Models of organisation and information system design

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We devote this paper to the models of organisation, and see which is best suited to provide a basis for information processing and transmission. In this respect we shall be dealing with four models of organisation, namely: the classical mode, the behavioural model, the systems model and the cybernetic model of organisation. The approach followed is that we first briefly present the model, then see how it can provide a basis for information processing and transmission. It is hoped by this means to demonstrate that it is the cybernetic model which is best suited to provide a proper basis for information processing and transmission.

I. The classical model of organisation :

It is possible to distinguish three major schools which make up the classical model of organisation (Jackson, 1985).

Taken together, they form what has come to be known as the classical theory of organisation. These schools are Administrative management theory, Scientific management and Bureaucracy theory.

I.1. Administrative management theory:

In his famous "Administration Générale et Industrielle" (Fayol, 1961), Fayol laid the foundation of this school. His contribution had a profound impact on subsequent writers of this stream of management thinking. He considered that there was a wide-spread need for principles of management to guide managers in their function. He outlined fourteen of these principles.

In spite of the criticisms (Simon, 1947), some, if not all, of the principles of management are still in use, and there are many companies still organised along lines recommended by the administrative management principles.

I.2. Scientific management:

This strand of management thinking is historically associated with F. Taylor. It was his contribution that gave the impetus to scientific management (Taylor, 1919, 1923, Pearson, 1929). Fayol and his point of view of top management looking down the line to the shop floor. Taylor looked at the organisation from the opposite angle, i.e. from down at the shop floor up to the top level of the hierarchy. In fact, his main concern was the function of the organisation at the operational level. His research was concerned with how to get the maximum production out of the work force for given periods of time.

In the context of scientific management, the main attribute of a worker's activity is that it is highly routinised and, therefore, can be subdivided into individual regulated movements. Consequently, the best way to improve performance is to standardise the activities to the last detail.

The underlying assumption of scientific management is that (of the classical economic theory of the time which stipulates that) people are motivated only by economic considerations. This dubious assumption about workers motivation is, very possibly, one of the reasons which led to its failure to become the dominant approach to management that its founder had predicted it would be.

I.3. Bureaucratic theory:

Being of a sociological background, Weber's bureaucratic model of organisation (Weber, 1984) is better viewed and approached as part of his vision of modern industrial society. The model was developed in the historical era as the other streams of classical thinking on organisation, which is why they all tend to be mechanistic in nature and highly formalised. The fact that he was an academic (as compared to the practitioners Fayol and Taylor) probably explains why Weber's model tends to be more descriptive as compared with the prescriptive nature of the other approaches.

The bureaucratic model is highly structured. It is meant to be the rational and most efficient solution to the complexities of modern large scale organisations.

To summarise, the classical model treats organisations as closed rational systems. Nor does it recognise the environment as having influence on the internal structure of the organisation (Jackson and Morgan,, 1978). It is a "machine model" in that "it fails to recognise the interdependencies of the parts making up the organisation" (Jackson, 1985, p.28). Another apparent deficiency of the classical model is its emphasis on the pursuit of the declared goal (s) of the leaders of the organisation (ibid.).

We turn now to the question of the way information is processed in the classical model.

I.4. Information processing within the classical model:
From the mechanistic nature and the pyramidal structure of the classical model, it is possible to distinguish different aspects of information handling inside the organisation. We shall do this in terms of operational and higher levels in the hierarchy.

At the operational level of the organisation the nature of activities performed are repetitive and "standardised", requiring only limited knowledge. They are programmed in advance. The information requirement relevant to the task, and the necessary resources for its completion, are provided in the form of detailed programmes, in line with the objectives to be achieved, specified at a higher level of the hierarchy (Simon, 1960, 1947). Given the assumed stability of the activity level, all the information needed at the "shop floor" level are satisfied.
At the higher levels in the hierarchy, the situation is manifestly different. As organisation grow larger, the number of hierarchical levels increases (Ouchi, 1977). The increase in the hierarchical levels compounds the control problems in the organisation.

The task of the individual manager is specified by the formal structure, and so it is the scope of the authority within which he or she can act without reference to his or her superiors. Task specification relates to information regarding the manager's role as integrator of the tasks of his or her subordinates, and channelling down (the information received) in the form of instructions for further action, or in the form of feedback relating to each subordinate's performance. Decisions outside those limits are considered exceptions, and should be passed upwards to the next level in the hierarchy. The filtration of exceptions continues with the same logic at every layer to the top level. That is to say, the classical (machine) model of organisation defines the instructions (information) that can be issued at every position, and what kind of information is to be passed upwards, and what is to be processed locally.

If the validity of the premises of the model are adopted without question, then it might seem that the vertical flow of information, as described, is quite feasible and straightforward as long as the number of exceptions generated inside the structure is kept to a minimum. However, there are inherent features of the model that suggest otherwise, i.e. the validity of the model's assumptions cannot be taken for granted in the pyramidal structure described above. The number of exceptions an individual manager is likely to have to handle is a function of his or her span of control, i.e. the number of exceptions increases with the number of subordinates supervised. Reduced span of control will, necessarily, lead to the increase of the number of management levels, and widen the distance between senior and junior management. This necessarily will lead to an increase in the number of exceptions (information) flowing through the hierarchy, therefore, this increases the amount of information a manager will have to handle. This, in turn, will lead to the creation of time lags between the moment of generating the information and receiving a response in the form of a decision at the point of action.

We may conclude this exposition of the classical model with the remark that the classical model, with its pyramidal structure is ineffective. It tends to produce valid information for the programmed problems and stops short of providing good and reliable information for the important and non-programmed problems.

II. The behavioural model of organisation :

The origins of the behavioural model of the organisation can be traced back in time to the research on human relations which flourished in the 1930's, during and after the Hawthorn studies.

In contrast to the classical writers, behavioural theorists consider members of an organisation are not a mere economic resource. They can affect as well as be affected by the organisation. The Hawthorn experiments (Mayo, 1960), and a myriad of other subsequent studies, have emphasised the importance of social processes organisation. The informal organisation which surrounds the formal one is no less important to the proper functioning of the organisation.

As for the individual, the behavioural model challenges the classical view that economic needs are the prime mover of individuals in the organisation, and that they are, therefore, the only needs worthy of concern. The behavioural view asserts that, in addition to economic needs, human beings also have psychological needs. An individual needs to be responsible, autonomous and to have his or her job enriched in a manner that allows individual input and contribution to the job and the way it is performed. Human relation theorists (Mc Gregor, 1984; Likert, 1961) maintain that an effective management is one which creates conditions where satisfying individual needs can, at the same time, lead to satisfying those of the organisation.

The behavioural model greatly emphasises participation and discretion as means of improving the managing of organisations. However, this insistence alone is incomplete, because the traditional hierarchical structure of the organisation is left intact by the behavioural model.

Let us consider now how the behavioural model deals with information processing and transmission. One of the criticisms directed at Mayo's early research is that it was "bent on the maintenance of the hierarchical structure but with the manager giving greater consideration to human factors in order to maintain the traditional system'" (Kast and Rosenzweig, 1985: p.83). This is to say that, for the behavioural model, the formal arrangement of information processing and transmission of the classical model is maintained. It is supplemented by the opening up of the informal network at the group level, mainly at the operational level.

The encouragement of informal contacts may help in the processing of information at the lower level of the organisation, and possibly reduce potential information overload at this (i.e. operational) level. However, the most significant problems encountered in information

processing and transmission in an organisation are generally those at the upper levels of the organisational hierarchy. Problems arising at the operational level are of a routine type. As such, the formal structure with its rules, procedures and programmes may be adequate to meet the information needs of the organisation at the operational level. However, the formal structure, and its processing arrangement, have not proved of great help to the manager above that level. It is in this area where help will be most appreciated (i.e. in relation to information processing and transmission). In this regard the behavioural model offers little useful advice.

We consider next the systems model as a possible basis for the construction of adequate information handling procedures.

III. The systems model of organisation :

The systems model of organisation, as a framework of thought, is generally attributed to the biologist Ludwig von Bertalanffy (Von Bertalanffy, 1968). However, Burrell and Morgan, in their discussion of the development of systems theory (Burrell and Morgan, 1979), trace its origins to the work of early sociologists, like Durkheim (Giddens, 1972), and the economist turned sociologist Vilfredo Pareto (Pareto, 1968).

There are various contributions to the systems model of organisation. Parson's treatment of the organisation (Parsons, 1956-57 (a,b)) remains within the sociological tradition inherited from Pareto in the sense that, for him, equilibrium is the driving force of an organisation as a system: "Parsons does indeed postulate an equilibrium-seeking tendency as a property of systems of any sort" (Deverreux Jr., 1961: p.33). However, he also makes use of the organism analogy in his open system model of the social system (Parsons, 1951). In this sense, his work provides a bridge between the closed system model and later, clearly open systems approaches, such as that of Katz and Kahn (Katz and Kahn, 1978).

There is another important body of research on the systems approach to organisations, which adopts a socio-technical and contingency approach (Rice, 1963; Kast and Rosenzweig, 1985; Lawrence and Lorsch, 1969; Burns and Stalker, 1961; Trist et al., 1987). This approach contends that considering organisations, as "open socio-technical systems", allows a better understanding of "how they are both influenced by and able to act back on their environment" (Trist et al., 1987: p.6). The model of the organisation dominating this approach is processural, i.e. input, process and output, in the words of Rice "Import - conversion - export" (Rice, 1963: p.16). In this approach, we find explicit recognition of the uniqueness of the structure of organisational subsystems and the interrelationships between them, as well as the uniqueness of the organisation's environment (Kast and Rosenzweig, 1985).

Also, there has been growing body of research within the systems approach known as Critical Systems Thinking (Jackson 1991a, Jackson and Flood 1991). It is built on the critic of traditional management science. It rests on five commitments which distinguish it from other branches of the systems approach. These commitments can be summarised as:

critical awareness, social awareness, complementarism at the methodological level, complementarism at the theoretical level and a dedication to human emancipation (Jackson 1991b, Jackson 1995).

The systems model views the organisation as a pyramid of three layers of managerial decision making: strategic, tactical, and operational (Anthony, 1965). As would be expected, the lines at which these levels interface are not clearly defined. They tend to overlap. Nevertheless, the design of the information system of the organisation must take into consideration the distinct requirements for information of the different levels of managerial decision making.

At the operational level, management is task oriented, its information requirements are largely well defined, and generally the information is generated internally. Decision making is repetitive and there is high use of the same items of information. This leads to highly structured and formalised information transmission procedures which enhance the scope for programmed decision making.

The decision making process at the tactical management level is characterized by coordination of the efforts of the organisational parts at the lower level. Apart from the dimensional aspect of the flow information, the types of problem tackled at the tactical level are also dissimilar to those at the operational level. As a consequence, its information requirements will differ. The vast majority of situations faced by tactical management are messy, and no routine procedure is available to deal with them.

The process of decision making at the strategic level of the organisation must concern itself with setting long term objectives. Design scenarii for the future of the organisation must be worked out, as well as alternative strategies by which to steer the organisation towards the desired future.

The integration of the information system is understood by designers as a task of creating an organisation-wide information system. The output of one level is to serve as an input to the next, so that the whole system is built on the detailed database collected at the operational level. This assumption fails to grasp the fact that the information requirements of management at higher levels are not mere aggregations of operational data. The requirements of information systems design at the operational level involve implementation of a general decision making model (such as provided by operational research) in a given organisational context. For example, production scheduling and inventory control. Outside the operational control area, however, the task of the information systems designer would be better understood as to educate the manager in the modelling process itself, since problems are necessarily non recurrent.

The most important question which concerns us is whether the systems model can provide a basis for information processing and transmission. Looked at it from this perspective, the systems model is not very promising. It recognises the openness of the organisation to the

environment and emphasises that an organisation is made up of a number of parts with interconnections between them. However, it maintains an adherence to the hierarchical nature of control in the organisation. An image system (i.e. the information system) of an hierarchical organisation is often subject to time lags and tends to overload the upper levels in the hierarchy. Further, the systems model makes room for lateral communication between the parts of the organisation, but does not really say how to deal with this. It is essential that lateral transmission of information is accompanied by a conscious design of the necessary channels. If we do not cater for the channel capacity and the transaction capacity at the cross-over points between the organisational sub units, the information will be lost.

We may state briefly that the systems model, since it maintains the hierarchical structure of the organisation, does not provide a sound enough basis for information processing and transmission. This being the case, we need to move now on and consider the cybernetic model of organisation.

IV. The cybernetic model of organisation :

Cybernetics can be considered as a constituent part of the wider framework of systems thinking (Jackson, 1987 (a); Flood and Carson, 1988). Although it was formally established as a separate discipline towards the end of the 1940's by Wiener (Wiener, 1948), it has been in existence, under some form or another, ever since ancient Greece. The word cybernetics itself is derived from the word "kybernetes" meaning steersmanship (Wiener, 1968).

Early developments of the new discipline of cybernetics were dominated by the emphasis on applications to physical systems or engineering systems. However, Wiener, although aware of the limitations of the quantified language of mathematics in formalising social problems, did not exclude the possibility of extending the scope of cybernetics to societal problems (Wiener, 1964).

We understand that the classical view of control is command. The essence of this notion of control is that the controller stands outside the system (the object of control). The two are linked together through the cause-effect relationship, where the system under control is supposed to do exactly what the controller wants it to do. Put crudely, control is seen as deciding on the goals, and then telling people what to do so that the organisation achieves its goals.
This attitude to control derives from a simplistic mechanical view of the organisation, i.e. organisational systems designed to serve predetermined objectives. A more sophisticated view considers organisations, in addition to being designed artefacts, as being also naturally occurring phenomena with self-regulating and self-organising capabilities (Beer, 1979). In this matter, the cybernetic understanding of the system (organisations are typical cybernetic systems (Beer, 1959) goes far beyond the classical view. It is in terms of the wider sense of control, which takes into account both complexity and uncertainty, that we will consider the cybernetic control of organisations.

Within the cybernetic approach, Jackson distinguishes two strands of thinking, management cybernetics and organisational cybernetics (Jackson, 1987(b)). The adherents of the former (i.e. management cybernetics) have maintained the status-quo in organisation theory. They have tried to adopt the tools of cybernetics (black box technique, feedback, etc.) to management control without questioning existing assumptions. They see the controller as standing outside the system (Glanville, 1987). So, control of organisations in this framework, remains essentially classical. Cybernetic is seen as helping to enhance the power of the controller (i.e. management) by applying new techniques. In other words, cybernetic "... recognises the authoritarian nature of control" (Robb, 1984: p.11).
However, this brand of cybernetics does depart from the classical, strictly mechanical and closed system view of the organisation, in that it recognises the influence of outside forces. In this respect, it falls within the open system perspective of the organisation. Management cybernetics explicitly accepts that the smooth running of an organisation requires that attention be given to the environment as well as to the internal process of the organisation (Strank, 1982).

It seems that management cybernetics does not provide its own model of the organisation. It seizes upon the classical model and attempts to adapt the cybernetic techniques of black box and feedback in order to make management function more efficiently, "between this form of cybernetics and traditional management science there is little to choose" (Jackson, 1987(b): p.141). It still remains within the confines of the traditional and hierarchical model, but with cybernetic coloration and flavour. Because of this close association with the classical model, it is incapable of acquiring sufficient regulatory power to meet the complexity of modern organisation and the complex and changing relationship the organisation has with the environment.

The control mechanism in the model above appears to be designed to meet the immediate needs of the organisation for stability and equilibrium. The way this model seems to operate implies that outside disturbances (although unknown) are fairly predictable. It does not seem to have provisions to meet those states of the environment which cannot be envisaged in advance by the controller. It is not explicit how cybernetic control as presented here can help in the process of learning and adaptation necessary for the long term survival of the organisation. We know that long term survival implies the capacity of the organisation to self-organise (Beer, 1979). To ensure that feedback control arrangements have sufficient regulatory power to match the variety increase in the black box (the organisation as induced by environmental pressure, we need continuously to redesign these mechanisms (Ibid.). However, this possibility is clearly lacking in management cybernetics.

An adequate model for the control of an organisation requires to be based on more than the input - black box - output: schemata underpinning management cybernetics. The model must meet the dictates of the law of requisite variety (Ashby, 1964). Since organisations are faced by higher variety from the environment than they themselves can exhibit (Beer,

1979, 1985), it is essential that organisations find ways by which to counter the overwhelming environmental variety. That is to say, they must acquire requisite variety not by merely maintaining their position in the environment but also by growing and expanding. In other words, it is necessary to supplement negative feedback or deviation correcting mechanisms with also positive feedback or deviation amplifying mechanisms, what Maruyama refers to as the second cybernetics (Murayama, 1968).

The methods of variety engineering necessary to meet the requirements of the law of requisite variety, and the keys to self-organisation and structural elaboration allowing the organisation to grow and expand, are to be found in what Jackson refers to as "organisational cybernetics" (Jackson, 1987(b), 1991a). Speaking of organisational cybernetics one is essentially referring to the work of Stafford Beer (Beer, 1979, 1981, 1985) and to that of the adherents of his Viable Systems Model "VSM" (Espejo, 1987, Clemson, 1984). Although Beer himself and the others do not explicitly employ the phrase organisational cybernetics, it is a useful term to use to distinguish the structuralist approach of the VSM (Jackson, 1987(a,b)) from the positivistic and mechanical view held by management cybernetics.

The VSM can be justified as the embodiment of the cybernetic model. It stands on its own, developed from cybernetic first principles (Beer, 1979, 1985). The unique feature of the model is that it provides for the full-scale variety engineering necessary for internal stability of the organisation, while the same time catering for the requirements of the organisation to meet the challenges of the environment (ibid.).

With respect to information processing, the cybernetic model (exemplified by the VSM) stands apart from the other models of organisation. The VSM provides elaborate recommendations to facilitate information flows between the organisational parts, and between the organisation and its environment so as to promote the processes of self-regulation and self-organisation. So, unlike the previous models, the image of the cybernetic model of the organisation (i.e. the information system) is not a mapping of an hierarchical structure. Rather, the information system is built to meet the requirements of organisations for self-regulation and self-organisation. This characteristic suggests that it could, potentially, provide a superior organisational model upon which to base information system design than any of the other three considered models.

The recognition in the cybernetic model that it is information flows and communication links which, more than anything else bind organisations together, is significant testimony to the superiority of this model (Jackson, 1985).
This emphasis on proper communication channels and elaborate information networks as a prerequisite for organisational design, makes the cybernetic model (meaning the VSM) the most appropriate model of the organisation.

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