THE MYTH OF ORGANISM AND MECHANISM: SOME THOUGHTS ON ORGANIZATIONAL STRUCTURE

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Abstract

Historically there have been several models attempting to describe organizations. One is the mechanistic view, where organizations are understood as machines. The other is the biological view where organizations are perceived as organisms. There is also a third view where organizations are considered cybernetic units where feedback takes place among all the systems and subsystems of the organizations.

In this paper a conceptual model is presented where a mechano-biological view of the organization is proposed. This view of the organization perceives the relationships existing between organisms and mechanisms within an organization as a symbiosis.

Introduction

Organizations have been conceptualized in a myriad of different ways. Most commonly, three mental models have been presented. Those being the organization as a mechanism (machine), the organization as a living system (organism), and the organization as a cybernetic unit. The organization as a machine metaphor was vividly portrayed in the 1936 Charlie Chaplin film titled "Modern Times" were the lovable little tramp (factory worker) gets lost within the gears of industry. Which conceptualization (mental model) is best for engineering managers (practitioners and researchers)? Does one of these conceptualizations accurately reflect organizations of today? This paper explores these questions in an attempt to better envision organizational structure and theory. To do this, several properties and characteristic of organizations (such as the issues of growth) need first be explored.

There exist systems that due to their nature and properties exhibit a natural tendency to grow. These systems are also referred to as growing systems. However, these systems not always increase; sometimes decrements are present in their development over time, then we talk about decays.

Since growth is not an object but a process it should be conceptually defined (Mesarovic and Pestel, 1974). One of the best descriptions of the process of growth is the one given by Boulding (1979). He states "if there is a defined set or a system with well-defined boundaries, additions to it increase its size and subtractions from it diminish its size" (p. 9). He calls this the "bathtub theorem". If water comes in the tub faster than it comes out then the water level increases. If it comes out faster than it comes in, then the water level decreases. If the water comes in and comes out at the same speed then the water lever remains constant.

When increases or decreases (growth or decline) are given by adding a constant quantity in certainty period of time we speak of "arithmetical growth". If increases or decreases happen at a certain rate then it is known as exponential or geometrical growth. These laws of growth are valid in several systems. In mathematics the "exponential law" is know as the "law of natural growth" and is valid for the growth of capital by compound interest. In biological (organic) systems it is valid for the growth of certain bacteria, where each bacterium divides into two and these into four, and so on. In social systems it is also valid for the unrestricted growth of population, where the rate of birth is greater than the rate of death (Bertalanffy, 1969). Exponential growth is a dynamic phenomenon where elements are changing over time. It is usually referred to in terms of doubling time (Meadows, Meadows, Randers and Beherens, 1974).

Many of the problems that the complex world we live in is facing now are attributed to this continuous, rapid and unbalanced growth over time. (See Mesarovic and Pestel, 1974; Meadows et. al., 1974, etc.). This is also valid in today's organizations. Growth gets complicated when several components of the organization increase at the same time, and when all of these components are interrelated and get feedback from each other in a complex way. Then the analysis of causes of growth and future behavior of these complex systems becomes problematical. In any given organism or system a main principle that applies to growth is that of equilibrium which can be described as the state where the rate of growth is zero and additions are equal to subtractions (See Bertalanffy, 1969; Boulding, 1979). Then we can speak of equilibrium population or equilibrium size. The former occurs when a population has reached a level where further increments of the population diminish the rate of growth. The same is valid for the concept of equilibrium size or optimum size, where an organism grows until it reaches its optimum size and then the rate of growth reduces until it gets to zero. In both cases, the equilibrium state depends on the environment of the system.

Thus far we have described must of the general characteristics of growth as a process. However there are still some questions that remain: Do all things and systems grow? Do all of them follow the same laws of growth?

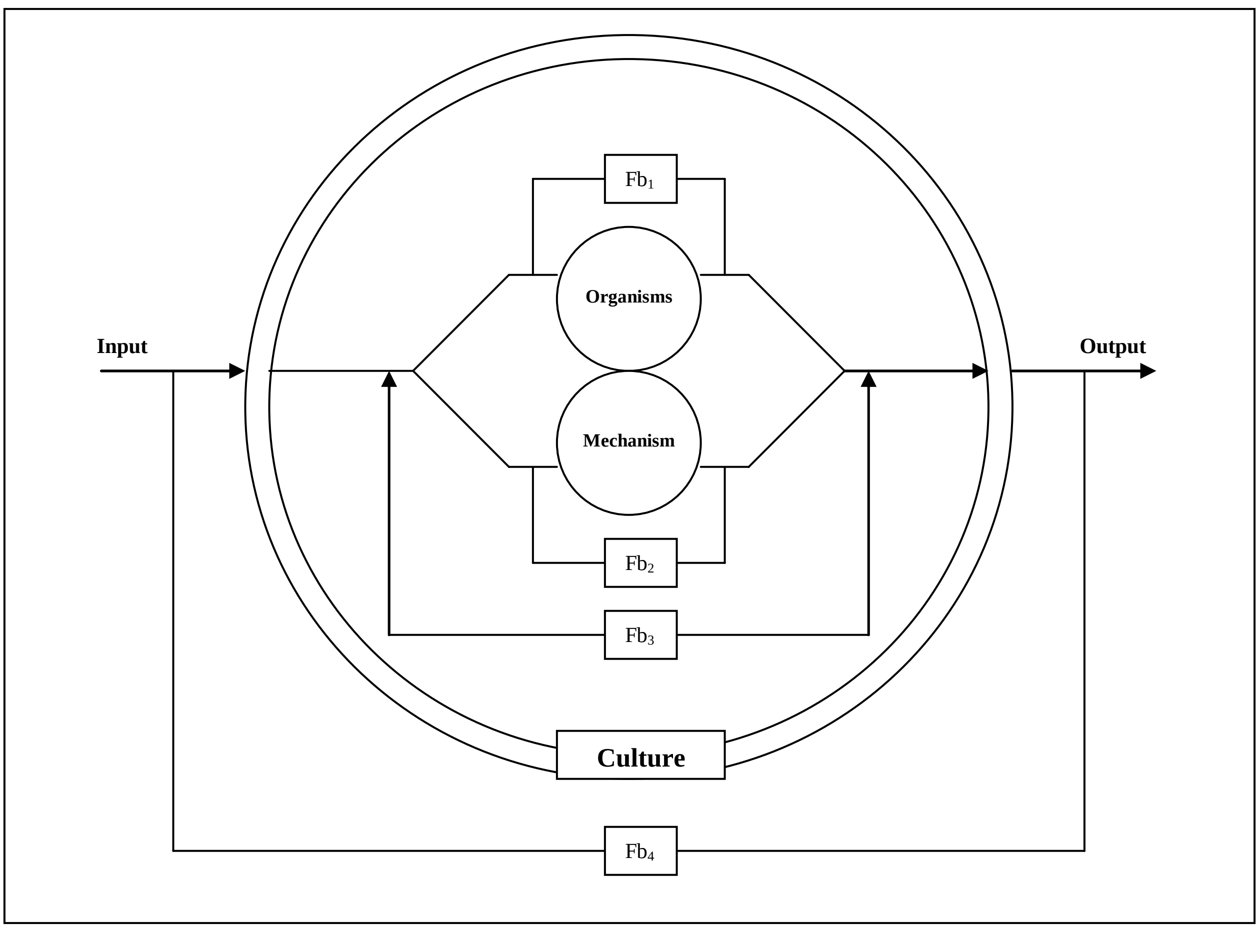
Growth Systems

Before we are able to answer these questions it is important to have a definition for systems. Generally a system is defined as a group of interdependent and interrelated components that together form a complex and integrated whole (Anderson and Johnson, 1997). Systems can be classified as closed or open systems. Open systems are systems in which a transmission of matter and energy exist. Closed systems are systems with impermeable boundaries through which no matter, energy or information can be transmitted (See Miller, 1965; Bertalanffy, 1969). For the purposes of this paper we will concentrate on open systems.

Open systems can be divided into living and nonliving systems. Nonliving systems are pure physical (mechanical) systems. Living systems can be divided into pure biological systems (one or a combination of two or more living systems), and a combination of living and nonliving systems. The difference lies only in the characteristics of the nature of the systems. Any system that includes one or more biological element has a predisposition to grow. These systems inherently have a non-zero slope development (Beruvides & Canto, 2004). Theses systems are characterized by their complexity and the diversity of their components' nature.

For a long time organizations were viewed as physical (mechanical) systems and their behavior was compared to that of machines. A prime example of this is what has been termed Taylorism, the seminal book on this being Frederick Taylor's The Principles of Scientific Management. It was believed that organizations and social systems followed the characteristics of growth of pure physical systems. In the 1950's with the emergence of General Systems

Exhibit 1: Relationships of a "living" organization



Theory the concept of the organization as a living system that interacted with other systems was introduced. Later on in the 70's the idea was extended and the Living Systems Theory was created.

There is no doubt that today's organizations are a conglomerate of living and non living sub-systems. Though this is sometimes viewed as a cybernetic entity it is in fact symbiotic. The interaction of the organization's component more closely resembles a symbiotic relationship, or what might be viewed as a mechano-biological or mechanorganic association. Exhibit 1 presents a diagram of the complex relationship existing between the components of a "living" organization.

The following sections describe in detail the main characteristics of growth of the components of an organization (living and non living) and how their symbiotic relationship works.

Pure physical (mechanical) systems

These systems do not grow by their own nature which makes them easy to describe in mathematical models. They have zero-slope growth. Thus, we never hear of a computer that has increased its size by itself, or that increment its number of components on its own. Neither have we seen a process that improved its output rate by itself. Growth is therefore not inherent to the nature of these systems.

They are usually activated or renovated by an external system that provides them with input energy and feedback. On constant or stable conditions their output can be predicted almost exactly. Some examples of these types of systems are mechanical processes, machines, tools, etc. Exhibit 2 presents a table with some of the most important characteristics of these types of systems.

Exhibit 2. Characteristic of Physical (Mechanical) Systems.

	Characteristics
1.	They do not grow by nature
2.	They present a zero-slope type of growth
3.	They are usually activated or renovated for an external system that provides them with input and feedback.
4.	On constant conditions their output can be predicted almost exactly.

Biological systems

When we speak of biological systems we are talking about all living organisms (animals, plants, and humans). The main characteristic that all living organisms share is that they have an intrinsic tendency to grow and develop. Bertalanffy (1969) explains this phenomenon when he states "Every living organism is essentially an open system. It maintains itself in a continuous inflow and outflow, a building up and breaking down of components, never being so long as it is alive, in a state of chemical and thermodynamic equilibrium but maintained in a so called steady state which is distinct from the latter" (p.39). Mesarovic and Takahara (1975) argue that in open systems under all conditions, the output of the system cannot be predicted exactly, which make it impossible to precisely represent it as a function.

Mesarovic and Pestel (1974) identify two types of growth among living organisms: undifferentiated and differentiated (or organic) growth. Undifferentiated growth occurs when all cells just replicate themselves. This type of growth is just an exponential increase in the number of cells. On the other hand, organic growth implicates a differentiation process, that is, the cells begin to differ in structure and function. Both types of processes follow the general characteristics of growth. However, organic growth systems present also some other particular characteristics. In the process of differentiation, the number of cells can still increase making the system grow also in size.

Growth in biological systems is not a uniform phenomenon. Different rates of growth of their components can be seen throughout the organism's life. This phenomenon is known as Allometric growth (Gilbert, 1991). Organic systems also reach an equilibrium state. But this equilibrium is dynamic. In every mature living organism the body renovates frequently. Organic growth is regulated by a "master plan" as Mesarovic and Pestel (1974) call it. They explain how this master plan is encoded in the genes and it evolves through generations. It determines the development and growth of the organism right from the beginning.

This "master plan" or "template program" as Miller (1978) refers to it, determines the ultimate amount of growth of the system. However this maximum amount of growth is sometimes inhibited by environmental factors as food supply, inadequate space, improper climate, diseases, etc.

We cannot talk about growth without talking about decay in biological systems. Decay occurs when the system is unable to maintain one or more of its critical variables in steady state, when it loses control because its feedback channels don't work properly, or when the system cannot keep its subsystems and components adjusted to one another and to its environment (Miller, 1978).

Living – Nonliving Systems

We defined living-nonliving systems as a combination of physical systems and biological systems where their interactions are structured. By definition all living organisms have a tendency to grow. When they interact with other biological systems or with physical systems a new system with specific characteristics is created. Characteristic of this new living system is its tendency to grow.

For many years social systems were not considered living systems with interactions and connection between its parts. They were studied and managed as if they were just individual entities, physical systems with no relation with other social systems. In the 1950's with the development of the General Systems Theory the concept of living systems was created. With this also emerged the idea that organizations are no more than open systems formed by living subsystems and that therefore they shared some biological characteristics.

This idea became more and more accepted and in 1978 James Miller published his book Living Systems which presents a detailed definition of living systems and includes organizations, and societies as part of these systems. From there on, the concept of organizations as living systems has been adopted by many managers and decision makers to explain organizational behavior.

All the characteristics of growth of biological systems are also valid for these types of systems. The main and most important difference between biological systems and social systems is that in the latter there is no master plan that determines the maximum growth of the system from the beginning. However, its level of growth is also regulated by factors in its environment and the way the system is structured, which influences the level of growth that the system is capable of reaching.

This paper attempts to describe the complex nature of the interaction existing between the living and non living components of an organization. Only when we have a true description of how organizations interact and grow will we be able to create models to measure and predict its behavior.

Organizations are complex systems formed by several open subsystems that are interconnected. Based on the behavior of the main components of the system we expect to be able to predict the general behavior and performance of the main system. An exact description of an organization is hard to obtain given that there is no theory that fully explains the complex nature of social systems.

To explain to some extend the complex nature of the socio-economic systems in an organization we have adopted the view of the living systems theory. That is, we believed that based on its composition and nature all organizations have an intrinsic tendency for growth (positive or negative) and zero slope status is in fact unusual, not inherent to any organization.

Discussion

Our view of an organization is a systemic view (See Exhibit 3 for the critical characteristics of systems, Bertalanffy, 1969). That is, an organization is seen as a complex living system, formed by several components that include living and non-living systems. As a living organism it exhibits all the characteristics of the living systems including the tendency to grow and develop. Growth in organizations follows the same principles of growth of biological systems, where the components feed each other through a symbiotic relationship.

Our research adopts the theory of living systems, where all social systems are living systems. However, we focus our classification of living systems on the nature and interaction existing among the subsystems of every system. Therefore, we have systems formed by an organism, system formed by two or more pure living systems (living-living systems); and systems formed by living systems and non-living systems. The relationship among the different subsystems of the system can be symbiotic or parasitotic. See Exhibit 4 for a presentation of the different types of symbiotic relationships. The definitions provided here, we believe could be representative of many business relationships. Symbiosis is a close, prolonged association between two or more different organism of different species that may but not necessarily, benefit each other (The American Heritage Dictionary, 2000). Miller (1978) argues that symbiosis exists if a living or nonliving system carries out a process for a system in exchange or economic trade off for some reward or service which constitute a cost for the first system. He also describes parasitosis as a relation that occurs when one system performs a process for another system in exchange of nothing or at its own expense. Thus, our research proposes to look at organizations as living mechanorganic systems with an intrinsic tendency to grow.

An exploration of these different views (mental models) may or may not have an impact on organizational theory and practice. Thus little if nothing can be put for at this time for practicing engineering managers. This initial study is theoretical in nature. But this does not preclude the value of

Exhibit 3. Concepts of General Systems Theory

CONCEPT	DEFINITION	AUTHOR PAGE
Organization	In biology, organisms are, by definition organized things. Characteristic of organization, whether of a living organism or a society, are notions like those of wholeness, growth, differentiation, hierarchical order, dominance, control, competition, etc. Such notions do not appear in conventional physics.	Bertalanffy (1969) p. 47
Isomorphism	The isomorphism found in different realms is based in the existence of general system principles, of a more or less well-developed "general system theory." There are three kinds or levels in the description of these phenomena. At first, there are *analogies*, superficial similarities of phenomena, which correspond neither in their causal factors nor in their relevant laws. A second level is *homologies*. Such are present when the efficient factors are different, but the respective laws are formally identical. The third level finally is *explanation.* These are the statement of specific conditions and laws that are valid for an individual object or for a class of objects.	Bertalanffy (1969) p. 84-85
State of Equilibrium	A closed system must, according to the second principle, eventually attain a time-independent state of equilibrium, defined by maximum entropy and minimum free energy, where the ratio between the phases remains constant. A closed system in equilibrium does not need energy for its preservation, nor can energy be obtained from it.	Bertalanffy (1969) p. 125
Steady State	Open systems may attain, under certain conditions, a time-independent state, which is called a steady state. In the steady state, the composition of the system remains constant in spite of continuous exchange of components. Steady states are equifinal; the same time-independent state may be reached from different initial conditions and in different ways.	Bertalanffy (1969) p. 159
Feedback	As is generally known the basic model is a circular process where part of the output is monitored back, as information on the preliminary outcome of the response, into the input thus making the system self-regulating; be it in the sense of maintenance of certain variables or of steering toward a desired goal. The following appear to be the essential criteria of feedback control systems: 1. Regulation is based upon pre-established arrangements ("structures" in a broad sense). 2. Casual trains within the feedback systems are linear and unidirectional. 3. Typical feedback or homeostatic phenomena are "open" with respect to a matter and energy.	Bertalanffy (1969) p. 161-163
Hierarchic order	Systems are frequently structured in a way so that their individual members again are systems of the next lower level. Such superposition of systems is called hierarchical order. For its individual levels, again the aspects of wholeness and summativity, progressive mechanization, centralization, finality, etc., apply. The principles of hierarchic order can be stated in verbal language; there are semi mathematical ideas connected with matrix theory, and formulations in terms of mathematical logic. In graph theory hierarchic order is expressed by the "tree" and relational aspects of hierarchies can be represented in this way.	Bertalanffy (1969) p. 74 p. 28
Self-regulation (Homeostasis)	"…. Maintenance of balance in the living organism, the prototype of which is thermoregulation in warm-blooded animals". Furthermore, feedback systems comparable to the servomechanism of technology exist in the animal and human body for the regulation of actions.	Bertalanffy (1969) p. 43

CONCEPT	DEFINITION	AUTHOR PAGE
Centralization	The principle of centralization is especially important in the biological realm. Progressive segregation is often connected with progressive centralization, the expression of which is the time dependent evolution of a leading part. At the same time, the principle of progressive centralization is that of a progressive individualization. An "individual" can be defined as a centralized system. Biological individuality does not exist, but only progressive individualization in evolution and development resulting from progressive centralization, certain parts gaining a dominant role and so determining behavior of the whole. Hence the principle of progressive centralization also constitutes progressive individualization.	Bertalanffy (1969) p. 71-73
Progressive differentiation	In progressive differentiation systems evolve from states of lower to states of higher complexity. This is of course the most obvious form of "self-organization" apparent in ontogenesis, probable in phylogenesis, and certainly also valid in many social organizations. Self-differentiating systems that evolve toward higher complexity (decreasing entropy) are, for thermodynamic reasons, possible only as open systems.	Bertalanffy (1969) p. 97
Dynamic Equilibrium		

Exhibit 4.

Concept	Definition
Symbiosis	A close, prolonged association between two or more different organisms of different species that may, but does not necessarily, benefit each member. A relationship of mutual benefit or dependence. The living together in more or less imitative association or even close union of two dissimilar organisms.
Antagonistic, or antipathetic, symbiosis	The association is disadvantageous or destructive to one of the organisms, but ordinarily it is used of cases where the association is advantageous, or often necessary, to one or both, and not harmful to either.
Conjunctive symbiosis	When there is bodily union (in extreme cases so close that the two form practically a single body, as in the union of alg[ae] and fungi to form lichens, and in the inclusion of alg[ae] in radiolarians).
Disjunctive symbiosis.	There is no actual union of the organisms (as in the association of ants with myrmecophytes),

exploring these issues, which fall in the realm of engineering management theory.

Further Studies

Thus, organizations have a mechanorganic relationship (biological-mechanical symbiosis). This symbiosis follows similar relationship patterns as found in biological symbiosis but with some critical differences. Unlike the biological-to-biological symbiosis, the mechanorganic symbiosis can actively evolve to well beyond its current state. This augmentation is seemingly unlimited. The potential for increase in growth, speed, facility to communicate, etc. are not infinite but the limits are hard to envision. And multiple evolutionary leaps are possible within an organism's lifetime. We thus venture, that our current mental models for organizations (simply organic or cybernetic), are incorrect. Organizations (especially business organizations) are mechanorganic. Please refer to Exhibit 5. This relationship needs to be further explored if we wish to better model organizations in the future.

Exhibit 5. Assumptions of the theories

	Mechanical	**Living Systems**	**Non-zero slope living systems**
Main assumptions	1. Organizations work as machines and their components can be evaluated individually. 2. Growth in organizations is not inherent to the system.	1. Organizations are living systems 2. They share the characteristics and properties of living systems. 3. Living systems are classified based on their complexity and hierarchies.	1. Organizations are living systems. 2. Organizations have an intrinsic tendency to grow. 3. Classification of living systems is made based on the nature of the subsystems and their relationship among them.
Main flaws	1. It failed to recognize the biological and systemic nature of organizations.	1. It does not recognize the tendency of biological systems to grow. 2. Due to its classification of living systems it is hard to describe other systems with characteristics different to those of the given seven categories.	It has not been validated.
Similarities with other theories		1. This theory developed from the General Systems Theory approach. It therefore supports its systemic view.	It follows all the views of the living system theory.

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