The Greater Whole: Towards a synthesis of SD and SSM

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"There never yet was any truth or any principle so irresistibly obvious that all men believed it at once"

- Tom Paine, 'The Rights Of Man'

Abstract

This paper concerns two system-based approaches used for organisational intervention - soft system methodology (SSM) and system dynamics (SD). After a brief description of the theoretical and methodological assumptions of the two a partial critique is presented.

SSM is strong on the generation and representation of diverse perspectives, or *Weltanschauungen* and attempts to deal with the socio-political elements of an intervention. But SSM is weak in ensuring what is termed here 'dynamic coherence': consistency between the instinctive behaviour resulting from proposed changes and behaviour deduced from ideas on causal structure. Hence, in situations where causal structure and instinctive behaviour are meaningful, the intervention is blind to the dynamic complexity of the proposed changes.

SD examines the causal structures capable of explaining and exploring the dynamic interaction of different policies. However, whilst SD emphasises the need for a clear issue focus for a study, the approach has little theory regarding the generation and explicit representation of diverse issues. Also, there is no theory for facilitating sensitivity to the socio-political elements of an intervention. A proposal is made regarding the dove-tailing of the two to form a synthesis. After an SSM intervention a second stage is described. This continues the socio-political analysis and draws on the previous *Weltanschauungen*. It operates within a new *Weltanschauung* which values dynamic consistency of the holon which is able to represent the proposed changes. A model of this holon is constructed using SD to represent causal structure and deduce behaviour. Using SD methods, the changes are thus rendered 'systemically desirable' in the additional sense that dynamic consistency has been confirmed. With due regard to respective theories and the preservation of ontological consistency, 'holon dynamics' is utilised to describe the process.

The paper closes with reflections on the proposed synthesis, particular emphasis being attached to the need for theoretical consistency when mixing tools.

The Greater Whole: Towards a Synthesis of SD and SSM

§1 Introduction

In this paper we try to demonstrate that some of the strengths and weaknesses of two widel used system-based approaches offer an opportunity for dovetailing the two together; the resultin synthesis being an approach which links the two in a mutually supportive way. Interest i multiple-method approaches is relatively recent in the field of management science. Technique in this field, particularly in the areas of systems thinking and 'soft' OR, have tended to be th creation of individuals, or individual groups, and have evolved separately - propelled by the nee of advocates to validate them by demonstrating their explanatory power. The approaches wit which this paper concerns itself, 'soft system methodology' (SSM) and 'system dynamic modelling' (SD), fit this pattern. This separate evolution of techniques produces difficulties, bot for theoreticians and for those interested in discovering tools for addressing practical problems i managerial situations. Throughout the worlds of theory (reflected in the literature) and practic (observable in consulting activities) we see the advocacy of single methods by those who ar either ignorant of the powers of others or who are insistent regarding the superiority of on method over any other.

Our decision to take a different approach has three strands. Firstly, it reflects a general interes amongst the SD community in tools which aid in the conceptualisation phase of model buildin The result has been an increased interest in, and actual usage of, methods originating elsewher Examples include Delphi workbooks (Vennix, 1990), magnetic hexagons (Lane, 1993a cognitive mapping (Vennix, 1990) and other soft OR tools (Lane, 1994a). Secondly, it resul from the realisation that soft OR and modern SD practice have more in common than thes powerful tools; at a much deeper level, they share a particular view of the nature of proble finishing processes in organisations and can be seen interpreted as sharing distinctive soci theoretic assumptions (Lane, 1994a&c). Thirdly, and finally, this paper arises from the particul interests of the authors.

§2 AN OUTLINE OF THE TWO APPROACHES

To describe each of the methodologies, we will first state its basic assumptions, and the explore how these are implemented through an intervention process. It is important to identif these assumptions because they have a double effect on the intervention process. First, an information that the practitioner receives from the people involved in the problem situation wi be filtered through these assumptions. Second, the assumptions become the framework und which new questions or additional exploration are generated by the practitioners; the practition will not only filter information to fit the core assumptions, but he/she will consistently look f information to validate them.

2.1. Soft Systems Methodology - SSM was developed during the 1970's by Peter Checkland an his colleagues at the University of Lancaster's Department of Systems. The methodolog emerged from an action-research process that to date includes 400+ cases and still continues th evolution of the methodology. The following description of the methodology draws c Checkland (1981) , Wilson (1984) and Checkland & Scholes (1990).

BASIC ASSUMPTIONS OF SOFT SYSTEMS METHODOLOGY. SSM holds an interpretativ perspective of social settings, organizational life included: "[S]ocial reality is the ever-changin outcome of the social process in which human beings ... continually negotiate and re-negotia with others their perceptions and interpretations of the world outside themselves." (Checklan 1981, pp. 283-284). Reality, under this perspective, is complex and cannot be assumed to hav systemic properties. Instead, Checkland (1985) suggest that the notion of the adaptive whol *i.e.*, what we normally call a system, is an epistemological devise, a conceptual abstraction wit which we might attempt to make sense of the real world. He (1988a) proposes the word 'holo to distinguish the systemic mental construct from the real-world entities that we have labelled a systems. In this paper we will hold to that distinction. This interpretative view of reality has tw crucial implications for SSM studies. First, it is difficult for an SSM practitioner to accept a uniqu definition of a problem: what some people call a 'freedom fighter' might be considered a 'terroris by others. SSM is not a problem-solving methodology; instead, it is intended as a methodology explore, question and learn-about 'ill-structured' problem situations or 'messes' (Ackoff, 1974

Second, the models built in SSM do not attempt to describe the real world nor are they intended to be used as normative models. The modelling process embedded in SSM generates 'holonic ideal types' of organized human behaviour under a particular world-view, or Weltanschauung (*W*). Each model can only be faithful to one *W*, thus, several models are used to explore the problem situation under different perspectives. The expected output of an SSM study is a set insights and changes that emerge from the comparison of these ideal types with the real-world problem situation.

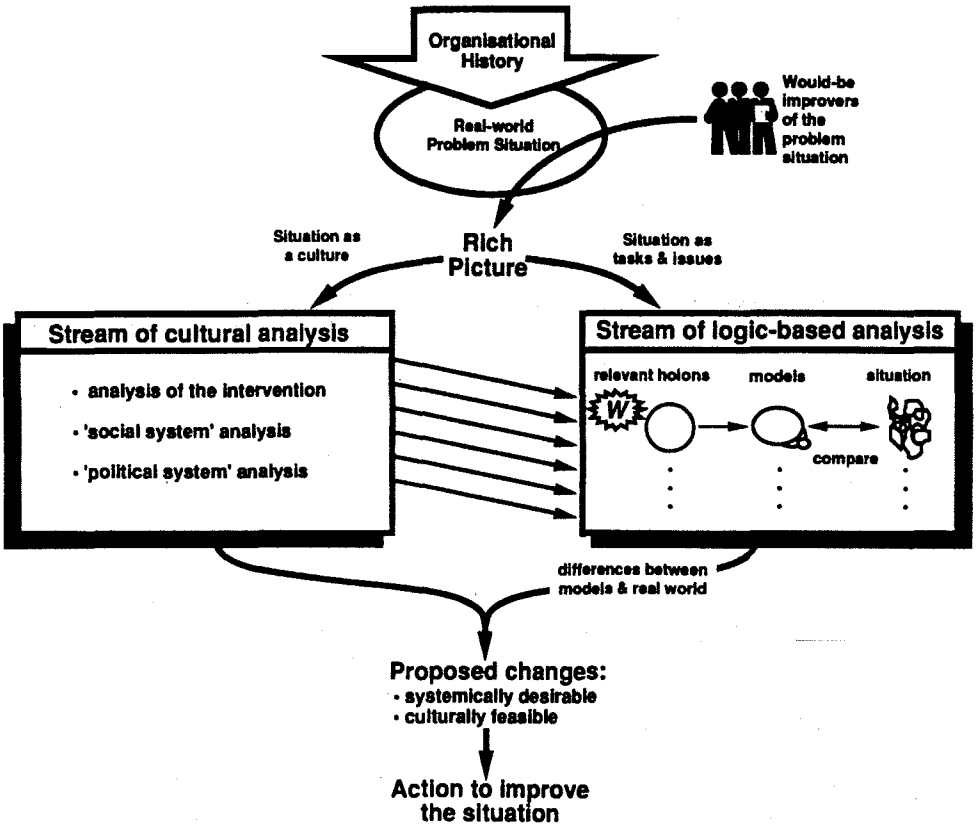


Figure 1

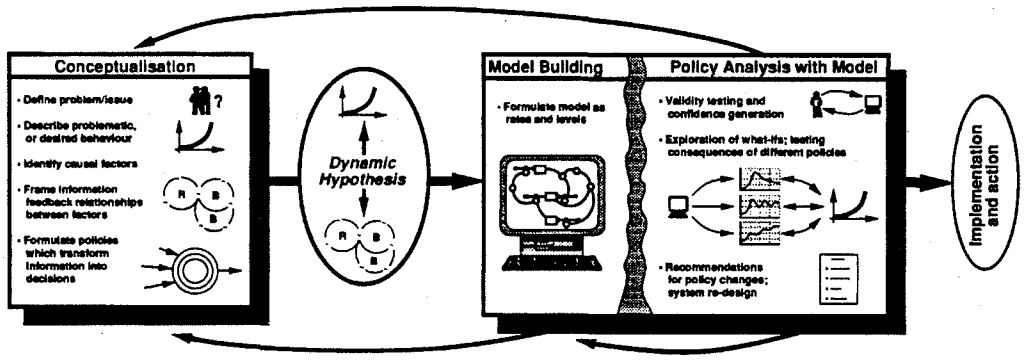
THE SSM INTERVENTION PROCESS. The SSM intervention process provides a systemic approach using the above assumptions through seven stages that can be applied in or out of sequence (Checkland, 1981). For presentation purposes in this paper the stages have been grouped into three distinct phases. Firstly, 'Finding Out About the Problem Situation'. The purpose of this phase is to form the "richest possible picture" of the situation (Checkland, 1981, p.165) to enable a wide selection of viewpoints to explore the problem situation. The process starts by scrutinizing the structure, processes and climate of the problem situation without using system concepts, probing the 'tasks' (purposeful actions) and 'issues' (perceptions causing disagreements) of the actors. The observations at this stage are normally expressed graphically in a 'Rich Picture' that focuses on the relationships, tasks and issues.

At this point the intervention divides into two strands (see Figure). Along with the initial finding out about the logic of the problem situation, a second line of inquiry is initiated to explore the cultural dimension of the problem situation (Checkland, 1988b). The cultural inquiry is done at three different levels. 'Analysis One' explores the intervention context-clients, problem owners, problem solvers, etc. 'Analysis Two' addresses the 'social system' in the situation through the mapping of norms, roles and values. 'Analysis Three' focuses on the politics of the situation - "[the] process by which differing interests reach accommodation" (Checkland & Scholes, 1990,

p.50) - by identifying what are the 'commodities' used to express power in the problem situation These analyses are meant to be a continuous reflection and documentation process during th whole duration of the intervention.

We turn now to 'Model Building'. Given the assumption that it is difficult to capture socia reality with a modelling language, SSM opts to build a variety of models, each representing a particular *W* over the problem situation that is considered relevant by some actor(s) therein. Tw kinds of models have been identified as good choices for promising relevant systems (Checklan & Wilson, 1980): primary-task models, *i.e.*, models of systems that carry out some major tasl manifested in the real world, and issue-based models, *i.e.*, models of notional systems chosen fo what it is considered matters of contention by the people involved in the study. It is worth notin that a model does not have to be a statement of something desirable to be relevant, *i.e.*, insigh can be gained by building models with *W*s not espoused by any of the actors in the problen situation. The search for potential relevant systems is informed by the expressed problen situation, and the cultural analyses that are being carried out. The modelling unit for SSM is a particular type of holon, a Human Activity Systems (HASs) - a model of purposeful activity tha could, in principle, be enacted in the real world by humans. HASs are represented through a language of 'Root Definitions' (RD) and 'Conceptual Models' (CM). The 'grammar' of th modelling language ensures that each model has attached to it an definite *W* of the situation, an that the core attributes of a holon - emergent properties, systems hierarchy, communication an control mechanisms necessary for the continuity of the system - are incorporated into th model. Particularly, activities are designed both to carry out a transformation process and t control the transformation. The modelling process yields a systemic, logically derived, 'ideal type of the assumptions stated by one of the stakeholders.

We call our third phase 'Using the Model in the Problem Situation'. Each model is nov confronted with the problem situation, either through an orchestrated debate or a point by poin comparison of the model and the real world situation. From this comparison two outcomes ar possible. Either we detect more, potentially relevant, systems to be modelled - in which case th modelling and comparison phases are iterated. Alternatively, a number of changes to the problen situation are identified. These are changes which the systems thinking reflected in the model recommends as being desirable, so they are said to be 'systemically desirable'. This list of identifie changes is further tested to ensure that the unique culture of the problem situation will be accep them. If so, the changes are said to be 'culturally feasible'. SSM does not give specific guide-line for change implementation; it assumes that once the participants involved in the problen situation have agreed on what the desirable and feasible changes are, implementation will be matter of time and co-ordination.



2.2. System Dynamics - System Dynamics was developed in the late 50's early 60's at th Massachusetts Institute of Technology's Sloan School of Management by Jay Forrester as he trie consciously to apply control principles to management and economics.

BASIC ASSUMPTIONS OF SYSTEM DYNAMICS. Meadows (1989) provides a statement of th basic ontological assumptions of SD; "[the SD paradigm] assumes that things are interconnecte in complex patterns, that the world is made up of rates, levels and feedback loops, tha information flows are intrinsically different from physical flows, that non-linearities and delay

are important elements in systems, [and] that behaviour arises out of system structure." Forrester, in his original articulation of the field, clarified the epistemological premises of the approach (Forrester, 1961). Even though the SD paradigm acknowledges a high degree of complexity of the 'real world,' it assumes that it is possible to capture this complexity in a model without loss of relevance (Forrester, 1961; Richardson, 1991). The model is used to identify, through experimental simulation, the appropriate levers to eliminate undesirable system behaviour.

THE SD INTERVENTION PROCESS. Forrester (1961) gives a clear, step-by-step definition of the process to be followed within the approach. As with any field of practice, SD has evolved over the years. In our description we will try to capture not only the intervention process as proposed by Forrester but also the emerging practice of SD. Note that the basic assumptions for this emerging process are predominantly still the ones identified above; indeed, that is why this new methodology can still be identified as SD, despite the considerable differences. Accounts of the SD intervention process from Randers (1980b), Richardson & Pugh (1981), and Forrester (1994) have been grouped into the same three phases used above for SSM.

'Finding Out About the Problem Situation'. One of the field's assumptions is that any SD study should have a purpose - a defined problem, issue, or undesirable system behaviour that is to be corrected (Forrester, 1961). The emphasis on problem definition has been repeated through the years (Forrester, 1969; Randers, 1980b; Richardson & Pugh, 1981; Sterman, 1988) and it is still at the core of the SD intervention process (Forrester, 1994). Once the problem behaviour has been identified and described in a reference mode, the practitioner should identify the factors that appear to be responsible for causing the symptoms and describe the relationships between them. These relationships are framed into information-feedback loops that could be used, in the next phase, to model the system.

The relationship between those causal structures and the identified reference mode is called a 'dynamic hypothesis' - a potential explanation of how structure is causing the observed behaviour. In addition to the 'dynamic hypothesis', a careful study of the decision making process is done in the initial stages of an SD intervention. The purpose of this is to capture the flow of decisions into a policy that continuously transforms information into decisions. Although the output of this first stage - a dynamic hypothesis - has remained constant, the process through which this is created has evolved over the years. While originally it was the 'systems expert' who performed this analysis now the 'clients,' i.e., the direct participants in the problem situation, are involved in the mapping and diagnosis of the situation. Different documented accounts of the facilitation process, and its implications, have been published recently (Lane, 1992; Morecroft, 1992; Morecroft & Sterman, 1992; Richardson *et al.* 1992; Vennix & Gubbels, 1992). All emphasise the importance of 'capturing' the mental models of the people participating in the situation and the role of the facilitator in this group process.

'Model Building'. Once a good understanding of the problem situation has been gained, the model is formulated using the explicit concepts of SD. The purpose of this task is to develop a computer-based model that is capable of tracking all the relationships between variables and their dynamic behaviour. Model formulation could be done in any computer language, although in practice it is usually done in one of several modelling languages that have been developed explicitly to model with the SD assumptions in mind (Richardson & Pugh, 1981; Richmond, 1987 describe examples). Although Forrester (1971b) has emphasized that it is the modelling process that generates the most insight about the situation, few authors have looked into the process itself (exceptions are Forrester, 1961; Randers, 1980b; Robinson, 1980). Here again the process has shifted; breakthroughs in software are enabling clients, without any previous experience in modelling, to be involved directly in the construction of the model (Homer *et al.*, 1993; Lane, 1993a&b; Richardson *et al.*, 1992; Senge & Sterman, 1992).

'Using the Model in the Problem Situation'. Once it has been built, for the model to be useful, it has to be credible to the people involved in the relevant situation. Traditionally, credibility has been equated with validity and the model's ability to replicate historical behaviour of the system. The process of building confidence in the model, through tests for validity and parameter estimation, has been described in detail by Forrester & Senge (1980). Once the model has satisfied basic validity tests, it can be used to test the impact of different policies (Forrester, 1961), explore what-if scenarios (Morecroft, 1988), or optimise key decisions (Coyle, 1985). In either case the model, if accepted, is used as an ontological description of the problematic situation to derive recommendations for policy or structural changes. The validation process and the

exploration of different scenarios might be a continuous source of changes to the model, making it difficult to separate the model building phase from the actual use of the model. The Figure attempts to capture this difficulty by a gray line. The implementation of recommendations is normally preceded by debate and education as it is necessary to convey the insights from the modelling process to the people that did not participate in the intervention process but will be affected by the recommended course of action. Recently the emphasis on validation has shifted to seeing whether the model represents the manager assumptions and mental models. Also, models are now being used for training purposes and shared throughout organizations with the use of management flight simulators (Bakken, Gould & Kim, 1992).

§3 PARTIAL CRITIQUE OF THE APPROACHES

3.1 A Limitation of SSM - Having used a series of *Ws* to create their respective CMs a group will have identified a set of changes which they would like to see enacted in the real world. However, the nature of these changes is limited. They are considered to be incremental improvements to the problem situation, enacted in an evolving process of learning. Prioritisation, optimisation, solution and closure are not on the agenda - they are not considered to be meaningful because they would assume agreement on one single *W*. The value lies in the systemic nature of the process used to identify the changes. The participants have undergone a systemic, a structured, process in which they tried to adopt various *Ws*, and explore the implications of so doing, in order to see whether they are meaningful. They have exchanged understandings and adapted their views. Their world of everyday experiences and actions in society (their *Lebenswelt* or 'life-world') is enriched by the process: they share a commitment to the changes which they now wish to effect. At this point, potentially, a serious limitation has arisen. To understand it we must first explore SSM a little further.

Throughout the SSM process, participants are dealing with a variety of conceptual abstractions - holons. Let us consider these rather more closely. A holon may extend to a causal structure and even non-linear relationships between that sub-set of activities for which causal relationships are meaningful and, in consequence, also (necessarily time-evolutionary) feedback loops of variables The notion of participants' holons being in this form is not unreasonable. A holon may also involve a notion of evolutionary behaviour, or progression over time, of some attribute. This implies an intuitive judgement, an instinctive view of the effects of the activities within the model. But if both of these possibilities hold, then there is no guarantee that the consequences of the activities, logically deduced using the assumptions of the causal structure part of the holon will be consistent with the instinctively inferred behaviour part of the holon. SD is predicated on the view that it is not possible for the human instinct to intuit the behaviour of complex feedback structures. Cognitive limitations mean that an unsupported interrogation of casual mental models will almost certainly not infer a behaviour over time which an individual would themselves consider to be logically consistent with their assumptions regarding causal structure As a result, there is no *a priori* assurance that changes to, or actions in, that causal structure will be logically consistent with the desired, instinctively inferred behaviour. We choose to call this missing property of structure/behaviour dynamic consistency 'dynamic coherence of the holon'.

Now this entire difficulty is one which Checkland foresaw. He suggested that groups might require that their individual holons are 'valid' or 'defensible', "in terms of any other systems thinking which the analysts revere" (Checkland, 1981, p.176). In cases where 'dynamic coherence of a holon' is meaningful and desirable, Checkland proposes the use of 'other systems thinking'. Such usage still concerns conceptual abstractions. The difference is that these are represented, or modelled, not just with RDs and CMs but also using tools which allow one to map and manipulate the causal structure in a way which facilitates the logical deduction of the behaviour implied by the activities within the holon and the comparison of that deduced behaviour with the instinctive behaviour.

We are now able to describe our suggested limitation. Suppose that a group has agreed that it 'reveres', that is, desires and finds meaningful, both the notion of structure/behaviour dynamic consistency and the use of SD to address this issue. Suppose also that it has arrived at its list of proposed changes. It is, then, surely inconsistent and unrealistic to dismiss the possibility that that group might require some form of 'dynamic coherence' related somehow to the list of changes, however that might be achieved. But we would argue that in this situation, the list, and

hence SSM, has a severe limitation. Although the search process of SSM is systemic, the output is not the implementation of a system (*ibid.*). Hence, the creation of proposed changes is not necessarily systemic: each suggestion for change might emerge from the comparison of the problem situation with a different model, having a distinct *W*. We might have changes {a,b}, {c,d} etc., arising from the use of the first, second, etc. CMs. Now pairs of changes - {a,b} and {c,d} - might arise from holons which are themselves dynamically coherent. But what of the list {a,b,c,d}? And what is the holon for which the property might be desired? It seems, then, that having previously agreed that structure/behaviour dynamic consistency is desirable, the group emerging from an SSM process might usefully consider themselves to be confronting an issue that SD aims to address: an issue for which computer support is necessary. Necessary, to avoid the policy lever combinations which produce the opposite of the effect that might be expected; to gain a sense of the strength of response of effective levers, to evaluate trade-offs between alternatives, to avoid counter-intuitive long-term effects, to avoid over-compensating and producing oscillations. Necessary, in short, to understanding causal structure so that one is sensitive to the actions that should be taken to obtain a desired mode of behaviour. Here we see the limitation of SSM. Although the proposed changes are aligned in the sense that they have the social belief and support of the team, there can be no assurance that they are consistent: changes may implicitly be contradictory, conflicting, self-defeating or ineffective. Some notion of dynamic consistency of an as yet undefined holon is meaningful, desirable and yet lacking. Unfortunately, there is nothing in SSM which ensures this new form of alignment in the proposed changes, or the evaluation of trade-offs between them. SSM is not capable of this type of analysis.We would suggest that for some groups or individuals, this may well be an issue of concern. In §4 we show how the description of 'dynamic coherence' given above might be used to address this limitation.

3.2 Some Limitations of SD - Particularly when it is contrasted with SSM, SD modelling has two limitations: a failure explicitly to handle the issue definition process and a lack of socio-political theory (as opposed to sensitivity) underlying interventions.

The theory of SD modelling places considerable emphasis on the need to have an issue at the core of the process. It is intended to ensure that models include only the variables necessary to study the aspects of a situation that are of interest. Yet the SD literature offers very little comment on ways of eliciting, creating and examining different issues around which a model should be focussed. This element of an intervention is not the central object of study and the underlying assumption is that this strongly convergent requirement of the process can be achieved easily, that a problematic behaviour will be readily at hand. But finding and defining a managerial issue or problem is a notoriously difficult human endeavour which is surrounded by subjective judgements (Smith, 1989). If a process locks into the examination of one issue, important differences of understanding can result. For example, the global model 'World2' (Forrester, 1971a) is criticised by Schroeder *et al.* (1975) for failing to address the issue of inequalities between the 'developed' and the 'underdeveloped' worlds. Forrester & Senge (1980) are right to defend the model on the basis that it is a good model of the issue that they chose to study, "the growth and transition of world society as a whole" (p.215). But, at a different level, the criticism stands. For those who see the disparities between the industrialised and the third worlds as key to any understanding of global development, and observe that this is not examined in World2, the issue of that model - aggregated global behaviour - is simply not meaningful. At least in this example, however, the choice of issue is conscious and subject to reflection and debate. In many cases it seems as though the choice of issue is passed over so rapidly, its obviousness so manifest, that it is no longer regarded as a legitimate source of interest; attention passes straight to the modelling process. This implicitly denies that the selection of an issue to model is a deeply subtle social process.

To some extent, SD can be used to address different issues in a single model. Certainly multiple models might be used to study different views about a social situation. However, this is not the point. The fact is that the theory of SD rarely touches on practical means of helping participants generate and articulate a richly divergent set of different views which might then inspire different issues upon which a model-building study may centre. An SSM practitioner might say that SD models are (merely) primary task models. Although the study of these is of value, there are others issues which might usefully have been considered too and the failure to do this is surely a limitation to the effectiveness of any intervention in a social system.

We turn now to the lack of socio-political theory in the field of SD. Recall that Checkland an Scholes (1990) view any group process as involving political and power considerations. It is perhaps, surprising then that the field of management science may justly be criticised as being tool for the powerful - 'management science' rather than 'workers science'. But SD has in no wa been immune to this same criticism (Lane, 1994a&b). The majority of studies occur in situation in which disproportionate power can reasonably be assumed to have been wielded by the hand o the purse-strings. Some examples have begun to occur in which the power of participants i addressed as part of the process (Vennix & Gubbels, 1992). However, the general case is that suc issues are either ignored or dealt with using the unique skills of a particular practitioner (see Lane 1994a). Almost the same comment can be made about the social nature of SD modelling Although some work in this area is under way (Richardson *et al.*, 1992 and Lane, 1994c), there i little recorded material on factors which are important in groups and which contribute to th creation of inter-subjective understanding and commitment. Again, this is a surprise, particularl when compared with the keen interest in social factors taken in the intervention methodologie of, for example, Eden and Phillips (*q.v.*).

§4 A TENTATIVE SYNTHESIS

The possibility of synthesis is now clear but its progression must be effected with great care an considerable attention to the underlying theories of the approaches (this is an issue to which w will return in §5). The synthesis is based on three areas of the two methods. Firstly, th *Weltanschauungen* concept and its use in the creation of a variety of CMs within SSM seems t offer a structured and proven way of generating multiple perspectives on a problem and studyin them carefully prior to any SD modelling. This could be of considerable value in avoiding 'grou think' and assisting the creativity of the participants. At the very least this approach would allo current assumptions to be viewed on that basis: not as givens but as predicates for the later work Secondly, Checkland's approach offers a theory for being aware of the socio-political aspects c an intervention: a stream of cultural analysis runs in parallel with the stream of logic-base analysis. Both the general approach and the outputs of this stream can be used elsewhere. In thes two areas what we perceive as a limitation to SD can be overcome by a strength of SSM. Th third area of synthesis reverses this relationship.

If the list of changes resulting from the use of SSM are associated with a desire to have what w call 'dynamic coherence' with respect to some, as yet undefined, holon then SD can make contribution. We are looking for situations in which a group find the idea of 'dynamic coherenc meaningful and desirable. The group need also require that their holons possess this property particularly with reference to proposed changes - and accept the framework and tools of SD a suitable for testing this via the representation and manipulation of them. The group therefo goes forward with this new 'dynamic coherence' perspective, articulated as *Wdc*, and includin also, perhaps, elements of the original *Ws*. They therefore create one or more representations c holons - whatever number is necessary to represent all members of {a,b,c,d} - and look fc 'dynamic coherence' between the instinctive behaviour and the behaviour logically deduced b manipulating the causal structure of those representations.

We must now be very careful about the underlying assumptions of our proposition. For those i the SD community a crucial shift in ontological assumption is required. We do not impose th common, realist SD view of social reality discussed in §2.2. Instead, we must take a nominali stance. We do <u>not</u> use a 'systemic feasibility' argument grounded in a realist view. The fact th we are working under *Wdc* indicates that we are nominalist, dealing with a particular form c holon. We remaining strictly with the *Lebenswelt* and the mental models of the group. W therefore propose that there are situations in which 'dynamic coherence' of a holon may becor part of the 'systemic desirability' criterion. An example not of system dynamics, but 'holc dynamics' (Lane, 1994c). If these are the circumstances, then the methods developed in the S field are required if the group is to achieve what they have together agreed is desirable ar meaningful. Just as 'catwoe' is accepted as a way of modelling a good RD and hence representing holon, the principles of SD ('formulate as rates and levels', *etc.*) might be accepted as a way c modelling a good causal structure and logically deducing behaviour so that it can be compared wi instinctive behaviour. Checkland & Scholes (1990) offer a dire warning about the difficulties th some systems thinkers may have; "Someone intellectually locked within the 'hard' paradigr believing the world to be systemic, will imagine that changes have to be systemically feasible ar

culturally desirable" (p.52-3). This comment reveals the ontological position of SSM and we have therefore sought to employ that position also and so avoid this difficulty.

We are now in a position to describe in rough outline a study which utilises our proposed synthesis of SSM and SD (see Figure). A group employs the SSM approach described in §2.1, involving both the explicit generation of multiple *Ws* on the issues to address, and the use of the stream of cultural analysis. For whatever reason, the members decide that 'dynamic coherence' of all of their proposed changes - as they relate to some, as yet undefined, holon - is desirable and meaningful. They agree that the tools of SD extend the representation of the nature of a holon and that this extension is aligned with how they, ideally, would wish to think about the holon. They agree that these new tools allow the manipulation of the representation to test for the property of dynamic consistency. Together, these views constitute *Wdc*. They then embark on what we might loosely think of as a second SSM study, but one which heavily employs the tools of SD and operates throughout under *Wdc*. The cultural stream is extended in parallel with a new logic stream. In the latter, they take their study further by identifying the holon which they perceive as having a causal structure in which they can represent the effect of their proposed changes. This process may be aided by their revisiting a sub-set or fragments of their previous holons as well as their generating new ones. It may result in one model or a set of different model, representing different holons. Whatever the case, the focus for this activity is *Wdc*, the issue of the need to test for dynamic consistency, a property now desired if they are to believe that the changes that they have identified, and which they believe will improve the real world system when implemented, will indeed yield desirable behaviour when set within their causal structure assumptions about their holon. They make representations of this holon (or holons), perhaps using SSM tools again but certainly by using the methods of SD. The causal structure is diagrammed and then represented as a simulation model (or models). The instinctive behaviour of the appropriate variables is elicited and represented. The model is simulated (manipulated) to produce the behaviour which is a logical deduction of both the causal structure and the effects of making the proposed changes. These runs are then compared with the instinctive behaviour. Changes are made in the representation until the deduced and the instinctive behaviours are the same. This is a process of team learning: its result is the production of a holon (in the minds of the members of the group) and a finalised list of proposed changes (*ditto.* but also in the real world), the two being 'dynamically coherent'.

The differences between this study and other studies are threefold. Firstly, from an SD stance, a divergent range of possible issues has been articulated and stated. They can be examined or even challenged, either by returning to the original *Ws*, or by engaging with those elements of them that have persisted into *Wdc*. Certainly, they are explicit and the importance attached to the changes and the behaviour of the model(s) can be explicitly illuminated by them. The group may even generate new *Ws* if they are challenged by counter-intuitive effects produced by the computer model. Secondly, the stream of cultural analysis extends into this process, continuing to contribute to the creation of inter-subjective understanding and commitment for the group. The third difference derives from an SSM stance. The result, as with straightforward SSM, is action intended to improve the situation. The difference is that the action is based on changes which are 'culturally feasible' and 'systemically desirable', with the new notion of 'dynamic coherence' accepted into the latter.

It is not difficult to misjudge the SD model(s?) which might be used in such circumstances. We have already suggested that it would be significantly different because it arises from a divergent process, is informed by the cultural analysis and is nominalist in nature. Such differences would be less obvious if one viewed only the code of such a model and performed the thought experiment of comparing it with the code of a model generated without any SSM contribution. Although we have profound doubts that the two would be the same, our fundamental proposition would be that this is simply not a relevant measure. If SSM had been used as described above, the model would be seen as an expression of the shared meaning which the group has consensually and inter-subjectively manufactured during the debate of divergent perspectives rather than as a record of the supposedly revealed knowledge elicited from the study of an implicitly, and possibly coercively, imposed issue. As such, we believe that the nature of the model as a social artifact among the group would be utterly transformed.

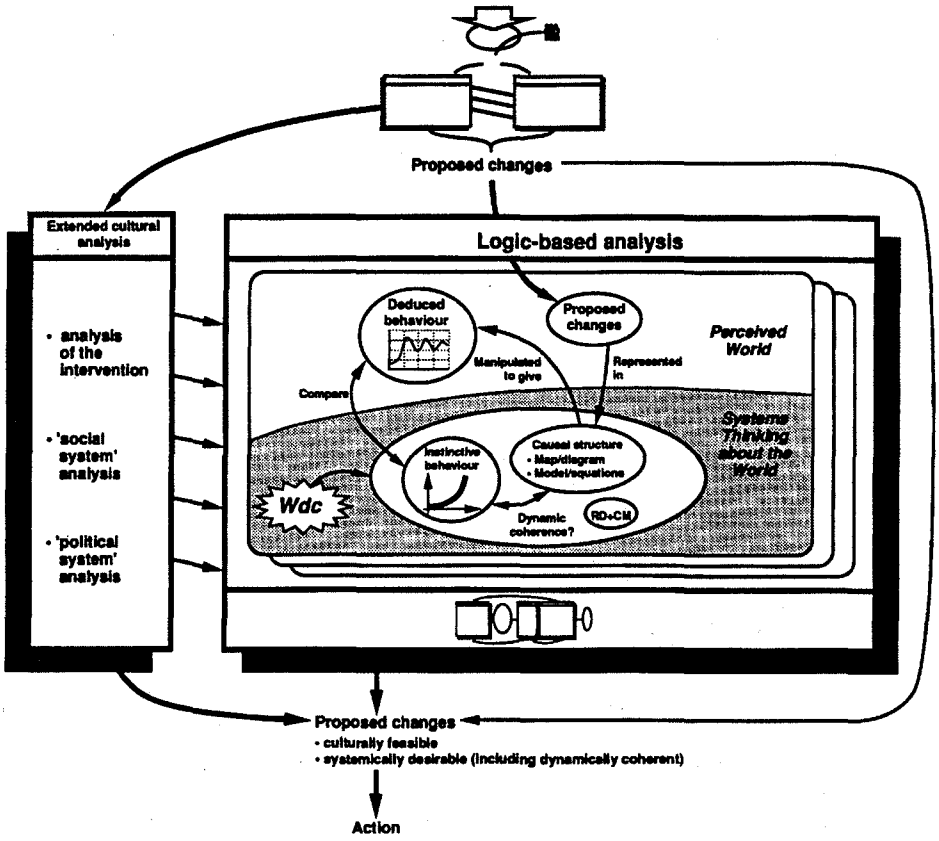


Figure 3

§5 CONCLUSIONS

LIMITATIONS AND BOUNDARIES OF THE PROPOSED SYNTHESIS. One of the three element involved in our synthesis was the cultural analysis offered by SSM. We should make it clear tha in no sense do we believe the current form of this theory to be complete or wholly satisfactory The socio-political sensitivity of SSM is not like the similar elements of the work of Eden (199(or Phillips (1990), both of which were explicitly founded on a view of human behaviour in group and organisations. In contrast, this element of SSM was not present in the original form (Checkland, 1981) but is a limited response to criticisms, a later addition. However, although it i in need of development, it has the potential to contribute to our synthesis. This is clear if w believe that the lack of theory on these matters in the SD literature can limit divergent discussio of issues and perceptions and result in the problematic imposition on a group of the issue c interest to its most powerful member.

We should also mention two things which our synthesis is not. Firstly, it is not a 'front-endin of SD using SSM with the goal of better translating the complexity of the world into an SI model. This idea was suggested by Lane (1994a) and supported by Forrester (1994) and a ver limited deployment of some SSM tools is mentioned in Fiddaman *et al.* (1993). But our synthes aspires to be much more than this. It is an intervention which is framed and supported by th theory and process of SSM but which has SD as a crucial partner; it takes an interpretivist view c human interaction and involves an interweaving of aspects of SSM and SD throughout its whol unfolding. It is, indeed, a synthesis. Secondly, it goes beyond Checkland's (1981) suggestion tha "it may be thought appropriate to re-express [a conceptual model] in the language of syste dynamics" (p.164). SD is not used to translate a particular CM. The synthesis is a process i which SSM has generated a set of changes for which the group, illuminated by the SD approac desire 'dynamic coherence'. This is a new issue which, as described in §4, is examined using a iterative combination of SD and SSM.

THE NATURE OF THE PROPOSED SYNTHESIS. Let us now address the question of what level we are operating at when we make our synthesis. Using the headings of Eden (1990), we might talk about an intervention approach as consisting of tools, techniques, method and theory. Are we not obeying the 'pragmatic' injunction that, "management scientists should not concern themselves with 'airy-fairy' theoretical issues but concentrate on building up a 'tool-kit' of techniques which have been shown to work in practice" (Flood & Jackson, 1991, p.47)? Might we be judged as operating at the tool level, so that our approach is purely pragmatic in this sense? Now it is certainly possible to mix methods at this level. The difficulty arises, as Eden (*ibid.*) warns, when we try to mix approaches which have consciously been constructed at all four of his levels. But would our approach not avoid this? Does it not simply fit the diverse issue generation tools of SSM to the corresponding lack in SD and swap the treacherous intuitive dynamics of SSM for the careful analysis of SD tools? A deeper consideration of what we are proposing reveals that this is not the case, that the synthesis is constructed with knowledge of the social theoretic elements of the approaches and that this knowledge is crucial. Let us briefly consider the theory underlying the two approaches. This is straightforward with SSM since Checkland (1981) explicitly grounds his approach in the paradigm of interpretive sociology; this position must be understood and respected if inconsistencies at the theoretical level are not to result. It is somewhat more difficult in the case of SD because, as Lane (1994c) argues, the social theory is not fully explicit and must be inferred from practice. Although that practice shows a predominant paradigm - functionalist sociology (*ibid.*) - within this there are quite different emphases and also Lane asserts that it is possible that SD is a method, not attached to one paradigm but capable of being re-crafted and applied in others. He calls for considerable attention to be given to socio-theoretic considerations when this is attempted.

Our proposed synthesis is not unlike an example of such a re-crafting, at the theoretical level. The acceptance that there are different, equally valid interpretations of social reality, the importance attached to the cultural analysis and the key ontological break with most SD practice (implicit in the notion that 'dynamic coherence' is not imposed but must arise as a meaningful requirement of a holon) all demonstrate a commitment to interpretivist social theory. Some of the preparation and advocacy of such an approach may be found in Lane (1994c), our synthesis being similar to the form of purely SD modelling which he calls 'fin de siècle SD'. We are therefore able to argue that although our synthesis does offer a rather neat dovetailing of tools, it also operates, and is therefore consistent when judged, at a theoretical level. In this way it seeks to avoid the potential difficulties which Eden flags.

CLOSING COMMENT. In closing, we would draw the reader's attention to our quotation from Tom Paine. We first alighted upon this as a reminder of the limitations of SD when it came to the issue selection process. We now see that it has greater significance. It is true of both SSM and SD that their benefits and value are not irresistibly obvious and believed. Worse, we might argue that there is a schism over the contribution that the two can make. In this paper we have tried to show that a study of the limitations and strengths of the two reveals the possibility of a synthesis of them which appears to be both more sound theoretically and more useful practically than either of the two. We should emphasise that we are not claiming to have achieved that synthesis. Rather, we have tried to identify, to move towards, a possibility which requires, and that we hope will attract, further work of a theoretical and action research nature. Doubtless the comment from Paine will also prove to be applicable to our proposal here. But we find this proposal exciting and powerful. It is exciting that the two approaches can be dovetailed to mutual advantage. And a synthesised whole which is greater than the sum of its SSM and SD parts could be very powerful. But then what could be more appropriate than the synthesis of two systems approaches having emergent properties?

REFERENCES

Ackoff, R.L. 1974. *Redesigning the Future*. New York:Wiley.

Bakken, B.E., J. Gould & D.H. Kim. 1992. Experimentation in learning organizations *EJOR* 59(1): 151-166.

Checkland, P.B. 1981. *Systems Thinking, Systems Practice*. Chichester: Wiley.

___. 1985. From Optimizing to Learning: A Development of Systems Thinking for the 1990's. *J. Opl. Res. Soc.* 36(9): 757-767.

___. 1988a. The case for 'holon'. *Systems Practice*, 1(3): 235-238.

___. 1988b. Soft Systems Methodology: An overview. *Journal of Applied Systems Analysis* 15: 27-30.

Checkland, P. & J.Scholes. 1990. *Soft Systems Methodology in Action.* Chicester: Wiley.

Checkland, P.B. & B. Wilson. 1980. Primary task and issue-based root definitions in systems studies. *Journal of Applied Systems Analysis* 7: 51-54.

Coyle, R.G. 1985. The Use of Optimisation Methods for Policy Design in a System Dynamics Model. *Sys. Dyn. Rev.* 1(1): 81-92.

Eden, C. 1990. Part III: Mixing methods - Introduction. In Eden & Radford, 1990.

Eden, C. and J.Radford. 1990.*Tackling Strategic Problems.* London: Sage.

Fiddaman, T., R.Oliva & R.R.Aranda. 1993. Modelling the impact of quality initiatives over the software product life cycle. In *System Dynamics 1993* (E.Zepeda & J.A.D.Machuca, Eds.) pp.122-131. System Dynamics Society: Boston.

Flood, R.L. & M.C.Jackson. 1991. *Creative Problem Solving:*. Chichester: Wiley.

Forrester, J.W. [1961] 1985. *Industrial Dynamics.* Cambridge, MA: MIT Press.

___. 1969. *Urban Dynamics.* Cambridge MA: MIT Press.

___. 1971a. *World dynamics.* Cambridge, MA: Wright-Allen Press.

___. [1971b] 1985. "The" model versus a modeling "process". *Sys. Dyn. Rev.* 1(2): 133-134.

___. 1994. System Dynamics, Systems Thinking, and Soft OR. *Sys. Dyn. Rev.* 10(2-3): to appear.

Forrester, J.W. & P.M.Senge. 1980. Tests for building confidence in system dynamics models. In Legasto, A.A., J.W.Forrester and J.M.Lyneis, (Eds.). 1980. *System Dynamics.* TIMS Studies in the Management Sciences Vol. 14. Oxford: North-Holland.

Homer, J., J.D. Sterman, B. Greenwood & M. Perkola. 1993. Delivery time reduction in pulp and paper mill construction projects. In *System Dynamics 1993* (E.Zepeda & J.A.D.Machuca, Eds.) pp.203-211. System Dynamics Society: Boston.

Lane, D.C.1992. Modelling as Learning. *EJOR* 59(1): 64-84.

___. 1993a. The Road Not Taken. *Sys. Dyn. Rev.* 9(3): 239-264 .

___. 1993b. From discussion to dialogue. In *System Dynamics 1993* (E.Zepeda & J.A.D.Machuca Eds.), pp.235-245. System Dynamics Society: Boston.

___. 1994a. With A Little Help From Our Friends. *Sys. Dyn. Rev.* 10(2-3):1-34.

___. 1994b. System Dynamics Practice. *J. Opl. Res. Soc.* 45(3): 361-363.

___. 1994c. Social theory and system dynamics practise. *Proc. of the 1994 Conference of the Int System Dynamics Society*, this volume.

Meadows, D.H. 1989. System Dynamics Meets the Press. *Sys. Dyn. Rev.* 5(1): 68-80.

Morecroft, J.D.W. 1988. System dynamics and microworlds for policymakers. *EJOR* 35(3): 301 320.

___. 1992. Executive Knowledge, Models and Learning. *EJOR* 59 (1): 9-27.

Morecroft, J.D.W. & J.D. Sterman (Ed.). 1992. *EJOR: Special Issue* 59(1).

Phillips, L.D. 1990. Decision analysis for group decision support. In Eden & Radford, 1990.

Randers, J. (Ed.) 1980a.*Elements of the System Dynamics Method.* Cambridge, MA: MIT Press.

___. 1980b. Guidelines for Model Conceptualization. In J. Randers, 1980a.

Richardson, G.P. 1991. *Feedback Thought in Social Science and Systems Theory.* Philadelphia PA: University of Pennsylvania Press.

Richardson, G.P., D.F.Andersen, J.Rohrbaugh & W.Steinhurst. 1992. Group Model Building. In *System Dynamics 1992:* (J.A.M.Vennix, J.Faber, W.J.Scheper and C.A.Th.Takkenberg, Eds.) pp.595-604. Boston, MA: System Dynamics Society.

Richardson, G.P. and A.L. Pugh III [1981] 19--. *Introduction to System Dynamics Modeling with DYNAMO.* Cambridge, MA: Productivity.

Richmond, B. 1987. An Academic User's Guide to STELLA. Lyme, NH: High Performance Systems.

Robinson, J.M. 1980. Managerial Sketches of the Steps of Modeling. In J. Randers, 1980a.

Schroeder, W.W., R.E. Sweeney and L.E. Alfeld (eds.). 1975. *Readings in urban dynamics: Vol 2.* Cambridge, MA: MIT Press.

Senge, P.M. & J.D. Sterman. 1992. Systems thinking and organizational learning: Acting locally and thinking globally in the organization of the future. *EJOR* 59 (1): 151-166.

Smith, G.F. 1989. Defining Managerial Problems. *Management Sci.* 35(8): 963-981.

Sterman, J. 1988. A Skeptic's Guide To Computer Models. In *Foresight and National Decision* (L.Grant, ed.), pp.133-169. Lanham, MD: Univ. Press of America.

Vennix, J.A.M. 1990. Mental models and computer models. Ph.D. dissertation, Catholic University of Nijmegen.

Vennix, J.A.M. & J.W.Gubbels. 1992. Knowledge Elicitation in Conceptual Model Building. *EJOR* 59(1): 85-101.

Wilson, B. 1984. *Systems: Concepts, methodologies and applications*. Chichester: Wiley.