AN INTRODUCTION TO SOFT SYSTEMS METHODOLOGY

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1. SYSTEMS THINKING

1.1 Introduction: systems thinking in the context of science

This section will look at a set of ideas - systems ideas - that are influential in many disciplines as a framework for understanding complexity. The discipline of Systems Analysis is an application of systems theory as is Checkland’s Soft Systems Methodology and, if we are to understand its philosophical foundations, it is important to understand first what is meant by systems thinking.

Systems thinking implies thinking about the world in terms of the concept of a system which can be defined as -

A set of elements connected together in an organized and inter-related way to form a whole, this showing emergent properties which are properties of the whole, rather than properties of its component parts.

The essence of systems thinking then is that it is a holistic approach to problem solving: analyzing things by looking at their simple components is inadequate as important characteristics which are observable only in the higher levels of the system will be missed.

Checkland gives an account of the origins of systems theory in the inadequacy of the scientific method to deal with complexity. The classical scientific method emerged from the sixteenth century onwards and is the product of the Enlightenment and the Industrial Revolution. It can be thought of as consisting of three elements -

- reductionism
- repeatability
- refutation

The complexity and variety of the material world is reduced in experiments whose results are validated by their repeatability, and knowledge is built through the refutation of hypotheses. Reductionism is necessary in order to make the complexity of the real world manageable and subject to proof through repeated experiment. Science therefore looks at simple, isolated components in order to analyze problems.

![Fig. 1. Checkland’s model of the scientific research method](image)

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1 From Checkland, P. 1998. *Information, systems and information systems: making sense of the field*. 
The crucial problem which confronts science is its lack of ability to cope with very complex phenomena. The method is only valid for complex problems if it holds that the division of the problem into its component parts will not distort the phenomena being studied. The concepts of holism and emergent properties - the idea that the whole is not solely to be understood through the sum of its parts - is the limitation on the scientific method.

The challenge to classical scientific method came, initially, from biology. A reductionist approach to studying living organisms would examine their simplest components - e.g. the cell - an approach which has the logical consequence of reducing biology to physics and chemistry. Biology though has the problem of understanding phenomena of a higher order - complex organisms that cannot be fully understood through their simple components. The phenomena under study are so complex that they cannot be isolated and reduced to simple experiments. The problem of complexity is even more acute when the phenomena under study are human, social phenomena rather than natural ones. Some problems are too complex to be solved through scientific experiment or understood through simple, general laws.

Systems thinking is an attempt, within the tradition of scientific rationalism, to compliment it by tackling the problem of irreducible complexity through a kind of thinking based on wholes and their properties. Systems thinking has been influential within the domain of organisation theory, management and information systems because it provides a framework for analyzing complex problems.

1.2 Foundations of systems thinking

Two pairs of ideas form the foundation for systems thinking -

- Emergence and hierarchy
- Communication and control

We shall now go on to look at these concepts in more detail.

1.2.1 Emergence and hierarchy

The first strand in systems thinking comes from biology. Holistic, systems thinking in biology was generalized by a theoretical biologist, Ludwig von Bertalanffy, who extended the ideas of organic, biological systems to a general way of thinking about any whole thing, or system. Twentieth century biology reinstated the idea of purpose, or organisation as being an essential feature of living organisms. It is the concept of organized complexity which became the subject matter of the new discipline of systems which began to emerge in the 40s and 50s.

The general model of organized complexity is that there exists a hierarchy of levels of organisation, each one more complex than the one below it, each level being characterized by emergent properties which do not exist at the lower level. As an illustration of these ideas consider a human being: at the lowest level there are atoms, molecules, cells; then tissues and organs; then the body’s highly-interrelated systems - e.g. the respiratory and circulatory systems; at the highest level the whole human with its specific outward form, a member of a species, which is one of a sub-group of animals classified as mammals etc. Systems are made up of a hierarchy of sub-systems.

The idea of emergent properties states that at all levels a system exhibits properties that are more than the sum of its parts. The example that is often quoted to illustrate this concept is used by the Soviet psychologist Vygotsky: the properties of the complex substance water (H₂O) – one of which is its ability to extinguish fire – are not found in either of its molecular components Hydrogen (which is combustible and explosive) and Oxygen (without which combustion cannot take place).
An important implication of the idea of hierarchy is that of the interfaces between the interrelated levels and the processes of control which operate between them. These ideas can again be illustrated with reference to the human respiratory and circulatory systems: if a person begins to run, or to work hard, they will require more oxygen in the muscles to convert food into energy. The speed at which the heart pumps blood containing oxygen around the body increases, as does their rate of breathing to bring more oxygen into the blood system to deal with the increased rate of metabolism. The arteries and veins dilate in order to increase the flow of blood ... This brings us to the second pair of foundational ideas underlying systems theory -

1.2.2 Communication and control

One of the ideas about systems developed by von Bertalanffy was the distinction between systems which are open to their environment and ones which are closed. Open systems interact with their environment: they take in things from it - system inputs - and export things to it - system outputs. The exchanges between an open system and its environment may be of materials, energy, information. Systems perform processes on the inputs in order to transform them and to produce outputs. This transformation model is widely used to illustrate the characteristics of an information system –

![Diagram of an open system](image)

**Fig. 2. Input/output model of an open system**

In this view information systems exist within an environment, and have a boundary which can be defined. The boundary determines the interface between the system and the environment in which it operates. The inputs and outputs of the system originate and end in the environment. (This model may more accurately be viewed as a model of a data processing system as opposed to an information system.)

The ideas of communication and control in systems originated in the application of quantitative techniques to solve logistical problems in the Second World War. This lead to the post-war development of the discipline of cybernetics - defined by Norman Wiener, one of its founding fathers, “as the entire field of control and communication theory, whether in the machine or in the animal”.  

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The basic concept of communication and control in systems is that, in order to achieve its purpose or goal and to remain in equilibrium with its environment a system uses information about its performance - feedback - to adjust its activities. Control procedures detect divergence from the goal and then adjust the inputs or processes in the system to regain equilibrium. Variations in controlled inputs, uncontrolled inputs, or processes may result in the system producing measured outputs that are outside the accepted tolerances of the system. If

the divergence is fed back into the control system, the inputs, processes, or goals can be altered - either positively or negatively - to regain equilibrium. A mechanical example of this is the thermostat which controls the operation of a central heating system: this detects a change in room temperature, compares it with a pre-determined temperature setting and uses this information to either turn the system on or off. An organic example is the human system described above - a self-regulatory system which adjusts inputs of oxygen or food, and outputs of energy and waste according to the body’s needs.

Control and communication in systems is important in the context of information management as an information system is a control mechanism for the organisation. It provides the information about the operation of the organisation upon which decisions to make adjustments are made. Timely and accurate communication of this information to individuals responsible for making decisions about the operation of the organisation is therefore of great importance.

1.3 The application of systems thinking

Although systems thinking has been developed as a general theory of systems, it has been most influential when applied in various disciplines - biology, geography, management and systems analysis to name a few. What then is implied by systems thinking in practice? The general ideas of systems thinking are summarized below -

• Thinking about phenomena as hierarchically organized wholes, made up of inter-related sub-systems which work together to achieve a common purpose or goal. At all levels of the hierarchy the system shows characteristics which are not apparent at the lower levels.

• Identification of some common principles which enable a system to be defined and a boundary drawn around it, distinguishing it from its environment (and the other systems in that environment).

• Defining the inputs and outputs which cross the system boundary (and help to define that boundary) which may be flows of materials, resources, information, energy, ideas etc.

• Identification of the mechanisms of control by the means of which the system maintains its identity and coherence.

• Identification of the purpose or goals of the system, and the principles by which its components, or sub-systems are organized.

• These ideas are sufficiently general to be applied to thinking about any kind of system - whether physical, biological or social.

1.4 A classification of systems

For the purpose of applying systems thinking to understand phenomena it is useful to think of the different classes of systems -

• Natural systems. The hierarchy of physical and living systems which are part of the natural, material world. (Atoms, trees, the solar system ...)

• Designed physical systems. Systems such as tools and machines which are the result of man’s intervention in the natural world - the consequence of planned, conscious design to satisfy some human purpose. (Hammers, trains, computer hardware ...)

• Designed abstract systems. Artefacts which are not physical, but are equally the creation of conscious activity. (Number systems, library classification systems, software ...)
• **Human activity systems.** Consciously organized human activity, individual or social, achieving some purpose. (Hammering, education, politics ...)

It should be noted that most systems are hybrids so far as this classification schema goes, particularly if they are complex systems. The human activity system “The University”, based on an abstract idea, has elements which are both designed physical (buildings, equipment, books ...) and designed abstract (courses, accounts, books ...). Applying systems thinking becomes a matter of determining the properties of each class, and the way in which they combine and interact to form wider systems showing emergent properties.

### 1.5 Strengths and limitations of systems thinking in organisational theory

Gareth Morgan⁷ looks at the application of systems thinking to organisation theory. His interpretation of general systems theory is that it is a metaphor from biology used to understand organisations: organisations are not organisms, but thinking about them as like organisms can be a source of rich insights. The organic metaphor is used to show that organisations - like biological organisms - are “open” to their environment and must maintain an appropriate relation with it if they are to survive. This metaphor has generated many new concepts for looking at organisations and has lead to practical developments in organisational management. (It has also been enlarged from the original systems ideas to encompass the idea of an organisation’s information systems as “ecologies” – a metaphor sometimes found in the knowledge management literature.) However, as with metaphorical thinking in general, it has limitations and can cloud issues as well as elucidate them.

Morgan highlights the following insights that systems thinking has given to organisational theory, which are highly relevant when thinking of the role of information systems in organisations -

- The image of an open system in constant exchange with its environment through ongoing processes leads to an open and flexible view of organisations.
- The management of organisations (and information systems) can be improved through analysis of the “needs” which must be satisfied if the organisation is to flourish and survive.
- Organisations are interacting processes which have to be balanced internally as well as externally. The organisation’s sub-systems also have needs for feedback, control, information etc.
- Because of the needs for flexibility and adaptability in organisations in order to survive in a changing environment, it follows that flexible and adaptable internal systems and management are required rather then mechanistic, rule-governed ones.

However, in Morgan’s perceptive phrase “Sometimes a way of seeing is a way of not seeing.” There are limits to the organic metaphor and it can distract attention from some other important issues -

- Unlike biological organisms organisations (and information systems) are socially constructed rather than given. Environments are equally the product of human action and the relationship between an organisation and its environment is therefore more complex and dynamic than that of an organism and its natural environment over which it has no control. Systems theory does not deal with the extent to which a human activity system can change its environment, preferring instead to see the relationship as one of internal

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adjustment through the mechanisms of communication and control, in order that the system can maintain a “dynamic equilibrium” with the environment.

- In organisms the elements of the system are functionally inter-dependent and can be truly said to work together for a common purpose. A biological system is unified and the only circumstances in which it breaks down are pathological (e.g. a heart attack causes respiratory arrest). Organisations may consist of sub-systems which do not work in harmony and may have differing goals, or different views of how goals are to be achieved. Contradictions, conflict and dissent can be a creative force in organisations which lead to transformation and progress rather than entropy and decay. Systems thinking applied to organisations has lead to conflict being viewed as undesirable and dysfunctional, a view which informs much management ideology.
Exercise 1 - applying systems concepts to human activities

According to Peter Checkland\(^4\), the originator of Soft Systems Methodology, a human activity system should have the following characteristics –

- Objectives or purpose – systems are goal-oriented
- Connectivity – a system is made up of interacting sub-systems
- Measures of performance
- Monitoring and control activities
- Decision-taking procedures
- Boundary – through which inputs and outputs cross – between the system and its environment, and other systems with which it may interact
- Resources – either things, people or information – for its own use
- System hierarchy – system activities can be decomposed into sub-systems
- Continuity – ensured through effective performance monitoring and controls

Checkland uses a template to model activity systems which show activities that –

- Plan or decide what to do
- Do what has been planned
- Check the actual performance against what is required (monitor, control, feedback)

Most of these ideas will be familiar to you through SSADM modelling techniques – Business Activity Models and Data Flow Models – which are based on systems theory.

On the next page is a template of a human activity system, showing the generic activities that should take place. You should consider the following system and then model its main activities, following the guidelines indicated by the template –

“A student individual project carried out by a level 3 undergraduate to satisfy the requirements of IS391/2”

You should aim to have approximately 6-10 activities on the top level model. Once you have produced a model that you are happy with try to use the template approach to model one of the activities that you have shown on it at a lower level.

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Generic template for modelling a human activity system

Information
- Find out relevant information
- Plan - determine ways to meet needs

Resources
- Obtain resources
- Organise resources
- Establish performance measures
- Take control action
- Monitor performance of all activities

Satisfied needs
- Identify constraints

Targets

Information

Resources
2. Background to Soft Systems Methodology

2.1 Two schools – hard and soft systems approaches

Although they employ the same concepts, there are two well-defined schools of thought in the systems community. Checkland distinguishes between a hard, engineering school and soft systems thinking. The application of the concepts of systems thinking to solve ill-structured “soft” problems is Checkland’s original contribution to the field of systems theory.

The hard, engineering approach, which emerged during and at the end of the Second World War, was developed to tackle well-defined problems. Such problems can be formulated in the following way -

There is a current situation $S^0$ and a future, desired situation $S^1$, and different alternative ways of getting from $S^0$ to $S^1$. Problem-solving, in this context, consists of defining $S^0$ and $S^1$, and selecting the best way of getting from the original state to the desired state.

This is the approach of structured information systems development methodologies – first analyse and define the current situation and the new requirements; then specify and design the new system and select from the available options the solution that best fits the requirements. It is then a straightforward matter to “engineer” the chosen solution or product. The belief that real-world problems can be formulated in this way is the distinguishing characteristic of hard systems thinking which is concerned with how to solve problems that can be clearly defined from the outset.

Soft systems thinking is concerned rather with defining what problems need to be solved – that is clarifying the problems that exist as a prerequisite for defining the options for improvement. Checkland notes that although very effective when applied to solving well-defined problems, hard systems thinking has been notoriously unsuccessful when applied to ill-structured, soft problems with a large human or social component. In such situations what is required is a methodology that allows the problem situation to be thoroughly explored – involving the problem stakeholders in the investigation process, which is itself a process of learning about the problem. In contrast to hard systems methods which concentrate on engineering a product, soft systems methods focus on problem solving as a process, which, if done effectively, will lead to changes in the problem situation and possible solutions emerging. This is the methodology of action research –
2.2 Origins of Soft Systems Methodology

Soft Systems Methodology (SSM) was developed by Peter Checkland and colleagues in the Department of Systems at the University of Lancaster, and its consultancy company ISCOL Ltd. Checkland describes the origins of SSM in the hypothesis that the principles of systems thinking – i.e. systems concepts – could also be applied to soft, ill-structured problems with a human as well as a technical component. The approach of Checkland et al was to apply systems thinking to the study of real-world, management problems, taking the concept of a human activity system as their guiding principle. The research sought to answer 3 questions –

- What are the special characteristics of human activity systems?
- Can such systems be improved, modified or designed?
- If so, how can this be done?

The object of the program was to develop a methodology through intervention in real-world problems – one that was capable of bringing about some improvements in complex problem. The criterion of success was that the problem owners felt that the problem had been improved, or that they had developed some insights and understanding of it. SSM was developed and tested through a large number of action research projects that simultaneously tackled real-world problems (action) while learning from this process to develop the methodology itself (research).

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2.3 Human Activity Systems

Fig. 4. Checkland’s activity model of a fence-painting system.

The idea of a Human Activity System (HAS) is fundamental to SSM. HASs comprise activities performed by people in the pursuit of goals; in systems design they are often modelled as a series of inter-dependent activities. Fig. 4. shows the simple example of a HAS to paint a fence. In modelling human activities in this way many systems concepts (input, output, transformation, boundary, environment, hierarchy of systems, communication, control and feedback) are used. The activities shown on the diagram above are themselves sub-systems that can be decomposed into activities.

HASs are always open systems – there is continual interaction with the surrounding environment. Unlike technical systems they are hard to define – many elements of an HAS do not have a tangible or measurable form and so are hard to describe unambiguously. People involved in the HAS may have different and even conflicting viewpoints about the nature of the system. Many of the activities in a HAS may be informal and even unobservable – such as the mental processes involved in the development of knowledge and expertise. Similar problems arise when attempting to model other aspects of the system and with measuring its performance. Activity models, although useful, do not show many of the complex human processes involved in HASs, which have a strong bearing on the success or otherwise of a project.

When introducing a new IS into an organisation it is insufficient to consider a HAS as merely a series of activities ignoring the social system which is integrated with the technical system. Introducing a new IS is about change. This change may be just to the activities which are performed by the humans in it, but it may mean replacing some of the activities with machines rather than people, may make some activities completely redundant, may require a change in

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the culture of the organisation and so on. Many people will resist change, especially if they do not know what the implications will be for them, and the social system will affect the acceptance of change. In addition, there may be no consensus in the organisation about what changes are required: many different viewpoints may exist. In order to include this aspect of a HAS SSM explicitly takes account of the different viewpoints in a problem situation, and the relationships between people in organisational activities.

- On the activity side of a human activity system the elements are the activities or what the system does. The interconnections between the activities show the logical dependence of some activities upon other activities.

- On the social side of the human activity system the components are the people and groups who perform the activity and these represent how the activities are performed. The interconnections are the inter-personal relationships and the lines of communication (whether formal or informal) which exist.

2.4 Basic concepts of the Formal Systems Model

Checkland defined a formal model of a system which he applied to HAS. The formal systems model is basically a checklist of characteristics that must be present in order for a HAS to satisfy the criteria of being a well-designed system. It can therefore be used as a benchmark to evaluate a real-world HAS, or as a template for re-designing a HAS – the uses of the formal systems model will become apparent as you learn how to apply SSM.

- Objectives or purpose. The system represented by the model has an ongoing purpose – it exists for a reason, has goals, and achieves some transformation or change through its activities. It must be possible to define explicitly the purpose or goals of a system.

- Connectivity. The activities in the system must be connected to other activities. If activities are not connected then they are part of a separate system.

- Measure of performance. There must be measures of performance and expected levels of performance to be met, which can be used for assessing the efficiency of the system. In a fully developed human activity system all activities are subject to individual measures of performance.

- Monitoring and control. There must be mechanisms to collect data about performance and to compare it with the expected levels of performance. There must also be control activities that have the authority to change other activities when performance expectations are not being met. Control activities change how other activities are done (what rules they follow, what resources are available, who does them etc.) rather than what they are.

- Decision-taking procedure. There must be decision-taking procedures which will be influenced by control actions.

- Boundary. The system must have a clearly defined boundary and communications across the boundary must be explicitly defined. The area within the boundary is that within the control of the regulating mechanism.

- Resources. All systems consume resources and these must be obtained, deployed, replenished and accounted for. Consumption of resources must be monitored and controlled.

- System hierarchy. A system can be decomposed hierarchically – i.e. it has components that are themselves systems.
• **Continuity.** A system has some expectation of continuity and has mechanisms that allow it to recover from disturbances.

These systems elements should be all present in the model of the system to paint a fence (Fig. 4.) if it is satisfy the criteria for a good system. For example, a goal of the fence-painting system might be to enhance the appearance of the property and to prevent the fence from deteriorating over the winter. There needs to be a means of estimating how much paint is required for the task (resources) and sub-systems to monitor and control how much paint is used (a measure of performance). Decisions have to be made about what colour paint is to be used given the decorative scheme of the property, generally understood aesthetic considerations and availability of colours; or to buy more paint should the supply run out.

2.5 **Measures of success of a system – Checkland’s 3 E’s**

Checkland states that the transformation of a system of input to an output can be judged successful or unsuccessful on three different counts, known as the ‘3 E’s’ –

• **Efficacy** – does the means chosen to transform the input actually work in producing the desired output?

• **Efficiency** – the relationship between the output and the resources used. A transformation should be carried out with the minimum of resources.

• **Effectiveness** – a transformation which works and which uses a minimum of resources also has to satisfy the criteria of achieving the longer term aim.

These criteria can be applied to the fence painting system, just as the formal system model can. The fence painting system can be judged a success if the means chosen to paint the fence results in a painted fence of the desired quality and colour (Efficacy); if it has been carried out using the minimum quantity of paint required to paint a fence of this size (Efficiency); and if the transformation has achieved the longer term aim of enhancing the look of the property and preventing deterioration of the fence from the effects of the weather (Effectiveness).

It has been suggested that there are a further two E’s that also need to be considered when evaluating a system – is it Ethical and Elegant?

2.6 **What is a methodology?**

Checkland stresses that SSM is a methodology rather than a method:

“The outcome of the research [i.e. the action research practice of SSM through which SSM evolved] is not a method but a set of principles of method which in any particular situation have to be reduced to a method uniquely suitable to that particular situation. ... I take a methodology to be indeterminate in status between a philosophy, ... and a technique or method.” (Checkland, 1981, p 161-162.)

A methodology is a stronger guide to action than a philosophy, although it embodies some philosophical principles or a particular world-view. SSM is a practice-oriented set of guidelines which can be applied in customised ways to assist in the analysis of ill-structured and complex problem situations. It is a problem oriented methodology which allows the problem to influence the way that the analysis is carried out, rather than a set of methods which are applied in the same way to all problems. SSM is then a framework into which the activities of a specific systems study can be structured. Checkland emphasises that it is not a “cookery book recipe” – i.e. a set of steps and techniques that can be followed procedurally in order to produce a desired outcome. The actual method pursued and techniques used will have to be modified and tailored to suit the specific needs of each project.
2.7 **Keys ideas of SSM**

Checkland defines SSM as “… an interpretive approach to organisational problem solving which can be used to provide a structure for action research in which desirable change and organisation learning are the objectives.” This definition embodies some important ideas. SSM is interpretive because it seeks to interpret complex and ill-structured problems which have no tangible existence or commonly understood definition. It interprets them in ways that are helpful to the organisation in understanding the problem and moving to a solution. Problem owners and actors should be involved in the SSM process as one of the objectives is that they should participate in the process of learning about the problem in order that they (rather than the analyst) can identify possible solutions. Some key ideas about the nature of soft problems underlie SSM:

- Problems do not have an existence independent of the human beings involved with them.
- People have different understandings of problem situations because they perceive them from different viewpoints or world views.
- If problems are intellectual constructs, determined by viewpoints, then solutions are also intellectual constructs.
- Problems do not exist in isolation and are not structured and well-defined. Problems interact with other problems. (Hence Checkland’s use of the terminology “problem situation” rather than “problem”.)
- Improvements in complex problem situations are likely to come about through the explication and sharing of viewpoints and through discussion. The analyst is a catalyst to facilitate learning about the problem situation and change.
- The analyst cannot be detached from the analysis. He is part of the situation.

SSM can be used to analyze any complex problem with a social dimension - managerial, personal, organisational etc. and is not just a methodology to deal with the development of IS. SSM is a methodology geared towards learning about and understanding problem situations in order to identify strategies for improving them - rather than finding solutions to pre-defined problems.
3. **SSM OVERVIEW**

3.1 **Stages of the Soft Systems Methodology**

Below is a model of the seven stages of the original Checkland Soft Systems Methodology.

![Diagram of the seven stages of SSM](image)

*Fig 5. The conventional seven-stage model of SSM*

This is the usual way that the methodology is presented as it was derived from the early action research projects through which SSM was developed. Checkland has developed the model in his later work (Checkland and Scholes, 1991, Chapter 2) to present it in a much more subtle and less prescriptive-looking way. However, the secondary literature (such as Patching) sticks to the 7 stage model and for newcomers to Checkland this is the best way to learn what is a undoubtedly a difficult methodology to grasp. SSM can only really be learnt through its application – it is against the spirit of action research that it can be learnt effectively through classroom teaching. In order to develop a more mature understanding of SSM it would be necessary to practice the methodology in the real-world. However, it is necessary to commence learning somewhere and for this it is best to stick to “novice SSM”.

The 7 stage model illustrates the process of SSM which consist of both taking action in the real-world problem situation to first understand it (stages 1 and 2) and lastly identify ways it could be changed (stages 5, 6 and 7), and using systems concepts to reflect on and model the problem situation (stages 3 and 4). This is shown in the division in the model with some of the stages being performed in the real world, others being part of the systems thinking world.

SSM is a methodology that aims to bring about improvement in areas of social concern by activating in the people involved in the situation a learning cycle which is ideally
never-ending. The learning takes place through the iterative process of using systems concepts to reflect upon and debate perceptions of the real world, taking action in the real world, and again reflecting upon the happenings using systems concepts. The reflection and debate is structured by a number of systemic models. These are conceived as holistic ideal types of certain aspects of the problem situation rather than as accounts of it. It is taken as given that no objective and complete account of the problem situation will be provided. (Below, 1981.)

Although the method is presented in stages it is important to understand that this does not mean that it is performed sequentially. In reality it may not be necessary to undertake or complete each step, or to perform them in sequence. The stages are iterative and the essence of SSM is that it is a learning process which evolves in a manner which is appropriate to the problem situation.

In the next section we will look at each stage in detail. Before that we will briefly summarise the stages of the methodology.

- **Stages 1 Problem situation unstructured & 2 Problem situation expressed.** Initially the analyst will look at the complex problem situation, representing its complexity without any preconceived ideas about the type of situation being investigated or even the nature of the problem itself. The initial investigation is likely to involve information gathering techniques (some of which are covered in this module) such as interviews and focus groups. The data from this investigation might be analyzed using techniques such as categorizing and coding in order to identify the main themes. The aim of the investigation is to find out about the problem situation from as many viewpoints as possible. A technique which has come to be synonymous with SSM is that of drawing rich pictures - the representation of the problem situation by a set of diagrams which are an aid to analytic thinking and which “express” the problem situation.

SSM uses the label “problem situation” rather than “problem” to draw attention to the ill-defined nature of the problem – and the fact that it may well-consist of not one but a number of interrelated problems. Problems are things with an implied solution, problem situations first need defining themselves before a solution can be identified. Checkland’s definition of a problem situation is “any situation in which there is perceived to be a mismatch between what is and what might, could, or should be.” It could consist of no more than a “vague uneasiness” that something is wrong – or an undefined aspiration for things to be different.

- **Stage 3 Root definition of relevant systems.** Taking the problem themes identified in steps 1 and 2 the next stage of the analysis involves the analyst moving from the “real world” and applying systems thinking to the problem situation. Relevant systems are identified and named. A relevant system is one which encapsulates a way of looking at the problem which provides a useful insight. Several relevant systems, embodying different viewpoints as well as the formal organisational viewpoint, can be explored in order to elucidate the problem situation. A root definition describes a relevant system in systems thinking terms – the transformation that should be taking place – as well as identifying the actors involved in the problem situation. Root definitions are developed by means of a “CATWOE analysis” to identify the system components that should be present in the root definition. CATWOE is a mnemonic for the following systems elements –
The Customer – people who either benefit from the transformation process carried out by the system, or who are effected by it some way, possibly adversely.

The Actors who would carry out the activities in the system.

The Transformation process which transforms the system inputs (i) into outputs (o).

The Weltanschauung (world-view or viewpoint) - how the system is perceived or defined from a particular viewpoint.

The Owner of the system - the decision-maker who has responsibility for the performance of the system. (There may be a hierarchy of system owners, where one is responsible to a higher owner.)

The constraints on the system from its Environment; features of the real world which the system interacts with but which are outside its control.

- **Stage 4 Conceptual modelling.** The relevant systems are then modelled as a conceptual model (CM) showing what the system would have to do if it were implemented as a real-world human activity system. The CM shows the essential activities that would have to be performed for the system to carry out the transformation that has been identified for it. It is a theoretical or conceptual model of the system because it shows the analyst’s ideas about what it should look like – it is not a model of something that exists in the real world at this stage.

- **Stage 5 Real world/systems world comparison.** Moving back into the real world the CM is compared with the real world situation to identify the differences between them. The CM can be used as a template to identify essential activities that are not present in the real-world system. Hopefully this will begin to reveal the problem sources in the real world situation.

- **Stage 6 Decide on desirable/feasible changes.** If it is considered desirable a debate about possible changes to the real world situation takes place, prompted by the problems identified in the previous stage. Changes must be feasible – i.e. acceptable to the organisation, and possible within the constraints with which it operates. They must also be desirable – i.e. they must be changes that would promote a change for the better in the system.

- **Stage 7 Make changes to improve to improve the situation.** If agreement can be reached amongst those involved then a way to implement the changes is identified.
4. THE PROBLEM SITUATION EXPRESSED: RICH PICTURES

When an analyst first begins to study an organisation it can take quite a while to gain a clear understanding of how work is carried out. This is a bit like starting a new job: for the first few days it is hard to see how activities are structured, who is responsible for what, and how lines of communication – whether formal or informal – link up activities. Even if the organisation describes itself as made up of formal structures and lines of management, the organisational model that newcomers are often given in their first few days does little to help make sense of the underlying organisation of work. An analyst working with a “hard” problem – such as designing a database – may have quite a job building up a complete and coherent picture of the data that is used in different parts of the system, and the job activities that process the data. For an analyst working with a “soft” problem where human behavior and attitudes are also important the problem is much greater. The unstructured problem situation will probably seem an incoherent mess at first, with contradictory evidence to be made sense of.

The first step in SSM is to gather data using some investigation techniques such as interviewing the actors in the situation, observation, or by holding focus groups to share information. It is the job of the analyst to structure this data in some way and to identify the relevant issues and components of the problem situation. This is the stage that SSM calls “express the problem situation”. In practice stages 1 and 2 cannot be separated and are done in tandem. The object is to build up “…the richest possible picture of the situation being studied.” (Checkland, 1981). In the subsequent practice of the method this was taken literally and the technique of drawing actual rich pictures was used to represent the problem situation. Although rich pictures are now almost synonymous with SSM they are by no means compulsory: they are primarily to assist the analyst with thinking about the situation and should only be used if the analyst finds them useful.

A rich picture is a pictogram or informal model of the problem situation. Some or all of the following should be shown in the rich picture -

- The structure of the situation - i.e. formal departments, hierarchies, buildings, physical layout.
- Processes - the tasks and activities which are carried within the structure.
- Interaction of structures and processes.
- A mixture of “hard” facts and “soft” subjective opinions. Major issues in the situation particularly things that are cause for discontent or barriers to progress.
- Social roles - formal and informal. Behavior of the actors - good and bad.
- The climate or context of the problem situation – factors such as its environment and the organisational culture. A rich picture should show the “big picture”.
- The role of the analyst – through their intervention the analyst becomes a part of the problem situation.

Note that although the first three features are found in systems theory, the others are features that are particularly emphasised by SSM. Identifying the issues is particularly important: these will be used in the next stages of analysis to represent the problem from different viewpoints. Having developed the rich picture the analyst should reflect on it; it might be desirable to use it as a prop in discussions with people in the situation.

There are no rules to guide the analyst in making a rich picture, although there are certain conventions and widely used symbols, such as crossed swords to represent conflict. If you have never used representations like this before it can be very hard to get started – the best advice is to look at examples of rich pictures and see how different analysts develop their own style. The technique is in essence a personal one where the analyst makes sense of the problem situation for themselves. Rich pictures may be annotated by textual footnotes.
Exercise 2 – Developing rich pictures

1. Starting off easily

Draw simple pictures, graphic symbols or annotated symbols to represent some of the following –

- Creative thinker
- Conflict or antagonism
- Technophobia
- Stress, pressure
- Authority
- Help, assistance
- Reinventing the wheel
- Offensive
- Individualism
- Non-creative thinker
- Fear of job losses
- Information overload
- Consensus, agreement
- A breakdown in communication
- Report, book or documents
- Crisis management
- Bad publicity
- Teamwork

2. Expressing the problem situation in the assignment case study

Read the One Stop Solutions case study carefully and then try to create a rich picture to show the features and issues that need bringing out. It will probably take several attempts before you achieve a satisfactory rich picture. Try to complete this before next week when you can use it to identify some of the “relevant systems” to model in the next stage of analysis.

There are no rules about what makes a good rich picture. In previous years students have developed a wide variety of approaches, including –

- Using clipart in the final version if they are not confident about their drawing abilities
- Annotating their rich picture with notes
- Creating an overview rich picture, and then homing in on one or more areas to depict them in more detail – ending up with a set of rich pictures
5. MODELLING HUMAN ACTIVITY SYSTEMS

5.1 Investigating problem situations

An enquiry begins when the analyst is bought in to investigate a problem situation - that is a situation where there might be no general consensus that there is a problem, let alone agreement on what it is or the means for solving it. Usually the situation will be a system of inter-related problems which the actors involved may perceive in many different ways, according to their roles.

Even when the problem is defined in concrete terms the analyst must explore further before committing to this view of the situation with its implied solutions. It is a good idea to start by clarifying the roles of the client, the problem owner and the problem solver. SSM uses the terms problem owner and problem solver to distinguish roles of actors in the problem situation.

The problem owner is defined by Checkland as “he who has the feeling of unease about a situation” and also as those persons “taken by the investigator to be those most likely to gain from an achieved improvement in a problem situation”. The problem owner is defined according to their relation to the problem rather than their role in the organisation. The problem owners will be a variety of different people involved in the problem situation - it helps to identify as many as possible as they may have different viewpoints of the situation which the analyst should consider.

The problem solver is whoever wishes to do something about the problem situation. To this extent the analyst is a problem solver insofar as they have been called in to investigate the problem. However, the role of the analyst is that of a facilitator – someone who helps the problem owners to identify and implement a solution i.e. to become problem solvers. The analyst’s role is to uncover the subjective views of the problem and help to identify possible changes.

The client is the person who causes the investigation to happen initially, the person who may ultimately become the problem solver. Checkland also says that there will always be a role of client – someone in the real-world situation who caused the study to take place.

5.2 Partitioning of the study into “real world” and “systems thinking”

If you refer back to the 7 stage model of SSM in section 3 (figure 5) you will see that the stages are partitioned into two spheres - real world activity and systems thinking about the real world. Stages 1 and 2 take place in the real world, as do stages 5 to 7 (these are covered in section 6). Stages 3 and 4 – which we will be concentrating on in this section – involve using systems concepts to develop models which can be used to facilitate learning about the real world situation. It is important to understand that the models developed in stages 3 and 4 are not models of the real world, or of any “system” that actually exists. Rather they are ideas about how the real world might look, or should look, if it was to be redesigned as a formal system (see the formal system model) that was efficacious, efficient and effective (see the 3 E’s).

5.3 Stage 1 – the unstructured problem situation

The first task of the analyst is, as in any project, to gather the relevant facts about the problem. In a well-defined “hard” project this may involve the collection and analysis of quantitative data – that is data that can be measured, enumerated or collected through experiments. Quantitative research methods were originally developed in the natural and physical sciences to study natural phenomena. In an SSM project the methods of information
gathering are more likely be qualitative. Qualitative research methods were developed in the social sciences to enable researchers to study social and cultural phenomena. Examples of qualitative methods include observation and participant observation, interviews, surveys and questionnaires, examining documents and texts, and the researcher’s impressions and reactions. Qualitative research methods are designed to help researchers understand people, their viewpoints, and the social and cultural contexts within which they work. The investigation is carried out by through talking to all or a sample of people involved in the problem – the extent to which it is possible to talk to everybody will, of course, depend on the size of the organisation and this will influence the design of the research. The widest possible view of the problem should be sought: the analyst should avoid putting their own interpretation on the problem, but instead listen to the interpretations of others. The analyst should also avoid imposing a systems view of the situation on the data at this stage: what is being studied is a real world situation and it is a mess rather than an ideal system.

The following is a list of tips on how to carry out stage 1 –

- Engage with the problem situation
- Resist attempts, by yourself, to impose a particular structure on the problem situation.
- Record the opinions of others but do not identify with them at this stage.
- Recognize that you are yourself an actor in the problem situation.
- Identify the client, the problem owners and the potential problem solvers.
- Make practical arrangements – somewhere to work; access to people and locations; a way of recording, transcribing and analyzing data.

5.4 Stage 2 – the problem situation expressed

In practice stages 1 and 2 cannot be separated and are done in tandem. The object is to build up “… the richest possible picture of the situation being studied”. (Checkland, 1981). In the subsequent practice of the method this was taken literally and the technique of drawing actual rich pictures was used to represent the problem situation. Although rich pictures are now almost synonymous with SSM they are by no means compulsory: they are primarily to assist the analyst with thinking about the situation and should only be used if the analyst finds them useful. Some or all of the following should be shown in the rich picture (or any other mode chosen to represent the situation, whether diagrammatic or textual) –

- The structure of the situation – i.e. formal departments, hierarchies, buildings, physical layout. Things that are slow to change.
- Processes – the tasks and activities which are carried within the structure.
- Interaction of structures and processes.
- A mixture of “hard” facts and “soft” subjective opinions. Major issues in the situation particularly things that are cause for discontent or barriers to progress.
- Social roles – formal and informal. Behavior of the actors – good and bad, acceptable and unacceptable.
- The climate or context of the problem situation – factors such as its environment and the organisational culture. A rich picture should show the “big picture”.
- The role of the analyst – through their intervention the analyst becomes a part of the problem situation.
The purpose of a rich picture is to assist the analyst in capturing a wide view of the problem situation – including the identification of several different issues and viewpoints that will assist in the next stage. Having developed the rich picture the analyst should reflect on it, trying to look at it from different viewpoints. It might be desirable to use it as a prop in discussions with people in the situation in order to gain more information. The analyst should identify the tasks (the key activities) and the issues (important problem areas) of the problem situation. Rich pictures can be annotated by textual notes if required.

5.5 Stage 3 – Root definitions of relevant systems

Stages 3 and 4 – the modelling stages – are the core of SSM. They are the most difficult to learn but, once grasped, are what gives the methodology its power. Stages 3 and 4 are the activities which most resemble a technique in SSM, with rules about notation and content. The stages involve thinking at a very abstract level: the models that are produced are conceptual models rather than models of the real world. The purpose of the models is to promote learning about the problem situation and the identification of improvements in the final stages of SSM. Systems thinking is holistic and SSM makes the analyst look at the system from many different viewpoints as a way of considering it as a whole.

5.5.1 Identifying primary task and issue-based relevant systems

The bringing together of many different views of the problem situation in a “rich picture” enables selection to be made of a viewpoint, or several viewpoints, from which to further study the problem situation. It is at this point that the analyst moves from the real world situation and employs the concepts of systems thinking to analyze the problem situation. One or more systems, which will be part of a hierarchy of systems, are defined as being relevant to solving the problem.

A relevant system is a systemic way of viewing the situation which is, in some way, relevant to the problem situation in the sense that it will yield insights into it when described. Relevant systems may be of two types -

A primary task relevant system will capture the essential nature of the key task (or activity) which must be carried out by the organisation under study. The definition of the relevant system is fairly straight-forward as most if not all of the actors in the problem situation will recognise and agree on it - it is non-contentious. Examples of primary task relevant systems are e.g. to sell commodities (retail organisation), to convert raw materials to products (manufacturing) or to educate students (school or university).

An issue-based relevant system will focus on specific problematic issues in the problem situation - derived from different ways of looking at the situation - in a way which helps in analysing them or addressing them in some way. The issues and viewpoints represented in the rich pictures are used to identify relevant issue-based systems. Although issue-based systems reflect a specific point of view, rather than a general one, this does not necessarily mean that they are illegitimate or contentious. For example an organisation may have secondary goals that could be represented in an issue-based system e.g. the goal to operate in an environmentally-aware way could be an issue-based system for a manufacturer or retailer. However, issue-based systems can also model systems that are contentious e.g. a manufacturer might also be viewed as a system for polluting the environment from one point of view; a supermarket might be viewed as a system for putting independent retailers out of business.

5.5.2 Deriving root definitions from a CATWOE analysis
Having defined one or more relevant systems to study the next task is to write a root definition. “A root definition is a concise description of a human activity system which captures a particular view of it.” (Checkland, 1981). Root definitions often seem simplistic and obvious, but this is not a problem: the power of the technique lies in the formulation of several root definitions from different viewpoints which can help to structure and define the problem as a whole.

A root definition can be formulated by means of a CATWOE analysis; CATWOE is a mnemonic which summarizes the elements that are needed in a root definition. These elements are derived from systems thinking - the elements of a system – as described in SSM’s formal systems model.

C The **Customer** – people who either benefit from the transformation process carried out by the system, or who are effected by it some way, possibly adversely.

A The **Actors** who would carry out the activities in the system.

T The **Transformation** process which transforms the system inputs (i) into outputs (o).

W The **Weltanschauung** (world-view or viewpoint) - how the system is perceived or defined from a particular viewpoint.

O The **Owner** of the system - the decision-maker who has responsibility for the performance of the system. (There may be a hierarchy of system owners, where one is responsible to a higher owner.)

E The constraints on the system from its **Environment**; features of the real world which the system interacts with but which are outside its control.

The CATWOE mnemonic is not meant to imply that the elements should be identified in a specific order – simply that they should all be analysed for the system under consideration. (Patching, p.74 suggests that it might be more helpful to consider first the Transformation carried out by the system and the Weltanschauung that is behind this definition of the system, before moving on to the other elements.) A root definition should include all or most of these elements to be a valid definition of a system: the Transformation seen from a specific Weltanschauung are the most essential. It is usually expressed in the following generic format:

A [O] owned system which under the following environmental constraints which it takes as given [E] transforms this input [i] into this output [o] by means of the following activities, among other, [T], the transformation being carried out by these actors [A] and directly effecting the beneficiaries or victims [C]. The world view which makes this transformation [T] meaningful contains at least the following elements among others [W].

Several root definitions may be drafted for one transformation reflecting the different weltanschauung that may exist. Many of these will be at odds since they may reflect incompatible viewpoints and interests in the system, or the system viewed from a specific point of view – these will be root definitions of **issue-based relevant systems**. However, a consensus **primary task root definition** should always be formulated - a non-controversial, generally accepted definition of what the main function of the system is.

**Transformations**

Since a system is essentially something that takes inputs and converts or transforms them into outputs, identifying the Transformation is vital to analysing both primary task and issue-based systems. It forms the basis of the activities which will be shown in Stage 3 in the Conceptual
Model. In structured systems analysis the identification of transformations or processes is also important: they are usually shown as in Fig 6.
Input e.g. book loan request

Processes transform ...

Output e.g. loan issue

Fig. 6. The transformation process in a library system

A transformation of this kind is relatively straight-forward to identify as it can be observed. In a HAS things may be more difficult as the transformations are more abstract and conceptual – they may not have an observable or tangible form. For example a Library may be also be considered as a “library user satisfying system” with the following transformation:

Library user needs

Transformation – to identify and satisfy user needs

Satisfied library user

Fig. 7. The transformation in a “library user satisfying system”

Weltanschauung

Weltanschauung is also known as worldview or viewpoint. It is a difficult concept as defined by Checkland – “the image or model of the world that makes this particular human activity system (with its particular transformation process) a meaningful one to consider”. Whatever system has been selected for analysis – whether the primary task or an issue-based system – will be a system perceived from a specific viewpoint. This viewpoint will depend on the individual’s relationship to the system – a customer or competitor, for example, will not perceive a retail system in the same way as the Board of Directors or a shareholder perceives it. Within an organisation the role, status or place of an individual in a hierarchy of inter-related sub-systems will give them different viewpoints on the system. It is important to make the viewpoint on the system which is being modelled explicit by defining the Weltanschauung.

Considering different viewpoints is an important aspect of taking a holistic view of a problem situation. For example take the example of a university where there is a concern by the government that it should provide value for money by educating the maximum number of students at the lowest possible cost. In order to achieve this objective (which is enforced through mandates and grants) the University Directors are considering a number of cost-cutting measures. However, it is discovered that the staff of the University regard it as a place of secure, if not very well-paid, employment, with flexibility in working practices and good holidays. In some departments such as Information Technology and Pharmacy, where employees can earn much higher salaries outside the University, it is these conditions of work that attract and retain staff. In such a situation looking at the problem holistically rather than in
a one-sided way might prevent efficiency measures being taken that would have adverse repercussions on staffing.

**The Environment**

The holistic approach also requires that all external factors that effect the system should be taken into account – “the world that surrounds and influences the system but does not control it”. These factors are relatively easy to identify and people within the system should be able to give the analyst information about the external factors which effect them. In systems thinking a system has to adapt and evolve in order to stay in dynamic equilibrium with a changing environment – for example a British manufacturer might have to cut its costs of production in order to cope with a highly valued pound; a teaching department in a university needs to develop the courses it offers in order to cope with the changing needs of students and employers.

**Customers**

The definition of customer within SSM is slightly different from the conventional definition – customers are the people who either benefit from the transformation process carried out by the system, or who are affected by it in some way, possibly adversely. If a system is decomposed into sub-systems the internal customers of each sub-system need to be identified – i.e. those actors who are dependent on a related sub-system for inputs of information or resources in order that their sub-system can carry out its transformation process.

**Actors and Owners**

Identifying actors and owners, and distinguishing them from customers may not be straightforward. Actors are anyone who carries out activities in the system. The Owner of the system (or sub-system) is the decision-maker who has responsibility for the performance of the system or sub-system. Customer, actor and owner are separate roles in a system, but in the real-world an individual may have more than one of these roles – for example a member of staff may be both customer and actor and, in certain circumstances also the owner of a sub-system.

### 5.6 Stage 4 - Conceptual modelling of systems named in the root definitions

The root definition encapsulates what the system is; the conceptual model (CM) expresses what the system does. The relevant systems defined in the root definitions are not things found in the real world; rather they are ideal constructs using systems thinking to reflect on a real world problem situation. So it follows that the CM is not a model representing something in the real world; rather it is a model of what the relevant system defined in a root definition would do if it was a system in the real world. “It is in no sense a description of any part of the real world: it is simply the structured set of activities which logic requires in a notional system which is to be that defined in the root definition.” (Checkland, 1981).

(This is in contrast to “hard” systems analysis methods which treat models, such as DFDs, as representations of what the real world is actually like.)

The CM should be, as far as possible, developed solely from the root definition, without reference to how things are done in the real world. This may take some skill on the part of the analyst. There is no constraint on showing activities in a CM which are not found in the real world - so long as the root definition implies that they are activities which ought to be there if the system is to resemble the one described in the root definition.

The CM is a type of model known as an activity model, showing a number of activities and their logical dependencies. Each activity is named by a verb. The technique of modelling is to
identify the minimum number of activities which are necessary in a system defined in the root definition, and to model how the activities are related to each other. Flows of material products or information across the system boundary may also be shown on the model by labelled arrows. Checkland defines a conceptual model –

“A systemic account of a human activity system built on the basis of the system’s root definition, usually in the form of a structured set of verbs in the imperative mood. Such models should contain the minimum necessary activities for the system to be the one named in the root definition. Only activities which could be directly carried out should be included – therefore admonishments such as “succeed” should be avoided.”

A conceptual model consists of a high level model containing 5 to 10 activities. Each activity is a sub-system that can be decomposed into its component parts. The CM can be checked against the formal system model in order to check that all the essential components have been shown. It should therefore have all the following characteristics –

- Objectives or purpose – it should achieve a transformation.
- Measures of performance.
- Monitoring, control and decision-making processes.
- Components that are themselves systems.
- Components that interact and are related.
- Interaction with other systems in its environment, outside of its boundary.
- Resources for its own use.
- An expectation of continuity.
- It should have all the activities that are required to meet the 3 E’s criteria. As a model of a purposeful human-activity system the CM should show activities which -

- Plan or decide what to do.
- Do what has been planned.
- Check the actual performance against what is required (monitor, control, feedback).

The purpose of developing conceptual models is to use them in stages 5, 6 and 7 to promote learning about the problem situation and the identification of alternatives. For this reason there is no such thing as a correct or incorrect CM; a good CM is one which stimulates thinking about the real world problem situation and which provides insights into it.
Exercise 3 - Formulate root definitions of relevant systems

The purpose of this tutorial is to give you some help in identifying a relevant system in the One Stop Solutions case study to analyse and model for your assignment. The suggestions I have made are a possible route to take – if you have identified a relevant system that is not covered here please do not be deterred from analysing it.

The following steps are taken in Stage 3 (Root definitions of relevant systems) in order to move from the rich picture to Stage 4, Conceptual modelling:

1. Examine the rich picture and identify which aspect of the problem situation you have depicted is relevant to solving the problem. Your rich picture will almost certainly show several inter-related sub-systems and you will now have to decide how to focus your study. For example, in the One Stop Solutions case study, you could choose to study one or more systems –
   - The whole organisation at a high level.
   - The IT Development Department, a sub-system of the company.
   - One Stop Solutions’ information system.
   - The failed intranet development project.
   (In a full SSM study of One Stop Solutions the analyst would probably look at all of these systems; you should select one only. Your rich picture may show other systems that you feel are worth studying.)

2. Having focussed the study you should identify the primary task relevant system and some issue-based relevant systems. Some examples are given below:
   - **The whole organisation**
     Primary task relevant system –
     o To sell a comprehensive range of computer services with the goal of achieving rapid growth with sound management.
     Issue-based systems –
     o To recruit and retain skilled staff in a highly competitive market, while controlling salary costs.
     o To encourage and facilitate an information-sharing culture in the company in order to develop flexible working practices.
     o To develop a sound, integrated information infrastructure within the company and all its branches within the next two years.
   - **The IT Development Department**
     Primary task relevant system –
     o To support the operations and business strategy of the company through an information technology network.
     Issue-based systems –
     o To develop an IT strategy for the next 3 years that will support the company’s plans for expansion.
     o To recruit and retain skilled staff in a highly competitive market, while controlling salary costs.
     o To discourage staff from developing their own data stores and keeping information to themselves.
The two examples above are mainly concerned with the business and IT strategies. Taking One Stop Solutions’ information systems or the failed intranet development as the systems to study would be more focussed on technology and user requirements. You should select a system to model that is in line with your own interests.

- **One Stop Solutions’ information systems**
  
  Primary task relevant system –
  
  - Issue-based systems –

- **The failed intranet development project**
  
  Primary task relevant system –
  
  - Issue-based systems –

3. Having identified the primary task relevant system and some issue-based systems for the problem situation that you have selected to study use the CATWOE analysis to identify the components of the root definition.

4. 

C  The **Customer** – people who either benefit from the transformation process carried out by the system, or who are effected by it some way, possibly adversely.

A  The **Actors** who would carry out the activities in the system.

T  The **Transformation** process which transforms the system inputs (i) into outputs (o).

W  The **Weltanschauung** (world-view or viewpoint) - how the system is perceived or defined from a particular viewpoint.

O  The **Owner** of the system - the decision-maker who has responsibility for the performance of the system. (There may be a hierarchy of system owners, where one is responsible to a higher owner.)

E  The constraints on the system from its **Environment**: features of the real world which the system interacts with but which do not control it.
Below is a CATWOE analysis for the primary task relevant system for the One Stop Solutions company –

To sell a comprehensive range of computer services with the goal of achieving rapid growth with sound management.

**C** Staff of the company – benefit from the company, but also may be effected adversely by its rapid growth. Clients of the company – benefit from its services, must not be adversely effected by rapid growth. Owners – benefit financially, as will the prospective shareholders.

**A** The management and staff of the company.

**T** To satisfy a market need for buying a range computer systems and services from one supplier, by supplying the required solutions.

**W** This view of the system is shared by its owners, its management and most of its staff.

**O** The owners of the company; management of the company, specifically the Board of Directors and middle management.

**E** Competitors; developments in information technology; financiers – particularly the City banks who will be involved with the flotation of the company in 2 years time; the national economy; education and training organisations for staff etc.

5. Then write one or two paragraphs for the root definition along these lines –

A [O] owned system which under the following environmental constraints which it takes as given [E] transforms this input [i] into this output [o] by means of the following activities, among other, [T], the transformation being carried out by these actors [A] and directly effecting the beneficiaries or victims [C]. The world view which makes this transformation [T] meaningful contains at least the following elements among others [W].

For example –

One Stop Solutions is a privately owned company under the management of a Board of Directors, with a middle management structure answerable to the Board. The business of the company is to satisfy a market need for buying a range computer systems and services from one supplier. It does this by supplying a comprehensive range of equipment and consultancy services – everything from hardware to staff training – as integrated solutions to its customers. The company operates in a very dynamic and competitive environment and has to keep abreast of constant developments in information technology, and the operations of its competitors. Sound financial management is essential as the company plans to float on the stock exchange within 2 years. Recruiting suitably trained staff is always a problem as the market for staff is very competitive.

The operations of the company are carried out by highly skilled staff employed in its various branches – sales and marketing, Training Solutions and Enterprise Solutions, EU and US operations, and the internal service departments such as IT and finance. The success of the company directly effects its owners, staff and clients, who might also be effected by the adverse effects of rapid growth unless this process is soundly managed.

The root definition above is an illustration of how the CATWOE analysis is applied to identify the components of the definition, that are then written into a description of the primary task system of the company. It is not meant as an example of a *good* root definition as it could certainly be improved!
Exercise 4 - Build conceptual models of the systems named in the root definitions

A root definition is a high-level definition of a system that can then be depicted as a conceptual model showing the activities carried out by the system and how these inter-relate. The conceptual model is not a model of activities as they are carried out in the real world, but rather an idealised model of the system described in the root definitions. The model should therefore be consistent with the Formal System Model and include activities such as performance monitoring and control (these currently may not be taking place in the real world problem situation at all!)

- Produce a conceptual model using a root definition for One Stop Solutions that you were working on last week. Validate it against the Formal Systems Model and Checkland’s criteria of efficacy, efficiency and effectiveness.
- Decompose ONE of the activities shown on your conceptual model and model it as a system in its own right.
6. USING CONCEPTUAL MODELS TO INTERVENE IN THE REAL WORLD

6.1 Moving back into the real world

Once the Conceptual Models (CMs) have been developed the final stages of SSM cross the conceptual line again, and return to the real-world problem situation. The CMs are used to make comparisons between the ideal, systems-thinking models (what should be done) and how things are actually carried out in the real-world. The purpose of these stages is to further explore the problem situation together with the client and other stakeholders, to identify the problems as a basis for debate about possible changes. A CM is a model of a system that does not actually exist and it is therefore a skilled task to identify the real-world activities that might relate to the CM activities (if they exist at all) in order to make the comparison.

6.2 Stage 5 - Comparison of models and the real world

The CMs represent what ought to happen in a system defined by a root definitions. If the root definitions are agreed to be desirable systems to have in the real world, the next step is to compare the CM set with what actually happens. If there is a discrepancy between what ought to be and how things are in the real world this suggests a problem area which has to be addressed in order to improve the problem situation. The comparison of the system modelled in the CM and the real world activities can be done in the following ways -

6.2.1 General discussion and observation.

The CM is used as the basis for discussions between the analyst, the client and the other stakeholders in order to identify desirable features shown in the CM that are not present in the real world. (Probably this has been done as a matter of course during the stages when root definitions and CMs have been developed, and it has contributed to the development of the models.) Issue based systems might reveal fundamental problems that have not been brought into the open before and which must be addressed.

6.2.2 Question generation.

The models are used to identify questions about the real world activities that need an answer. For each activity in the CM questions are asked to elicit -

- does a corresponding activity exist in the real world?
- if so, how is the effectiveness of that activity monitored?
- how is the activity carried out and by whom?
- how well does the process work at present?
- any other thoughts or comments?

Patching suggests that a checklist can be used to focus thinking on each component of the model –

<table>
<thead>
<tr>
<th>System/activity</th>
<th>Exists or not</th>
<th>Measure of Performance</th>
<th>How it is done</th>
<th>Assessment</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The checklist can be used to evaluate the real-world problem situation and identify some questions for discussion.
### 6.2.3. Historical reconstruction.

Historical reconstruction is undertaken by comparing what actually happened in a past situation (such as a failed project) and comparing it with an ideal CM of a system designed to achieve the same purpose (i.e. with the same root definition). Consider the case of an information systems project that went wrong – failing to meet its objectives, its budget and resource targets, or to deliver on time, for example. In order to learn from this experience – and to do better next time – a model would be developed to show how the project would perform if it was designed as a well-formulated system. This could yield insights into what went wrong in order to do better in the future.

### 6.2.4 Model overlay.

Model overlay is a formalised way of comparing the real world situation with the CM. The CM is a model of a notional model described by a root definition: a second model is drawn using the same form as the first, but based on the activities and sub-systems that exist in the real situation. The two models are compared in order to identify the mismatches and missing elements in the real-world situation.

### 6.2.5 Extended analysis.

Further breakdown (decomposition) of the CM may be required before it can be compared with the real world. Root definitions are formulated for each activity (or sub-system) shown on the top level CM and second level CMs are made. Each activity is treated as a system in its own right, that must be checked against the formal systems model (see lecture 9) in order to ensure that it is a properly designed system. This is a lengthy process requiring a great deal of time and effort and should only be followed where a high level comparison of the CM and the real world is inadequate. High level CMs are fairly simple models of high-level, aggregated activities following a generic format. Decomposing the top level CM to show its sub-systems in detail can enable systemic re-design of the real world situation if this is what is required.

### 6.2.6 Stage 6 – identify feasible and desirable changes

During Stage 5 the analyst has carried out a critical appraisal of the existing situation as compared with models of ideal systems. This process should lead to identification of the areas which need to be addressed and areas where possible changes should be made. It then follows that the analyst, the problem owners, the potential problem solvers and so on should be involved in discussion on the changes. Stage 6 seeks to identify, from what is quite possibly a multitude of options of different levels of importance, the changes that are both feasible and desirable for the organisation in question.

Soft Systems Methodology does not claim to be capable of solving all the problems of the organisation. The changes that might be possible i.e. achievable in an organisation may in fact be quite small ones and it may be idealistic to attempt to make larger improvements. This is particularly the case when the viewpoints of actors involved in the problem situation are mutually irreconcilable (as they are in highly political issues) and where the room available for compromise may be marginal. What SSM does achieve, by a holistic analysis of the problem situation, is to define the problem and the constraints, and to enable actors to identify the scope for improvements. Stages 6 and 7 are where action (in the form of discussion, reflection as well as actions to improve) takes place in order to intervene in the problem situation.

Checkland suggests that three orders of change are possible –

- **Changes to structure.** The factors that are not dynamic such as organisational structures, the make-up of groups.
- **Changes to processes.** The activities through which the organisation carries out its transformations and realises its goals.
• Changes in attitudes. Changes in the expectations of individuals (as reflected in their Weltanschauung – the viewpoints that are the basis for issue based systems).

The changes that are decided on should meet two criteria. They must be systemically or logically desirable i.e. they must be consistent with the systems models that have been developed. They must also be culturally feasible i.e. acceptable to the organisation and the people in it, given the attitudes and viewpoints that are present. It may be difficult to identify changes that meet these criteria, but the process of debating them may well have an effect on changing the culture and attitudes of the organisation and individuals.

6.3 Stage 7 - Take action to improve the problem situation

The discussions about potential improvements carried out in stage 6 will result in agreement to pursue a course of action (which may, in some cases, may be a decision to after all do nothing). This course of action has itself to be formulated and designed – possibly by means of an SSM study. Wilson, in his book *Systems: Concepts, Methodologies and Applications*, uses a notional, generic systems model for this process of project planning with the following root definition –

“An organisation owned and managed system for cost-effective implementation of a set of agreed changes to existing structures and processes in a way which is acceptable to the organisation and the appropriate unions and which minimises the intended disruption of the social situation.”
6.4 Practical applications of SSM

Lectures 3, 4 and 5 have described the 7 stages of SSM and the techniques of CATWOE analysis, root definitions and conceptual modelling that are used in stages 3 and 4. The methodology is one which is best suited to situations where the problems are ill-defined and lacking in structure. It is essentially a methodology to be used in situations where the client is willing to cooperate in exploring the problem situation in a process of learning about it.

Patching uses the following flow diagram as a guideline for the selection of SSM as an appropriate methodology to use –

![Flow diagram for selecting SSM vs hard techniques](image-url)

**Fig. 9. Use of the soft and hard approaches**

The diagram shows that SSM and “hard techniques” are not mutually exclusive. Rather, SSM is one of a repertoire of techniques at the disposal of the analyst and should be made use of where appropriate – including situations where it may be used alongside other methodologies.

6.5 Conclusions and critique

Finally it must be emphasized that although SSM has here been presented as a seven stage approach this does not prescribe a sequential order to be followed in the project. The stages are logically sequential, but not temporally sequential. In a real project stages could be performed concurrently and iteratively: i.e. the root definitions and CMs for one part of the system could be developed, while another part was still being investigated: some stages could be returned to and repeated one or more times while changes were actually being implemented in the real world: some stages might be missed out altogether. The presentation of SSM in these lectures is best understood as “novice SSM”. It has emphasized the techniques of SSM, rather than SSM as a collaborative learning process involving the analyst and the actors in the problem situation. Checkland’s later writings on SSM present it in a considerably more developed way, which has evolved through practice of the methodology.

Once “novice SSM” has been mastered no doubt practitioners of the methodology would also go through a similar intellectual development and become more accomplished in its practice.

Finally soft systems methodology has many critics, both from the “right” and the “left” -

- Technically oriented critics complain that SSM doesn’t actually tell you how to build a system, that there is no real method. A possible reply is that we have plenty of technology based methodologies which don’t (always) work - what we need is a way of securing commitment and taking into account a variety of interests. Management oriented critics
worry that the open ended nature of SSM makes it impossible to manage - Checkland himself has said that there is no way of telling whether an SSM project is a success or a failure

- Radical critics say that SSM assumes that all members of the enterprise have choice, in fact equal choice. The idea that managers and workers can openly discuss their problems and needs is fanciful - SSM ignores issues of power. SSM supporters would reply that the very act of open discussion changes the organisational culture and empowers workers, though some would also argue for the rationalist "common good" view - "what's good for the company is good for the workers". Critics also argue that SSM involves manipulation by the consultants, that, like "human relations" management, can "trick" the participants into thinking they are happy with the consultant's hidden agenda. Further, critics claim, SSM imposes values of openness and "niceness" which are more suitable to middle class academics than to managers or workers. These criticisms do indicate that SSM has a fairly simple understanding of society, unsurprising given its basis in systems theory.
READING

Systems thinking


- Links to relevant pages of the *Principia Cybernetica Web* site – you can access these from the IS348 learning resources web pages.

If you want to understand the subject of this lecture in more depth try the following -

- Checkland, P. 1981. *Systems Thinking, Systems Practice*. Chichester: Wiley. Checkland’s classic foundational text in which he introduced the ideas behind Soft Systems Methodology (SSM). Chapters 1 - 4 deal with the origins, context and concepts of systems thinking. Chapter 5 contrasts the hard and soft approaches to problem solving.

Soft Systems Methodology overview and rich pictures

- Patching, D. *Op Cit.* Chapter 4 is an overview of SSM; chapter 5 “Expressing an Unstructured Situation” deals with the use of rich pictures as an initial step in visualising the problem situation.


If you want to understand this section in more depth try the following -

- Checkland, Peter (1981). *Op Cit.* Chapters 5 and 6, pp 125 - 191. See, in particular, the case study “Structural Change in a Publishing Company” (pp 183-189), the application of SSM to an ill-structured problem which Checkland uses to illustrate the practice of Soft Systems Methodology.


Modelling human activity systems

- Patching, D. *Op cit.* Chapter 6 deals with root definitions and conceptual modelling, with examples of how to apply the techniques. His example of “the pub as a system” is very easy to follow and a good illustration of how to do an SSM analysis.

If you want to read about the subject of this lecture in more depth try the following

- Checkland, Peter 1981. *Op Cit.* Chapter 6, pp. 161-191; Appendix 1, Building Conceptual Models, pp. 286-293. (Early or “mode 1” SSM - the basis of these lectures.)


Using the conceptual models

APPENDIX: Worked example of an SSM analysis of a problem situation

There are many worked examples of how to apply SSM in the text books, including some from Checkland’s own consultancy experience⁷. Patching⁸ has a very accessible example modelling a pub from different viewpoints which you should look at.

In order to illustrate stages 3 and 4 of SSM the following example uses the techniques to analyse the problem of a degree course at a University. This is a context with which you are familiar; you may not agree with the interpretation given below, which should demonstrate to you that SSM models depend on the viewpoint taken of the situation – and that of the analyst.

In a real SSM project these stages would be preceded by an information-gathering stage investigating the problem situation and expressing it in the form of a rich picture. Assume that there is an undefined problem with the degree course in question – applications from prospective students have been dropping off over the last three to four years. The course leader feels that this fall in demand, although partly related to a general fall in applications for Higher Education, is also specific to the course in question. She has a “vague uneasiness” and wants to investigate and understand the problem in order to find ways of addressing it. An investigation of the circumstances surrounding the fall in applications discovers the main influencing factors –

- There has been a general fall in applications for courses in this subject in UK universities.
- There is strong competition from other universities that have updated their degrees in this subject area.
- Students are choosing courses which lead to identifiable employment opportunities rather than non-vocational degrees.
- Although the content of the course has evolved, the name of the course does not reflect this.
- The course is not well-designed to attract students who require a flexible, part-time approach to studying.
- Some of the staff teaching on the course are nearing retirement and are not very up to date with using new technology for teaching, or with the content of their modules.
- Other staff who might teach on a redesigned course are already overworked with their existing teaching load.

In this hypothetical problem situation certain viewpoints could be selected as being relevant for modelling issue-based systems such as –

- Prospective and existing students.
- The staff teaching on the course and staff who might teach on the course.
- The course leader.
- The School/University management.

There would also be a neutral, generally accepted viewpoint of what a degree course should be that would be the basis for the primary task system. “An educational product that will attract the target number of student applications” for example.

In order to illustrate the method we will take two viewpoints – that of the students and that of the teaching staff and model these as issue-based relevant systems. These two viewpoints might give significantly different, even conflicting versions of the degree course system.

⁷ Checkland 1991
⁸ Patching 1990
Students (the customers) are naturally concerned with the quality and relevance of the degree, their prospects of landing a good job on completion of the degree, how it is taught and whether they can study it with the financial and other constraints they may have. The staff may be concerned with issues to do with their conditions and hours of employment, as well as with the quality of the degree.

The student root definition

C  The Students – existing students are customers of the system, prospective students are potential customers.
A  Everybody involved in running, teaching and marketing the course – course leader, lecturers, administrators.
T  The transformation of student needs (for a relevant degree course) into identified and satisfied needs.
W  A University course should provide an up-to-date, relevant education; enhance student employment prospects; and be delivered flexibly to enable participation of students with different needs.
O  The course leader and also the School and University management.
E  Competition from other universities; changing requirements from employers; system for funding education; changing profiles of students in HE.

A system owned by the course leader, ultimately under the management of the School and the University, which operates under a number of environmental constraints such as competition from other universities; changing requirements from employers; the system for funding education; changing profiles of students in HE. The system is operated by the lecturers and administrators of the School, and by the administration of the University. The system identifies and satisfies the needs of prospective and existing students for an education that is up-to-date, relevant and that will enhance their employment prospects. This education must be delivered in a flexible way that will enable students with different needs to participate.

The teaching staff root definition

C  The lecturing staff – both those working on the course, and those who might be required to work on it in the future.
A  Everybody involved in running and teaching the course and also the students.
T  The transformation of staff needs (for secure, pensionable employment with reasonable hours of work) into identified and satisfied needs.
W  Teaching is a job that provides secure, pensionable employment with relatively low pay. It is becoming increasingly stressful, with longer hours; further demands put an unacceptable workload on staff.
O  The School and University management.
E  Competition from other universities and the private sector for staff; growth in student numbers and administrative requirements.
A system owned by the School and University management, which operates under environmental constraints such as the competition from other universities and the private sector for staff; the changing demands on staff due to the growth of student numbers and increased administrative workload. The system is operated by the lecturers and administrators of the School, with the participation of students. The system identifies and satisfies the needs of teaching staff for a job that satisfies their need for secure and pensionable employment; where the relatively low pay is offset by the satisfying nature of the work, and good hours and conditions; and where staff turnover is therefore kept to a minimum.

The student relevant system conceptual model
Taking the root definition for “identifying and satisfying the needs etc” analysed from the student viewpoint the conceptual model might include the following sub-systems/activities –

- Identify latest developments and trends in the subject
- Identify student needs for different modes of study
- Identify employment market for qualified graduates in this subject
- Determine ways of meeting these needs
- Obtain resources
- Organise resources to provide the education required
- Monitor and control the effectiveness of the system in satisfying the needs of existing and prospective students
Satisfied needs

The next step would be to decompose the high level CM and model each subsystem/activity showing in detail what lower level activities are required to make the notional system work in reality. In order to do this a root definition must be developed for each activity that is to be shown as a lower level CM, as activities on the top level CM are systems in their own right.

The teaching staff relevant system conceptual model

A CM developed from the staff issue-based root definition would have the same generic characteristics the student issue-based system, but the activities themselves would be completely different.

- Define staff expectations – pay, hours, conditions etc.
- Identify alternative employment markets and rates of pay.
- Identify constraints.
- Determine ways of meeting these needs.
- Obtain resources.
- Organise resources to meet staff expectations.
- Monitor and control the effectiveness of the system in satisfying and retaining staff.
Satisfied needs

Targets