Manthan, *International e-Journal, Vol. 11, June, 2010, ISSN No. 0974-6331*

Contribution of Cybernetics to Management Science

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Cybernetics is a mathematical modelling approach for an understanding of regulation and control in any system. Stafford Beer is acknowledged as the first to explicitly apply the principles of cybernetics to management and claim its relevance to Operations Research and Management Science. This paper gives a brief outline of the main manifestation of Beer's work and reflections on management cybernetics-The Viable Systems Model (VSM). Out of the various themes of Beer's work on management cybernetics, only three have been highlighted here. These are communication, variety and participative management. Other developments in management cybernetics have also been discussed in this paper. Cybernetics is applicable to almost any problem area because of its generality, and so the main domains of applications have also been presented here.

Keywords: Cybernetics, Management, Control

1. Introduction

The term "cybernetics" was first used in 1834 by the French physicist Andre-Marie Ampere (1875-1836) to describe "the science of managing processes". Elsewhere, he refers to it as "the science of government".

However, the origins of modern cybernetics as a recognized science are to be found around one hundred years later. The pioneering principles of the new scientific field of regulation, control and communications in systems were developed primarily by Norbert Wiener, Warren McCulloch, William Ross Ashby, Warren Weaver, Claude Shannon, Gregory Bateson, Heinz von Foerster, John von Neumann and Walter Pitts. These pioneers were supported by the Josiah Macy Foundation. The new scientific field of cybernetics emerged from the interdisciplinary and now legendary Macy conferences. In 1948, Norbert Wiener published his book "Cybernetics". He defined cybernetics as "the science of control and communication in the animal and the machine"- in a word, as the art of steersmanship. This original definition points to the relationship between control and communication, and to the existence of general laws affecting equally animate and inanimate systems. The first principle of such general importance to be recognized was the significance of feedback in all systems, whatever the fabrics of their components.[1]

In the words of William Ross Ashby, one of the founding fathers of cybernetics and systems theory, ''Cybernetics studies the flow of information through a system and the way in which that information is used by the system as a mean of controlling itself."[2]

Although the word "cybernetics" comes from the Greek word "kybernetes" meaning steersman, today it is considered more likely to be associated with cyberspace than the Greek kybernetes meaning steersman. Funk and Wagnall (1984) define cybernetics as "the science that treats of the principles of control and communication as they apply both to the operation of complex machines and the functions of organisms".[3]

2. Management Cybernetics

According to Jackson (2000), "Beer was the first to apply cybernetics to management, defining cybernetics as the science of effective organization". Late 1950s , he published his first book about cybernetics and management, building on the ideas of Norbert Wiener, Warren McCulloch and especially William Ross Ashby for a systems approach to the management of organizations. In the 1960s and early 1970s "Beer was a prolific writer and an influential practitioner" in management cybernetics. It was during that period that he developed the viable system model to diagnose the faults in any existing organizational system. In that time Forrester invented systems dynamics, which "held out the promise that the behavior of whole systems could be represented and understood through modeling the dynamical feedback process going on within them".[4]

Management cybernetics is the application of cybernetic laws to all types of organizations and institutions created by human beings, and to the interactions within them and between them. It is a theory based on natural laws. It addresses the issues that every individual who wants to influence an organization in any way must learn to resolve. This theory is not restricted to the actions of top managers. Every member of an organization and every person

who to a greater or lesser extent communicates or interacts with it is involved in the considerations.

3. Principles of Cybernetics

Beer's work provides the basis for the development of a model for proper functioning of an organization. Beer postulates that the primary long-term objective of Management is the survival of the enterprise which it conducts. His purpose to write the book "Cybernetics and Management" was to convince scientifically trained and imaginative managers that a machine, using the term in its widest sense, could be constructed continuously to adjust the activities of a firm to its environment in such a manner as to attain this objective in an optimum manner. Defining his project as the "science of effective organization", he argued that the cybernetic principles can be applied to all types of organizations and institutions, and to the interactions within them and between them, with the objective of making these systems more efficient and effective. He also claimed that cybernetics is the basis of control in any system and thus provides the foundation for defining organizational control.[5]

There are many themes in Beer's work on management cybernetics, out of which the following three are noteworthy: communication, variety and participative management.

The first of these themes, i.e., communication is drawn from the work and insights of Bavelas who, in terms of the relational structures, described an understanding of how an organization can communicate with itself. One of Bavelas's main insights is the paradox of peripherality (autonomy) versus centrality (control) of actors in an organization.[6] This insight led Beer to claim that centralised systems often do not work and was further developed in "The Heart of Enterprise"[7] and later refined in "Beyond Dispute"[8]. This issue has been a common theme for cybernetic research of social systems, particularly in the area of governance.[9]

The second theme-variety is defined by Beer as "the total number of possible states of a system, or of an element of a system". This number grows daily for every organization because of an ever- increasing range of possibilities afforded by education, by technology, by community, by prosperity, and by the way these possibilities interact to generate yet new variety. These produce complexity in organizations and create the possibility of great uncertainty. In order to regulate a system, we have to absorb its variety. If we fail in this, the system becomes unstable. Ashby's Law of Requisite Variety (LRV) stated as '' Only variety can absorb variety" led Beer to suggest that the activities and management of an organization should be such that identifies the minimum number of choices needed to resolve uncertainty. Beer claimed that LRV is fundamental to matching resources to requirements in organizations and to measurement of performance. He also claimed that it can be used allocate the management resources necessary to maintain process viability or survival. There are many examples of the use of LRV in the management science literature covering a range of topics such as a strategic planning, production and control, and the environment.[10]

The third theme is participative management. Beer was concerned to insure that every member of an organization and every person who to a greater or a lesser extent communicates or interacts with it is involved in the organization's matters. Participative management builds on the two themes described above and is concerned with seeking more effective ways to manage the complexity that would arise with an increase in communication. This would require people within the organization setting to have adequate autonomy in order to prevent the hazardous inadequacy of richly connected system. Beer consistently argued for decentralisation and devolved decision-making and he suggested that as much autonomy as possible must be provided to the lower levels of the organization which would deploy requisite variety effectively.[11]

As cybernetics is the scientific study of nature of control, a proper interpretation of the fundamental nature of control is essential for the modern understanding of cybernetic theory. Beer explains the meaning of control as self-regulation or self-emergence surfacing from a system. It means that managers use the word ''control'' in an abstract sense if they equate ''what happens intrinsically'' to ''what evolves when they (as parts of those systems) decide, react and adapt to the situations they normally encounter on a daily basis''. Cybernetics needs to be clearly interpreted by managers from this perspective of self-regulation existing within. It must be seen as surfacing from whole organizational systems. To interpret it in the narrow sense of the giving of orders and directions to various parts of the organization is to lose this important sense. From the readings of Beer's initial text ''Cybernetics and Management'', we can conclude that the four elements of a systems approach, interactivity, interconnectivity recursive layers (viewing processes as circular) and self-regulation play an important role in organizational control for today's managers.

Beer classified systems into three categories- Simple, Complex and Exceedingly Complex, each being either probabilistic or deterministic. Under this categorization, control referred to the management of modern companies viewed as exceedingly complex, probabilistic systems. Control is manifested in its emergent organizational sense when a desired output is achieved by self-regulation, i.e., both output and input calm down and stabilize so that the operation exists in a steady equilibrium state.

Beer's aim was to strive for the ''ideal company control system". For Beer, this search naturally involved the interdisciplinary nature of cybernetics. He pondered over naturally occurring and seemingly intrinsic control mechanisms, specifically from a biological sense. He summarized these control mechanisms as homeostats (control devices for maintaining variables between preferred limits) and thus described the ideal control company system as "a homeostatic machine for regulating itself". Today, this "homeostatic machine" description generates a crucial point to an appropriate interpretation of cybernetic theory. The portrayal of the company as a homeostatic machine needs to be considered according to the original Beer appraisal-a machine as a purposive system, albeit exceedingly complex and probabilistic. Any search for "a homeostatic machine for regulating itself" must recognize that such a control system encompasses a cohesive collection of items, people and information forming some purposive system.

Viable companies act as homeostatic machines. They exhibit exceedingly complex, probabilistic character. They continuously deal with and adapt to events both expected and unexpected. Overtime, adaptation to such events enables managers to recognize some consistent patterns. Beer referred to these types of patterns as stochastic. Today the word stochastic is more appropriate than probabilistic in describing company behaviour..

Beer suggested that some sort of machine must have been producing this continuity and pattern. Beer termed this machine "the secondary machine- the machine that lives inside the first like a parasite''. He proposed that if managers apply primary cybernetic thinking, they may be able to investigate the secondary machine/parasite components that produce the stochastic, homeostatic behaviour evident in viable companies.

Seeking congruence with this secondary machine/parasite, Beer introduced the concept of isomorphic (having a similar form) mapping. He suggested that managers should map the information flows emanating from any level of the company operation.

For Beer, the isomorphic mapping of information flows revealed insight into the parasite components of the stochastic, purposive machine. We agree that the mapping of information flows is essential for managers searching for a better understanding of their company-produced behaviours.[12]

4. An Overview of Cybernetic Models

Beer's most influential model for organization modeling is the Viable System Model (VSM). Other major developments in Beer's work are Syntegrity and POSIWID. The term "Syntegrity" is a portmanteau of "synergistic tensegrity" and "POSIWID" stands for "The purpose of a system is what it does".

Viable System Model

The Viable System Model (1975) is a model of the organizational structure of any viable or autonomous system. A viable system is any system organized in such a way as to meet the demands of surviving in the changing environment. One of the prime features of systems that survive is that they are adaptable or capable of learning. The VSM expresses a model for a viable system, which is an abstracted cybernetic description that is applicable to any organization that is a viable system and capable of autonomy. The model aims to specify the minimum functional criteria through which an organization can be said to be capable of independent existence or to maintain its identity in a changing environment. It was developed to diagnose the deficiencies in an existing organizational system.[13]

Syntegrity

Syntegrity is a formal model presented by Beer in the 1990s and now is a registered trademark. It is a form of non-hierarchical problem solving that can be used in a small team of 10 to 40 people. It is a business consultation product that is licensed out to consulting firms as a model for solving problems in a team environment.

" Syntegrity", "Syntegration", "Team Syntegrity" and "Team Syntegration" are all registered trademarks.[14]

POSIWID

Beer coined and frequently used the term POSIWID to refer to the commonly observed phenomenon that the de facto purpose of a system is often at odds with its official purpose. Beer coined the term POSIWID and used it many times in public addresses. Perhaps most forcefully in his address to the University of Valladolid, Spain in October 2001, he said "According to the cybernetician, the purpose of a system is what it does. This is a basic dictum. It stands for bald fact, which makes a better starting point in seeking understanding than the familiar attributions of

good intention, prejudices about expectations, moral judgment or sheer ignorance of circumstances."[15]

5. Applications of Cybernetics

The science of cybernetics has produced much has had an impact on modern life. These include a wide range of mechanical and electronic automata and mechanisms of different types serving a variety of purposes, the invention of the computer, current information theory and the most effective forms of psychotherapy. In addition, many other current methods of problem solving in a wide range of different scientific disciplines are best on discoveries within cybernetics. These include educational science, sociology, communications, mechanical engineering, environmental sciences. Stafford Beer himself in his management theories combines cybernetics with his practical experience and knowledge of neuropsychology, neurophysiology, computer science, communications, operations research, mathematics, formal logic and philosophy. The other areas of applications of cybernetics include control theory, artificial intelligence and artificial neural networks, robotics, adaptive systems, large- scale socio-economic systems and systems science.

6. Conclusion

The techniques of cybernetics guide managers to discover the ability of a system to teach itself optimum behaviour. Beer's ideas about decentralization, devolved decision-making and human relations may be viewed as an antidote to conceptions of scientific management. Beer's models provide managers with interesting insights into the ways in which they can tackle complexity. As a result, their organizations may become more able to react effectively and appropriately when faced with complexity. This, in turn, make for a more stable, sustainable and flexible business.

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