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Lessons to Management from the Control Loop Phenomenon

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***Abstract*—**In a none-super-competitive environment the concepts of closed system, management control remains to be the dominant guiding concept to management. The merits of closed loop have been the sources of most of the management literature and culture for many decades. It is a useful exercise to investigate and poke into the dynamics of the control loop phenomenon and draws some lessons to use for refining the practice of management. This paper examines the multitude of lessons abstracted from the behavior of the Input /output /feedback control loop model, which is the core of control theory. There are numerous lessons that can be learned from the insights this model would provide and how it parallels the management dynamics of the organization. It is assumed that an organization is basically a living system that interacts with the internal and external variables. A viable control loop is the one that reacts to the variation in the environment and provide or exert a corrective action. In managing organizations this is reflected in organizational structure and management control practices. This paper will report findings that were a result of examining several abstract scenarios that are exhibited in the design, operation, and dynamics of the control loop and how they are projected on the functioning of the organization. Valuable lessons are drawn in trying to find parallels and new paradigms, and how the control theory science is reflected in the design of the organizational structure and management practices. The paper is structured in a logical and perceptive format. Further research is needed to extend these findings.

***Keywords*—**Management theory, control theory, feed back, input/output, strategy, change, information technology, information systems, IS, organizational environment, organizations, open systems, closed systems.

I. Introduction

THE science of management has evolved during the past century as the need to organize larger and more complex enterprises. The fundamental assumption of the business enterprise is a coordinated set of activities that produce desired results (products or services) Samuel (2002). To do that concerted activities by management is required to plan, coordinate, execute, and control the use of resources to attain the desired results. Numerous approaches as to the organizational structures and practices have evolved based on the progress in the understanding of the nature of resources, and more specifically the human, the science of processing, and the mechanisms of control. All this comes under the category of management science. The increasing global interdependencies, especially with the advent of WTO global dominance, and the accelerating pace of change demand more flexible and adaptive organizations [9], [10]. Malone and Smith [10] have defined organizational flexibility in terms of "vulnerability" and "adaptability".

To achieve this flexibility it is necessary to study the dynamics of the organization, as the understanding of any system cannot be achieved without a constant study of the forces that influence it [6]. In addition, Baker [2] notes that organizations are changed in the course of interacting with and adjusting to their environment and also affects that environment. This means that sensing mechanisms to pick up signals from the environment, and to enable the organization to digest these changes, foment a corrective action to adjust, and even change course must populate the organization. When the environmental dependency inhibits the organization's ability to function autonomously, it must manage such dependency to survive as an independent self-sufficient entity [7].

Huber [5] uses organization theory to formulate hypotheses for empirical testing which reflect the impacts of IT on the decision behavior and design of organizations. In addition, [15] commented that the open systems approach has potential and usefulness in "synthesizing and analyzing complexity" in "live" organizations. Leavitt, Pinfield and Webb [8] also recommended open- systems transparent approach for studying contemporary organizations, which now exist in a fast-changing and turbulent environment, and an out growth of this approach is what is known now as "open-book" management approach. Sharlett et al. [14] recommended all forms of communication channels, including verbal to enhance the visibility across the organization as a guarantor to better management of projects.

Ramstrom [12] suggests increased emphasis on systems thinking to comprehend the increased interdependencies between the system and its environment, and between the various parts of the system.

The open systems approach to complex organizations emphasizes that consideration be given to the relationship between a system and its environment as well as what goes on within the system [4]. One of these considerations Is the

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dynamics of the Feed Back (FB) loop and the ramifications it may have on the workings of the control cycle of the management process.

The significant new paradigm that is evolving now is the fact that the old management school where organizations are frozen, or framed in some dogma, that assumes that from now to future, things will stay as we want them to be, is no longer adequate, not because future started to move, as future will always be moving, but it is moving faster now. In addition, companies started to use the fast paced straddling of the marketplace to gain competitive advantage. Terreberry [16] described turbulent situation as one in which the accelerating rate and complexity of interactive factors exceeds the capacities of prediction of the organizational systems, which makes up the environment, and hence these systems tend to lose control of the compounding consequences of their actions. This turbulence magnifies the need for a feedback, thus the corrective action. Law of requisite variety [1] implies that the rate of change of organizational systems must correspond to the rate of change of environmental systems, i.e., organizations with complex environmental interactions would develop complex structures Bennis [3] like adhocracies or networks. Adhocracy is suitable for a dynamic and complex environment, when the firm has sophisticated technical systems and the focus is upon consistently offering differentiated products [11] for retaining the customers.

This paper will examine the environment of the organization within the context of control and adaptation strategies. This is important in light of the ever-increasing pace of information flow between organizations and markets. The control theory of the electro-magnetic control loop will be investigated and analyzed to extract lessons that can be mirrored upon the control issues in managing the organization. Several conclusions are drawn to highlight the implications of different scenarios of control loop functioning and how they are mimicked in the organization.

II. Types of Management Controls Schemes

Many attributes of management systems were researched and discussed in the annals of management literature Samuel [13]. Many cases investigated the elements of good management, and robust management styles. The jury is still out as to what would be the essence of good management. In this paper, an attempt to distill these attributes from the knowledge gained from examining the characteristics of the electro-magnetic control loops. One distinct variable stands out, namely the stability of the organization as a reflection of the ability of management to create conditions of sustainability, controllability, and most of all predictability. The last is the core of the aim of control theory, and that is to be able to control and gain predictable behavior and results.

In addition, the stability is selected as it includes a time dimension, and this is an important variable in the life of any organization. This characteristic is examined from the control theory perspective and how it is translated into management concepts.

A. Stability aspects in Control Theory

A stable organization is characterized, as a second order system with roots located at the left hand side of the complex domain. (Obviously higher order representation is possible, but with similar conclusions).

III. Management Models

The essence of management in the running of the organization is to pro- or re-acts in the face of uncertainty. This will have to be rationalized to the ultimate benefit of the organization's struggle with adversity or changes in the environmental variables. This will determine the position of the organization (competitive or otherwise) posture in the future. Therefore, it is useful to examine the relationships between the FB embedded into the control system and the way (magnitude and form) the organization's management will deal (react) with it.

There are three distinct patterns that can be isolated to show the relationships between two important variables, namely the magnitude of FB and the strength of the corrective actions. Figure 1 is a graphical depiction of these relationships.

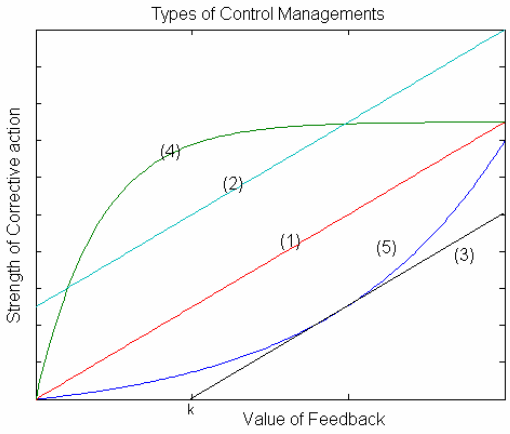

Fig. 1 Management Models [17]

Model 1: The straight-line relationship

This is a case of a consistent system where the strength of the response is consistently proportional to the value of Δ. In other words, the simple linear system is:

$y = ax + b$ where $x = \Delta$; there are few extrapolations as follows:

Proposition 1: Fig. 1, State 1:

When $b = 0$ *and* $a \neq 1$ *then the system is ideal.*

Proof:
Any nonzero value of *b* indicates a systems' malfunctioning (situation 2&3). And any zero value of a is a trivial case.
Proposition 2: Fig. 1, State 2:
When $b > 0$ *and* $a = 1$ *then the system is initially unstable.*
It exhibits a positive y for the value of $x = 0$ In other words,

it exhibits a situation where there is a response (corrective action) while the value of $x = 0$, or no Δ or deviation. For successive values of positive x the system responds in a linear fashion.

Proposition 3: Fig. 1, State 3:
When values of $y = 0$ *for* $0 \le x \le k$ *; or the corrective action lags for he values of* $0 \le x \le k$ *; this mean that there is a minimal value of* x *for the system to respond.*

Proof:
Every system has a threshold of response. This could be due to inertia, mechanical, electrical, chemical, or any other reason, like a backlash.

Model 2: Minimum action control system

$$y = k_1 /(k_2 + e^{-x}) \quad ; \text{where } k_i \text{ is a constant}$$

When the value of x increases, the response increases at an exponential rate. Any further increase in the value in x, the system will loose it ability to respond proportionally, until the response becomes fixed irrespective of the value of x. In other words, for higher values of x>k the response becomes constant.

Proposition 4: Fig. 1, State 4:
The minimum action control system is insensitive for systems suffering from high level of feedback, or x. In other words, management becomes numb when deviation level becomes high, which will aggravate the situation even further, call it crisis level. Some bureaucratic systems tend to behave in this way, to the point it looses touch with reality, thus furthering the decline of the organization, by not reacting proportionally or effectively to the high values of x, thus x will have no or insignificant effect on the response. This happens when management reaction becomes insensitive to larger changes in the values of x. In other words, problems may multiply, while management becomes incapable of handling them, thus become paralyzed. This is the point where management must either change, or wither on the vines.

Model 3: Maximum action control system:
Proposition 5: Fig. 1, State 5:
When the value of x *increases moderately the system response become exponentially increasing to the point of becoming uncontrollable.* Management characterized by this model will inevitably exhaust the organization resources.

$$y = k + e^{x} \text{; Where } k \text{ is a constant}$$

There is a cutoff value of feed back that the system must change mode to higher level. This is what we may term, a crisis level, when the system reacts disproportionately to changes to the FB.

IV. Lessons

Corollary 1
Open loop management is insensitive to small or big changes in the organization and may lead to disastrous outcome.

Corollary 2
Closed loop management produces stable organization if and only if it has proper feedback.

Corollary 3
Negative feedback will always tends to stabilize the organization. On the other hand positive feedback will fluctuate the organization and may lead to unstable system.

Corollary 4
The time required to minimize the turbulent of an organization depends mainly on the volume of the feedback.

V. Conclusions

In this paper we examined a number of different scenarios or situations extracted from the electro-magnetic control systems theory. They were analyzed to discover similar or parallel control situations in the management of organizations. Several cases and propositions were elaborated. The lesson we wanted to learn from this treatise is two folds:

1. There is a wealth of knowledge that can be gained by examining systems, like natural systems and use this knowledge to understand similar or parallel systems.
2. In the cases discussed, the control loop states were examined, like their mathematics, what they entail, their resolutions, and how this can be applied to the management control of organizations' and their corollaries.
3. The fundamental lesson that we learnt from this, despite the fact that it is not something hidden or unknown, but rather not well appreciated, is that the FB is a cardinal part of the effective, progressive, and competitive management and organization. The presence of the FB, small or large, little or much, is the essential organ that management must keep open and improve its functioning. The reason is simple, there is no amount of predictability that will enable us to allow zero feedback and still navigate through the future with success.
4. There is a need for further research in this area, i.e. the implications of improving genuine FB mechanisms in the organization and the correlation of this to the real success on the organization.

Although the genesis of this work was the observation that the input output model of a living system is germane to the thinking about organizations, and the presence of the FB loop is an essential component in it, however this does not in anyway mean that the measurement of the error or the amount of deviation for any measured attributes is an easy endeavor. This is true even in the most basic electro magnetic control systems, where the transmitted signal may be affected by

noise, errors, or many other sources, and eventually may render the entire system useless as the FB cannot be sensed or felt at the location where correction is warranted. The lessons we learnt were based on observations of fundamental situations, where one can draw conclusions and extrapolations from this phenomenon of organizations systems.

The implicit assumption that organizations are going through normal, albeit turbulent phases that would require persistent sensing and adjustments, but in no way they are at the levels of crises. The dynamics of dealing with systems in crisis and undergoing trauma are not within the scope of this paper. There is a need for research in this area, not of crisis management per se but of crisis prevention through judicious management policy making that are robust, and follows the common sense that may be extracted from our understanding of the design and operation of the natural systems, in the same manner this topic is discussed.

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