Introducing Systems Thinking

by Prof Jake Chapman

Contents

This material provides the general introduction to Systems Thinking. It is essential that you have read and understood the material prior to the workshop on 28th February It is recommended that you read through the material once and then reread it, making notes of questions and queries that you wish to raise during the workshop.

1. Introduction

Systems thinking provides a powerful way of thinking about complex issues and is often able to generate insights and understandings that are not available through more conventional analytic approaches. The main aim of the material presented here is to provide an introduction to what systems thinking is about and how it differs from other approaches. It is anticipated that it will take you about an hour to study this material, and it is essential that you complete this prior to the workshop on February 28th.

Systems, as a way of addressing complex issues, has been around for more than 75 years. The next section provides a brief history of the main strands of its development since the 1930s. It is impractical to provide a thorough theoretical description of the subject that can be mastered in three hours. As a result many of the core ideas are presented in a simplified form. Furthermore, the main features of systems thinking are drawn out by comparison with what is referred to as mechanistic thinking. Whilst this is a useful pedagogic device it may also lead to an exaggerated polarisation, painting the world as black and white when it has many shades of grey. This means that it is quite likely that you may want to explore some of the shades of grey that are not explicitly covered, or you may wish to ask further questions to clarify the ideas. As you study the material make notes of your questions and the areas where you require further explanation. There is time set aside at the workshop for addressing these issues and answering your questions.

2. Historical

Systems has its origins in the 1930s when ecologists, biologists studying organisms and gestalt psychologists all developed a holistic way of describing the world in terms of ‘systems’. A key characteristic of a system is that it has properties that none of the parts or components of the system possess. These are known as emergent properties and disappear when the system is dissected or divided. For example vision, being able to see, is an emergent property of organisms that have an eye, an optic nerve and a brain. None of the components alone can ‘see’, it is only when they are assembled in a particular way that vision emerges as a property. In biology there are many examples of emergent properties at many different levels; for example at the cellular level, at the level of the nervous system, the organism, a population of organisms and at the level of ecosystems. Another feature of systems identified at this time was the ability of the whole system to adapt to changes in its environment so as to preserve some essential structure or characteristic. This extended the scope of evolution from organisms to ecosystems.

The next significant development took place as a result of Operations Research during and immediately after the Second World War. This lead to the development of cybernetics, control theory and the appreciation of both natural and engineered ‘systems’ in terms of their structure and feedback. The advent of computers lead to the formal study of ‘system dynamics’ in which quantitative computer models were constructed that could reproduce the behaviour of a range of systems – including biological populations and engineered industrial processes.

There was an expectation that the understanding of system behaviour and feedback, coupled with multi-disciplinary teams, would lead to a systems approach that could also tackle social, even global, problems. However the attempts to apply systems thinking and modelling to social problems was doomed by fundamental disagreements about both the nature of the problem, the goals of any intervention and even what exactly was malfunctioning within the system. Since the 1980s social and managerial applications of systems thinking have been largely based on 'soft systems' – an approach that explicitly recognises the pluralistic views and goals present in social and organisational issues. In the 1990s many systems ideas were incorporated in, and in some cases hijacked by, 'complexity theory' and 'network models' of organisations. What is presented here is a personal synthesis of these various strands of development.

3. Current Position

It is quite likely that you will not have heard much about systems thinking. If it is a potentially useful way of addressing complex issues why should it be so little used and poorly known? There are a number of reasons for its lack of popularity.

The first is that to become adept at systems thinking requires you to develop a new way of thinking. Few people are aware of how they think, and still fewer that there are alternative ways of thinking about issues. As you will probably discover when you start to use systems tools, learning to think differently can be an uncomfortable process. But without the shift in your thinking you will not gain the benefits available.

The second is that systems thinking, by its very nature, presents a significant challenge to the way that most people have come to understand the way that the world works. It challenges assumptions about cause and effect and about what can be predicted and controlled. Frankly, busy managers and leaders feel they need challenges of this sort as much as they need a hole in their head.

Third, systems tools and approaches take more time – particularly initially - and time is probably the scarcest resource for all senior managers. It has been my own experience that although a systemic approach requires more time initially, there is a significant *saving* in time in the longer term. But until one has had this experience there is an inevitable reluctance to commit to spending more time initially.

Finally it turns out that a systemic way of thinking requires a development in the way that the individual makes sense of the world, and this development usually occurs in adulthood – generally much later than formal education – and even then only for a minority of individuals. According to the theories of adult development, including leadership development, systems thinking is a key aspect of a certain stage of development that enables managers and leaders to be particularly good at managing complexity and introducing change. The theories of development point out that a key element in making the necessary developmental transition is the acquisition of sufficient personal awareness to be able to genuinely appreciate other people's perspectives.

For all these reasons systems thinking has not become well known or widely practiced – this despite being the subject of one management fashion in the 1990s (described in Section 12). However over the last five to ten years there has been a growing awareness that a new way of thinking about complex issues is required, and systems thinking has come to be regarded as an approach that yields valuable insights and understandings. In a review of the relevance of systems thinking to policy and government Geoff Mulgan[1] identified seven factors that required a systemic approach[2]:

- the ubiquity of information flows, especially within government itself
- pressure on social policy to be more holistic
- the growing importance of the environment, especially climate change
- connectedness of systems brings new vulnerabilities
- globalisation and the ways in which this integrates previously discrete systems
- need for ability to cope with ambiguity and non-linearity
- planning and rational strategy often lead to unintended consequences.

As a result of a year working in the Performance and Innovation Unit (PIU) in the Cabinet Office, Geoff Mulgan suggested that I write a pamphlet about the application of systems thinking to public services and government policy more generally. This resulted in a Demos pamphlet[3] that, surprisingly, became a best seller and has lead, amongst other things, to the inclusion of a systems component in TMP. The pamphlet argued that the current approach to policy would, in systems terms, have three consequences – namely unintended consequences, staff dissatisfaction and a loss of systemic capacity. The pamphlet succeeded because it helped many policy makers and managers make sense of their experience. At about the same time Vanguard Consulting started applying their *Lean Systems* approach to public services, with remarkable success[4]. So, notwithstanding the difficulties outlined above, there is evidence that systems thinking is a useful discipline to master, and that as the world becomes more complex the payoffs from its application become more profound. (The issue of whether the world is becoming more complex is addressed in Section 10.)

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[1] [1] Mulgan founded the think tank Demos in 1994 and was instrumental in developing the ideas behind 'New Labour'. He worked as Director of Policy and later as Head of the Strategy Unit at 10, Downing Street from 1998 to 2005. see also http://en.wikipedia.org/wiki/Geoff_Mulgan

[2] *Systems thinking and the prqctice of government* by G. Mulgan, Systemist Nov 2001, 23.

[3] *System Failure: why governments must learn to think differently* Jake Chapman, Demos, London 2002. Available as a free download at http://www.demos.co.uk/publications/systemfailure

[4] See [the] articles available at http://www.lean-service.com/6.asp or the OIDPM report on applying lean systems to housing at http://www.communities.gov.uk/index.asp?id=1165574

4. Mechanistic Thinking

After a relatively short time, almost all conversations with civil servants about public policy will involve the use of a mechanical metaphor. "Stepping up a gear", "driving through change", "the levers of government", "changing direction", "the machinery of government" are all common phrases and are based upon regarding government and the organisations involved as machinelike.

"The ubiquity of the machine-metaphor was the legacy that the military bequeathed to governments and then to manufacturing…. Well oiled, efficient and measurable, the ideal machine had a clear purpose or function which it carried out perfectly. Everything could in principle be conceived as a closed system, consisting of cogs and wheels, instructions and commands, with a boss or government at the top, pulling the requisite levers and engineering the desired effects. ..

These machine images have had a profound influence on how we think… They influenced ideas of organisation to such an extent that many organisations were built deliberately as machines, and so long as their environments remained stable, these machine bureaucracies proved extremely effective in marshalling resources and energies to particular ends. But the environment for machine-like things has gone into decline."[5]

Conceiving of organisations as machines powerfully conditions the way that people think about management. In particular it makes "scientific management", developed by Taylor in 1911, an obvious and attractive approach. The key elements of scientific management as applied to machine-like organisations are

- the separation of design and operations. This was originally developed for production lines, but has become more widespread – as for example in the continued separation of policy and implementation.
- a presumption that organisations behave linearly and predictably. Linear behaviour means that if one unit of change produces two units of difference, then three units of change will produce six units of difference. This also presumes a simple, mechanical, relationship between cause and effect (as in the case of a lever).
- tackling complicated problems by breaking them down into smaller parts, each of which can be analysed separately – a strategy known as reductionism.
- the presumption that there is only one correct perspective on a situation and that decisions can be resolved by establishing the 'facts' of the case.

Once one enters into this mechanistic way of perceiving organisations then the whole spectrum of performance management, the use of targets and milestones is a natural and logical consequence. And historically the approach has succeeded, particularly in domains that involve sequences of repetitive tasks.

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[5] *"Connexity: Responsibility, Freedom, Business and Power in the new century"* by Geoff Mulgan Vintage, London 1998 p.150 –1

One of the reasons why this way of thinking is attractive is that by conceiving of the organisation as a machine one is presuming that its behaviour is both predictable and controllable. So if one is a senior manager, charged with the task of controlling an organisation in a predictable fashion, one will be attracted to this type of metaphor and its associated thinking.

But what if organisations really don't behave like machines? Or, as Mulgan suggests in the above quote, what if the age of machine like entities is past? Then what way of thinking and what metaphor would be more appropriate?

5. Systems Thinking

There are three key components to systems thinking.

The first component is the collection of concepts and theories that have emerged from biology, cybernetics, operations research, control theory, general systems theory, complexity theory and other disciplines all of which have contributed to an understanding of how complex systems behave. These include emergence, feedback, single and double loop learning and several different ways of representing and analysing system behaviour. The key concepts and ideas will be introduced as far as is required to understand both a systemic approach and the use and application of the systems tools. One example of this body of theory is the application of the 'control model' to organisations described in section 6. More explanation of theories and concepts this will be during the sessions at Sunningdale.

The second component is the development of holistic ways of approaching complex problems. Reductionist approaches presume that the whole can be understood by analysing the behaviour of the components of a system. This approach fails under two conditions. The first is where the behaviour of interest is an *emergent property* of the system that cannot be accounted for by properties of the system components. The second is where the interest or source of problems is in the *connections* between the components, not in their individual properties.

Highly complex problems or situations have to be simplified in some way in order for us to be able to comprehend them; there is a limit to our mental processing capacity that has to be circumvented. Reductionism overcomes this by breaking the larger problem or situation into progressively smaller parts until each part can be comprehended. Holism adopts a different approach. It retains the appreciation of the whole and achieves simplification by going up a level of abstraction and discarding detail. This is a familiar process. For example when one talks about the performance of a group one is discarding the detail of the individual members. When one talks about an organisation one is discarding the detail of the departments and groups in the organisation. So thinking at the organisational level is at a higher level of abstraction than the departments, which are at a higher level than the groups, which are at a higher level than the individuals.

Systems thinking is holistic, so it requires one to consciously go up levels of abstraction so as to retain the connections and relationships involved. The most powerful systems tools for facilitating holistic thinking involve the use of diagrams, some of which will be taught as part of the course. In many contexts a systemic appreciation of a situation or problem precedes more detailed analyses. The advantage of this strategy is that the detailed analyses are carried out in the context of an appreciation of context and relationships.

The third component of systems thinking is the appreciation of significantly different perspectives operating within a particular problem context – referred to as pluralism. Significant differences in perspective mean that there will be no agreement on diagnosis, on the grounds for admitting evidence, on the goals for the system and for the values and principles that should determine action. It turns out that in order to appreciate fully these differences in perspective an individual has to first disidentify from their own particular perspective on the issue or problem. This disidentification requires a combination of specific tools and a significant level of personal awareness, as mentioned earlier in the context of adult development theory. There are a range of systemic tools that foster the development of a pluralist approach, some of which will be taught as part of the course at Sunningdale.

It is the combination of holism and pluralism that gives systems thinking the power to generate new insights – and to challenge your current way of thinking about issues. In contrast mechanistic thinking is based on a combination of reductionism and positivism (the presumption that there is only one valid perspective on a given situation). This contrast can be represented as follows.

holism		systemic
reductionism	mechanistic	
	positivism (one perspective)	pluralism (many perspectives)

It is important to emphasise that systems thinking is not being held up as superior or better or worse than mechanistic thinking. They are different ways of addressing complex issues, each with relative strengths and weaknesses. In Section 9 I will distinguish between different types of problems with a view to clarifying the domain in which systems thinking is most relevant. My general position is that one ought to be able to think in all the quadrants of the above diagram and also be able to select the mode of thinking that is most relevant to the problem or issue being addressed.

In the following three sections I will introduce a number of systems concepts and demonstrate their utility by applying them to simple examples. The first example is based in cybernetics and therefore closest to a mechanistic perspective.

6. The Control Model

Cybernetics is the formal study of control and regulation in engineering systems and much of our understanding of the effects of feedback has arisen as a result. The basic structure of any effective control system is represented below and is known as the 'control model'. Here a system is controlled in such a way as to produce an output determined by a predefined goal – and this diagram represents the minimum components required to achieve effective control.

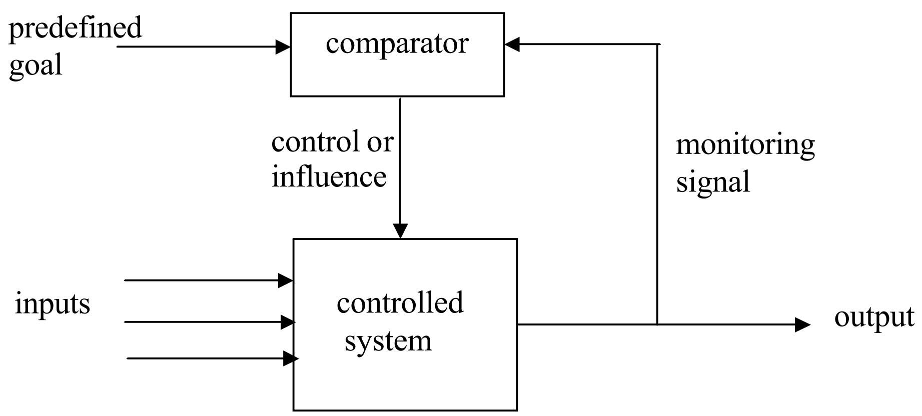

Figure 1. The control model

In order to illustrate how this relates to real control situations I will use it to describe the operation of a central heating system. In this case the *system being controlled* is the boiler, pump, radiators and connecting pipes. The *input* to the system is the gas (or perhaps oil) burnt in the boiler. The *output* from this system is warm air in the house. This is *monitored* using a room thermostat; that's the device on the wall with a dial allowing you to set the temperature you desire. Your choice of temperature on the room thermostat is you setting the *goal* of the system. So the room thermostat combines the function of monitoring the air temperature (simply by being immersed in it) and *comparing* this with the goal (the setting on the dial). When the air temperature is less than the dial setting then a switch is closed that turns on the boiler and pump so that hot water is sent to the radiators that heats up the house. Once the air temperature matches the temperature set on the dial (the goal) then the thermostat switches off and the boiler turns off. So the *control or influence* is, in this case, an on/off signal that turns the boiler and pump on or off.

The control model is also known as 'closed loop control' and as 'first order control'. It has three essential components. First there must be some process for *monitoring* the output of the system. Second there must be a process of *comparing* this monitoring of the output with a predefined goal. One requirement of this process is that the monitoring and goal are specified or/and measured in the same terms. Finally there must be some process of *control or influence* over the system so that if there is any deviation from the desired output then the behaviour of the system is corrected.

The control model is an example of an 'ideal system'. Ideal systems are useful because by comparing a real situation with the ideal it is sometimes possible to identify what is wrong or ways to improve a situation. The key items that need to be checked for adequate control are:

1. What exactly is sensing the output?
2. What is it that is being monitored?
3. Is the monitoring signal fed back to a comparator?
4. What is the goal?
5. How are the goal and monitoring signal compared?
6. Is there sufficient control or influence on the system to correct any detected difference between goal and output?

There are numerous ways in which apparently reasonable control systems can fail, some of which are illustrated in the following examples.

Example 1
An industry Regulator wants companies to improve the quality of customer service. It requires companies to monitor how promptly customer calls are answered and report on this quarterly. What is the result?

According to the Control Model what is controlled is what is monitored. In this case what is being monitored is the speed of answering telephones, so that is what is being controlled. It is clearly part of customer service, but not necessarily a good measure of customer service. Especially when it is realised that companies doing best in this scheme are those who installed computerised answering and routing systems (the ones that drive you mad with menus of options, none of which are what you want!).

Example 2
Comparing their performance with that of their competitors made it clear to the Board that they needed to improve productivity. In order to achieve this they instituted a performance related pay scheme in which each person's pay had an element that was increased or decreased depending upon their output each quarter. Reviewing the situation a year later the Board discovered that pretty well everyone in the Company had increased their pay, but overall performance had not changed.

Here the problem is a mismatch between what is being monitored, which is the output of each member of staff, and the overall goal, which is an improvement in Company performance. There are all sorts of ways whereby individual outputs can increase without improving overall performance; the most common is by generating lower quality or erroneous or incomplete items (thereby also increasing the workload and performance of staff later in the process).

Example 3
Toasters are commonly fitted with a control that, it is claimed, determines how brown the toast will be. However there is a significant variation in the degree of toasting, especially of different types of bread. Why?

The toaster does not have a feedback control, it is not actually sensing 'how brown the toast is'. What is being adjusted is the length of time that the toaster will cook the bread. There is thus no monitoring, or comparison with the desired level of 'brownness'. This is actually an example of 'open loop control' – there is no feedback. And the problems with it are well known to all toaster users. Dry bread comes out darker because the same length of toasting has a greater effect on it than on fresher, more moist, bread.

These examples illustrate how insight can be obtained by comparing a real world control model with the 'ideal'. This strategy is adopted in a number of different systemic approaches.

7. Systems, sub-systems and boundaries

The other root of systems thinking, biology, is rich in examples of systems within systems within systems. For example it is legitimate to consider a human being as a system, and it clearly comprises other systems such as the nervous system, the circulatory system, the muscular-skeletal system and so on. These can be regarded as *sub-systems* of the original system. What is more these sub-systems are themselves composed of other systems such as organs and cells. So organs and cells are sub-systems of sub-systems. And of course human beings are themselves part of larger systems, families, organisations, social groups and so on. So the system I originally started with can itself be regarded as being a sub-system. Clearly families, organisations and social groups are themselves part of still larger systems, government, industrial or commercial sectors, ethnic groups and nation states - so this nesting of systems within systems extends both upwards and downwards from the starting point.

This hierarchical nesting of systems is not restricted to biological examples. A computer can be regarded as a system, and has sub-systems in the form of graphics cards, processors, storage devices and so on. Most computers are connected to peripheral devices such as printers, scanners and so on, thereby forming a larger system. They are also likely to be connected to one or more networks, such as the internet, which link the computer and its peripherals to a much larger system of other computers and their connected devices. Once again we have a sequence of systems within systems.

The nesting of sub-systems within sub-systems is a ubiquitous characteristic of systems. Each layer of sub-systems is referred to as a different *level*. There is no firm definition of different levels within systems since the identification of sub-systems depends upon the purpose of the analysis and perspective of the enquiry.

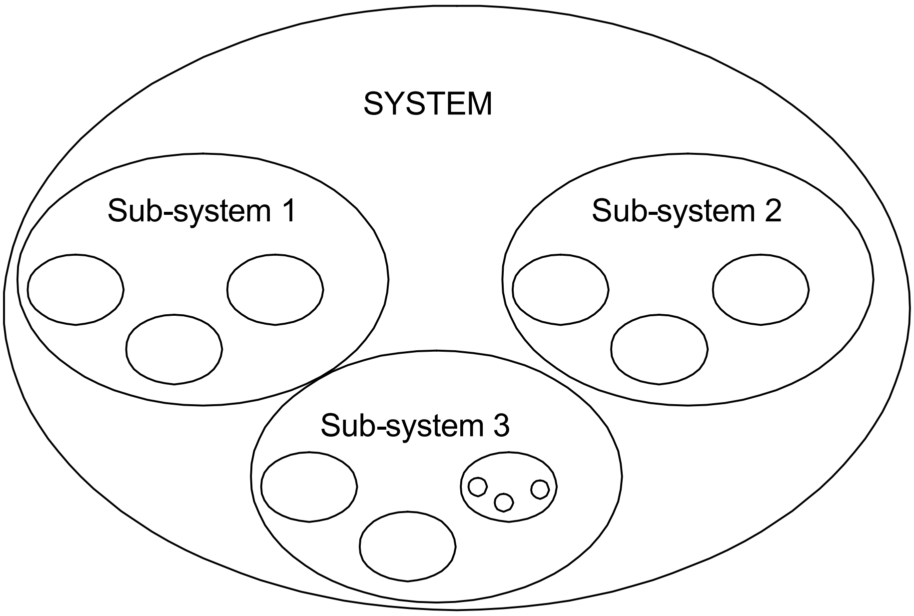

Figure 2. A system map illustrating the nesting of sub-systems within a system.

The general nesting of systems within systems is represented in Figure 2 above. This type of diagram is known as a system map and can be used as a tool for gaining an initial appreciation of a complex situation. The main benefit of assembling a system map is that it forces one to circumscribe the situation – to determine what is considered inside the system and what outside.

Everything that is excluded from a system is regarded as part of its *environment.* A system is separated from its environment by the *system boundary*. It is important to recognise that system boundaries do not have to be, and usually are not, physical boundaries in space. System boundaries are conceptual boundaries which may sometimes coincide with a physical boundary, but usually do not.

By way of example consider a bank. The bank as a system certainly includes its head-office, its many branches, specialist offices (for example stock-broking) and its staff and equipment. As well as these physical entities there are also the shares in the bank – these are clearly part of the bank but may be physically dispersed or even just represented by data in a register. The total funds on deposit in the bank do not exist as a pile of notes or gold bars, though there may be some of these, but again exist as a set of records. And then there are the items that could be identified as being within some definitions of the bank as a system, but not others; its personal customers, its commercial borrowers, the regulators of the bank, the computer servers used for its internet banking and so on.

Neither ownership, nor physical location determine system boundaries. And different people may well place the system boundary in different positions – because the boundaries are constructed for the purpose of a particular analysis and from the perspective of an individual or group. In general engineered and biological systems are subject to less ambiguity than 'human activity systems' – such as a bank or the legal system or the health service. The ambiguities in the definitions of 'human activity systems' and the delineation of their boundaries reflect the real world differences in perspectives on such systems.

8. Complex Adaptive Systems

The machine is the metaphor used to represent organisations in mechanistic thinking. A popular metaphor for organisations in systems thinking is that of the complex adaptive system. It is useful to explore the implications of adopting a different metaphor, both to elucidate further systems concepts and also to demonstrate the way that metaphors can condition thinking.

The concept of a system has already been introduced. It is a whole that displays emergent properties, i.e. properties that are not present in any of its components and which disappear if the whole is dissected or divided.

Another key characteristic of many systems is the ability to adapt to changes in circumstances or its environment in such a way as to conserve some core characteristics. Everyday experience provides many examples of this adaptation, which is what makes systems thinking intuitively attractive. For example the human body can maintain its internal temperature within quite close tolerance for a wide range of external temperatures. An institution such as the army has continued to survive in a recognisable form even though the world in which it operates and the technology it uses have changed beyond recognition. Businesses adapt to both long and short term changes in the markets in which they operate, with varying degrees of success.

Institutions and organisations have internal processes that allow them to survive changes within the environment within which they operate. Severe changes to the environment may force an institution to make changes to its staffing levels and organisational tree, but it will remain recognisably the same institution. What is conserved is its internal organisation, core values and culture and these are conserved by the ways in which 'the right way to do things' are internalised by the individuals within the institution. Viewed from this perspective the resistance to change exhibited by many organisations is not due to the bloody-mindedness of the individuals involved, though that may also be a contributing factor. The resistance to change is actually a measure of the organisations ability to adapt, it is a measure of its resilience. This resilience is therefore expected to be greater the longer that the institution has existed and been required to adapt – which is broadly the case.

Although this adaptive ability can be recognised and appreciated, the precise way in which the organisation or institution will respond to changes in its environment is much harder to predict. There are two reasons for this. First the adaptation will not usually be designed, it will occur through an evolutionary process that includes a random component. Second the institution or organisation is highly complex and subject to *non-linear* behaviour. Non-linear means that there is not a simple relationship between an increment of input and the resulting output. One unit of input might produce half a unit of output, two units of input produce three units of output and three units of input produce a thousand units of output.

The non-linearity is a result of the web of interactions between components within the system. These will all affect each other in different ways with very large numbers of feedback loops operating. This level of relational complexity, the non-linear behaviour and the adaptive response to changes, means that the system is inherently unpredictable. It is not that given more information an accurate prediction could be made – it is inherently unpredictable. (This is developed further in the discussion of complexity in section 10.)

The difference between the machine metaphor and the complex adaptive system metaphor has been graphically illustrated by Plsek[6] using an analogy first used by Richard Dawkins. The analogy involves throwing things. When the object being thrown is a rock, a mechanistic lump of matter, then Newton's laws of motion and gravity allow us to calculate with great precision the exact force and angle required to get the rock to land in a predetermined place. Witness our ability to fire missiles and shells with great accuracy over large distances. However it is not possible to predict the outcome of throwing a live bird in the same way, even though the bird's motion through the air is ultimately governed by the same laws of physics. Everyone knows that even if the rock had the same chemical composition and weight as the bird, the two behave completely differently. The mechanical properties of the bird are not what determines its behaviour – because it is a complex adaptive system with an internal organisation that allows it to respond adaptively and non-linearly to changes in its environment.

As Plsek points out, one approach is to tie the birds wings, weight it with a brick, and then throw it. This will make its trajectory (nearly) as predictable as that of the rock - but in the process the capability of the bird system has been completely destroyed. Plsek says that this is more or less what policy makers try to do when using a scientific management approach, based on a mechanical model, to try to control the behaviour of a complex system for which they are devising policy. He also points out that a more successful strategy for getting a bird to a specified end-point might involve placing a bird feeder or other source of food at the destination. Here he is extending the analogy to emphasise that influence is possible, but rather than using control it is generally more productive to devise strategies that take account of the behaviour and properties of the system involved.

[6] 'Why won't the NHS do as its told' by P.Plesk, Plenary Address NHS Conference, July 2001 (see also Leading Edge 1, October 2001 published by NHS Confederation, 1 Warwick Row, London SW1E 5ER)

It is important to recognise how the shift of metaphor, from machine to complex adaptive system, shifts the way one thinks about the organisation and one's expectations about its behaviour. I am not claiming that organisations really are complex adaptive systems, but the metaphor can be developed at least as convincingly as the machine metaphor – and leads to very different implications.

For example cybernetics provides another perspective on the adaptive process through the concept of homeostasis. Homeostasis refers to the ability of complex adaptive systems to maintain certain governing variables within prescribed limits, for example body temperature. Whilst these governing variables are within the prescribed limits then the system can devote resources to other activities. However if any of the governing variables approaches or exceeds the limit then the system responds by devoting resources to returning that variable to within its limits. This principle can be used to account for the ways in which many organisations, including government, respond to events and other changes in their environment. For example in a recent policy exercise in which I was involved, there was a debate about how different policy objectives should be prioritised.

The key policy objectives in question were economic, social, environmental and security. Various contributors to the debate sought to prioritise one or other of these objectives, but were always defeated by someone else hypothesising circumstances under which some other objective would clearly take priority. The debate was resolved by reference to the characteristics of homeostatic systems, namely that the priority given to any objective (governing variable) depends upon how close that objective is to some constraint or limit. Thus if all objectives were being satisfied and a new threat arose in regard to (say) social objectives, then the policy process would correctly prioritise social objectives until such time as they were safely within the boundaries or limits regarded as acceptable. In short the prioritisation of policy objectives is entirely determined by context, which is why the process of policy making, and much else of government, is driven by events (i.e. changes in context or environment). It should be noted that in policy issues, the perception that an objective is close to a constraint depends upon the perspective adopted, it is not as unambiguous as in biological or engineered homeostatic systems.

9. Types of Problem

A number of different authors have recognised that the problems that confront people in all types of organisation are not all the same. Although each author uses slightly different criteria for distinguishing the broad categories, and gives them different names, there are recognisable similarities.

On the one hand there are problems which have been confronted before, there is general agreement about what is wrong and what a solution would look like. Indeed in most such situations organisational procedures have been established to deal with this type of problem. It may be difficult, time consuming and require effort, but there is a sense of working towards a recognisable solution – and everyone knows when they have reached the end. These problems have been referred to as ‘difficulties’, ‘tame problems’ and ‘technical problems’ – here I’ll use the shortest term, *difficulty*.

The contrast is a problem situation in which there is very little agreement about what is wrong, what a ‘solution’ would look like and the values and principles that should guide any intervention. The problem may be unique, or it may be one that has defied repeated previous attempts at resolution. It will probably interact with a number of other ill-defined problems in which there is equal ambiguity and disagreement about what is wrong, what a ‘solution’ would look like and how to proceed. This class of problems has been describes as ‘a mess’, ‘a wicked problem’ or ‘an adaptive problem’. Although all the authors may use different criteria and terminology, they are all agreed that this second class of problem requires a completely different approach to the ‘difficulty’ category.

I will refer to these problems as *messes*. The key characteristics of a mess are:

(a) lack of agreement on what the problem is and what goals to pursue
(b) at least several, and often many, different perspectives on events and issues
(c) unbounded in terms of what it would take to resolve the issue, in both time and resources
(d) significant ambiguity and uncertainty about what is actually occurring
(e) suspected interactions between efforts to engage with this issue and actions likely to be taken on other messy issues i.e. a lack of separation between issues and actions undertaken for their resolution

In order to classify something as a mess it is not essential that all these components are present, but they usually are. However these characteristics are precisely those which defeat a mechanistic approach. So in a culture dominated by mechanistic thinking difficulties are sorted, but messes stack up - these are the problems that remain unsolved. These are also the type of problems where systems thinking is potentially most useful.

Clearly many real world situations may contain elements that are messes and others that are difficulties. Further there may well be disagreements as to the classification of any particular issue or problem – and such disagreements may indicate that the problem should be considered to be a mess. However in ambiguous cases the characteristic that defines the situation as a mess is a lack of agreement about goals – which usually indicates significant differences in either values or diagnosis of what is wrong, or both. It is the disagreement on goals, values and diagnosis that will defeat any attempt to resolve the situation using a mechanistic approach. An intervention that solves the key problem from one perspective will aggravate the situation from another perspective.I have laboured the distinction between a mess and a difficulty because it has profound implications for how one can best approach each type of problem. This can be summarised as follows:

If a problem is best regarded as a difficulty then the aim is to find a good ‘solution’ that meets the agreed and defined goals. If it is a difficulty then all the participants and stakeholders would agree that the solution does indeed resolve the problem.

If a problem is a mess then the aim is to find a process for exploring the different perspectives so as to establish sufficient common ground to agree the first steps in addressing the issues. The aim is to *improve* the situation – not find a solution. Indeed in dealing with a mess people who think that they have a solution simply make the mess worse (because their 'solution' is ignoring the ambiguity and disagreement that exists).

10. Complexity

Being complex is not the same as being complicated. Something is complicated when it has lots of components or/and when there are a lot of interactions to bear in mind. Sometimes complicated things may also be complex, but they need not be. The computer I am using to write is a complicated piece of technology – but it is not complex. I assert this because my perception is that the computer can be understood in detail (though it requires a specialist to do so) and its outputs are predictable (indeed the machine is only useful because it is reliably predictable).

In contrast what I mean by complex is something that has an inherent degree of unpredictability. Within natural systems it is the combination of adaptive behaviour, feedback and non-linear behaviour that leads to the unpredictability. Within organisations the same mechanisms are at work and are amplified by the fact that the organisation consists of a large number of *autonomous* agents (people) who choose how they respond to, and are affected by, others and the messages they receive.

Many of the technical advances of the 20th Century had a profound effect on communication. The telephone, telegraph, radio, television, computers, facsimile, mobile phone, internet and e-mail have all made it easier, cheaper and faster for people to exchange messages. However the *meaning* that individuals take from a message is not predictable; it is a function of their perspective, their current goals, their experience – and even their mood. Thus the meaning extracted from the message, and the response to the message, remains inherently unpredictable. Furthermore there has been a growing emphasis on individuality, less adherence to authority and a loss of shared frameworks on which interpretations, decisions and actions are based. So although there has been a significant increase in the number of messages being passed, this has not lead to increased co-ordination or agreement – it has instead increased complexity[7]. This has been exacerbated by the increased speed of communication – which reduces the time for individuals and organisations to consider a response to the messages.

The rate at which a situation is subject to change can affect its complexity – or at least its perceived complexity. When someone is confronted with a new situation they may regard it as more complex and less comprehendible than someone who has dealt with the situation many times previously. Thus what may be difficult to one person may be *perceived* as complex to someone with less experience. However if the situation is

[7] This is an abbreviated version of the argument presented in *Harnessing Complexity* by R.Axelrod and M.D.Cohen. The Free Press. New York 1999

changing at a faster rate than the manager or leader can learn to appreciate or respond appropriately, then the situation will appear complex to everyone, not just a newcomer. Much of the general claim that the world is becoming more complex arises as a result of the increased rate of change that confronts leaders and managers. And the same improvements in communication technology noted earlier are also responsible for much of the increased rate of change.

11. Systemic Approach to Management

Systems theory does not have a simple formula or recipe about how policy makers or managers should proceed, but it does provide a number of guidelines. Here the main features of a systemic approach are summarised. Some of these ideas are expanded in the Appendix to this text. Further amplification of the ideas in this and the following section can be found in the references in the Bibliography.

In his essay on complexity, Simon[8] observes that systems tend to be organised hierarchically and that the upper layers of the hierarchy operate slower and on longer time spans than the lower levels. This is essential for effective control and is observed in companies, where typically the Board decides which markets to enter whereas production supervisors are concerned with meeting this week's schedule. Similarly in the human body the brain may take a second or two to compose a sentence whereas individual nerve cells discharge in milliseconds. The upper levels of the hierarchy provide a stable environment within which the lower levels can execute operations on a shorter time scale. If the upper levels change direction, or adopt different goals, at a rate faster than the response time of the overall system then chaos (lack of effective control) results, because different parts of the system will be aiming at different goals or moving in different directions.

Stafford Beer developed a comprehensive theory of organisational management based on a cybernetic approach[9]. One of the key features of this approach was the recognition that most organisations have to deal with a high level of variation in the demands made on it by clients and customers. He was able to show theoretically that the only effective way for the organisation to cope with this 'variety' was to delegate as much autonomy as possible to the staff dealing directly with the clients and customers. The delegation has to be carefully circumscribed, with the specification of boundaries that must not be crossed, the scope for innovation clearly defined and clearly negotiated means of evaluation and resource requirements. The application of these principles to service organisations is one of the key ingredients in the application of Lean Systems to public and private service organisations.

The systemic metaphor for an organisation is a 'complex adaptive system' – and its two key characteristics referred to earlier are its unpredictability and uncontrollability (in the sense that it will respond to changes adaptively, rather than compliantly). To the degree

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[8] Simon, H "The architecture of complexity" in Sciences of the Artificial, MIT Press 1981

[9] See for example *The heart of the enterprise* by S. Beer, Wiley & sons 1979

that this is a valid metaphor, it clearly requires a different management philosophy – one that is consistent with the characteristics of complex adaptive systems. Essentially this means that the manager must adopt a learning-by-doing approach. The basic structure is represented by the learning cycle in Figure 3 below.

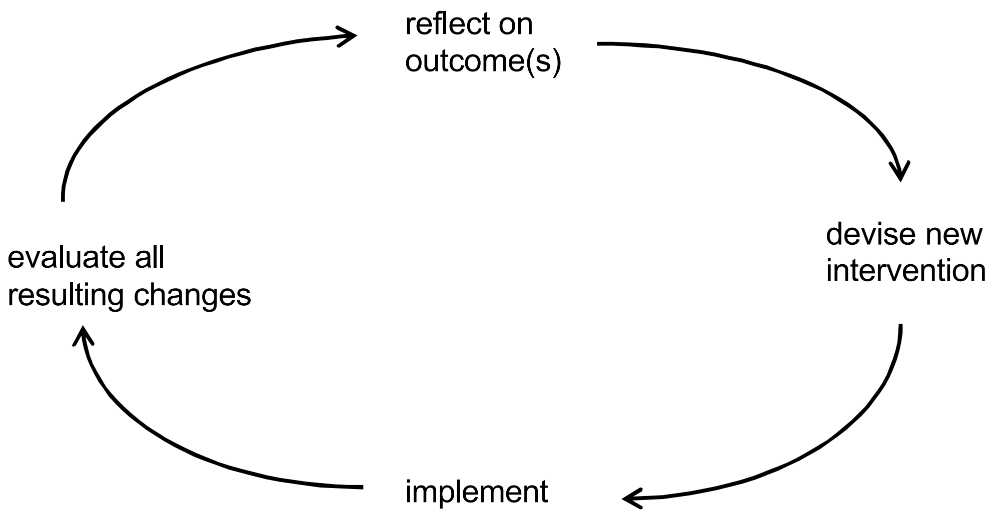


Figure 3. The Learning-by-Doing cycle

There are two key requirements for making this an effective learning cycle. The first is to ensure that the evaluation of whatever is done is as 'broad-band' as possible. This means not simply looking for the intended changes but seeking feedback that identifies as many of the resulting changes as possible – including the unintended, the subtle, the surprising and the beneficial.

The second condition required for effective learning is that this loop is actually completed by an individual or a group. In particular that there is sufficient time and length of engagement to reflect on the evaluation and modify the intervention as a result. All too often people set up evaluation procedures, but fail to provide the means or the time for the results of such evaluations to be incorporated.

One of the more serious ways in which the learning cycle is not closed is through the process of separating design from operations, separating policy from implementation. Whenever this separation takes place then the designers do not receive feedback from the operations that would lead to improved design. This is one of the key reasons why pilot projects often succeed whereas the 'roll out' may fail or produce insipid results. The point is that the design and implementation is usually carried out by the same individual or group in the pilot project – and indeed the design may well be modified in the light of feedback. However when the successful pilot is "rolled out" this link is lost and those implementing the new process may not understand its design and may not have the necessary freedom to modify its operation to meet any differences in local context.

The learning cycle is a serial process, by which I mean that one change at a time is implemented, evaluated and subsequently modified. An alternative approach is to use an evolutionary model whereby a spectrum of alternatives are all tried together – effectively creating a parallel learning situation. Again there are two keys for this approach to lead to successful learning. The first is to have very clear criteria for determining which of the alternatives being tried out will be deemed successful – and to ensure that the evaluation of all the options includes these criteria. It is acceptable to revise the criteria in the light of the evaluation – especially if potentially important unintended benefits and consequences emerge. The second is the willingness and means to kill off the unsuccessful variants. Where evolutionary processes work successfully – for example in many commercial markets – it does so because the mechanisms for removing failing or weaker variants operate effectively.

Establishing an effective learning process sounds straightforward –but it is rarely accomplished. There are many reasons for this – some of which I will discuss at the end of the next section.

12. Learning Organisations

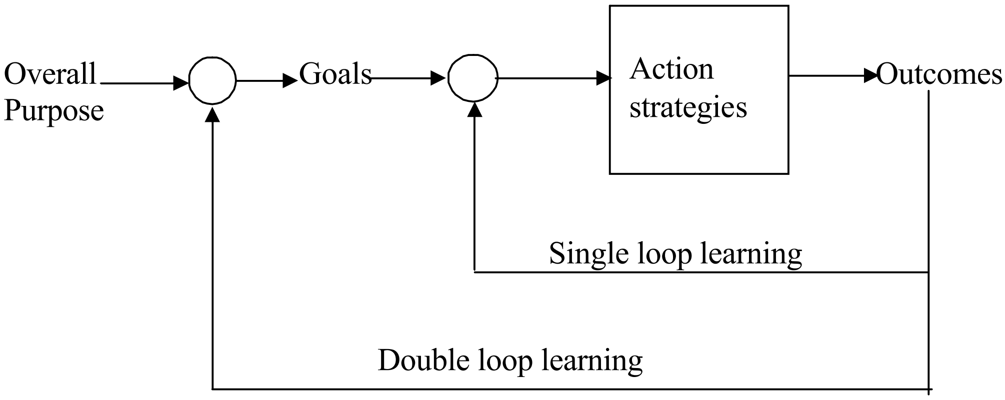
Almost all organisations will have processes and procedures for staff training and development. These involve staff attending training courses ranging from management styles to learning new skills. Acquiring new knowledge or skills is often helpful, however this is not usually sufficient to make a significant difference. In order for a new skill to be useful you have to try it out, you have to experience using it and be able to learn how to use it more skilfully over time. This requires a personal commitment to, and organisational support for, experiential learning – learning by experience of doing. The degree to which different organisations support this type of learning varies from 'totally' to 'not at all'. Of equal significance is the degree to which organisations support different modes of learning.

Of particular significance in this respect is the distinction made by Argyris and Schön[10] between single and double loop learning. The Control Model introduced earlier is a single loop model. A goal is set and the comparator compares the current output with the goal and makes adjustments accordingly. Translated into learning this corresponds to a person or organisation setting itself a target and then adjusting its activities to try to meet that target. Most organisations have processes, procedures and structures to facilitate this type of learning; for example meeting budgets or sales targets or performance targets.

Double loop learning involves questioning and exploring alternatives to the original, single loop, goal. So undertaking double loop learning might involve seeking alternative means to achieving the same outcome, or questioning whether the original goal was actually what was required. The diagram below provides a simplified representation of single and double loop learning. The key difference is that single loop learning accepts

[10] See for example *"Theory in practice: increasing professional effectiveness"* by C.Argyris and D. Schön Jossey-Bass Publishers San Francisco and London 1974

the goals as given, double loop learning involves questioning, and if necessary, changing these goals.



The core idea embedded in the concept of a learning organisation is that it should foster all types of learning, especially experiential and double loop learning throughout the entire organisation. Learning organisations were all the rage amongst management consultants in the late 1980s and 1990s. They were held up as the ideal organisational form and one likely to see off commercial competitors as well as improve the effectiveness of public sector enterprises. There are academic journals devoted to the theory of, and case studies involving, learning organisations. Originally pioneered by people like Argyris and Schön, learning organisations came to the fore with the work of Senge, particularly his "*Fifth Discipline*"[11]. Senge describes a learning organisation as one "where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning to learn together". Heady stuff and an ideal that has attracted a great many consultants, managing directors, chief executive officers and even a few public sector managers to find out what is involved.

In his exposition of learning organisations Senge advocates the convergence of five disciplines that he regards as essential for the creation of a learning organisation. Two of these are basically personal :

Personal Mastery is the discipline of continually clarifying and deepening our personal vision, of focussing our energies, of developing patience and seeing reality objectively. **Mental Models** starts with turning the mirror inward to unearth our internal pictures of the world, to bring our assumptions to the surface and subject them to scrutiny.

Two are concerned with group processes and skills:

Building Shared Vision involves the skills of unearthing shared 'pictures of the future' that foster genuine commitment and enrolment, rather than compliance.

[11] "*The Fifth Discipline: The art and practice of the Learning Organisation*". P.Senge, Random House Books, London 1990

Team Learning starts with dialogue, the capacity of team members to suspend assumptions and enter into a genuine 'thinking together'. It also involves recognising the patterns of defensiveness in teams that undermine learning.

And the fifth discipline, the one that binds all the others together, is

Systems Thinking is a conceptual framework, a body of knowledge and tools that have been developed over the last fifty years, to make the patterns of connection clearer, and how to change them effectively.

For systems practitioners, and those advocating the use of systems theory, it is natural to turn to the body of literature on Learning Organisations for support. From a systemic perspective the learning organisation concept embodies just about all of the cybernetic principles set out by Stafford Beer whilst also acknowledging the importance of different perspectives and continual learning. Just as economists gravitate towards perfect markets so do systems practitioners congregate around the ideal of the learning organisation. However, like perfect markets and other ideals, putting it into practice is not as straightforward as the theorists would like.

The strength of the learning organisation ideal is due to its appeal that capabilities and performance can be improved by processes of individual and collective learning. The ideal portrays a win-win-win situation in which individuals have their own performance enhanced, collectively the organisation improves and the clients or customers served by the organisation receive a better service or product. Its broadly emancipatory and inclusive language and its emphasis on organisational goals that transcend the pursuit of short term profits or targets helps managers and operatives alike to raise their perspective on the meaning of their work. Its emphasis on building learning and reflection into the routines and day-to-day culture of management makes sense and gives hope to people who find themselves facing complex or impossible situations and wonder whether they will ever have sufficient skill to cope. There are also sufficient examples of organisations[12] that have successfully adopted this approach to inspire others to try to emulate them.

In practice few organisations have been able to achieve anything like the ideal results claimed for learning organisations, and even those that have been able to make some progress have found it hard to sustain. There are many reasons for these difficulties, but basically they boil down to institutional and personal barriers to learning.

A key issue that applies at both levels is the collective and personal attitudes to failure. In an organisation that has a low tolerance of 'failure' then there will be very little scope for innovation, for exploring alternatives – and to accepting critical evaluations of performance. A low tolerance of failure is usually associated with a blame culture where people and groups spend time "covering their backsides" with a view to avoiding blame –

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[12] There are case studies throughout Senge's Fifth Discipline and many more included in the subsequent books, particularly *"The Fifth Discipline Fieldbook"* by Senge, Ross, Smith. Roberts and Kliener. Nicholas Brealey Publishing, London 1994. This book has examples from both the public and private sectors.

rather than actively seeking what they can learn from a situation that has turned out differently from that which was expected..

The key issue for individuals, particularly senior managers and leaders, is their willingness to engage with a situation with sufficient humility to be able to learn. This is a particular problem for senior people because they will have been promoted largely on the basis that they 'know best' – making it doubly difficult to be open to learning. Ultimately this is also a key issue in adopting a systemic approach to management, policy and leadership since systems emphasises the unpredictability and low ability to control complex situations. The challenge is to retain the position of senior manager or leader whilst being open to learning and perceiving the world in a new way. The magnitude of this challenge should not be underestimated.

13. Summary

The dominant mode of thinking in our culture is based upon a scientific approach. This simplifies complex problems by breaking them down into more manageable parts, a strategy known as reductionism. This strategy presumes that the whole can be understood by understanding the parts. This discounts two well established features of many social situations. The first is that the issues of interest often lie in the *relationships* between the parts, not in the detailed properties of the parts themselves. The second is that whole systems have characteristics that cannot be explained in terms of the parts; these characteristics are known as *emergent* properties.

Systems thinking provides an alternative way of addressing complex problems. Its strategy for simplifying complexity is to go up a level of abstraction i.e. discarding detail. The advantage of this strategy is that it retains the connections and relationships between the parts: it is therefore a *holistic* approach. Systems thinking explicitly recognises the existence and significance of emergent properties. It also adopts a *pluralist* approach to gathering evidence and understanding about systems. This means that it explicitly recognises the importance of different perspectives or world views in understanding systems, particularly social systems.

Systemic and scientific thinking are complementary. The key is to be able to identify which is the more appropriate to use in any given situation. Problems or issues can be broadly categorised as either *difficulties* or as *messes*. A difficulty is characterised by agreement on, what is wrong, the goal of any intervention and what an appropriate solution would look like. A difficulty is also characterised by remaining inherently predictable even though the situation or issue may be complicated. In contrast messes are characterised by lack of agreement about, what is wrong, what should be the goal of any intervention and very little idea on what an improvement, let alone a solution, might look like. It is also characterised by being complex, which involves a degree of unpredictability. Generally systems thinking is appropriate for messes, scientific thinking for difficulties. Many real world problems include elements of both. Under these circumstances it is generally helpful to start with systems thinking, to gain an appreciation of the whole and significant relationships and interactions and to follow this up with scientific analyses of definable problems.

Scientific management uses the metaphor of a machine to describe organisations. This presumes that organisations can be controlled, that they behave predictably, that there is only one valid view of what is occurring and that it is appropriate to separate design (policy) from production (implementation).

Systems thinking provides a different metaphor, namely that of a complex adaptive system, typified by a living being (the bird- rock story). The essential characteristics of complex adaptive systems are :

- As systems they have emergent properties, these are characteristics not accounted for by properties of the parts. So the system is more than the sum of its parts.
- One such emergent property is the ability to respond to changes adaptively. The adaptive response is such as to preserve some core function or structure. If systems did not have adaptive capabilities then they would be eliminated by any significant changes in their environment.
- It has many feedback loops, both positive and negative, that affect the behaviour of its components and the overall system so that it responds non-linearly. This means that the change in the output or overall response is not proportional to the initial change or intervention.
- In human activity systems (organisations) the interactions between autonomous agents and agencies means that the overall behaviour is essentially unpredictable. In its turn this means that it may be impossible to control the system to behave in a particular manner.

A systemic approach appreciates the significance of different perspectives or world views held by the various agents and agencies within the overall system. These differences contribute to the unpredictability of the system and have to be taken in to account if effective change is to be managed.

Table 1. Summary comparing mechanistic and systemic approaches

	Mechanistic	Systemic
Management Style	Scientific management Command and control	Learning Organisation Autonomy and innovation
aim	Control the situation	Learn how to manage better
presumptions	Organisation and agents are both controllable and predictable	Organisations and agents are adaptive and likely to respond non-linearly
metaphor	Machine “levers”, “driving change”, “stepping up a gear”	Organism “adaptability”, “evolution through innovation”
strategy	Centralise control with clear separation between design (policy) and operations.	Delegate and grant autonomy so as to maximise local flexibility and ability to handle variation
Thinking Style	Reductionist break the problem down into smaller components	Holistic retain the connections between components, discard detail
aim	Find a solution based on detailed analysis of how the parts work	Make an improvement based on identifying feedback and interactions between issues
works best with	Complicated predictable problems for which there are agreed goals and recognisable solutions	Complex issues that involve multiple agencies and which have so far resisted all attempts at improvement
epistemology	Presumes existence of ‘objective facts’ to resolve decisions and disputes – even in the social domain	Recognises the existence of different perspectives based on different values, goals and culture. Problem solving explicitly pluralist

Bibliography

My aim here is to provide you with a few key references that will enable you to pursue any particular interest in the area of systems thinking and methods.

Jackson, M.C. *Systems Thinking: Creative holism for managers.* (Chichester, Wiley. 2003) This is an extremely authoritative and useful book. It covers twelve different systemic approaches to management. For each approach the author gives an account of its historical development, the underlying philosophy, the methodology and methods used with a case study example and a critique. This is a real tour de force and is supported by two overviews of how the different approaches can be classified and their appropriateness established. If you only read one systems book this is the one to choose.

Seddon, J. *Freedom from Command and Control: a better way to make the work work.* (Buckingham, Vanguard Education. 2003). This book describes the 'Lean Systems' approach in detail, with some useful case study examples.

Rosenhead J and Mingers J (eds) *Rational Analysis for a Problematic World Revisited: Problem Structuring Methods for complexity, uncertainty and conflict.* (Chichester, Wiley 2001). In broad content this is quite similar to Jackson's book in that it describes a number of systemic approaches. However the emphasis is slightly different and the reader is taken into more detail for each of the eight methods covered. The are also fuller case studies supporting each approach.

Bill Torbert et al *"Action Inquiry: The Secret of Timely and Transforming Leadership"* (Berret Koehler Publ.Inc, San Franciso 2004.) This book is based upon a model of adult development adapted to leadership and describes the characteristics of seven different stages of development. It does not refer directly to much systems theory, but is focussed on how an individual can enhance their capability as a leader. A book that relates adult development to systems thinking – but is rather dense reading – is "*In Over Our Heads: The mental demands of modern life*" by Robert Kegan, Harvard University Press 1994.

Checkland,P and Scholes,J . "*Soft Systems Methodology in Action*", Chichester, Wiley, 1990. This describes the mature version of the Soft Systems Methodology in some detail. The book also contains in depth case studies on its application.

Senge P.M. *The Fifth Discipline: The art and practice of the learning organisation* (London, Random House Business Books, 1990) This was an important book for bringing systems thinking and learning organisations into the area of management and inspired many commercial organisations to adopt the approaches set out in the book. The book also introduces the basics of System Dynamics.

Capra, F "*The Web of Life*" Harper Collins, London, 1996. This book provides a comprehensive introduction to the ways in which systems thinking, chaos theory, complexity, self-organisation and evolution form a comprehensive and new view about the biology of life *and* how we come to know what we know.