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Addressing wicked problems in a range of project types

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Abstract

Wicked problems are recognised and need to be seen as a subset of complex systems or projects. Complex projects are identified within a hierarchy of simple, complicated, and complex and then complex projects are separated into three distinctive types. Wicked problems (type B) are focused on and solution methods addressed. Methodologies to identify stakeholders and project boundaries are identified and it has been found that the use of soft system methodology, especially to create meaning, is valuable. Multiple perspectives are identified through use of Dooyeweerd's suite of aspects in which to frame the rich picture and consequently the root definition and solution.

Keywords: Project categories; wicked problems; soft system methodology; system dynamics; SAST, CSH, SSM; Dooyeweerd's suite of aspects.

1. Introduction

The purpose of this paper is to recognise the need for wicked problems to be seen as a subset of complex projects, to contribute to identifying solution methods for these and to draw some conclusions about how these solutions methods differ from those for other complex systems. In doing so complex projects are identified within a hierarchy of simple, complicated, and complex and then complex projects are separated into three distinctive types.

While the focus is on wicked problems, such as terrorism, climate change, international disputes and illicit drugs, it is recognized that the methods appropriate for addressing wicked problems are also available for creating meaning which is necessary to address a number of problems in business.

A methodology is proposed for dealing with wicked problems, for a set of complex projects, which uses systems thinking techniques.

2. Categorization of project types

2.1. Background to categorization

For at least two decades projects have had available a range of bodies of knowledge to assist their planning and execution. The most common is the Guide to the Project Management Body of Knowledge (*PMBOK*[®] Guide) [1], IPMA's Competence Baseline [2], ISO 21500 [3], APM [4], PRINCE2TM [5] and the Japanese P2M [6]. Furthermore there is the INCOSE Systems Engineering Handbook [7], for more engineering based projects.

However it has been found that these bodies of knowledge primarily have a reductionist approach and there is strong evidence that the application of these to complex projects is a hindrance. Bar-Yam reports very significant losses, amounting to multi-billions of dollars through treating complex projects as traditional command and control systems [8]. Bar-Yam's work is supported by Mihm and Loch [9], De Rosa et al [10] and White [11].

There are many relevant research papers to assist practitioners and researchers understand traditional military SoSs, and these include Sauser, Boardman & Gorod [12], Gorod, Sauser and Boardman [13], Keating et al [14], Firesmith [15], Bar-Yam [16], and White [11, 17 & 18], and other references in this paper. However, all of these papers have a reductionist flavor and none explicitly recognizes SoS projects. Furthermore, even more complex projects than the 'traditional' SoSs, many of which are military, such as addressing terrorism, international disputes, and climate change, which require a soft system methodology to identify stakeholders, boundaries and possible solutions, are not addressed in a BOK.

A complex projects BOK has been under development since September 2009 by several dozen contributing authors and reviewers, carefully chosen from the Systems engineering field including many members of the International Council on Systems Engineering (INCOSE). However, recognizing the definition of system of systems as including autonomous systems, wicked problems are seen as a system of systems [12]. There is a guide for system of systems [19] which, defines SoS as 'a set or arrangement of systems that results when independent and useful systems are integrated into a larger system that delivers unique capabilities', and applies to wicked problems, the details of the guide are very military based and of limited use to complex and wicked problems. The DoD guide specifies seven core elements that characterize SoSs. These are: translating SoS capability objectives into high level SoS requirements; understanding the constituent systems and their relationships over time; assessing the extent to which SoS performance meets capability objectives over time; developing, evolving and maintaining an architecture for the SoS; monitoring and assessing potential impacts of changes on SoS performance; assessing SoS requirements and solution options; and, orchestrating upgrades to the SoS. This document is purposely written for a defence context and does not have the breadth of other definitions of complex systems, which will be applicable to wicked problems, such as that described by Ramalingam et al [20], who define complex systems as including the following elements: interconnected and interdependent elements and dimensions; feedback processes which promote and inhibit change within systems; system characteristics and behaviours which emerge from simple rules of interaction; non-linearity; sensitivity to initial conditions; phase space - the space of possibilities; attractors, chaos and the edge of chaos; adaptive agents; self-organization; and, co-evolution.

2.2. Categorization

Projects can be categorized and this paper recognizes a hierarchy of Simple, Complicated and Complex among projects and explores three types of complex projects [21] these being:

- Traditional SoS projects in which there is inclusion of an existing system into a new project, the existing system being independent and autonomous (Type A complexity); see Ireland et al [22];
- SoS projects which require systems thinking to determine stakeholders, project boundaries, and soft systems methods of Checkland or Systems Dynamics to develop a potential solution (Type B complexity);
- Integration of independent assets into a larger system (for example a corporation or a food supply) into a system, or state control of rivers which flow through multiple states, in order to reduce waste (Type C complexity).

An outline of these project types is provided in Ireland et al [23].

The approach for the complicated projects (reductionist) does not assume the project elements have autonomy and independence. It assumes suppliers are locked into a relationship with the deliverer (general contractor) via contracts, and that employees are locked in by conditions of employment. This is in contrast to the case where contributors have autonomy and independence. An example of the difference between complicated and complex is making jet engines is complicated whereas selling jet engines is complex, in which case the behaviour of competitors and customers cannot be predicted. Lane and Valerdi [24] define a SoS as 'a very large system using a framework for architecture to integrate constituent elements, [which] exhibits emergent behaviour, with constituents systems: [they are] independently developed and managed, [with] new or existing systems in various stages of development/evolution, [they may] may include a significant number of COTS products, and their own purpose, and, can dynamically come and go from the SOS'.

Norman and Kuras [25] provide an example of a more traditional military SoS in which this independence and autonomy is described. The Air and Space Operations Centre (AOC) of the US, which provides tools to plan, task, and monitor all the operations in Afghanistan and Iraq, is composed of 80 elements of infrastructure including communication balance, application, servers, and databases.

SoSs have been further described as having: Operational Independence of the Individual Systems. Managerial Independence of the Individual Systems, Geographic Distribution, Emergent behaviour and Evolutionary Development [26]. In the authors' view the issue of inclusion of autonomous and independent systems is a crucial aspect because this requires significantly different methods of management. Heylighen [27] points out that complex projects are self organizing. Addressing SoSs is assisted by developing granularity in describing complexity. Snowden and Boone [28] take-up the classification of systems into categories of simple, complicated, complex and chaotic. This is used by Glouberman and Zimmerman [29] as well in the classification of health care systems. Tools for distinguishing complicated from complex are provided by Cotsaftis [30]. The test to identify whether it is complicated or complex is: identify whether the system can be explained by reduction (ie are there equations, or obvious hierarchic relationships between the system and its components)? Complicated and complex projects are separated by the following test: Identify the degrees of freedom in the system (the number of variables or aspects free to vary); Decide if it is simple or complicated – how many degrees of freedom are there; Check the number of control tools and do

these match the degrees of freedom? If the number of control tools is less than the number of degrees of freedom, the system is complex (Type A, B or C).

3. Addressing wicked projects

The notion of wicked problems was first outlined by Mason and Mitroff [31] however they built on the work of Churchman who was disappointed by the development of operations research which, although it set out to be a holistic, interdisciplinary, experimental science addressing problems in the social systems, it had ended up obsessed with perfecting mathematical tools and techniques and relevant only to narrow range of practical problems. Jackson reports that Churchman had drawn on the whole of Western philosophical tradition [32]. Jackson describes complex systems as those which are ‘interconnected and complicated further by lack of clarity about purposes, conflict, and uncertainty about the environment and social constraints. In tackling wicked problems, problem structuring assumes greater importance than problem solving using conventional techniques. If problem formulation is ignored or badly handled, managers may end up solving, very thoroughly and precisely, the wrong problem’. Mason and Mitroff added that such an ill structured problem situation is made up of highly interdependent problems. Jackson comments that we learn lessons from Kant and Hegel in that, whatever world view, or in German *Weltanschauung*) we hold it is based on certain taken for granted or a priori assumptions.

We need to recognize that there are many possible, alternative Ws constructed on different sets of taken for granted assumptions. Therefore completely different evaluations of social systems will inevitably exist. ‘The only way we can get near a view of the whole system is to look at it from many different perspectives as possible’. Furthermore every world view is terribly restricted. In soft system dynamics, objectivity can only be approached by considering different understandings of objectivity, that is one that includes subjectivity rather than trying to exclude it. Furthermore although particular world views are terribly restricted, they are also usually very resistant to change. The world view of participants addressing a complex issue such as terrorism cannot seriously be challenged by just exposing such Ws to apparently concrete facts, which they will simply interpret to fit their own assumptions. What we need to do therefore is to get at the foundation of W is by examining them systematically. The first W should then be challenged by another ‘deadly enemy’ W based on entirely different assumptions that give rise to alternative proposals [33]. Checkland's soft system methodology does exactly this by providing multiple views from very different viewpoints, which are then compared in order to achieve meaning. Different viewpoints from the perspectives of religion, politics, ethics and aesthetics, need to be developed. Creating meaning and sense making. Complexity does not only address the types of problems listed above. In business, and even in traditional reductionist projects, developing and addressing common meaning is a major task [33 & 34] and lack of agreed meaning is a common problem in the implementation of Information Systems: senior managers do not adequately understand information technology and information technology specialists do not adequately understand business strategy.

4. Using soft system methodology on Type B projects

4.1. Identifying stakeholders

Using soft system methodology (Type B), for establishing stakeholders, Mason and Mitroff [31] see a problem with conventional planning and problem solving in that it fails to recognize the value that can be obtained from entertaining different world views. They believe that most organizations fail to deal properly with wicked problems because they find it difficult to challenge accepted ways of doing things and approaches which diverged from current practice are not given serious consideration. They developed Strategic Assumptions Surfacing and Testing (SAST), which attempts to surface conflicts and to direct them productively as the only way of eventually achieving a productive synthesis of perceptions. Their methodology is based on four key principles: participative, adversarial, integrative, and managerial mind supporting. The debate can be guided by asking the following questions: How are the assumptions of the groups different? Which stakeholders feature most strongly in giving rise to the significant assumptions being made by each group? Do groups rate assumptions differently (eg as to their importance for the success of the strategy)? What assumptions of the other groups does each group find the most troubling with respect to its own proposals? A technique is to judge each assumption on the basis of most certain to least certain and most important to least important and obviously only deal with the certain and important assumptions. Jackson criticizes the SAST process in that Mason and Mitroff appear to assume that formulating a problem is synonymous with dealing with it however, in the author's view, the SAST process supports soft system methodology and is consequently of benefit [35].

4.2. Identifying boundaries

In identifying boundaries Ulrich, a PhD student of Churchman's, developed Critical Systems Heuristics because he felt that, in trying to grasp the whole system, we inevitably fall short and produce limited accounts and sub-optimal decisions based on

participative presuppositions - to correct this we need to recognize the partial presuppositions that underpin the whole system judgments we make [36]. This stance is in contrast Popper's position that critical reason can only assist social systems design with technical issues [35]. Ulrich's view is that if we are to improve social reality we must add an additional dimension of purposefulness. In a purposeful system the ability to determine purposes must be spread throughout the system and knowledge should be produced relevant to purposes and encourage debate about purposes [35]. Ulrich focuses on the nature of boundary judgments that must inevitably enter into social systems design, which are said to have heuristic necessity, because it is only by making those explicit does it become possible to reflect critically on the presuppositions conditioning a social system design.

Ulrich advocates use of twelve boundary questions based around a series of 'oughts', which assist in the definition of boundaries. Jackson comments that particular attention needs to be paid to ensuring representation of those affected by the proposed approach but not involved in their formulation. He also comments that Ulrich should develop the appropriate social theory to genuinely assist emancipation otherwise its approach could be seen as utopian [35]. Checkland's basic process to address wicked problems is to use the seven step approach, which is called a soft system methodology (SSM) [37]. It takes a series of questions an outline of which is provided in Jackson [32].

4.3. Creating meaning and sense making

A number of papers focus on the application of Checkland's soft system methodology (SSM) to both wicked problems and sense making in business. The main focus will be on a contribution made by Andrew Basden and Trevor Wood-Harper [38] who focus both on the three alternative Weltanschauungs suggested by Checkland's W's. They also particularly focus on the benefits of using Dooyeweerd's [3] suite of aspects in which to frame the rich picture and consequently root definition; these are: qualitative aspects, of amounts; spatial element, of continuous extension; kinematic aspect of flowing movement; physical aspect, of energy and mass; biotic aspect, of life functions; sensitive aspect, of sense, feeling and emotion; analytic aspect, of distinction, abstraction; formative aspect, history, culture, creativity, achievement and technology; lingual aspect, of symbolic meaning and communication; social aspect, of social interaction, relationships and institutions; economic aspect, frugality, skilled use of limited resources; athletic aspect, of harmony, surprise and fun; juridical aspect, of giving love, generosity, care; and, Pistic aspect, of faith, commitment and vision; Basden and Wood-Harper also see a redefinition of CATWOE as being an advantage as follows: C no longer focuses on individual but on repercussion; A helps us consider competences; T is no longer input-output but human functioning; W is not to be as pure, as simple as possible but it is the perspective given by the qualifying aspect of the system linked to all the other aspects; O is not power but responsibility; E is not a wider system but constraints and enablings. Kotiadis [40] used SSM to determine the objectives of a simulation in health care: the study identifies a purposeful activity model by aligning the study objectives with real-life situations and then breaking the performance criteria into specific monitoring activities. SSM was seen to enable creativity to take place by seeing a relationship in the situation that other people fail to see, ability to define the problem well or the ability to ask the right questions, which makes it an important element in problem definition; it was found to assist in dealing with the 'hardwired' nature of the brain. Olle Bjerke focused on getting changes accepted within the purchasing system at Volvo: this was a complex problem due to an attempt to integrate multiple systems, including unclear sources of power, specific roles played by people working together, and finally providing new perspectives on old problems; SSM highlighted a number of serious problems with current financial reporting and facilitated development of a new finance reporting system and it was concluded that SSM provided a better solution to alternatives approaches such as business process reengineering and iterative software development methods: of course, competent financial managers are required to initiate a workable solution [41]. Bob Williams applied SSM to identifying the best solution for sustainable food production within the Kellogg foundation; he found SSM constrains your thinking in order to expand your thinking; he also comments that the CATWOE approach can be amended to replaced C with two concepts; B for Beneficiaries, and V for Victims producing BATWOVE [42]. Heidemarie Winklhofer used SSM to identify an appropriate IT strategy in a business during a period of significant organizational change: she found SSM assisted the research in making sense of a complex situation [43]. Checkland and Holwell essentially described the use of radar in the Battle of Britain in 1941 as an exercise in developing a process for organization meaning in capturing data and transforming this into critical information and consequently knowledge which is essentially what the SSM does [33].

Unfortunately the application of soft system methodology to climate change, illicit drugs and international disputes, are difficult to find.

4.4. Systems dynamics

Systems dynamics, popularized by Peter Senge [44], employs the science of feedback and recognizes both favorable or positive and unfavourable or negative responses from a system. An example is provision of funds to a developing country may induce a negative response of discouraging growth as people become reliant on the aid and less reliant on their own initiatives. Another example of a negative feedback loop is when advertising encourages greater sales however the increased productivity required reduces the quality of the product or service thus discouraging additional sales. These two examples are unintended

consequences. A positive response occurs when an individual takes up physical exercise as more exercise allows one to address even more difficult physical tasks.

5. The process

Using this methodology to develop a process for one of the most intractable complex problems, addressing a dispute between two neighbouring and warring states, which have not been comfortable with each other for a very long time, is as shown in Fig 1.

NOTES FOR FIG 1

1. Members of one or both races may not want to work with the other side - Use SAST processes;
2. Systems dynamics processes could be used to mould more compliant behaviour: the purpose of this action is to attempt to make participants more positive and not just dwell on past 'wrongs' by the other side;
3. Use CSH;
4. Use Dooyeweerd's irreducible aspects chosen by the participants: this is the beginning of an attempt to see the problem from multiple perspectives;
5. The comparison of stances is the only way to address such divergent issues as perceptions of truth and injustice will vary remarkably among representatives of the disputing countries;
6. Such divergent participants will almost certainly have divergent views on what is an acceptable World View;
7. A key concept of complex systems is self organisation, as is use of adaptive agents: complexity theory supports self organisation and bottom-up approaches [20] and thus one can question leadership by the United Nations and an American President;

A key concept of complex systems is self organisation, which is essentially a bottom-up concept.

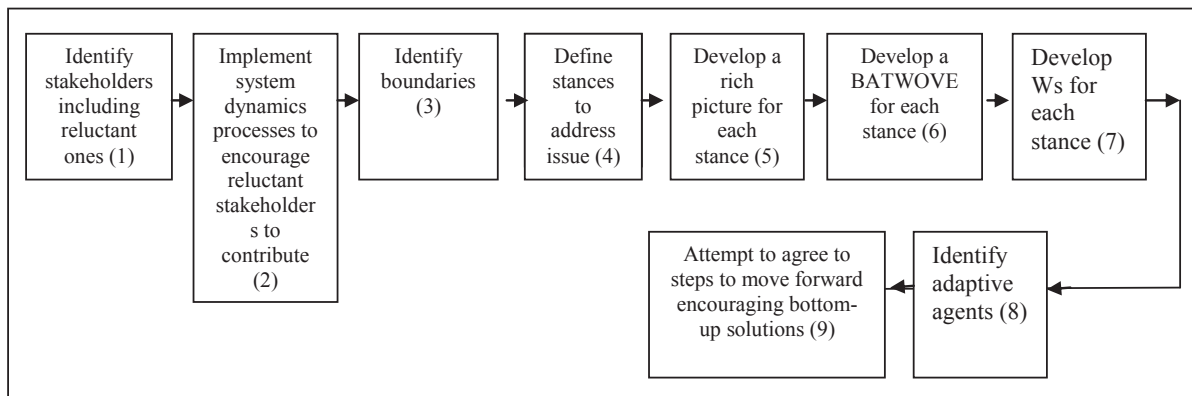


Fig 1: Example of a systems thinking process to address the wicked problem of two neighboring states that have been in dispute for many year

6. Conclusion

This research and other studies of the author have shown the benefits of recognizing a complex project context of categorizing projects recognizing the special aspects of complex projects. Furthermore, breaking complex projects into three primary types, each of which requires a different structure, is of significant benefit.

This paper has focused on the form of complex projects which are recognized more generally as wicked problems, a term which applies to climate change, terrorism, illicit drugs and international disputes, and some other problems. The use of the soft system methodologies, including system dynamics, SAST, CST and Checkland's SSM, by the analysis of a case studies of intractable international disputes, has found significant benefit in both the methodology and also in the use of these systems thinking techniques to address the problem including clarifying meaning among the participants.

Dooyeweerd's suite of aspects in which to frame the rich picture and consequently root definition, in order to get breadth of contribution in recognizing the wicked problem, has been found to be very valuable, which indicates that multiple frames of reference are necessary to address complex and wicked problems.

No doubt there will need to be loops through this process. Further research needs to be done to test this methodology.

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