Complex Projects
What are they and how can we manage them more effectively?

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Summary

The word 'complex' is now being widely used to describe projects which are extraordinarily difficult to manage and control. Are these projects just very difficult or do they exhibit special characteristics that entitle them to be called 'complex'? Some authors argue that so-called 'complex projects' are simply larger projects with more stakeholder issues. Nevertheless, there is a growing recognition amongst project practitioners and academics that particular projects seem to be more than just difficult and these projects have very special characteristics that pose extraordinary management challenges. This paper argues that these special projects exhibit aspects in common with 'complex adaptive systems'. If we accept that some projects behave in very different or unpredictable ways, how do we manage them? This is the practical question at the focus of this paper. Do approaches exist which will assist the practitioner with these special or 'complex' projects? The paper presents a discussion of project complexity using 'complex adaptive systems' thinking as a lens. Findings from part of a continuing research program are presented and discussed.

Introduction

This research program has involved projects in a number of different countries and across several disciplines. The aim has been to discover whether managers of successful projects that are perceived to be complex (more than ordinarily difficult) use tools and approaches beyond those that are normally associated with project management practice. While some projects can be described effectively as simple systems for which fully pre-determined control of outcomes may be possible, in other contexts there will be projects or aspects of a project for which control, in the sense of total pre-determination of outcomes, is unlikely or even impossible to achieve. These projects may benefit from approaches informed by other ways of thinking, such as Complexity Theory (Baccarini, 1996). Arguably these projects can be more effectively thought of as complex adaptive systems than as simple systems.

The paper is set out as follows: A description of the method underpinning the research is followed by a brief examination of some relevant theory. These are followed by a discussion of some of the major findings, recommendations and conclusion.

Method

The object of the research project is to reveal the range and variety of strategies that project managers are using to help them deliver complex projects. 'Complex adaptive systems thinking' is used as a theoretical lens to interpret the findings. The data draws upon an extensive literature search for evidence of use of tools and approaches which are not usually part of standard project management methodologies. This was augmented by a series of case study interviews with experienced practitioners from across the globe. In order to be eligible for inclusion in the study, projects were judged by project owners and other key stakeholders to be complex (beyond the normal expected level of difficulty), successful (key stakeholders were satisfied with the final deliverables) and the project managers had used a range of different tools and approaches. However we recognise that there are many variables that contribute to the success of a project. Therefore direct correlation between the management strategies selected and the success of the project cannot be claimed.

In addition to the literature, research data was derived from 17 different projects, spread across commercial and public sectors in six countries: UK, Sweden, Australia, New Zealand, Malaysia and Dubai. Commercial projects were drawn from the telecommunications, rail transport, banking/finance and construction sectors. Public projects were drawn from the public housing, defence, taxation, prison, health and education sectors. Interviews were conducted with key project personnel. Most interviewees wished to remain anonymous.

Data was thematically analysed using NVivo software[1] to discern any common themes and to extract approaches tools and techniques that appeared to be useful to the managers concerned. Particular attention was paid to tools and techniques not necessarily emphasised within the mainstream discipline of project management. During the interviews, the respondents were also asked to indicate the capabilities they valued most when managing very complex projects. The results of the study with respect to key project management capabilities is being reported elsewhere.

Theory

Systems thinking in various forms has been recognized as an important model for thinking about management for some time (Jackson, 2000; Midgley, 2000; 2003) and projects (Kerzner, 2005; Crawford et al. 2003; 2005). Some projects can be described effectively as simple systems. The outcomes of these kinds of projects are theoretically so well defined that fully pre-determined control of outcomes is possible. However, in other contexts there will be entire projects or at least aspects of a project for which control, in the sense of total pre-determination of outcomes, is unlikely or even impossible to achieve. These projects may benefit much more from approaches informed by other ways of thinking, such as Complexity Theory.

Complexity Theory developed out of the observation of emergent, non-linear behaviour, and particular sensitivity to initial conditions, apparent in many natural systems (see Lewin, 1999). Ralph Stacey (1996) and others such as Griffin et al. (1999), Lissack and Roos (1999) and Anderson (1999) have applied ideas based on complex adaptive systems to general management. Complexity Theory can also provide insight into the systemic nature of some unusually difficult projects (Baccarini, 1996; Williams, 2002; Remington and Pollack, 2006; 2007). Arguably these projects can be more effectively thought of as complex adaptive systems than as simple systems.

Like all systems, all projects exhibit the attributes of inter-connectiveness, hierarchy, communication and control. However complex adaptive systems also exhibit characteristics

[1] NVivo (like other similar qualitative analysis software products) assists in analysis of very rich information, such as information from in-depth and open-ended interviews, where deep levels of analysis is required to allow the researcher to explore trends, build and test theories and find answers to questions.

such as non-linearity, phase transition, emergence, adaptiveness and sensitivity to initial conditions. We argue that these other characteristics are applicable to complex projects. This makes complex adaptive systems thinking a useful lens through which to view these particularly challenging projects (Williams, 2002; Remington and Pollack, 2007).

Explaining project complexity through complex adaptive systems thinking

Many of the project phenomena described in the literature and by the practitioners interviewed could be easily discussed using the metaphors provided by Complexity Theory.

An example of 'non-linearity' can be found in the following simplified causal map taken from an analysis of a construction project (Remingtion and Pollack, 2007, Ch. 16., Fig. 16.2). Notice the shaded areas which illustrate reinforcing loops or cycles.

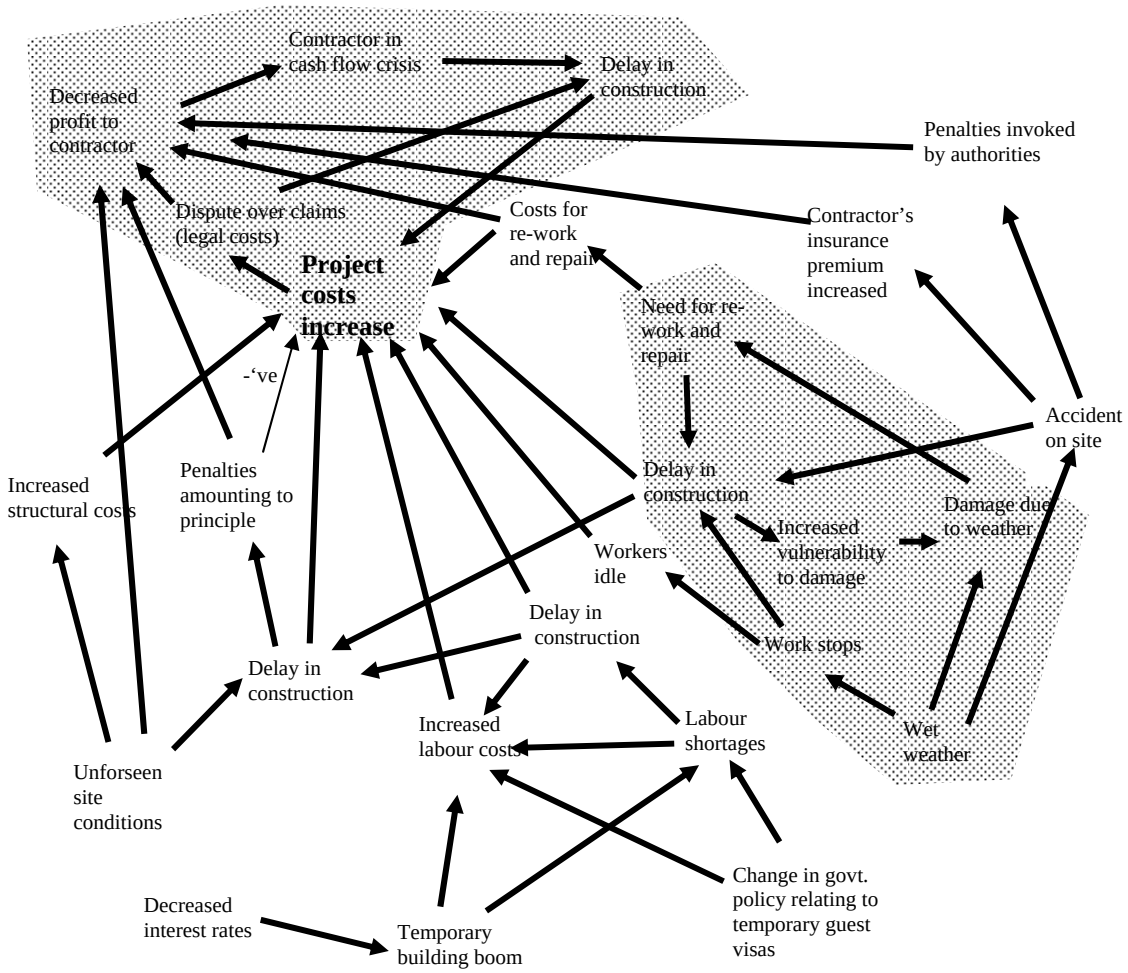

Figure 1: Causal risk map for a construction project

An example of 'adaptiveness' was illustrated in a project to establish a new financial reporting system in a foreign country. Management in one country selected a system untried in the new context. The project management team adapted their behaviour to meet local conditions, changing methods and approaches as they went. 'Sensitive dependence on initial conditions' can clearly be seen in a government sponsored defense project for which specialist cabinet funding was required. With a change of government the cabinet papers were sealed and therefore resulting in uncertainty regarding the project's future. An example of a 'phase transition' was found during an international tax avoidance and evasion investigation. The investigation proceeded routinely using the civil system until something potentially illegal was discovered and sufficient evidence had been accumulated. At this point the nature of the

investigation changed; there was a dramatic change of behaviour by all concerned as criminal proceedings commenced. An example of ‘emergence’ was found in a large residential apartment project for which Council approval was not forthcoming. However, as a result of this risk being triggered, the architect realised that the design could be readily adapted to fit within hotel zoning. The development was then approved immediately, as the project was now in line with a local Council policy to promote tourism. An entire hotel brand is now emerging from a constraint which was converted into an opportunity.

Framework for analysis of the tools and approaches

During the data synthesis phase we developed a framework to help analyse the nature of the complexity encountered by the participants. Based on the source of complexity and informed by the work of others (such as Turner and Cochrane, 1993; Williams, 2002) we proposed four types of project complexity as useful categories for analysis:

- Structural complexity – found in large projects with many interconnecting parts
- Technical complexity – where there are unknown technical or design challenges
- Directional complexity – where goals and goal-paths are unshared or unknown
- Temporal complexity – where there are significant environmental changes over time

The source of project complexity will influence the project life cycle, including the critical review points and lengths of project phases within the life cycle, the governance structure for the project, selection of key resources, scheduling and budgetary methods and ways of identifying and managing risks. Different sources of project complexity will also have a major impact on choice of procurement method and approaches to contract management. Any large project, and many smaller ones, will exhibit one or more types of complexity.

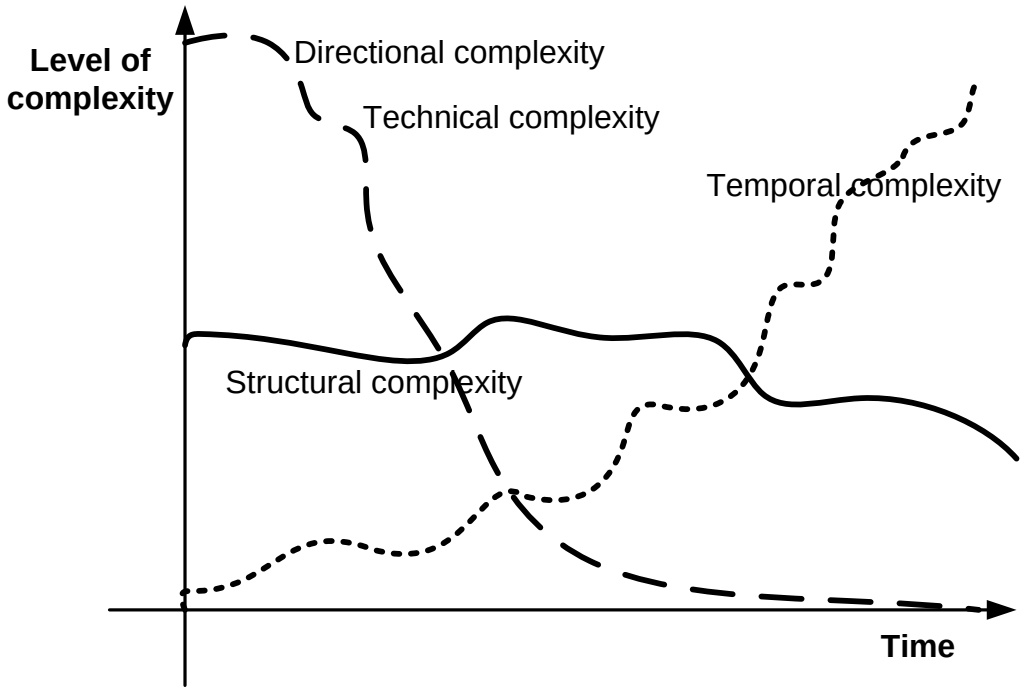

Figure 2: The effect of time on the level of complexity according to type

As time progresses the sources of complexity will change. For instance directional and technical complexity are often able to be reduced dramatically early in the project life cycle. Whereas temporal complexity might increase as time progresses. The longer the duration of a project, the more likely it is to incur the effects of temporal complexity.

Results and Discussion

In relation to how complexity was successfully managed – the following strongly recurring themes were revealed from the analysis of the data:

1) Recognition of complexity

There was a sense amongst interviewees that it would have been useful if key stakeholders had recognised from the outset, or been willing to admit, that the project might be more than just very difficult. The awareness by all parties concerned alerts all concerned to special needs that might distinguish the project.

> *Initially we had an idea of the scope of the project but as we got into it, it turned out that there were many more stakeholders within the customer's organization than we realized, and hence many more interfaces and functionality were required from our system. As the project went on we realized that some of the technologies involved, we didn't actually know much about ourselves.* Interview PM 24

Early understanding by sponsor, owner and project managers that the project is not going to be routine might influence decision-making, particularly with respect to selection of personnel, setting realistic milestones, budget and estimating procedures and risk management. However sometimes it is difficult to anticipate the level of complexity in advance.

> *The project on paper actually looked easier than it was, and [the sponsor] hated that ambiguity…It wasn't one plus one equals two, at all … so [senior executives] struggled with it. So you'd deliver pieces of information in small chunks, so they could go okay I understand that, let's move on to the next step.* Interview PM-17

The role of the executive sponsor in recognising and articulating that the project is likely to be complex is fundamental. In earlier research we found that there was less likelihood of success if the executive sponsor was not able to understand the potential complexity associated with the project or was unwilling to support the project managers to manage the complexity (Helm and Remington, 2005). Sensible decisions made early in the project life cycle help substantially in managing risks due to nonlinear and emergent events. An atmosphere of preparedness develops, even though people cannot directly predict where significant risk events which might trigger nonlinear consequences would come from, when they might arise or how they might escalate.

2) Use of multiple management paradigms

Interviews with project managers of successful complex projects revealed that they drew from an extensive palette of tools, approaches and behaviours. Apart from complying with organisational reporting, risk and procurement requirements most project managers did not slavishly follow a standard methodology.

> *We just had to juggle our way through it all. There wasn't an awful lot of project management tools used. We attempted to apply some, but the rate of change of events made it almost impractical.* Interview PM 20

In some cases requirements set by organisations were viewed as inhibiting. Most found that they broke or bent rules in order to deliver their projects.

> *Well we did a lot under the carpet, under the table. And the resources actually were under the carpet as well. The manager didn't know anything about it. He just knew he was getting the revenue and the work was being done. He would have freaked.* Interview PM 22

The range of tools, approaches and behaviours employed by the project managers was extremely impressive. In terms of behaviours utilised, there was evidence of a high degree of political awareness and skill in relation to organisational politics, facility to adapt their communication styles, a high level of creative thinking and general flexibility. These attitudes and behaviours probably contributed to a state of preparedness and willingness to evaluate

each given situation, then to find or even invent new tools and methods if standard ones did not suit.

In order to cope effectively with complex projects it appears that managers must adopt a pluralistic approach to practice. They must be able draw from a wide range of tools and ways of thinking. They need to be able to develop their own methods, their own patterns of practice, according to the exigencies of each particular project context. No one approach to project management is appropriate for all situations. One tool does NOT fit all! This is consistent with other management research (Miles, 1988; Midgley, 1997).

Tools and approaches used in complex projects

We focussed on tools and approaches which were not part of traditional project management practice. To be worthy of inclusion tools and approaches were simply identified and described by practitioners as useful, were not normally associated with the standard project management repertoire or were considered to be significant variations there from. Proprietary tools and methodologies and standards were excluded from the analysis. We classified each tool or approach according to which of the four types of project complexity (Structural; Technical; Directional; Temporal) it addressed and whether the tool or approach was most suitable to small, medium or large projects. Finally we classified each tool or approach in terms of whether it applied to the whole project or parts of the project:

- **Ad hoc** – tools or approaches that might be used at different stages during the project life cycle at the discretion of the project manager
- **Start-up** – the tool or approach was used at the beginning of the project to clarify objectives, gain agreement or generate ideas
- **Whole of the project** – the tool or approach determined or guided the way the project was managed as a whole

Some of these non-standard tools were used in an ad hoc manner. Project managers used these tools as additions to the normal suite of project management tools at various stages in the project life cycle when and as they deemed them necessary. Several were developed by the project managers themselves. Some tools and approaches had been developed or adapted to assist in project initiation. Where directional complexity was present several of the tools were derived from disciplines such as operations research or soft systems thinking. Where technical complexity was present some tools were influenced by the design disciplines.

Some approaches governed the whole of the project management design and were adopted to address specific types of project complexity. Examples include:

- A technically complex global telecommunications project was particularly interesting in its use of a series of one-page diagrams as a central management and control tools (see Taxén, 2003; Taxén and Lilliesköld, 2005) used to effectively integrate the project while allowing regional and national differences in practice to be preserved.

- Dua (2007) had developed the existing technique of Earned Value Performance Measurement and integrated it with a partnering approach to successfully manage large construction and engineering projects. This involved enhancing and combining standard project management tools and techniques in a new and innovative manner. It relies on careful and collaborative estimation and control of costs which are defined in terms of Targeted Outturn Cost (TOC) hours which are negotiated with each sub-contractor in the partnership (Latham, 1994; Rix, 2004).

- Extending Miles' work (1988), Pollack (2005) developed a way in which the relationship between project management techniques and problem structuring techniques can be managed throughout the life cycle of a temporally complex project with the aim of enhancing ongoing learning about the environment in response to

regular contextual change. Traditional approaches to project management tend to work on the assumptions that goals and risks are defined once during the project, then monitored. In many cases these assumptions are not met and these needs can be better addressed using separate problem structuring techniques.

Why project managers chose certain tools over others was not entirely clear from the interviews and subsequent discussions. It is likely that choices were influenced by educational norms, prior work experience and probably also the preferred learning styles of the project managers concerned. This is not unexpected. However it would be interesting to investigate preferences further to see if choices were conscious, based on the needs of the stakeholders and the context itself, or unconscious, based on knowledge, experience and personal learning styles.

An additional sub-theme of interest, was the use of non-standard graphical tools to help key players understand aspects of the complexity. Non-standard graphic techniques were used, either to stimulate creative solution building, or to assist with sharing meaning and obtaining agreement, or for communicating and monitoring progress. The engineering origins of many project management tools are indeed graphical however we found that graphical tools from 'soft systems' thinking (Checkland, 2002; Eden and Ackerman, 2004) were useful in helping to achieve shared understanding and agreement, and design tools (see Kokotovich and Purcell, 2001; Kokotovich, 2007) were helpful to stimulate development of alternative solutions.

Conclusion and Recommendations

In addition to the standard project management tools and approaches experienced practitioners are finding useful strategies to manage projects which are judged to be more than simply difficult. However willingness to select, or invent and use a range of tools outside standard project management repertoire might relate to managers' knowledge, experience and education and possibly also to personal behaviour preferences.

Our research to date suggests that project sponsors and managers will be better equipped to deal with complex situations if they acknowledge as early as possible if a project is likely to be more than just difficult and that managing a complex project requires a multi-methodological approach. Project managers need to be able to develop new approaches or at least substantially tailor approaches to suit each complex context. Standardised approaches and methodologies only seem to work in clear-cut situations where project time frames are short and project objectives can been confidently defined and agreed. We refer to a multi-methodological approach as systemic pluralism – 'systemic' because methods adopted must consider as much of the system as can possibly be grasped; and 'pluralism' because the management approaches must be drawn from a wide range of paradigms. Flexibility is the key and the manager needs a raft of tools, methods and behaviours at his or her disposal.

Tools and approaches fell into one of three categories: those affecting the whole of the project management approach, those used to initiate the project and those use in an ad hoc manner, throughout the project life cycle. Finally, although many useful tools and approaches were revealed there is no one tool that fits all. Instead, project managers need to be equipped with a variety of different tools and ways of thinking about projects, a palette from which managers can pick and choose as the needs of the situation dictate. This is particularly true in environments characterized by confusion and transient conditions, typical for projects labeled as complex.

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Appendix A:

List of tools and approaches:

Proprietary tools and methods, project management standards and those methodologies which are considered to be mainstream were excluded from the analysis.

Code	Description of tool or approach	Source of complexity				When used in practice			Size
		Structural	Technical	Directional	Temporal	Life cycle	Start-up	Ad hoc	Small - Medium - Large Project
L1	An approach developed for the telecommunications industry which involves used of single page graphics for co-ordination of work between international centres	X	X	X	X	X			S-M-L
L2	An approach developed for the construction industry which controls through partnering and strict application of use of earned value management	X	X	X	X	X			M-L
L3	An approach which uses programme management to define differential strategies for managing projects within the programme according to the identified source of complexity	X	X	X	X	X			M-L
L4	An approach which uses a checklist to define roles according to the identified source of complexity	X	X	X	X	X			S-M-L
L5	An approach to project organisational structure which aims at balancing creativity and output.		X	X	X	X			S-M
L6	An approach which embeds soft-systems thinking into the project throughout the entire project life cycle.				X	X			S-M-L
L7	An approach which utilises the idea of variable control gates to help manage project risk	X	X			X			M-L
S1	An approach which assists with mapping expected levels of complexity at each phase of the project so that appropriate management decisions can be made.	X	X	X	X	X	X		S-M-L
S2	An approach which grafts soft systems thinking to the front of the project or project phase.			X			X		S-M-L
S3	An approach to help prepare realistic ranges of estimates during conditions of uncertainty		X	X	X		X		S-M
S4	An approach to help define key project management concepts between sponsors and project managers for the project			X	X			X	S-M
A1	A qualitative tool for quick deployment to help manage emergent risk patterns in small to medium size projects	X	X	X				X	S-M
A2	A set of graphical tools to assist in stimulation creative solution finding.		X	X				X	S-M
A3	A tool to help stakeholders expand personal perspectives in a given situation.		X	X				X	S-M
A4	A tool to help with communication and managing difficult stakeholder relationships.			X	X			X	S-M
A5	A tool which helps project managers to observe and collect data from different perspectives	X	X					X	S-M
A6	A tool which compares similarities and differences between the breakdown structures to allow people to break down the situation in different ways.	X	X					X	S-M-L
A7	A tool which helps managers ask questions to ascertain what needs to be reported and in what form.			X	X			X	S-M
A8	A tool to challenge expert opinion through the introduction of 'non-experts'.			X	X			X	S-M
A9	A tool using semiotics to share meaning between key stakeholders			X	X			X	S-M
A10	A tool which helps translate the complexity of the situation in such a way that the salient information is presented.	X	X					X	S-M