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AN OPEN-SYSTEMS PERSPECTIVE ON URBAN
PORTS: AN EXPLORATORY COMPARATIVE
ANALYSIS¹

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Abstract

Emery and Trist's Open-Systems Thinking (OST) school is identified as an important but underutilised approach in systems theory. The main features of OST are described, and the concepts are then demonstrated through application to a case concerning the complex social dynamics of urban port domains in New Zealand. An exploratory comparative exercise is then undertaken, in which the case is re-framed in terms of three other systems schools: system dynamics, soft systems methodology, and critical systems thinking. This exploration reveals some fundamental differences in their ontological underpinnings. It also illuminates some lacunae in the previous representation of the port domain case. The exercise helps us to begin to articulate a framework to aid in cross-referencing the four systems schools, and to situate OST concepts in relation to other systems approaches.

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INTRODUCTION

The need for more holistic approaches to corporate, governmental and societal problems has become increasingly recognised in the 1990s, and several schools of thought in systems theory have flourished during the decade. Yet despite important commonalities *and* important differences, contemporary approaches to systems thinking remain significantly isolated from one another. In some respects this isolation can be explained by the extent to which the different systems schools have retained strong allegiances to their origins. Each school seems to have emerged with a principal researcher who was confronted with a particular issue and who proceeded to address it in terms which reflected his own background, experience and worldview. While significant improvements have been made in the specifics of each school over time (sometimes decades), most of the fundamental ideas have prevailed. Within each school, adherents and followers appear to protect and reinforce the vision of the original researcher. Indeed, Lakatos' assertion - that every theory has a "hard core" of basic assumptions, surrounded by a belt of further assumptions and hypotheses, which protect the hard core and help resist attacks from empirical counter-evidence and scientific argument - seems to be operative. Such a dynamic can undermine explorations of possible synergies and improvements (Lane & Oliva, 1998).

An important but currently less well known school in systems theory is the open systems thinking (OST) school, also called the socio-ecological perspective. Fred Emery, an internationally recognised Australian systems theorist, was a key developer of the OST school and a leading proponent of open systems planning and action research methodology for both organisations and large scale systems (e.g. industries, communities, policy sectors). Along with several colleagues, Emery made distinctive contributions to understanding active adaptation in turbulent environments by individuals and organisations. In OST, active adaptation is concerned with the key processes of learning, planning and appreciation of the nature of system environments.

This paper starts to compare OST to other contemporary approaches to systems thinking. Three have been selected: *system dynamics*, because of its emphasis on causality mapping and the validation of causality by means of simulations; *soft-systems methodology*, because of its claim to dealing with complex organisational problems using action research method; and *critical systems thinking*, because of its explicit emancipatory thrust. Note that our sample of comparator schools is, and is intended to be, heuristic and idiosyncratic.

We believe it is important that the schools be cross-referenced, so that synergies might be gained from particular schools' insights. This in turn might provide a better basis for intervention to address practical problems (Lane & Oliva, 1998). This is a large task. At a theoretical level, cross-referencing systems schools requires a metatheory to discuss the features of the different schools, to interpret similarities and differences among them, and to resolve dilemmas. Consistent with this belief, in this paper we explore some possibilities toward a practical complementarism among the four schools, but leave for future research the articulation of a proper metatheory. At a practical level, concrete instances of real-world problems would help to ground the cross-referencing exercise. In this paper we use an existing research study on urban port and harbour management in New Zealand as a vehicle to explore the main features of the OST school and to explore some advantages and difficulties in cross-referencing the four systems schools.

Urban ports and harbours are a useful application arena for comparing systems schools because they are large scale systems with complex interdependencies, embedded in broader social and technical contexts. These large scale systems embrace a variety of different kinds of actors, including dominant users (e.g. port companies and associated organisations), less dominant users (e.g. recreational fishermen, yachties, swimmers etc.), regulators (local and national, from a variety of ministries), community residents, environmentalists etc. Moreover, issues and problems deriving from the interdependencies among these

actors can emerge at different system levels, and can implicate the actors in various ways. Finally urban port domains can easily become politicized.

We proceed as follows. We first indicate the main features of the OST school, then show in what ways the urban-ports case makes use of them. We then briefly describe the origins and current conceptual and practical terrains of the three other schools, and demonstrate how each school would approach the urban-ports case. This exercise reveals some fundamental differences in the worldviews assumed in the different approaches, as well as in their epistemological and ontological underpinnings. This helps us to begin to articulate a framework to aid in cross-referencing the four systems schools.

This comparative exercise enables us to begin to situate OST concepts in relation to other systems approaches and to current debates in organisation studies regarding the unique contribution of open systems theory to operational, strategic and change management. It is also consistent with the recent interest in multi-perspectival research methods in organisation studies (see for example Bolman & Deal, 1991; Morgan, 1997). Bringing multiple perspectives to bear on complex, real-world cases acknowledges the interpreted nature of social phenomena, enables novel insights about the phenomena to emerge, and recognises the value-laden nature of research - and researchers.

THE OPEN-SYSTEMS THINKING (OST) SCHOOL

OST is also known as the socio-ecological perspective (Emery & Trist, 1973; Trist, 1977; Emery, 1997) and the Emery-Trist Systems Paradigm (Baburoglu, 1992). The origins of OST lie in an acknowledgement that

“[t]he importance of self-regulating organizations has become much greater in the context of the increasing levels of interdependence, complexity and uncertainty that characterise societies at the present time. Beyond certain thresholds the center/periphery model (Schon, 1971) no longer holds. There come into being far more complex interactive webs of relationships that cannot be handled in this way. These changes in the wider environment prompted the creation of the socio-ecological perspective” (Trist, Emery & Murray, 1997:32).

The interpretations of reality that stimulated this perspective find expression in several distinctive concepts. Most fundamental is the belief in a “*system principle*” (Angyal, 1941). This is the essential, operative basis for a system’s behaviour, that is, a system’s fundamental organising logic. In addition, a system, its actors, and its environment are defined by a set of *lawful relations*: internal (within the system itself), transactional (two-way between system and environment, which define planning and learning dynamics), and external (in the environment itself) (F. Emery, 1977; M. Emery, 1997). The socio-ecological perspective focuses on shared fields of organisational action, and on proactive, purposeful action by decision makers in organisations inhabiting those fields.

The concept of *environment* in OST is distinctive. Environments are “extended social fields with a causal texture, where the properties of the extended social field affect the behaviour of all systems within it” (M. Emery, 1997:8). The environment is thus a “quasi-independent domain” and needs to be appreciated as such (Emery & Trist, 1965).

The *causal texture* of these fields conditions the relations among the inhabiting organisations/actors. Textures range from placid-randomised to turbulent and beyond.² The turbulent field is characterised by high relevant uncertainty about how to formulate and achieve objectives (Emery & Trist, 1965). How does this texture emerge? In the socio-ecological perspective, standard competitive environments (the “disturbed-reactive

² The original classification was developed in Emery & Trist’s (1965) seminal article, “The Causal Texture of Organizational Environments.” It included four causal textures: placid-randomised, placid-clustered, disturbed-reactive, and the turbulent field. The classification was later extended to the hyperturbulent (McCann & Selsky, 1984) and the vortical (Baburoglu, 1988) textures.

texture" in Emery & Trist's (1965) parlance) are produced and re-produced by concrete decisions and actions made by managers in specific firms within an industry. Decision-makers in firms in an industry react to one firm's competitive actions/decisions; they attempt to "adapt" by mobilising their own competitive tools in order to achieve their own objectives. Mutually reactive chains of decisions and actions result, but they are constrained by tacit agreements about the rules of competition, i.e., about the actions that the decision makers can expect of each other. Actions which are consistent with the agreements serve to sustain the rules.

However, unintended consequences often are generated by these standard competitive business practices when they occur in politicized, pluralistic and fragmented contexts (Emery & Trist, 1973; McCann & Selsky, 1984). That decision makers must cope with unintended consequences accelerates the texturing of the shared environment. Turbulence emerges when unpredictable changes in a shared environment are triggered by the intersection of unintended consequences, creating effects in the extended field, or what we may call "meta-effects". Meta-effects can then build up in the shared environment and affect all actors within it. Indeed, the shared environment itself becomes volatile (Emery & Trist, 1965). This is the turbulent-field texture.

Meta-effects often manifest at system levels larger than the organisation, e.g. as public-policy issues (e.g., homelessness; health insurance), emergent social problems (violent crime in schools; road rage), or "chronic disasters" (Erikson, 1994) in the natural environment (biodiversity loss; ozone depletion). These issues are characterised by long, complex chains of cause and effect that obscure the sources of the problem and possible paths to solving it. *Inter-organisational domains* often arise to address these issues (Trist, 1983; Selsky, 1998). These are comprised of organisations with some shared interests in the issue. The unit of analysis is the domain as a system-in-environment, and its constituent elements are not the organisations themselves, but the relations between and among organisations and other social actors that inhabit and co-evolve the domain (Selsky, 1998).

Collaborative endeavours are posited as the primary mechanism of coping with meta-effects. Such endeavours are based on shared values discovered among the organisations in a shared environment, that is, referencing to the same domain.³ This is because there is a belief that shared values might cohere the fragmented parts of the social field (Emery & Trist, 1965, 1973). Thus domains often become the vehicles for collaborative action. Decision-makers involved in collaborations seek proactive solutions that can simplify or give meaning to ambiguous and complex situations. This is *active-adaptation*. Willingness to engage in collaboration is affected by how decision makers experience meta-effects, because their severity is moderated by the adaptive capacities perceived and mobilised by individuals or groups of organisational actors (McCann & Selsky, 1984). Failure to engage collaboratively leads to forms of maladaptive behaviour, which can have serious negative consequences for the system, its actors and the extended field.

Methodologically, active-adaptive planning (Baburoglu, 1992), search conferences (Emery & Purser, 1996) and participative design workshops (Emery, 1989) have been developed within the OST tradition to give voice to active adaptation in dealing with meta-effects in specific problematic domains. These techniques enable (1) common ground to be forged among pluralistic stakeholders, based on an articulation of the system principle and an appreciation of the extended field; and (2) concrete strategies and action plans to be developed and implemented to cope with the problematic issue.

In sum, a field-theoretic concept of system-in-environment is the essential construct in the OST school. The environment is real, consequential, and able to be acted on. The assumptions about systems are that they are complex and pluralistic (from Flood & Jackson, 1991). The problems dealt with are interorganisational, large-scale or public; and the techniques involve a belief in and reliance on participation and consensus.

An application to urban ports in New Zealand

A current research project on the social dynamics of urban ports in New Zealand (see Selsky & Memon, 1995; Memon & Selsky, 1997; Selsky & Memon, 1997) uses OST as its systems base. The impetus for this

³ It has been suggested that "shared values" be replaced by "ideals" in this and the next sentence (M. Emery, pers.comm.). This will be explored in subsequent research.

project was the major institutional reforms in port ownership and management signalled in the Port Companies Act 1988.⁴ A pilot case study of the Otago Harbour in 1994 yielded a major issue, namely chronic conflicts over port development between the port company, Port Otago Ltd., and local residents in the port zone. The research has recently evolved to a comparative stage, involving other ports in New Zealand and the competitive dynamics among them, as well as the social dynamics within each of them.

This research takes a multi-disciplinary perspective, using an urban-planning discourse and putting emphasis on how the institutional arrangements among the actors condition their behaviour. The actors include the owners of a port's assets (e.g. regional council), those who manage those assets (e.g. port company), residents and communities in the vicinity of a port (e.g. ratepayers association), local authorities which regulate impacts on the natural and social environment (e.g. district council, environment ministry), the national Environment Court (arbiter of disputes) and other "social actors." A behavioural model was developed to guide the research, namely the *complex common-pool resource system* (Selsky & Memon, 1995). Common pool resource systems (CPRs) are

"social system[s] of local users reliant on a resource; within the system one user's use of the resource diminishes the ability of others to use it, and use is limited to a definable community of users which establishes rules for appropriating the resource" (Selsky & Memon, 1997: 260).

Complex CPR systems arise in turbulent environments and are distinguished from simple CPRs by the presence of multiple, overlapping and potentially conflicting uses and user groups; volatility in uses and institutional arrangements; and variances between *de jure* and *de facto* property rights. These conditions give rise to *emergent patterns* of use and management of the resource(s), which do not occur in simple CPRs. The model suggests that institutional arrangements (a configuration of uses, pluralist values, technologies and political-economic arrangements) produce the emergent patterns. In turn, it is the emergent patterns, not the institutional arrangements themselves, that produce the system's outcomes (Memon & Selsky, 1997). That is, institutional arrangements are interpreted locally and manifest in unique local patterns of decision and action; these patterns can have system-wide as well as local ramifications.

The chronic conflicts at Otago were sparked by actions of the port company to expand the port by increasing the volume of cargo throughput. More noise, more trucks on local roads, and new proposals for harbour reclamations violated in different ways some statutory and some assumed amenity rights of local residents. The authors develop the concept of the *amenity commons* to describe the emergent phenomenon of residents' sense of violation of their assumed neighbourhood amenity rights (Selsky & Memon, 1997). They analyse how this phenomenon might be an unintended consequence of the institutional reforms. Other potential conflicts are with recreational, environmental, and Maori interests.

These conflicts and potential conflicts lead the researchers to identify the urban *port domain* as the unit of analysis. This is defined as a complex, whole, harbour-based system embracing port facilities and surrounding communities, plus the interactions among organisations, interests, communities and individuals concerned with the operation, management or governance of the port (Memon & Selsky, 1997). Thus a port domain is interest or issue based; it is generally more encompassing than a port zone, which defines the specific physical location of a port plus its immediate locale. The port domain is both a physical and social entity which affects and is affected by decision making processes and structures in port management. Port management is not limited to decisions and actions taken by port-company officials or territorial authorities, but instead is defined as the ongoing process of taking decisions and actions on the part of any social actor in a port domain that has implications for the mobilisation or deployment of natural, human, physical or financial resources associated with that port.

⁴ This act corporatised all ports in New Zealand, which previously had been owned and governed centrally by the New Zealand Port Authority. Port assets were assigned to territorial authorities (regional and district councils), and management of ports was undertaken by newly created port companies, which are "stand alone commercial entities" (Selsky & Memon, 1997).

The authors advocate that port domains be viewed and managed as complex CPR systems, using co-management principles. In the past, conflicts in port domains have tended to be addressed through non-holistic "logics" such as corporate social responsiveness or locational conflict. These logics have tended to polarise the interests of the parties and lead to contention and litigation. In contrast, the authors advocate dialogue and partnerships in order to address conflicts, based on the holistic logic of co-management of a complex CPR system. There is a belief that partnerships based on this logic have the potential to transform the thinking of parties involved in a problematic issue "from us-and-them to us-with-them... [and] recognises that the parties' fates are inevitably linked" (Memon & Selsky, 1997: 266).

However, the authors recognise that decisions about partnerships in port management now occur within a national and local institutional "infrastructure" which presents conflicting incentives and pressures. For instance prior to their corporatisation, ports were often loss-making and their managements did not care, because there was strong pressure from local stakeholders (e.g. residents, public officials, labour unions) to have full port facilities in the locale, regardless of efficiency. Ports provided employment and contributed to regional development. The port reforms were meant to make a clean break from the "inefficiencies" produced by incorporating those broader values in decision making, enabling the new port companies to focus on commercial objectives. However the energy-draining contentions that erupted in the Otago port domain soon after corporatisation, and that continued for years, must certainly have contributed to inefficiency in the management of the port, and ironically appears to have resulted in community involvement anyway.

The authors question whether the sweeping institutional reforms that have occurred in New Zealand in the past ten years have achieved their stated policy objectives in local urban port domains. This is the essential systems question in the research because it is heuristic for identifying other systemic issues. For example the question opens the possibility of examining whether the change in the ownership of the ports was a non-systemic policy move because it did not take into account residents' de facto rights and other (social) objectives in the port domain, or whether the policy makers recognised those social objectives and intentionally marginalised them in the service of the commercial objective. Similarly one could propose for empirical research purposes that the Otago residents' de facto rights were able to be articulated because the reforms (an emergent outcome of system change) now provided an institutional mechanism for doing so. The logic is that under the previous institutional arrangements those rights had been latent, uncontested, and uncontestable.

To date, the authors are inconclusive in responding to these questions. They recognise that "conflicting forces" are challenging localities as they

"assimilate the dramatic national statutory changes of the past decade... The social ecology in port domains is evolving; it is new uncharted territory, but it is bound to be contested terrain between the global (privatising port companies) and the local (community control of regional assets)" (Memon & Selsky, 1997: 20).

The authors have produced four propositions regarding the long term institutional consequences of the port reforms for local port domains (Memon & Selsky, 1997). These are intended to guide the next, comparative phase of the research during 1998-99.

Assessment

The system in this research is the port domain. System levels are articulated in terms of individual and group interests that constitute the domain, and the infrastructure of national policies "above" the domain; these levels are concatenated. The key issues are emergent: (1) development conflicts and ways of addressing it; and (2) the port domain's effectiveness in achieving sustainable outcomes for the different stakeholders. The systemic assumptions are complex and pluralistic, with a slight nod to the power dynamics among the actors in port domains.

The system change concept in the research is implicitly incremental. The authors examine the institutional arrangements and find them lacking in some areas, and they advocate dialogue and partnership in order to ameliorate the social tensions in the domain. They do not support a complete overhaul of those

arrangements, which might emancipate residents from a position in the system where their residential amenities are dependent on the activities of a powerful port company and on the judgements of the local council and the Environment Court. Nor do the authors indicate how dialogue and partnership might be achieved in the face of intensely political and pluralistic dynamics, nor how common goals might come to be recognised.

The main concepts developed during this research - the complex common pool resource system, the institutional arrangements which comprise it, and the port domain - are strongly informed by the OST tradition. Those concepts emerged as the research evolved; they did not spring forth from a predetermined research plan. Similarly the improvement agenda was emergent. There is a clear search for a different lens or perspective that could be brought to bear on the domain and its dynamics, so that the development conflicts - which appear to be structural under non-holistic perspectives - might be addressed in a different way from the failed conventional ways. The authors advocate the concept of the complex CPR system as that different, holistic perspective. This systemic conceptualisation would provide a basis for an intervention like a search conference to address the conflicts, but the research does not broach an explicit intervention agenda.

The examination of this case in terms of OST principles yields an important conceptual variance. The port domain is construed as the system under investigation, and the elements of that system are construed as the relations among the social actors inhabiting that domain. However OST defines systems in terms of the *system principle*, not in terms of relations among structural elements. Moreover the researchers implicitly conceptualise the system as an emergent whole, an epiphenomenon of the actors' relations as they unfold over time. In contrast, a strict OST interpretation of the case would be in terms of the operative logic of the whole port, and each part (e.g. actor) would be defined in terms of its alignment with the overriding system principle of the port.⁵

SYSTEMS SCHOOLS IN COMPARISON

In this section we outline the main features of three other systems schools that would appear to have some relevance to OST: system dynamics, soft systems methodology, and critical systems thinking. For each school we then outline its likely approach to the urban-ports case. In the spirit of Jackson's (1990: 664) insight that any problem situation can be viewed in a variety of ways, it is likely that each systems school will tend to highlight certain facets of the case that may be in shadow in others. Bringing these lacunae to light "...should assist analysts in seeking creative solutions" (*ibid.*)

System Dynamics (SD)

The origins of SD lie in Jay Forrester's perception that a "gap" existed between "management science and econometrics" on the one hand, and "practicing management and descriptive economics" on the other hand (Forrester, 1961: 4). Forrester was most concerned that management science, with its bias towards mathematics, was not really addressing the issues faced by senior managers and boards⁶. At the heart of the SD approach is the argument that a system's underlying structure determines the patterns of events and performance in it. Consequently, if we wish to improve performance, the highest leverage solutions will come from an exploration of this structure and not from reacting to individual events.⁷ This underlying structure is described in the physical terms of stocks and flows which are controlled by information flows

⁵ This is the concept of directive correlation (Sommerhoff, 1969).

⁶ It is interesting to note that, in a recent email discussion, Forrester effectively declared that after 40 years of trying to influence senior management about the wisdom of systems thinking, he had given up. At the age of 75 years he now prefers to put his considerable energy into trying to achieve a generational change through the education of young children.

⁷ SD is not alone in using this argument. It is also fundamental to Deming's TQM and in industry economics where economic efficiency is linked to the level of market competition.

and decision points incorporating feedback. Delay structures in both the physical and informational flows are critical elements in the determination of system behaviour.

SD is concerned with understanding the *dynamic* behaviour of systems. System behaviour is defined in terms of outcomes, which are represented by the behaviour over time of key performance indicators called *reference modes*. The SD technique uses explicit cognitive mapping processes to describe systems in such a way that causal hypotheses can be defined and then mapped in causal loop diagrams (i.e., directed graphs). These descriptions and hypotheses are often counter-intuitive, because SD believes that intuitive human understanding of whole-system structures and dynamic behaviour are often deficient. Computer simulation models are used to refine and help validate the causal hypotheses. Once established, these models are considered definitive descriptions of the system and its behaviour, and can be used to explore scenarios and policy options.

A fundamental aspect of the SD approach is that these modelling aspects form an integral part of a learning structure for a system's participants. However, over time the specification of this learning structure has been piecemeal. Learning is construed as error detection and correction, not as questioning of norms or goals; e.g., Lyneis' (1980) description of a SD-based corporate planning process as a feedback/learning system integrating analysis, planning, and control.

SD is usually associated with a "hard-systems" or realist stance, that is, the belief that "there is an external world made up of systems the structure of which can be grasped" using the models described above (Flood & Jackson, 1991: 79). Forrester (1961) clearly recognised the importance of using "soft data" and "team research", and the need to accept "the world as it is, not as an idealised abstraction that fails to be meaningful". The world "as it is" is assumed to exist. In SD this world is the problematic system, as it is in OST; depending on how SD is practiced, the world tends to get divorced from its social context (Lane & Oliva, 1998), unlike OST.

The learning aspects of SD have proven to be the most challenging, and those which have received particular attention by its adherents (e.g. Senge, 1990); Richardson, 1996; Vennix, 1996). Indeed a more complete learning framework is emerging as SD has undergone a 'socialisation' process in recent years; for example, bridges between SD and organisational learning concepts (Senge, 1990) and others); a proposed "soft SD" (Wolstenholme, 1990); and icon driven software. Unfortunately, the learning aspects of SD are largely ignored when SD is described and compared with other approaches (e.g. Flood & Jackson, 1991; Pidd, 1996).

An important characteristic of SD models is that loop dominance can shift over time as the result of internal dynamics. Thus volatility in system behaviour is endogenous and reflexive. That is, the purposeful behaviour of a system's actors may produce unintended side-effects which can unwittingly amplify latent negative patterns in the system (see Morgan, 1983). A consequence of this endogenous view of volatility is that a clear understanding of underlying structures is required in order to design effective, contingent policies in the face of possible external shocks⁸.

SD would approach the port domain case by first identifying the problematic behaviour, and expressing it in terms of reference modes relating to the performance interests of different stakeholders. These reference modes might include economic or social indicators such as volume/value of cargo throughput over time, transaction costs incurred in litigation, or quality of water used for swimming or fishing. In developing these reference modes, crucial decisions would have to be made by the SD modelling team regarding the relationships between and involvements of the various domain participants. In addition the domain's stock-flows (e.g. port-capacity cargo movements) would be mapped. Then a causal hypothesis would be formulated as a synthesis of the causal logic believed to be present in the domain; this would be expressed

⁸ There appears to a strong parallel between SD's endogenous view, and Maturana and Varela's autopoiesis concept, although they are each explained in quite different terms, i.e., using different world views.

in feedback terms, for instance, the effects of escalating conflicts between the port company and community residents. A simulation model would be used to test the validity of this causal hypothesis by comparing its outputs to the identified reference modes, and to explore policy options for creating the desired outcomes. An ongoing planning process would be structured to implement and evaluate the policies selected. Important constraints on SD in terms of this case would be its ability to clearly articulate actual and desired performance, and to develop and maintain the group processes necessary to adequately facilitate the modelling and policy development. The model and ongoing processes could become an important planning tool for port company officials, and would be most useful as part of a larger learning-planning process.

Soft Systems Methodology (SSM)

SSM had its genesis in an attempt to move the systems approach from being an "attractive idea", but largely without practical substance, to being a significant approach to problem solving (Checkland, 1981). Like Forrester, Checkland was also concerned at the lack of relevance to management of received theory and practice in operational research and engineering systems thinking (hard systems).

Significantly influenced by the work of Churchman⁹, Checkland (1981) asserts that systems thinking

"starts with an observer/describer of the world outside ourselves who for some reason of his own wishes to describe it 'holistically', that is to say in terms of whole entities linked in hierarchies with other wholes. This leads to the most basic prescription of what the observer's description will contain: his purpose, the system(s) selected, and various system properties such as boundaries, inputs and outputs, components, structure, the means by which the system retains its integrity, and the coherency principle which makes it defensible to describe the system as a whole" (p121).

In practical terms the observer's description finds expression in a configuration of "root definitions of relevant systems" associated with a problematic situation amenable to systems intervention.

The centrepiece of SSM is an action research framework for intervention. Originally described as a seven-stage process which separates the "real world" from the "systems thinking" constructs, the process uses systems concepts to establish a conceptual model ("root definition") consisting of tasks (purposeful actions by participants), issues ("perceptions causing disagreements" among participants (Lane & Oliva, 1998: 217)) and the surrounding "culture" (intervention field, norms, roles, values and politics). This model is used as the basis for proposing "feasible, desirable changes" and "actions to improve the problem situation". This systems-oriented, action-research "roadmap" represents a reflective process involving consideration of the framework of ideas (F), the method (M), and the area of application (A). (The FMA framework will be used in a broader context in the final section of this paper).

Using the root definition as a starting point, SSM proceeds to develop a number of systemic models, each representing a "human activity system". The latter is defined as "a structured set of activities, connected together so that the entity could constitute a *purposeful* whole, as a new kind of system" (Checkland, 1995: 50). "Such models are, in general, not designs for what *ought* to exist (that is the occasional special case); they are epistemological devices serving coherent discussion" among the system's participants (*ibid.*: 51). "Each phrase in the root definition should lead to particular activities in the model; each activity in the model should be traceable back to a particular word in the root definition" (*ibid.*: 53). These models are effectively process models, showing the relationships between activities.

The process diagrams used in SSM play a similar role to the more highly structured stock-flow models of system dynamics, but the SSM diagrams are not converted to causal hypotheses or diagrams. This is because of SSM's interpretive epistemology. That is, different actors in a system (may) hold different worldviews, which will lead them to construct the problematic situation in different ways. SSM is designed

⁹ This provides a further link between contemporary systems thinking and the philosophy of pragmatism associated with Singer, Dewey, James and Peirce etc, and hence back to Kant.

to accommodate different 'Weltanschauungen', whereas SD attempts formally to integrate these different views.

SSM has focused largely on intra-organisational problems, and some observers have criticised it for its inattention to power and politics and for its lack of application to larger-scale systems and government policies (Boulding, 1982; Jackson, 1992). Checkland & Scholes (1992) have countered that SSM could be used in conflictual/coercive situations.

As a large-scale system, the port domain case is not the typical kind of situation that SSM has involved itself with. However if it undertook the task it would find comfort in the contrasting perspectives offered by the researchers: Complex CPR systems, locational conflict, and corporate social responsibility would find expression as alternative human activity systems that could be brought to bear on the development conflicts. The rich picture would be rich indeed, with numerous participants holding different worldviews, but it is less clear how SSM alone might accommodate those differences. No specific guidelines for intervention would be offered, as this is considered to be "a matter of time and co-ordination" among participants (Lane & Oliva, 1998: 219). Yet this is of course part of the problem in this situation, namely the lack of co-ordination of viewpoints between the port company and the community residents.

Critical Systems Thinking (CST)

CST arose out of a desire to critically appraise the varieties of systems thinking as they were perceived in the 1980s. CST embraces

"five major commitments. It seeks to demonstrate critical awareness; it shows social awareness; it is dedicated to human emancipation; it is committed to the complementary and informed development of all the different strands of systems thinking at the theoretical level; and it is committed to the complementary and informed use of systems methodologies" (Jackson, 1992: 184-5).

SSM was the first target of CST's appraisal (Jackson, 1982), and most other major systems approaches have followed, creating a comparative "system of systems methodologies" (Jackson & Keys, 1984; Jackson, 1990; Flood & Jackson, 1991). The several varieties of CST that have emerged in the 1990s share the above commitments, and the school can be seen as a loose "evolving debate around a set of themes that are considered important by a significant number of systems practitioners" (Midgley, 1996:12). CST is realised as a mode of systems thinking in practice by Ulrich's (1983) "Critical Systems Heuristics" (CSH) and Flood and Jackson's (1991) "Total Systems Intervention" (TSI). In this paper we concentrate on the former.

A critical approach entails surfacing and evaluating norms and assumptions. For systems design, for example, this means "planners making transparent to themselves and others the normative content of designs" (Flood & Jackson, 1991: 199). This "allows those who have to live with the results of plans to challenge the 'systems rationality' of the planners" (*ibid.*: 198). CSH claims to be a practical method for use in coercive situations, which, CSH argues, have received scant attention or acknowledgement by other systems approaches. It identifies four kinds of participants in systems, and queries them with 12 "boundary questions" that are heuristic for surfacing latent or consciously hidden assumptions and motives: clients (questions about motivations and values); designers (questions about expertise); decision makers (questions about control and power); and witnesses (those affected but not involved; questions about consequences). This heuristic exercise is engaged in two modes: what currently *is*, and what *ought to be*. It appears to be carried out by the CSH practitioner, possibly in conjunction with the participants themselves.

There are many similarities with OST, though using a different discourse (Habermasian critical theory rather than Lewinian field theory). Yet the lack of reference to OST concepts is surprising. For example, the CSH technique is in fact a form of action learning based on principles similar to those of OST. Furthermore, the major thrust of Emery's life work related to the emancipation of people from various constraints under which they labor, from the workplace to the society (see Weisbord, 1987; Chapter 8), and a liberatory theme has been recognised as pervading the Emery-Trist paradigm (Baburoglu, 1992).

Boulding's criticism of SSM could also be leveled at CSH. While conflict and coercion forms the genesis of the field of critical systems thinking, there is not much evidence that the techniques have been applied to large-scale systems.

Thus, as a large-scale system with little overall structure, the port domain case would present a challenge to a CSH interpretation in this early stage of its (CSH's) development. In a CSH approach the social dynamics in a port domain would be evaluated using the 12 boundary questions. The port company would likely be revealed as a coercive actor in coalition with powerful governmental and business interests. Local residents and environmental interests would likely emerge as marginal "witnesses," that is, the parties affected by the plans of those powerful interests, but who have minimal input into those plans. Other social actors would likely be seen as aligned with the port company or with the witnesses, depending on their access to local policy makers. National-level institutional arrangements (e.g. competition or ownership policies) would be seen as largely outside the control of local actors, but affecting the local dynamics. No overall systems designer(s) would be evident; this might be seen as a deficiency in the system, inhibiting dialogue and the accommodation of interests. The overall system would be assessed as complex and pluralistic-coercive, which could be conducive to an SSM intervention.

A FRAMEWORK FOR COMPARISON

Some of the commonalities and differences among the four systems schools discussed in this paper are apparent. All purport to deal with real-world problems. Ackoff (1981) aptly described that world as one of managing "messes", i.e. systems of interacting problems. All schools recognise the tangled webs of problems that arise in organisations or large-scale systems.

One of the more interesting areas for comparison is the schools' views on the source of volatility in systems. We discovered that in OST turbulence is exogenous; it is a feature of the concrete external environment. However McCann & Selsky's (1984) assertion that turbulence is relative to perceived adaptive capacity would make volatility quasi-endogenous. CST also ascribes to an exogenous view of change. In SD volatility is endogenous, arising from the structural relations in a system. Some writers in the various schools try to finesse this issue by expanding the system boundary. We believe this is not merely a boundary-definition issue, for it has important implications for adaptation. This is clearly an area that needs further exploration.

More fundamentally, adherents of all the schools wrestle with the challenges of representing that real world and its messes in whole-systems terms. This either leads them into or reflects their certain ontological positions: Is the real world systemic, or are our models of the world systemic? "Realist" schools like SD use causal modelling to reflect the former position; "interpretive," or "nominalist", and critical schools like SSM and CST use process models to reflect the latter position; and existential schools like OST use force-field models also to reflect the latter position. All schools also wrestle with the perennial problems of system identity and system boundary; each finds solutions in the ways it configures its diagnostic/conceptualisation aspect and couples it to its action/intervention aspect.

A promising vehicle for examining possible complementarities among the systems schools is suggested by Checkland's "FMA" framework for action research. In that framework, approaches to systems inquiry involve strands of thinking which address three questions: how the logic of systems is described (Framework of ideas), how this logic is applied to the system identified (Method), and how the domain of discussion is defined (Application area). For example, in OST this corresponds to identifying the system principle, adopting the logic of open systems, and employing an action learning intervention such as the search conference. In SD, this process involves identifying reference modes, using the logic implicit in the structure-performance framework, and applying the learning structures described by Senge and others. In SSM, the system is identified through the development of the root definition, the logic is expressed in the SSM models, and the learning through the SSM process. CSH is dominated by systems thinking being a

critical project, and is less explicit about domains of discussions and systems logic; applications are in terms of the 12 questions.

There is much work to be done in fleshing out the FMA framework as a basis for comparing systems schools. Doing so would enable us to appreciate the ontological and epistemological bases of the schools. Bawden (1997) observes that in recent years

“a ‘second generation’ of systems practices has been developed based on the notion of the system as a critical construct....In these approaches, attention is shifted from the analysis of the organisation as a system, to the process by which the organisation’s issues are analysed. In other words, the systems idea is moved from the ‘nature of the thing’ to the ‘nature of the process of inquiry into the thing’” (p2).

Moreover Bawden (citing Checkland, 1988) asserts that the soft approach represents “the shift in systemicity (the systems ideas in action) from reality to the process of inquiry into reality” (1997:3).

This shift from the idea that organisations *are* systems, to the critical idea that organisations can be analysed *as* systems represents a shift from an ontological framing to an epistemological framing. In effect, systems are being seen as “soft” because of this philosophical shift, and the question of the relationship between ontology and epistemology is raised with respect to systems inquiry.

This recent emphasis on the epistemologies of systems has tended to crowd out the importance of ontologies. Indeed, it is the ontological basis which most clearly distinguishes the systems approaches from each other, and from other possible modes of inquiry. What characterises systems thinking is that it employs a form of reasoning which emphasises a “logic of wholes” (Angyal, 1941), that is, it employs synthesis as well as analysis. The expression of this logic is strongly conditioned by the observer’s worldview. Hence epistemology and ontology often merge in the systems thinker’s mind (as well as in the mind of observers of systems thinking), although their value as distinct constructs is not disputed (cf. Burrell & Morgan, 1979).

In the systems schools outlined above, the expression of this logic occurs in the kinds of models employed. For example, OST does not attempt to describe systems in terms of the kinds of causal or process models used in SSM and SD. This reflects fundamental differences in the way holism is conceptualised in these schools. Both SSM and SD employ structural-functional frameworks which are essentially closed-system, and which reflect mechanistic or organic worldviews (Pepper, 1942). SSM uses an organic image of a system, whereas SD uses a mechanistic image. Both ascribe to unitarist notions of potential harmony and consensus in the systems they examine. In contrast OST and CST employ a field-theoretic framework and a critical framework respectively, both of which are essentially open-system and which reflect a contextualist

worldview (*ibid.*). Consequently, we would not expect to find descriptions of “hard” systems with mechanistic structures in OST.¹⁰

For OST the ontological and epistemological issues are inseparable. Because the OST locus of concern is the socio-ecological dimension of human systems, and because of OST’s postulate of a dynamic, interdependent relationship between system and environment, the hardness or softness of a system is meaningless. The essential nature of a system-in-environment, its issues/problems, and the worldviews of its stakeholders are inextricably connected.

This explains Emery’s (1982) disappointment that Checkland had effectively tackled the wrong problem. Both Emery and Trist consistently displayed a strong awareness and deep feeling for the wider significance work practices, educational values, institutional norms and other social dynamics. They were adamant that we needed to keep the notion of “open systems” continually in front of us, to not only build understanding, but to remind us of the wider ramifications of our behaviour.

Significantly, Tsouvalis & Checkland (1996) now recognise the problems with creating the divide between the “real world” and the “systems world.” Although “initially helpful in drawing attention to the conscious use of systems thinking to explore real-world complexity, [the distinction] can be taken to indicate a false dualism; it is necessary to move beyond it if we are to make sense of contemporary sophisticated uses of SSM” (p35).

The FMA approach enables a balance and interconnectedness between the ontological and epistemological aspects of systems inquiry. It also provides a suitable framework for the development of an appropriate comparative-systems method for the management of strategic or operational issues. Most importantly, this approach emphasises the application of this thinking within a learning-change framework. That is, the degree of alignment of SD, SSM or CST with the principles of open systems depends crucially on the nature of the learning structure employed, and not so much on the metaphor used to organise ideas as part of a system’s learning structure.

CONCLUSION

We believe this exploratory comparative exercise has been worthwhile. Addressing the port domain case explicitly in terms of open systems thinking has enabled us to expose the mental models and some assumptions of the researchers which previously had been latent. This is consistent with the “critical” turn in systems thinking. In addition, by undertaking the thought-experiment of re-framing the case in terms of

¹⁰ This analysis suggests that the different schools might be talking about “open systems” in different ways. For example, in comparing SD with OST, the critical point is the way in which SD handles the relationship of the system to its environment. That is, can SD in any way be considered part of the theory of open systems, or is it unequivocally a closed system approach? Forrester drew a distinction between “open” and “feedback” systems: “A feedback system, which is sometimes called a ‘closed’ system is influenced by its past behaviour... [it] has a closed loop structure that brings results from past actions of the system back to control future distinctions... Whether a system should be viewed as open or closed is not intrinsic to the particular assembly of parts but depends on the observer’s viewpoint in defining the purpose of the system” (Forrester, 1968/1990). He then cites the example of an engine without a governor as being ‘open’, but which becomes ‘closed’ once a governor has been added. In practice, SD models extend their boundaries to endogenize whatever variables are necessary to replicate the desired reference modes. The SD practitioner then studies the effects of exogenous shocks (OST’s learning function?) and devises strategies which minimize their effects. In other words, SD recognises that however broadly the system boundary is set, there will always be some distinctly exogenous effects. Nevertheless, this does not preclude the resulting behaviour of the real organisation (as distinct from the model structure) from influencing its environment (OST’s planning function?). But for this to be so, SD must be conceived of not just as a technique for building simulation models, but as a learning structure which utilises simulation modelling. If this broader conceptualisation of SD is accepted, then arguably SD embraces an open systems approach, in that it is based on a field-theoretic world view. This is despite SD’s reliance on a machine metaphor, which carries connotations (certainly in the minds of many systems thinkers) regarding the openness and closed-ness of systems. These speculations are areas for future research.

three other systems schools, we have garnered several new insights into urban port domains and have enriched our understanding of the case.

Moreover that thought experiment has provided a basis for comparing the underlying philosophical bases of the four systems schools. The major difference among the schools appears to lie in the different worldviews at the core of their systemic logics. This is an ontological issue. But more research is clearly needed to tease apart and to synthesize the various schools and their underlying assumptions. The promise of such research lies in more effective systems practice and intervention.

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