SEARCHING FOR OURSELVES: A METHODOLOGICAL EXPLORATION OF A SOFT SYSTEM DYNAMICS METHOD AS A SOCIAL LEARNING TOOL FOR WATERSHED IMPLEMENTATION PLANNING

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ABSTRACT

Theories of environmental planning acknowledge that social-interactional dynamics contribute significantly to the complexity of environmental problems. Especially, the collaborative capacity to coordinate activities among diverse interests is crucial for successful plan implementation. However, environmental planning typically takes successful implementation as a given rather than as a problematic outcome. Consequently, we understand very little about how to measure the institutional capacities of communities to carry out plans. On a more practical level, if successful implementation depends on the coordination of multiple stakeholders, then we need an effective tool for learning how to join different institutional purposes. And if, as this proposal contends, common purpose is embedded in (rather than separate from) collective action, the implementation-planning tool will conform to a participatory action research methodology. Drawing on Rodriguez-Ulluoa and Paucar-Caceres' (2005) Soft System Dynamics Methodology, and informed by the cognitive model of institutions, I am proposing a Soft System Dynamics Method (SSDM) that combines the richness of Soft Systems Methodology storytelling and the rigor of System Dynamics (SD) modelling into a social learning tool for action planning. A central premise of SSDM is that socio-cultural values underlie patterns of social interaction. In watershed planning and management, the "environment" represents social goods but also contexts of social interaction where often tacit norms about roles and responsibilities are enacted and negotiated. In this sense, watershed communities are sociotechnical systems, or "communities of practice." My dissertation research is a methodological exploration of SSDM as a social learning tool for watershed implementation planning. Three contemporary cases of watershed implementation planning processes will be selected to receive the SSDM intervention. The primary objective of the study is to explore whether and how SSDM promotes group learning about the institutional context and associated leverage points of watershed plan implementation. The study will also demonstrate SSDM both as a tool for developing middle-range theories of collaborative capacity and as an implementation planning tool for problem structuring and institutional design. This paper outlines the proposed SSDM and study design, arguing that a design view of systems can and should contribute to a participatory action research methodology for measuring and realizing group learning. Ultimately, it is hoped that SSDM represents a step closer to realizing C.W. Churchman's vision of the "Singerian Inquiring System" where social learning is characterized by the synergistic integration of theory and practice, facts and values.

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Keywords: social systems design; social learning; action research; soft systems methodology; system dynamics modelling

INTRODUCTION

This paper proposes a Soft System Dynamics Method (SSDM) as a social and policy learning tool that promotes group learning about the institutional context of watershed problems. A central premise of SSDM tool is that socio-cultural values underlie patterns of social interaction. Since technical planning problems always occur in a particular socio-cultural context, it follows from this that ostensibly bio-physical environmental problems are mediated by values that operate as rules governing how stakeholders interact with one another. It is not simply that the environment represents certain "social goods," such as clean water; environmental problems also become contexts of social interaction where often tacit norms about roles and responsibilities are enacted and negotiated. Watershed communities illustrate this integration of instrumental and social logic where stakeholders negotiate institutional claims with and through environmental practices and policies. In this sense, watershed communities are sociotechnical systems, or "communities of practice."

Such a conceptualization follows a "design view" of systems that holds that purpose is embedded in (as opposed to separate from) patterns of interaction. If watershed communities embody particular sociotechnical purposes it also means that they can become problems in their own right: they can become "communities of malpractice." That is, watershed problems may be viewed in terms of poor implementation of a good purpose or successful implementation of a poor purpose, including having no common purpose at all. A second premise of this paper is that successful implementation of a common purpose, whether or not that purpose is expressed in an explicit plan, requires coordination of diverse institutional stakeholders into a (sustained) pattern of interaction. Therefore, poor implementation, taken in this more general sense, reflects a conflict of purpose between a given watershed plan's purpose and the larger community's vision.

For any given watershed problem, the question then becomes: where does the problem reside: in the watershed plan (or lack thereof) or in the community of practice? The approach taken here asserts that the two aspects of the problem cannot be separated and that problem conceptualization depends on the level of perspective taken. Regardless of how a watershed problem is defined, the definition carries with it an implicit judgment of the values that are embedded and enacted in a community of practice. A planning response, for it to be meaningful, will similarly assume a particular pattern of interaction among stakeholders. It will, in other words, embody a common purpose. Thus, the entire process of reflecting on and responding to environmental problems is always ultimately driven by historically situated visions of what constitutes "the good society."

Generally, environmental planning theory and practice overlooks the socio-cultural context of implementation because such a conceptualization implies a response that is largely absent in the repertoire of planners. Not surprisingly, the "problem of implementation" is often diagnosed and addressed by improving plans or planning processes, depending on one's training and bias. It is not that technical or process considerations are not important; they obviously are. But they are not, by themselves, sufficient to address the problem of implementation.

To address this deficiency in environmental planning, this paper proposes a Soft System Dynamics Method (SSDM) as a learning tool for stakeholder groups to reflect on the institutional challenges and opportunities of implementing watershed visions. SSDM adheres to a systems-informed Participatory Action Research Methodology (PARM) which asserts that implementation should be measured as an outcome in terms of particular patterns of interaction among stakeholders; that is, implementation can be thought of more generally and more dynamically as the overall behavior of a sociotechnical system. SSDM thus seeks to measure the collaborative capacity of watershed communities of practice in terms of the extent to which the community's actual behavior pattern differs from a particular, desired behavior pattern, or "DBP."

SSDM is based on a root definition grammar that integrates descriptive and prescriptive purpose and thereby encourages stakeholders to reflect on the socio-cultural values that drive problem definition and response. The rich picture format of the Soft Systems Methodology (SSM) enables stakeholders to collectively tell the "implementation story" which is then operationalized into a System Dynamics (SD) model. A significant benefit of SSDM is the discipline it imposes on thinking about levels of analysis regarding causality. Once a common purpose or DBP is identified, the group can begin to systematically vary and test for institutional factors that seem to be important determinants of system behavior. These leverage points can then become the focus of further inquiry and, eventually, intervention in the form of institutional design.

Thus, SSDM's value is both theoretical and practical: it can contribute to middle-range theorizing about inter-organizational collaborative capacity while also serving as a tool for implementation planning. Ultimately, it is hoped that SSDM will contribute to the larger social learning project as envisioned by Churchman's "Singerian Inquiring System" where theory and practice, facts and values, are integrated to synergistic effect.

LITERATURE REVIEW

Environmental policymaking's current emphasis on managing rather than eliminating uncertainties was in fact anticipated by planning theorists who, starting in the 1960's and early 1970's, observed that planning problems are complex, or "wicked," to the extent that there is no universal agreement on the nature of problems or on their solutions (Rittel & Webber, 1973). Since then, the emergence of Complexity Theory has also ushered in an increased awareness and use of modelling methods and technologies in planning (Byrne, 2003). Modelling emerged as a formal discipline within the Operations Research (OR) field and has been used in planning since the late 1950's. True to its OR roots, modelling was primarily used to solve optimization problems within ostensibly technical domains, particularly within transportation. Since then, modelling and planning methodologies have followed parallel and at times mutually informative paths, with increased attention being paid to the complex interdependencies of "socio-technical systems."[i] Here, socio-technical systems are conceived as being composed of "hard" and "soft" elements, the former being amenable to optimal design considerations and the latter being concerned with values. For Byrne (2005) and others, Complexity Theory provides a systematic understanding of the context-driven nature of socio-technical systems that is rooted in an action-research-oriented modelling framework. Under this framework, stakeholders articulate a common purpose that organizes the joint exploration of problems and alternative futures. Because action-research-oriented modelling is sensitive to the local context of action, it is more likely to lead to an implementable plan (cf. also Friedmann, 2003)

But to date, socio-technical modelling in the environmental planning context has favored technical over social considerations. This technocratic bias assumes the more traditional form of focusing on technical aspects of the given problem. But it is also expressed as a tendency to reduce "value" considerations to quantified valuations of natural resources and other public goods (cf. Reed & Brown, 2003). For instance, the environmental justice discourse continues to be dominated by technocratic concerns with measuring "risk" (Rhodes, 2002). Similarly, in the context of Integrated Environmental Assessment (IEA), modelling is primarily expert-driven. Multiple Objective Analysis (MOA) or Multiple Criterion Decision Method (MCDM) methods are employed to solicit stakeholder valuations of environmental goods or services, which are then fed into (expert-driven) algorithms for selecting the "best" alternative scenario (Cai et al., 2004; Winn & Keller, 2001). Ecosystem marketplaces are also being implemented as experimental test beds that rely on the marketplace to calculate optimal allocations of economic activity by assigning a monetary value to "environmental services" such as clean water (Sterner, 2002). And recent work in mediated, or "collaborative," environmental modelling focuses on measuring stakeholder perceptions and uses of the physical environment in terms of environmental and/or economic utilities in order to predict and evaluate different policies in terms of their social utility outcomes (Cockerill et al., 2006; Daniels & Walker, 2001; Innes and Booher, 1999; Mostashari & Sussman, 2005; Purnomo et al., 2004; van den Belt, 2004 Videira et al., 2003).

While stakeholder valuations of the biophysical environment are important, this approach is based on a narrow concept of "environment" that overlooks the importance of the socio-cultural environment of interaction. As a result, we understand very little about the social dynamics of environmental policy and plans. And yet planning is centrally about coordination of institutional stakeholders (Alexander, 1993). Recent theoretical work on eco-social systems, particularly within the framework of adaptive environmental management (AEM), is beginning to highlight the importance of social learning in collaborative environmental governance (Bouwen & Taillieu, 2004; Davidson-Hunt, 2006; Lee, 1993; Maurel et al., 2007; Pahl-Wostl et al., 2007)[ii]. Some attempts, popularized of late by the concept of "social sustainability," have been made to measure the relationship between stakeholder views about one another and collaborative capacity (see, for example, Weber et al., 2007). These studies are to be commended for conceptualizing "collaborative capacity" as an outcome measure rather than as a given. But models of "collaborative capacity" are typically static and thus ignore temporal dynamics that may influence inter-organizational effectiveness. What is needed is a truly multidisciplinary and dynamic approach to the study of the institutional context of social practices, including plan implementation.

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Richard Scott (1995) identifies three basic models of institutions: the regulative, the normative, and the cognitive (cf. also Shinn, 1996). Neo-institutional economics concerns itself largely with the way governance structures economize transaction costs through regulation. The regulative model assumes that decision-makers are rational and follow an instrumental logic. In contrast, the normative model emphasizes the normative character of institutions. Adherents of the normative model of institutions focus on the formal and informal rules of interaction that evolve in the collective process of solving recurring problems (March & Olsen, 1989; cf. also Schein, 1990). The evolution of routine procedures compensates for the fact that individuals are "boundedly rational," that is, limited in their ability to collect and process information (March & Simon, 1958). Decision-makers are assumed to follow a "logic of appropriateness" that specifies largely stable expectations for various roles in specific contexts.

While the normative model addresses the inadequacies of the regulative (and rational actor) model, critics point out that it does not account for agency in organizational decision-making. Advocates of the cognitive model of institutions emphasize the way that cultural meaning is internalized and enacted through everyday practice. They point out that while actors may be bounded in their rationality, they nevertheless are presented with choices that represent opportunities for critical reflection, calculation, and even learning (Schön & Rein, 1994; cf. also Burke & Reitzes, 1981; Rosenberg, 1979; Stryker, 1980).

The epistemological underpinning of the cognitive model of institutions is social constructionism. Social constructionism emerged in an attempt to resolve the structure-agency debate by asserting that discourses imbue problems with socially constructed meaning and that social actors strategically select from the available set of discourses in pursuit of their own interests. The choices which actors are given, their interests, as well as the outcome are to a large extent determined by prevailing socio-cultural structures of practice. But because cultural meaning is embedded in action, actors have a direct or indirect influence on those structures (Giddens, 1984).

Social constructionism has been influential in policy-analytic formulations, including Institutional Analysis and Development (IAD), which argues that policy actors make strategic decisions to form alliances and mobilize discourses or resources according to "structures of opportunity" which may themselves change as a result of these decisions (Ostrom, 1999; Rydin, 2003). Sabatier and Jenkins-Smith's (1999) propose a similar marriage of structure and agency in their Advocacy Coalition Framework (ACF) which examines policy systems and subsystems. More generally, the "communicative turn" in policy analysis and planning theory during the 1980's signalled an increasing interest in the communicative aspects of social action and generated new questions about social learning and institutional design (Hajer & Wagenaar, 2003; Hoch, 2007). In particular: if patterns of social interaction presuppose some learned system of communication (Bateson, 1958; Luhmann, 1984) and if social communication is itself at least partly contingent on the random confluence of social action, how can collective action among diverse interests be meaningfully obtained and sustained? This question has special relevance for the planning and management of common pool resources like water, where "defection" is always a real possibility (Hardin, 1968; cf. Axelrod, 1984; Dietz et al., 2003; Karkainnen, 2002; Ostrom, 1999).

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New institutional theorists that adhere to the cognitive model of institutions have begun to highlight the importance of culture or "communities of practice" in collaborative capacity, be it at the firm or societal level (Berger & Luckman, 1967; DiMaggio & Powell, 1983; Katz & Kahn, 1978; Meyer & Rowan, 1977; Meyer & Scott, 1983; Scott, 1992; Silverman, 1971; Smircich & Stubbart, 1985; Weick, 1993; Zucker, 1991). But while the cognitive model of institutions has informed work in organizational learning and development, most applications have been limited to strategic planning in the private sector (Banner & Gagne, 1995; Collins & Porras, 1996). And even within the private sector, most theoretical and empirical work has predominantly been concerned with single organizations rather than with (inter-)organizational fields.

There is currently a dearth of understanding of inter-(or "trans-")organizational dynamics and the institutional conditions that promote collaborative capacity. To be sure, some promising lines of analysis that build on the Open Systems tradition have started to shed light on the influence of broader institutional fields on organizations in general terms (Baum & Rowley, 2005; DiMaggio & Powell, 1983; Smircich & Stubbart, 1985). Unfortunately, however, the majority of the work has tended to focus on the impacts that inter-organizational collaboration have on the single organization, reflecting its status as the dominant unit of analysis (Hardy et al., 2003). We know less about the dialectics of (mutual) influence between single organizations or coalitions of organizations and their relevant inter-organizational field (but cf.: Hardy & Phillips, 1998; Miner et al., 1990; Osborn & Hagedoorn, 1997). But we can at least expect this relationship to be dynamic and complex.

In fact, theories of inter-organization collaboration require some sort of theory of social learning to explain the coordination of purpose, values, and activities in addressing a specific problem (cf. Phillips et al., 2000). To this end, theories of "communities of practice," although traditionally focused on the single organization, can shed some light on the kinds of communicative and other conditions that must be met to realize inter-organizational collaboration (Lave & Wenger, 1991; Wenger, 1998; Wenger & Snyder, 2000). Studies of social capital have, in turn, directed our attention to the way social networks simultaneously facilitate and constrain social action towards a common purpose (Bourdieu, 1977; Castells, 1996; Putnam, 1995; Verma & Shin, 2004).

Recent studies of networked governance suggest that networks are especially well suited to address both technical, strategic (largely "regulative"), and institutional (largely "normative") uncertainties (Koppenjan & Klijn, 2005). Koppenjan & Klijn (2005) show that networks reduce uncertainties in the three areas by "steering signals" that articulate the core vision and values of the network and by "steering through rules" that regulate membership composition, interaction, (e.g., conflict regulation mechanisms), and outcomes (e.g., product standards and compliance enforcement). Given the socio-technical nature of network governance, extensive and durable weak ties are especially important to the extent that they facilitate better communication and coordination among a diverse array of interests, values, and visions (Clarke, 2005; Molleman & Broekhuis, 2001; Sink, 1991). In this respect, effective reticulists or policy brokers (which could be more than one person) can be critical to overall network performance (Bogason, 2004). Regardless, networks must address the trade-off between flexibility and coherence. With this trade-off comes the need to sustain "creative tension" between competition (or advocacy) and cooperation (or inquiry). Managing this creative tension is a central requirement of learning organizations and networks (Knight & Pie, 2005; Koppenjan & Klijn, 2005; Senge, 1990; Thompson, 2005). Especially in the context of environmental planning and policymaking, effective networks are characterized by their ability to not only recognize relevant problems but to channel competition between constituent interests to generate ideas and then convene processes for integrating and/or vetting the alternative responses.

Social learning entails both rational (regulative) and normative processes characterized by long periods of incremental adjustment that are punctuated by more fundamental shifts (Baumgartner & Jones, 2002; Healey, 2005; Marcussen & Torfing, 2003). Network management entails "steering through rules" but also occasionally reframing the entire network. On this point, some theorists have drawn attention to the importance of problem frames, especially for environmental conflicts (Gray, 1997; Lewicki et al., 2003). Gray's (2004) typology of conflict frames is theoretically useful for predicting in general terms the way stakeholders will interact, the likely consequences for the outcomes of planning processes, as well as the likelihood of implementation. But we also need a method for describing the particular form that problem frames assume, depending on the cultural context. To this end, Schön and Rein's (1994) concept of "cross-frame reflection," referring to the way policy actors (and theorists!) learn or generate metaphors to move from one frame to another depending on the problem context, is compelling (cf. also Barrett & Cooperrider, 1990; Gold, 2001; Torlak, 2001). But their concept relies heavily on a rational model of learning. In addition, there is a problem with employing a network analytic lens: it tends to "flatten" the view of what are actually recursive processes of communication and control.[iii] As a metaphor, "network" is practical to some extent, but it is theoretically limited.

In contrast, theoretical frameworks working in the new institutionalist vein like IAD and ACF suffer from the opposite problem. On the one hand, they achieve a richer integration of rational and normative process models by distinguishing and then linking the various operational, strategic, and constitutional levels of policymaking (cf. Healey, 2005). But while these cognitive model-frameworks are theoretically compelling, their complexity has to date eluded sufficient operationalization for reliable empirical testing and development. In particular, temporal dynamics associated with delays and adjustment times can have surprisingly significant impacts on overall system behavior (Sterman, 2000). Conventional research methods are not up to the task of capturing many of the temporal dynamics implied by cognitive models of institutions.

But there is still a more fundamental methodological problem. Theories of planning, like theories in general, today find themselves in an epistemological crisis at the intersection of science and policy (Ozawa, 1991; Fischer, 2000 and 2003). In a post-empirical world, are there objective criteria for evaluating the "truth" of statements? The way out of the relativist trap is to loosen the requirement of theoretical completeness. Instead, social action and learning depend on making and testing "hunches" (Schön & Rein, 1994). Modelling provides just such an experimental environment to critically reflect-in-action (van den Belt, 2004) and thereby to integrate different forms of expert, lay, factual, and normative knowledge. Of course, it is important to identify the values or assumptions driving the process and to bound the confidence of our claims accordingly (Ozawa, 1991;

Sterman, 2000). Indeed, studies of modelling demonstrate its potential for facilitating discussions, critical thinking, individual and collective reflection, and learning in a variety of contexts, including planning (Khisty, 1995; Kris, 2003; Meligrana and Andrew, 2003; Ozawa, 1993). Furthermore, computational modelling carries with it the advantage of being able to capture complex dynamics whose nonlinear interdependencies would otherwise elude human intuition (Sterman, 2000; van den Belt, 2004).

To the extent that social practice is communicative, planning theory faces a crisis of legitimacy in practice as well, and nowhere is this more apparent than with the general problem of implementation. Planning theorists have long noted the uneven success of implementing plans, particularly in conflict-ridden contexts (Friedmann, 1969; Pressman & Wildawsky, 1973). They point out that conflicts arise as a result of disagreements not only over goals but over ways to achieve those goals: thus, processes and outcomes cannot and should not be separated. Unfortunately, however, the "implementation problem" reflects a disconnect between planning theory's traditional focus on technical matters (with its implicit physical determinism) and the social and political realities standing in the way. To address this gap, implementation theorists argue for the need to integrate technical and implementation planning both in theory and in practice (cf. Friedmann, 1993). Above all, plans must be culturally feasible. In a profound sense, planning is as much about building communities of practice as it is about bricks and mortar.

Summarizing, there exists a methodological "gap" between fairly sophisticated social theories of organizational and institutional interactions and operationalized models where specific hypotheses can be made and tested. To the extent that planning is about deliberate intervention of socio-technical systems to bring about some desired future, the field must address this lacuna. First, we need a method to develop middle-range theories of inter-organizational/institutional collaboration. Second, we need a problem-structuring tool that facilitates the joint exploration of the institutional causes and consequences of planning problems. This tool would supplement rather than replace conventional fact-finding methods currently used in planning by broadening the scope of "facts" to include rules of social interaction underlying implementation. Indeed, while an institutional-problem-structuring tool could directly inform institutional designs for implementation, its primary value would be to both generate insights into collaborative capacity (or lack thereof) as well as identify areas needing further inquiry. Furthermore, given the normative nature of planning knowledge, such a method should incorporate a Participatory Action Research Methodology that integrates technical, cognitive, and institutional perspectives (cf. Linstone, 1999) within a learning environment that facilitates individual and collective reflection-in-action.

METHODOLOGICAL FRAMEWORK

In order to address the gap in theoretical and practical understanding of institutional contexts of environmental practices, I propose a Soft System Dynamics Method (SSDM) that focuses on cognitive dimensions of transorganizational dynamics. The components of such a method are already available and merely await assembly. Yet the assembly itself must adhere to some kind of methodology. To this end, I propose to follow the

Participatory Action Research Methodology (PARM) in general and a Soft System Dynamics Methodology in particular. A brief rationale for using PARM and Soft System Dynamics Methodology will be followed by a description of their application in SSDM.

PARM derives from Action Theory (AT), which has proved especially promising for understanding patterns of social interaction. Building on General Systems Theory, AT asserts that the "purpose" of a given action is only revealed in the effect that the *relation* between the action and the evoked response has in addressing a given problem. AT takes a systems view that describes "behavior" in terms of the pattern of interaction of parts. AT also emphasizes the importance of implementation since, in this view, a system of interacting parts is only as good as its performance in its relevant task environment. The task environment defines the "goal" or desired behavior pattern (DBP) against which the system's behavior is measured. *The task environment is, in other words, the system's context of implementation*.

AT builds on the recursive paradigm in communication theory to posit a richer understanding of learning (Pearce & Cronen, 1980). In this paradigm, social action (e.g., a planning response) is meaningful to the extent that it fits within a context of interaction that is itself selected for (Luhmann, 1984). Building on Gregory Bateson's (1958, 1972) pioneering work, Argyris and Schön's (1978) model of "double loop learning" describes processes in which groups acquire the competency, in the form of a particular feedback loop structure, to respond effectively to problems of a specific type. Working in the same vein, C.W. Churchman (1971) argued for a need to design "inquiring systems" that incorporate an explicit acknowledgement of the value-laden nature of knowledge.

Soft Systems Methodology (SSM) is a form of PARM that starts with the distinction between the "real world problem situation" and systems thinking (or "weltanschauungen") about the problem situation (Checkland & Scholes, 1990).[iv] As an epistemological starting point, the distinction reflects the assumption that all knowledge is fundamentally purposeful, that is: pattern recognition is always governed by some specific search procedure and furthermore this procedure is unexaminable to itself.[v] This fundamental distinction, then, posits a "design view" of socio-technical systems, or, to use SSM terminology, of "Human Activity Systems" (HAS). The design view builds on Action Theory to assert that systems are "doubly problem-driven:" first, a system recognizes problems it can anticipate and therefore address; in this sense communication and cybernetic control are related (Ashby, 1956). Secondly, this problem recognition is itself governed by a deeper purpose that, to the extent the system-as-search-procedure "survives," addresses a correspondingly deeper problem (Campbell, 1974; Simon, 1996). A design view stresses the importance of the observer who defines or "brings forth" a system as the focus of some kind of intervention (Lendaris, 1986; Maturana & Varela, 1992).

According to SSM, HAS's are a special case of design systems that carry within them representations of real-world problems – the people comprising these systems have minds of their own quite apart from the outside observer! – and these worldviews are themselves purpose-driven. Thus, HAS's can be described has having both "descriptive" and "prescriptive" purpose. Descriptive purpose conforms to a recursive logic where value is embedded and cannot therefore be directly measured by the system in question, whereas prescriptive purpose is objectified ("exteriorized") by an instrumentalist logic that optimizes value. [vi] In this respect, anyway, HAS's are both "soft" and "hard." Furthermore, SSM's design view of HAS is systemic, emphasizing the complex interdependence of parts. Thus, SSM is a collective inquiring system (an HAS in its own right) that incorporates both technical and socio-cultural streams of analyses of tasks and issues with an eye toward total system intervention (Checkland & Scholes, 1990; also Armson et al., 2001; Manning & Binzagr, 1996; Steil & Gibbons-Carr, 2005). The strength of SSM is an explicit acknowledgement of the interdependence of inquiry and purpose that facilitates critical reflection on the multiple perspectives that are embedded in, and drive, socio-technical systems. The goal-oriented perspectives are viewed as part of the problem to be modelled.

SSM's pragmatic value is to provide a root definition grammar to describe and map HAS's with respect to a given real-world problem situation. The root definition grammar is process-based: various model elements are organized to describe each HAS in terms of solution-oriented transformations. These elements are: "Clients" (the beneficiaries or cost-bearers), "Actors" (those performing the transformations), "Transformations" (the process by which inputs are converted into desiderata), "Worldviews" (used here in the narrower sense of "goals"), "Owners" (the holders of the goals who can stop the transformation), and "Environments" (given constraints).[vii] Together, these elements are summarized in the mnemonic "CATWOE." A major advantage of SSM is the discipline which the grammar imposes on problem exploration. By using a mnemonic checklist, participants in an SSM process are encouraged to reflect on the many perspectives of the problem.

Furthermore, SSM brings attention to the problem of implementation: problem exploration usually starts with the (often vague) notion that some worldview – again, treated here in the narrower sense of "goal" – is not being implemented. Therefore, no solution is complete without (descriptions of) processes of monitoring and control. Similarly, planning theorists and practitioners are beginning to inject more accountability into planning by including implementation plans within technical plans. Thus, planning can benefit from SSM's approach by making the "implementation story" a central concern of the modelling effort.[viii] Additionally, SSM's root definition grammar and rich picture techniques facilitate the collective telling of that story by incorporating multiple perspectives on the given problem (Checkland & Scholes, 1990; Gold, 2001; Torlak, 2001).

However, SSM's solution-orientation ironically results in an overemphasis on prescriptive purpose that fails to conceptualize how diverse purposes can be inscribed into a system of practice (cf. Larsson, 2001). That is, conventional SSM focuses on "tasks" in describing relevant HAS's while "issues" stemming from differences in worldviews are overlooked. In particular, while SSM's "stream of logical analysis" is robust, its "stream of cultural analysis" remains methodologically underdeveloped. I argue that this underdevelopment stems from a false theoretical separation of communication and action. A more robust design view more in line with the recursive communication paradigm would assign equal weights to the roles that prescriptive and descriptive purpose play in defining and responding to problems (Larsson, 2001; cf. also: Brocklesby, 2007; Romme, 2003; Vickers, 1965, 1968, 1973; West, 2005). But even if we overlook this problem for a moment, the technical promise of conventional SSM to uncover discrepancies between the participants' mental models and the real world is limited by the bounded rationality of the participants (Rodriguez-Ulluoa & Paucar-Caceres, 2005).

To address some of these shortcomings, Rodriguez-Ulluoa and Paucar-Caceres (2005) propose a Soft System Dynamics Methodology that combines "hard" and "soft" research principles. In particular, they stress the need to make the value-laden aspects of problem scoping and structuring more explicit. To the extent that a problematic pattern of interaction is persistent, we can surmise that the pattern serves some kind of "purpose." But the evaluation of that purpose – and treating the purpose as a problem that requires an evaluation in the first place – is itself determined by some kind of higher order purpose that must be vetted and arrived at by the stakeholder planning group. That is, problem exploration is first and foremost a search for a shared set of values or common purpose that will serve as an organizing principle for collective action. Only once the stakeholders agree on an organizing principle will they have a framework with which to define the problem and begin to test solutions for both their cultural feasibility and their system desirability. A central outcome of a successful SSM process, then, is a vision statement that articulates the pattern of interaction or DBP that the group desires to achieve. This common purpose subsequently defines the planning problem as a problem of social interaction or coordination and thereby guides the stakeholder group in the modelling and in the eventual policy response.

Having gone through this visioning process, participants in the SSM process can begin to model the problem. First, SSM follows principled negotiation theory in collecting information on stakeholder interests with respect to the planning problem proper and is consistent with SSM's traditional solution-orientation. This information covers the rational dimension. A key innovation of the method, however, consists of asking stakeholders to describe *how they interact with one another in pursuit of their interests*. This information covers the normative dimension. The two dimensions are then integrated to render the cognitive story of the watershed as a community of practice with greater or lesser collaborative capacity to implement a common purpose. In watershed planning and management, the SSM process should therefore be driven by three basic questions: 1) what values, both in the narrower utilitarian as well as normative sense, does the watershed hold for the various stakeholders and for the community as a whole?, 2) how is the watershed also a community of (mal-) practice?, and 3) what is the relationship between (1) and (2)?

In the language of modelling, the focus of problem definition and intervention defines the domain of model variables which shall be systematically varied and tested. This domain is conventionally called the "model throughput" and falls on the "inside" of the model boundary. "Model throughput" refers to the process by which inputs are transformed into outputs. On the other side of the boundary are the "inputs," namely, those parameters which are treated as constant throughout the modelling process. Finally, the "outputs" are measures of model behavior or performance. Both problems (inputs) and their responses (outputs) are measured by evaluation criteria derived from the model structure. Thus, I propose that SSM should treat the answers to question (1) as model inputs, while the outputs will be composed of measures of the actual behavior pattern of the watershed community as captured in general question (2). The answer to question (3) roughly corresponds to the vision statement or common purpose and provides the criteria by which questions (1) and (2) will be answered. Figure 1 is a schematic of the SSM modelling process:

Figure 1. Schematic of SSM Modelling Process

To illustrate, consider a simplified hypothetical example of a North American watershed community composed of farmers, the National Oceanic and Atmospheric Administration (NOAA), and environmental watchdog groups. Each stakeholder group has a distinct set of interests with respect to the biophysical watershed. Assume for a moment that the watershed community currently finds itself embroiled in political strife characterized by lawsuits, distrust, poor compliance of existing regulations, and general ill will among the stakeholder groups. Using SSM, there are two general aspects of the watershed problem to consider: what are the interests among the various stakeholders, and how are those interests playing out as a pattern of interaction among the stakeholders? Using root definition grammar and CATWOE, stakeholders deliberate on both questions.

For example, because one mission of NOAA is to enforce the Endangered Species Act (ESA), one of its primary "inputs," or interests, would be the health of any endangered species in the watershed. This would comprise NOAA's "worldview" (or at least part of it), as specified in the "W" in CATWOE. An input such as a ESA listing may trigger an increased oversight by NOAA over farmers, with economic but also social and political implications. That is, the input is relevant to the group in so far as it influences interaction dynamics. These dynamics are uncovered as the participants compare and integrate their CATWOE's, perhaps with the visual aid of a picture board. For example, depending on the level of compliance (treated here as a model variable that might itself be a function of NOAA budgetary constraints), environmental "watchdog" groups may sue NOAA for failing to adequately enforce the ESA. Lawsuits can have implications for liable parties such as NOAA but also for the trust and goodwill between the parties, with repercussions for future compliance rates, and so on. Table 1 summarizes the component HAS's of our hypothetical watershed community and their corresponding CATWOE's.

Table 1. Component HAS's of a hypothetical watershed community

(Proto-)HAS	Irrigation	ESA	Environmental watchdogging
(Relevant) Clients	Farmers, salmon	Salmon, public, farmers	Salmon, public, NOAA, lawyers
(Relevant) Actors	Farmers	NOAA, watchdogs	Environmental orgs
(Relevant) Transformation	Diversion of water for irrigation	Stop illegal withdraw	Improvement of ESA enforcement
(Relevant) Worldview (prescriptive and descriptive purpose)	Reliable supply of water for irrigation needs where water is a limitless resource and farmers are "free agents"	To keep salmon off ESA list where water is a limited resource and regulatory "sticks" is the central or only strategy that works	To keep salmon populations and their biophysical watersheds healthy where the biophysical environment is limited and should be conserved for its own sake
(Relevant) Owners	Public, NOAA	Public, NOAA	Environmental orgs
(Relevant) Environment	Biophysical watershed, irrigation ditches, policy system environment	Biophysical watershed, regulatory instrument (fines), budget, policy system environment	Biophysical watershed, budget, litigation, policy system environment
Root definition grammar (descriptive purpose not explicitly stated)	A public-owned system overseen by NOAA (Owners) and carried out by farmers (Actors) to divert water from the riverbasin to become irrigation water (Transformation) by digging irrigation ditches (Environment) in order to secure sufficient and reliable water for agriculture (prescriptive Worldview)	A public-owned (Owners) system overseen and managed by NOAA (Owner and Actor) to stop illegal withdraw (Transformation) through fines (Environment) in order to keep salmon off the ESA list (prescriptive Worldview)	A privately-owned and managed (Owners and Actors) system to improve ESA enforcement (Transformation) by suing NOAA if it fails to adequately enforce the ESA (Environment) in order to keep salmon and their biophysical watersheds healthy (prescriptive Worldview)

By enumerating and then connecting HAS's, it becomes possible to identify important feedback loops and their parameters that influence the behavior pattern of the stakeholder group *as a whole*. This is done by translating the CATWOE stories into Causal Loop Diagrams (CLD's) that may elucidate emergent properties. Figure 2 depicts the story linking the three HAS's (a "+" indicates a positive correlation and a "-" indicates a negative correlation between the variables).

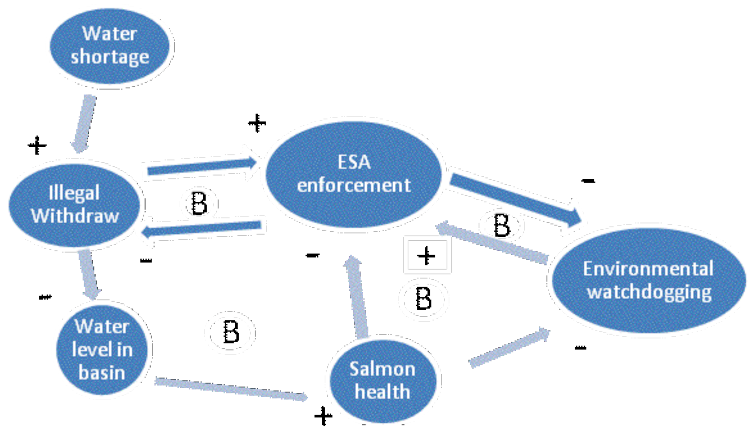

Figure 2. Irrigation-ESA-Environmental Watchdog HAS ("B" signifies a "balancing feedback loop"

As behavioral attributes of the group are uncovered, this stimulates the group to deliberate on which attributes are most important to them. The multiple objectives serve as DBP's against which the actual behavior pattern is compared. Problems will then be defined in terms of the disparity between them. The group may eventually discover, for instance, that lawsuits have a deleterious effect on compliance rates by decreasing trust. Intervention may therefore focus on reducing dependence on lawsuits to improve salmon health. More generally, the group would be able to make their underlying assumptions explicit and furthermore specify the ranges of inputs and conditions which are not covered. Sensitivity analysis would help to identify which areas of model uncertainty are most important and merit further investigation. As this hypothetical scenario illustrates, SSM provides a dynamic framework for a stakeholder group to begin to collectively reflect on and tell the story of their watershed community.

After SSM is implemented, the Soft System Dynamics Method (SSDM) calls for translating "the implementation story" as captured in the CLD into a System Dynamics (SD) model, the second major component of SSDM. SD provides a dynamic and rigorous framework with which to test "hunches" and thus introduces a degree of precision that would otherwise be difficult or impossible to attain (Rodriguez-Ulluoa & Paucar-Caceres, 2005). Forrester (1961) developed SDM from General Systems Theory and the Cybernetics of Communication and Control (Ashby, 1956). SDM starts by conceptualizing a system in terms of "stocks," which accumulate values (e.g., "x"), and flows which add or subtract values from stocks over time (e.g., "dx/dt"). SDM is based on the notion that complex system behavior is caused by some kind of underlying structure composed of stocks, flows, and feedback loops. These loops interact to generate dynamic behavior. SDM entails the operationalization of causal statements into Ordinary Differential Equations (ODE's), which can then be computed using mathematical integration (Sterman, 2000). In this way, complex dynamics can be described and explained. And the user-friendly interface encourages experimentation to discover "leverage points," those relations or parameters that seem to have a significant impact on overall system behavior (Senge, 1990).

Searching for Ourselves

The entire SSDM process is iterative, for the future search conference and subsequent mediated modelling changes the group even as they search for their collective purpose. Thus, some initial inputs or outputs that are identified may be discarded as the problem takes on a new focus. In the end, the inputs, the throughput (the focus of the SSDM intervention), and the outputs all reflect and embody a common set of values of practice, which the group arrives at through the SSDM process. On this point, the unique benefit of SSDM to planning is perhaps most apparent. In conventional planning, plans are "once-off" affairs in the sense that they are never dynamically tested until they are implemented (assuming they are implemented!). They are at that point subject to the inevitable trial-and-error process with its attendant real life costs. In contrast, the SSDM provides an experimental test bed where alternative visions can be compared and tested. It is not only that the "final" institutional design can, in a sense, "anticipate" and thereby avoid many real world lessons. This is, of course, helpful and potentially represents significant cost savings. But perhaps more importantly, the participants in an SSDM process are changed as well and so, to a certain extent, is the real world policy arena about which those lessons are learned. The virtual world of SSDM affords stakeholders the opportunity to discover and articulate the common purpose which is eventually embodied in their design. Thus, when a group of stakeholders learns about the institutional context of the watershed problem, it is, in a profound sense, learning about itself. To that extent, SSDM is a social and policy learning tool for bringing about collaborative capacity.[ix] Figure 5 summarizes the SSDM process.

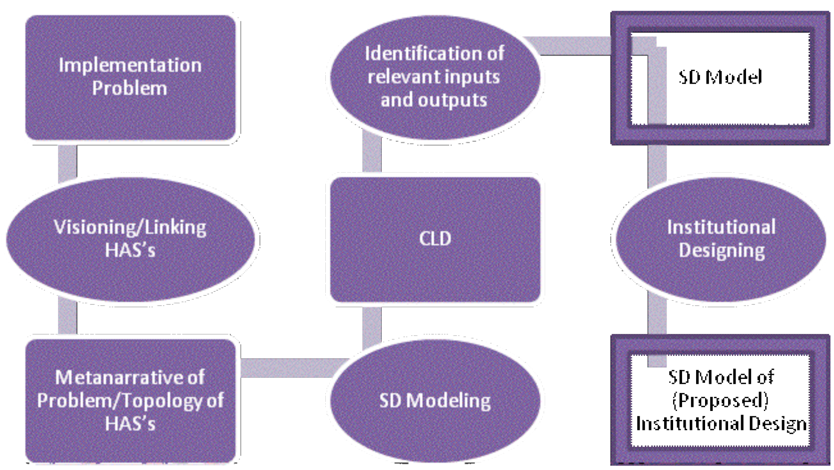

Figure 3. Flow Diagram of the SSDM Process

DISCUSSION AND CONCLUSION

For several reasons, the marriage of SSM and SD is a natural one. For one, SSM's root definition grammar can be readily translated, by way of rich picture format and Causal Loop Diagram (CLD) or other means, into the language of Ordinary Differential Equations that drives System Dynamics programs. Furthermore, the user-friendly quality of SSM's rich picture approach as well as SD's stock-and-flow interface is consistent with the participatory action research philosophy. And perhaps most importantly, both SSM and SD utilize the language of feedback loops that focuses on processes and relations and thus facilitates critical reflection about complex interdependencies and levels of analysis. In sum, the language and the user-friendly format combine to produce a simultaneously rigorous, relatively cost-effective, and fun environment for individual and group learning.

In accordance with PARM, SSDM should not be overly theoretical or expert-driven. At the same time, it is entirely consistent with both PARM and Soft System Dynamics Methodology to reserve a place for "theory" in model-building. In particular, SSDM proposes to use the cognitive model of institutions. Beyond this general framework, the paper will briefly discuss several key concepts from institutional theory and theoretical work on inter- and transorganizational dynamics that are amenable to SD operationalization. Building on Wilbur and Harrison's (1978) work, Michael Radzicki (1988) first proposed the concept of "Institutional Dynamics" that is based on the integration of new institutional economics and SD. The idea is to combine the descriptive richness of institutional economic's case-study method and the explanatory precision of SD's "pattern modelling." Radzicki goes on to note that perhaps the biggest insights into socioeconomic complexity are to be gained not from any particular model but rather from the modelling process itself (Radzicki, 1988).

Radzicki's work was geared towards theory development. Since then, there have been few attempts to continue his "institutional dynamics" research agenda, although Bardach (1999)'s examination of the developmental dynamics of interagency collaboration extends Radzicki's analysis to propose an evolutionary "platform model" to explain the emergence of inter-organizational collaborative capacity, or "ICC." Bardach's model posits a bottom-up emergence that is perhaps more amenable to an Agent-Based Simulation (ABS) framework than to an SD framework.[x] But his concepts for "platforms," ranging (in increasing order of abstraction) from "trust" and "creative opportunity" to "continuous learning," along with his "momentum processes" (affecting enthusiasm, bandwagon effects, consensus, and trust), "leadership legitimacy," and "commotion processes" are all compelling and could be operationalized to fit a SD framework. Similarly, Senge's (1990) "system archetypes," generic structures that produce recurring types of organizational problems, can and do serve as building blocks for SD modelling.

Sastry (2001) in fact develops an "evolutionary" SD model that combines several loops: a balancing "performance loop," a reinforcing "competence loop," to which are attached a reinforcing "inertia loop" and a reinforcing "ability to change" loop. According to Sastry's model, evolutionary dynamics emerge from the tension between two determinants of performance: competence and "appropriateness" (viz-a-viz the larger institutional task environment). Along similar lines, Repenning (2002) proposes a general model of innovation implementation by connecting a balancing "normative pressure" loop to a reinforcing "commitment-effort-results loop," to which is attached a reinforcing "diffusion" loop. Repenning observes the same "tipping point" phenomenon, and he identifies a "motivation threshold" that seems to play a critical role in implementing organizational innovation. While these theoretical formulations can inform

SSDM, to be consistent with the underlying PARM, the specific model structure and parameters will depend on the particular institutional context.

There are to date few applications of SD modelling of organizational dynamics to specific cases. Tucker et al.'s (2005) SD model of a non-profit organization is valuable for demonstrating the significant system impacts that can result from seemingly small parameter changes. Echoing the new institutionalist concept of "punctuated organizational change," they make the distinction between incremental increases in program support and those actions that trigger a reinforcing feedback process (Tucker et al., 2005, 495). They go on to say that organizations can facilitate double-loop learning if they identify criteria to evaluate decision outcomes before vicious cycles begin (cf. also Garud & Kumaraswamy, 2005). At the same time, they identify the inherent limits of using SD models (or any model for that matter) to evaluate system-wide changes.

Ultimately, SSDM modelling is subject to the real world trial-and-error process. In fact, SSDM can be inserted as a Communication and Information Technology (CIT) technology component into an organization's knowledge infrastructure to facilitate (trans-)organizational learning.

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NOTES

[i] Indeed, the two methodologies share a general form: problem structuring and definition, development of selection criteria, generation of alternatives, testing/selection of alternative, and implementation.

[ii] Nevertheless, attempts to theorize, let alone model, the dynamic interaction between the ecological and social spheres is still in its infancy (cf. Gunderson & Holling, 2002; Lebel et al., 2006; Walker et al., 2006).

[iii] The view that is rendered is one of reified nodes and their "links" which are imbued with a physical character, often projected on Cartesian space, while the cultural rules that produce the observed behavior pattern are never adequately examined.

[iv] Coinciding with, and closely related to, SSM is "Value Systems Design" and "Metasystems Methodology" (cf. Hall, 1989)

[v] A fuller articulation of this idea can be found in Gödel's Incompleteness Theorem as well as in the notion of the Turing Machine (cf. also Bateson, 1958: Epilogue).

[vi] In the language of cybernetics, the distinction between descriptive and prescriptive purpose corresponds roughly to the distinction between "error-controlled" and "cause-controlled" regulation (Asbhy, 1956). Within planning, the distinction between descriptive and prescriptive purpose has informed the long-standing debate between those who argue that planning is (or should be) a rational process (cf. Faludi, 1972) and those who contend that planning is a more incremental and irrational process of "mutual adjustments" (cf. Lindblom, 1959).

[vii] In SSM, the classes "Clients," "Actors," and "Owners" may overlap in their membership.

[viii] I use the term "implementation stories" to refer to SSM models of problems in order to highlight the notion that problem structuring must consider institutional practices – and the stories they tell! – as part of the problem. The label reminds us of the need to carry out implementation planning in conjunction with, rather than as an afterthought of, technical planning, as is so often the case.

[ix] Ultimately, of course, the value of SSDM as a social or policy learning tool depends on the extent to which stakeholder representatives truly represent their constituents. A serious question is: to what extent does SSDM merely help to uncover a previously "hidden" common purpose as opposed to truly facilitating creative policy "reframing?" In the former case, SSDM facilitates group learning that reflects on the real world policy arena, almost as a policy analyst might; in the latter, SSDM facilitates a kind of group learning that is less empirically-driven and simultaneously more creative and less reflexive. The greater the initial collaborative capacity of the watershed community, the

more the SSDM process will resemble the former scenario, in which case stakeholder representativeness is more assured. But if there is less agreement on the nature of the problem, and therefore on the need to even convene, the latter scenario is more likely and implementation of any agreement will hinge crucially on whether constituents accept it.

[x] Ann Seror (1994) states that modeling epistemologies are generally one of two types: top-down, or deterministic, and bottom-up, or "emergent." However, as Seror points out, systems are comprised of both aspects, which suggests that a more integrated modeling approach may be desirable.