Complication, complexity and uncertainty in the program/project context

By Alan Stretton

INTRODUCTION

In an article in the last issue of this journal (Stretton 2017b) I was concerned with sources of complexity in the program/ project context. I broadly compared sources of complexity from eight different contributors, and attempted to align them under some broad categories, to come up with a draft basic checklist of such sources.

In the course of assembling that article, I came across three authors who made a sharp distinction between program/project complexity on the one hand, and complication on the other. This distinction appeared to me to be rather important when it comes to assessing the relevance of "traditional" project management standards to the management of complex projects. In following this up, a few associated connections emerged which I also found interesting, as will be recounted.

This rather exploratory article first discusses the above distinction, and a complication arising there-from. After noting how several authors relate complexity with uncertainty, we go on discuss some causal elements and management issues relating to program/project uncertainty, and thence, albeit indirectly, to complexity.

PROGRAM/PROJECT COMPLICATION, COMPLEXITY AND UNCERTAINTY

Distinguishing between complication and complexity

It is first noted that the two dictionaries consulted, namely *The New Shorter Oxford English Dictionary*, and *The Macquarie Concise Dictionary*, do not appear to make any real distinction between complication and complexity. However, some writers on project management have found it useful to make such a distinction in the project/ program context, and we will now look at three of these.

Cooke-Davies 2016:263 has made the following distinction between complexity and complication in the context of programs.

> It's worth distinguishing between 'complex' and 'complicated'. Something can be said to be complicated if it is composed of many interconnected and interrelated parts. Complexity, on the other hand, is related not only to the number of moving parts and how they relate to each other, but also the predictability of each part (and thus of the ability of the pieces to be melded together in ways that are foreseeable).

It is first noted that Cooke-Davies definition of *complicated* corresponds with the two dictionary's definitions of both *complicated* and *complex*. Second, if I am interpreting the above quotation correctly, Cooke-Davies is saying that program complexity typically has associated elements of uncertainty.

Hayes 2016 also makes a distinction between complication and complexity. He says that Australia's CSIRO identifies two properties that set a complex system apart from one that is merely complicated, as follows:

- emergence – the appearance of behaviour that could not be anticipated from a knowledge of the parts of the system alone;
- self-organization – where no external controller or planner is engineering the appearance of the emergent features

As defined here, emergence also appears to have the element of uncertainty – here associated with complex systems, and thence with complex programs/projects.

Parth 2016 also distinguishes between the two when he says that "Complexity is more than just being complicated". He goes on to list seven sources of complexity (which have previously been listed in Stretton 2017b, Figure 7). Most of these sources of complexity have obvious and significant elements of uncertainty.

Parth's listing was one of eight listings shown in Stretton 2017b, which in total covered some eighty sources of complexity. Most of these have significant, but varying, elements of uncertainty.

I will return to the topics of complexity and uncertainty shortly. Focusing for the moment on the difference between complication and complexity, the above three authors make a clear distinction between the two. However, this distinction is not necessarily as straight-forward as it might appear. Prieto 2015 says that such a distinction becomes invalid with very large programs/projects, as now discussed.

Effects of scale on complication in relation to complexity

Prieto 2015, Chapter 2 discusses "gigaprograms", which encompass programs/ projects with constructed values in excess of $10 billion. In his words,

> I have chosen this subset of projects since I believe that many of the particular challenges we see at this scale and level of complexity exist more broadly in large complex projects but are perhaps not as easily seen.

Prieto then goes on to discuss differences between giga-programs and what he calls traditional projects. He says (his emphasis),

> There is a tendency to think of the essential difference between megaprojects and more traditional sized projects as one of scale. If only it were that simple. A better analogy, and something we see more clearly in the world of programs, is that this scaling up in size has the concomitant **effect of "unfolding" unseen dimensions** that were likely always there but whose effects were not readily noticeable.

Prieto goes on to discuss six of these unseen dimensions, including the following:

- [They] drive us to a level of complexity where the scaling of the activities is dramatically outweighed by the scaling of the possible network connections and effects that are created.

This would appear to be confirmed in a slightly indirect way by Shimizu 2016:

> Complexities and ambiguities derived from the complicated relationships among the elements relating to the programme are the main cause of negative uncertainties.

Thus, it appears that, as we move from smaller projects through mega-projects and into giga-programs, we move away from Cooke-Davies' perception of "many interconnected and interrelated parts" being seen as a complication, to its becoming a distinctive form of complexity in its own right.

The distinction between complication and complexity has some relevance when we come to look at the applicability of traditional project management tools to these two types of programs/projects, as now discussed.

Complication, complexity, and program/project management standards

Cooke-Davies 2016:263 makes the following distinction about the utility of project management standards to complicated and complex projects.

> Traditional project management tools such as the work breakdown structure (WBS) are excellent for complicated projects but, on their own, are inadequate for complexity.

This seems to me to clarify a problem I have encountered from time to time, which is that colleagues have argued that traditional approaches have, in fact, worked well for many complex projects. This may well be so, but I suspect that they have really been talking about complicated projects, rather than about complex projects in the sense identified above.

With regard to the latter, Hayes 2016 says,

> When dealing with complex programmes, the reality is that, while they remain important, traditional project management methods and tools are not sufficient.

Bob Prieto has long been concerned with large complex projects, and has published extensively in this journal on this topic. In his recent book "Theory of management of large complex projects" (Prieto 2015:119) he says (his emphasis),

> Large complex projects differ from those that comprise the traditional domain of projects as defined and served by the Project Management Institute and its Project Management Body of Knowledge (PMBOK). Remember its admonishment that PMBOK provides a management framework for ***most projects, most of the time.*** Large complex project appear to live outside these boundary conditions.

There appears to be wide-spread agreement with the position of Prieto and Hayes that traditional project management standards, guidelines, and tools and techniques, are quite simply inadequate for complex programs/projects, particularly large ones.

Relationships between program/project complexity and uncertainty

We saw earlier that Cooke-Davies 2016, Hayes 2016 and Parth 2016 associated program/project complexity with uncertainties of various kinds. It was also observed that most of the eighty-odd sources of complexity identified in Stretton 2017b had elements of uncertainty of many types.

That is not to suggest that complexity is always associated with uncertainty. For example, Wagner & Lock 2016:7 say, "Team dynamics and conflicts are perceived as complexities that project or programme managers need to deal with". Perhaps these could also be seen as having elements of uncertainty, but they are very indirect. However, many, if not most, sources of complexity do have somewhat more direct links with uncertainty, and we go on to look at the latter in more detail.

Causal elements of uncertainty, and the program life cycle

Shimizu 2016 identifies the following causal elements of uncertainty, and categorised them under six main categories, as shown in Figure 1 below. These are also broadly associated with phases of a program life cycle, as shown on the left.

Phases of the PLC	Major categories and causal elements of uncertainty
Mission definition	**Programme goals** (multiple meaning or ambiguity of objectives, programme complexity) • Inappropriate goals, insufficient clarification • Goals too ambitious
Scenario development	**Complexity and change of environments** (market, economic environment, and so on) • Uncertainties of market size, growth rate and so forth • Complexity (interaction of products, market and technical innovations) • Rapid change in market and environment • Product lifecycle
Programme design	**Intention of competitors or collaborators** • Porters five forces from competitors *[Shimizu does not describe these]* • Disruptive innovation • Opportunism of collaborators (hold up problem)
	Deficiencies of organizational capabilities • Planning and design
Execution phase	**Uncertainties in execution process** (deficiency of capabilities and resources, mis-estimation, incidental events) • Human resources (such as engineering or management capabilities) • Physical resources (such as facilities or materials) • Limit of predictive capability • Bankruptcy of collaborator
	Unexpected cataclysmic incidents (cataclysmic change of external environment) • Economic crisis, international conflicts • Huge natural disasters, accidents

Figure 1: Adapted from Shimizu 2016, Figs 31.2, 31.3 – Major causal elements of uncertainty

Although he does not say so directly, Shimizu is evidently concerned with manufacturing (or similar) organisations which operate in very competitive market/technical environments. Three of Shimizu's six broad categories are directly concerned with causal elements external to the program. Two are concerned with internal causal elements, whilst the first category could be seen as a mixture of both.

Uncertainty management issues, and the project life cycle

Atkinson et al 2006 also looked at uncertainty issues, in their case in the context of a project life cycle. Although not a program, the project life cycle they use is a very extended one, starting with conception, and going right through to post-delivery support. They have a multitude of relevant uncertainty management issues, as shown in Figure 2.

Stages of the PLC	Uncertainty management issues
Conceive the product	Level of definition Definition of appropriate performance objectives Managing stakeholder expectations
Design the product strategically	Novelty of design and technology Determining 'fixed' points in the design Control of changes
Plan the execution strategically	Identifying and allowing for regulatory constraints Concurrency of activities required Capturing dependency relationships Errors and omissions
Allocate resources tactically	Adequate accuracy of resource estimates Estimating resources required Defining responsibilities (number and scope of contracts) Defining contractual terms and conditions Selection of capable participants (tendering procedures and bid
Execute production	Exercising adequate coordination and control Determining the level and scope control systems Ensuring effective communications between participants Provision of appropriated organisational arrangements Ensuring effective leadership Ensuring continuity in personnel and responsibilities Responding effectively to sources which are realised
Deliver the product	Adequate testing Adequate training Managing stakeholder expectations Obtaining licences to operate
Review the process	Capturing corporate knowledge Learning key lessons Understanding what success means
Support the product	Provision of appropriate organisation arrangements Identifying extent of liabilities Managing stakeholder expectations

Figure 2: Adapted from Atkinson et al 2006 – Typical uncertainty mgt. issues in PLC stages

It can be seen that Atkinson et al are mainly concerned with internal uncertainty management issues, to which they have given quite detailed coverage.

It should also be noted at this point that Atkinson et al are not specifically concerned with projects that are complex. However, because there are often connections between uncertainty and complexity, I thought their contribution might also be seen to be relevant in a broader context.

Atkinson et al 2006 also identified two other broad sources of uncertainty, as follows.

Uncertainty in estimates

Atkinson et al say that the causes of uncertainty about estimates include:

- Lack of a clear specification of what is required
- Novelty, or lack of experience of this particular activity
- Complexity in terms of the number of influencing factors and associated inter-dependencies
- Limited analysis of the processes involved in the activity
- Possible occurrence of particular events or conditions that might affect the activity
- Bias exhibited by estimators, typically optimism bias

Uncertainty associated with project parties

Atkinson et al say that this type of uncertainty arises from several factors associated with each project party, including

- Uncertainty about the level of performance that will be achieved
- The objectives and motivations of each party
- The quality and reliability of the work undertaken
- The extent to which each party's objectives are aligned with the owner's objectives, and the scope for moral hazard where one party is motivated to do things which are not in the best interests of the project owner
- The actual abilities of the party
- Availability of the party

Once again, it is emphasized that Atkinson et al were concerned with uncertainty in a broad project context, which is not necessarily related to complexity. But these sources of uncertainty, or at least some of them, may also be relevant to complex programs/ projects.

Discussion on uncertainty listings

The above causal elements of uncertainty and associated management issues in the program/project context undoubtedly cover only some of the possible uncertainties. However, a combination of the listings from Shimizu and Atkinson et al should provide a useful starting checklist, and perhaps a basis for developing more comprehensive checklists of program/project uncertainty factors.

There is an association of uncertainty with risks and risk management. Wagner & Lock 2016:11 made the following observation.

> Risks and uncertainties are inherent characteristics of programmes. Risks (and opportunities) are something we can predict; we can estimate the probability and the impact based on previous experiences.

This appears to me to imply that there are certain types of uncertainty that are too unpredictable to be covered by risk management. I have had only limited experience in either area, so would be interested to know if more knowledgeable people could confirm or deny this implication.

SUMMARY

This article first discussed differences identified by three authors between complication and complexity in the program/project context. Complication was associated with programs/projects having many interconnected and interrelated parts. Complexity added an element of uncertainty about the predictability of certain factors, which could be either internal, or external, to the program/project.

It then noted that on giga-programs (and probably many mega-projects) complication can become complexity in its own right, because of practically exponential increases in numbers of possible interconnections. However, on programs/projects of lesser scale it appears that traditional project management tools can still work well on complicated programs/projects – but not so well on complex programs/projects, with their elements of uncertainty.

Returning to complex programs/projects and uncertainty issues, we focused on the latter. Shimizu identified some sixteen major causal elements of uncertainty in programs, which he categorised into six categories. Three of these were causes external to the program, two categories were internal, and one included both. These were broadly related to phases of a program life cycle.

We then looked at Atkinson et al 2006, who identified some thirty-two typical uncertainty management issues, which they related to eight phases/stages of an extended project life cycle. These were mainly issues internal to the project, and are much more detailed than Shimizu's internal causal elements.

Atkinson et al also listed six elements of uncertainty in relation to estimates, and six issues about uncertainties associated with project parties.

Although Atkinson et al were not specifically concerned with complexity, it appeared to me that their representations could be seen as complementary to Shimizu's, and that, in combination, they could provide quite a substantial checklist of sources of uncertainty as they relate to programs/projects.

REFERENCES

APM (Association for Project Management) (2012). *APM Body of Knowledge.* 6th Edition. High Wycombe, UK; Association for Project Management.

ATKINSON, Roger, Lynn CRAWFORD & Stephen WARD (2006). Fundamental uncertainties in projects and the scope of project management. *International Journal of Project Management,* Vol 24, pp 687-698.

COOKE-DAVIES Terry (2016). Managing strategic initiatives . In the *Gower Handbook of Programme Management,* 2nd Edition, Eds Dennis Lock and Reinhard Wagner. Chapter 18, pp 259-267.

HAYES, Stephen (2016). Managing complexity in programmes. . In the *Gower Handbook of Programme Management,* 2nd Edition, Eds Dennis Lock and Reinhard Wagner. Chapter 30, pp 444-458.

PARTH, Frank R (2016). Successful program delivery starts long before the program does. *PM World Journal,* Vol. V, Issues VII, VIII, IX, July, August, September.

PMI (PROJECT MANAGEMENT INSTITUTE) (2013). *A Guide to the Project Management Body of Knowledge.* 5th Edition, Newtown Square, PA; Project Management Institute

PRIETO, Bob (2015). *Theory of management of large complex projects.* E-book published by Construction Management Association of America (CMAA)

SHIMIZU, Motoh (2016). Managing uncertainties in programmes. . In the *Gower Handbook of Programme Management,* 2nd Edition, Eds Dennis Lock and Reinhard Wagner. Chapter 31, pp 459-472.

STRETTON Alan (2017b). Some sources of complexity in programs/projects. *PM World Journal*, Vol VI, Issue II, February.

WAGNER Reinhard & Dennis LOCK (2016). Introduction to programme management. In the *Gower Handbook of Programme Management,* 2nd Edition, Eds Dennis Lock and Reinhard Wagner. Chapter 1, pp 3-17.

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