Chapter 3: Tools for Complex Projects

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If the only tool you have is a hammer, you tend to see every problem as a nail.
—Abraham Maslow

This chapter first defines the differences between a tool or technique, a methodology, and a theory. It then describes the results of some of the research carried out by the author and her colleagues by focusing on the tools, techniques, or approaches developed by senior project managers specifically to address highly complex projects. Selected tools are discussed in more detail. The chapter concludes with a discussion of tools in application.

A Case for Thinking Outside the Tool Box

Maslow's comment is entirely relevant to projects that we might define as complex. It preempts one of the most important findings from our research (Helm & Remington, 2005a, 2005b). That is, managing a complex project successfully requires unconstrained thinking: thinking that embraces more than the standard textbook approaches to project management or the standard tools and methods. We asked senior project managers, who were selected because they had managed high risk, complex projects (judged as such by their key stakeholders), to list the key attributes that enabled their success. Without exception all respondents cited phrases like the ability to "think outside the box"; "flexible approach to management"; "not being constrained by rules"; and ability to "think creatively."

Most standard project management methodologies carry the implicit assumption that the practitioner will use a particular set of tools in a defined order, and that all or most of the tools in the methodology will apply. Complex projects can rarely be managed by applying a standard methodology that has been designed to be used unvaryingly in all contexts (Crawford & Pollack, 2004; Pollack, 2007a). Our research data reveals that tools, techniques, and approaches—and we bracket these three terms together in this context—were selected by experienced project managers as and when the situation demanded, and, if no appropriate tools were available, one was created to fit the purpose. Based on this research data, and supported by mounting anecdotal evidence, the project manager who successfully manages high risk and complex projects appears to be someone who can select from a vast range of tools, methods, and approaches, to apply what is needed, when it is needed. In some cases this means engaging others who are more experienced with a tool or approach, in other situations, it means being familiar enough with a range of tools and approaches to be able to "move with the moment."

One Size Does Not Fit All. Traditional Approaches versus "Systemic Pluralism"

Differences between individual projects have been recognized for some time (Turner & Cochrane, 1993; Payne & Turner, 1999; Shenhar, 2001). In addition, management research in this field has expanded in the recognition that traditional approaches were not always delivering the best results. Our research suggests that project managers who manage complex project successfully tend to develop their own methodologies and vary these considerably from project to project (Helm & Remington, 2005a, 2005b; Pollack, 2007b. The most productive methods appear to be based on the concept of systemic pluralism(Remington & Crawford, 2004). "How do we handle it? Well it's difficult …There isn't one single answer" (Smith, 2007, p. 22). Systemic pluralism requires two things from practitioners: that project managers recognize the systemic nature of projects; and that they adopt a pluralist approach to the tools and methods they apply. That means applying many different tools and approaches and being alert to the need to change tools and approaches as the project complexity develops or changes.

The idea of systemic pluralism was developed as part of the systems field, under the banner of critical systems thinking, a branch of systems thinking which emphasizes theoretical and methodological pluralism. Authors such as Midgley (1996, 2000), Mingers (1997a, 2003), and Flood & Jackson (1991) all provide discussion on the development of critical systems thinking and pluralist ideas in the systems, operational research and management science fields. Discussed in more detail in other chapters of this book, most projects can be more readily described as complex adaptive systems than as simple systems. Complex projects vary dramatically in form and character, exhibiting many different characteristics and aspects of systemicity. A single complex project may even demonstrate multiple kinds of systemicity, with various parts of the project showing markedly dissimilar characteristics and behavior. Differences in systemicity will almost certainly vary considerably within any program or group of interrelated projects.

For those projects that can be described effectively as simple systems, where the outcomes of the project can be so well defined that fully predetermined control is possible, standard or traditional project management tools and processes are very efficient. However, in more complex contexts, where ambiguity, uncertainty, or lack of trust prevail, there will be aspects of the project for which control, in the sense of total predetermination of outcomes, is unlikely or even impossible to achieve. These parts of a project, or subprojects, may benefit much more from approaches based on both systems thinking and multidimensional approaches. In fact, faced with the pluralistic nature of the projects themselves, project managers have no choice but to adopt a pluralistic approach to practice that means drawing flexibly and dynamically from a range of tools and approaches in order to deliver satisfactory outcomes. When implementing a systemic and pluralistic approach the manager must first identify the nature of the complexity; then like an artist, select from the palette of tools, those tools which will provide a variety of perspectives, reveal the layers of complexity and make the project manageable.

Defining Tools, Methodology and Theory

Defining these terms is problematic because the words are used in different ways and in different contexts. Therefore, for the purpose of this chapter, functional definitions will be used. From a

purely functional perspective, philosophy and theory can be seen as providing a formal conceptual framework for examining the world, an explicit perspective through which the world can be viewed. Likewise, paradigm is broadly defined as "... a world view, spanning ontology, epistemology, and methodology..." (Healy & Perry, 2000, p. 121), "…based on a set of fundamental philosophical assumptions that define the nature of possible research and intervention" (Mingers, 1997b, p. 429–430). Readers interested in a more thorough exploration of the ontology of paradigms should refer to Kuhn (1962). Complexity theory itself comprises a broad group of ideas, models, and predictive descriptions about how complex systems behave.

Also from a functional viewpoint, a methodology can be seen as a structured set of guidelines for the improvement of the effectiveness of a system or project (Mingers, 1997a). It develops within a particular paradigm and embodies particular philosophical and theoretical principles (Mingers & Brocklesby, 1997; Mingers, 1997b). However, methodology differs from theory and philosophy in that it contains practical guidelines. Checkland (1981, p. 162) placed methodology as the middle ground between philosophy and technique, containing elements of both, while "...a technique tells you 'how' and a philosophy tells you 'what', a methodology will contain elements of both 'how' and 'what.'" Here, methodology is considered to be "...the logos of method..." (Checkland, 1999, p. S36). It provides the principles on which the method is based (Checkland, 2002), and can be considered "...a higher-order term than method and, indeed, than procedures, models, tools, and techniques, the use of all of which can be facilitated, organized and reflected upon in methodology" (Jackson, 2000, p. 11).

Tools, approaches, and techniques are the most practical part of the hierarchy, and they tend to make little direct reference to theory or philosophy. However, they are often created under, or associated with, particular theories or philosophies. For instance, PERT and Gantt charts are both associated with the way of thinking embodied in project management and can be linked to positivist and realist philosophies. Tools, approaches, and techniques generally involve a series of clearly delineated steps. Because of this, it is possible to create clear standards for their use, while this is significantly more difficult for methodologies. According to Mingers (1997b) and Mingers and Brocklesby (1997), tools are specific activities with well-defined purposes. A tool can also be an artifact, such as computer software, that can be used to perform a particular technique. Use of tools can "...lead to an end point without the need for reflective intervention..." (Rosenhead, 1997, p. xiii), however, reflection on tools, in relation to theory and methodology, can be useful in learning from past mistakes and improving future performance.

The Relationship Between Tools, Methodology, and Theory

One popular way of looking at the relationship between tools, methodology, and theory, is to think of them as a hierarchy. In this kind of hierarchy, theory is usually thought of as sitting at the top, with methodology below that, with tools sitting at the bottom of the hierarchy (see Figure3.1). In this kind of hierarchy, the upper layers can be thought of as more philosophical or theoretical and distanced from the mess of practical application. By contrast, the lower levels are never as "clean," requiring actual engagement with pragmatic necessity and providing a context where theoretical claims can be tested. Many different practitioners and researchers have found it useful to view this relationship as a hierarchy with different levels of abstraction (see e.g., Mingers & Brocklesby, 1997; Fitzgerald & Howcroft, 1998; Ragsdell, 2000).

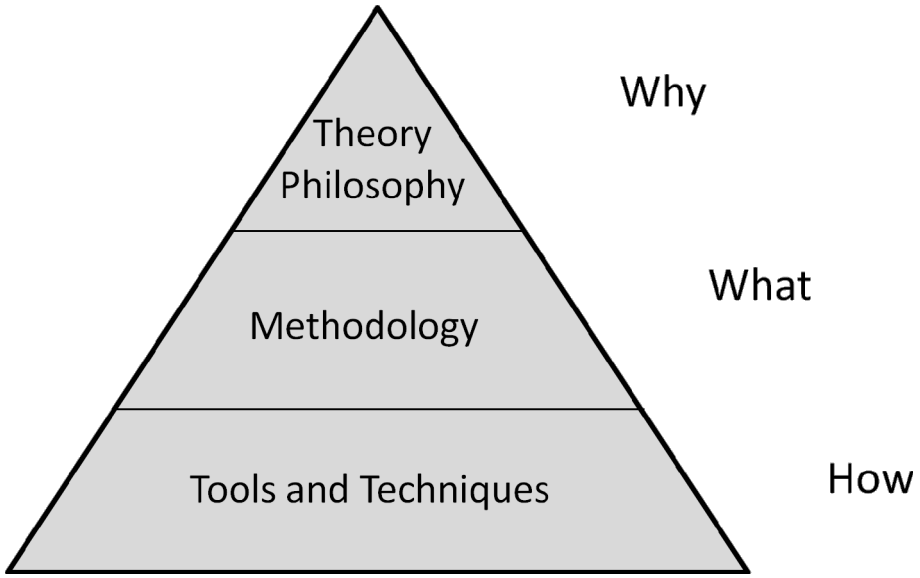

Figure 3.1: A hierarchical relationship between the theoretical and practical).

The upper levels in this hierarchy constitute the conceptual basis and intellectual context for the increasing practicalities in the lower layers. The upper layers provide a basis against which consistency can be judged. These philosophical and theoretical aspects provide the "why" for methodology. Methodology can be thought of as specifying "what," while tools and techniques specify "how" (Mingers, 1997b, pp. 429–430). We can "...learn more about these tools by reflecting on their links to methodologies, or about methodologies by reflecting on their links to theory" (Jackson, 1999, p 19).

The practical world of the lower layers plays a different role in this hierarchy. A theory that bears no relationship to the real world of practice is not of much practical value. For theory to be valuable it must enable action, it has to be applied and tested in the real world. Testing the real-world efficacy of the practice provides justification for statements made in the realms of theory and philosophy. Practical application of the lower layers can be used to test the validity of claims made in the upper layers, resulting in either validation of claims or the need to reassess and rework statements about the nature of the world. The lower layers can be thought of as a feedback system for the upper layers.

For Midgley (2000), thinking of this relationship as a hierarchy suggests that theory and philosophy are given special value and thought of as incontestable. He argues that such a hierarchical relationship precludes the idea that practice itself '…may signal a philosophical inadequacy' (Midgley, 2000, p. 21). However, it is clear that in practice theory and philosophy are often challenged based on practical experience. Midgley argued that philosophy, methodology, and tools should be viewed as mutually supportive.

Methods can generally be thought of as an interrelated series of tools, used in practice to achieve a specific purpose (Midgley et al., 1998). Methods may include representational guidelines, such as modeling techniques, and procedural guidelines, which describe how work is to be conducted. To Paton (2001) a method is constructed to deal with an individual situation. It is particular and individual. Methodologies "…provide us with logic to help us construct a method from a given set of

tools and techniques" (Paton, 2001, p. 99). Methods can be thought of as the practical output of the combination of methodologies and tools (see Figure 3.2).

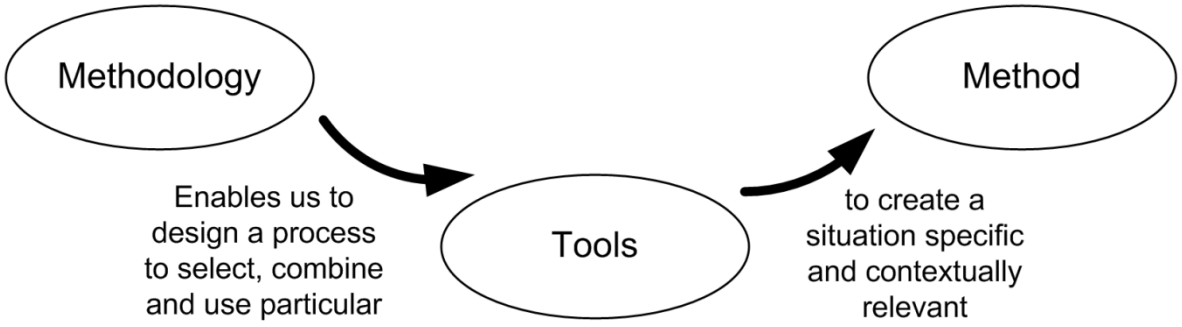

Figure 3.2 :The derivation and design of methods (adapted from Paton, 2001: 99)

Finding Tools that Suit the Nature of the Project Complexity

Although we found many different tools in use, it was apparent that only some were relevant to complex projects, some were only relevant at particular times in the project life cycle, and some were relevant to one type of projects but not others (Remington & Pollack, 2006, 2007). One of the tasks we set for ourselves, was to try to discover which tools were relevant, to what kinds of complex projects and when. However, we first needed a frame to define a complex project. As other writers in this book demonstrate, definition of a complex project is highly problematic. The definition is influenced by perception and context. Perception of the complexity of a project is influenced by prior experience, personal capabilities, and the key stakeholders who are involved in making the judgment —their political agendas, cultural needs, and their own abilities to perceive an issue[i] as complex. For example, in earlier research, we found that many sponsors did not perceive the complexity of the project in the same way that the project managers understood it. Some project managers felt they had to simplify the complexity in order to facilitate communication with a sponsor (Helm & Remington, 2005a, 2005b).

From our interviews with senior project managers, we collated a range of tools and approaches used, most of which differed from standard tools and methods found in project management textbooks. We then analyzed the tools and approaches to discover the characteristics of the perceived complexity each tool or approach addressed and the stage of the project to which they were relevant. This, coupled with an extensive literature search, lead to a classification of complexity types for projects, based on the source of complexity. With the exception of the fourth category, which we included to account for a particular source of complexity associated with time, this work extended the work of several other authors (Turner & Cochrane, 1993; Baccarini, 1996; Williams, 2000). The four categories or dimensions, which are based on the source of complexity and may constitute a tool to assist stakeholders in identifying the nature of complexity, are as follows:

> ***Structural complexity***—derives from a classical view of complexity based on the structure of information pathways. The source of structural complexity is many interrelated and interdependent activities. Complexity, particularly in the form of non-linear feedback, can

arise due to complicated organizational and approval pathways as well as in huge work breakdown structures with myriads of activities that might interact.

Technical complexity—derives from technical or design challenges that are more severe than anticipated and in particular, problems that might not yield a solution within the time available.

Directional complexity—was viewed as a type of complexity that arose from unclear or unshared goals or goal-paths. Although this is most common at the beginning of a project, it can arise at any time due to changes of direction resulting from technical or environmental change.

Temporal complexity—was coined in response to projects that appeared to be unduly sensitive to unpredictable changes over time, due to the volatile nature of the internal or external environment. Even if the nature of the change could be anticipated, knowing when the environmental or organizational impact might occur, what form it might take and its potential impact on the project can be hard to predict. Temporal complexity increases with the duration of a project.

The classification proved to be a very useful tool because it can assist project managers and other key stakeholder to identify or anticipate the source of complexity and the approaches that might best address the complexity. Some tools and approaches apply to the whole of the project, others to specific phases, and others to specific dimensions of complexity (for more detailed discussion see Remington & Pollack, 2007, chapters 1-4).

It should be noted that although other classification systems include attributes such as uncertainty, we argue that categories or dimensions of complexity can have behavioral consequences, such as uncertainty, ambiguity, and loss of trust, which exacerbate perceptions of complexity. Thus, with the exception of directional complexity, uncertainty is treated as a consequence in this model, rather than a cause.

Whole of Project Tools and Approaches

Tool for Mapping the Complexity

A tool emerging from our classification project has proved to be useful in helping key stakeholders recognize when a project is more than just complicated. Based on this knowledge, choices can be offered to key stakeholders about whether to proceed, how to proceed, and what tools and approaches might be useful and when they can best be used. An example provided by the authors (Remington & Pollack, 2007, chapter 8) was a remote area medical facility. Being able to identify and agree upon the nature of the complexity and the expected level of complexity at the beginning of each phase of the project encouraged key stakeholders to monitor and control the project based on the nature of the expected complexity. It enabled them to make appropriate adjustments to the project's organizational structure, key role definitions, and procurement systems as the project progressed through a temporally unstable landscape. As the assessment of complexity is based on perception, it is important that any tool captures the combined perception of the stakeholders. This in itself helps to stimulate dialogue about what contributes to the complexity of the project that,

without such a tool, might not occur. As mentioned previously, earlier research revealed that although many project managers understood that the project was more than just difficult, their key stakeholders, such as owners and sponsors did not (Helm & Remington, 2005a, 2005b). This tool assists in structuring the kind of dialogue that is necessary if the project manager is to be given the kind of support needed for a complex project.

System Anatomy Tool

One project approach that stood out in the research was the "system anatomy," which is now referred to as the integration centric development (ICD) approach, and was developed by the team at Ericcson, for a telecommunications rollout that spanned many countries (Lilliesköld, 2003; Taxén & Lilliesköld, 2005; Lilliesköld & Taxén, 2006). The challenge was integrating implementation in vastly different cultural settings by geographically distributed and often isolated teams, with different local work practices. The solution was to contain the master planning and communication documents to a one-page "anatomy" diagram that is constructed by key stakeholders. This document became the focus of all communication, control, and monitoring. Essentially the approach allowed central control of key elements and local control of work practices that could be developed locally to suit the particular context; including availability of labor and resources and cultural and political needs.

Time-Linked Semi-Structures

Another project tool, titled Jazz or time-linked semi-structures (Remington & Pollack, 2007, chapter 13) was derived from observation of projects managed in the entertainment and design industries where time to performance(or market) is often the critical driver in an atmosphere of highly interlinked creative team activity. Particularly in the theatrical world, there are also very tight economic drivers and high levels of competition for those all-important opening night reviews. More of a theoretical model than a tool, as such, this approach supports maintenance of a dynamic balance between a more formal structure at one extreme and the more chaotic environment needed to optimize creativity. The reference to Jazz derives from the improvisational nature of jazz music, which is created "on the spot" without a prescribed score or plan. However, jazz, as a musical form, is guided by a non-negotiable framework that constrains what the soloist can play at any time. As the bassist Charles Mingus said "You can't improvise on nothin'. You gotta have something.'" The structure in the projects we observed was provided by a schedule, highlighting nodal points only, such as design or production meetings, and very clear role definitions that were well communicated and respected by all concerned. Around that structural spine or "time-linked semi-structure" the projects hovered near "the edge of chaos"—the hypothetical point where creativity and associated learning is like to be greatest.

Tools to Address Specific Aspects of Complexity

Earned Value

One tool that addresses complexity is earned value management. Although this tool is part of the mainstream of project management tradition, our research suggests that it is still under-utilized as a tool. Earned value management is particularly useful in projects exhibiting high structural complexity and is indeed often applied in large engineering and defense procurement projects. Where high-level structural and technical complexity exist the most effective procurement options may be in the

form of alliances or partnerships . However, successful alliances or partnerships depend on maintaining high levels of trust (Bjørkeng, Clegg, & Pitsis, 2009). For an alliance or partnership to work, all transactions must be completely transparent to all partners in the alliance (Lendrum, 1998). Transparency requires demonstration of rigorous monitoring and control. Earned value management -assists in communicating transparency and maintaining trust in alliances or partnerships. If sensibly applied, it is one of the most effective ways of keeping track of the value of what has been delivered within a specified time frame compared with projected delivery and expenditure.

Problem Structuring and Soft Systems Thinking Tools

Unclear or unshared goals or goal paths may exist in the absence of technical barriers or may exist before technical barriers have been discovered. Particularly, if the relationships are conflicted or where political agendas are unstated, this can lead to high levels of complexity. Associated with this can occur a loss of trust and willingness to cooperate or work together. What is referred to as directional complexity occurs most frequently at the beginning of a project. If it is not addressed fully at the beginning, lack of clarity breeds loss of trust. Often larger goals are shared, for example, "we want to reduce customer complaints," but the goal paths to achieve the overarching goal are unclear or unshared by the various levels of the organization charged with delivering the goal. Our research in the defense industries indicated that more often than not senior management understood the goals but the project personnel or industry partners, either did not understand, or had a different interpretation, of the goal or goal paths. Although directional complexity is probably the easiest to address given experienced facilitators using a raft of problem structuring and soft systems thinking tools, it is often not addressed adequately because people either do not recognize its presence or tend to ignore it in favor of leaping into what they believe is the meaning of the project. A number of soft systems thinking tools can be applied with great effect to clarify and share goals and goal-paths (Flood and Jackson, 1991; Midgely, 2000; Jackson, 2000).

Summary of Tools for Complex Projects

The following table summarizes some of the tools and approaches used by expert practitioners to address different dimensions of project complexity (adapted from Remington & Pollack, 2007).

Dimension	Source of Complexity	Tools To Be Considered
Structural	High levels of interconnectedness and codependency between activities or organizational complicacy resulting in unclear or redundant communication and approval pathways.	High level monitoring and control tools, including earned value management, procurement via partnerships, flexible procurement options, program management tools, OR tools, complex systems-based risk tools.
Technical	Design or technical challenges that are extreme or for which no solution is apparent within the time available	Clear role definition, procurement via partnerships and alliances, value management, "hands-off" management control approaches, creative thinking tools, integrating tools facilitating "rich" communication

Directional	Unclear or unshared goals and goal paths; covert or conflicted objectives; cultural barriers, language and communication barriers; covert agendas	Soft systems thinking tools, appreciative enquiry, trust building exercises, value management, problem-structuring tools.
Temporal	Shifting and unpredictable landscape over time; uncontrollable scope changes; uncertain political, regulatory, technical environments over the life cycle of the project	Parallel processing tools (multidimensions in series), environmental scanning, problem structuring and problem analysis tools, change management tools focusing on team motivation.

Complexity in Combination and Tools

The reality is that when a project is complex it exhibits several dimensions of complexity over time, if not all at once. Each dimension of complexity requires different tools and in some projects, a vast range of tools must be used in parallel (Pollack, 2007b). Even an apparently simple project can go very wrong if the nature of the complexity is not recognized. In addition, the nature of the complexity can change over time, as in the case of the area medical facility discussed above. It is also important to note the potential impact of one dimension of project complexity on another and the effect that intersection has on choice of tools and approaches. A project that initially presents few technical challenges can become highly problematic with a change of goal path when client requirements change. A structurally complex project might suggest the use of high level project control tools, however if there are technical challenges control needs to exercised in such a way that solution finding is not stifled too early in the project. This kind of situation requires a phased use of tool with approaches, like Jazz, that encourage rich communication, rather than overt control. If directional complexity is also present, enough time must be allowed to achieve understanding and alignment using soft systems thinking tools.

In reality, however, particularly with mega projects, such as large construction and engineering projects, a myriad of projects and interests intersect, each at different stages and exhibiting different dimensions of complexity. In an intercity rail upgrade project, for example, temporal complexity was expected due to the duration of the project (over 10 years), the possibility during that time of a change of government (which might mean cancellation of the project), and the probability of significant advances in technology during the project life cycle. This is coupled with high structural complexity due to the size of the project, the number of railway stations involved, limited access to tracks and stations, the complicated approval pathways involving government and commercial entities and the potential for bottlenecks due to shortage of specialist expertise. Technological challenges also abound, associated with how to address the number of bridges, tunnels, and stations that have existing heritage orders when few alternative tracks are available. However, the most challenging aspects relate to the directional complexity involved in aligning goals, addressing and monitoring conflicting requirements of the many stakeholder groups. Tools are only helpful in these kinds of projects if they form part of a philosophy and methodology that support a systemic and

pluralistic approach and if they are able to be used and applied in a timely manner, by people who are competent in their usage.

Conclusion: Tools are just Tools

It is important to recognize that managing a complex project is a higher order management activity and should be treated and resourced accordingly. A discussion of tools is not complete without addressing organizational and individual capabilities. Tools in themselves are useless without the appropriate level of capability. Most important is the capability of the governance team in identifying the nature of the complexity associated with a project, ability to identify the tools or approaches needed, ability to identify the skills and competences to apply the tools, and the willingness to ensure that the right people are engaged to deliver the project. Our data strongly suggests that the project managers who manage complex projects successfully are like artists, selecting the most appropriate tools and approaches from their very large palettes and working with those tools to produce the color, form and texture appropriate to the work in hand. However, they also behave like scientists in their ability to select, analyze, and synthesize empirical data, and like politicians in their ability to influence and manage a network of relationships. Tools are, in the end, just tools.

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