Fifty years of systems thinking for management

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The point of this paper is to provide an account of the history of systems thinking applied to management, over the last fifty years, that is insightful and useful to those interested in the theory and practice of operational research (OR). In seeking to fulfil this purpose, it employs Boulding's well known 'hierarchy of complexity' to think through the reasons for the emergence of different strands of applied systems thinking and to detail their strengths. In theoretical terms, operational researchers will find a number of the key issues that have engaged their field (e.g., hard versus soft approaches) mirrored in debates that have taken place between systems thinkers. They may discover new theoretical avenues to follow to advance their discipline. OR practitioners may also be surprised by the nature and scope of the systems applications described and conclude that systems approaches should be added to their own intervention strategies. At the least, the paper is designed to reinvigorate discussion around the relationship between OR and systems thinking that has occasionally surfaced over the last half century but has never been satisfactorily concluded.

Keywords: complexity; systems; philosophy; methodology

Introduction

Both OR and applied systems thinking were born from the interdisciplinary ferment created during the second world-war when scientists from different disciplines found themselves working together on vital military problems. Since that time the histories of OR and applied systems thinking have frequently come into contact and impacted upon one another. For example, some of the early pioneers of OR (Ackoff, Churchman) later adopted the systems thinking label in preference to OR; soft systems thinking began life by defining itself in opposition to hard systems approaches such as OR (Ackoff, 1979; Checkland, 1978); and, more recently, both soft OR and soft systems thinkers have been involved in the development of problem structuring methods (see Rosenhead and Mingers, eds, 2001).

To discover these points of interaction is not surprising because OR and applied systems thinking (AST - and in this paper I always assume the application is to management) have some crucial commonalities that draw them together and differentiate them from other approaches. Firstly, given the distinction made by Gibbons *et al.* (1994) between Mode 1 and Mode 2 forms of knowledge production, it is clear that both OR and AST are Mode 2. In Mode 1 research the problems tackled are defined by the particular scientific interests of an academic community. By contrast, Mode 2 research is produced to satisfy the demands of particular users. It is:

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> “Knowledge production carried out in the context of application and marked by its: transdisciplinarity; heterogeneity; organizational heterarchy and transcience; social accountability and reflexivity; and quality control which emphasises context – and use – dependence” (Gibbons *et al.* 1994).

Tranfield and Starkey (1998) argue that management research generally should adopt a Mode 2 orientation, positioning itself in the social sciences as equivalent to engineering in the physical sciences and medicine in the biological sciences. In fact, OR and AST have already occupied this space. This explains their joint interest in ‘clients’, ‘customers’ and ‘decision-makers’.

Second, both OR and AST insist that rigour can be brought to Mode 2 research by building explicit models and using these during the course of an intervention and for later reflection. Various types of model are employed, and it is arguable that AST uses a much wider range, but this emphasis on modelling differentiates OR and AST from most other organizational development and management consultancy approaches.

Despite these crucial commonalities, that make OR and AST natural bed-fellows, advocates of the one often tend to know surprisingly little about the other. They have their own textbooks, journals and conferences and relate to their own communities of practice. Applied systems thinkers often refer to the classical textbooks and write off all OR as a form of hard systems thinking. Operational researchers have been known to see systems thinkers as either unscientific, or impractical and too much in love with philosophising. This paper, by looking at the last fifty years of systems thinking in a manner that is relevant to OR, hopes to correct the distortion from at least the OR side. Using Boulding’s (1956) ‘hierarchy of complexity’ three different approaches to AST are identified, and labelled ‘functionalist AST’, ‘structuralist AST’ and ‘interpretive AST’. Each of these approaches is described in a separate section of the paper. An account is then provided of more recent developments in AST before conclusions are drawn. Throughout, the importance of developments in AST for OR theory and practice are explained.

The next section outlines Boulding’s hierarchy, its relevance to our concerns, and the use to which it is put in what follows. As a final point of introduction, however, it has to be said that any account of ‘fifty years of systems thinking for management’ will be partial. I acknowledge the partiality of my account, particularly in respect of its bias to UK and US sources.

Boulding’s ‘hierarchy of complexity’

In his paper ‘General Systems Theory - The Skeleton of Science’ (1956), Boulding sets out two routes to developing general systems theory. Either you seek to develop a theory of general principles applicable to all systems, which was von Bertalanffy’s approach, or you take a complementary course, which he preferred, which was

> “to arrange the empirical fields in a hierarchy of complexity of organization of their basic individual or unit of behaviour, and to try to develop a level of abstraction appropriate to each”.

In pursuit of his preferred approach, he produced an intuitive, nine-level hierarchy of levels of real-world complexity, stretching from structures and frameworks at the simplest level to transcendental systems at the most complex. This is summarized in Table 1.

Table 1 A summary of Boulding's (1956) hierarchy of complexity

1. At level 1 are structures and frameworks which exhibit static behavior and are studied by verbal or pictorial description in any discipline; an example being crystal structures

2. At level 2 are clockworks which exhibit predetermined motion and are studied by classical natural science; an example being the solar system

3. At level 3 are control mechanisms which exhibit closed-loop control and are studied by cybernetics; an example being a thermostat

4. At level 4 are open systems which exhibit structural self-maintenance and are studied by theories of metabolism; an example being a biological cell

5. At level 5 are lower organisms which have functional parts, exhibit blue-printed growth and reproduction, and are studied by botany; an example being a plant

6. At level 6 are animals which have a brain to guide behavior, are capable of learning, and are studied by zoology; an example being an elephant

7. At level 7 are people who possess self-consciousness, know that they know, employ symbolic language, and are studied by biology and psychology; an example being any human being

8. At level 8 are socio-cultural systems which are typified by the existence of roles, communications and the transmission of values, and are studied by history, sociology, anthropology and behavioral science; an example being a nation

9. At level 9 are transcendental systems, the home of "inescapable unknowables", and which no scientific discipline can capture; an example being the idea of God

Reviewing his hierarchy, Boulding notes that the characteristics of lower level systems can be found in higher level systems; for example, aspects of all levels 1-6 in level 7, people. Each level, however, presents emergent properties that cannot be understood simply in terms of the theoretical constructs employed successfully at lower levels – hence the need for new disciplines like psychology, anthropology and sociology at more complex system levels. This reminds us of the danger, for the purposes of explanation, of employing a level of theoretical analysis below the level of complexity of the empirical phenomenon that is of concern. Concluding his analysis, Boulding uses the hierarchy to point out gaps in our knowledge, especially our lack of adequate systems models much above level 4. The key problem in predicting system behaviour at higher levels of complexity is the intervention of 'the image' into the chain of causality. As we ascend system levels, brains develop which organise information intake into a knowledge structure or image. Behaviour results from the structure and setting of the image rather than directly from some stimulus. Human images are highly complex and, furthermore, have a self-reflective quality – people not only know, but know that they know.

Despite the apparent difficulties we face in building appropriate theoretical constructions at higher system levels, Boulding notes a surprising twist, an ‘inside track’ to a rather different kind of knowledge relevant to these levels:

> “Nevertheless as we move towards the human and societal levels a curious thing happens : the fact that we have, as it were, an inside track, and that we ourselves *are* the systems which we are studying, enables us to utilize systems which we do not really understand”.

We can now exploit Boulding’s remarkably insightful paper to chart the different directions taken by AST over the last fifty years.

One strand builds on Boulding’s contention that, in a sense, each level of the hierarchy incorporates all those below it. Therefore, as he argues,

> “much valuable information and insights can be obtained by applying low-level systems to high-level subject matter”.

Followers of this approach often employ mechanistic models, from levels 1-3, and organismic models form levels 4-6, to try to assist managers with the complexities they face.

A second strand of AST, in its quest to help managers, has taken its lead from the alternative path to general systems theory that Boulding highlighted but did not follow. Its adherents seek out laws governing general phenomena of system behaviour whatever the level of complexity that is being addressed. In this they follow von Bertalanffy (1968), in principle at least, in believing that

> “there exist models, principles and laws that apply to generalized systems or their subclasses, irrespective of their particular kind, the nature of their component elements, and the relations or ‘forces’ between them. It seems legitimate [therefore] to ask for a theory, not of systems of a more or less special kind, but of universal principles applying to systems in general”.

A third approach to AST largely abandons the notion of general systems theory. Instead it focuses its attention on the ‘inside track’ to the different kind of knowledge that becomes available once we reach the human and socio-cultural system levels. Emphasis is placed on the complex ‘images’ which structure information and enable individuals to attribute meaning to their actions and interactions.

These variants of AST will be detailed in the next three sections under the labels ‘functionalist AST’, ‘structuralist AST’ and ‘interpretive AST’.

Functionalist AST

Functionalist systems thinkers use mechanistic or organismic models to ascertain that everything in the system is functioning well to promote either efficiency or survival. They believe that an understanding can be gained of how operational and organisational systems behave by using scientific methods and models perfected at levels 1-6 of Boulding’s hierarchy. Knowledge is gained about the nature of the parts of the system, the interrelationships between the parts and the relationship between the system and its environment; and managers are, therefore, put more in control.

There have been numerous attempts to apply mechanistic and organismic models to the study of organisations and their management. For example, Barnard (1938) and Roethlisberger and Dickson (1956) employ a mechanical equilibrium model. Katz and Kahn (1966) and Kast and Rosenzweig (1981) are the best known of many texts advocating a ‘systems and/or contingency’ approach based on the organismic analogy. Our interest here, however, is on applied systems thinking – that kind of systems thinking comparable to OR in seeking knowledge directly relevant to a client. The best examples of functionalist AST for our purpose are, therefore, systems analysis, systems engineering and the socio-technical systems approach.

Systems analysis and systems engineering are part of a family of approaches (to which can be added the classical OR described in textbooks) that Checkland (1978) calls ‘hard systems thinking’. All members of this family share a basic orientation, identified by Checkland (1978) as

> “the assumption that the problem task they tackle is to select an efficient means of achieving a known and defined end”

The predefined goal, which is a requirement of hard systems thinking, is agreed with the client and key decision-makers. Analytic models are then favoured to capture the most important variables and interactions in the system of concern, and to determine the most efficient way of reaching the goal. Inevitably these mathematical models represent the system in machine-like terms.

Systems analysis had its heyday under President Johnson who, in 1965, ordered its adoption (under the label ‘planning-programming-budgeting systems’) in all departments of the US federal government. In 1972 the International Institute for Applied Systems Analysis (IIASA) was established in Austria, on the initiative of the academies of science (or equivalent) of 12 nations, with the remit to apply systems analysis to world problems (e.g. energy, food supply and the environment). Since that time IIASA has become the official guardian of the development of systems analysis as a discipline and profession (see Miser and Quade, 1985, 1988; Miser, ed., 1995).

Systems Engineering was pioneered in the USA at Bell Telephone Laboratories to meet the networking challenges faced in the communications industry. It spread rapidly to the defence, space and energy industries and, in the 1960s and 1970s, various guidelines and standards were established for the use of systems engineering to develop military systems and in civilian aerospace and energy programmes. Today, the International Council on Systems Engineering (INCOSE) sees the approach as relevant to problems as wide and diverse as transportation, housing, infrastructure renewal and environmental systems (www.incose.org).

Hard systems thinking has been revolutionary in valuing knowledge directly relevant to clients and in developing models as an alternative to laboratory experiments for testing hypotheses concerning system behaviour. However, a dependence on predefined goals and models that represent systems as logical machines limits its domain of applicability. Hoos’ (1972) critique of the use of systems analysis and systems engineering to tackle public policy issues in California in the 1960s, under Governor Brown, demonstrates the problems that arise for hard systems thinking at higher levels of complexity in Boulding’s hierarchy.

Socio-technical systems theory was born at the Tavistock Institute of Human Relations and is particularly associated with the names of Emery, Rice and Trist.

From the 1940s onwards, these systems thinkers attempted to transfer behavioural science and systems ideas to industry through the consultancy mechanism. In the earliest 'Coal Mining Studies', Trist and Bamforth (1951) made use of a mechanical equilibrium model. Following the publication of von Bertalanffy's (1950) work on 'open systems', however, socio-technical systems theory rapidly embraced organismic thinking. In its classic expression, the theory sees organizations as pursuing primary tasks that can best be realized if their social, technological and economic dimensions are jointly optimized and if they are treated as open systems and fitted into their environment. In designing the social aspects of socio-technical systems attention has to be given to the psychological needs of humans, which are best met through appropriate job design and group working.

In the 1960s, 1970s, and 1980s work based upon socio-technical ideas burgeoned. An ambitious project was conducted, involving employers, unions, and gradually the government, to democratise the whole of Norwegian industry (Emery and Thorsrud, 1969, 1976). In Sweden hundreds of projects began including the famous experiment at Volvo's car plant at Kalmar, which was designed and built around the concept of semi-autonomous group working (Gyllenhammer, 1977). In Britain there was Shell's ambitious attempt to establish a 'new philosophy of management' using socio-technical systems concepts (Hill, 1971).

It would be harsh to blame the fall away in interest in socio-technical systems thinking simply to the organismic analogy that underpinned its interventions. There are a host of political and economic factors that were probably more significant. Nevertheless, adherence to the notion of a primary task, usually defined as the task an organization had to perform in order to survive, and to the ideology of human 'psychological needs', undoubtedly constrained its ability to learn and develop as an approach. That said, the rich array of concepts employed and the many ambitious projects undertaken, make the literature of socio-technical systems thinking a treasure-house for those wanting to advance the theory and practice of OR.

Structuralist AST

Boulding, it will be recalled, envisaged two different routes to establishing a general systems theory. Hammond (2003), in her study of the origins and social implications of general systems theory, sets out clearly just how important this distinction is. In one camp were those who emphasised 'isomorphisms', similarities at different levels of organization. Von Bertalanffy (1968), as we saw, expresses this as the search for "models, principles and laws that apply to generalized systems ….. irrespective of their particular kind". In the other were those, such as Boulding himself, who stressed 'emergence'; the new properties that arise at higher levels of complexity.

'Structuralist' systems thinkers follow von Bertalanffy, in spirit if not in detail, in looking for those key mechanisms or structures that are fundamental to system behaviour whatever system type we are dealing with. They seek to dig 'beneath the surface' to discover the most important structural aspects that lie behind system viability and performance. This 'structuralist' approach enables analysts, in their view, to determine at a deeper level what is going wrong with the system and to learn how to manipulate key design features so that the system can survive and be effective over time.

Various systems approaches have sought to establish themselves as candidate general system theories of the kind von Bertalanffy would have countenanced.

Miller's (1978) general 'living systems theory' follows his intent most closely; setting out the nineteen 'critical sub-systems' that govern system behaviour at eight hierarchical levels, from the cell to supranational systems. Maturana and Varela (biologists by training, like von Bertalanffy) developed a theory of 'autopoiesis', or self-producing systems, which has been transferred from the biological domain to disciplines such as sociology, organization theory, the law, family therapy and cognitive science. Mingers (1995) provides an excellent account, and while he is happy with the theory in biology he is less certain (as, indeed, have been the originators) that it applies rigorously in the social realm. The structuralist systems approaches that have had the most impact in management are system dynamics, organizational cybernetics and complexity theory, and it is these we shall now describe in a little more depth.

The founding father of system dynamics was Jay W. Forrester, a professor at MIT with a background in computer science and control engineering, who wished to extend the range of applied systems thinking to more strategic problems than he thought OR could tackle. System dynamics would employ the science of feedback, harnessed to the power of the modern digital computer, to unlock the secrets of complex, multiple-loop non-linear systems. Social systems are seen as being of this kind and as causing no particular problems of their own for system dynamics because the impacts of the decisions of human actors can be modelled according to the same rules. The scale of application grew from 'industrial dynamics' to 'urban dynamics' (Forrester 1969) to 'world dynamics' (Forrester, 1971).

More recently Senge, with his book <u>The Fifth Discipline</u> (1990), has popularized system dynamics as the key to creating 'learning organizations'. In his view:

> "Systems thinking is a discipline for seeing the structures that underlie complex situations, and for discerning high from low leverage change …. Ultimately, it simplifies life by helping us to see the deeper patterns lying beneath the events and the details".

Senge has identified a number of the counter-intuitive aspects of complex systems, deriving from the relationships between positive and negative feedback loops, and the effect of 'lags' in systems, and elevated them into 'laws of the fifth discipline' or 'system archetypes'.

The encapsulation of Beer's organizational cybernetics, the viable system model (Beer, 1972, 1979), is often described by commentators as 'organismic'. This is not surprising given that his primary example of the 'science of effective organization' is the human body as controlled by the nervous system and brain. A more accurate representation however is to view it, like system dynamics, as structuralist in nature. In the case of system dynamics it is the relationship between feedback processes operating at the deep structural level that give rise to system behaviour at the surface level. With organizational cybernetics it is the cybernetic laws and principles at work below the surface that generate the phenomena we observe. Beer advocates a rigorous scientific procedure to unearth these cybernetic laws. Following this procedure, the management scientist can get beyond mere metaphor and analogy to produce models that can be shown, by logic and mathematics, to be homomorphic in character because they express genuinely interdisciplinary laws. The viable system model (VSM) is Beer's attempt to demonstrate, in as simple a way as possible, how cybernetic laws underpin the operation of all complex systems.

Beer used the VSM in a country-wide application, together with aspects of OR and system dynamics, in support of the Allende government in Chile (Beer, 1981); an experiment that only ended with bombs dropping on the presidential palace. This is an essential case study for operational researchers and systems thinkers. Many other applications are described in Beer's books, and in Espejo and Harnden (1989) and Espejo and Schwaninger (1993).

Complexity theory, however, must be the current favourite to assume the mantle of a credible general system theory. Originating in the physical sciences and developed, particularly, at the Santa Fé Institute, it has since found application in areas as diverse as astronomy, geology, physiology, economics, computer art and music (Gleick, 1987). Recently it has become very fashionable to apply complexity theory to management. The attraction is that the theory focuses attention on disorder, irregularity and randomness – those things that bother most managers most of the time – but suggests that there is some pattern underlying them which might be discoverable. As Stacey (1993) puts it:

> "Although the specific path followed by the behaviour [of complex systems] ….. is random and hence unpredictable in the long term, it always has an underlying pattern to it, a 'hidden' pattern ….. Chaos is therefore order (a pattern) within disorder".

Apprehending patterns in complexity theory is similar to recognising 'system archetypes' in system dynamics, although the process often seems less sure. Wheatley (1992) looks for patterns of movement in the whole, focusing on qualities like rhythm, flow, direction and shape.

Structuralist AST shares much in common with the functionalist variety, not least the need for a 'unitary' client to give direction to an intervention and ensure implementation. The main criticism is also similar : are the systems models produced by structuralist AST really applicable at higher levels of Boulding's hierarchy? The critics argue that human beings, through their intentions, motivations and actions, shape social systems. If we want to learn about social systems we have, therefore, to grasp the subjective interpretations of the world that individual social actors employ. Structuralist explanations can, indeed, often seem 'reductionist' – pitched at the wrong level. The after-work drinker is not subject to some 'system archetype' that sees her unknowingly treating the symptom of her stress rather than the cause, thus stoking up problems along the way. She is well aware of this, as well as of the personal and social pleasures that can be gained in the pub. She makes a judgement call. Interestingly, as we shall see later, system dynamics, organizational cybernetics and complexity theory have all recently spawned 'soft' variants in attempts to deal with the issue of being reductionist in this sense.

Interpretive AST

A third strand of AST, interpretive AST, was opened up in both the US and UK by systems thinkers determined to exploit the 'inside track' to knowledge of human and social systems that Boulding had hinted at. In the US, Ackoff and Churchman developed 'social systems sciences' and 'social systems design', respectively, to deal with 'messes'; ill-structured problem situations made up of highly interdependent problems, that they felt were beyond the scope of OR. In the UK Checkland, taking inspiration from Vickers' (1965) concept of 'appreciative systems' (which has remarkable similarities to Boulding's notion of the 'image'), tested systems engineering to breaking point in managerial situations and, from the remnants, built 'soft systems methodology' on wholly different foundations. Ackoff, Churchman and Checkland see some value in mechanistic and organismic analogies in a limited set of circumstances but have little sympathy with the grander aspirations of general system theory. Ackoff and Gharajedaghi (1996) summarise their position as follows:

> "Our society and the principal private and public organizations that it contains have reached a level of maturity that eliminates whatever effectiveness applying deterministic and animalistic models to social systems may once have had".

The soft systems approaches of Ackoff, Churchman and Checkland are labelled 'interpretive AST' because instead of trying to build systems models of the world they seek to work with different interpretations of reality. Checkland (1989) puts this succinctly in stating that soft systems methodology shifts 'systemicity from the world to the process of enquiry into the world'. The idea of a 'unitary' client with whom goals can be agreed in advance is abandoned. Multiple 'stakeholders' (Ackoff), 'customers' (Churchman) or 'problem-owners' (Checkland), with alternative values, beliefs, philosophies and interests, are admitted. Attention turns to ensuring sufficient accommodation is achieved between different and sometimes conflicting world views in order that coalitions can be fashioned in support of change.

In Ackoff's (1981) social systems sciences, organizations are seen as purposeful at three levels. They are themselves purposeful systems and have their own goals, objectives and ideals that should be taken into account. However, they also contain, as parts, other purposeful systems, individuals, whose aspirations need to be met. And they exist, themselves, as parts of wider purposeful systems whose interests also should be served. Ackoff's interactive planning methodology wants to bring together multiple purposes in value-full agreement around an 'idealized design' (a model of the vision that the stakeholders have for the system) which they then become committed to approximating in reality.

Churchman's social systems design, as developed by Mason and Mitroff (1981), encourages dialectical debate between the world views of different stakeholders (which can be captured in different models) so that a 'synthesis' of perspectives can be achieved to inform future action. Checkland's (1981) soft systems methodology uses multiple 'human activity system' models to engage participants in a systemic learning process through which they come to appreciate more fully alternative world views and, as a result, an accommodation becomes possible between those who started with and may still hold divergent values and beliefs.

In the US take-up of soft systems thinking, beyond Ackoff and Churchman and their immediate followers, has been disappointing, with only isolated pockets of activity. Checkland's soft systems methodology has, however, found widespread favour in the UK, particularly to assist with information systems design and in specific areas of application such as the National Health Service (Checkland and Poulter, 2006).

Interpretive AST extends the domain of applicability of systems thinking to ill-structured problems, or 'messes', but it has not been without its critics (see Jackson, 1982). Problems arise in 'coercive' contexts, where stakeholders have little in common, compromise is difficult to achieve, and decisions are taken in their own interests by those with power. In these circumstances, how do we ensure full stakeholder involvement, an open process of debate and outcomes that fairly reflect the debate that has taken place? To address issues of this sort, Ulrich's (1983) 'critical systems heuristics' allows questions to be asked about who benefits from particular system designs and seeks to empower those affected by management decisions but not involved in them. In effect he widens the definition of 'client' again to include 'witnesses', those affected but not involved. Beer's (1994) 'team syntegrity' seeks to specify an arena and procedures that enable all stakeholders to debate openly and democratically the issues with which they are confronted.

Depending on one's point of view, Ulrich's and Beer's work can be seen as extending interpretive AST or opening up the potential for 'emancipatory AST'. The argument against the latter perspective is that they largely ignore the organizational and societal pressures that suppress the voices of disadvantaged groups in the first place.

Recent developments in AST

In this section, to complete our picture of 'fifty years of systems thinking for management', we consider briefly the softer re-workings of some established systems approaches, the development of 'critical systems thinking' and 'multi-methodology' practice, and the emergence of certain consultancy-led systems methodologies.

Both soft systems thinking and soft OR are now firmly established, at least in the UK, and are normally viewed favourably as offering strengths complementary to traditional strands of these disciplines. Their success is due in large part to the strong theoretical anchorings provided by such as Checkland (1981) and Eden (see Eden and Ackermann, 2001) in consciously embracing the 'subjectivism' of the interpretive paradigm. This allowed them to retain (some would say enhance) the relevance embedded in the Mode 2 form of knowledge production and the rigour provided by using explicit models, but to make the modifications necessary to translate these advantages coherently to an alternative theoretical domain. System dynamics, organizational cybernetics and complexity theory have also responded to criticism of their lack of applicability to more ill-structured problems by giving birth to softer variants. Here, however, the situation is much more confused.

In system dynamics, the work of Senge (1990) and Vennix (1996) has edged closest to the interpretive paradigm. Vennix's group model building, for example, is said to focus

> "on building system dynamics models with teams in order to enhance team learning, to foster consensus and to create commitment with a resulting decision" (Vennix, 1996).

In organizational cybernetics, Harnden (1989) has sought to align the VSM with interpretive theory and methodology; seeing it as an 'hermeneutic enabler', capable of permitting an extremely rich discourse to unfold about the emergence and evolution of appropriate organizational forms. In both cases, however, the process has been painful to watch as those involved recognise that moving too far in an interpretive direction risks jettisoning the claim to managers' attention that derives from the presumption that they can capture the laws that govern system behaviour.

If humans are free to construct social systems as they wish, what determining influence do system structure or cybernetic laws have? Lane (2000) gets to the heart of the matter :

> “Indeed, if the placation of subjectivists involves the denial of the relevance of causal laws, causal explanations and the grand structural claim of system dynamics then the field should stop placating and start declaiming”.

Complexity theory transferred to social systems is, if anything, even more theoretically uncertain. Stacey (1996), in his earlier work, took the structuralist tack of looking for ‘control parameters’ that could drive organizations to a desirable ‘edge of chaos’ state. In his more recent writings, however, he wants to reinvent complexity theory by using its concepts in the service of the interpretive paradigm (Stacey 2000, 2003). Cilliers (1998) tries to marry complexity theory to postmodernism. Here lies a problem for complexity theory. If it remains theoretically adrift as it tries to extend into the social domain, then its ideas can easily be captured by any paradigm. We end up with structuralist, interpretive, emancipatory and postmodern versions of complexity theory emphasising, respectively, order beneath chaos, learning, self-organization and unpredictability. The whole thing falls apart as a coherent general system theory and its sole purpose becomes to add a fashionable twist to existing theories as a means of getting money out of research councils.

The development of critical systems thinking can be traced to three ideas. (see Flood and Jackson, eds, 1991). First, it became clear that all the individual systems approaches had their different strengths and weaknesses. When applying them it obviously helps to be ‘critically aware’ of what these are. Second, it was recognised that if they all do have strengths and weaknesses then some benefit must be gained from using them in combination - the notion of methodological pluralism. Third, any approach to changing social systems surely needs to take into account the possible social consequences of its use. This is especially the case for systems thinking which claims to consider the ‘whole system’. Critical systems thinking took upon itself the responsibility for investigating the meaning of words like ‘emancipation’ and ‘improvement’ in systems thinking.

The emphasis on methodological pluralism intertwined happily with a growing interest in multi-method use in practice, not least by operational researchers. Mingers and Gill (1997) edited a definitive collection of papers on multimethodological thinking that was able to draw on highly theoretical work in critical systems thinking as well as on multimethod applications by consultants. The result was the emergence of something of a community of those interested in critical systems thinking or multimethodology, call it what you will, which has driven a range of applications. At the same time, debates continue around providing an appropriate theoretical basis for methodological pluralism - with Midgley (2000) favouring ‘boundary critique’, Mingers (2006) ‘critical realism’, and Jackson (2000, 2003) ‘creative holism’.

Finally, we need to mention two systems approaches that have been little discussed, to date, in the academic world but are having a considerable impact on practice.

‘Whole Systems Working’ has been influential in the field of health and social care. It is described by Hudson (2006) as

> "the process of involving all stakeholders of a domain in discussion about service change - all parties are encouraged to think about the way the whole service delivery system works, rather than focusing only upon their own service".

Vanguard's systems thinking combines aspects of systems thinking, lean thinking and intervention theory to deliver, it claims (Seddon, 2003),

> "a method for ….. achieving the ideals many managers aspire to : a learning, improving, innovative, adaptive and energised organization. It provides the means to develop a customer-driven adaptive organization".

This approach is getting significant take-up in the public sector, where it offers a damning critique of existing ways of doing things as well as numerous examples of a better way (Seddon, 2008).

Both approaches provide an object lesson in how relatively simple (though not simplistic) combinations of systems ideas can have a huge impact on improving managerial practice and the efficiency and effectiveness of organizations (Jackson, Johnston, Seddon, 2008).

Conclusion

OR and AST have much in common. They started about the same time and their communities have frequently interacted. They produce their outputs, of both research and (hopefully) beneficial change, in the context of application, and are committed to the use of models to provide rigour to their interventions.

In many ways, historically, OR seems to have been more successful than AST. It has remained unified whereas AST has splintered. OR has the stronger societies and journals, and can point to a history of there being large OR groups established in the public sector and in industry. On the other hand, it is easy to argue that AST has been braver, both in terms of its theoretical explorations and in the scope and type of projects that it has undertaken. I have argued elsewhere (Jackson, 2006) that the future of management science must be pluralistic in character, concern itself with improvement in all its meanings, and use the rich diversity of methodologies and methods it now has at its disposal. It may well be that the theoretical and practical adventures undertaken by AST put it in a much better position than OR to seize that future.

Whatever other conclusions we may draw, I hope I have demonstrated that OR and AST can benefit from engaging in dialogue and that this paper provides a focus for future discussions.

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