Modelling Change and its Effect on Quality

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Abstract

This paper addresses the problems of how to create an organisational structure that encourages personal initiatives to flourish within the constraints of a competitive manufacturing company. It uses ideas from both System Dynamics, Cybernetics and mathematics. The paper redefines terms such as mass, momentum and inertia in a organisational context and shows that the eventual state of a company is a delicate balance between these quantities.

Philosophically, the paper shows that continuous change is crucial for survival. A case study of a Danish hearing Aid company is used to demonstrate the results.

1. Introduction

This paper is the third in a trilogy of papers that addresses the problems of how to create an organisational structure that encourages personal initiatives to flourish within the constraints of a competitive manufacturing company. The first paper used the innovative structure of a Danish Hearing Aid company called Oticon to suggest some inherent causal relationships. A full causal model was developed in the second paper and several runs were discussed.

2. Mass, Momentum and Inertia.

The beauty and the strength of mathematics is its ability to formulate laws which can then be applied isomorphically to many different application areas. It is thought that management science or cybernetics should not be exempt from this process. The authors are especially interested in which mathematical terms and principles can be redefined to be meaningful in the context of organisational structure. Three such terms Mass, Momentum and Inertia are considered.

Physical Mass is a measure of the inertia in the system. The inertia can be described as the reluctance of a body to change its state of motion. The Principle of Inertia (or Newton's First Law) states that " a body has no power of itself to change its state of rest (or motion) when not acted on by external forces. The temptation when applying these terms to an organisation would be to equate mass with size i.e. with the number of people employed. We have decided to define this quantity as the Volume of the organisation. Its mass we define in terms of the requisite data available to it i.e. its data-content. This definition allows mass to be independent of the size of a company in the same way as physical mass is independent of physical size. It also allows one to define density (mass per volume) as the amount of requisite data available to each person. Thus a small company (an SME) with a high data density could have a large organisational mass whereas a large company with a low amount of requisite data available to each employee would have a low organisational mass.

There is a difference between information and data. We will define information as data that has been directed to the right place (or person) at the right time (or decision instant). The informational content of a company depends on its organisational mass and its organisational shape or structure.

When describing a physical object, one would refer to its size, (volume), its mass and its shape. In the same way, every company has its own organisational shape. Many follow a hierarchical structure e.g. a pyramid shape but other structures are possible e.g. a icosahedron as in the Syntegrity process (Beer 1988).

The inertia of a physical mass reflects its reluctance to change . We thus define the inertia of a company as its reluctance to be affected by new information. It can be represented in our model as the time it takes information to reach the precise place it is intended to reach i.e. a delay. This is obviously also related to the organisational structure. We use two forms of Inertia - of perception and of implementation. The first is the time it takes for information about the external world to be registered in the company information database. The second represents how long it takes the registered information to have an effect on the workings of the company. The analogy can be extended to the term

‘ Moment of Inertia ‘ This represents physically a measure of how the mass is distributed about the body i.e. the previously defined organisational structure of the company. It is often used in calculating the energy of a system. The creative energy of an organisation can thus be connected to the moment of inertia.

Experiments carried out by Lee and Pangaro (1952) at Du Pont support these views. Three key issues emerged in their analysis of structure, communication and decision making which were Group Dispersion, Relative Centrality and Peripherality. Group Dispersion is the sum of the number of steps each person is from everyone else in the structure. Relative Centrality is the quotient of Group dispersion over the minimal connectivity of the individual and Peripherality is the variance between the relative centrality of the most central member of the structure and the individual. The level of group dispersion in a hierarchy is twice that of an icosahedron, thus the potential for errors in mediation, filtration and subjectivism are much increased in a hierarchical structure. This compounded by the inpenetrableness of the structure which will behave as a high inertia mechanism opposing the ‘flow ‘ of information

The third term - momentum - is defined in the physical world as the tendency of a body to keep moving in the same direction. It is the product of a body’s mass and its velocity and is a vector quantity meaning that the speed with which it is moving has a direction. In the organisational sense, we define the momentum of an organisation as its tendency to continue behaving in the same manner. In certain companies, certain procedures can build up as normal i.e. behaviour becomes hard-wired into the system. Information links and decision points are short-circuited - information is ignored. Thus an artificial velocity of implementation is built up, creating momentum. A recent example of this was IBM where because of their massive success in building mainframes, they ignored the danger signs that demand was switching to workstations. The mainframe momentum was dominant. They had also developed a large inertia. By the time they reacted, IBM- the most successful computer manufacturer in the history of the world - nearly went bankrupt!! If a company has in built stimuli and is constantly renewing its behaviour, these artificial velocities will not build up and such momenta will be ignored.

3. Definition of the problem

The problem addressed in this paper is how a modern competitive company can maintain product quality in a dynamic world. We must first define quality. The term quality is over used today and can assume many meanings.(Reeves and Rednor 1994) We consider it to be strongly connected with meeting the expectations of the consumer. In our view there are three images of the product. There is the product the customer wants.(Customer worth) There is the company’s marketed image (desired worth) and the actual product produced.(actual worth) If perfect quality is achieved then these three images will be identical. We suggest that in most cases they are not. There is a gap between what the company perceives as quality and what is actually being produced. The ratio of these two measures can be termed the qualitative efficiency of the company. There is also a gap between what the firm is producing and what the customer wants - this ratio is termed the quality of the product. It is assumed that the customer viewpoint is continuously changing so a mark of the quality is the speed with which the company can respond to change. A description of a product depends on many attributes such as design, price, usefulness, comfort and intrinsic qualities. To represent this we considered using a multidimensional vector but decided against as it would lead to unnecessary complications. We therefore assume that these different attributes can be given a weighted average and thus can be represented as a scalar quantity called ‘worth’ Thus both quality and efficiency will be a scalar quantity lying between zero and one.

This definition of quality has an influence on the conceptual model of organisational management. (Williamson 1981). Clemmer (1992) discusses the traditional paradigm of management. He noted that in the old paradigm, management do the thinking - employees are there solely to follow instructions.. Objectives, standards and measurements start at the top and cascade down the organisation. this paradigm corresponds to what can be called the mechanistic model of an organisation described by classical management theorists. this model describes the organisation as a tool or a machine designed solely to create profit for the owners and its organisational life is governed by clockwork precision. Nowhere in this paper do we discuss profit and loss. A company must make a profit to survive but we believe that that is an essential bi-product of a correct organisational structure - the mission of the company should not be to make a profit - if it is so then it will fail. In our model the objective of the

company is to ensure quality, if it can do so then it will be able to sell its products and ipso facto make a profit. However, the economic theoretic underpinning of the model in this respect follows the spirit of Cyert and Owen (1964)

The mechanistic model contrasts to the organismic model of management adapted from von Bertalanffys work on General Systems Theory.(1971) Here the organisation is committed to an organism whose whole purpose is survival. Like living organisms, organisational structures are dependent on their environments for resources and they can adjust the behaviour of their parts to maintain the properties of the whole to acceptable limits. Beer (1961) has extended von Bertalanffy's model in his Viable Systems Methodology. - viable meaning able to survive. Beer has mapped out five systems (called Systems one to five) which must be present for a system to be viable and each systems must have predetermined links with each other and with the environment. Hence Beer places great emphasis on information and communication. He also uses the term _" variety" which means the number of possible states a system can hold. In our model we equate "variety" with mass and the system as shown below is attempting to satisfy Ashby's Law of Requisite Variety between the Customer information and the company information. Using the concepts defined above and some of the ideas from Viable Systems , we have devised the Influence diagram shown in Figure One.

4. An Influence Diagram for managing Change

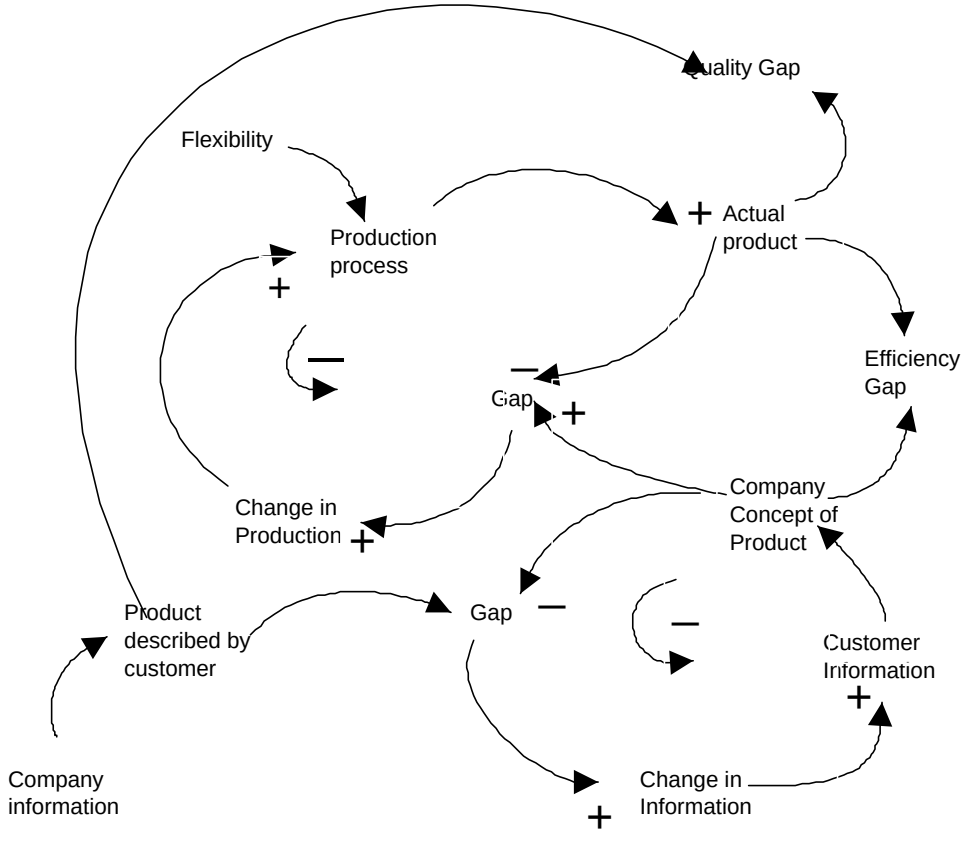

Figure One. Influence Diagram

We are assuming that a firm is trying to survive in an oligopoly. The range of its products is lumped together under one heading and the three viewpoints (customer worth, desired worth and actual worth) has been explained above. We see that we have two negative feedback loops. The first (A) tries to match the product as seen by the firm with the product as described by the customer. The information

delay represents an inertia of perception. The second loop (B) tries to match the production of the product with the firms conception of it. There are two information delays one of perception and one of implementation.. The perception gap will lead to suggested changes in production. These changes have to be implemented but their are factors working against this. One is that the firm may have built up a momentum in doing things a certain way. This will need to be disrupted. Also the flexibility of the organisation is important - how easy is it to change? One can see that both factors are represented in the diagram. The firm must have a dynamically changing 'aspirational level' as defined by Marris (1964)

5. The Oticon Experiment.

Oticon is a hearing aid company operating in both national and international markets. Competition in this industry was intense and urgent and innovative adjustments to the company were needed to save it. The organisational structure was changed so that ideas could travel very quickly through the organisation. This became the principal motivation for change. The organisation became known as a ;spaghetti organisation' The old hierarchical structure was abolished. All staff worked in constantly changing project teams. Former department heads became project leaders. Employees could be part of several teams at the same time. This gave Oticon a loose intertwined structure that had the potential of self structuring whenever necessary. In the communication context, everything becomes connected to each other with no boundaries. The aim was an ever changing project driven knowledge based organisation.(Poulsen 1995)

Oticon's employees not only participate in several projects simultaneously but have different roles in each project. Individual employees have multiple jobs. People are encouraged to take on tasks they feel they can and are willing to do. This increases enthusiasm and motivation increasing creativity..

It is recognised that communication is critical for effective product development. Dialogue is encouraged as the main means of communication. The entire building is designed for dialogue and action. Small cafes are spread around to encourage meetings and direct contact. Decisions were not just done on special occasions but were an ongoing everyday event. The information system was built around a common industry standard graphical user interface. General applications include the normal office automation, technical applications include computer aided mechanical, electrical, acoustical software and IC design, simulation and proto-typing. Time management, financial management and quality management systems help integrate the work of individuals and project groups into a coherent whole. The whole information system is perceived by the group as one single system. Everybody is given access to all available knowledge..

No working place is fixed. No one has a traditional office. No one has a permanent desk.- just a trolley with the minimum amount of documents that can be moved when work requires. Specialised 'ad hoc' workstations exist to allow highly specialised work to be done. All paper coming to the company is scanned into the computer system and then shredded. A tube in the canteen shows the shredded documents descending to the waste disposal as a constant reminder to the workforce.

The firm also took a holistic view of the customer. They realised that they were in a fast moving market and installed sensors to be aware of the changing moods of the customers

It is interesting to examine the performance of this company in the light of our previous concepts.

1. The company is very small compared to their immediate rivals (Siemans, Phillips) but because of the informational structure they have a high mass and they are an information dense firm. Nonetheless, modern technological based production systems require economies of scale to maximise profit. Oticon survives against market tendencies by vertical product differentiation

2. The flexible structure, multiple jobs and emphasis on communication means that they have low inertia and thus can easily adapt to new customer profiles. They can achieve this without requiring economies of scale. Oticon is a niche operator.

3. The non permanent work spaces means that unwelcome momenta have little time to build up which again aids their response times.

4. Their emphasis on product quality means that they are trying to satisfy Ashby's Law of Requisite Variety since they are engaged in a endless Chain - Store - Paradox quality game with rivals.

6. A Systems Dynamics Model

The influence diagram was used as a basis for the System Dynamics Model shown in Figure Two. Although this is a soft model, realistic units can be determined. The worth of the product (in all of its three guises) has been stated to be a weighted average of its attributes. This could be measured in Utils as per Morgenstern The production process could be evaluated using Balance Scorecards (Kaplan 1997) and would then be a dimensionless quantity. Information (or mass) could be measured on a scale from 0 to 1 There is a quantity termed flexibility which represents the ability of the company to adapt (momentum) This again is scored on a scale of 0 to 1, where the higher value reflects a greater propensity to adapt. There are also three information delays representing two inertias of perception and an inertia of implementation

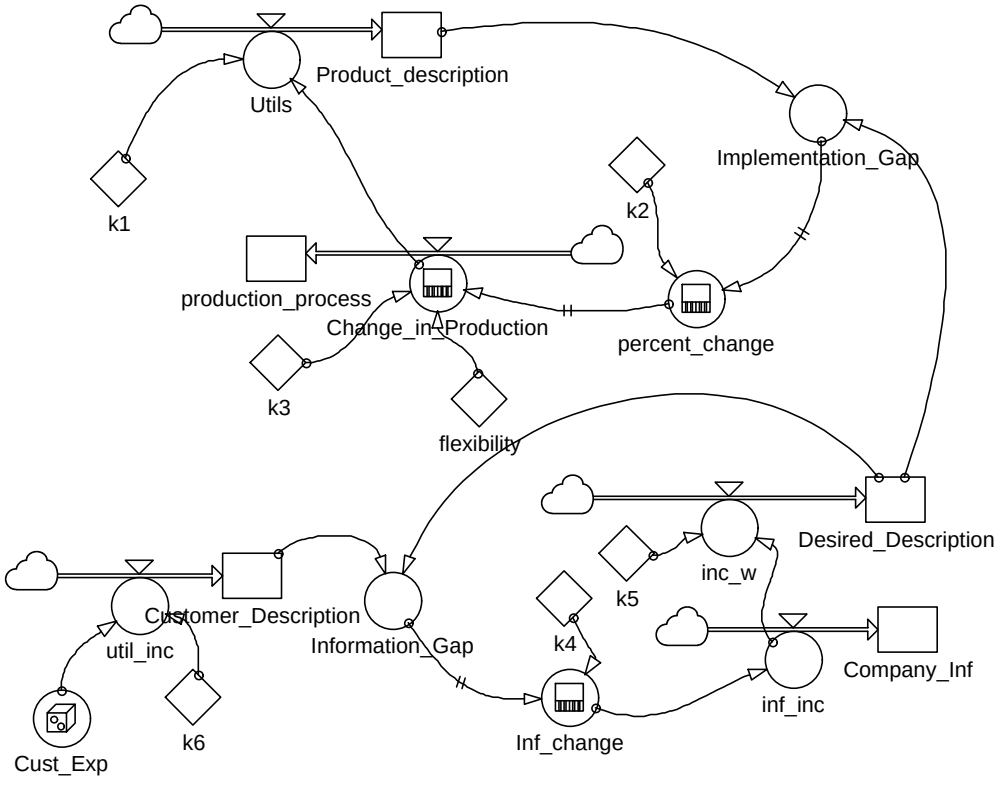

Figure Two A Causal Model

The first run was to represent an average company which had a medium flexibility index (0.5) and a large inertia (i.e. delays of 6, 16 and 6). The second run represents a company such as Oticon with a high degree of flexibility (0.8) and small inertia (more accustomed to change). In both cases, the information supplied by the customer was a random distributed normal variable of mean 0 and standard deviation 1000

It can be seen that the model reflects the behaviour one would expect. In the Oticon Case, the product description follows the customer expectation quite closely. In the other case it oscillates out of phase with both the customer and the desired worth.

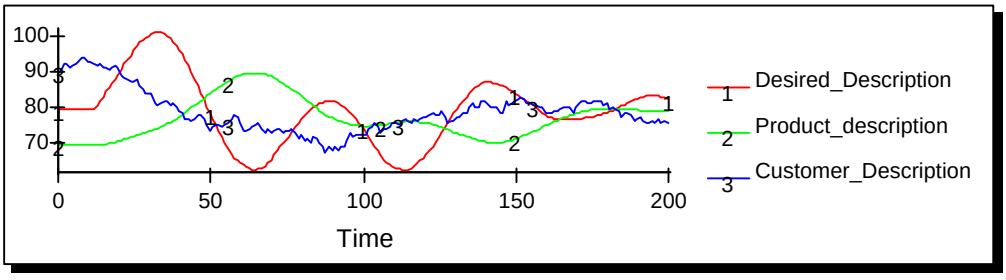

Figure Three Large Inertia Medium Flexibility

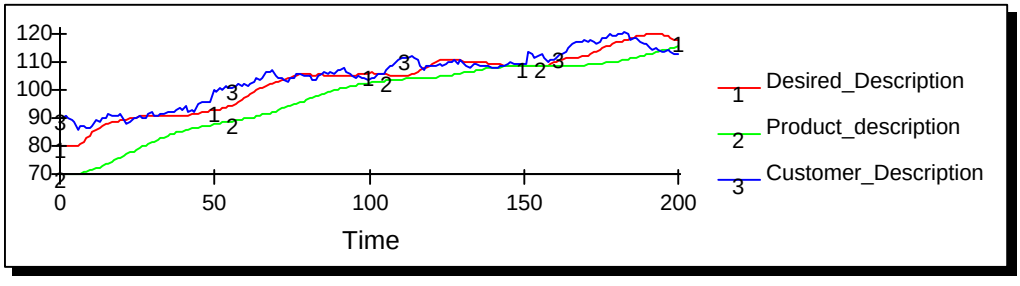

Figure Four Small Inertia Good Flexibility

7 Conclusion

This is a modelling exercise. We do not claim that the model is an ‘absolute picture of reality’. It reflects the fact that continuous change to adapt to the environment is necessary for survival. Oticon has looked for success in the breakthrough for quality, culture and the ability to adapt. We have used terms such as organisational mass, momentum and Inertia to help us model these properties and explore the dynamics generated by the interplay of these variables.

Recent models of social systems (Mosekilde 1997, Prigogine 1989) show that in nature, many systems operate in far from equilibrium conditions. When this is so, small changes can cause new structures. Self organisation occurs - order appears out of seeming chaos.. Oticon is an example of a company that tries to allow order and disorder in the same system to develop creativity and effective use of resources. Control is necessary but so is the freedom to allow every member of the organisation to reveal their capabilities and originality.

The Systems Dynamics methodology allows the conceptual space to use models such as this for both contemplation and creation. As a human activity, modelling is an act of knowing - thus our models are not and can never be ‘true’ or complete in the absolute sense of the objectivist tradition. In interaction with our environment we do not acquire a direct mapping (representation) of it, rather we acquire relative and temporary specifications that develop with our ability to distinguish while at the same time enhancing this ability by continually bringing forth new ideas.

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