contribute information for use by management in achieving system self-regulation and includes such subcomponents as the cost accounting and analysis system, the capital project evaluation system, the operations research system, and the like. In systems other than business firms, accounting will still consist of the same two basic components, with subcomponents designed to meet the particular needs of the external and internal users of information relative to the system.

Management and Information Components

The functions of the management component of a system are to identify system objectives, plan for the achievement of the objectives, evaluate system performance and output, and adjust the system as required. The information component measures and communicates feedback information to be used by management in achieving for the system a steady state of self-regulation. Accounting as a system should have management and information components active in performing these functions.

The basic objective of accounting is to provide information useful to external users in evaluating a system's performance and
state and/or useful to internal management in controlling the system. The management component of accounting in a particular system then must design and operate, within the general principles of information measurement and communication, an accounting system that will provide information output related directly to the needs of the particular organization.

Each organization should have persons with overall responsibility for the accounting or information system in the organization. These persons should operate as the management component which directs the information system toward the sole basic objective of output useful in maintaining suprasystem functioning as a self-regulated system. This accounting system should have a feedback information component which monitors accounting's performance in meeting its objective, allowing accounting management to continually adapt the accounting system to the needs of its suprasystem. Measurement of the usefulness of information output is certainly difficult, but maximum efficiency of accounting as the information component of a system can be achieved only if accounting itself has information on its success in meeting its objective.

If accounting is viewed as an abstract system, a profession, a body of knowledge, or an academic discipline, its management and information components as presently constituted become nebulous at best. A system functions most effectively if it is goal-directed, that is, organized and directed toward the meeting of specific objectives. Is accounting goal-directed at present? Hardly, since there is no agreement on its objective. If there were agreement, there would be no need
for Wheeler to state, as mentioned earlier, that "one useful piece of research might be a study of the nature of accounting." This dissertation proposes that accounting's objective must be the production of information output useful in the maintenance of self-regulation by human organizations. With this objective of accounting in mind, accounting educators, practitioners, and committees of the American Institute of Certified Public Accountants, American Accounting Association, National Association of Accountants, and other organizations, would have a coordinating goal that might allow them to bring greater coherence to accounting as a body of knowledge.

Accounting should also have an information component supplying feedback information on the usefulness of accounting's output to its users. Accounting must not only be motivated by a desire to be useful but it must also determine whether the output it thinks is useful is really useful. Again it may be stated that determining the usefulness of accounting output is difficult. But this fact merely indicates that this area needs not to be ignored but to be the subject of careful, intent, and immediate study.

The conception of accounting as a self-regulating information system, within a specific organization, with functioning management and information components, is not at all unrealistic. The construction of an abstract view of accounting as a self-regulating system presents certain difficulties, but these are surmountable. The direct and total application of this abstract model to the aggregate of

concrete accounting systems, however, may well be impossible, mainly because of the human factors involved in the resulting web of power, authority, and responsibility relationships. This impossibility does not invalidate or destroy the systems view of the nature of accounting, however. This view of the nature of accounting, with its limitations, still seems to be the best basis yet offered for coherence in the information activities in organizations.

Summary

The structure of any system may be viewed as consisting of several elements. In particular, the basic elements of any system are the environment, objective, boundary, inputs and outputs, and components. The components of a system are of three types—management, production, and information.

The immediate environment of accounting consists of the organizations in which it functions as the information component. The total environment includes also the economic, social, and political systems in which these organizations are subsystems. Accounting must be designed to aid its suprasystem in meeting its objective, which objective is in turn shaped by the suprasystem's environment. In the case of business firms, the immediate environment of accounting is comprised of the firms themselves. In order to serve a business firm, accounting must supply information relative to the firm's objective of providing output to meet the needs of owners, creditors, workers, customers, government, and the general public.

The objective of accounting viewed in a system framework is the production of information output of maximum usefulness to its
suprasystem. Usefulness is determined by the information being related to a suprasystem output objective and its being measured and communicated in a way designed to facilitate decision-making relative to the suprasystem's state of self-regulation.

The boundary of accounting is first of all the state of affairs which identifies it. This state of affairs is in one respect determined by tradition or general acceptance, but ideally should be determined by a structure of accounting theory. The boundary is also a link between accounting and its environment, selecting and coding input for processing, and decoding output for use by the environment.

Maintenance inputs to accounting are allocated by its suprasystem in the cycle of system functioning. Signal inputs are selected by accounting for processing on the basis of their relevance to the production of feedback information relative to system performance in meeting its objective. The output of accounting is the result of a process which transforms the inputs into information different in some detectable characteristic from the inputs. The survival of accounting depends on its output being useful to the suprasystem in the achievement of self-regulation.

The two basic production components of accounting are (1) accounting for external users, and (2) management accounting. Accounting for external users provides information on system performance and state in forms specially suited to the needs of those in the environment who contribute inputs to the suprasystem and receive output from it. Management accounting produces feedback information for use by management in achieving system self-regulation. These two basic
components of accounting in turn consist of subcomponents which make specific contributions to the information output of accounting.

As a system, accounting must itself have management and information components which allow it to achieve self-regulation toward its objective of information output of maximum usefulness to its suprasystem. In a particular organization, persons should be clearly identified with the responsibility of directing accounting toward its objective, making use of a feedback information system. At the aggregate level of accounting as a profession or body of knowledge, self-regulation is much more difficult to achieve, but all efforts toward this goal, guided by systems principles, will surely be of value to the long-range survival and progress of accounting.
CHAPTER VI

THE BEHAVIOR OF ACCOUNTING AS A SYSTEM

Accounting, at the highest conceptual level, is a social system. Social systems are best understood when they are conceived of as open systems, rather than closed systems.

A system is considered closed if it is relatively self-contained, functioning within itself, without interchange with its environment. A closed system may be considered "as sufficiently independent to allow most of its problems to be analysed with reference to its internal structure and without reference to its external environment."¹ Structure, or the elements of the systems, thus are most important in studies of closed systems. "The inherent tendency of closed systems is to grow toward maximum homogeneity of the parts."²

Open systems, on the other hand, are characterized by interchange with their environment, this interchange being an essential factor underlying the system's viability.³ Open systems, to maintain this indispensable interchange with their environment, must continually


²Ibid.

adapt to the needs of the environment. Thus open systems are dynamic, continually adapting, reaching a steady state that becomes one of preserving the character of the system through growth and expansion. Thus a major focus of the study of any open system must be on its relationships with its environment, the relationships among the components of the system which are its process, and the dynamic behavior of the system in adaptation to environmental changes.

Accounting as a Process

Input-process-output. The basic function of accounting is to process input data into output information which consists of measurements of the performance of its suprasystem in meeting its objectives. The basic activities involved in the accounting process are measurement and communication. These activities are directed toward the transformation of input data into output information useful in the evaluation of suprasystem performance and state.

Signal inputs to accounting are the data which are processed into output. These inputs are selected by the boundary of accounting from the mass of unordered data according to their relevance to the measurement models of the accounting process. These inputs include data relative to various phases of suprasystem input, process, and output, and data from the suprasystem environment which has been admitted by the suprasystem boundary.

Accounting as the feedback information component must receive maintenance inputs from its suprasystem. The output of accounting, 

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if of usefulness to the suprasystem in promoting self-regulation, al­

ows the suprasystem to produce output efficiently, thus providing for

the receipt of maintenance inputs by the suprasystem to be allocated to

accounting. The maintenance inputs to accounting are essentially ma­

terial—money to provide for the staffing, equipping, and supplying

of the accounting system. In addition, however, there should be moti­

vational inputs to accounting from the suprasystem. These inputs

would originate in an understanding by the suprasystem of the vital

role of the feedback information component in the achievement of effi­

cient system performance. The suprasystem, particularly the management

component, thus should encourage, and, if necessary, require accounting

to fashion its output to meet the suprasystem's information needs, and

then see that accounting receives the other maintenance inputs and the

production inputs required to meet that objective.

A basic activity of the accounting process is measurement. Ac­

counting as a measurement system has received considerable attention

recently. The scope of this dissertation does not cover an extended

discussion of the complex subject of measurement. The intention here

is only to indicate briefly that measurement is a basic accounting

activity.

Measurement may be defined as "the business of pinning numbers

on things." The scales by which number measurements are assigned vary.

5See, for example, Robert K. Jaedicke, Yuji Ijiri, and Oswald

Nielsen, eds., Research in Accounting Measurement (American Accounting


6S. S. Stevens, "Measurement, Psychophysics, and Utility," Measurement Definitions and Theories, ed. C. West Churchman and

Stevens identifies nominal, ordinal, interval, and ratio scales. Thus it might be said that measurement involves the use of a scale, or measurement model, to represent the state of the thing being measured.

The concept of measurement used herein to apply to accounting relates closely to that proposed by Rothstein: "A measuring system maps a set of states of an object of interest into the set of possible indications of the apparatus." Measurement in accounting involves the mapping of the states of the suprasystem into measurement models designed to ultimately provide indications of the states to users of the measurements. Measurement thus involves the design of measurement models to provide representations of system state relative to output objectives and the fitting of relevant input data into these models so as to arrive at the desired measurements.

Some may say that accounting does not measure because all the input data have been assigned numerical measures before entering the accounting system. The contention herein is that accounting measurement is not the assignment of numbers to input data but is in the use of these input data to arrive at indications of system state. For example, accounting is not involved in the setting of a sales price for a particular sales transaction in a business firm. Accounting measurement occurs when accounting selects that sales price as relevant data and uses it as an input to a model that is designed to measure revenue or income.

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7Ibid., p. 25.

The second basic activity of accounting process is communication. Rothstein states: "A communication system maps a set of messages from a source into a set of messages at a destination."\(^9\) Thus communication in accounting involves the mapping of the measurements of its measurement models into messages useful to the users of the measurements of accounting. Accounting's measurement models will likely be designed to serve the processing needs of the accounting system itself. Its output must be designed to serve the needs of users in determining suprasytem state. Thus communication involves the transformation of the measurements of accounting into messages attuned to the receiving systems of the environment. Communication, of course, is as complex a subject as measurement, and thus is not discussed in detail here.

The output of accounting, information useful to users, is the communication of accounting measurements to the environment. Output is regulated by the boundary of the accounting system, that is, the principles of accounting theory involving the communication of information.

The functioning of accounting, as with any system, is cyclical, as described by Katz and Kahn: "The product exported into the environment furnishes the sources of energy for the repetition of the cycle of activities."\(^10\) This cycle seems true of accounting in two respects. First, useful feedback information supplied to the suprasytem by accounting allows it to function most efficiently as a self-regulating system.

\(^9\)Ibid.

\(^{10}\)Katz and Kahn, op. cit., p. 20.
system, thus insuring the suprasystem's vitality as the source of maintenance and signal inputs. Second, the output of useful information from accounting will establish its importance to its suprasystem, which will then support it with required maintenance and signal inputs.

Probabilistic behavior and equifinality. The behavior of open systems has been described as fundamentally probabilistic. That is, the interactions within an open system are not fixed, and thus it is not possible to predict perfectly the output of a system from given inputs. Some open systems are more nearly deterministic, or perfectly predictable, than others, but all open systems are probabilistic to some degree.

Both accounting and the suprasystems of which it is a component are open systems and are thus probabilistic in behavior. An immediate implication of this fact would seem to be that the measurement models of accounting, particularly the predictive models of management accounting, should incorporate probabilities into their measurements.

The probabilistic behavior of systems also seems to indicate that the development of complete uniformity of accounting measurements in accounting for external users is not possible. A rigid accounting measurement model would apply only to a determinate system, one in which the interactions and relationships are fixed. Open systems in which accounting is useful, however, are not determinate. Thus even the measurement models of accounting for external users must allow for the probabilistic nature of system behavior.

This is not to say that the probabilistic nature of system behavior is an excuse for there being several conflicting accounting
models designed to measure the same thing, with the choice of model in a particular situation being mainly arbitrary. Rather, accounting models should be designed around central tendencies of organizations, but with enough flexibility to fit situations that vary, within a reasonable range, without destroying the usefulness of the measurement.

Another intriguing characteristic of open system process, proposed originally by Bertalanffy,\textsuperscript{11} is equifinality. The attempt to apply this characteristic to accounting is rather perplexing. A continuing attempt may well help in the understanding of the nature of accounting, however, since many writers consider equifinality an important characteristic of open systems.

Katz and Kahn interpret equifinality to mean that, in open systems, "there are more ways than one of producing a given outcome."\textsuperscript{12} These writers go on and apply the idea to social systems, and state:

In practice we insist that there is one best way of assembling a gun for all recruits, one best way for the baseball player to hurl the ball in from the outfield, and that we standardize and teach these best methods. Now it is true under certain conditions that there is one best way, but these conditions must first be established. The general principle, which characterizes all open systems, is that there does not have to be a single method for achieving an objective.\textsuperscript{13}

These ideas also seem to conflict with current demands that there be more uniformity in accounting measurement models, particularly those of accounting for external users, where comparability of measures from different systems is important. Katz and Kahn


\textsuperscript{12}Katz and Kahn, op. cit., p. 26.

\textsuperscript{13}Ibid., p. 27.
indicate that only under specified conditions is there one best way for
doing something. Accounting operates in many diverse organizations,
and conditions in one are never exactly the same as those in any or
all of the others. The most-forward-looking and promising approach to
accounting measurement would therefore seem to be in the development of
measurement models that are broad and flexible in scope but which pro-
duce measures of system state, relative to the desires of the environ-
ment, that are comparable among different systems. That is, the mea-
sures may be comparable without their having been arrived at through
identical procedures.

Dynamics of Accounting as a System

Feedback and steady state. Feedback is an essential mechanism
in the achievement of self-regulation by a system. As a total mecha-
nism, it involves the measurement and communication of information
on system performance, the evaluation of that information, and the
adjustment of the system as required. A system that is in a condition
of maintained self-regulation is said to have achieved a steady state.

Steady state in reality is basically a dynamic condition as
opposed to the static concept of equilibrium. Buckley emphasizes
this idea as follows:

In dealing with the sociocultural system, . . . we need
yet a new term to express not only the structure-maintaining
feature, but also the structure-elaborating and changing feature
of the inherently unstable system. . . . The notion of "steady
state," now often used, approaches or allows for this conception
if it is understood that the "state" that tends to remain steady
is not to be identified with the particular structure of the
system. That is, in order to maintain a steady state, the system
may have to change its particular structure.14

Katz and Kahn state that "the steady state . . . at more complex levels becomes one of preserving the character of the system through growth and expansion."15

Bakke argues that growth is the inevitable result of a system's efforts to maintain a steady state. According to Bakke, a system or organization grows or evolves because:

1. It operates in a dynamic environment which is constantly changing, making changes necessary in the parts of the organization;
2. such changes in parts impose the necessity for adaptive changes in other parts;
3. such adaptive changes inevitably modify the requirements for cooperative unity and therefore the character of that cooperative unity;
4. the result, unless the organization disintegrates, is that it does grow or evolve into a new state of dynamic equilibrium, a new form of the whole.16

Accounting's steady state must be based on the constant fulfilling of its objective of providing information useful to users inside and outside its suprasystem in their evaluation of the state and process of the suprasystem. The steady element is useful output; to achieve this, accounting's structure must be adaptive, flexible, dynamic. The environment is dynamic, thus its information needs change. Accounting must adapt its output to a changed environment.

In order to maintain a steady state or even to survive, a system must import energy from its environment to counteract entropy, the natural tendency of a system to run down. Accounting will survive only as it is provided maintenance and signal inputs from its environment. This input in turn is dependent on receipt by the suprasystem of useful output from accounting.

A self-regulating system is a system designed and operated to maintain stability of output production. There thus exists the possibility that, in such a system, stability, based on past conditions or fixed standards not related to environmental conditions, can become an end in itself. That is, a system may build such a strong internal reliance on a structure and output that at one time produced system stability that it fails to change in response to changed environmental conditions. Such a condition may be avoided if the system objective is related to environmental needs with the feedback mechanism attuned to the acceptability of system output to the environment.

John Lawler was previously quoted as warning against accountants reacting to change by "descending to the storm cellars—retreating to the comfort of old ruts of routine—adopting . . . a 'business-as-usual' attitude." In order to maintain a steady state, necessarily based on continued maintenance and signal inputs from the environment, accounting should monitor the quality of its information output in terms of usefulness and have a structure flexible enough to react to changed environmental conditions on a less than crisis basis.

Quantitative and qualitative growth. Accounting, in order to survive and maintain its steady state, must grow and expand in reaction to changing environmental conditions. Katz and Kahn state that "the most common type of growth is a multiplication of the same type of cycles or subsystems—a change in quantity rather than quality." The implication seems to be that a system may continue to do the same

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things on an expanded scale. Much of accounting's growth may have been of this type in the past. Unfortunately, however, many of accounting's traditional activities have been looked on by organizations as "necessary evils" required by outsiders. In an age of computers and newer quantitative techniques that make their case on usefulness, an expansion of accounting's "necessary evil" functions may well result in survival, but in a position subsidiary to other information systems.

Katz and Kahn state further that "social systems will move . . . towards incorporating within their boundaries the external resources essential to survival."19 This type of growth may well be qualitative as well as quantitative. Accounting may grow through the addition to itself as components other subsystems which can contribute to the maintenance of the usefulness of its information output to the environment. The enlarged system of accounting would thus consist of various specialized subsystems contributing to the system output of information useful to users.

Mattessich, in 1964, evaluated the future of accounting as follows:

It thus appears that accountants are confronted with the choice of one of the following two alternatives: (1) to acquire a profound knowledge of many aspects of jurisprudence (civil law, commercial law, corporation and partnership law, and tax law) and develop their discipline into a purely legalistic-dogmatic field of knowledge; or (2) to acquire proficiency in modern quantitative analytical methods and try to maintain the old status of their discipline, namely that of the most important quantitative tool of economic practice.20

19 Ibid.

The alternatives might also be expressed as: (1) Accounting may limit itself to its traditional activities and become a subsystem, and perhaps an increasingly insignificant subsystem, of a feedback information system, or (2) accounting may expand its boundaries, incorporating the newer information techniques, and thus become the total feedback information system, consisting of various subsystems.

**Summary**

Accounting and the systems of which it is a component are open systems. They thus are dynamic, in a steady state of continually adapting to the needs of their environment. A study of the nature of accounting must therefore be concerned with the dynamic functioning which characterizes its behavior as a system.

The functioning of accounting is, as with any system, basically input-process-output. Accounting receives signal inputs from its suprasystem which it then processes into information output. This activity is supported by maintenance inputs, material and motivational, from the suprasystem, which are made available in the cyclical functioning of the systems.

The basic activities of accounting process are measurement and communication. Measurement in accounting relates to the mapping of states of the suprasystem into measurement models designed to provide indications of these states. Communication involves the mapping of these indications into messages useful to the users of the accounting measurements.

General systems theory describes the behavior of open systems as probabilistic and equifinal. That is, the behavior of open systems
is not fixed or perfectly predictable, and a given output of a system may result from various inputs and various process relationships. The basic implication of these characteristics of systems is that the measurement models of accounting must be flexible enough to allow for these characteristics without compromising the usefulness of the measures.

The steady state of accounting may be described as an adaptive, flexible system structure oriented toward the constant objective of producing information output useful to its environment. This steady state can be maintained only through growth and expansion. Accounting may grow quantitatively by a multiplication of its traditional activities, but the qualitative growth required to maintain its position of importance most likely will consist of an expansion of the boundaries of accounting to include all information techniques relevant to its role as the feedback information component of human organizations.
A Definition of Accounting

Accounting, from the viewpoint of general systems theory, may be defined as follows:

Accounting is the system for the measurement and communication of feedback information on the state and process of human organizations.

This definition indicates, first of all, that accounting is a system, a part of the hierarchical structure of the universe as a nesting of systems. Thus accounting itself should be designed as a self-regulating system to be most effective, just as should be the systems in which it functions as the information component. Principles of general systems theory therefore are helpful in describing accounting's place in the hierarchical structure as well as in describing the hierarchical structure and functioning of accounting itself.

Accounting is called the system rather than a system because the contention here is that the scope of accounting should be broad enough to encompass the entire field of feedback information production in organizations. A system with such a scope is not accounting as it has been known, it is true, but then accounting today is not
what it was even twenty years ago. We are in a period of explosive change, and the urgent need is for a basis for cohesion. The need exists in information production as elsewhere. The contention herein is not that accounting should usurp the activities of statisticians, operations researchers, and the like, but that accounting is the best qualified candidate to provide the coordination to direct information-producing components and subcomponents toward the single objective of information output useful to the process of suprasystem self-regulation. This single information system could be called accounting or something else, but its best hope of creation seems to lie in an expansion of accounting to encompass the whole realm of feedback information.

The basic activities carried on by accounting and its subsystems are measurement and communication. Measurement involves the design of measurement models and the use of input data in these models to provide measures of suprasystem state and process. Communication involves the transformation of these measures into information output attuned to the needs of the users of the information.

The output is described as feedback information to emphasize the role of accounting as the information component of self-regulating systems. Accounting's output in part relates to users outside the immediate environment, the suprasystem, and in part relates to users inside the suprasystem, but it all should be directed toward facilitation of the maintenance by the suprasystem of a steady state of self-regulation.

The feedback information relates to the state and process of the suprasystem. The state of a system refers to the particular
relationships among its components at a particular point in time. The process of a system here is conceived of as the functioning of the system or the results of that functioning over a period of time. This feedback information includes all measurements of system state and process, past, present, and future, that may be useful in maintaining self-regulation.

The systems in which accounting functions are the human organizations through which most of the activities of mankind are accomplished. These organizations may be business firms, social clubs, government agencies, charitable or religious organizations, or even a family. In fact, accounting may function in the affairs of an individual. Accounting thus is concerned with the activities of people, is part of behavioral patterns and social systems, and is a social system itself.

Accounting as a Body of Knowledge

Accounting may be viewed as a body of knowledge as opposed to the view of it as a concrete social system functioning in human affairs. This view of accounting as a body of knowledge is the "academic" or "theoretical" view, an abstract view of accounting as consisting of a theoretical structure of principles that define the boundary of accounting and provide a framework for the measurement and communication of feedback information.

Some accounting writers have voiced the opinion that the theoretical foundations of accounting are unclear at best, and others,

seeking an expanded scope for accounting, have lamented the lack of a theoretical basis for such an expansion. R. K. Mautz states: "If one were to conclude . . . that much of the difficulty we now have in accounting is because our concepts are not worked out completely or are not well established, he would not be far wrong." One group of writers argue that "adherence to a general framework or methodology is the hallmark of theory formulation in many . . . disciplines," but Ijiri states that "unfortunately, conventional accounting is a collection of many different principles and practices, which, in some cases, are mutually inconsistent." Writers suggesting an expanded scope for accounting state that the methodology is lacking and that there is no unifying theme to support research.

Two Accounting Research Studies issued by the American Institute of Certified Public Accountants represent the result of the most concerted effort to identify the conceptual basis for current accounting practice. Moonitz presented a set of postulates in Accounting Research


Study No. 1 as the basic assumptions on which accounting principles rest. In Accounting Research Study No. 3, the writers presented a set of accounting principles based on the postulates. Although these studies have occasioned considerable discussion, they seem to have had little concrete effect on accounting practice.

The contention in this dissertation is that the theoretical framework on which accounting practice is based should be founded on general systems concepts and the view of accounting as the information component in self-regulating systems. Such a systems view of accounting seems most useful as a structure to guide the elaboration of accounting theory and the revamping and extension of accounting practice. General systems theory provides an interdisciplinary foundation for accounting theory and can guide the development of accounting theory and practice in an objective-oriented development.

Some accounting theorists have attempted to present the basis of accounting theory and practice in terms of particular perceptions of the firm. Thus there have been advanced the proprietary theory, the entity theory, and the enterprise theory. Although these theories have given some insight into the nature of accounting in business firms, they do not seem to hold much promise as a general basis for accounting theory and practice.

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The proprietary concept emphasizes a view of the business firm as an extension of the owners of the firm. The center of interest of accounting thus should be on the proprietors, with all transactions interpreted in light of their effect on the owners. In contrast to the view of systems theory, the proprietary concept is extremely narrow, because it relates only to business firms and is concerned only with one environmental element, the owners.

The entity theory views an organization as something separate and distinct from those who contribute to it. This theory seems to view an organization as a closed system and is thus directly in conflict with the view of organizations as open systems. General systems theory indicates that an organization's vitality and viability depend on exchange with the environment, and thus an organization must be viewed not only in terms of its internal structure but also in terms of its relationships with the environment.

The enterprise theory is probably most closely related to the general systems view of accounting. Hendriksen describes the theory as follows:

... In the enterprise theory the corporation is a social institution operated for the benefit of many interested groups. In the broadest form, these groups include, in addition to the stockholders and creditors, the employees, customers, the government as a taxing authority and as a regulatory agency, and the general public. Thus, the broad form of the enterprise theory may be thought of as a social theory of accounting.

... From an accounting point of view, this means that the responsibility of proper reporting extends not only to stockholders and creditors but also to many other groups and to the general public.¹⁰

The general systems view of accounting is very similar, but is superior because it has more general application to all types of organizations and more clearly defines the role of accounting in organizations.

Accounting's objective of usefulness does not require that accounting be a strictly passive body of knowledge, directed toward the production only of the information requested of it. Rather, accounting must be normative. If accounting theory and practice are based on the view of accounting as the information component of self-regulating systems, then they must be deliberately designed to produce information useful in evaluating system performance and state. Accounting as a body of knowledge should provide a basis for producing the information users should have as well as the information they request.

Accounting must be an interdisciplinary body of knowledge. The general systems viewpoint serves to point out the universal nature of accounting in organizations and emphasizes the behavioral considerations involved in the information output of accounting. Another side of general systems theory, which has not been emphasized in this dissertation, is the mathematical representations and applications of its principles. Accounting theory and methodology must include concepts from the behavioral sciences, mathematics, and other disciplines which are relevant to its objective of information output useful in maintaining suprasystem self-regulation.

Accounting as a body of knowledge should evolve into a universal feedback information system. That is, it should include principles of information measurement and communication that may be applied in all organizations. Accounting's future role in human affairs should
not be limited to business firms, but accounting should become a part of all human organizations to allow them to achieve maximum effectiveness through self-regulation.

Accounting as a body of knowledge then is an abstraction of accounting in its concrete role as the information component of human organizations. It should consist of a framework of general principles, based on general systems concepts, that provide a coherent basis for accounting practice in general and in the components and subcomponents. There would be general principles relating to the measurement and communication of information in organizations, principles relative to external and internal users, and principles relating to such subcomponents as financial reporting, auditing, taxes, cost analysis, capital project evaluation, statistical analysis, operations research, and so on. At a lower level there might be principles relative to organizations of a particular type, while at the lowest level there would be principles relative to information production in each particular organization.

Accounting as a Profession

Accounting may be viewed as a profession or vocation. This view is of accounting, the body of knowledge, applied to organizations through people, that is, accountants. From this point of view, accounting involves the application of its principles to concrete situations, and it thus becomes part of a social or behavioral process.

As the computer takes over more and more of the physical record-keeping work in organizations, accountants are being freed to work
toward making the results of the record-keeping process more useful. That is, the work of accountants more and more involves the design of measurement models, the selection and drawing out of data to be used in the models, and the communication of the measurements to users. Communication here involves not only transmission of information but also interpretation and explanation of the information.

R. C. Rhea describes two firms of Certified Public Accountants he visited. One firm, housed in unattractive quarters, served a dwindling number of clients with services little changed from twenty years ago. The second firm, planning enlarged office quarters, served a rapidly growing number of clients with a modern repertoire of useful information services. The point is that accountants, public and private, that expect to maintain their position of importance in organizations must not be tradition-bound but must modernize their techniques and assert their role as purveyors of information indispensable to effective organization performance.

The inevitable result of an expanding scope for accounting will be specialization by individual accountants. Mattessich predicts that the "anticipated diversification of accounting ... may well-nigh lead to a close cooperation between specialists." The key point, though, is cooperation. Over-specialization and resulting isolation defeat the entire interdisciplinary spirit of the general systems approach. The specialists must not lose sight of their common objective of useful information production. Thus, although specialization is inevitable


and is already occurring among accountants, these specialists should have their special skill grounded in an appreciation of the general systems framework in which they function and a conceptual knowledge of the other specialties with which they must cooperate to produce the aggregate information output.

As accountants are involved more and more in providing information and even advice for managers, the next logical evolutionary step may seem to be for accountants to start making managerial decisions. Such a role for accountants does not fit the systems view of organizations presented in this dissertation. Accounting as the information component of a system has an objective distinguishable from that of the management component and thus it is separate from management. Accounting's objective is the production of useful information, which might include evaluations and recommendations, but management's objective is attainment and maintenance of system self-regulation, and this objective requires action, in terms of adjustment of the organizational structure and process in adaptation of the system in reaction to internal and external disturbances. Accountants often become managers, but when they do they move from one system component to another, from the advisory role of an accountant to the action role of a manager.

People in organizations are the factor that makes the auditing aspect of accounting necessary. Thus there will continue to be accountants checking up on other accountants and issuing opinions on some of accounting's output, because accounting information can be, accidentally or deliberately, false, misleading, or unfair. However, it seems probable that the significance of the attest function will
diminish as the automation of record-keeping increases. That is, the auditor is likely to become less of a policeman, and more of an advisor and interpreter, both to accountants and to users of accounting information.

Accounting then is conceived of as becoming a diversified field with specialists with a broad general knowledge cooperating to produce feedback information on the performance and state of organizations. These specialists will be experts in information, capable of functioning in any organizational unit, and able to deal with all information, financial or statistical, historical or prospective, quantitative or verbal, that relates to the organization's maintenance of self-regulation.

**Accounting Education**

Accounting will evolve into a body of knowledge with a broad scope applied by information specialists with broad general knowledge only if accounting education introduces into the practice persons who are inspired by an understanding of the vital role of accounting in human affairs and equipped with a broad conceptual knowledge that will enable them to fulfill that role for the discipline. Accounting education then has a primary responsibility in leading accounting to the fulfillment of its service potential.

The general systems view of organizations and of accounting's role in organizations suggests that accounting education must be interdisciplinary, with more conceptual emphasis as opposed to a study of the minutiae of technique. In 1968, the Committee on Education and
Experience Requirements for CPAs of the American Institute of Certified Public Accountants issued a report\textsuperscript{13} containing recommendations for the development of accounting education. This report seems to emphasize a trend toward an interdisciplinary, conceptual education for accountants. Accounting curricula of the sort recommended by the report might well be a first step in an evolution of accounting education that will encourage an evolution of accounting toward an expanded scope.

The basic knowledge required by beginning accountants probably cannot be gained in a four year undergraduate college program. The AICPA committee report recommends a five year program.\textsuperscript{14} The interdisciplinary character of this program is indicated by the following summary of its coverage:

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<td>Communication</td>
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<td>Behavioral sciences</td>
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<td>Economics</td>
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<tr>
<td>Business administration (Social environment of business, finance, marketing, business law, production systems, business policy)</td>
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<td>Mathematics</td>
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<td>Quantitative applications in business</td>
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<td>Other general education and electives</td>
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<td>Accounting</td>
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The recommended program does not seem to take the systems view of accounting as the information component in organizations, nor does it view accounting as the whole realm of information production. The committee states: "We are concerned with the preparation of young accountants for the changing environment of the modern business firm. The education of accountants must be comprehensive. It must include business, management, and economics, in addition to the necessary knowledge of accounting."

\textsuperscript{13}American Institute of Certified Public Accountants, Committee on Education and Experience Requirements for CPAs, Academic Preparation for Professional Accounting Careers (New York: American Institute of Certified Public Accountants, 1968).

\textsuperscript{14}Ibid., pp. 16-17.
people for careers in professional accounting, in which breadth of education does not justify deficiencies in accounting understanding. If it were necessary to sacrifice accounting competence in order to gain the desirable breadth of education, we would need to oppose that trade-off."^{15} As more and more accountants enter practice with a working knowledge of information measurement and communication concepts other than the traditional accounting model, however, inevitably the nature of accounting practice will change, expand, and, pressed by the demands of information users, evolve into an information discipline of broad scope.

The further evolution of accounting education must occur as part of a general evolution in business education. That is, the systems view of organizations must become the basis for all business education. The concept of organizations as consisting of three basic groups of components—management, production, and information—would seem to indicate that these should be the three basic elements of business education. Management would involve the entire field of business administration, that is, the concepts and techniques involved in the achievement of self-regulation by business firms as social systems. Production would involve the technical aspects of business operation, that is, the concepts and techniques involved in the physical production of goods and services. Information would involve the concepts and techniques for the measurement and communication of feedback information on system performance and state.

^{15}Ibid., p. 12.
The student desiring to become an administrator would major in management, with less intensive coverage of production and information concepts. The student of information or production would likewise gain conceptual knowledge of the two areas other than his major subject. The student in each area would, early in his university education, be exposed to an intensive coverage of the overall systems view of the business firm as an organization, to learn how his specialty contributes to the process of objective-oriented system self-regulation. This system perspective then should be part of every course presented to students, whether in management, production, or information.

A start at the integration of business education with technical areas such as engineering has been made by a few universities. Louisiana State University at Baton Rouge, for example, recently announced plans for a Center for Engineering and Business Administration (CEBA). The proposed center will house the College of Business Administration and the College of Engineering in separate areas of the center, but will permit use of facilities "to provide practical and functional interplay of instructional, research, and service resources. . . . CEBA is presented as a unique adaptation of resources geared to produce by the interrelation of two disciplines a new breed of college product--call him what you will, business-engineer, scientist-executive, manager-technician--which business and industry need, and need badly."16 Programs of this type represent a beginning effort toward a systems approach in education.

The argument is presented in this dissertation that all organizations, business firms and others, should function as self-regulating systems, and that accounting should serve as the information component in all such organizations. The long-range implication for education would seem to be that business administration education should evolve into a general administration discipline that would encompass all the applied arts and sciences in three major groups of disciplines—management, production, and information. Each group would have numerous components that would be autonomous in many respects, but which should all have interrelationships based on their common role of contributing to the attainment and maintenance of self-regulation by human organizations.

These conjectural implications of the application of the systems viewpoint in accounting and business education are admittedly abstract, probably idealistic, and likely to be implemented only through a relatively long evolutionary period. But the effectiveness of a systems approach has been proved in other areas, and such an approach should certainly contribute to increased effectiveness for higher education.

Summary

Accounting may be defined as the system for the measurement and communication of feedback information on the state and process of human organizations. This definition views accounting as a system that encompasses the entire field of feedback information measurement and

17Although the achievement was considered a fantastic impossibility for centuries, man has reached the moon and returned, and it was done by a massive organization that was self-regulated toward a clear objective, sending men to the moon and returning them safely.
communication. This information is an integral part of the process of attainment and maintenance of self-regulation by organizations.

Accounting as a body of knowledge is an abstraction of the aggregate of concrete accounting systems functioning in organizations. The suggestion in this dissertation is that accounting should be founded on a framework of principles, based on general systems concepts, that will provide a coherent basis for accounting practice in all self-regulating human organizations.

Accounting as a profession is the application of accounting principles to organizations through people, that is, accountants. The projection of the accounting profession of the future, based on the viewpoint of general systems theory, is that it will be a diversified field, staffed with specialists, information experts, who have a broad general knowledge, and are capable of functioning in any organizational unit in producing feedback information of all types.

Accounting education is conceived of as becoming a more broadly based, interdisciplinary, conceptual program whose initial phase should consist of a course of college study at least five years in length. The expansion of accounting education will probably occur as part of a general evolution in business education, based on the systems theory conception of organizations, with increased coordination of academic disciplines related to the management, production, and information phases of system functioning.
CHAPTER VIII

SUMMARY AND CONCLUSIONS

An era of rapid change in technology, science, human behavior, and social organization has confronted the discipline of accounting with the need for a careful evaluation of its place in human society. Many accountants have concluded that the survival of their profession will require a continuing expansion of its scope beyond the traditional business-oriented financial accounting model.

Attempts at an expansion of the scope of accounting have often been restricted by the lack of a clear understanding of the role of accounting in society and by a lack of a framework of principles to guide the expansion. Efforts directed toward the delineation of the nature of accounting and the statement of a theoretical basis for the overall functioning of accounting have not been spectacularly successful.

General systems theory seems to offer a set of concepts and a viewpoint which can be quite useful in describing the nature of accounting and as a basis for a structure of principles to guide the growth of accounting. This developing body of concepts views the universe as consisting of a hierarchy of systems, and thus accounting may be viewed in terms of its place in this structure.

General systems theory has developed from an idea first publicized by the biologist Ludwig von Bertalanffy. The theory is an attempt
to take an interdisciplinary or macro view of the universe as opposed to the micro view taken by most individual disciplines. The characteristic of all phenomena which will allow this general view is their common attribute of existence as "systems," with a system defined as any complex of elements in mutual interaction. Since all phenomena can be viewed within the framework of systems, then general knowledge about the nature of systems should lead to a better understanding of particular phenomena.

An important concept of general systems theory is the distinction between closed and open systems. Closed systems are considered to be relatively self-contained, without interchange with their environment. Open systems, on the other hand, are systems in contact with their environment, with input and output across the boundaries of the system. The concept of the open system is significant because it forms the basis for the application of general systems concepts to social systems.

The view of the universe as a hierarchical structure of systems is fundamental to general systems theory. The assumption is that the universe may be conceived of as a nesting of systems, with smaller systems embedded in larger systems. Thus any particular system is in a hierarchy of the order suprasystem-system-subsystem.

The concept of the cybernetic system envisions a system that is self-regulated toward the achievement of its objective through the process of feedback. Feedback as a process involves the measurement and communication of information regarding system performance in relation to its environment. This information is transmitted to a control point where it is evaluated and transformed into inputs which adjust
the system as required to direct it toward desired output. Complex systems such as social systems will be most effective if they are designed as self-regulating systems after the cybernetic model. Human organizations operating as self-regulating systems will consist of three basic groups of components—management, production, and information. The management components give life to the system and direct it toward the achievement of its objectives, the production components process the inputs into outputs, and the information components measure and communicate feedback information. Accounting is regarded in this dissertation as being the feedback information component of self-regulating human organizations.

A system may be studied in terms of its structure. The structure of a system is composed of certain elements—objective, environment, boundary, inputs and outputs, and components. Open systems are dynamic, however, continually adapting to their environment. Thus a study of a system must go beyond its structure at a point in time to a study of its process, its internal functioning in relation to its environment.

The total environment of a system includes all things outside the system's control which affect the accomplishment of the system objective, while the immediate environment is the suprasystem, the next higher system in the hierarchy. The immediate environment of accounting consists of the systems in which it functions to measure and communicate feedback information. These systems are human organizations of all kinds, including business firms, governmental bodies, churches, and others.
The survival of a system depends on its production of output useful to its suprasystem. The objective of accounting then should be the production of information of maximum usefulness to its suprasystem or environment. The standard of usefulness is the value of the output in directing the suprasystem toward self-regulation to the meeting of its objective. The objective of usefulness of information output must be the motivating force in accounting as a self-regulating, goal-directed system.

The boundary of a system is the state of affairs which identifies the system, separates it from its environment, and selects and codes input and output and regulates their flow. The boundary of accounting is, in one respect, determined by intangible factors such as tradition, acceptance, reputation, competence, and professional status, but ideally it should be defined by accounting theory. In terms of the intangible factors, there seems to be evidence of a considerable extension of accounting's boundary and thus of its scope. The need now is for the development of accounting theory to support the expansion of the scope of accounting. If accounting is viewed as the information component of self-regulating systems, then general systems theory should provide a basis for principles of accounting theory that would support accounting with a scope broad enough to encompass the entire field of feedback information production.

A system receives maintenance inputs for energy and sustenance and signal inputs to be processed into output. The output consists of useful and waste products, with a viable system producing useful products whose value offsets the worthlessness of the wastes. Accounting is allocated maintenance inputs by its suprasystem and thus the
production by accounting of information useful in maintaining suprasystem self-regulation assures a continued source of maintenance inputs. Accounting selects signal inputs that are relevant to its measurement models so as to produce feedback information on system state and process. The output of accounting must be useful to the suprasystem so that the suprasystem may achieve self-regulation assuring its survival and thus the survival of the accounting component.

The objective of accounting as a system is the production of feedback information output useful to the suprasystem in achieving and maintaining self-regulation. The production components of accounting then are the subsystems that make a distinguishable contribution to that output. All feedback information production is considered as taking place in two basic accounting subsystems. These are accounting for external users and accounting for internal users, or management accounting. Accounting for external users produces information particularly useful to outsiders in the evaluation of the suprasystem's state and performance, whereas management accounting produces information for use by the suprasystem management in the process of system self-regulation.

Accounting itself ideally should function as a self-regulating system, both within a specific organization and in the aggregate as a profession or body of knowledge. To achieve self-regulation, accounting must have management and feedback information components. The functioning of accounting as a self-regulating system in a specific organization does not seem to present any great difficulties, but in the aggregate the difficulties are formidable. However, all
efforts to install characteristics of self-regulation in accounting as a profession or discipline will surely have salutary effects.

The basic functioning of accounting, as with any system, is of the order of input-process-output. The process activities of accounting are basically measurement and communication. Measurement involves mapping suprasystem states into measurement models to produce indications or measurements of the suprasystem states, and communication involves the mapping of the measurements into messages useful to the users of the measurements.

A system in a condition of maintained self-regulation is said to have achieved a steady state, a condition of dynamic equilibrium. This state is one of constant adaptation to environmental changes, which inevitably means growth and expansion of the system. The steady state of accounting then should be that of constant production of useful information output with an adaptive system structure that is growing not only by a multiplication of usual activities but also through incorporation within its boundaries of other information subsystems to maintain and improve the usefulness of its output. Accounting thus ultimately would achieve a scope that includes all feedback information production.

Accounting then may be defined as the system for the measurement and communication of feedback information on the state and process of human organizations. As a body of knowledge, accounting should consist of a framework of general principles, based on general systems concepts, that provide a sound basis for accounting's role as the information component of organizations. Accounting as a profession or vocation should
be staffed with information specialists capable of functioning in any organizational unit to produce the feedback information required in the maintenance of self-regulation. If accounting is to reach the state suggested here, then accounting education must become, probably as part of a general evolution in business education, a more broadly based, interdisciplinary, conceptual program that produces graduates inspired by an understanding of accounting's vital role in human affairs and equipped with the knowledge that will enable them to fulfill that role for accounting.

Many major and minor conclusions and implications arising from the application of general systems theory to accounting have been offered throughout the text of this study. Only some of the more significant conclusions are repeated in this summary. These ideas are all based on the assumption that the view of organizations as systems and of accounting as the information component of such systems holds great promise as a basis for the achievement of greater coherence among the various aspects of accounting and as a basis for the expansion of the scope of accounting so as to maintain and increase its importance in human society.
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VITA

Eldon Robert Bailey, son of Mr. and Mrs. E. B. Bailey, was born in Lake Charles, Louisiana, on August 23, 1935. He attended the public schools of Lake Charles and was graduated from Lake Charles High School in June, 1953. He enrolled in McNeese State College in September, 1953, and in May, 1957, he received the Bachelor of Science degree with a major in accounting. He enrolled in the Graduate School of Louisiana State University at Baton Rouge in September, 1957, and received the Master of Business Administration degree in January, 1960. He was licensed as a Certified Public Accountant in Louisiana in 1961.

After a tour of duty in the U.S. Army, he worked as accountant for a construction firm in Lake Charles. From September, 1964, through August, 1966, he served as Instructor of Accounting at McNeese State College in Lake Charles and as Assistant Professor of Accounting from September, 1966, through August, 1967.

In September, 1967, he reentered the Graduate School of Louisiana State University at Baton Rouge. From September, 1968, through May, 1970, he worked as Graduate Assistant in the Department of Accounting. During the 1969-1970 school year he held an American Accounting Association doctoral fellowship. He is presently a candidate for the degree of Doctor of Philosophy in Accounting.
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Major Field: Accounting

Title of Thesis: "An Application of General Systems Theory to the Determination of the Nature of Accounting"

Approved:

[Signatures]

Dean of the Graduate School

EXAMINING COMMITTEE:

[Signatures]

Date of Examination:

May 19, 1970