Tools for Complex Projects

KAYE REMINGTON and JULIEN POLLACK

GOWER
Nearly all large and many small projects exhibit characteristics of complexity. Nevertheless projects of all sizes continue to be managed using linear thinking strategies based on project management traditions that go back to the building of the great pyramids in Egypt during the third millennium BCE, when societies and workgroups were arranged hierarchically. Much of the thinking dominating project management as it is currently practiced and taught is still founded upon control theories which were developed in the early modern period to deal with nineteenth- and twentieth-century industrialization and imperial expansion. There is nothing intrinsically wrong with this. However, issues do arise when these ideas are applied unilaterally to all kinds of projects in all contexts.

In complex environments problems for management stem from the assumption that the outcomes, envisaged at the inception of the project, can be sufficiently determined early in the project and then delivered as planned. This approach to project management only works for a limited number of projects. Those projects tend to be rather small in scale and short in duration. However, once a project reaches a critical size, timeframe, level of ambiguity and interconnectedness, control-based approaches simply do not work for the entire project.

Several authors have recognized that projects are systems and should be addressed systemically. However the systemic view of the world presented is usually predicated upon what Peter Checkland (1981; 1999) refers to as ‘hard systems thinking’. This kind of thinking is highly appropriate for mechanical systems but not so useful when people are the key elements in the design, operation and delivery of the system. The problem is that people are unpredictable in their behaviour. We are self-determining, self-willed, self-motivated and selfish. We can disrupt the most carefully planned project simply by refusing to play, doing something entirely unpredictable or acting in what we consider to be in the best interests of the organization, the project or ourselves. The high numbers of major project failures being observed suggests that project methodologies founded on control systems thinking alone are not appropriate for many of today’s projects (Remington and Crawford, 2004; Williams, 1999; Baccarini, 1996). Projects are being subjected to numerous constraints, and project managers are expected to deliver outcomes in increasingly ambiguous and politically charged environments. In order to deliver satisfactory outcomes project managers need to adopt both a systemic and a pluralistic approach to practice.

A new approach to project management

‘Systemic pluralism’ is an approach that practitioners need to pursue if they are to survive and deliver successful project outcomes in complex contexts. 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 theories they apply. 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 (1997; 2003) and Flood and Jackson (1991) all provide discussion on the development of Critical Systems Thinking and pluralist ideas in the systems, operational research and management science fields.

Management of most, if not all, projects can be aided by thinking of projects as systems. However, this does not mean the same thing to all people. Many different authors have placed different emphases on the systems concept, variously focusing on the attributes of open, closed, hard, soft, feedback and control systems. Although these different approaches all talk about systems, the different emphases they bring to the debate result in highly divergent forms of practice.

In this book we draw upon Complexity Theory, a cross-disciplinary branch of science which enquires into the nature of complex adaptive systems. Complexity Theory developed out of the observation of emergent, non-linear behaviour and particular sensitivity to initial conditions apparent in many natural systems. Its concepts have been developed through simulation and observation of complex behaviour in fields as diverse as biology, geology and meteorology. Lewin (1992) provides a good summary of the development of Complexity Theory. Ralph Stacey (1996) and others such as Griffin et al. (1999) and Lissack and Roos (1999) have applied ideas based on complex adaptive systems to general management. Complexity Theory also has considerable scope to provide insight into the systemic nature of projects.

Most projects can be more readily described as complex adaptive systems than as simple systems. In order to cope effectively with complex projects managers must adopt a pluralistic approach to practice. They must be able draw from a wide range of tools and ways of thinking to develop their own methods, their own patterns of practice, freely, according to the exigencies of the particular project. No one approach to project management is appropriate for all situations. There is no one size 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 characterised by confusion and transient conditions. Project managers should be able to select and vary the design of their methodologies or their approaches to managing different projects.

Complex projects vary dramatically, exhibiting 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 behaviour. Differences in systemicity will almost certainly vary considerably within any programme or group of interrelated projects.

Some projects can be described effectively as simple systems. For these projects the outcomes of the project might be so well defined that fully pre-determined control is possible. When this is the case traditional project management tools and processes are very efficient. However, in more complex contexts 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 sub-projects, may benefit much more from approaches based on complex systems thinking. 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 methods in order to deliver satisfactory outcomes to the stakeholders.
What is a Complex Project?

Aim of this book

This book is designed to assist practitioners to recognize the different sources of project complexity that might be confronted in a project context, as a guide to selecting the most appropriate management strategies. Based on the sources of complexity, we have defined various types of project complexity. We introduce whole-of-project approaches and individual tools that might assist practitioners to address different types of project complexity. The tools discussed in this book are not intended to be comprehensive. That would be impossible. In all cases it is the purpose behind the tool or approach, and the problem it is attempting to address, that are significant. Other tools can be selected if they fulfil the same purpose.

This book is a guide, not a step-by-step prescriptive methodology. Rather, it is a bag of tools and approaches from which managers can select in order to carry out the management activities needed for the project. The assumption is that the manager will make informed decisions about the most appropriate tools for the situation.

The focus is on tools and approaches which are not normally part of the project manager’s palette of techniques. More traditional project management tools may be referred to in this book but will not be covered in any detail. However, there is no intention to dismiss the use of traditional tools. Traditional project management techniques and processes are entirely appropriate and effective in situations where project objectives are clear, fully understood, agreed and relatively stable over time. Traditional project management methods and tools are comprehensively addressed elsewhere (see excellent coverage in Harrison, 2004; Pinto and Trailer, 1999; Turner, 1999; and many others).

A complex project is a complex adaptive system

Complexity Theory in the form that has been applied to organizations (Anderson, 1999) may also be applied to projects (Williams, 2002; Baccarini, 1996). All projects exhibit the attributes of interconnectedness, hierarchy, communication, control and emergence, attributes which are generally useful in describing all kinds of systems. Most large and many small projects also exhibit the characteristics of complex adaptive systems. They exhibit characteristics such as phase transition, adaptiveness and sensitivity to initial conditions. These latter characteristics can be understood through reference to Complexity Theory.

It is commonly accepted that systems thinking is a way of looking at the world. Systems concepts, and the idea of systems, are frameworks which we use to interpret the world. We use these concepts in response to our recognition of stable relationships between different entities. Systems concepts aid our understanding of the relationships between parts and wholes. Thinking in terms of systems is something we do naturally. We intuitively make sense of the world by recognizing patterns of interaction and feedback. This book provides a selection of practical tools and techniques to allow managers to apply systems thinking and the concepts developed within Complexity Theory deliberately and with conscious effect.

An example of a system at a primitive level involves our ancestors who might have recognized that certain plants can be gathered at certain times of the year, that the bison pass through the lower ranges around 20 days after the solstice, and that if we follow the migrating bison we will arrive at the junction of the rivers in time to eat the spawning fish. This is a stable, repeatable pattern or system. The system is about us finding food in predictable way so that we can survive. We may not have understood why the system is stable or how the system
fits into the greater ecosystem, but this does not prevent us from recognizing the relationships and taking advantage of them.

How we recognize systems and what is seen as a system is based on our points of view. Systems are based on stable relationships which must be recognized as existing and evolving over time. If there is no repeatable pattern, then we are looking at a single occurrence, not a system. When Douglas Adams’ character, the detective Dirk Gently, noticed ‘the interconnectedness of all things’ he was recognizing the systemic nature of his universe:

‘Whether we see a system in a situation is dependent upon what we are looking for at the time. For instance, most people are unlikely to perceive a simple pile of apples as a system. However, for very specific reasons, it may be useful to view this pile of apples as a system. If you were engaged by an apple producer to investigate the spread of a colony of bacteria in apple storage bins, thinking in terms of systems might be very useful. If you were an artist, and your intent and focus is the maintenance of a perfectly symmetrical pile of apples, then your focus changes again. Now, there is a perceived relationship between the apples and removing one apple fundamentally alters the properties of the pile of apples as a whole.’

Complex adaptive systems exhibit characteristics of all systems but it is the special additional characteristics that make them particularly difficult to understand and manage. Most authors agree that complex adaptive systems have the characteristics described as follows.

**Characteristics of complex adaptive systems**

**HIERARCHY**

Systems have sub-systems and are sub-systems for larger systems. This is often described as nested behaviour, like the Russian babushka dolls which fit one inside the other in seemingly endlessly diminishing replications.

In the same way, a chemist working on a drug development project is part of a project team. The interactions between the project team members can be considered to be a system. The team is one of many within a department, which can also be considered to be a system. The department is one of many within the organization, which is also a system. There are many organizations competing in this field, which together constitute another system.

Work breakdown structures are common ways of depicting a nested system of hierarchies, formally breaking down the activities in a project into manageable chunks. The project can be perceived at a number of levels, depending upon the focus of interest of the viewer.

**COMMUNICATION**

Information regarding the state of the system is passed between elements of a system. Information regarding the state of the system and the state of the environment is also passed across the system boundary. For example without anyone instructing them to do so, employees in an organization use the grapevine to rapidly communicate any changes to the organization that might affect them. Note however that rapidity and accuracy do not necessarily go together as anyone who has played the game Chinese whispers will agree. Projects have both formal and informal communications. The informal communications may both support and undermine the formal communications patterns.
CONTROL
Systems typically maintain the stability of the relationship between their parts, and so maintain their existence as a system. Control is what holds the system together. It maintains a stable state of operation. For example, a thermostat in the human body operates to maintain a comfortable body temperature by inducing sweating or shivering. In a workgroup, a congenial emotional climate and adherence to group norms are two of the conditions that hold the team together. If one team member does something to disturb this relationship other team members take action to re-establish the desired state of congeniality. Actions to control the behaviour and therefore maintain the system might be in the form of a joke, such as, ‘I think we need to include the cost of an alarm clock for Fred in the next budget’, which communicates acceptable group norms to a person who is habitually late for meetings. If the behaviour is allowed to escalate more serious control may be needed, such as exclusion of the member from the team.

EMERGENCE
At different levels of the system different properties emerge which may not be apparent from levels below. These properties are based on the stable interaction between different elements at a level of the system. Emergence is a property of the stable relationship between parts, not of any part in itself. In this respect the whole can be more than the sum of the parts. For example, when separated, the parts of a bicycle do not constitute a system of much interest. However, when combined, the capability of being able to be ridden emerges. This property only exists at the level of the whole bicycle but does not exist for any of the parts individually. It is a property which springs into being at a particular level of interaction with the system (see Dooley and Van de Ven, 1999).

PHASE TRANSITION
A complex adaptive system can suddenly take on a new form in response to changing conditions. It is the same system, just exhibiting different properties. This is usually an internal response to an external change. Descartes, in his *Meditations*, describes the transition of a piece of wax melting. When it melted he posed the question: How do we know is it the same piece of wax? It no longer looks the same. It doesn’t feel the same. Nonetheless science now tells us that it is the same system of atoms and molecules, just in a different phase state. This in turn creates different emergent properties, such as runniness instead of solidity.

Another example can be illustrated with respect to specialized work teams. When a navy vessel changes from general operating conditions to battle stations the interactions between the people and within individuals themselves go through a phase change. People start behaving differently to each other. However, the system is still stable. It is just responding to a different environmental constraint.

NON-LINEARITY
Non-linearity is caused by ‘positive feedback’ and induces change (see Daft and Lewin, 1990). This is in contrast with control, a process of ‘negative feedback’ for maintaining stability, like a thermostat.

For example, the 1960’s pop group, The Beatles, were only moderately successful until Ringo Starr replaced the original drummer. Although it could be argued that Ringo was no
more proficient than the original drummer, he interacted with the group in such a way that they ‘spun off each other’ to create one of the most successful pop music groups in recent history. Something about the group interaction after Ringo joined allowed the creativity of each to be a positive influence on the others causing a spiral of creative output which had not been present before. This can also happen in project teams, particularly design teams.

ADAPTIVENESS

In response to changes in the environment a complex system adapts to accommodate and take advantage of the changes, to maintain or improve itself. The system adapts so that it can survive and maintain internal coherence in relation to the environment. Simple control involves maintaining the system against a fixed reference point. When a complex system adapts, the actual points against which the system regulates itself can be considered to move (see Lissack and Gunz, 1999). System adaptation can be in response to variation in the supply of resources which the system relies upon, new environmental constraints or the appearance of new possibilities.

For example, in the face of changing regulatory requirements for standards of production of vitamins it may not be possible for all companies to comply with production standards. Those companies that can adapt will survive and possibly expand. Others will be forced either to cease production or diversify.

SENSITIVE DEPENDENCE ON INITIAL CONDITIONS

This is the famous ‘butterfly effect’. In 1972 the meteorologist Dr. Edward Lorenz pointed out that even tiny differences in initial conditions in a complex system (such as a butterfly flapping its wings in Brazil) can produce unanticipated and often catastrophic effects (such as a tornado thousands of miles away in Texas). As an example, the same team delivering the same project in a different environment with different initial conditions may achieve radically different levels of performance. This characteristic of a complex project, together with non-linearity and the positive feedback loops that may result, can cause risks, triggered by seemingly unimportant anomalies in initial conditions, to escalate out of control (see Arthur, 1989).

Recognizing the type of project complexity

Different kinds of complexity require different management methods. It is useful to be able to recognize different types of complexity as an aid to selecting the most appropriate tools and approaches to manage the project. Strategies for managing different kinds of complexity exhibited by different projects or project parts might need to vary enormously.

Based on the source of complexity and informed by the work of others (such as Turner and Cochrane, 1993; Williams, 2002) we suggest four types of project complexity as useful categories for analysis:

- structural complexity
- technical complexity
- directional complexity
- temporal complexity.
What is a Complex Project?

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.

**STRUCTURAL COMPLEXITY**

This kind of complexity may be found in most large and certainly all very large projects. Because the project management discipline has developed its knowledge based on management of such projects, they are often referred to as complicated rather than complex. We would argue that this classification is influenced by familiarity with the project type and that the dividing line between what can be considered as simply complicated and what can be thought of as complex is very unclear. The complexity in these projects stems from the difficulty in managing and keeping track of the huge number of different interconnected tasks and activities. This kind of complexity is commonly associated with large construction, engineering and defence projects. To manage these projects, outcomes are decomposed into many small deliverables which can be managed as discreet units. The underlying assumption is that the individual units, when delivered, will come together to make the required whole. The major challenges come from project organization, scheduling, interdependencies and contract management.

Structural complexity and its implications for managing projects in which it occurs will be discussed in more detail in Chapter 3.

**TECHNICAL COMPLEXITY**

This type of complexity is found in projects which have technical or design problems associated with products that have never been produced before, or with techniques that are unknown or untried and for which there are no precedents. Here the complexity stems from interconnection between multiple interdependent solution options. It is commonly encountered in architectural, industrial design, engineering, explorative IT projects and R & D projects, such as those found in the chemical and pharmaceutical industries. The project management challenges are usually associated with managing the critical design phases, managing contracts to deliver solutions to ill-defined design and technical problems and managing the expectations of key stakeholders.

Technical complexity and its implications for managing projects in which it occurs will be discussed in more detail in Chapter 4.

**DIRECTIONAL COMPLEXITY**

Directional complexity is found in projects which are characterised by unshared goals and goal paths, unclear meanings and hidden agendas. This kind of complexity stems from ambiguity related to multiple potential interpretations of goals and objectives. The management challenges tend to be associated with the allocation of adequate time during project definition (initiation of the project) to allow for sharing of meanings and revelation of hidden agendas. Managing relationships and organisational politics often become the keys to success. Political awareness and cultural sensitivity are two fundamental capabilities needed to manage these projects successfully.
Directional complexity and its implications for managing projects in which it occurs will be discussed in more detail in Chapter 5.

TEMPORAL COMPLEXITY

These projects are characterised by shifting environmental and strategic directions which are generally outside the direct control of the project team. This kind of complexity stems from uncertainty regarding future constraints, the expectation of change and possibly even concern regarding the future existence of the system. Temporal complexity can be found in projects which are subjected to unanticipated environmental impacts significant enough to seriously destabilise the project, such as rapid and unexpected legislative changes, civil unrest and catastrophes, or the development of new technologies. Often associated with this kind of complexity are paranoia and anticipation on the part of the personnel within the organisation. Changes of government can create this climate within the public sector, while a similar effect can be found in the private sector during periods of mergers and acquisitions and projects which have very long durations. This kind of complexity relates to change in external influences over time that may happen at any time during the project life cycle. Temporal complexity can be found in apparently straightforward projects, particularly those of long duration where delays due to external factors, such as monopolies on supply of vital goods or services, can occur at any time during the project life cycle.

Temporal complexity and its implications for managing projects in which it occurs will be discussed in more detail in Chapter 6.

Each one of these types of project complexity exhibits characteristics found in a complex adaptive system. Any project or programme of projects can exhibit one or more of these types of complexity.

Patterns of thinking about project management

Thinking and research in project management have emphasized structurally complicated projects. Therefore many project management techniques can be adapted to the needs of structural complexity. However, these approaches, and the broad patterns of thought which have spawned them, do not always translate effectively to the needs of technical, directional or temporal complexity. In order to address these radically different requirements, it has been necessary to do more than just extend the current thinking in project management by tweaking existing tools. What we have done is appeal to a wide range of thinking, starting with Complexity Theory and systems thinking, but also extending to include design theory, cognitive and behavioural psychology and various aspects of organisation theory.

COMPLEXITY IN COMBINATION

The bigger the project or programme the more likely it is to exhibit all four types of complexity, albeit in varying degrees.

For example, an international telecommunications company initiated an organisational change project involving the introduction of new, company-wide human resource management processes. The initiative had been stimulated by a perceived need to restructure and consolidate some departments. The organisation was also dealing with a volatile legislative environment which had different impacts in different countries. This kind of initiative exhibited elements
What is a Complex Project?

of structural, technical, directional and temporal complexity. The structural complexity came from the sheer size of the programme and the number of component parts and dependencies. The technical complexity was related to the design and implementation of a new IT system and its integration with the huge variety of existing processes. The directional complexity was derived from the lack of shared understanding amongst key departments within the global organisation of the project objectives and lack of agreement on how to proceed. Temporal complexity came from difficulties in anticipating and responding to the frequent changes in legislation due to a volatile, international, political environment. Different management approaches were needed to deal with each of the types of complexity.

However not all parts of a project or programme will necessarily exhibit complexity. Some parts of the telecommunications initiative described above were able to be rolled out as relatively standard discreet projects. These individual project elements within the programme were fully understood by key stakeholders, they were able to be thoroughly defined with very clear objectives and they involved standard technologies. Therefore they could be successfully managed by project managers using standard project management tools and processes.

This is an example of how systemic pluralism works in practice. The whole programme is viewed as a system with various sub-systems. Those sub-systems or parts that do not exhibit characteristics of a complex adaptive system may be more suited to hard systems approaches to management and may be successfully managed using standard project management procedures. However other sub-systems might require different approaches (see Turner and Cochrane, 1993; Shenhar, 2001; Payne and Turner, 1999; Engwall et al., 2005).

More useful concepts from complexity theory

ORDER TO CHAOS – A CONTINUUM

At this point it is useful to mention the continuum that exists between order and chaos. Fully ordered systems are not complex. They obey very tight, stable sets of rules and lack the ability to adapt to environmental change. Similarly, a chaotic system is not complex either. Neither is it random. Completely chaotic systems may appear to be random but the actions of individual parts within the system are predictable at a local level. Chaotic systems lack the stable relationships and patterns of interaction between parts which allow for emergent properties. Chaotic systems also do not react as a whole in response to environmental change. They lack internal coherence (see Stacey, 1991; Griffin et al., 1999 and Lissack and Roos, 1999).

All complex systems exist somewhere between order and chaos. More ordered complex systems tend to be highly efficient in relation to a limited range of functions. As a consequence of this level of specialisation their propensity for adaptation is lower. The area of focus in an ordered complex system is very tight and it may only be open to very specific information from the environment. Systems tending more towards chaos are open to a wider range of information from the environment and are able to explore multiple options and aspects of the environment at any one time. This is because while the system maintains cohesion, different sub-systems may be engaged in very different functions. As a consequence there is less efficiency through economy of scale, repetition and specialisation of tasks. Complex systems closer to chaos also face a greater danger of losing coherence and breaking up, and ceasing to be systems.
A metaphor for the difference between order and chaos can be seen in the changes in city planning policy which occurred during the sixteenth and seventeenth centuries in Europe. Prior to this time mediaeval cities had grown up in organic, apparently haphazard configurations of buildings and thoroughfares. Inspired by publications such as Antonio Filareti’s *Trattato di architettura* (‘Treatise on Architecture’) of 1465, the Renaissance brought a desire to plan cities based on ideal models. The careful geometry of the Renaissance city plan permitted no building to take place outside the idealized geometry of the city boundary wall and city functions were carefully segregated within. Mediaeval towns by contrast grew as the population increased, and evolved organically over time in response to topography and available resources and social needs. However, judging by the political turmoil that characterised the Renaissance, social order did not necessarily follow the imposition of architectural order. When built, these geometrically perfect cities, planned with wide streets radiating from a symbolic centre, were easier to defend in times of attack. Nevertheless the populations soon outgrew them and the cities expanded, often in a chaotic manner beyond the walls.

We should expect that any large project or programme will attract very different approaches to management depending upon the various levels of order and chaos within the project and within the larger systems of which it is also a part – the organisation and the environment (Turner and Cochrane, 1993; Shenhar, 2001; Payne and Turner, 1999; Engwall et al., 2005). The key is to identify those parts of the project which exhibit characteristics of complex adaptive systems so that they can be handled differently from simpler parts of the project. Simpler parts or projects which have clear, shared objectives, use standard technologies and are able to be delivered over relatively short time spans will be more effectively handled using standard project management control processes.

**FITNESS LANDSCAPES**

Complexity theorists talk about the concept of fitness landscapes. Imagine a rugged landscape with rolling hills. Within that landscape your fitness is measured by your height relative to others’ positions in the landscape. This can be thought of as having a better view. If you find yourself on a slope the tendency is to move up the hill if you want to improve your view and therefore your fitness. Once you reach a relatively high level of fitness, a local peak, you tend to stay there because leaving that peak, even to get to another higher nearby peak means becoming less fit during your progress to the higher peak. You have to travel through valleys to get to the second, more advantageous position, a process which might take considerable time. There may be little incentive to leave your local peak or position of advantage, especially if you cannot see any higher peaks nearby (see Griffin et al., 1999 and Lissack and Roos, 1999).

Being on the current peak may not necessarily be the optimum level of operation or the fittest position in the landscape. It may simply be a level sufficient to sustain activity. We often see this kind of adaptiveness in projects, particularly those involving technical innovation or design components. There is a point at which the design phase must come to a close so that something can be delivered. Enough of the needs of the key stakeholders are met and the urgency to deliver the product outweighs the need to make further refinement to ‘perfect’ the design. The local peak may be good enough to meet client needs. There may be no point striving for a better solution, moving to another peak, and there may possibly even be some level of risk as the situation may have changed by the time you get there.

A fitness landscape is not static. The landscape surrounding a complex adaptive system, such as a large organisation, might best be thought of as a moving sea, or shifting sand dunes in a desert. It changes over time. It also changes in response to your movement within it.
What is a Complex Project?

You are in and also part of the landscape, changing it for yourself and for others who may share the landscape with you. Movement in the fitness landscape can cause risks, particularly if what was once a local peak changes over time to become a valley. This can become even more problematic if your position within the landscape does not change. Therefore there can be great advantage in being aware of the need to take as many positions and viewpoints as possible and having the skills to do so.

EDGE OF CHAOS

The edge of chaos is a theoretical point between order and chaos (see Crutchfield and Young, 1990; Beinhoffer, 1997). When a system is at the edge of chaos it is in a poised state, able to readily react to environmental change. It is a state close to chaos, but just before the system starts to break down into truly chaotic behaviour. At the edge of chaos the system gets the benefits of a high level of creativity and diffuse sensitivity to the environment, whilst maintaining sufficient coherence and internal consistency to survive. For an organisation delivering part or all of its business by projects, the edge of chaos occurs at a point that permits maximum use of information both internally and from the environment (see Stacey, 1996; Griffin et al., 1999).

Where the edge of chaos is for a system will vary. It partly depends upon how rugged the fitness landscape is at that particular time. For instance you can be quite ordered while moving towards greater fitness in a relatively flat environment. You can see a long distance when on a hill surrounded by plains. In such a situation you may be able to move reasonably safely across a flat landscape to the next high vantage point. You can focus on control and efficiency as the situation is well structured and clear. On the other hand, in a rugged environment where observation is obscured by other hills or valleys, less order and consequent wider boundaries will be useful in noticing and moving towards points of greater fitness. In this kind of landscape you would be wise to send out investigating expeditions to get a sense not only of the actual lie of the land but also what surprises it may hold behind the hills and ridges where you cannot see.

Where the edge of chaos occurs for any project at any one time depends on the context and will move in relation to changes in context. For instance, for a very well-defined project the edge of chaos will be very close to order. Because the project is in a stable and well-defined context it is possible and useful to apply traditional techniques, such as decomposition of work and specialisation, defined by clear objectives. There is less need to be exploratory. In a project characterised by turbulence and lack of clarity the edge of chaos may be more towards chaos. This is because the project team needs to have greater awareness of the environment and may need to trial multiple options. Specialisation might not be a possibility until the context is more stable.

Summary

This chapter discussed the following concepts:

**Systemic pluralism**  Managing within complex environments requires the ability to observe systems from many different perspectives and to apply a range of tools and methodologies to suit the needs of the situation at that time.

**Types of complexity**  Based on the source of complexity, four different types of complexity have been identified, each exhibiting distinctly different characteristics, and presenting different management challenges.
Tools for Complex Projects

Complexity types in combination  All large projects and many smaller ones can exhibit more than one type of complexity. It must also be recognised that complex projects may also have aspects that are straightforward. These are most efficiently managed using standard project management processes.

Order to chaos – a continuum  There exists in any system a continuum between order and chaos. Complex systems will exhibit a varying degree of order and chaos. Neither a fully ordered nor a fully chaotic system is complex.

Fitness landscapes  This is a concept used by complexity theorists to describe different positions of advantage in a system. The concept uses the idea of peaks and valleys which are not static but move over time. Being higher on the landscape implies greater fitness, but it is not always worthwhile trying to reach a higher peak. You may have to walk through many valleys of lower fitness to get there.

Edge of chaos  This is another concept developed by complexity theorists. It is a point between order and chaos where the system gets the benefit of some level of chaos and the resulting creativity whilst the system still has enough order to survive, maintain coherence and specialisation in some functions.

In the chapters to follow

The book is divided into two parts. Part I will explore the special conditions characterising each of the four types of project complexity summarised above and issues related to managing complex projects in organisational settings. Part II will describe a series of tools and techniques influenced by and developed from complexity theory, design theory, soft systems thinking, behavioural psychology and adult education theory which can be used to help unravel and manage the various types of complexity.

References and further reading


McKelvey, B. (1999), ‘Complexity Theory in Organization Science: Seizing the Promise or Becoming a Fad?’, *Emergence* 1:1, 5-32.


