

Systems Thinking

1. What Is A 'System'?

A system is “*an organised or complex whole; an assemblage or combination of things or parts forming a complex whole.*”

This definition covers physical and mechanical systems; biological systems; and human and social systems. A tree is a system, living and growing within a wider natural environment which is also a system; a car is a system for transporting people, dependent on the wider road system and itself dependent on the motor and other systems that combine to create a single vehicle.

General systems theory provides a basis for understanding and integrating knowledge from a wide variety of specialisms, and a framework for synthesis and integration of very diverse and differentiated fields of scientific understanding that enables communication to occur between them. Systems thinking has been particularly relevant to the social sciences and is related to the development of functionalism - the analysis of social and cultural life from the standpoint of the primacy of wholes or systems. It looks at things like the norms that people use to make judgements, the customs and traditions that shape our behaviour and beliefs, and the institutions that operate within society. These are all part of the whole that is a social system and give it its structure and enable it to function, just as the fuel and the injectors enable an engine to work. The basic emphasis of this approach is upon systems of relationships and the integration of parts and sub-systems into a functional whole. It looks at social systems in terms of structures, processes and functions and attempts to understand the relationship between these components, and their place within a broader system. When we examine how organisations work, we are concerned with exactly these elements - how does the organisation function and why do issues like culture and structure affect the working of the organisation.

Organisations are *open systems*. An *open system* operates within an environment and, although systems are defined by boundaries that separate the system from that environment, it interacts with that environment. It receives various inputs from its environment, transforms them and export outputs back to the environment. These inputs and outputs range from materials to information, energy to influence. Thus the open system is in a state of continuous interaction with its environment and must achieve a "steady state" or *dynamic equilibrium* in order to continue to function or survive. (For example, an organisation imports inputs - raw material or information - transforms them, and exports goods and services to maintain its equilibrium. A failure to import inputs would cause the system to break down.) By contrast, a closed system has no interaction with the outside world; it is completely self-sufficient. Although not totally closed, North Korea attempts to operate as a totally self-sufficient closed system.

This need to interact with the wider environment results from a common property of all systems, a tendency towards *entropy*. This means that systems have a tendency to decay unless they interact with the environment, to import new inputs and/or export outputs. This is why the concept of a learning organisation is so important; learning is about bringing new inputs of information into an organisation to prevent it from gradually decaying.

2. Organisations as systems

An organisation is an open system that combines both social and technological sub-systems that interact with each other. In analysing or designing systems it is important to consider:

- the relationship between people and their role in performing tasks;
- the equipment, its operations and the relationship between machines; and
- the interactions between the people and machines.

Such socio-technical systems were first explored by the Tavistock Institute in the UK in the 1950s, and helped to break management thinking away from the Taylor model, which saw organisational systems as operating optimally when people were treated as being comparable to the machines they operated. The Tavistock Institute demonstrated that small changes in the way that people and machines worked together could produce significant differences in work output. This was one of the first uses of systems thinking as a way of understanding social organisations.

Consider the collection and analysis of financial data, as a system: various clerical and administrative staff form one sub-system, gathering and communicating data to each other. The input of the data into a computer and its processing by that computer is also a sub-system. The passing of the output of that processing to accounting staff for evaluation is a further sub-system. However, the whole system involves the interaction of the technological and human systems in a particular way which influences the social and psychological dimensions of the system. Direct input of data into the technological system and its display on monitors is not just a different system physically, it affects the relationship between the staff and the output of the technological sub-systems. For example, users of such data will often react differently to the data according to their role in its collection and analysis.

This interaction between people and machines reflects one of the important differences in the nature of organisations, in comparison with biological systems. Other differences include the fact that organisations:

- are contrived rather than naturally occurring systems, consisting primarily of people;
- that they can cease to exist overnight or outlive the biological organisms which created them; and
- that they are held together by psychological rather than biological cement - the attitudes, perceptions, beliefs, motivations, habits and expectations of human beings.

3. System boundaries

An important characteristic of open systems is the *boundaries* that separate a system from the environment in which it operates. Boundaries exist as potential barriers in interactions between people inside and outside the system. Power relationships, communication and activities occur within the boundary and help to determine where the boundary is, since it will often be vaguely defined and quite *permeable*¹. The key feature of many organisations is the degree of boundary regulation between systems; management has a primary role to act as the contact between systems, spanning boundaries. It is through this role that systems are integrated and co-operate together - or not, as the case may be - allowing transactions to occur across boundaries at the interface between systems.

Systems operate within systems. Each of the systems that is embedded in another is a *sub-system* of the system in which it lies. When describing systems it is useful to use the term 'order' to define the system's relationship to other systems. A first order system is the outer system being described and provides the environment for second order systems which are sub-systems of the

¹ ie, it is possible for information, materials and people to move through the boundary

first order system. Third order systems are sub-systems of second order systems, which each provide environments for fourth order systems; and so on.

Furthermore, in complex organisations there will be *hierarchies* of systems and sub-systems, with corresponding managerial hierarchies. Each level in the hierarchy may have a number of embedded sub-systems within that level. The three main levels within hierarchies are described as:

- operational
- organisational
- institutional

Operational systems are responsible for the actual task performance of the Organisation; some will be concerned with the main functional purpose (eg production) others with ancillary tasks necessary for the function to occur (eg administration). *Organisational* systems exist to co-ordinate and integrate the operational systems, to ensure the supply of inputs (materials, people, information, etc) to enable operational tasks to occur. Functions like IT or HR are organisation level systems. *Institutional* level systems relate the activities of the organisation to its environment, ensuring the supply of inputs from the society to enable the transformation activities to occur*. (The concept of hierarchies of systems is concerned with functional levels; a 'company' may be regarded as an institutional system, a 'department' as an organisational system, and a 'production line' as an operational system.)

Management at these three levels has different orientations; at operational level it is concerned primarily with reducing uncertainty and excluding too many variables. In the main this level of management is responsible for minimising external pressures on the functional activity - policing the boundaries so that externalities only permeate the system via the managers. Conversely at institutional level the organisation faces maximum uncertainty in terms of inputs from the environment over which it has no control. Management should concentrate on adaptive and innovative strategies to enable the organisation to respond to these externalities. At *organisational* level, management has an intermediating and co-ordinating function, to act as a buffer between the subordinate (lower order) and superordinate (higher order) systems. This involves translating the uncertainty of the environment into the certainties required for functional activity to occur.

Joseph Juran, in the *Handbook of Quality Control*, says that operational staff speak the language of 'things' since that is what they deal with, whereas senior managers speak the language of 'money' since that is the only way they can bring together the diverse operations of the organisation. He describes middle managers as needing to be *bilingual*, to be able to translate between the two. This is a reflection of the problems that often occur in organisations, a failure to recognise the characteristics of the different sub-systems that make up the whole.

At each level systems must interact with their environment, but boundaries will be least permeable at operational level, minimising interaction with the environment other than at designated interfaces. At institutional level the system will be most permeable, interacting with its environment at a range of interfaces and in a variety of forms.

* Ricardo Semler offers an interesting perspective on the roles of managers and other employees in his description of the structures in his company's factories. The different categories of employee correspond loosely to these three hierarchies. See *Maverick* (Arrow Business Books: 1993)

4 Systems and change

Clearly the imperatives of the systems at different levels create possible conflicts between pressure for change and pressure for continuity. Often these pressures will be most apparent in the conflicting *adaptive* and *maintenance* systems. *Adaptive systems* are sub-systems of the organisation that exist to enable and encourage change; they will include systems such as training and development activities. Their role is to identify and facilitate change and therefore challenge the operational systems that are geared to continuity.

Maintenance systems are designed to ensure continuity, to provide balance between sub-systems and between the system and its environment. Performance appraisal systems often exist as maintenance systems, to ensure that resources are being utilised effectively and efficiently. A dynamic equilibrium (equilibrium arising from the organisation's functioning) requires that these adaptive and maintenance systems are able to function in a balanced way but they will inevitably cause tension, stress and conflict. Dysfunction will occur if one so effectively overrides the other as to create either *stasis* (maintenance systems dominate) or *chaos* (adaptive systems dominate).

Managers rely on *feedback* from the environment to ensure that systems are functioning effectively. Feedback is essential for dynamic equilibrium since it provides a means by which adaptation can occur to respond to environmental change. The environment of the system is the larger system in which it operates, so the operational manager is primarily dependent on feedback from within the organisation. All too often organisations fail to ensure effective feedback to systems and thus allow change to occur only as a dysfunctional transformation, rather than as an adaptive transmutation. Monitoring, evaluation and review systems provide the feedback loop in operational systems; it is important to identify how far they are meant to act as part of maintenance systems, and their role as adaptive systems. Furthermore, as W Edwards Deming regularly used to point out, those people who are part of a system cannot change the system, as they do not control it. Providing people with feedback on how well the system is functioning can allow people to fine tune the system, but they will need to get those higher up the hierarchy to make or allow changes to the system itself.

Peter Senge² explores the significance of feedback in some detail, and demonstrates how learning in organisations and individuals is dependent on it. He also draws on Chris Argyris and Donald Schon's concepts of *espoused theory* (what we claim to do) and *theory-in-use* (how we actually behave)³ to show how reluctant most managers are to use feedback to learn. All too often we use feedback to reinforce our mindsets, rather than challenge them, yet without being able to learn from the inputs which originate outside the system we are in danger of *entropy*, of the system of which we are a part gradually decaying.

5. Spanning boundaries

Systems function through the group responsible for the tasks that the system is designed to undertake. Their activity and their relationships to each other and to other groups are a dominant feature of *sentient groups*, that is groups which are meaningful to group members. Sentient (i.e. aware of themselves) groups will tend to be highly conscious of systems boundaries since these serve to define the group - perhaps most sadly in urban gangs based on neighbourhoods, which exist as geographical boundaries for the group. Within the group, individual boundaries will be highly permeable, allowing a high level of interaction to occur between group members, but inter-group relations in an organisation involve interactions between systems. Such interactions involve boundary-spanning activity, as a member or members of a group operate outside the boundary of

² Senge P (1990) *The Fifth Discipline* Century Business

³ Argyris, C and Schön, D (1974) *Theory in practice: Increasing professional effectiveness* San Francisco: Jossey-Bass.

the system within which the group functions, or the group includes a new member or members in its activities.

This can have two consequences; it can change the boundary map by including functions within the system previously excluded. (For example, the establishment of a cross department project - a system - interacts with the various operating systems). It can also cause the group responsible for a function to lose power if a member is divorced from it by attachment to another group, or if new members come in upsetting the relationship between existing members. It is for this reason that the managerial function of boundary spanning, of ensuring effective interaction between systems and the groups who function therein, is so important. Rosabeth Moss Kanter⁴ identified the significance of this in enabling change to occur. Gatekeepers control the boundaries and can prevent change from occurring by ensuring that these boundaries become less permeable and more robust. Without powerful sponsors who are able to break down these barriers, change becomes virtually impossible.

Given their multi-level nature as complex open systems, medium-sized and large organisations may appear to have the potential for substantial internal diversity. In fact, most organisations consist of 'nested' systems and sub-systems (ie where the component systems are enclosed within the boundaries of other large systems) the consequence of which is the tendency for them to exhibit similar properties. This, the principle of *recursiveness*, is important in explaining how internal tension is avoided. As systems reproduce the same properties (structure, culture, roles and relationships, etc) so they become more able to communicate across boundaries and to process information. While many common properties might appear to be designed into organisations, it is probable that a substantial number have arrived through mutation as the systems adapt towards the dominant set of properties of the whole system.

One consequence of this is that a substantial change in one dominant area may well become a common feature of all, albeit unintentionally. (Dominance may be a formal dominance based on power, or informal based on influence or importance in the smooth running of an organisation.) This is why it is not uncommon to find that the basic organisational unit of a large organisation is very much larger than the basic organisational unit of a small organisation. Common sense says this is rational, whereas rational logic says that if there is an optimum size for a basic organisational unit (the 'building block' from which the whole is constructed) this would remain constant irrespective of the size of the whole. Small organisations would have few such building blocks, large one would have many. However, recursiveness says that 'large' and 'small' are properties of the respective systems and will tend to recur throughout. These structural characteristics are primarily maintained through the organisation's culture ('How things are around here'), one of the most powerful forces in social systems.

6. The value of systems thinking

Systems thinking is simply a way of looking at organisations. It offers a grammar for describing them and a set of principles that help to make sense of them. Behavioural psychologists will apply their grammar and principles, just as classical economists. None is better or worse, just different. Where systems thinking has its greatest value is in looking at the organisation as an organism that has a set of qualities that cause it to behave as it does, and that are not static but changing, sometimes for the better and sometimes the worse. Because it is not specific to any one discipline, it enables different perspectives (whether from psychology or economics) to be used side by side in making sense of the whole and its parts.

Certain common disciplines in organisations (engineering, quality management, IT) rely heavily of systems concepts to and practices, and so an understanding of systems thinking is a necessary part of working in that environment. Given that most managers will need to have some involvement

⁴ Kanter RM (1983) *Change Masters* New York: Simon & Schuster

with one or other of these disciplines at some time, being able to make sense of systems thinking - at least a familiarity with the grammar and principles - is valuable. This introduction is designed to help in doing this. If you want to learn more, there is a list of further reading below. You may also find the related paper - Soft Systems - of use, in presenting a specific approach to analysing organisations.

Further reading

General Systems Theory von Bertalanffy: George Braziller, New York (1969)

Theory and Management of Systems Johnson, Kast and Rosenzweig: McGraw-Hill (1967)

The Fifth Discipline P Senge: Century Business (1990)

Diagnosing the system for organisations S. Beer: Wiley (1985)

Systems management and change: a graphic guide R. Carter et al: Harper & Row (1984)

Systems thinking, systems practice P. Checkland: Wiley (1981)

Managing Chaos: Dynamic business strategies in an unpredictable world Stacey Kogan Page: 1992

Sociology And The New Systems Theory: Toward a Theoretical Synthesis Kenneth D. Bailey State University of New York Press (1993)

GENERAL SYSTEMS THEORY: Ideas And Applications Lars Skyttner (University of Gävle, Sweden) Imperial College Press (2000)