SOFT SYSTEM DYNAMICS METHODOLOGY (SSDM): A COMBINATION OF SOFT SYSTEMS METHODOLOGY (SSM) AND SYSTEM DYNAMICS (SD)

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Abstract:

Soft System Dynamics Methodology (SSDM), a systemic methodology product of the combination of two widely used systems-based methodologies from two different systems thinking paradigms, Systems Dynamics (SD) and Soft Systems Methodology (SSM), is presented. The paper argues that by combining some of SD and SSM stages, within the intellectual framework proposed by SSDM, a methodology developed by one of the authors[1] and already in use in various countries in Latin America, much can be gained in a systemic intervention to tackle complex social problematic situations. A framework for comparing the ontological, epistemological and methodological principles of SD, SSM and SSDM is proposed and the synthesizing role of SSDM is advanced. The ten stages of SSDM are presented followed by an application of SSDM on a small Peruvian enterprise where it helped to clarify its problematic behavior, and to analyze and propose culturally desirable and systemically feasible changes to improve its problem situation. Finally, a reflection on SSDM as a systemic intellectual tool is proposed, and conclusions and points for further research are suggested.

Key words: Soft System Dynamics Methodology-SSDM, Systems Dynamics-SD, Soft Systems Methodology-SSM, Multimethodology, Modelling, Weltanschauung

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1. INTRODUCTION

Multi-methodology (Mingers, 1997a) is the name given to the practice that combines and links techniques, methods and methodologies from the same or different systems thinking paradigms, Mingers (1997a, 1997b), Mingers and Brocklesby (1996), Jackson (1997, 1999) amongst others. Multi-methodological practices that combine methods from across the hard-soft systems methods spectrum have been widely reported in Mingers (1997a); Munro and Mingers (2002); Brocklesby, J. (1995, 1997); Lane and Oliva (1994) amongst others. Also, over the last years there have been concerns and debate, amongst members of the System Dynamics community, about SD links with other systems methodologies and about its philosophical principles, role and position within more wider social theories, Lane (1999; 2001a; 2001b); Vennix (1996); Richardson and Andersen (1995); Vennix, Richardson and Andersen (1997a, 1997b.

The paper is largely based on the work of Rodríguez-Ulloa who, after a long action research work that started in 1992 and culminating with the formal appearance of SSDM around 1999, Rodríguez-Ulloa (1995, 1999, 2002a, 2002b, 2004). Essentially SSDM can be regarded as a synthesizing and dialectical methodology that emerges from the combination of two widely used systems-based methodologies from two different systems thinking paradigms, Soft Systems Methodology and Systems Dynamics. The methodology, through its careful application, aims to demonstrate that much can be gained in a systemic intervention. In this paper, this largely used methodology in Latin American setting is formally re-visit here, and the main stages of Soft Systems Dynamics Methodology (SSDM) are described in some detail, emphasizing that this constitutes a new and creative intellectual framework that has emerged from combining some of the stages of SD and SSM. To some extent, SSDM underpins the SD approach by the SSM philosophical principles, concepts and steps; this, in a way, resonates with Lane's claims when he describes to be working in the agent/structure SD paradigm and his Holon Dynamics or Interactive Dynamics approach, Lane (1999, 2001a, 2001b). The framework that SSDM proposes can also be seen, in general, in line with the works of other system dynamics academics and practitioners (Vennix (1996; 1999); Vennix, Akkermans and Rouwette (1996); Vennix, Richardson and Andersen (1997); Andersen and Richardson (1997); Rouwette, Vennix and Van Mullekom (2002); Lane and Oliva (1994), Morecroft and Sterman (1994)).

To those in the systems community interested in the application of a combination of systemic methodologies, the main SSDM's contribution is that it advances a general framework, with clear steps to follow, which not only helps the analysts (i.e. decision makers) to make sense of the problematical situation but also to model the real world under what it can be called the feedback paradigm and to intervene in the implementation of systemically desirable and culturally feasible changes in the real world and culminating with a learning process from all the experience including the implementation of those changes in the real world. We believe that these aspects that SD and the other approaches commentated by the above mentioned authors have not been tackled. To demonstrate these claims an application illustrating the stages of a systemic intervention using SSDM together with the benefits gained in a real world problematic situation in a Peruvian organisation and a reflective analysis from that experience useful for further research are fully reported.

The structure in this paper is as follows: (1) the two systems-based methodologies SD and SSM are briefly outlined together with their epistemological and ontological assumptions underpinning their correspondents paradigms; (2) a framework highlighting the assumptions of

SSM, SD and SSDM, as a synthesis of both approaches, is reviewed; (3) the ten steps of SSDM are presented together with an example based on an systemic intervention carried out in Peru; (4) from the experience of its application a reflective analysis on SSDM is outlined; and finally (5) conclusions and learning points for further research are suggested.

2. THE TWO SYSTEMS BASED METHODOLOGIES: SYSTEMS DYNAMICS AND SOFT SYSTEMS METHODOLOGIES

Before describing the combination of the two methodologies into SSDM, a brief outline of the two methodologies involved is presented in the next section. A summary of the main ontological and epistemological assumptions embedded in SD and SSM paradigm is then presented followed by a summary of, what we argue, are the main limitations of each methodology.

2.1 SYSTEMS DYNAMICS (SD)

Systems Dynamics (SD) originally known as Industrial Dynamics is a creation of Jay Forrester in the 1960s in the Massachusetts Institute of Technology, (Forrester, 1961). SD is essentially a methodology which uses theory of information feedback and control in order to evaluate businesses. The basic idea underpinning this approach is that any complex situation can be described in terms of elements and flows; flows being the relationships between the elements. The main focus of the methodology is the structure composed by the interactions of the elements (flows and levels) between them. This description constitutes the dynamic behaviour of the system. Essentially, SD aims to predict the behaviour of a system, and for doing this, it relies heavily on the use of a model which must contain the intricacies of a complex structure and the multiple feedback loops that link each element within that structure.

The SD process follows three steps that can be summarised as:

(a) Understanding of Situation/Problem Definition: The purpose of the study has to be stated clearly for an SD intervention: a problem, an issue or a system whose behaviour needs to be corrected. The problem is described together with the factors that appear to be causing it and the relationships between them. Forrester (1961) emphasis on Problem definition is one of the key steps on the SD methodology. Problem, possible factors causing it are framed into information-feedback loops that then are used in the modelling part.

(b) Model conceptualisation/Model Building: Since SD is concerned mainly with structure, the first thing that we need to solve is the level of resolution at which we need to model the situation. This is the ‘order of the system’. A sign causal diagram helps to understand the influences between the variables/elements. Model building uses explicit concepts of SD that are transforming the flows into levels, rates and auxiliary variables. The model formulation is done using one of many computer software developed to assist SD modelling logic.

(c) Running the Simulation Model/Using the results: Once the model is built, different scenarios are analysed and used to test different policies/decisions. People involved can explore different what-if situations. The model is used as an ontological description of the situation perceived and if successfully accepted by the people involved both structural changes and recommendations for policy making can be introduced.

Systems Dynamics Paradigm

The basic assumption underpinning the SD paradigm is based around the belief that although the real world exhibits a high degree of complexity, it is possible to capture that complexity in a model. These assumptions have been articulated by Forrester (1961); Richardson (1991) amongst others. Jackson (1992) places SD under the functionalistic, deterministic, hard end of the Management Sciences methodologies. To discuss fully the SD paradigm development is outside the scope of this paper but it is worth to report that in recent years SD has been 'relocated' due to the attention to its actual practice and its involvement in the more general Systems Thinking movement and Systems practice. As Lane (2000, pp 4) states 'On a superficial level, systems dynamics appears to be locatable within the functional sociology paradigm of social theories, … However, the craft of systems dynamics, and hence its theory in use, has many links with more interactionist schools of thought and even some connections with interpretivism'.

It is fair to say that in the 70s and 80s, SD was seen as an outsider in the Systems movement and perhaps most of its practitioners were, in general, situated on the hard end of the systems approach. However, as it has been said above, during the 90s, a number of SD and systems commentators have been making bridges between systems dynamics and the general developments of systems thinking, Senge (1990); Lane and Oliva (1994); Lane (1999, 2000, 2001a, 2001b); Vennix (1996, 1999); Vennix, Akkermans and Rouwette (1996); Vennix, Richardson and Andersen (1997); Andersen and Richardson (1997); Rowette, Vennix and Van Mullekom (2002); Lane and Oliva (1994), Morecroft and Sterman (1994), Sterman (2000), Warren (2002), amongst others. These attempts have moved SD from the hard end of the management sciences spectrum to a much softer interpretive paradigm.

Systems Dynamics 'limitations'

Although System Dynamics was seen as a methodology suitable for Peruvian problem situations, Rodríguez-Ulloa (1995, 1999, 2002a, 2002b, 2004), became increasingly aware, from his experience of working in several Peruvian cases, that certain limitations embedded in the SD´s assumptions were not taken into consideration by the SD's practitioners, specially when, during the diverse interventions the following questions were faced (Rodríguez-Ulloa, 1999, 2004):

- Under which world-views (weltanschauungen) are constructed the causal models representing the problem – situation occurring in the real-world?
- Who are the observers and why they observe the real world under a specific weltanschauung and not through other ones?
- Do human affairs and natural phenomena existing in the real–world can be described under the basis of human rationality?
- In case the real world phenomena behave in an 'irrational' and unexpected way, is it possible to delineate a logical framework of its behaviour?
- Which are the constraints and motivations which make an observer to choose a particular perspective to observe a specific problem-situation? Which kind of interests and values lead he/she to observe the real-world in that way?
- How can someone give a 'solution' about something, if the 'problem' has not been clearly understood or formally defined or if he/she has not realized himself/herself on the

world-view under which he/she is observing the real world?

- Is the 'solution' provided by the System Dynamics approach culturally feasible and systemically desirable to be possible to implement in the real world?
- What learning points can be obtained from constructing problem-oriented and solving – oriented system dynamics models and implement them in the real- world?
- Also, one of the SD's main weaknesses encountered in real-world problem intervention was that it does not clearly distinguish between what in SSM terminology are known as the Problem Solving System (PSS) and Problem Content System (PCS) (Checkland, 1981; Rodríguez-Ulloa, 1988), two basic aspects to be considered in any systemic intervention. SSDM assimilates these two concepts in its methodological framework.

During the interventions that Rodriguez-Ulloa carried out, it was felt that System Dynamics by itself did not answer fully these vital questions and there were areas in which stages of another systems-based methodology such as SSM could help and complement SD in a systemic intervention. Feeling fully conversant in both SD and SSM paradigms and using a critical position in its application, we followed what Jackson (2003, p. 83) states: 'Rather than believe that system dynamics can do everything, a critical system thinker is likely to want to combine the strengths of system dynamics with what other systems approaches have learned to do better'.

At the same time that SSDM was emerging in the LA context, as it was acknowledged above, system dynamics academicians and practitioner were also raising similar concerns. According to Lane (1999, 2000, 2001a, 2001b), what was happening to system dynamics can be seen as an intellectual evolutionary journey that has started from its initial conception by Forrester (1961) in the 60s, where great care was given to both the mathematical modelling and the replication of the behaviour of the real-world using a clear positivistic/objectivistic position, a philosophical paradigm under which SD was created at MIT, called 'austere SD' by Lane. The journey has continued to the present time in which SD claims to be abandoning its functionalistic beginnings an immerse in epistemologies closer to interventions in a more phenomenological strands, thus arising what is called Holon Dynamics, Interactive Dynamics, Group Model Building, Modelling as Radical Learning, Agency Dynamics (Lane (1999), Vennix (1996)), which are approaches near to the interpretive and learning paradigm.

2.2 SOFT SYSTEMS METHODOLOGY (SSM)

Peter Checkland's Soft Systems Methodology (SSM) is one of the most developed Systems Methodologies in terms of its theoretical premises and philosophical underpinnings. It is also one of the most widely used in the UK and in other parts of the world (Mingers, and Taylor, (1992); Ledington, *et al*, (1997); Macadam, R. D. and Packham, R. G. (1989); Macadam, R. D. et al., (1990); Macadam, R. D. et al., (1995), Rodriguez-Ulloa (1994a, 2003), Wilson (1984, 2001) amongst others. During the 1970s, Checkland and his colleagues at Lancaster University questioned the use of hard systems thinking to real-world situations and started to test a new methodology that shifted the systemicity from the real world to the process of enquiry itself.

SSM articulates a learning process which takes the form of an enquiry process in a situation that people are concerned. This process leads to action in a never ending learning cycle: once the action is taken, a new situation with new characteristics arises and the learning process starts again.

The methodology is summarised in Fig 1. This is the SSM best known methodology and although Checkland has expressed a most flexible way of applying his ideas in his latest book (Checkland and Scholes, 1990), the 7 stage methodology is still the most convincing and helpful account of the SSM enquiry.

The basic structure of SSM rest on the idea that in order to tackle real-world situations, we need to make sure that the 'real-world' is separated from the 'systems thinking world'. This distinction is crucial for SSM because that assure that we won't see systems 'out there'; that is in the real world. SSM urges us to consider 'systems' as abstract concepts (preferably, the word 'holons' should be used) which, when use against the real-world, can eventually help to bring some improvements to the situation concerned.

SSM Paradigm

SSM paradigm location is clearer than SD's. SSM follows an interpretive perspective (Checkland (1981, 1986), Checkland and Scholes (1990), Wilson (1984, 2001), Jackson (1992)). This can be summarised as follows: According to Checkland, life world is an ever changing flux of events and ideas and 'managing' means reacting to that flux. We perceive and evaluate, take action(s) which itself becomes part of this flux which lead to next perceptions and evaluations and to more actions and so on. It follows that SSM assumes that different actors of the situation will evaluate and perceive this flux differently creating issues that the manager must cope. Here, SSM offers to managers the systems ideas as a helpful weapon to tackle problematic situations arising from the issues. The world outside seems highly interconnected forming wholes; therefore it seems that the concept 'system' can help us to cope with the intertwined reality we perceive.

SSM 'limitations'

SSM limitations have been exposed mainly by Jackson (1992, 2003); Flood and Jackson (1991); Mingers (1984); and Lane and Oliva (1994) amongst others. Essentially they argued that because of the interpretive underpinning, SSM is not a 'problem-solving methodology' and that can cause concern and uneasiness amongst practitioners. SSM according to Lane and Oliva (1994) is a methodology to explore the real world and because its models are not descriptions of the real world (SSM firmly believe that the real world is difficult to grasp) they are not normative; they are 'ideals' only faithful to one particular world-view.

Although the authors of this paper acknowledge the fact that SSM has been successful in its application to real world complex management situations, they are aware of its limitations raised above; in particular the modelling step, it was found to limit the intervention, (Rodriguez-Ulloa, 1994a, 1994b, 1995, 1999, 2003, 2004), because it did not offer a technological tool to help grasping the consequences and sequels of the assumedly culturally and feasible models suggested; the analyst(s) therefore could not realize about the real impact of the changes proposed. It was felt then that through the incorporation of some of the SD quantitative modelling features, the intervention could be largely enriched. So, Rodríguez-Ulloa (1999, 2002a, 2002b, 2002c, 2004) started to unify both approaches into one intellectual tool by taking the valuable aspects of each one. This combination allowed to build up a working framework which has proved to be useful to understand and to deal with the different perceptions of the people involved in real world complex problem situations, in both qualitative and quantitative terms.

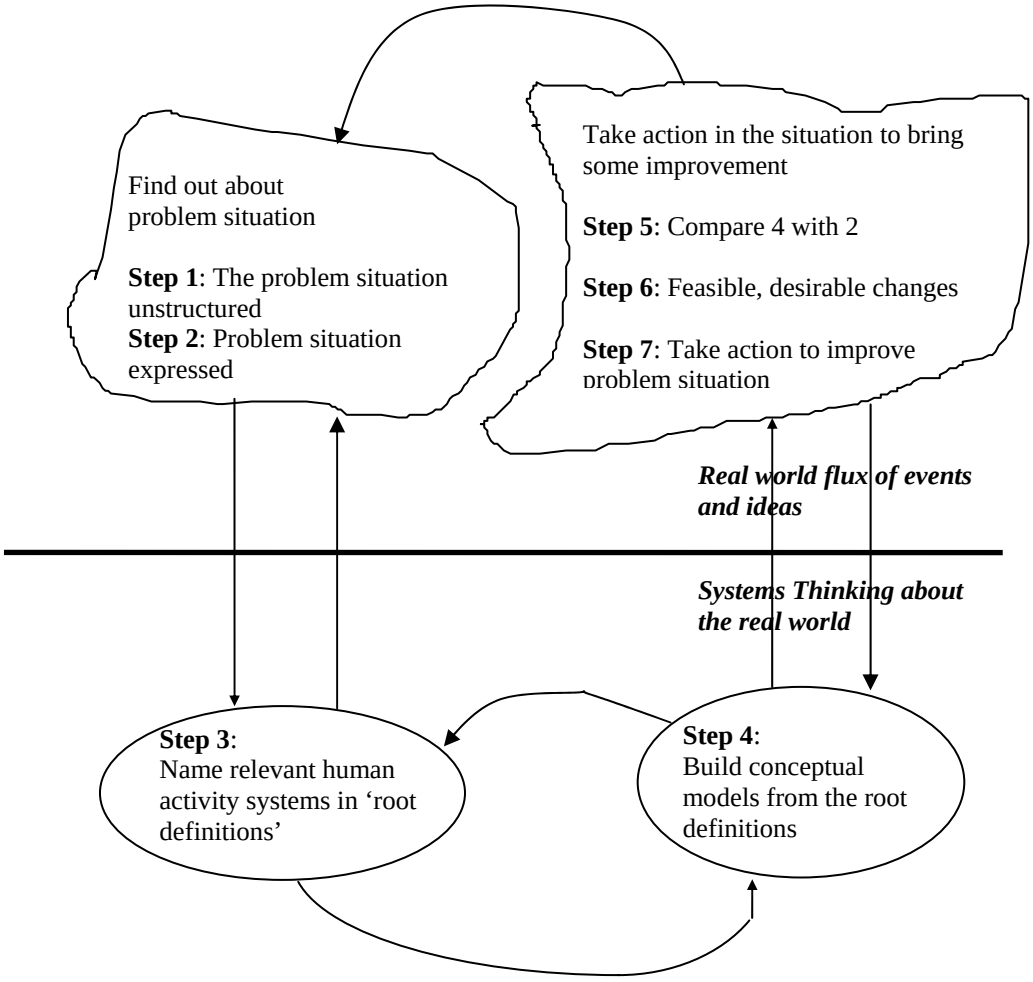

Fig. 1 The Basic Structure of Soft Systems Methodology – SSM.

3. SOFT SYSTEM DYNAMICS METHODOLOGY (SSDM)

As mentioned before, SSDM arose as a product of an action research project started by the end of 1992 at the Andean Institute of System – IAS (Lima – Peru), when Rodríguez-Ulloa (1994a, 1994b, 1995) began to lecture SD for under and graduate students in diverse academic Peruvian institutions and finished in 1999 with a framework of ten (10) steps as it is shown in fig No. 2. Thus, examining the SD approach he noticed that important concepts coming from SSM, which are very important for understanding real world problem situations, were not considered explicitly in the formal analysis of SD. He thought, then, that *combining* both approaches could allow the emergence of a synergistic intellectual tool for systemic studies of complex situations.

SSDM paradigm

During the 90s there has been a great debate in the systems community around issues concerning the use of more that one methodology (combinations of them or parts of them) when intervening in complex situations. The general term of multimethodology, Mingers (1997a), Paucar-Caceres (2002) has been coined to group systemic practices that combine and link various methodologies or some stages of two or more methodologies. SSDM paradigm (Rodríguez-Ulloa, 1995, 1999, 2002a, 2002b, 2002c, 2004) follows what Mingers calls a Multi-paradigm / Multi-methodology approach.

Mingers (1997a, 1999) argues that Critical Systems Thinking and Total Systems Intervention (Jackson (1992, 2000, 2003), Flood and Jackson (1991)), are only one particular form of multimethodology and takes the view that any intervention should gain benefits from being approached with a variety of management science methodologies in what he calls 'strong pluralism' arguing that agent(s) (i.e. person(s)) intervening in the situation would benefit if the intervention is tackled using a 'blend of methodologies'. In Mingers' view the following arguments favour an application of a multiplicity of methodologies: (1) any situation is in itself complex that not a single methodology can claim to be able to tackle it completely, rather we should pay attention to three aspects involved in any intervention: material, social and personal. Some methodologies will bring more enlightenment to some of the three aspects; (2) an intervention is not a discrete event but continuous and therefore some methodologies are more suitable to certain phases of the intervention. We should not disregard the possibility of combining methodological stages, methods or tools from different methodologies serving to different paradigms; and (3) finally there are practical reasons in favour multiparadigm multimethodology: many systems practitioners have already started to practice it. Mingers provides numerous examples supporting his claim and uses five dimensions to characterise the different types of multimethodology practice: (a) one/more methodologies; (b) single/multi paradigm; (c) same or different intervention; (d) whole/part methodology; and (e) imperialist/mixed (Mingers, 1997b). We argue that SSDM will be a particular case of (b) and (d) that is Multi-paradigm and multi-methodology.

Although there have been intents to merge this two approaches (Oliva and Lane, 1994) and although some system dynamics academicians and practitioners have been already working in the arena of messy problems (Lane (1999, 2000, 2001a, 2001b); Vennix (1996, 1999); Vennix, Akkermans and Rouwette (1996); Vennix, Richardson and Andersen (1997); Andersen and Richardson (1997); Rowette, Vennix and van Mullekom (2002); Lane and Oliva (1994), Morecroft and Sterman (1994), Sterman (2000), Warren (2002)), we argue here that SSDM contribution lies on in the elucidation of a methodological framework (i.e. ten clearly defined steps are proposed), where the principles, concepts, philosophies, techniques and technologies from both sides are taken into account and put them to work together. SSDM, thus, is an intellectual tool that can be regarded more than just a merging between SD and SSM but a synergistic systemic framework that Rodríguez-Ulloa arrives from the fusion of these two methodologies.

Table 1, based on Rodríguez-Ulloa (1999, 2004) and Mingers (1997b) shows a comparison on the ontological, epistemological, and methodological foundations between both approaches (SSM and SD) and those of the emerging one (SSDM).

	SSM	SD	SSDM
Ontological principles	- Systems are not assumed to exist in real world; social world of attributing meaning	- Systems exist in the real world Describe the real - world in ontological terms (use of nouns)	- Systems are not assumed to exist in the real – world. The social world has meaning for the observer
Epistemological principles	- Interpretivist, phenomenology and (possible) hermeneutical claims. - Describes the real – world in epistemological terms (use of verbs) - Separation of the real world and Systems Thinking world; systemiticity is in the process;	- Mainly positivistic assumptions - Describe the structure underlying the real world in terms of flows and rates (verbs, nouns and adverbs) - Separation of real world and systems world is not very clear	- Interpretivist, rationalistic, phenomenological and hermeneutical assumptions. - Describes the real-world in epistemological and ontological terms (verbs, nouns and adverbs) - Separation of real world and systems thinking world is clear; Divides SSDM systems thinking world into two: (1)Problem Situation-Oriented Systems Thinking World; and (2) Solving ProblemSituation-Oriented Systems Thinking World
Methodological stages	- Systemic approach based on 'logical' linked human activity systems - Seeks for cultural feasible and systemically desirable changes in the real – world - It is a problem and solving oriented methodology - Unable to measure and assess the possible changes by itself through the time - Clearly establishes the 'what' and 'how' transformation process performed or to be performed in the real – world, to ´improve´ it - It is not a dialectic approach - It finishes with a learning process from the application of the whole methodology in an informal way	- Systemic approach based on 'rational' cause-effect relationships - Does not mention explicitly this important issue - It is a problem- solving oriented approach - Able to measure and assess the changes by itself through time - The 'what' and 'how' transformation process implemented or to be implemented in the real world is not clear - It is not a dialectic approach - It finishes with a learning process of the model-building process in an informal way (Interactive Dynamics, Holon Dynamics, Group Model – Building, Modelling for Radical Learning)	-Systemic approach based on 'logical' linked human activity systems and 'rational' cause-effect relationships - Looks for cultural feasible and systemically desirable changes in the real – world - It is a problem and solving oriented methodology - Able to measure and assess the problematic and improved situation by itself through time - Clearly establishes two transformation processes (1)which explains 'what' is the problem - situation and 'how' it behaves; and (2)which explains 'what' and 'how' should be the transformation process to 'improve' or 'alleviate' that problem-situation and 'how' the improved situation should behave. - It is a dialectic approach - It finishes with a formal process of learning since three positions: (a) From the problematic view of the Problematic – Situation (SSDM's World 2); (b) From the solucionatic view of the Problematic Situation (SSDM´s World 3) and (c) From the Implementation process in the Real World (SSDM´s World 1).

Table 1: Ontological, Epistemological and Methodological comparison of SSM, SD and SSDM (After Rodríguez-Ulloa, 1999, 2004 and Mingers, 1997b)

4. THE TEN STAGES OF SOFT SYSTEM DYNAMICS METHODOLOGY (SSDM)

It is important to emphasize that the10 steps of SSDM work across of what we define as three worlds: (1)the Real World; (2) the Problem-Situation Oriented System Thinking World; and (3) the Solving-Situation Oriented System Thinking World.

We argued that SSDM when applied provides a dialectical view of the real –world situation. This becomes clear when it is applied to a real-world intervention. Thus the first approach in intervening the real world (World 1) using SSDM is just to appreciate the Problem – Situation and to understand its behaviour in a holistic manner (called here World 2). On the opposite (dialectical) side, after having understood the way the Problem-Situation behave, then, systemic thinking of ways to 'solve', 'finish' or 'alleviate' the problem-situation are studied and proposed in the Solving-Situation System Thinking World (called here World 3).

Fig. 2 shows the ten stages of SSDM. The three 'worlds' are clearly illustrated in SSDM:(1) Real World (the green coloured steps); (2) Problem Situation-Oriented Systems Thinking World (the orange coloured steps); and (3) Solving Situation- Oriented Systems Thinking World (the yellow coloured steps). The ten stages of the methodology are iterative (feedback is recommended and encouraged) but for illustration purposes, it helps to think that the first pass (what we called here the 'first loop') is to do with the 'Problem Situation-Oriented Systems Thinking World' and the 'second loop' deals with the ´Solving Situation- Oriented Systems Thinking World´. In the following sections these stages are outlined. A full account of the detailed the stages of the methodology can be found elsewhere (Rodríguez-Ulloa (1995, 1999, 2002a, 2002b, 2002c, 2004))

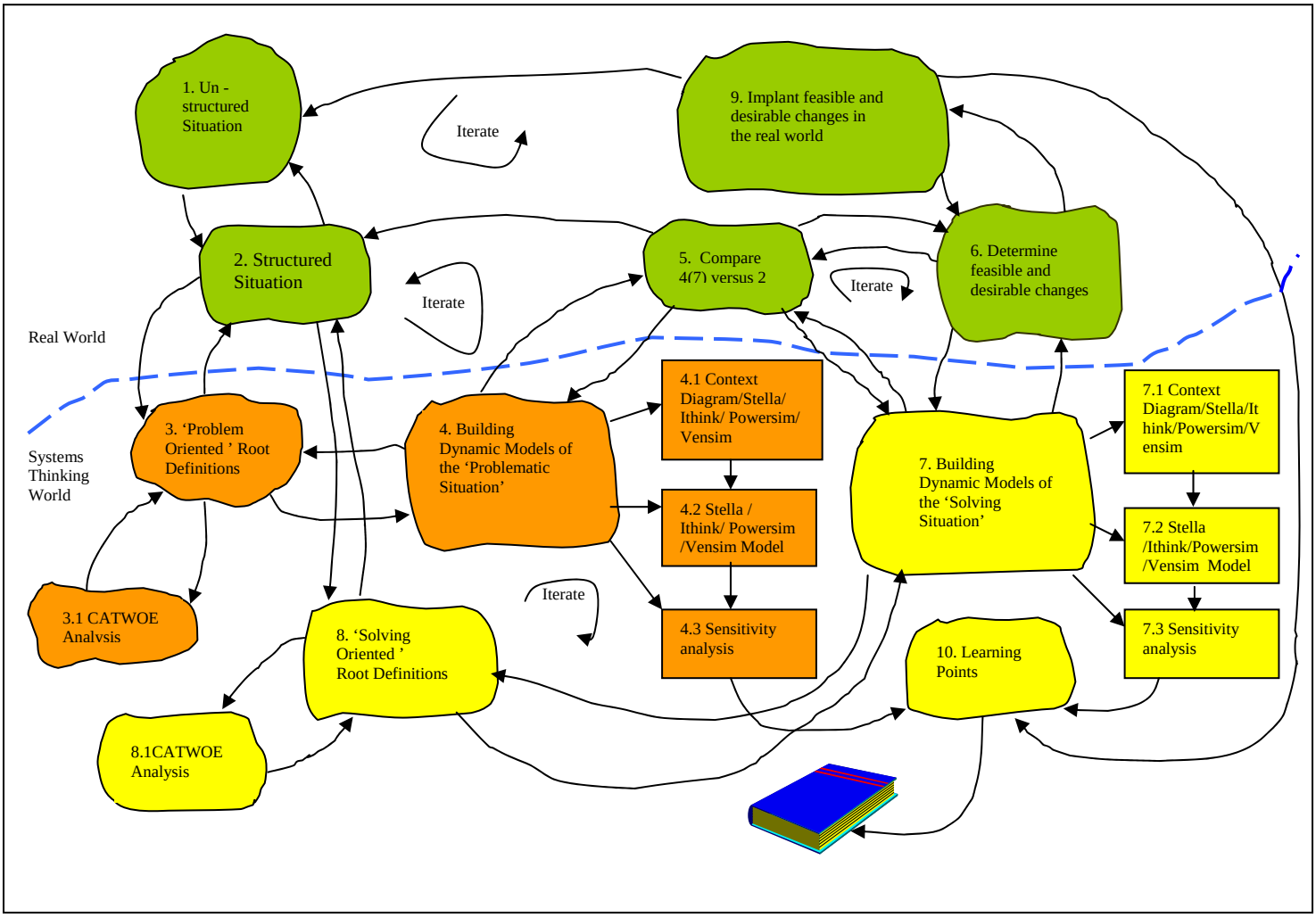

Fig. 2: Soft System Dynamics Methodology (SSDM): A General View (After Rodríguez-Ulloa, 1995, 1999, 2002a, 2002b, 2002c, 2004).