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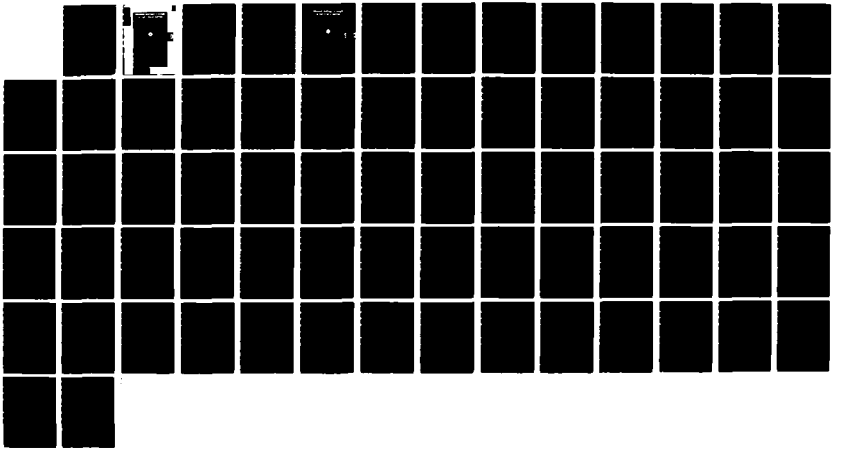

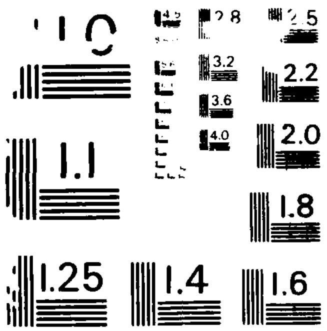

DECISION SUPPORT SYSTEMS IN THE PUBLIC SECTOR

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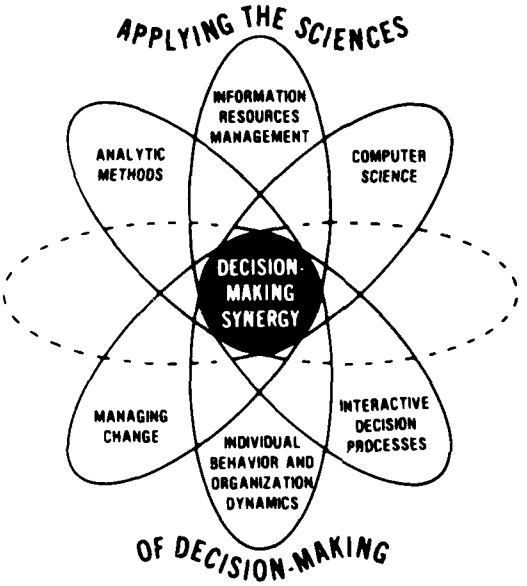

A CYBERNETIC MODEL FOR THE PROACTIVE ORGANIZATION

DR. FRED WAELCHLI

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THE DECISION SUPPORT SYSTEMS RESEARCH INSTITUTE

THE DEFENSE SYSTEMS MANAGEMENT COLLEGE

THE ARMY INSTITUTE FOR RESEARCH IN MANAGEMENT INFORMATION AND COMPUTER SCIENCE

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The logic underlying decisions, and decision support systems, depends fundamentally on our assumptions about, and models of, the organizations in which these decisions are made. In this monograph, Dr. Fred Waelchli, a DSMC Professor of Management, suggests that current systems models of the organization are incomplete and defective, and that implicit use of these models may corrupt the decision process in our organization. Dr. Waelchli proposes a cybermetic model of the organization, derived from the work of W. Ross Ashby and Stafford Beer, that resolves the difficulties with the existing system models, and establishes a methodical foundation for Peter Drucker's major premise that the organization exists fundamentally to create useful change in society.

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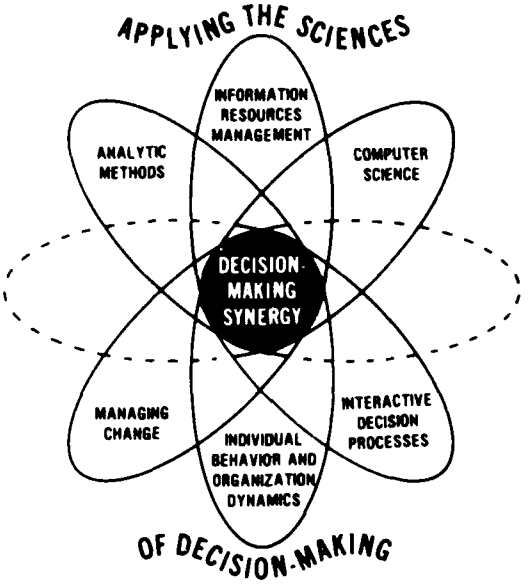

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FOREWORD

The Decision Support Systems Research Institute was established to identify and maintain awareness of on-going research in decision support systems, to develop research needs in decision support systems and to provide a means for technology information exchange relating to decision support systems.

There are six primary disciplines that we believe to have a major influence on the decision-making processes of executives and managers. These are: 1) Analytic Methods—the analytic tools of the decision-making process, 2) Computer Science—the capability to investigate many potential solutions and conduct numerous calculations in a reasonable time, 3) Interactive Decision Processes—an application of other techniques; e.g., artificial intelligence to the decision-making process, 4) Individual Behavior Organization Dynamics—bringing the person, in relation to the organization, into the process, 5) Managing Change—the process of education, training and implementation of developed systems (what good are they if you don't implement them) and, finally, 6) Information Resources Management—what the whole decision-making process is about.

I like to depict these disciplines as six petals on a daisy flower. They emanate from the center and are all of equal importance.

There are, also, other disciplines that affect the decision-making process and though we take cognizance of them we do not try to enumerate them. Their influence varies in the process. In our pictorial, the analogy to the daisy, these can be represented by two more undesignated petals.

What is more important than any one of the disciplines, however, is the effect of the synergy of the interaction of these disciplines working together in the decision-making process. What does one label this synergistic effect? How does one describe it? What exactly is its effect? This can be represented by the center of the daisy.

There is another discipline that has been around for some time. It is called general systems theory (GST). It is a theory that some people, I for one, have a hard time grasping and understanding. It is clearly associated with the other six disciplines, but I am not sure how to relate it to the daisy of decision-making. Is it a new petal that should be labeled as GST because it is of equal importance to the other six primary disciplines? Or is it, as some people propose, the center of the flower—the synergy that results from the interaction of the other disciplines? Or is it an umbrella that sits above or around the daisy and itself influences each of the disciplines?

What is the true relationship of GST and its subdiscipline, cybernetics, to the decision-making process? That is a question you, the reader, might keep in mind as you read Dr. Waelchli's paper.

Your thoughts on this matter are of interest to me and to the author. We would appreciate hearing from you on this subject. Please drop us a line addressed to DRI-S, Defense Systems Management College, Fort Belvoir, Virginia 22060-5426. Thank you.

HAROLD J. SCHUTT
Co-founder
Decision Support Systems
Research Institute

A CYBERNETIC MODEL FOR THE PROACTIVE ORGANIZATION

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ABSTRACT

The logic underlying decisions, and decision support systems, depends fundamentally on our assumptions about, and models of, the organizations in which those decisions are made.

I suggest below that current systems models of the organization are incomplete and defective, and that implicit use of these models may systematically be corrupting the decision process in our organizations. I propose a cybernetic model of the organization, derived from the work of W. Ross Ashby and Stafford Beer, that resolves the difficulties with the existing system models, and establishes a methodological foundation for Peter Drucker's major premise that the organization exists fundamentally to create useful change in society. The model carries interesting implications for organizational behavior and the decision processes. The paper concludes with speculation about the prospects for, and possible composition of, a complete and consistent cybernetic theory of management.

INTRODUCTION: FOUR IDEAS IN SEARCH OF A THEORY

In this paper I take four apparently unrelated ideas that have existed on the periphery of management and organization theory for some time, and suggest that with reemphasis and reordering they fit together to form a coherent theory of management.

The first idea is Drucker's seminal assertion that every organization exists essentially to cause useful change in society. There is support for this idea in the literature, but it is generally muted and unfocused. I argue here that this postulate is primal, and a vital determinant of organizational effectiveness. The organization's effort to cause external change, I call proactivity.

The second idea: contrary to the popular notion that there have been a large number (a jungle) of competing organization

theories or models, there have been, in fact, only two. They are the closed system model and the open system model, and they have been sequential rather than directly competitive. Because neither model maps the principle of proactivity, it is necessary now to take a step forward in organization theory; it is time for a third model.

The third idea is also an assertion: The framework for the necessary third model has existed for some twenty years; it is a cybernetic model articulated by Stafford Beer (1959, 1966, 1975, 1979, 1981, 1984), based on theoretical foundations laid down by W. Ross Ashby (1956, 1960). This framework, called here the Ashby-Beer model, has occasioned a footnote or two in the literature of management, but its true nature remains unrecognized and its effect on the mainstream of management thought has been nil. The third model, offered here, is an extended version of Ashby-Beer, called the Proactive System model.

The theoretical core of the Ashby-Beer model is Ashby's "Law of Requisite Variety." The fourth idea of this paper is Beer's intimation that Ashby's Law may in fact be the "Iron Law of Management"; that it illuminates all managerial principles and theories heretofore expressed. Again, there has been a foreshadowing of this idea in the literature but no one, save Beer, has climbed this far out on the cybernetic limb.

Organization of the Paper

The search for a theory leads through each of the four ideas in turn, and then to an examination of the meaning and value of the curious edifice they establish.

In the development and illustration of the Proactive System model, I make frequent use of ideas from three contemporary management works; Mintzberg (1973), Drucker (1974), and Peters and Waterman (1982). Each has contributed to management thought and has provoked debate in academia and practicing managerial circles. More importantly, each is implicitly grounded in a different organizational model. Mintzberg operates primarily within the simple open system model. The adaptive open system model dominates in Peters and Waterman, while Drucker's work is consistent with the Proactive System model. I eqivocate because none of the authors formally declares an underlying model or operates in unvarying obedience to one. In each case the assignment to a model is mine, based on the relationships I perceive to exist between the author's "organization" and its environment.

This paper asks the reader to consider the Proactive System as a candidate for a generally valid model of the organization.

It is proper therefore to test this model with established ideas that are both well regarded and disparate. The three works cited fill this bill.

Many of the ideas presented below are accompanied by multiple citations. This is deliberate, and done to show that little of what follows is original with me; that nearly all of the ideas stitched together here are widely (if not deeply) present in the literature of management.

THE FIRST IDEA: PROACTIVITY

> Nothing could be sillier than the oft-repeated assertion that "management only adapts the business to the forces of the market." Management not only finds these "forces"; management creates them by its own actions. (Drucker, 1954:34, also 1974:58).

Peter Drucker tells us here (and he repeats it often, in varied tones and tints) what we all surely recognize implicitly; that the purpose of every organization is to change its environment. An organization comes into being or remains in being to cause something in its environment to be different from what it would be without the organization.

To oversimplify, a trade union exists to cause management practices to be different from what they would be without the union. A football team exists to make its opponents winless. General Motors exists to create certain spending patterns in the car-buying public. Supporting its primary external objective, the organization also has many subordinate and associated goals, not all of which are mutually consistent. Clearly, therefore, not all of an organization's variegated objectives can be achieved. But if an organization consistently fails to accomplish the primary environmental changes that are the reason for its existence, eventually it will cease to exist.

A popular idea in management theory today is that the organization succeeds by adapting to its environment. But as Drucker points out above, no well-managed organization passively adapts to its environment. In fact, it strives to cause the environment to adapt to itself. And one measure of its success as an organization is the nature and extent of the change or adaptation it causes in its environment.

The Concept of Proactivity

A logical name for this effort to work change in the environment is proactivity, which means "action in advance of a change." Organizations that exhibit the quality of proactivity, I call proactive organizations.

I believe the concept of proactivity in organizations fits well with our reflective view of the world and of the purpose of organizations within it. Common sense insists that all successful organizations are proactive; we see no successful organization that does not work for and achieve changes in the world around it. Drucker states the case for the proactive business organization:

> [The purpose of a business] must lie outside the business itself. In fact it must lie in society since the business enterprise is an organ of society. There is only one valid definition of business purpose: to create a customer. Markets are not created by God, nature or economic forces, but by businessmen. (1954:37, also 1974:61)

The Mutual Influence of Environment and Organization

Although organization theory today focuses on the adaptation of the organization to its environment, it has long been recognized that organizations and environments mutually affect each other, as witness the following:

> Every actual organization is in constant change or motion. This change or motion is of two sorts. The environment changes the organization and the organization changes the environment. (Feibleman and Friend, 1945:39)

> The organism affects the environment and the environment affects the organism: such a system is said to have "feedback." (Ashby, 1960:37)

> Two or more adaptive systems, as well as an adaptive system and its natural environment may be said to be selectively interrelated by a mapping process. (Buckley, 1968b:491)

The difference between these expressions (which represent current thinking) and the concept I propose is that environmental intervention is here considered to be deliberate and essential, not accidental or fortuitous, and the primary reason for the organization's existence. There is some evidence that proactive behavior is necessary for the long-term health and survival of the organization. Failure to manage the environment (i.e., the

markets) proactively may prove to be the ultimate form of mismanagement.

In conventional organization theory, Drucker is alone, so far as I can discover, in insisting that what I call "proactivity" is a necessary attribute of the successful organization. Neither of the two established organizational models, the closed system model and the open system model, include any mechanism that permits proactive behavior in organizations.

THE SECOND IDEA: THE MANAGEMENT THEORY DESERT

Harold Koontz, in his 1961 article, "The Management Theory Jungle," (surely the best known and most imitated work in management literature) argued that the discipline of management had proliferated theories to the point of becoming "...entangled by a jungle of approaches and approachers to management theory." In 1984 he was still convinced "...there can be no doubt that the management theory jungle still persists...and may even be becoming more dense." (p. 66).

But other management scholars see a more arid landscape. Those who study the actual practices of managers and organizations tend to complain about the lack of, or barrenness of, management theory in explaining what managers and organizations actually do. Examples from the three works referred to above will illustrate.

Henry Mintzberg did the classical study on the actual work of the manager; his feeling about management theory was:

> Although an enormous amount has been published on the manager's job, we continue to know very little about it. Much of the literature is of little use, being merely endless repetition of the same vague statements. (1973:7)

Peters and Waterman published a study of managerial behavior in excellent major U.S. corporations. They said:

> No existing theory helps much in explaining the role of the customer in the prototypical excellent company. At most, recent theory talks about the importance of the external environment in influencing the institution. (1982:156)

Peter Drucker comments:

> We do not yet have a genuine theory of business and no integrated discipline of business management. (1974:49)

I see each of these laments stemming from the same cause. When each comment is considered in full context, it appears that the writer has encountered and is intuitively reacting to the phenomenon of proactivity in managers and organizations. At the same time he has found the dry hole in the management theory desert where the concept of proactivity ought to be. In each case, he appears to be struggling for reconciliation. Here are Peters and Waterman reacting to a statement that all organizations adapt to their environments:

> There's nothing wrong with that. We find it intriguing, however, that in reviewing the indexes of three clearly bellwether works, we could not unearth the word "customer," or "client" or "clientele." All three books talk about the environment, but wholly miss the excellent company richness of customer contact... (1982:117)

The "jungle of theories" issue has filled countless pages in management journals over the last twenty plus years. It appears now, however, to be an issue more of form than of substance. Without question, management is a dynamic discipline; in its relatively brief history as an academic pursuit it has produced between three and eleven "schools" of thought (depending on who is doing the cataloging), and countless variants and subschools. But each of these "schools" seems to me to be either an unsystematic collection of ad hoc principles, or a set of specialized techniques. None includes a construct of the type that defines true theory. This, I believe, is why there is so much room for legitimate differences among the "scholastics."

Extending this logic one more step, I believe that the rich and turbulent flow of approaches and schools catalogued by Koontz and others has taken place within the framework of only two true organizational theories or models. They are the closed system model and the open system model. Emery and Trist recall:

> The first steps in systems theory were taken in connexion with the analysis of internal processes in organisms, or organizations, which involved relating parts to the whole. Most of these problems could be dealt with through closed-system models. The next steps were taken when wholes had to be related to their environments. This led to the open-system model... (1965:255)

The Closed System Model

First, I must state that there has never been a true closed system organization theory. No author has ever seriously contended that everything outside the organization is irrelevant.

It is, rather, a question of degree and emphasis. Awareness of the importance of the organization's environment has been growing. If we project far enough backward along the growth path we arrive at the mythic "closed system" model, in the same sense that if we project the expanding universe backward in time we arrive ultimately at the infinitely dense dimensionless point. Nevertheless, closed system thinking and closed system models both loom large in management theory and practice.

Closed system thinking probably entered management from the economic model of pure competition, where the firm sells all it can produce at the market price, and only at that price. In such a situation, where nothing the manager does can affect his market, the only appropriate work of management is the pursuit of internal efficiency. Whatever its genesis, what we now call the closed system model of the organization developed from the works of F. W. Taylor (1911), Henri Fayol (1916), Max Weber, and subsequent writers associated with the so-called classical school of management thought. This model relates exclusively to the organization itself, and does not deal with its environment, which is why it is called closed. Users of this model look only inward, and seek internal organizational efficiencies. Implicitly, they assume the environment to be invariant. Peters and Waterman comment:

> Management theorists of the first sixty years of this century did not worry about the environment, competition, the marketplace, or anything else external to the organization. They had a "closed system" view of the world. That view...centered on what ought to be done to optimize resource application by taking into account only what went on inside a company. (1982:91)

This model is very much alive today in the boardroom and in academia. Emery and Trist note that there is still

> ...a tendency to continue thinking in terms of a "closed" system; that is, to regard the enterprise 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. (1960:281)

As a business example, Harold Geneen's (1984) account of his twenty-year stewardship at International Telephone and Telegraph (ITT) rarely strays beyond corporate boundaries; the ITT customer is virtually invisible. Geneen surely was vitally concerned with the ITT customer; the point revealed by his book, I think, is that the implicit "system" of which he saw himself a part was limited to the corporation. Contrast this mode of thought with, for example, Peters and Waterman (1982). Wickham Skinner (1986)

appears to attribute the failure of modern industrial firms to increase market share despite massive efforts to improve labor productivity as the product of a form of closed system thinking.

In academia, many of today's management textbooks derive substantially from the closed system model. These texts may be recognized by a glance at the tables of contents, where one typically finds chapters on the functions defined by the familiar Luther Gulick (1937) acronym, "PODSCORB" (planning, organizing, directing, staffing, coordinating, reporting, and budgeting). Mintzberg lamented in 1973, "PODSCORB took hold and lives on. It continues to dominate the writings on managerial work to the present day." (1973:9) Nearly fourteen years later, it still does.

The Open System Model--Three Stages

The first organizational model to deal substantively with the organization's environment, the open system, developed from the work of General Systems theorists, particularly von Bertalanffy (1968). This model, which explicitly recognized the environment as a source of inputs to, and a sink for outputs from, the organization, developed in three stages. The first stage, the well-known simple open system, is often diagrammed as in Figure 1a. The diagram shows inputs entering the organization and outputs leaving it. The environment exists, by implication, but the diagram and the model say nothing about its nature and structure, nor the nature of the interactions between the organization and the environment, except that there are transfers of matter, energy, and information. These transfers, called "signals," are examined more closely below.

The second stage of the model followed recognition of three first-stage deficiencies: the need for a mechanism to explain control in the organization, the perception that inputs to the organization from the environment are variables, not constants, and realization that the organization must adapt internally to these changing stimuli. Katz and Kahn comment:

> The major misconception [of the closed system model] is the failure to recognize fully that the organization is continually dependent on inputs from the environment and that the inflow of materials and human energy is not a constant. (1978:26)

Peters and Waterman agree:

> Theorists began to acknowledge that internal organizational dynamics were shaped by external events. Explicitly taking account of the effects of external

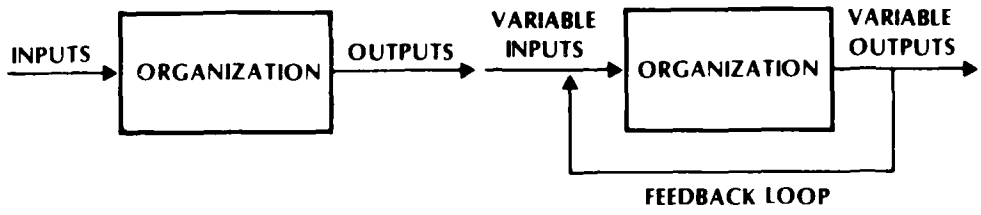

FIGURE 1a. FIRST STAGE OF THE OPEN SYSTEM MODEL

FIGURE 1b. THE SECOND STAGE; THE ADAPTIVE OPEN SYSTEM MODEL.

FIGURE 1. TWO VERSIONS OF THE OPEN SYSTEM MODEL OF THE ORGANIZATION

> forces on the organization's internal workings, then, launched the "open system" era. (1982:91)

The mechanism of internal control in open systems is perhaps the most important construct in all of control theory: error-actuated negative feedback. The output signal is fed back as an input into the organization and compared against a standard. If a difference is found, the organization adjusts internally to correct the output.

The second stage of the open system model is often diagrammed as in Figure 1b, which shows the feedback loop. As noted, the second stage of the open system model recognized input signals as variables, not constants. The system, therefore, had to adapt its internal structure and processes to variable signals from the environment as well as to feedback from its own output.

This second version of the open system model is known as the adaptive open system model of the organization. Adaptation means that the organization changes its internal processes and structure in response to changing signals from the environment and the internal feedback loop (Berrien, 1968; Miller, 1978). Walter Buckley states, as "a fundamental principle of open adaptive systems":

> [that] Persistence or continuity of an adaptive system may require, as a necessary condition, change in its structure, the degree of change being a complex function of the internal state of the system, the state of the relevant environment and the nature of the interchange between the two. (1968b:493)

Katz and Kahn put it this way:

> The organization exists in a changing and demanding environment and it must adapt constantly to the changing environmental demands. Adaptive structures develop in organizations to generate appropriate responses to external conditions. (1978:39)

The Unkept Promise of General System Theory

General System theory and open system models caused a flurry of excitement among management theorists. The models seemed to offer great promise for advances in organization theory. Thayer commented:

> Few concepts ever burst on the intellectual scene with so much promise as General System theory. Holding out the hope that for the first time we could discover a truly general theory of organizations, GST promised deliverance from the despised mechanistic tradition...(1972:481)

But, despite considerable effort, it proved difficult to derive from the theory anything useful to practicing managers. Impatience and frustration set in. The entire December 1972 issue of the Academy of Management Journal was devoted to General System theory in management. In that issue, which included the Thayer comment above, both the excitement and the disenchantment were evident.

Kast and Rosenzweig (1972:458) summed up the frustration: "We need vitally the system paradigm but we are not sufficiently sophisticated to use it appropriately." In the same paper they suggested a move toward the third stage of the open system model, Lawrence and Lorsch's (1967a, 1967b) concept of "contingency thinking."

The Contingency Variant of the Open System Model

In a later work, Kast and Rosenzweig explained what they mean by contingency thinking:

> Contingency views represent a middle ground between (1) the view that there are universal principles of organization and management, and (2) the view that each organization is unique and that each situation must be analyzed separately....one of the consequences of this approach is a rejection of simplistic statements concerning universal principles of organization design and management practice. (1979:115)

No diagram of the contingency variant is provided because there is no external difference between the contingent model and the adaptive open system model. All differences are internal, within the organization, and don't show on a diagram relating the organization to the environment.

The implied premise of Kast and Rosenzweig that, since we are unable at present to deduce or decipher universal laws, therefore there are none, is a persistent theme in contingency thinking. Luthans comments:

> The contingency approach denies the universal assumption and pragmatically relates the environment to appropriate management concepts and techniques. (1976:54)

The contingency variant of the adaptive open system model presents a philosophical problem for me. Contingency theory is represented as the logical extension of open systems theory and, indeed, it does continue the effort to forge closer links between organization and environment. But it also denies the fundamental premise of systems theory, and, in fact, of all science, which is the universality of law. That premise seems to me to be so deeply embedded in our culture that its excision is done only at great danger to our intellectual corpus. Leon Lederman (1984:40) speaks of:

> ...A single and economical law of nature, valid throughout the universe for all time. The quest for such a unified scientific law has been undertaken and advanced by all nations and all creeds. Indeed, the idea of the unity of science has been a major force in developing the unity of humanity....

The entire history of science, even very recent history, appears to contest the contingency premise. In recent months, for example, mathematicians have made startling progress in describing chaos itself (Taubes, 1984). Surely now is not the time to recant the premise of universal and discoverable law. The extent of this problem will become more visible as the paper unfolds.

Limitations of the Existing Models

Three of the models described above; the closed system model, the adaptive open system model, and the contingency variant of the adaptive open system model, are the basis for essentially all of today's orthodox management thought.

Even proponents of the closed system model recognize this model to be limited in application and scope. But the open adaptive system model, especially the contingency variant, seem to represent the frontier of today's thinking about organizational models.

My need to look beyond these models arose first from philosophical discomfort with the contingency variant, and second from the realization, made explicit by Drucker in the earlier quotations and confirmed by observation, that the adaptive system model is incomplete.

There is nothing intrinsically wrong with organizational adaptation. Organizations do adapt internally in response to signals from the environment. The question is: Why?

The adaptive system model describes the organization as monitoring its own output and adjusting internally to cause the output to conform to a standard. Again: Why? How is that standard chosen? The answer relates back to Drucker's postulate that each organization exists for a societal purpose, and incorporates the idea of proactive adaptation.

Proactive Adaptation

If, as argued here, proactivity is a fundamental property of the organization, then any viable organizational model must exhibit and explain proactivity. Three concepts need to be added to the conventional adaptive open system model to render it proactive. First is Drucker's axiom that the organization exists for the purpose of contributing to society. Second is the realization that the "open system" organization is actually part of a larger closed system that links the organization and its markets, and that therefore there are causal relationships connecting an organization's outgoing signals to the signals returning to it from its environment. Third is recognition that the well-managed organization not only understands the fact of this causality, but actively exploits it in designing output signals to create the environmental changes that are the reasons for the organization's existence.

The organization, in this view, does adjust internally in response to incoming signals (as the adaptive system model postulates), but in a proactive, not reactive, sense; that is, by developing new output signals that provoke the environment to make the desired changes.

Managerial Implications of Proactive Behavior

The managerial behaviors prescribed by the adaptive and proactive models are different. These differences carry deep implications for organizational health. Hayes and Abernathy (1980), in their widely-heralded analysis of the decline of U. S. industry during the last two decades, assign part of the blame to managements that have, in accordance with the adaptive system model, adapted unilaterally to their markets. They call this "market-driven behavior," and suggest that the key to long term organizational survival is "...to create new product opportunities in advance of consumer demand and not merely in response to market-driven strategy." Or, in a word, proactive behavior.

George Bernard Shaw understood the value of the proactive individual to society:

> The reasonable man adapts himself to the world: the unreasonable one persists in trying to adapt the world to himself. Therefore, all progress depends on the unreasonable man.

Drucker added altruism to proactivity and extended both to the organization:

> Business enterprises--and public service institutions as well--are organs of society. They do not exist for their own sake, but to fill a specific social purpose and to satisfy a specific need of society, community, or individual. They are not ends in themselves, but means....
>
> The enterprise exists on sufferance and exists only as long as society and economy believe that it does a job, and a necessary, useful, and productive one.
>
> What people mean by bureaucracy, and rightly condemn, is a management that has come to misconceive itself as an end and the institution as a means. This is the degenerative disease to which managements are prone... (1974:39, 113)

Could it be that domination of contemporary organization

theory by the adaptive open system model has contributed to the prevalence of market-driven behavior and to management's degenerative disease, and thence, perhaps, to the problems chronicled by Drucker, and by Hayes and Abernathy?

Proactive Adaptation in the Literature of Management

As a description of observed organizational behavior, proactive adaptation is not new. The concept is expressed directly by Drucker and indirectly throughout contemporary management literature. Here are five examples, beginning with a definitive statement by Russell Ackoff:

> Adaptive responses are of two types. In the first, passive adaptation, the system changes its behavior so as to perform more efficiently in a changing environment.... In the second, active adaptation, the system changes its environment so that its own present or future behavior is more efficient. (e.g., ...bringing about legislation to prevent price cutting by competitors.) (1970:18)

Lawrence and Lorsch:

> ...an organization is an active system which tends to reach out and order its otherwise overly complex surroundings so as to cope with them effectively. (1967a:230)

Joseph T. Nolan:

> Companies that prosper in the decade ahead are likely to be those that can manage effectively in a changing environment--those that have decided to get into the policy formulation process early and that have learned how to shape the issues agenda rather than letting it shape them. (1985:81)

S. N. Eisenstadt:

> The organization must manipulate several aspects of its external environment. (e.g., the directors must deal with boards of trustees and legislative committees, the sales manager with buyers and sellers, the manager with trade unions and labor exchanges.) (1959:257)

Kast and Rosenzweig:

> So far we have looked at environmental-organizational relationships as a one-way street; organizations react to external forces as if they were passive systems. A counterview suggests that the organization is proactive in selecting the environment in which it will operate and continually attempts to shape that environment to accomplish its goals. (1979:138)

As the last citation shows, not even the label "proactive" is new. The term as used here by Kast and Rosenzweig, however, is Weick's concept of proactivity (1969), which differs from the concept in this paper.

Proactive adaptive behavior, then, is an established subordinate theme in the literature of management. The major premise of this paper is that proactivity is a fundamental property--perhaps the most fundamental property--of the organization and a major determinant of the organization's long term health and, perhaps, its continued existence. Key to the discussions that follow, therefore, is the fact that neither the closed system model nor any version of the open system model provide a mechanism for the process of proactive adaptation.

In Ackoff's terminology, contemporary adaptive system models embody the passive version of adaptation, not the active one that includes proactive behavior and causal links between organizational output and the return input from the environment. The Hayes and Abernathy findings suggest that persistent passive adaptation ultimately becomes suicidal behavior in the organization, and that the need for proactive management is acute.

In this paper I argue for the proactive form of adaptation; that is, internal restructuring of organizational elements and information flows to cause changes in the environment. I also argue that the properly managed organization does not unilaterally adapt. The organization, as represented in this paper, is an active participant in a mutually adaptive process that changes both the organization and its environment. Drucker strikes this theme for the business, but it is equally true for all organizations:

> Managing a business must be a creative rather than an adaptive task. The more a management creates economic conditions or changes them rather than passively adapts to them, the more it manages the business. (1954:47, also 1974:73)

Finally, I argue that it is necessary for organization theory to take a step beyond the adaptive open system model and to embrace a mutually adaptive model--one that describes the organization and the environment as reciprocally accommodating. The Proactive System is proposed here as a candidate for that model.

THE THIRD IDEA: THE PROACTIVE SYSTEM MODEL

As I suggested above, there is a model that does elucidate a mechanism for proactivity. It is a cybernetic and general systems model developed by Ross Ashby and explicitly applied to the organization by Stafford Beer. This model has been largely ignored in management literature, and its few mentions reveal a lack of understanding of its true nature.

The purpose of this section is, first, to carefully develop the Ashby-Beer model within the context of system theory, to extend the concepts of Ashby and Beer to form the Proactive System model, and then to show how this model applies to the organization.

Development of the Ashby-Beer Model

The Concept of System

The theoretical foundation of the Ashby-Beer model is the concept of "system." Most of Ashby's works deal with the theory of systems. Beer develops the system concept as a tool for modeling the organization. In this paper, system theory is invoked only to the extent necessary to support the Ashby-Beer model. Readers interested in a more complete treatment of systems theory should read the original works of Beer (1959, 1966, 1975, 1979, 1981, 1984) and, especially, Ashby (1956, 1960).

Systems can be divided into two types. First are the natural systems that appear to exist independent of human purposes, such as the solar system. Second are the so-called purposive systems (Ackoff and Emery, 1972), formed by, or nurtured by, man as vehicles to accomplish some purpose. This paper is concerned with purposive systems. (Note: above, and throughout this paper, the term "man" is used in the gender-independent original sense of homo, not vir. In this paper, "man" embraces "woman.")

A system is a bounded collection of three types of entities: elements, attributes of elements, and relationships among elements and attributes. Both attributes and relationships are characterized by measurable functions called variables. The

"state" of a system at any time is the set of numerical values held by its variables at that time. The state of a system can be represented as the location of a point (in Ashby's words, (1960:22), the "representative point") in n-dimensional space, where n is the number of variables of the system, and the coordinates of the point are the values of the variables.

Certain system variables (Ashby (1960:41) calls them "essential" variables) must remain within specified value ranges for the system to continue in existence as the system. If these variables are within prescribed limits, the system is said to be in physiological control. A second form of systemic control, operational control, is fundamental to the organization, and is discussed below.

Many system variables display equilibrium; that is, a tendency toward a single or small range of values and, when displaced from these values, a tendency to return. This quality, exhibited by all living systems, is known as teleological or goal-seeking behavior. Within the category of goal-seeking systems are purposive systems, whose goals are consciously set by man.

The process of keeping the values of designated variables within specified limits is called "homeostasis." The normal mechanism of homeostasis is error-actuated negative feedback, mentioned above in connection with the adaptive system model of the organization. Values of specified system variables are continuously measured and compared with standards. If the value of any variable strays from its standard, the system acts to restore it. Homeostasis, through the operation of negative feedback, is considered to be the basic mechanism of control in all systems, natural or man made.

Second Order Systems and Heterostasis

The purposive social system requires an expansion of the traditional concept of homeostasis, and a departure from the Ashby-Beer model. Many goals or purposes of real organizations are described by second-order variables; that is, variables that measure the rate of change of other variables. Obvious business examples are rates of change in sales, earnings, and market share.

Second-order variables introduce a complication because the values of the related first-order variables are no longer held in a static range, but in a range that moves as a function of some other variable, in this example time. Homeostasis in second-order variables requires positive and negative feedback because positive feedback is the agent of growth, differentiation, and change. Beer handles this complication through Hierarchical Metasystems, a derivative of Russell and Whitehead's "Theory of Types," and a

methodology beyond the scope of this paper.

The Proactive System model, developed below, deviates from Ashby-Beer in the treatment of higher order variables, and employs the control process known as "dynamic homeostasis," or "heterostasis" (Stagner; 1951, 1968; Davis, 1958). Heterostasis uses both positive and negative feedback to govern second-order, or higher level, systems. Purposive systems are overwhelmingly heterostatic.

A Sketch of General System Theory (GST)

The Ashby-Beer model is a General System theoretic model; it was available at the time of management's flirtation with General System theory and subsequent embracing of the adaptive open system model. One can speculate that had management theorists not taken the antisystemic detour toward the contingency variant, but instead continued down the systems path and encountered this model, they might have avoided some of the frustrations chronicled by Thayer, Kast, and Rosenzweig.

General System Theory deals with the general laws of systems, and how man accomplishes his desires through purposive systems. To understand the logic underlying the model, it is necessary to introduce briefly two general system concepts--the universal system (or Universe), and the "relatively isolated" system--and some important implications of these concepts.

The Universal System

Although the term "system" is frequently used to refer to a selected set of variables that describes some limited situation in the real world (and that term is so used in this paper), the true general system theorist believes that there exists only one "system," and that is the Universe (or universal system). It is open or closed according to one's theology (and perhaps one's physics--recall the Cambridge theory of continuous creation). By the definition of system, all the variables of the Universe relate to all the other variables; some of the relationships are strong and evident, others less so. The laws of the universal system are invariant through time and throughout the system.

Among the elements of the universal system are people; men and women. Let us suppose that a person or group of persons desire to change some aspect of the universal system; that is, to change the values of certain variables to new values specified by them.

It is intuitively evident (and an argument is presented below

to support that intuition) that the complexity of the Universe is beyond the power of man to control. Man cannot deal analytically with the Universe as a whole. He must select from the universal system some subset of elements, attributes and relationships, and then attempt to accomplish his desires through organized interactions with this subset.

The Relatively Isolated System

How is this subset of the universal system, which Beer calls the "relatively isolated system," defined and [illegible]? Ideally, man identifies all the world variables he desires to change, and then attempts to further identify all the elements, attributes, and relationships in the universal system that measurably affect the values of the chosen variables. This total collection of related elements, attributes, and relationships--the required subset of the Universe--is specified as a "world system." The world system of a specific organization is known as the "relevant environment" of that organization, and represents the concrete answers to such questions as, "What is our business?" and "Who is our customer?" If the selection of elements, attributes, and relationships has been complete, the system composed of them can be treated as an entity separate from the universal system, since, by definition, none of the attributes or relationships "left behind" in the universal system have a measurable effect on the specified world system.

Implications of the System Concepts

I have discussed only two constructs from General Systems theory, and those two at a very abstract and theoretical level. Even so, there are practical implications for any process mapped by a general system model.

First, the proactive principle is fundamental; it is the human desire for some form of world change that triggers the creation (or recognition) of a specific system to be the agent of that change.

Second, complexity is also fundamental; it is the unmanageable complexity of the Universe that causes us to invoke "system" as a limiting concept.

Third, purposive systems are not innate in nature, but are defined by man according to the changes he wishes to accomplish in society. "Purpose" is expressed mechanically by the world variables to be changed and the new values chosen for them.

These three points will be reencountered below when the model

is applied to the organization.

Complexity and Variety

Complexity was described above as a fundamental feature of world systems. The overwhelming complexity of all natural systems is a dominant theme for Ashby and Beer. Ashby deals with the complexity of natural systems in general; Beer with the complexities of the organization.

Ordinary intuition does not do justice to the degree of complexity that surrounds us, nor to the implications of this complexity for the process of management and control. It is worthwhile, therefore, to make one calculation that dramatically illustrates how great complexity can grow, even in systems we view as simple.

The unit used by cyberneticians to measure complexity is "variety." The variety of a dynamic system is the number of distinguishable states it can occupy. Variety is a function of both the number of variables in the system and the number of values that each variable can assume. The purpose of the following calculation is to show that the amount of variety generated by intrinsically simple systems can far exceed intuitive expectations.

Complexity and Intuition

Consider a rectangular grid of light bulbs, eight bulbs wide and eleven long. Total number of light bulbs is 88. Each bulb can be either on or off. How many patterns can this grid display; i.e., what is the variety of this system? One light bulb has a variety of two. A system of two light bulbs has a variety of 2x2 or four, three bulbs a variety of 2x2x2 or eight. The total system has a variety of two multiplied by itself 88 times. Suppose that for some reason it is necessary to search all the states of this system. If we scan the light patterns at the electronic speed of one billion per second, it will still take about ten billion years, twice the accepted age of the earth, to complete one full search of this modest eight-by-eleven grid.

The Bremermann Limit and Complex Systems

A grid of 17 lights by 18 lights produces a variety of 1.3 followed by 93 zeros. This number approximates the so-called Bremermann Computational Limit. Through basic quantum-mechanical computations Bremermann (1962) showed that a computer the mass and age of the earth could have processed to date no more than 10 to

the 93rd power bits of information. This number, 10 to the 93rd power, is the Bremermann Limit.

Practically, the Bremermann Limit is a nonsense number, much like the speed of light for human terrestrial travel. For procedures that depend on enumeration of system states, variety this great becomes essentially infinite. A system with variety so great that it approaches the Bremermann limit is called in this paper a "complex system." The essential quality of a complex system is that it is too large for any mind (or computer) to "know" completely. No mind can hold or follow all of the states of a complex system, and no procedure that tries to deal sequentially with all the states of a complex system can succeed in real time.

Every living system is a complex system, and clearly more complex by orders of magnitude than the two relatively small grids of light bulbs in the examples. Of particular interest in this paper is the complex system we know as the organization.

Control in Complex Systems--Ashby's Law

If complexity (variety) is so pervasive in natural systems, what is the mechanism by which control (defined as the maintenance of each designated variable within its prescribed limits) is achieved and maintained? (We do observe around us that such control is achieved and maintained.)

This question led Ashby to what has become known as the first law of control; The Law of Requisite Variety. Stated in Ashby's words (1956:207), "Only variety can destroy variety." That is to say, for control to exist, the controlling system must be able to generate at least as much variety as the system being controlled. Beer (1959:50) says, "Only variety in the control mechanism can deal successfully with variety in the system controlled."

In all three of the above versions the law sounds simple and trivial. It is neither. Beer describes a number of political and managerial attempts to circumvent Ashby's law by trying to manage high variety situations with low variety controls, and the disastrous consequences of these attempts. He concludes, "We mislead ourselves into thinking we can outwit the natural law of requisite variety, just as many imagine they can beat other natural laws on the race track or at the casino." (1966:313)

A case can be made for calling Ashby's Law the "Iron Law of Management;" this case will be presented as the last of the four ideas linked together in this paper.

Controlling Complex Systems

Beset by the twin burdens of Ashby's law and the manifest complexity of natural systems, what chance has man to control the sea of natural systems in which he lives immersed? Theory implies insurmountable difficulties--yet it is a commonplace that we do control most relevant systems. The inescapable conclusion is that the control procedures we use somehow comply with Ashby's law. Cybernetics affirms this conclusion. Ashby and Beer explain how it is accomplished. The primary device is a construct that Ashby calls the "joined system." Beer adapts this construct to the organization and calls his version the "Self-Vetoing Homeostat."

The Joined System

Given the Bremermannian variety of real systems, what entity can possibly be found that generates enough variety to control a complex natural system or world situation? The answer can only be another complex system. The mechanism, therefore, for controlling a complex system is to couple it to another complex system and allow the two systems mutually to control each other. This is the method of Ashby-Beer.

Ashby (1960:76) calls the new system created from the original two, or more, complex systems a "joined system." Beer (196:291), for reasons that will be explained below, calls his organizational adaptation the "Self-Vetoing Homeostat (SVH)." A modification of the SVH is sketched in Figure 2, which is adapted from Beer (1966:291).

Description of the Joined System

For simplicity, I represent each of the two systems, A and B in Figure 2, as fully described by two variables, the values of which are the x and y coordinates of any point in the plane of the paper (Ashby's "representative point"). In Figure 2 each system (box) is plotted in its own coordinate system; in Figure 3, below, they are partially redrawn in a common coordinate system. Possible states of each system are categorized in four ways, each a function of the location of the representative point.

1. The smaller of the two concentric circles in each box (the shaded circle) is unique to human purposive systems, and is a departure from Beer's classic SVH. This area represents the set of states that support planned heterostasis; states that involve deliberate destabilization of the system in order to move to higher levels of homeostasis. In the organization these goals have to do with growth and improvement; movements away from currently acceptable performance toward higher levels. Managerial heterostasis corresponds to Drucker's (1974:45) "creation of

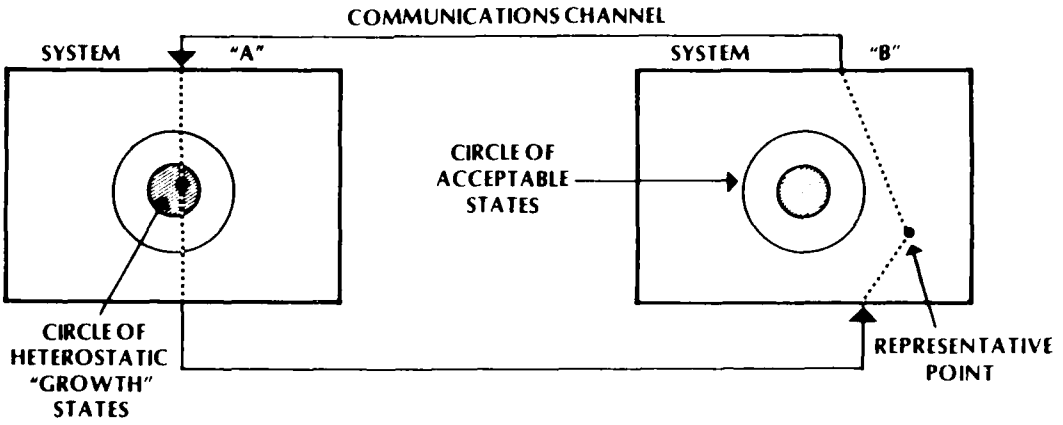

FIGURE 2. THE JOINED SYSTEM OR SELF-VETOING HOMEOSTAT. SYSTEM "A" IS IN GROWTH STATE; SYSTEM "B" IS OUT OF CONTROL. DIAGRAM IS ADAPTED FROM S. BEER, DECISION AND CONTROL, p 291

tomorrow" through the entrepreneurial function of management.

2. The remaining area of the larger circle (the ring surrounding the circle of heterostatic states) in each box represents states of normal homeostasis. In the organization, this area represents acceptable values of key variables, values that permit the organization to maintain a steady state. Managerial homeostasis corresponds to Drucker's (1974:45) "administrative" function of management. The device of the circles of preferred and acceptable states is analogous to the concept of the "consumer's utility hill" in cardinal microeconomic utility theory.

3. The area outside the circle but still within the box is temporarily tolerable but not acceptable. The system is out of control; it can accept this status for a while, but ultimately it must either return to control or die. In the organization, this area represents states--hopefully temporary--of unacceptable values of essential variables; low sales volume, negative cash flow or earnings, a strike, or perhaps a spate of poor quality control. Figure 2 shows System A in a "growth" state, and System B as out of control.

4. The area outside the box represents immediate death states. Should one of the variables assume a value located outside the box, the system has ceased to exist.

The lines connecting Systems A and B are communication channels. Signals called "information" and "entropy" flow from one system to another along these channels.

Information and Entropy

For cyberneticians, the word "information" and its companion word "entropy" have special meanings when applied to purposive systems. Information and entropy are both defined as signals that cause changes in the system which receives them; the difference between information and entropy is that information causes the system to change in ways that favor achievement of system goals, while entropy does not. Entropy can cause changes that actively oppose system goals or can be purely random signals ("noise" in electrical systems).

By definition, each bit of information or entropy that enters System A or System B (in Figure 2) causes its representative point to move. Information moves the point within the circle of control or moves it back toward the circle; entropy moves it away from control, or perhaps just delivers a mindless Brownian bump.

In addition to the information and entropy entering a system through the communication channels, there is also self-generated information and entropy (e.g., feedback) within each system and a continuous entropy "rain" of random signals entering each system directly from the environment.

Given the definitions of information and entropy, it is clear that movement of the system toward its goals depends on proper information flows and on the suppression of entropy within the system. Information is a purposeful signal; it cannot arise spontaneously or by chance. Since all system goals are defined by man, only man can generate information. Entropy on the other hand is the collection of all signals that are not purposeful (with respect to system goals). We expect entropy to arise spontaneously. We would also expect most of the signal traffic in any system to be entropic. The prime tasks of control ("management" in organizations) are then to generate appropriate information, to help that information get where it is needed in the system, and to suppress entropy wherever found.

Mathematically, entropy is identical in form to information--but opposite in sign. In fact another name for information is "negative entropy," shortened by cyberneticians to "negentropy." Functionally, negentropy kills entropy. The only way to defeat entropy is to annihilate it with information. It follows then that man must generate massive amounts of information in all parts of the system in order to neutralize the naturally occurring

entropy.

Transmission of Signals in Noisy Channels

Information travels in channels that also carry noise (entropy). Some important cybernetic laws concern the transmission of signals in noisy channels. For this discussion, two will suffice.

First, practical channel capacity must be large, far beyond intuitive expectations, to pass the amount of information required to establish and maintain control in complex systems. Second, the accurate transmission of information through noisy channels is accomplished in one of two ways; by sending the same message through a number of parallel channels at the same time and taking a "majority vote" on the various versions of the received message; or by multiplexing, which is sending the same message several times through the same channel.

Control Behavior in the Joined System

In any natural joined system, sooner or later some entropic signal will knock the representative point of one of the systems out of its circle of acceptable states. Figure 2 shows System B in this predicament. Since one of the component systems of the joined system is out of control, the joined system itself is out of control. Mutual control must be reestablished if the joined system is to continue to exist. System B begins the process with a signal to A: "Help! I am out of control. Do something." System A then signals B with information designed to restore B's representative point to the convex hull that represents its set of acceptable states. The signal that A sends may or may not be well-designed. If the nature of B's disturbance is familiar, the signal may be a routine and effective one. If the disturbance is new or not well understood the signal may be tentative in the extreme. As Beer (1966:292) notes, "...in the last resort the proposals made by each sub-system to the other can be random trial and error mutations."

The rescue signal may or may not work. It may work for B, but in doing so provoke a return signal from B that knocks A out of his circle. In this case, A must now sound the alarm. The process continues, with each system vetoing unacceptable actions of the other, until both systems have reestablished homeostatic control, or until the joined system dissolves; hence Beer's label, the "self-vetoing homeostat."

Homeostatic and Heterostatic Modes of Adaptation

To examine in more detail the process of mutual adaptation, the "circles of acceptability" of Systems A and B are replotted in Figure 3, using a common coordinate system. Recall that in each system the larger circle represents all states acceptable for homeostasis, while the smaller circle represents states that support heterostatic growth and improvement. We see that the four circles of acceptable states overlap, as in a Venn diagram. The area outlined in Figure 3a represents the locus of all states that are mutually acceptable. This area is outlined with a dotted line in each of the succeeding diagrams. Points falling within one of the large circles but not the other represent states acceptable to one of the systems but not to both and, thus, not acceptable to the joined system.

Figure 3b shows, in outline, states in which System "A" can achieve heterostatic growth but "B" can only remain in homeostasis; a quasi-parasitic relationship. Diagram 3c shows the shoe on the opposite foot; "B" now can grow at the expense of "A." Diagram 3d shows the optimum; a symbiotic set of states in which each system can heterostatically maneuver toward its highest goals. I will argue below that management's prime challenge is to find ways to consistently operate the organization and its relevant environment in this "double preferred" set of states.

If one system's representative point should move into an area of singular self-acceptability (in one of the large circles, but not in the other), the message it sends to the other system will indicate its own control but the location (state) indicated by the message will be unacceptable to the second system. The second system will veto that state, and the first system will have to seek a new state.

Even if both systems are in acceptable states, voluntary movement does not cease. Proactivity requires that each system seeks for even more favorable states. It continues this search until it reaches a state that for some reason is vetoed by the other system. At that point it must retreat or the joined system will dissolve. In addition, each system sends messages designed to drive the other system into states more and more favorable to itself. This also continues until the second system is driven into an unacceptable state, at which time the first system must again retreat.

As noted above, the exchange of signals continues, with each system vetoing signals from the other system (and therefore states of the other system) that dislodge its representative point from its circle of acceptability, until each system is in its set of acceptable states or until the joined system dies. The joined system is in control (achieves homeostasis) only if both of the

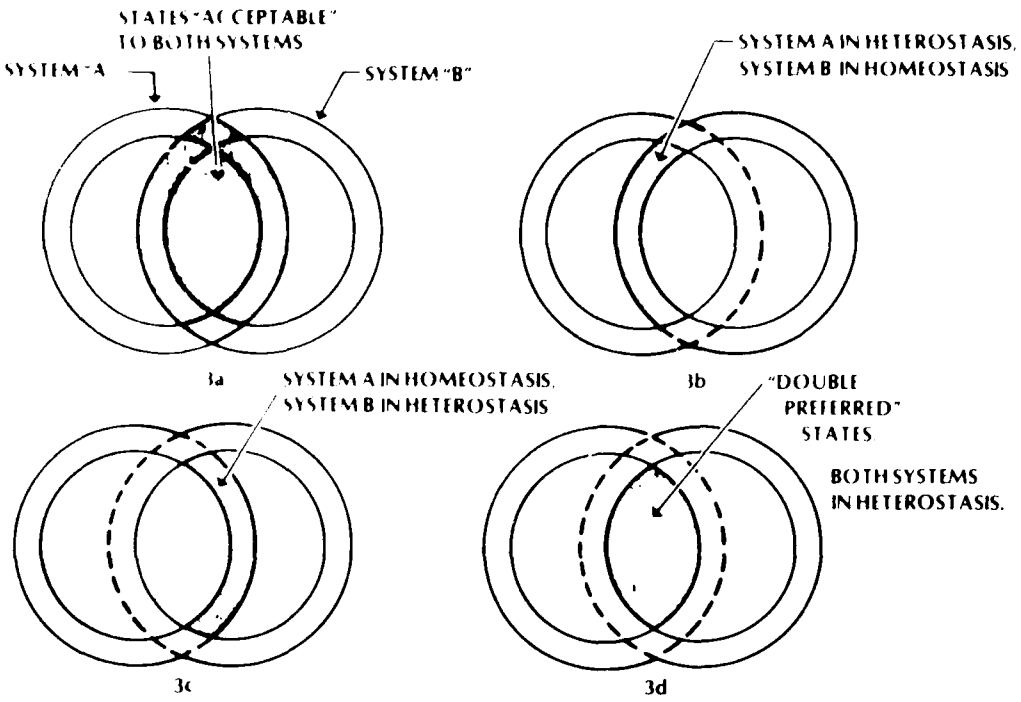

FIGURE 3. FOUR MODES OF OPERATION OF THE JOINED SYSTEM COMPRISING SYSTEMS "A" AND "B"

component subsystems are in control. Total system control is mutually arrived at and mutually maintained. Note also that control is established from within the joined system, not imposed from without. Cybernetic control is self control.

Shifting Control and Variety Management in the Joined System

The joining of two complex systems does not by itself insure compliance with Ashby's law. Even though both systems are complex beyond human ken, still, one must have more variety. How then can we speak of mutual control? How can the less complex system ever control the more complex one if Ashby's law is valid? The answer is that neither system establishes permanent and absolute control; each situation is different and no real situation involves all of the variety that either system possesses. Situational rules apply.

Shifting roles of controller and controlled mark the process of mutual control in the joined system. Temporary variety advantage shifts with control, and is accomplished in one of three ways. First, a way is found to reduce the variety of the system to be controlled; second, a way is found to amplify the variety of the controller; and third, a way is found to match exactly the variety of the controller to the variety of the controlled system (a special case). The idea of situational rules may call to mind the contingency variant--treated so roughly above--but the

situations are not the same. In this model the situational shifts take place under the direction of established and invariant a priori laws; they are not ad hoc constructions.

The Coenetic Variable

An important variant of variety reduction is the common or "coenetic" variable (Beer, 1966:285; Sommerhoff, 1950), which acts uniformly throughout all parts of the system at once. This variable is important philosophically because it is a direct consequence of the principle of the universality of law. It is important practically in variety reduction because it renders unavailable or illegal whole classes of actions or ranges of values that oppose the direction of the coenetic variable.

Examples of the use of each of the three techniques of variety manipulation and of the coenetic variable are found in management practice, and will be discussed below.

The "Poorly Joined" System"

Ashby's law forces a restriction on the homeostatic control process in the joined system. The inherent complexity of natural systems is so great that the unconstrained variety, if allowed to flow through the communication channels, would overload both of the joined systems and the communication channels. The mean time to reestablish homeostatic control, amid continuous entropic buffeting, would exceed the mean time between destabilizing messages, and the joined system would oscillate forever.

Therefore, not all of the variety present can flow between the systems; variety-limiting devices must be employed, and the joined system must become--again in Ashby's words (1960:208)--"poorly joined." As noted above, Beer (1966:292) calls a system that has its input variety artificially limited, as with both elements of the poorly joined system, "relatively isolated." The poorly joined system is labeled by Ashby as "ultrastable." The joined system composed of two (or more) relatively isolated systems and exhibiting ultrastability, is called by Beer the "Self-Vetoing Homeostat."

It is this ultrastable, Self-Vetoing Homeostat (SVH) that cybernetic[illegible] believe to be the essential control mechanism [illegible] every complex system, natural or man made. The SVH, [illegible] in the homeostatic processes, is also proposed here as the mechanism of productivity. Implied in the [illegible] SVH [illegible] the system model is the proposition that productivity [illegible] [illegible] in all complex systems, [illegible] [illegible] [illegible].

Contemporary management theory partially supports this thesis by recognizing proactive behavior within organizations. What has been missing is first, a mechanism for the process and, second, the extension of the concept to relationships among organizations. (Which of course is really proactive behavior of individuals within an organization, but directed externally.)

In life, the SVH is not this simple. Instead of only two subsystems there are usually many interlocked systems in every real joined system (Beer, 1966:392). Further, even in poorly joined systems the amount of information and entropy circulating through the channels within and between subsystems is incalculably large. On the plus side there are coenetic variables, which reduce variety by restricting the number of states acceptable to the system. But despite help from the coenetic variables, complexity still reigns. All variables (essential and otherwise) in all elements of the SVH are constantly changing value under the influence of streams of internal information and entropy, and the massive set of signals pouring in from the environment.

Because of this signal volume and the variability of the time lags between outputs and returns, it is generally impossible to deduce functional relationships between a system's outputs and the resultant return signals. The cybernetician's way of handling this problem of "unknowability" due to inherent complexity is called "Black Box theory."

The Black Box

According to Beer, a Black Box is:

> A box to which inputs are observed to lead and from which outputs are observed to emerge. Nothing at all is known about the way in which the inputs and the outputs are connected inside the box--which is why it is called black. (Beer:293)

Cybernetic[illegible] stress that the only way to gain information about the contents of the box is to stimulate it with inputs from outside, then read the values of the outputs. One can vary the inputs in some orderly way and record the consequent outputs. Finally, perhaps a set of inputs may be found that regularly result in predicted or desired values of the outputs. We may form a model of the interior processes of the box. Even though we still have no direct knowledge of the "true" contents and causal processes of the box--no knowledge of whether or not our model is an accurate mapping of the interior of the box or just a [illegible] approximation--we still may be able to cause the box to

behave in a predictable or even a desired manner.

The scientific method is the archetypical Black Box procedure. Nature is a Black Box. The experimental scientist, to the extent he can, isolates a natural system (as Beer does with his relatively isolated system) to control the relevant inputs. He then varies one input in an orderly way, reads the corresponding output values, and uses the experimental data to model processes inside the box (nature). Einstein described the process as follows:

> In our endeavor to understand reality we are somewhat like a man trying to understand the mechanism of a closed watch. He sees the face and the moving hands, even hears its ticking, but he has no way of opening the case. If he is ingenious he may form some picture of a mechanism which could be responsible for all the things he observes, but he may never be quite sure his picture is the only one which could explain his observations. He will never be able to compare his picture with the real mechanism and he cannot even imagine the possibility or the meaning of such a comparison. (1961:31)

Because science is cumulative, the typical scientist rarely deals with a totally black box. He attempts to add a small fringe to existing knowledge through investigation of familiar situations, with informed expectations. The boxes he typically investigates are varying shades of grey. Thomas Kuhn (1970) calls this process the "normal science" of paradigm articulation. The scientist sends to the box messages (stimuli) expected to elicit certain responses. Messages, some expected, some unexpected, return from the box. The unexpected responses then suggest new outgoing messages.

Every complex system is by definition a Black Box and, therefore, both elements of the SVH are also Black Boxes. The prime use of the Black Box concept in this paper is to serve as a model for the environment of the organization or of the manager. The virtue of the Black Box is that it frees us from the need for causal models. As in the case of the light bulb examples, the variety developed by a Black Box is counterintuitively large. A box with eight inputs and one output, each an on-off switch, possesses variety approaching the Bremermann limit. The Black Box therefore is capable of developing sufficient variety to map the complexity of nature.

A Summary of the Proactive System Model

To sum up, the Ashby-Beer model has four major constituents.

The first is Ashby's Law of Requisite Variety. The second, which incorporates the first, is the mechanism of the modified Self-Watching Homeostat. The third is the law of information and entropy, which says that all changes in a system are accomplished by information and entropy flows. The fourth is the concept of the Black Box, which gives us a procedure for managing situations too complex to understand. To the Ashby-Beer model a fifth constituent was here added to obtain the Proactive System model; the mechanism of heterostasis, used to explain proactive behavior as well as internal growth and change in organizations.

The modified SVH is the mechanism through which Black Box theory and the laws of requisite variety, information, and entropy operate to establish and maintain homeostatic or heterostatic control in all systems. It is the centerpiece of the Proactive System model as that model is applied below to the organization.

The Proactive System Model and the Manager

To briefly recapitulate: We have developed the concept of proactivity; a systemic adaptation of Drucker's postulate that the purpose of every organization is to disturb or change its environment in some specifically useful way. We then showed that none of the current organizational models include a mechanism for proactivity, and introduced one that does, the Proactive System. The central premise of this model is that (under the provisions of Ashby's law) a complex system is controlled by linking it to another complex system and letting the two systems control each other. The essence of this control is mutual adaptation; a linked system can exercise its will only so long as its actions are acceptable to the other system.

So we have arrived at this point with two competing constructs; an organization that desires to control its environment, and a model that prescribes rules for, and set limits to, control of external complex systems.

The task of this section is to reconcile the conflict; to show how and to what extent the organization can control its environment. We begin by describing the structure of the Proactive Managerial System (PMS), then proceed to a discussion of three major tasks of management; defining the relevant environment that requires change, creating an organization to effect the change, and managing this organization so that the change is accomplished. The words "change" and "control" are used above to describe the aims of the organization; "change" means causing certain variables of the world situation to assume specified new values; "control" is the operational control referred to above; maintenance of these values within the new tolerances.

The Organization and the Proactive Managerial System (PMS)

The heart of the Proactive System model is the modified self-vetoing homeostat, a (supra)system formed by linking two or more relatively isolated complex systems. The SVH was described above; the challenge now is to apply it managerially. For this purpose we define a device called the Proactive Managerial system (PMS).

The template for the PMS is a joined system comprising an individual (who is also the organization in its least form) and a complex natural system. The natural system can take three forms; another individual, a group of individuals, or a system of persons and machinery. Every other Proactive Managerial system is built by combining versions of this template. "Managerial" means that the individual (or the organization) is actively attempting to change and control the natural system. The PMS is the heart of the cybernetic managerial model. Its most common forms are:

--One person and a complex system of nature

--Two persons (colleagues or junior and senior)

--The supervisor and his department

--Two departments

--The manager and his organization

--An organization and its relevant environment (markets)

--Two organizations.

The next section of the paper describes the organization's struggle to assert control over its "relevant environment." We investigate how the proactive organization attempts to institute change in and maintain control over the relevant environment within the constraints of the laws of cybernetics.

The Tasks of Management in the PMS

The Proactive System model suggests an ordered sequence of three major tasks for management as it seeks environmental change and control through the device of the PMS. These tasks are first, to define the relevant environment, i.e., the world situation of interest (particularly the desired world changes), second; to create an organization to effect these changes, and third to manage this organization, once created.

Task One--Defining the World Situation

Management defines the relevant environment by determining what the world situation of interest is, and how it is to be changed. A premise of the cybernetic model is that no organization will form unless there is a world change to be made. The procedure, discussed above, is to define a relatively isolated system that includes all the world variables to be changed and all the other variables that measurably affect them, then to specify the new values for those world variables to be changed.

It should be clear that this is a conceptual and not a mechanical prescription. The manager has no method, beyond experience or perhaps a model, to capture all of the intertwined variables that belong in his environmental system. Like the scientist, the manager's relevant environment is partly known, mostly unknown; a Grey Box.

Task Two--Creating the Organization

The second management task is to create an organization that will cause the chosen world variables to move, against opposing forces of competitors and the randomizing forces of entropy, toward the desired values.

This task has three parts. First is the setting of an internal organizational value structure; a common understanding of how the organization will behave internally as it attempts to control the world situation. Second is choosing and bounding internal variables, qualitative and quantitative, that both embody the internal value structure and generate the information needed to change the specified world variables. Third is organizing resources; people, material and information, to support the internal value structure and promote control of the world situation.

Setting the Value Structure. The value structure is usually expressed qualitatively, and relates to the most basic and fundamental questions. Why does this organization exist? Who are its "customers" and what do they value? How will people treat each other in this organization? Ethically, what types of behavior are to be encouraged and what types prohibited?

Peters and Waterman (1982:281) suggest that a formal value structure is a hallmark of successful companies, but is often neglected by the less successful ones. They believe the value structure, once established, must actively permeate every part of the organization and guide every thought and action.

Cybernetically, the effect of this shared value system is the potential transmutation of the worker from a source of entropy in the workplace to a source of managerial control. This idea is developed in more detail below.

Setting and Bounding the Variables. Given an understanding of the external (world) purpose and the internal value structure, the next step is choosing qualitative and quantitative variables that embody purpose and values, and setting behavioral or numerical limits on them. If the external purpose and the internal values have been successfully embedded in the human organizational fabric, then the choice and bounding of these variables can (and should) be done at all levels of the organization, not just at the top. The value structure is expressed both qualitatively and quantitatively: qualitatively in coenetic variables; common beliefs, agreements or policies that act throughout the organization and declare some behaviors and some results essential, some illegal. Quantitative expressions of value structure are discussed below.

Setting and Bounding the Variables--a Business Example. Among the crucial quantitative variables for a business, cash flow and earnings immediately come to mind. No business can live long if these variables are negative. But there are many other important variables, including second order "growth" variables, some of which are latent in the system, some defined by management. Examples might be; return on investment, hours lost to labor disturbances, machine down times, market share, finished and raw material inventories, relative and absolute amounts of debt and equity, size and quality of the work force, age and sex distribution of the work force, and product quality.

Also important is the set of second order variables that measure the time rate of change of each of these variables. Most companies would strive to maintain these variables (along with many others) within policy limits. As noted, the proactive principle dictates that many of the organization's crucial variables will be located in the environment, and that others will be second order or "rate of change" variables either inside or outside the organization.

It may seem that the appropriate strategy for many of the above variables is obvious--maximize (or minimize) them. Throughout history (to take one example), the idea of profit maximization has rung like a siren song in the ears of economists and managerial theorists. But in a real situation, each of the company and world variables interacts with every other variable (to a greater or lesser extent) and entropy acts on all of them. Because of these interdependencies, no variable (including profit)

can be allowed to approach an unconstrained maximum (or minimum). As an example, an attempt to push "labor time lost" too close to zero would probably drive payroll up and productivity down, both beyond acceptable limits. This behavior of the PMS, keeping a large set of variables within prescribed limits while avoiding the attempt to maximize any one of them, is reflected in management theory. Two examples that incorporate static homeostasis are the "satisficing" process of Simon (March and Simon, 1958), and Lindblom's (1959) "Science of Muddling Through." Dynamic homeostasis (heterostasis) in the PMS is mapped by Ackoff's (1970:15) concept of adaptive planning or "adaptivizing."

Structuring the Organization. The next management challenge is to create an organization, within the constraints of its value structure, to accomplish the necessary world changes, and maintain control over the world situation. We will consider only two factors in organization design; process and structure. Process relates to the need to generate very large amounts of information for control purposes; structure to the need to engineer specific types of communication channels, both in the organization and in the environment, to guide this information where it is needed.

Process and Information Generation. Control implies the ability to change the values of specified variables. Cybernetics says that variables change value only as a result of information and entropy flows. Changes in values of organizational or world variables are caused by flows of information and entropy from three sources; the organization, the relevant environment, and the remainder of the organization's environment (that portion the organization is not trying to change). The fact that the "non-relevant" organizational environment is a source of entropy is another reminder of the impossibility of even "relatively" isolating a real system.

Entropy is in constant supply everywhere in the world and in the organization, but the only source of information is man--who sets the purpose and value structure for the organization. Man therefore must generate information in quantities sufficient to combat the large amounts of entropy naturally present. Information is a signal that moves a target variable toward its desired value. Information is generated as individuals within the organization read signals from the environment, or from other locations in the organization, compare these signals with those anticipated, some dictated by the value system, some predicted by models, and devise return signals to institute or maintain control.

Given a world situation so complex that it is literally "unknowable" in detail, how does the manager devise the right

messages? To oversimplify, he or she generates a large number of messages, some of which may be quasi-random, tests them all in the world situation, and cancels the wrong ones. The remaining messages must be "right." This is done interactively, inside a Black Box, by the method discussed above. Faced with a totally unexpected message, the manager guesses. He resurrects the closest historical analogue and tries the signal that worked then. If the message is familiar, he issues a response known to have produced the desired effect before. In either case, the key to success is his next action, which is to observe how his message moves the representative point of the world system, and modify his signals as necessary to move the point in the right direction.

Organizational Biofeedback. To summarize, in the Proactive System model, the relevant environment is envisioned as a Grey Box. The organization has only imperfect knowledge, partly due to entropy or faulty information, but mostly due to sheer complexity, of all the variables and interactions that affect its customers, its suppliers, the labor market, the financial markets and other relevant external systems. But, in keeping with Black Box theory, the organization works out over time, through heuristic processes that use enlightened trial and error, a set of signals to the world system that elicit the desired set of responses from the environment. This is the mechanism of the process I call "proactivity."

Thus, despite the lack of complete knowledge of the world situation, the organization may be able to achieve and maintain mutual homeostatic or heterostatic control between itself and the world, through Black Box procedures using the process described above; an organizational form of biofeedback.

Structuring the Information Channels. A second function of management is structuring the information channels within the organization and to the relevant environment, to insure that sufficient and proper information can arrive when and where it is needed, and, through the use of appropriate information flows, destroying entropy wherever possible and moving the world system toward organizational goals. This is more difficult than it may seem.

For perfect control a signal must arrive at its destination undistorted. It is impossible to transmit a signal without distortion through a noisy (entropic) channel, and all real channels are noisy. How can management get accurate information where it is needed? One technique specified by information theory, and widely used in management, is the multiple channel process mentioned above. The same message is transmitted simultaneously through a large number of separate channels. At

the common destination, each version of the message is slightly different, due to noise in the channels, but the errors are randomly distributed. By taking a "majority vote" in each disputed case, the original message can be accurately reconstructed. A second method is the transmission of the same message through the same channel more than once.

A second consideration for the structure of communication channels concerns the feedback path. The concept of feedback was first encountered in the adaptive system model. It has been expanded in the cybernetic model in two ways. First, positive feedback has been added to the model to account for growth, differentiation, and for second order variables in general. Second, while the organization still adapts internally in response to feedback, now one path for that feedback is through the relevant environment, which in this model is the "other half" of a Proactive Managerial system. Litterer notes:

> [a] feedback loop must exist wherever there is control, however it does not always exist within the unit being controlled. Frequently the feedback loop is made through some element in the unit's environment. (1969:267)

Task Three--Managing the Organization

Beer defines the organization as a "structure for reducing proliferating variety" (1975:313), and as "the tool for handling complexity" (1975:380). So we have returned to the idea that managing the organization means managing variety; that management and the organization exist to control the variety and entropy of world systems so that organizational and world variables are kept within (or restored to) the boundaries set for them.

We saw above that under the provisions of Ashby's Law there are only three ways to control a real world situation (system); to amplify the variety of the controlling organization, to reduce the variety of the world system, or to exactly match the variety of the world system with that of the organization. The organization uses devices that employ each of these principles. In the next two sections I discuss the first two of these methods.

Amplification of Control Variety

Control variety amplification is used in many ways. Let's look at some examples.

[illegible] integration of authority, under the [illegible] splits of [illegible] system, amplifies [illegible] variety. The word "[illegible]" [illegible]. If the delegating [illegible] [illegible]

full authority to act (i.e., new sources of negentropy), then total control variety is multiplied by the number of new decision centers. If significant authority is withheld by senior management, if non-routine decisions must be referred higher, this is not true delegation as I use the term. This is departmentation, a technique for situational variety-reducing.

A more powerful form of delegation, different in kind as well as degree, is found in the advice of contemporary writers on organizational effectiveness (Ouchi, 1981; Peters and Waterman, 1982; Peters and Austin, 1984; Clifford and Cavanagh, 1985), whose common theme, seen cybernetically, is that the worker, when imbued by management with a common corporate vision and shared value system, can operate as an extension of management as it endeavors to control and shape the organization's markets, and thus extend and amplify managerial control variety.

The classical "staff" function of analysis and generation of information for use by management is a form of managerial variety amplification.

In nature, the seed and the gene are variety amplifiers. They contain within them templates for distinct, mature individuals of the species, and direct the process of growth and differentiation according to the templates.

A common and useful variety amplifier for the manager is the model. The managerial model can take many forms, among them mathematical, physical, electronic, or conceptual. A model that validly (homomorphically) maps the structure and function of the system it models is truly creative; it generates information about the system totally unsuspected by the model builder. Beer observes:

> ...almost any scientific model, however exiguous and crude, quickly surpasses the capability of the brain to evaluate a complex situation in quantitative terms. (1975:59)

Variety Reduction

Variety reduction is the most common and, perhaps, the most important method for establishing everyday control over complex systems. Beer notes:

> The first act of a would-be controller of a high variety system is to find a means to reduce the variety in a way which would make it possible to deal with the situation at all. He has no choice in this by definition. (1966:305)

Society could not function without a large number of variety-reducing devices, some legislated and some maintained by convention. The managerial principles and techniques of the so-called classical school of management, particularly those of Taylor (1911) and Fayol (1916), are examples of situational variety reduction within the organization, as we will see below.

Most dramatically in human history, when man replaced idiographic language with the economies of an alphabet, and Roman or cumulative mathematical notation with place-value notation, his analytic, communication, and control abilities exploded.

The substitution of heuristic for algorithmic problem solving procedures (Beer, 1981:52) is another practical method for reducing unwanted variety. Heuristics are enlightened search methods. They are rules for continuous improvement; open-ended methods that insure progress toward a goal but hold no guarantee of reaching it. An algorithm is a rule that lead directly to the solution, if a closed solution exists. Because algorithms are generally optimizing schemes, they tend to have low variety, while multipath heuristics tend toward high variety. The exchange of signals between member systems of an SVH is a heuristic process.

Scientists working on artificial intelligence suspect that what we term "intelligence" is related to the use of heuristics as variety-limiting devices. Douglas Lenat (1984:204) says, "...the essence of intelligence [lies in] finding ways to solve otherwise intractable problems by limiting the search for solutions," in problems that "...are too complex to be solved by random search...." Heuristic methods draw on knowledge of "...the world's regularities to constrain the search for a solution." Heuristic methods, in this view, rationally and systematically reduce potential variety by circumscribing problem phase space; i.e., "...organizing and applying knowledge to reduce search."

The trick to gaining control through reduction of situational variety is to "throw away" only those signals not related to the controller's goals; to reduce variety within a homomorphic mapping; i.e., to retain in the map all relationships that are relevant to control in the "territory."

The Coenetic Variable and Variety Reduction

More commonplace but no less important in variety reduction are the coenetic variables of society. As noted above, the coenetic variable is a force or variable that acts similarly and simultaneously on all elements of a joined system. Real-world examples might include the force of gravity, violent weather,

large stock-market swings, electric fields, strongly held company policies, new surgical techniques, or the Keynesian demand model of the economy.

Coenetic variables also describe conventions of society. We agree to drive on the same side of the road. We usually observe traffic signals, and other laws, even when there is no traffic and no one is looking. We have developed a common understanding of the control meanings of green, yellow, and red. Conventions of manners, etiquette and attire help reduce social interactions to a confident routine.

The coenetic variable is a most important variety-reducing agent in managerial cybernetics. The shared value system or accepted policy is a coenetic variable particularly important to the organization. This variable declares whole sets of otherwise acceptable behaviors invalid because they do not support policy or the value system. Though he does not use the term, Drucker's concept of innovation (1985) depends fundamentally on organizational discovery, analysis, and exploitation of marketplace coenetic variables.

Each profession invokes conventions that one must obey to be accepted. (The conventions of style in academic papers is a coenetic variable all too familiar to most readers.) Many professions recognize certain procedures as "best" or "preferred" practice. Most engineers, physicians, professors, bricklayers, machinists, and professional athletes--uniquely equipped with their esoteric yet global tools--could probably walk into their workplace in virtually any company or country and function professionally rather quickly.

The fourth idea presented in this paper is the thesis that the entire management function is centered in variety management. This topic will be discussed more extensively in a later section.

Sports and Variety

The combined operation of the three approaches to variety management is seen vividly in sports. The rules generally require an equal number of players on each side, which makes the idea of matching (if not the idea of variety) an obvious one. Variety-matching or "man-for-man" defenses, where each player is responsible for controlling a single opponent, is a staple part of most sports strategies.

[illegible] when a ball reaches a certain location [illegible] football, and basketball--[illegible]

times. This is true for both the offense and the defense. Since the offense usually has certain legislated advantages like a "play" (a template to reduce the situational variety faced by each offensive player), the defense may seek a countervailing route to a strategic personnel surplus. This may be a zone defense, which allows quick concentration of personnel at an originally unknown danger point as soon as the defense discovers that point.

An offensive player of unusual skill causes any defense great difficulty, often because that player finds his greatness in an ability to generate more variety (speed or maneuverability) than a less gifted opponent. Several defenders may be assigned to constrain his variety, with obvious advantage going to some other "unmarked" player. The opposite situation is also encountered. A determined defender can neutralize a gifted offensive player through tenacity, because the offensive player must perform some variety-draining tasks, and because offensive success is more narrowly defined than defensive success. In cybernetic jargon, the offensive player tries to follow a tight or narrow information protocol, while anything the defender does to disturb that protocol counts as success for him. The defender tries to introduce entropy into the offense, while the offense tries to be fully informational. Here, as elsewhere, entropy tends to dominate.

Two Examples of the Proactive Managerial System

The two invented examples that follow illustrate the working of the PMS. The first example focuses on a single variable located within the organization, the second on several variables located both in the organization and in the environment. The variable in the first example is deliberately chosen to be important, but not one whose ups and downs normally cause daily tremors in an organization. Note that in both examples the organization is striving to cause certain things in the environment to change.

A Single-Variable Example. The first example uses the internal variable, "age of the labor force." Consider a manufacturing company located in a turbulent area with a high net efflux of young people. The personnel department is unable to hire a sufficient number of qualified young people, and so it hires experienced workers away from other employers. Two important variables start to rise: age of the labor force and average salary.

Management notes these two variables heading up, and signals the personnel department to reverse the trend. Personnel signals back its problems. Management, if sufficiently concerned,

responds with more budget for personnel.

Personnel may then try many tactics: an in-house "upward mobility" training program; a college scholarship program; a summer son and daughter employment program; more advertising; paid relocation allowances for persons recruited from other markets; vandalism protection through indoor parking, and anything else that an ingenious personnel manager can concoct.

The variable "age of labor force" is not normally considered immediately crucial to an organization. But as the example shows, any important variable that goes beyond control limits and stays there long enough can become life-threatening. If none of the tactics tried by personnel is successful, eventually the company will have to move the plant or close it.

What subsystems are locked together in this PMS? Originally, we saw the personnel department and top management, but it quickly became apparent that the labor market was also interlocked, as were salary schedules, housing, crime rates, transportation, and a host of other variables, each affecting all the others.

Note that the company is not passively adapting to the labor market; it is trying to get the labor market to adapt to it. In doing so, the company makes internal changes designed to influence external events and behaviors. If the value of the variable age of the labor force is restored to acceptability, there will have been a mutual adaptation between the company and the labor force.

A Multivariate Example. For a second example, let us look at an automobile manufacturer as one element of the PMS and its dealer network as the other. This PMS is diagrammed in Figure 4.

From an initially acceptable state, there is a sudden and unexplained drop in sales volume. Both elements are thrown into unacceptable states, as revenues fall and dealer inventories rise. The manufacturer, signaling directly to the market, offers rebates. Sales rise; this restores the dealers to acceptable sales and profit states, but manufacturer's profits drop too low. The manufacturer, trying a new signal, raises prices and increases warranty protection. Sales remain strong, initial manufacturing profits rise, but the dealers signal unacceptably high warranty repair costs. The manufacturer tightens warranty coverage and increases advertising. Sales fall again. The frustrated manufacturer lobbies the Congress for import quotas.

Again, a series of signals flow among system elements, attempting to drive each variable into its acceptable range. What are the elements of this PMS? The situation is diagrammed in Figure 4.

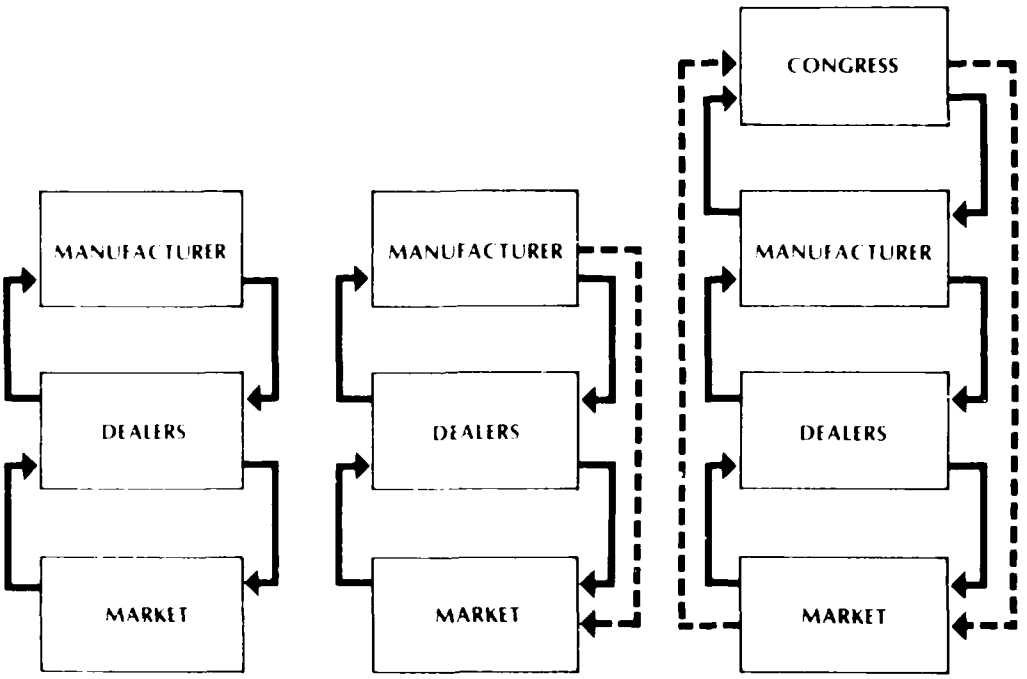

FIGURE4. ILLUSTRATION OF THE SHIFTING STRATEGIES WITHIN THE CAR MANUFACTURER-CAR DEALERS SELF-VETOING HOMEOSTAT.

Initially, there was the structure shown in Figure 4a. When sales fell, the manufacturer first signaled the market directly with rebates (Figure 4b). When all stratagems failed, the company enlarged the joined system (Figure 4c), and asked the Congress to legislate mandatory changes in the buying patterns of the market (right hand dotted line) to restore manufacturer and dealers to control status. The market, in its the role as the electorate, will, perhaps, have some signals (left hand dotted line) to send to the Congress.

Attributes of the Functioning PMS

Both examples illustrate basic operating principles of the Proactive Managerial system. First, proactivity itself; each element actively uses information flows to cause other elements to adapt in its favor. Second, the use of Black Box procedures as each element tries different messages to see which, if any, will have the desired environmental effect. Third is the final achievement of either mutually acceptable control or dissolution as each PMS element exercises its power to veto unacceptable states in other elements. This last point does not necessarily mean that all elements of the system die. If the system in the second example fails, all dealers may migrate to other manufacturers and continue to operate, and all people working for the manufacturer may get other jobs, but the system, as originally

specified, no longer exists.

Practical Problems in Environmental Control

There are significant practical problems in accomplishing the mutual control process described above.

A major problem is accurately defining the environmental system to be controlled. History shows that the true nature of the relationships in the Universe are not obvious. Correctly and completely identifying the attributes and relationships affecting the key variables in any real world system (i.e., constructing a "leakproof" relatively isolated system) is an impossible task, for at least three reasons.

First, we are overwhelmed by the sheer complexity of nature. The human mind cannot hold or manipulate all elements of any complex natural system. Second, we are sure to leave out important elements or relationships whose influences on key variables are not apparent. Third, systemic relationships change with time, so that even if a system is correctly specified at a given moment, at some later time new variables in the Universe begin to affect the system and some formerly important variables become irrelevant (Emery and Trist, 1965:241).

The wrong variables that man includes will create entropy within the system, while the missing variables will produce an insufficiency of information. Man is often unable to tell, even when his purpose is clear, which signals are informational and which entropic. Finally, man is likely either to ignore unwanted pieces of information or to arbitrarily declare them false.

For these reasons the specification of a "relatively isolated system" by management, although unavoidable, carries real risks. The inevitable omission and misidentification of important attributes and relationships create a false world map. Unless the map is constantly verified and revised, some unpredicted force will emerge and "blind side" management.

The concept of proactivity is vital in this updating process. The more active the organization is in molding its environment, the better it understands the new world situation, and the better it reads the map it helped to draw.

This concludes the discussion of the series of managerial tasks implicit in the Proactive Managerial system. In reprise, management is faced with three complex tasks: defining the world situation to be controlled, creating an organization to institute the appropriate control, and managing this organization so that the desired control is achieved.

We now turn from sketching new ideas about the organization to understanding older ones. The next sections test the Proactive System model as a tool for rationalizing existing management theory. First, three ideas from four familiar modern authors are examined, then part four explores the relationship of the Proactive System to more conventional management theory.

Three Management Theories in the Light of the Proactive System

Here we return to the three works written by Mintzberg, Drucker, Peters, and Waterman, and view certain ideas of each through the spectacles of the Proactive System model. The first idea is Mintzberg's theory of managerial behavior, second the "excellent" organization of Peters and Waterman, and third Drucker's "responsibility" definition of the manager. In each case the purpose of the inquiry is to see how well the Proactive System model illuminates the concept.

Mintzberg and Managerial Work

Mintzberg's (1973) research led him to view the manager essentially as an information processor. He sorted managerial work into ten roles within three groups. Each role has major information-processing features. All of the roles evolve, directly or indirectly, from the manager's status as "head" of the group.

The first group of three roles are interpersonal and derive from the leader's authority. In the figurehead role the leader performs as the group's symbolic and ceremonial head; as leader he motivates and sets group values; as liaison he builds, outside the group, information source contacts available only to the titular head.

The second group, labeled informational, also includes three roles, each related to handling information uniquely available to the manager because of his position. As monitor he receives, and processes internally, information from outside and inside the organization. As disseminator he retransmits within the organization information from within and without. As spokesman he transmits information about the organization to the environment.

The third group, labeled decisional, comprises four roles, each related to decisions reserved to the boss because of the unique patterns of information available to him. As entrepreneur he changes the structure and function of the organization in response to opportunities or dangers in the organization or environment. As disturbance handler he quells uprisings of

entropy within the organization. As resource allocator he is responsible for all organizational resources. As negotiator, he represents the organization externally in decision-making situations.

This is a meager sketch of what is, in fact, a detailed and well developed model. Even so, it is possible (for me) to see the Mintzberg manager functioning as one element of the PMS, manipulating information flows to achieve company goals.

Mintzberg's model allows the manager to function proactively within the organization and as a medium for importing the information that would permit passive adaptive behavior; and, as entrepreneur, to restructure the organization according to the passive adaptive model. It does not specifically include a provision for external proactive behavior--attempts by the manager to make the organization's environment adapt to the organization.

The roles of liaison, monitor, spokesman and negotiator require the manager to communicate outside the organization, but my reading of Mintzberg does not suggest active effort to shape the environment. This is why I judge the Mintzberg model to be a simple open system. The addition of a proactive external role to the Mintzberg manager would change the form of the underlying model from simple open system to proactive.

What Makes an Organization Excel?

While Mintzberg studied the individual manager, Peters and Waterman (1982) focused on whole organizations. Their goal was to discover factors that lift an organization above the crowd. If Mintzberg's message was that the manager spends his time creating and moving information, Peters and Waterman's key messages are (my words, not theirs), "Your people are your only source of negentropy; turn them loose," and "Your company and your markets constitute a single system."

Peters and Waterman found the over-arching attribute of success to be the ability to manage ambiguity and paradox. Their starting point was an appreciation for "...the limited capacity of the decision makers to handle information and reach what we usually think of as 'rational' decisions..." (p. 5), and the belief that, "Treating people--not money, machines, or minds--as the natural resource may be the key to it all" (p. 39).

They found eight qualities that characterized highly successful companies. Let's examine these qualities with particular attention to aspects bearing on the cybernetic model. Many of the behavior patterns relate to more than one of the qualities.

The first of the eight qualities characteristic of the excellent company was a bias for action, which was expressed in three ways. First, an overwhelming emphasis on free, open and informal communication at and between all levels of the organization. Second, a pronounced effort to cut all problems and efforts into small pieces and manage them in small autonomous groups, with quick action and much experimentation. Third, concentration on simplifying the forms of management, e.g., short memos, few control numbers, and small staffs.

The second quality was closeness to the customer. Four ideas play here. First, the customer is figuratively (and sometimes literally) brought "inside" the company. The customer's values become those of the company, and innovation originates in the marketplace. Second, an internal obsession with quality, even beyond apparent market demands. Third, a sharp eye for niches; unsatisfied wants in the marketplace that the company can profitably satisfy. Fourth, the fact of being driven more by quality and value than by cost.

The third quality is characterized by autonomy and entrepreneurship. The company may be big but it tries to act small. This is accomplished by radical decentralization and delegation of authority to the lowest possible level, product champions, a policy of betting on the man rather than on the product, resolution of differences by competition within the company, intense communication about what everybody else is doing (and how well), tolerance of failure, and the use of "forcing" devices to encourage innovation.

The fourth quality is productivity through people, which involves treating people with respect, as mature adults, and as sources of innovation. People are given significant challenges, long leashes, and put into small groups. Formal chains of command are made nearly to disappear. Staffs are kept very small. Peer information is widely available and peer evaluation is encouraged.

The fifth ideal is hands on, value driven. The device that controls all the autonomy described above is a powerful set of common values, against which all proposals and disputes are measured. These values are usually qualitative and are centered in concepts like service, quality, and the desire to be the best. Management is responsible, above all, for instituting and maintaining the value structure, which permeates the organization and drives the least details of company behavior.

Sixth is the idea of sticking to the knitting. Stay with the markets you understand. Innovate frequently, but in small bites and always into familiar markets; into "Grey Boxes." Do not "bet the company" on big and irreversible decisions.

Seven. Defeat complexity with a simple form and lean staff. Keep policy to a minimum and individual judgment to a maximum. Push authority as low as possible. Keep action groups, and especially staffs, small.

Eighth and finally, simultaneous loose-tight properties. Tightness in dogged adherence to the corporate value structure, looseness in allowing maximum local autonomy within the organization. The constructive tension thus generated is governed by the value structure and is controlled by peer pressure activated by massive information flows about all aspects of the business and the work of everyone in it.

Excellence and the PMS

The Peters and Waterman prescription for the excellent company strikes me as a prototypical description of the Proactive Managerial system in action. Consider my rewording of a litany of ideas from Peters and Waterman that could easily have come from Ashby or Beer.

"We first must accept the fact that the complexity of the world is too great for the human mind to absorb. The prime task of management is the setting of a clear and unambiguous value structure (through the agency of coenetic variables), and continuous enforcement of that value structure through internal competition, peer pressure, and massive internal information flows. Variety is constantly reduced by chunking problems into small pieces and placing them in small autonomous groups for solution. Communications channels are very large and are consciously and continuously multiplied as deliberate company policy. Many small, decentralized, autonomous decision centers are the rule, not the exception. People are treated as sources of solutions (negentropy) not sources of problems (entropy). All eyes are constantly focused on the customer (environment), reading and reacting to events and signals generated by the Grey Box that is the customer. In fact, the customer is so tightly "wired" that he is essentially inside the company, forming a mutually adaptive PMS. Finally, there is a constant process of innovation in small bits, much experimentation, tolerance of failure and, always, with attention firmly fixed on the customer and his needs and reactions."

Drucker's Theory of "Managerial Responsibility."

Peter Drucker has made contributions to management theory too numerous to catalog. One of the more important but less appreciated is his unique definition of the manager. In classical

management theory the manager is someone who takes responsibility for the work of others. Drucker does not accept this concept. He says:

> To be a manager means sharing in the responsibility for the performance of the enterprise. A man who is not expected to take this responsibility is not a manager.... What makes a manager is responsibility for contributing to the results of the enterprise rather than "responsibility for the work of others." (1974:380, 389)

This is the quality that, for Drucker, separates managers from administrators, bureaucrats, and clerks. Administrators accept responsibility for correct performance of tasks; the manager accepts responsibility for results.

In the language of the Proactive model, this means that the administrator or bureaucrat (operating in the context of the adaptive open system model) accepts responsibility for keeping the output signals within the tolerances (somehow) set for them through the feedback procedures of the model. These persons perform the "compare and correct" function in the adaptive system feedback loop.

The Druckerian manager, on the other hand, operating proactively as one element of a PMS, reads incoming signals from the environmental Grey Box, compares them with the organization's goals for change in the environment and, by taking action within the organization, adjusts outgoing signals until incoming signals are acceptable. His job is to bring the environmental Grey Box under control by whatever signals are required. His responsibility is for results--in the environment.

Summary of the Three Theories

While the analyses of the three selected theories were far from rigorous, it appears that the model is sufficiently versatile to map each of the theories and sufficiently robust to suggest a possible extension of one of them. The cybernetic model appears to possess theoretic utility; the next sections explores this possibility further.

THE FOURTH IDEA: ASHBY'S LAW AS THE IRON LAW OF MANAGEMENT

> The management problem is precisely a problem in handling variety. If we examine any managerial action we will find

that it is a variety reducer. (Beer, 1975:110)

> It has always seemed to me that Ashby's law stands to management science as Newton's Laws stand to physics; it is central to a coherent account of complexity control. (Beer, 1984:11)

Here finally is the audacious assertion about the essence of management.

Beer now declares that the proposal hinted at throughout this paper is true; that Ashby's Law is, in fact, the Iron Law of Management. If this proposition is valid we should be able to find Ashby's Law, and by extension the Proactive System model, at the center of every management principle, theory, and action. Note, however, that although Ashby's law provides two avenues to variety management, situational variety reduction and control variety amplification, Beer invokes only the former. We will examine this significant omission below.

Full exploration of Beer's thesis would require a complete reinterpretation of management theory, for which a book is the proper vehicle. To see where such a reinterpretation might take us, however, I will explore a few logical consequences of Beer's assertion and then examine one historic management issue through the lens of Ashby's Law. For that example I have selected the controversy that Ernest Dale (1973:205) called the "principal quarrel" of organization theory, the dispute between the behaviorists and the classicists over the proper role of man in the organization. The classical management position will be represented by Fayol and Taylor, the behaviorist riposte by Argyris.

I am neither declaring to be true nor seriously advancing as theory the idea that management is "nothing more than" the application of Ashby's Law to purposive social systems. I am, rather, interested in seeing what ideas result if we revisit the major themes of management using both modes of Ashby's Law as illuminating principles. I am looking for answers to questions like the following: Are the ideas coherent? Do they seem reasonable? Do they offer any insights? Would a complete theory based on this law offer anything useful?

Management and Ashby's Law

What are the logical consequences of Beer's assertion? Some candidates: First, that management itself was called into being to tame the unwonted complexity that appeared when men first joined together to do work; second, that management has continued to develop in response to the changing patterns of complexity in

the world.

From inception then, the practice of management has been the practice of controlling or limiting variety in natural systems, of suppressing entropy so that the natural forces within the system could move the system toward man's chosen goals. All of the tools, techniques, and theories of management have come about (we hypothesize) as products of the eternal battle against situational variety.

Logically, management began when tasks became too complex for one person. Wherever people had to join together to accomplish a task, complexity multiplied and what we now call management was required. We see this, of course, in hindsight. At the dawn of commerce, there were no management theorists or managers, only owners and workers. Over time, complexity expanded beyond the capacity of the owner to control. By the time the need for management appeared in economic organizations, the problem of organizational complexity had already been faced by the church and in the military, and hierarchical authority structuring had become a recognized response.

As the power specialization became apparent, some workers' jobs were restructured so that they personally "did no work," but undertook, as a specialty, supervision of other people. Here were the roots of management and, perhaps, the origin of the idea that management "is" responsibility for the work of others.

Early Managerial Themes

By the early 1900s, a few managers had begun to reflect on what these new events meant in the workplace. Two in particular, F. W. Taylor and Henri Fayol, tried to generalize about the nature of managerial work; Fayol (1916) from the top of an organization down, Taylor (1911) from the shop floor up. Fayol suggested there were universal functions performed by all managers; Taylor that there were certain universal and systematic ways of approaching every type of human labor that led to the most efficient accomplishment of work. Taylor and Fayol worked within the closed system framework; both adduced principles that are still viable in the appropriate contexts, and that can be analyzed in the light of the Proactive System model.

Fayol's Principles of Management

The idea that there are "principles" of management--that this fledgling, empirical profession rests on a theory base--began with Henri Fayol (1916). He postulated general management maxims, many of them formalizations of rules of thumb that had been found,

lost, and rediscovered countless times since man first formed purposeful groups. Beer's assertion requires that the Fayolian rules relate directly to complexity and its control. Fayol's five elements of management (planning, organizing, commanding, coordinating, and controlling) can all be interpreted as variety-limiting devices.

Take, for example, planning. The cybernetic interpretation of planning is evident in Ackoff's description:

> ...the design of a desired future and of effective ways of bringing it about....a process that is directed toward one or more future states which are not expected to occur unless something is done. (1970:1, 3)

Planning, seen cybernetically, is the selection from the unconstrained set of all possible future states, those that the organization wants to see. The actions necessary to create this future are deduced, and appropriate controls are built into the PMS.

Organizing (which for Fayol also meant staffing) can be seen as selecting from the set of all possible organizational forms the one believed best for realization of the planned future, and selecting from the pool of all possible employees those whose abilities best conduce toward that future. Management then devotes effort and energy to maintaining the organizational form and supplying human talent.

And so on for the other elements. The generic process of variety reduction can be seen. In each case, a selection process limits the original large set of possible choices to a small set. The key to making the process work, as Lenat pointed out above (p. 39), is using policy, experience, judgment, intuition, or analysis to systematically rule out whole classes of potential choices; to eliminate the need to separately consider each choice.

Similarly, Fayol's principles of Division of Work, Unity of Command and Direction, Centralization, and the Scalar Chain can be seen clearly as devices to limit the variety faced by the organization. The seven famous functions of PODSCORB, pillars of the closed system model, are duplications of or variations on the Fayol theme, and are variety-limiting techniques, each directed to a different population of variables. Again, the knowledge that certain selection procedures have been successful in the past is used to eliminate whole classes of competing alternatives.

In sum, under the lens of the Proactive System model, Fayol's management principles and processes can be seen as a set of devices whose essential and common purpose is the selective

reduction of variety within the organization.

F. W. Taylor and Scientific Management

Taylor (1911) believed that management should precisely define the job and the exact methodology of the work. Taylor aimed to have the workman function as much as possible like a machine. As March and Simon note:

> ...the scientific management group was concerned with describing the characteristics of the human organism as one might describe a relatively simple machine for performing a comparatively simple task. The goal was to use the rather inefficient human organism in the productive process in the best way possible. This was to be accomplished by specifying a detailed program of behavior...that would transform a general-purpose mechanism, such as a person, into a more efficient special-purpose mechanism. (1958:13)

Any attempt by the worker to design his own job under this regimen would be anathema. In cybernetic terms, Taylor behaved as if he believed the workman was a source of entropy in the workplace. Given that Taylor's ideal was the machine, and that his desire was to make the worker as machine-like as possible, this premise is not illogical. Only the legendary John Henry could beat the machine at machine-like work, and he not for long.

Behavioral scientists and modern organization theorists have fought Taylor's mechanistic idea of man ever since they understood it. The cybernetic organization theorist says that a person is a complex system and the only source of negative entropy (information) in the organization. This paper supports that position. Yet Taylor was spectacularly successful. How can these positions be reconciled?

Taylor took advantage of the first major manifestation of Ashby's Law to appear in the world of work: the concept of "specialization" or "division of labor." Division of labor is the archetypical variety-limiting device, still viable and used today where the work is mechanistic. Scientific Management is one man's best effort to turn the worker into efficient deterministic machinery.

Where does the Taylor approach succeed? It succeeds where work can be simplified to rote; where work is best performed by machines, and where economic motivation dominates. It succeeds where man works alone, or performs repetitive tasks with simple machinery. It succeeds, in short, in non-complex systems, where

people do work of low variety. The essence of scientific management is the design of low-variety jobs that anybody can do. Even today, the highly profitable United Parcel Service uses an intense and rigorous variety-reduction program to manage an effective modern Taylor system (Machalaba, 1986).

A Cybernetic Summary of Classical Organization Theory

F. W. Taylor simplified and depersonalized work in order to standardize jobs. He minimized the variety of the work in order to suppress entropy. This technique of variety reduction worked phenomenally well for him, and has continued to work well where the type of work is appropriate. Fayol and his followers distilled personal experience into maxims to guide the general manager. Those principles can now be seen as generic procedures for reducing situational variety in the organization.

In the light of the behavioral rebellion against classical theory, some modern organization theorists suggest that the prescriptions of classical organization theory were merely guiding principles, never intended to be taken as law. But like most theories, classical organization theory had its dogma and its dogmatists. Consider this advice from Lyndall Urwick:

> It may be objected that...the organiser...can't sit down in a cold-blooded, detached spirit and draw an ideal structure, an optimum distribution of duties and responsibilities and relationships, and then expect the infinite variety of human nature to fit into it....
>
> To which the reply is that he can and he should. (1947:36)

The Human Behavior Movement

Classical organization theory, particularly Taylor's ideas, provoked instant and intense criticism from many sources, including the U.S. Congress. But as Dale noted:

> ...the most insistent criticism leveled against classical theory comes from exponents of the behavioral sciences, the sciences that deal with human behavior....Writers identified with these fields claim that classical theory is too mechanistic and so ignores major facets of human nature. Some even say that the theory is incompatible with human nature. (1973:175)

The definitive behavioral rebuttal to classical organization theory was made in 1957 by Chris Argyris, who gathered together

"as much of the existing empirical research...on human behavior in organizations... as possible" (1957:ix). His analysis of the work of scores of behavioral scientists led him to conclude that "classical" organizations, those derived from Fayolian principles as well as the Taylor model, were not congruent with the needs of healthy people. The rigidities of the formal organization made the employee feel dependent, submissive, and passive. He was able to use only a few of his less important abilities. Because of the constraining effects of the formal organization, the worker was unable to release enough of his psychic energy to achieve self-actualization. In Argyris' words:

> A number of difficulties arise with [the classical] assumptions when properties of human personality are recalled. First, the human personality we have seen is always attempting to actualize its unique organization of parts resulting from a continuous, emotionally laden ego-involving process of growth. It is difficult, if not impossible, to assume that this process can be choked off... (1957:59)

A cybernetic restatement of Argyris' argument is that a person is a complex system, an inherently high variety entity who cannot function in good health under the low variety controls of classical theory.

Argyris (1957:233) concluded that classical formal organization structure frequently injured both the worker and the organization. But, most significantly, he also found that:

> Some human relations researchers have unfortunately given the impression that formal structures are "bad" and that the needs of the individual should be paramount in creating and administering an organization. (1957:58)

In the years since Argyris wrote those words, a salient of behavioral scientists has continued to advance this position. The reaction of managers and owners has been predictably volcanic. Some practicing managers dismiss everything behavioralistic. Most managers rate the idea that the organization (and its goals) should be subsidiary to the individual (and his goals) as (at worst) a pernicious heresy, and (at best) an irrelevant excursion. According to Peters and Waterman (1982:95), this excursion was the reason that "...the human relations school of management has fallen into disrepute over the last decade...a failure ordained by its own...silly excesses."

And so was joined the "principal quarrel" of organization theory. The excursive behaviorists, who wrote a prescription pathogenic to managers, nevertheless validly saw the conventional

organization as a source of entropy in the worker. But they also insisted that the organization and the worker were inevitable antagonists. They converted the worker from a potentially contributing member to an individual within but apart from any organization, and endowed with inalienable rights, but no discernible duties. This position, which provoked the "silly excesses" seen by Peters and Waterman, is decisively rejected by management.

A Cybernetic Exploration of the "Principal Quarrel"

In the language of the Proactive System model, Taylor saw the worker as a source of entropy in the organization, while the behaviorists saw the rigidity of classical control methods as a source of entropy in the worker. The cybernetician, understanding both positions, accepts the concept of variety limitation, which leads to the need for strict controls over rote work, but also subscribes to the behaviorist complaint that people are not well served by low variety controls, and to the need for high variety controls in social systems. The interesting, and unanswered, question raised by the behaviorists is whether it is necessary for any work to be rote.

Erosion in the efficacy of low-variety control methods began when work became complex enough to require groups. Work now needed man's negentropic faculty. The concept of man as the source of negentropy provides a legitimate theoretical basis for an attack on mechanistic classical organization theory. But the cybernetic premise that organizations exist to make specific contributions to society also legitimizes the primacy of organizational goals. The organization exists for a societal purpose; it must serve that purpose, even if the required work is behaviorally suboptimum. The needs of society take precedence over the needs of the individual worker.

Scientific management was right for the work it oversaw. But modern technology has made the Taylor model obsolete for most occupations. The Proactive System model also suggests that Beer erroneously limits the management function to situational variety reduction. Complex organizations need the information (control variety amplification) that the individual worker can supply--if he will.

Consider the effects of deliberate withholding of the negentropic function during "by the book" labor actions of [illegible] air traffic controllers. It is clear that the [illegible] low variety "book" procedures, although [illegible] as "controls," are impotent (or worse) until [illegible] with requisite variety by the worker. Chester Barnard [illegible] captured this phenomenon in his "acceptance theory" of

authority. Acceptance of authority means, among other things, willingness of the worker to supply the variety (beyond that specified or even understood by "authority") that permits the system to function.

The cybernetic model formally reconciles self-actualizing behavior with organizational productivity. The self-actualizing worker improves personal and organizational productivity, and amplifies managerial control variety, if he has made the company goals (the common value structure introduced above) his own, and if he generates negentropy to help the organization move, even a small distance, toward those goals.

The combatant positions in the principal quarrel, when viewed cybernetically, are not conflicting but sequential. The classic view, expressed above by Urwick, derives squarely and logically from the assumption that organizations require, and are agents for, suppression of the entropy that man--poor machine that he is--inevitably introduces into the workplace. Classic low-variety Fayolian controls are appropriate in low variety work situations even though, as Argyris confirmed, people are not happy in variety-suppressed jobs.

But when jobs grew more complex and less mechanistic, classic variety-suppressing controls failed, and control variety amplification measures were needed. Adjustment was slow (and is still incomplete) in the workplace, and even slower in academia. It was at the beginning of this transition, when classical theory was still the conventional wisdom, but negentropic behavior was forcing its way (perhaps unseen but not unfelt) into the workplace, that Dale's "principal quarrel" took place in the literature.

Ironically, some writers not primarily associated with the behaviorist movement did anticipate the cybernetic interpretation of behavioralism. Here, once again, is Drucker:

> ...we will have to learn to look on people as resource and opportunity rather than as problem, cost, and threat.... Business enterprise (or any other institution) has only one true resource: man. It performs by making human resources productive. (1974:30, 41)

So, in sum, I see the Proactive System model illuminating the original goal of behavioral research (which was to ameliorate the classical regimen), explaining the anti-organization excursion, and pointing a way toward a reconciliation of the two positions. The model again shows a modicum of power.

SUMMARY OF THE PAPER: A THEORY ADUMBRANT

This paper described four ideas present (to varying degrees) in management thinking, and suggested they fit together into a viable management theory. Later it was argued that they fit because all four ideas are products of the same cybernetic model.

The first idea was proactivity, a concept I believe (with Drucker) to be fundamental to organizational success, to be intuitively evident to theorists and practitioners, but not present in any current organizational model. The second idea was that there have been two true management theories (not a jungle), neither of which maps the principle of proactivity. The third idea was the Ashby-Beer model, which, when extended to form the Proactive System model, does allow for the concept of proactivity, and also forms a theoretical basis for understanding other management concepts; considered here were "satisficing" behavior and the acceptance theory of authority. The last part of the paper sought perspective on the fourth idea, Beer's assertion of the ubiquity of Ashby's law.

The cybernetic approach, as sketched here, does not represent a complete theory of management--though I think it foreshadows one. Much additional work is needed to articulate such a theory. I believe, however, that a cybernetic theory of management would include, as a minimum, the concepts listed below.

Elements of a Cybernetic Theory of Management

The first and most important concept is that the laws of nature are consistent and invariant throughout the universe, and throughout the discipline of management; in Lederman's felicitous phrase, "A single and economical law of nature, valid throughout the universe for all time."

The second principle is Drucker's thesis: The purpose of every organization lies outside itself--in society. An organization exists solely for the purpose of causing useful change in society.

The third concept is the complex purposive system. It was shown that this system is different from the simple system in kind as well as degree. Laws that apply to simple systems break down in extension to complex purposive systems. In particular, methods attempting to control a complex system by dealing with every possible state of the system cannot succeed. In contemplating complex systems we have tended either to treat them as simple systems or to assume they are not amenable to control. But we see that all of society is composed of interacting complex purposive systems. We see that some form of volitional control does exist

in complex social systems, and that this control is not the type seen in simple systems. We conclude that laws of control for complex systems do exist.

The fourth point is that cybernetics, the science of control, has discovered some of the laws of control in complex systems. Chief among them is Ashby's law, which ultimates itself in the Proactive Managerial system. It appears that control in all complex systems can be modeled and explained to some degree by the PMS. There are a number of managerial implications in the type of control demonstrated by the PMS:

--The complex system is controlled by coupling it to a second complex system, and allowing the two to control each other. Both subsystems attempt to establish control proactively; that is, by causing the other subsystem to adapt to it. But each subsystem also has the power to veto actions that are unacceptable to it. Cybernetic control is, therefore, mutually adaptive control; both subsystems must be in control for the system to be in control. If mutual control cannot be established the PMS dissolves.

--Control is established from within the PMS and is not imposed from without.

--Control behavior is generally non-maximizing.

--The process we call management is inextricably bound up in the problem of variety control. Ashby's law lies somewhere near the heart of management. Much of a manager's work revolves around techniques for accomplishing the twin tasks of amplifying personal or organizational control variety and mitigating variety in the markets.

--All control is achieved by information flows. Information causes the system to proceed, against the randomizing effects of entropy, toward humanly defined system goals. The fundamental and primary tool of management, therefore, is information, and the primary day-to-day tasks of management are generating information and suppressing entropy.

--The nature of the PMS suggests that the optimum place for management to operate is in the set of states that favor both systems; the "double preferred" set of states. Behaviorally, this translates to the so-called "win/win" strategy; a strategy that is cooperational, not confrontational. This prescription gives an interesting perspective to Adam Smith's venerable theory that the greatest good to society occurs if each person and organization maximizes personal utility, without regard for the effects of this behavior on others.

The fifth point is that management is the profession of

control in purposive social systems. Therefore, all that the science of cybernetics can discover about control in complex systems directly concerns management. The early fruits of the application of cybernetics to management are the cited works of Stafford Beer. His primary device, the Self-Vetoing Homeostat, was used here as the basis for the Proactive System model and the Proactive Managerial system. The PMS appears to cast a generally useful light on the nature of interactions in complex systems, and therefore on the the manager's job.

Finally, I must mention Beer's Viable System model, from which the SVH was extracted for use in this paper. This model, unfamiliar, I suspect, to many readers, is introduced here with no evidence of empirical or theoretical validity. Beer (1984), however, cites and reviews this evidence in detail. It is clear that whatever neglect the model has suffered at the hands of management and organizational scholars, it has survived frequent tests of operational validity, and further, finds rigorous formal expression in cybernetics, mathematics and formal logic. It is the visible power of the Viable System model that leads me to conclude that a coherent cybernetic theory of management is possible.

A Verdict on the Proactive System Model

Despite its towering prolixity, this paper has only sketched, in a descriptive and non-rigorous way, some potential uses of the Proactive System model in management and in organization theory. I have proposed the Proactive System model as a third model (preceded by the Closed and Open system models) in what will, of course, be a continuous series of improving models of the organization.

The Verdict? It can only be "Not Proven." But I believe it has been shown that the Proactive System model has promise as a foundation for the understanding of historical management thinking, and for the extension of management theory; an extension that may, perhaps, provide a return to the concept of the universality of law.

There may be, after all, an oasis in the management theory desert.

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