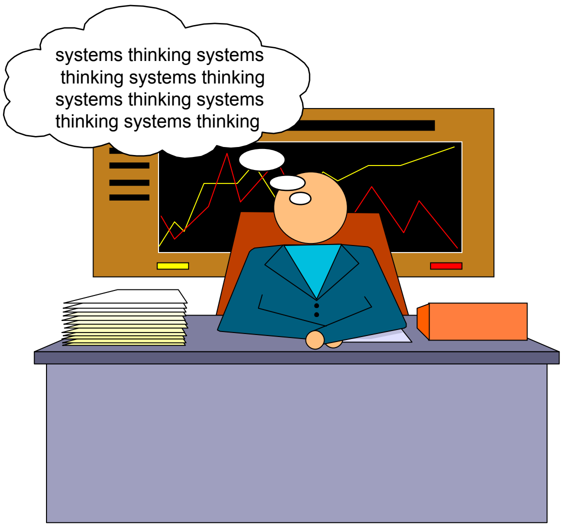
Soft Systems Methodology



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History

Soft Systems Methodology (SSM for short) was developed by Peter Checkland and colleagues at the University of Lancaster. It is based upon systems theory, which provides an antidote to conventional, 'reductionist' scientific enquiry - with its tendency to 'reduce' phenomena into smaller and smaller components in order to study and understand them. Systems theory attempts to study the whole picture; the relation of component parts to each other, and to the wider picture - it is 'holistic.' Biology and environmental science use its principles widely, as do other disciplines including systems analysis. SSM is *not*, contrary to popular supposition, an information systems design methodology - it is rather a general problem solving tool. Brian Wilson, a colleague of Checkland's at Lancaster, has adapted the methodology for business information analysis, and various attempts (Avison's 'Multiview,' for instance) have been made to incorporate it into systems design work.

What do we mean by 'system?'

We use the word 'system' quite a lot in everyday language ('computer system,' 'the educational system', 'systematic;'); we even talk about 'the system' - a vague, sinister officialdom. Three uses of the word must be distinguished:

1. a way of doing things, an organisation of resources and procedures.

2. a computer, or information system

3. (a specialised SSM use) - a conceptual organisation of resources and procedures defined according to systems theory - more about this later.

It will be a useful discipline to check that you understand which of these three senses of the word is being used every time the word occurs in this handout.

Checkland's 'formal systems model' identifies the properties we associate with human activity systems:

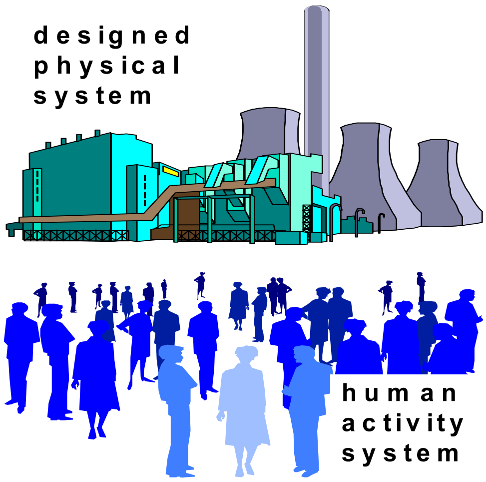
formal systems model	**example - a university**
a system has a purpose (or purposes) - it exists for a reason and achieves some change, or 'transformation'	a university educates, promotes learning - it 'transforms' undergraduates into graduates
its performance can be measured, and it can be shown to be more, or less efficient	student/staff ratios, pass rates, research papers published
there is a mechanism for control - a decision-making process	management structure

it has components - which can themselves be taken to be systems	faculties, departments
its components are related, and interact	board meetings, shared courses,
it exists as part of a wider system or systems - its environment, with which it must interact	education system, community
it has a boundary - which defines what is, and what is not part of the system	the dean is part of the university, the mayor is not, John Dalton building is, the town hall is not
it has its own resources	staff, buildings, finance
it has an expectation of continuity, and can be expected to adapt to, or recover from disturbances	the university expects to exist in ten years time, though it may have to accommodate government spending cuts

Another governing principle is the idea of 'emergence' - most simply expressed as ' the whole is greater than the sum of the parts.' When the constituent parts of a system act together they have properties which the individual parts do not have. You need staff *and* students (as well as many other things) to make a university.

Why 'soft?'

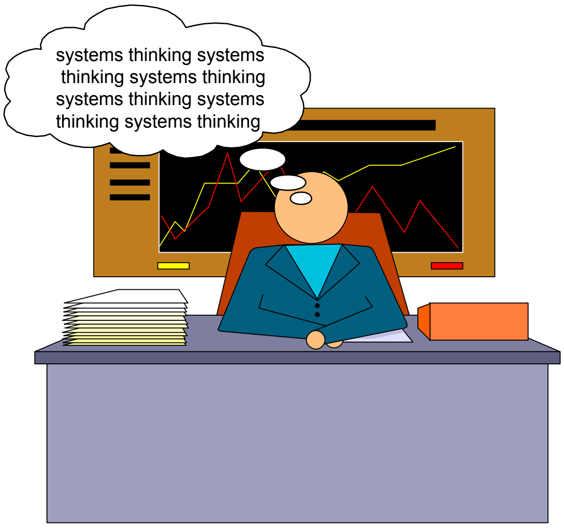
Systems thinking has come to be characterised as either 'hard' or 'soft.' There are fundamental differences between a man-made ('designed physical' system), such as a nuclear reactor, and an organisational system - a 'human activity' system. Where mechanical components are involved, their behaviour can usually be predicted with reasonable accuracy - these are 'hard' systems; where human beings are involved this is not necessarily the case. Because human behaviour is unpredictable, organisational and management problems are seldom clear cut and well-defined; they are normally complex, with many indeterminable variables - 'soft' systems. At first glance, information systems would seem to be 'hard' - designed physical - systems, but experience shows that they seldom add value unless they are closely married to their organisational context, and the people who use them. There are therefore many softer issues which are important in information system planning, design, and implementation. 'Soft' has another, more specialist



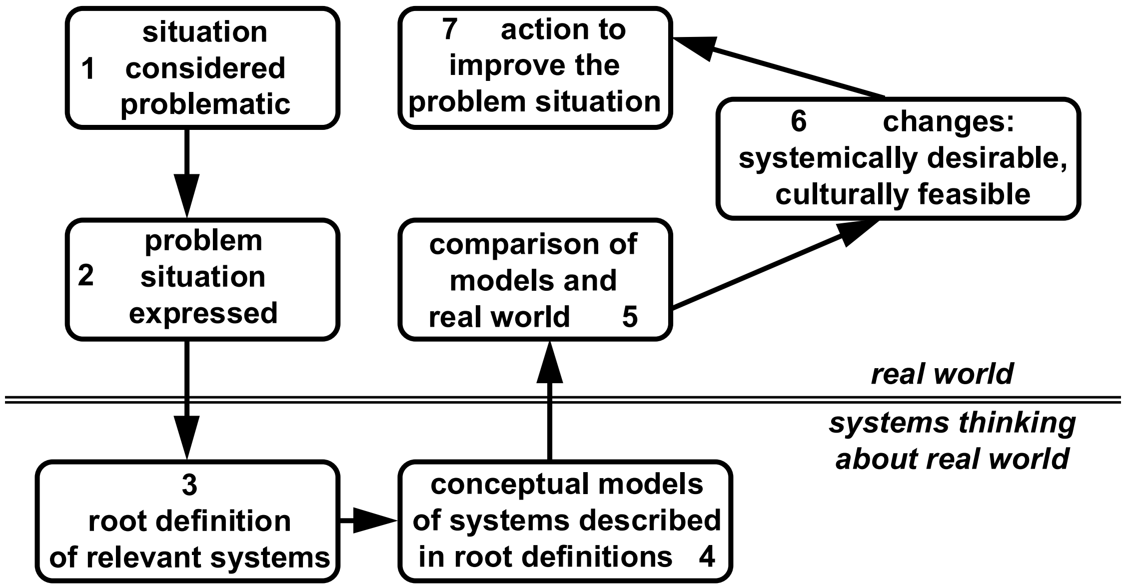
meaning - depending on the type of person you are, and your training and experience, you may understand 'systems' as tangible things which are really present in the world. You may, however, understand systems ideas as a series of intellectual constructs that we use to help us deal with the enormous complexity of the real world. This is an interesting, but un-resolvable argument; SSM tends strongly to the latter position.

Overview

SSM helps formulate and structure thinking about problems in complex, human situations. Its core is the construction of conceptual models (based on the understanding of human activity systems outlined above) and the comparison of those models with the real world. This process can greatly clarify those multi-faceted problems with many conflicting potential solutions, or no obvious way forward. Conceptual models are not representations of the real world, like a data-flow diagram - they are constructs which embody *potential* real world systems, but, more importantly, follow rigorously the systems principles already discussed, and their own well-defined internal logic. SSM is not, therefore, about analysing systems found in the world, but about applying systems principles to structure *thinking* about things that happen in the world - a difficult, but crucial distinction to grasp. It is most usefully carried out by people involved in the problem situation, with expert help available to guide and facilitate.



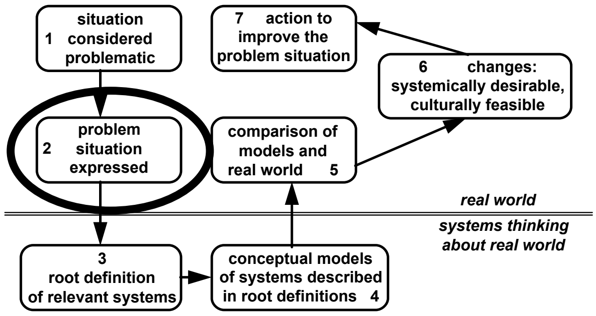
Here is Checkland's seven stage overview, which has come to be known as 'mode 1' SSM:



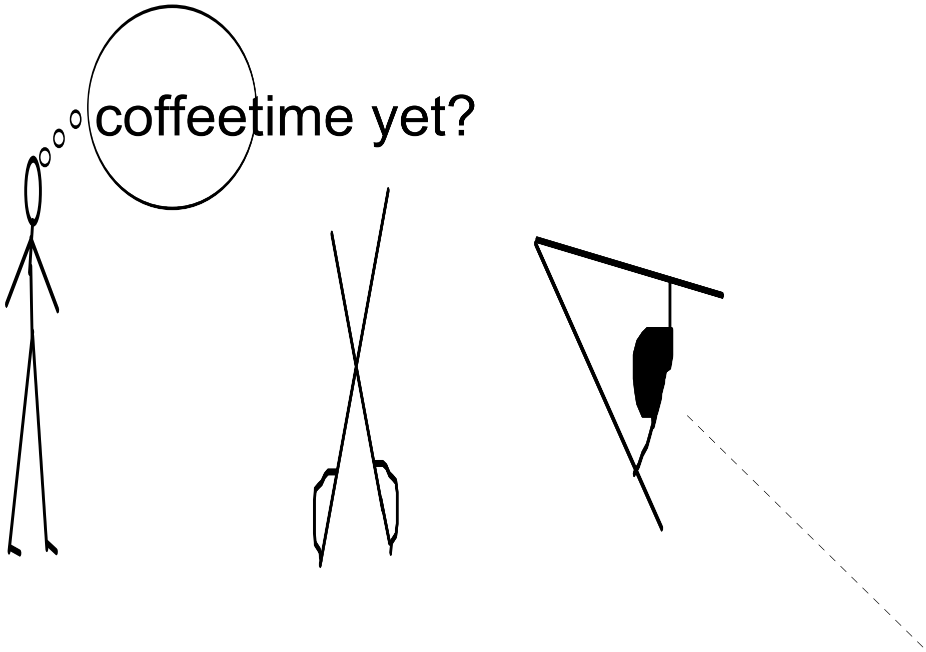
The diagram maps out the SSM investigative procedure, making a clear distinction between things which happen in, or which express the real world, and systems thinking, which is conceptual. The problem situation is often expressed in the form of a *rich picture* (2). *Root definitions* are then derived (3) - textual statements (somewhat like mission statements) which describe potential relevant systems to be considered. These may be *primary task* (which model basic, long term functions such as the operation of a production department, or *issue based* (which deal with transient, or more abstract concerns, such as the re-organisation of an office, or a system to implement total quality management). *Conceptual models* are activity models of these potential systems (4). A root definition and a conceptual model are two expressions, one descriptive, the other diagrammatic, of the same potential system, and should always justify and explain each other. There are various, (normally straightforward) ways of comparing these models with what is actually happening in the world (5). This comparison should lead to suggestions for improvements (which will be desirable according to the systems way of thinking of the world, but should also be feasible in the culture of the organisation considered) (6) and action on those suggestions (7).

This explanation implies that SSM practitioners follow a step-by-step logical progression in their investigations. This is hardly ever the case - stages are often re-visited, taken out of order, and sometimes omitted as the situation dictates.

Rich Pictures

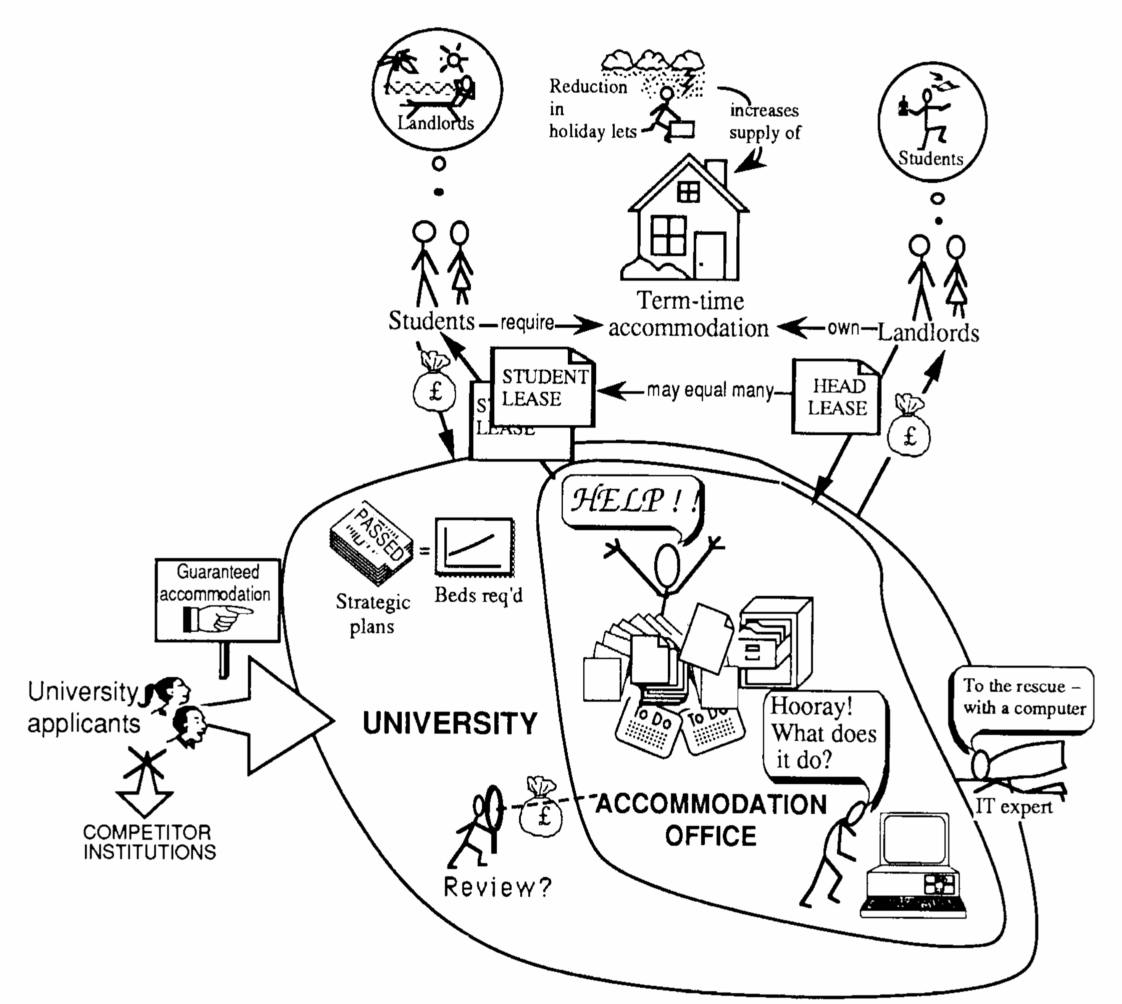


The analysts' first task is to 'express' the problem situation - to form a *rich picture*. This is really a metaphor for 'thorough, but non-judgmental understanding' (which is acquired through normal investigative techniques), but has become associated in SSM with a particular kind of diagrammatic representation of the problem situation. Our business culture is number and text dominated - busy professionals often regard time spent drawing pictures as wasted - but pictures can provide an excellent way of sorting out and prioritising complex problem areas. Pictures also display relationships - the way business functions work together, for instance - better than text. Rich pictures are normally hand drawn, and may include elements of *structure* (the departments of a university, for instance), or *process* (studying, examining), *issues, concerns,* or *developments* (implementing a quality service). They set down what is considered important in the situation. There are no rules; some graphical talent obviously helps, but is not a pre-requisite since the purpose is investigative, not artistic. Matchstick men and women are common, sometimes with bubbles coming out of their mouths to indicate important issues, crossed swords for conflict, eyeballs indicate something being overlooked, inspected or supervised - you can make up your own icons as you go along.



The discipline is simply to get something on paper - often in discussion with others who may have different, even conflicting, ideas.

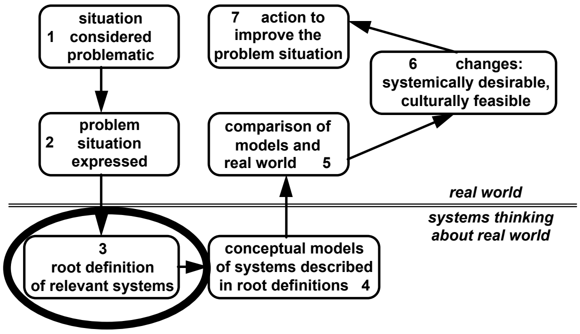
Here is an example of a rich picture:



source: P.J. Lewis, 'Rich Picture building in the SSM,' European Journal of Information Systems

The picture expresses a university student accommodation problem situation: at its centre is the accommodation office which is snowed under with paperwork - computerisation may be the answer. The university holds a competitive edge over rivals by guaranteeing beds to students, but numbers are rising. Lines round parts of the picture represent nominal systems to be considered - the accommodation office system is part of a wider university system. Different types of leases are represented together with the perception of students and landlords of each other. Taken together, the various components of the picture express those elements of the situation which the analyst considers of particular importance.

Root Definitions



A root definition is a short textual definition of the aims and means of the system to be modelled. Remember that it is not the real world that is being modelled, but potential or 'virtual' systems that are logical and coherent (which the real world seldom is) according to systems principles. Root definitions often follow the form:

A system to do **X**, by (means of) **Y**, in order to **Z**

telling us *what* the system will do, *how* it is to be done, and *why* it is being done (its long term aims). Here is an example of a primary task root definition:

A university owned and operated system to award degrees and diplomas to suitably qualified candidates (**X**), by means of suitable assessment (**Y**), (in conformance with national standards), in order to demonstrate the capabilities of candidates to potential employers (**Z**).

Clearly this is not everything a university might do - it is part of a much wider system - and opinions may differ as to the validity of various parts of the statement. Remember, it is not supposed to be a description of what assessment *actually* does in the university, but a well-defined concept - '*if* this is what assessment is supposed to be, how would we go about doing it?' Here is an example of an issue-based root definition:

A university owned and operated system to implement a quality service (**X**), by devising and operating procedures to delight its customers and control its suppliers (**Y**), in order to improve its educational products (**Z**).

CATWOE

Each conceptual system has at its heart a *transformation process* in which something, an *input,* is changed, or transformed, into some new form of itself, an *output.* This is normally notated:

input ➔ output

Accompanying this transformation ('T' for short) is a *weltanschauung,* or *worldview* - a very powerful SSM concept which defines the belief or point of view that makes the transformation reasonable - worth achieving. Together, T and W form the core of CATWOE analysis - a mnemonic which helps to build coherent and comprehensive root definitions.

Here are the components:

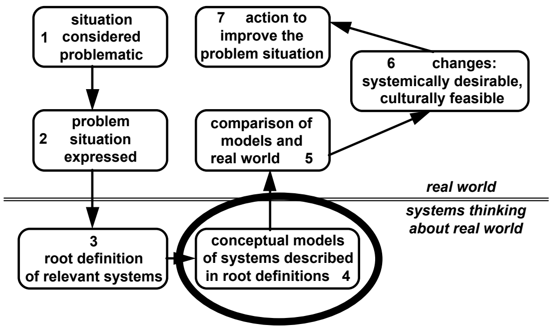
Customers	the victims or beneficiaries of T
Actors	those who do T
Transformation process	input ➔ output
Weltanschauung	the worldview that makes the T meaningful in context
Owners	those with the power to stop T
Environmental constraints	elements outside the system which are taken as given, but nevertheless affect its behaviour

Although some of these terms are commonly used, they have particular meanings in SSM which do not necessarily correspond exactly with their everyday meanings. Each element of CATWOE will be identifiable from a good root definition, if only by implication. Here is the CATWOE analysis for the assessment system:

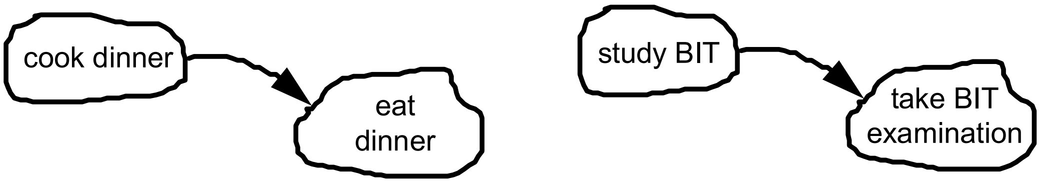
> A university owned and operated system to award degrees and diplomas to suitably qualified candidates (**X**), by means of suitable assessment (**Y**), (in conformance with national standards), in order to demonstrate the capabilities of candidates to potential employers (**Z**).

Customers	candidate students
Actors	university staff
Transformation process	candidate students ➔ degree holders and diplomates
Weltanschauung	the belief that awarding degrees and diplomas is a good way of demonstrating the qualities of candidates to potential employers (note that there is absolutely no point in operating this system unless you believe this)
Owners	the University governing body
Environmental constraints	national educational and assessment standards

Conceptual Models

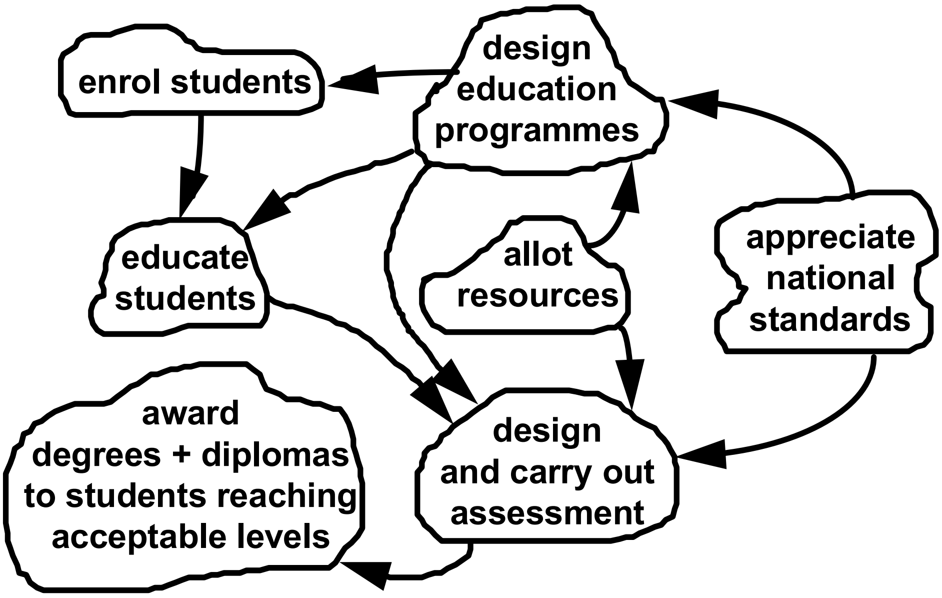


Conceptual models demonstrate potential activities and their logical dependencies. The activities, which ***must*** be expressed in a verb noun phrase ('do something,' 'eat dinner,' open new factory' etc) are placed in rough, hand drawn bubbles. The bubbles may be joined by arrows, indicating dependence: - that one activity is consequent upon another - it cannot be performed, unless the other has been performed, or that it will be done poorly if the other is done poorly.



7-9 activities usually makes for a reasonably understandable model. If more detail or complexity is required, then the system may be modelled at a *higher level of resolution*. (This is equivalent to levelling in a data flow diagram). Any activity in a conceptual model may be taken to represent a system in its own right - for instance we could take the activity ***study BIT***, describe it with its own root definition, and then make a new conceptual model of this root definition. In this way it is possible to decompose complex activities into considerable detail without losing sight of how the component parts fit together.

Here is a conceptual model built from the assessment root definition outlined above:



It is not possible to say whether this model is *correct*, though some models are obviously more logical and coherent than others. Its value lies in the resulting debate and consensus, and the comparison with the real world that it is now possible to make.

Monitor and Control - measures of performance

According to the formal systems model - every human activity system, as we commonly understand the meaning of the word must have some ways of evaluating its performance, and ways of regulating itself where the desired performance is not being achieved. It is normal to make these monitoring and control mechanisms explicit in a conceptual model, and in particular to establish measures of performance. SSM describes these in terms of *efficacy, efficiency,* and *effectiveness,* which, like the terms in CATWOE, have specialist, well-defined meanings:

E^1 - **efficacy** - does the system work - is the transformation achieved?

E^2 - **efficiency** - a comparison of the value (not necessarily monetary) of the output of the system and the resources needed to achieve that output - in other words, is the system worthwhile?

E^3 - **effectiveness** - does the system achieve its longer term goals? - (closely allied, therefore, with the **Z** of the root definition)

It is an essential discipline to say how, for any given system, the three **E**'s will be measured.

Here are the measures of performance for our assessment system:

E[1] - **efficacy** - are degrees and diplomas awarded?

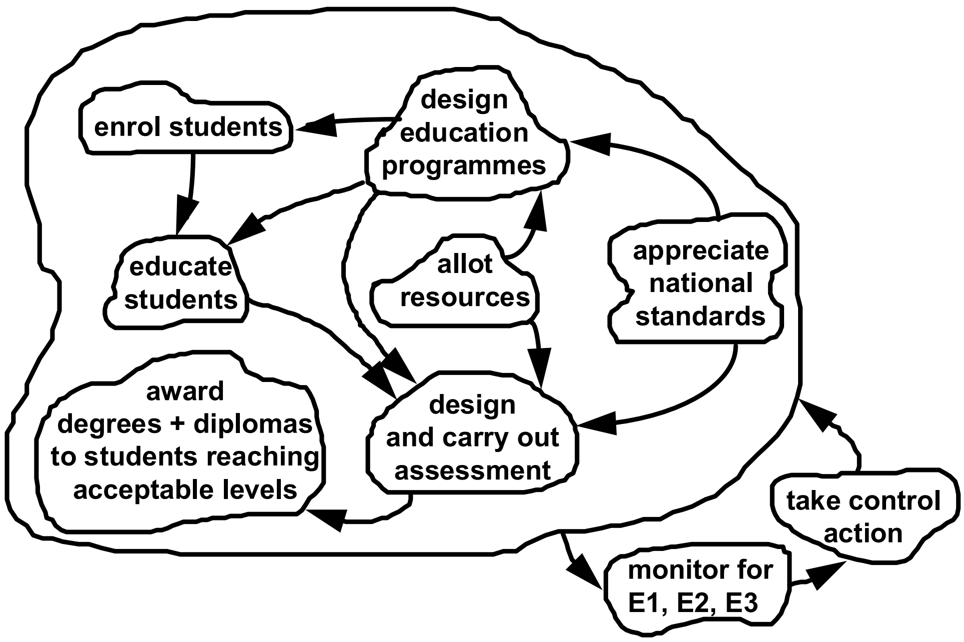
E[2] - **efficiency** - how many degrees and diplomas, of what standard, are awarded for the resource consumed?

E[3] - **effectiveness** - do employers find the degrees and diplomas a useful way of assessing the qualities of potential employees?

Here now is the complete conceptual product that has been built up:

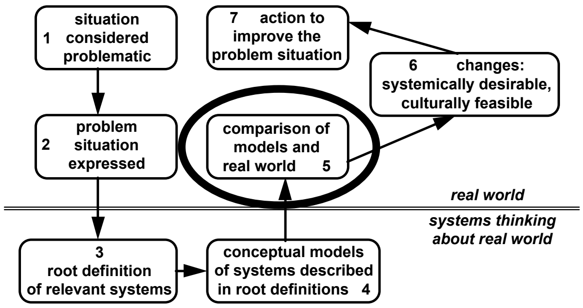
A university owned and operated system to award degrees and diplomas to suitably qualified candidates (**X**), by means of suitable assessment (**Y**), (in conformance with national standards), in order to demonstrate the capabilities of candidates to potential employers (**Z**).

C	candidate students	**E1**	are degrees and diplomas awarded?
A	university staff		
T	candidate students ➔ degree holders and diplomates	**E2**	how many degrees and diplomas, of what standard, are awarded for the resource consumed?
W	the belief that awarding degrees and diplomas is a good way of demonstrating the qualities of candidates to potential employers	**E3**	do employers find the degrees and diplomas a useful way of assessing the qualities of potential employees?
O	the University governing body		
E	national educational and assessment standards		



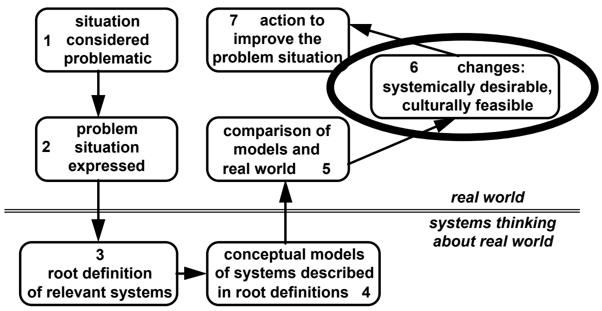
Comparisons

Once the SSM practitioner has several root definitions, with accompanying conceptual model, CATWOE, and measures of performance (which together constitute rigorous and defensible conceptual systems) (s)he is ready to look at the problem situation again. The aim is to compare the defensible conceptual version of what *might* happen, with what really *does* happen in the situation. At this stage it is often easy to spot activities which are poorly done, or not done at all, and make recommendations for improvements. Comparisons may be simply set out in tabular form:



activity	is it done in the real situation? how is it done?	comments, recommendations
enrol students		
educate students		

The activities in the conceptual model are set out in the left hand column, with proposed changes in the right hand column. More complex tables may be developed to suit the situation. This comparison will normally lead to suggestions for real-world improvements based on the logic of the conceptual model.



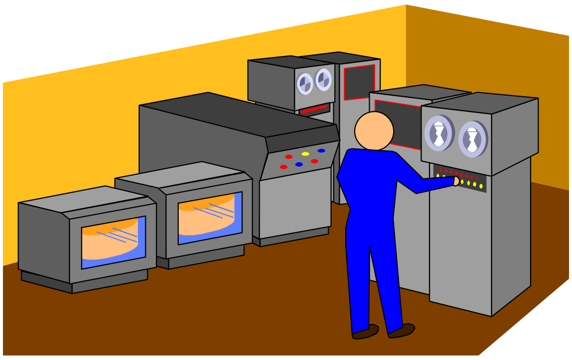
Mode 2 - for sophisticated users

Experienced SSM practitioners now tend to view the seven stage model as rather rigid and prescriptive. Two trends are evident: firstly the tendency to use the SSM resources described above as a toolbox, from which to select appropriate means for tackling a wide variety of organisational tasks: secondly the emergence of a second, parallel stream of analysis - 'cultural enquiry.' This, at present less well developed than the 'logic' stream, revolves around three forms of analysis:

Analysis 1 - analysis of the intervention itself, recognises that intervening in a problem situation is itself a problem! It clarifies the roles of *client* (the person who commissioned the study, *problem solver(s),* and *problem owner(s).*
Analysis 2 - 'social system' analysis which examines the culture of the situation studied in terms of *roles* (the social position of people in the problem situation), *norms* (their expected behaviours) and *values* (beliefs about the merit of those behaviours of role holders).
Analysis 3 - 'political system' analysis which examines power and how it is expressed and exercised in the problem situation.

SSM and Information Systems

SSM has been used widely in the IS field; but more commonly for information management, information strategy, and business analysis work than for computer system design. Brian Wilson (1990) has developed an extension of the methodology for business information analysis. A number of primary task systems, with a wide spectrum of W's are modelled - this results in a wide variety of activities which should cover most of the formal and informal activities carried out by the business. Then a *consensus primary task model* is put together, which involves those activities that most of the people in the problem situation agree are fundamental. Each activity (there may be a large number) is examined in turn, and the information inputs (information which is necessary to carry out the activity) and outputs (information which results from carrying it out) are specified in the form of *information categories.* This gives a broad picture of information requirements which may then be mapped on to the existing information systems to identify duplication and shortcomings.



Paul Lewis (1994) gives a good account of the value of soft systems thinking in information system development work, as well as developing 'interpretive' data models directly from soft systems models. However, It is not common to design an information system using SSM alone. There is no tried and tested way of developing entity relationship models, data flow diagrams, entity life histories, or any other conventional systems analysis structure from SSM products - root definitions, conceptual models, rich pictures. Its real influence has been to highlight what is missing from traditional structured systems analysis and design - the ability to cope with multiple conflicting viewpoints, and to rethink a business, rather than automate processes (which may be profoundly unsatisfactory, or may not exploit the potential of the new technologies) to achieve (at best) an incremental gain. Its strength and weakness derive from two factors:

- its ability to include human complexities in analysis - vital for building successful systems, but leading to a degree of ambiguity intolerable to the system builder
- its exclusively *logical* approach - most systems analysis starts by documenting what currently happens, then 'logicalises' what has been discovered' - which offers a reasonable chance that the resulting information system will do what is currently being done better, but usually precludes any fundamental rethinking.

JR, 12/09/05

References and further reading:

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