Series on project contexts

4. Context of project dimensions[1]

By Alan Stretton

INTRODUCTION

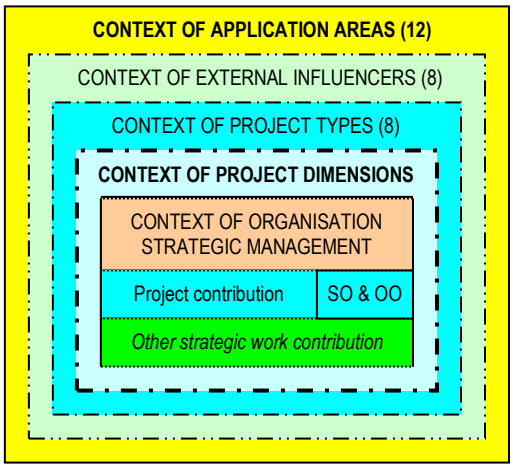

Figure 1: Outline project context model

This is the fourth of a series of seven articles which identify and discuss a variety of key contexts which impact on the management of projects. The basic reason for developing this series is that there is far too little attention given to the contexts of projects in the relevant literature – particularly when you consider that, in practice, effective management of projects' contexts is usually quite critical to achieving overall project management (PM) success.

The first article of this series (Stretton 2019e) identified six key types of project contexts. These were summarised pictorially into a combined model, depicted in skeleton format in Figure 1 to the left.

The second article of this series (Stretton 2019f) was concerned with the context of organisational strategic management, and the third (Stretton 2019g) with the contexts of projects being undertaken by supplier organisations (SOs), and by owner organisations (OOs). This fourth article is concerned with the context of what Shenhar & Dvir 2007 describe as project dimensions. Its place in Figure 1 is illustrated by bolder typeface and a heavier outer border.

RECAPPING DISCUSSIONS OF THE CONTEXT OF PROJECT DIMENSIONS IN THE FIRST ARTICLE

I discussed aspects of this context in Stretton 2019e, under the following headings.

The NTCP model of Shenhar and associates

NTCP is shorthand for what Shenhar and colleagues describe as the four project "dimensions" of Novelty, Technology, Complexity, and Pace. In Shenhar et al 2016 these are described as follows.

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NOVELTY: *Market Innovation* – How new is the product to the market, users, and customers.

TECHNOLOGY: *Technological Innovation* – How much new technology is used

COMPLEXITY: *Level of System Innovation* – Represented by the complexity of the product or the organization.

PACE: *Urgency of the Innovation* – How critical is your time frame.

In the last version of the NTCP model that I know of (Shenhar et al 2016), each of the four dimensions has four levels, as indicated in Figure 6. The heavily outlined diamond illustrates a project with rather low levels of each of the Novelty, Technology, Complexity and Pace dimensions.

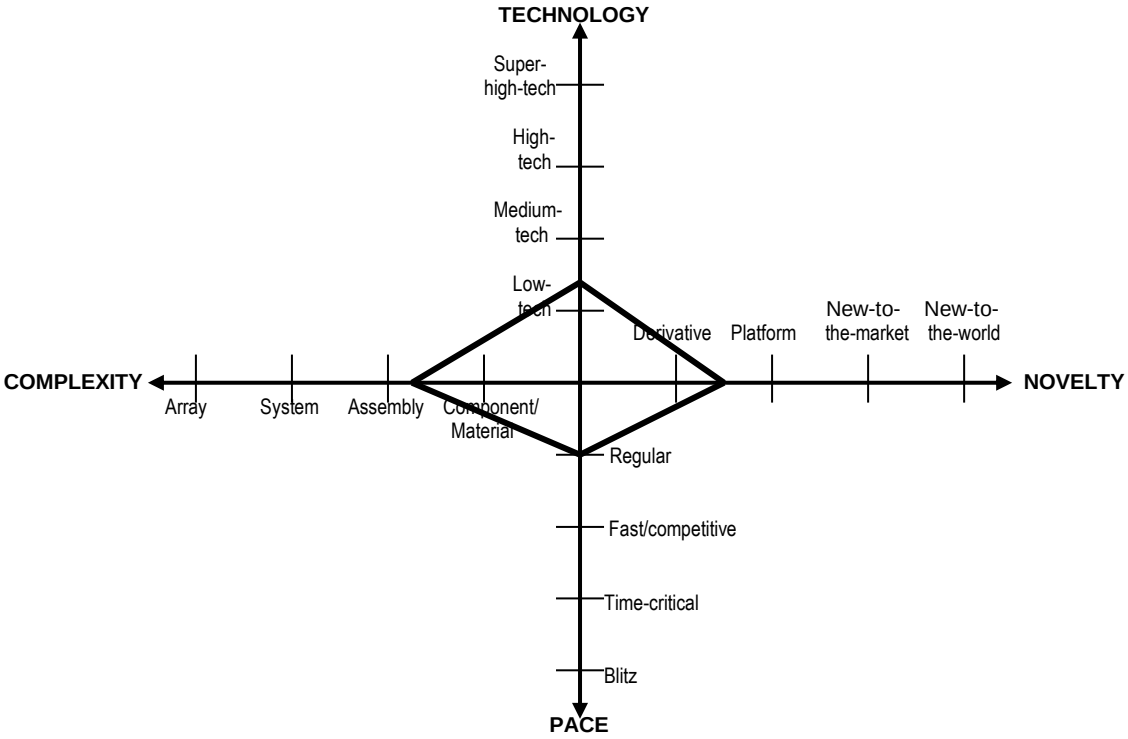

Figure 2: The NTCP model, adapted from Shenhar at al 2016

Most of the descriptors of the four levels of the Technology and Pace dimensions are reasonably self- explanatory. In the Novelty dimension, the descriptor *Derivative* denotes improvement in an existing product, and *Platform* a new generation on an existing product line.

For the Complexity dimension, the descriptors of each level are as follows.

- *Component/Material:* The product is a discrete component within a larger product, or a material
- *Assembly:* Subsystem performing a single function (e.g. CD player, cordless phone)
- *System:* Collection of subsystems, multiple functions (e.g. aircraft, car, computer)
- *Array:* Widely dispersed collection of systems with a common mission (e.g. city transit system, air traffic control, Internet)

Guidelines for managing "non-traditional" dimensions of projects

We went on to record that Shenhar & Dvir 2007 have two major groups of tables which discuss the impact of each of the various levels of each of their *dimensions* on rather a wide range of project management characteristics. In particular, one group of four tables in the Appendices shows each level of each of the four dimensions, and indicates how these can affect the traditional processes of project management characterised by the (then) nine major PMBOK Guide knowledge areas (PMI 2004). The format of these four tables was then illustrated as follows. (I have extended the original to include all nine PMBOK knowledge areas nominated at the time – a *Stakeholder* knowledge area has since been added. Also, Shenhar and colleagues have since added the two levels, shown by the numbers in square brackets below.

DIMENSIONS & Levels / PMBOK Knowledge Areas	NOVELTY	TECHNOLOGY	COMPLEXITY	PACE
	Levels: 1; 2; 3; [4]	Levels: 1; 2; 3; 4	Levels: [1]; 2; 3; 4	Levels: 1; 2; 3; 4
Integration				
Scope				
Time				
Cost				
Quality				
Human resources				
Communications				
Risk				
Procurement				

Figure 3: Format of Shenhar & Dvir 2007 tables in Appendices 4, 5B, 6B, and 7

We will look further at an example of how one of the knowledge areas is described by the authors at the end of this recap.

Additionally, it was noted that each of the four NTCP dimensions also has a separate table which summarises the impact of its various levels on other project management processes that are particularly relevant to that individual dimension. We will also look at an example of this group of tables shortly.

In the meantime, we continue our recap of the relevant materials in the first article.

Combining the previous two contexts with that of the project dimensions

Figure 4 shows how I superimposed the abbreviated combined organisational strategic management and SO & OO contexts discussed earlier onto the approximate position of the diamond in Figure 2, to illustrate how this combination of contexts might look.

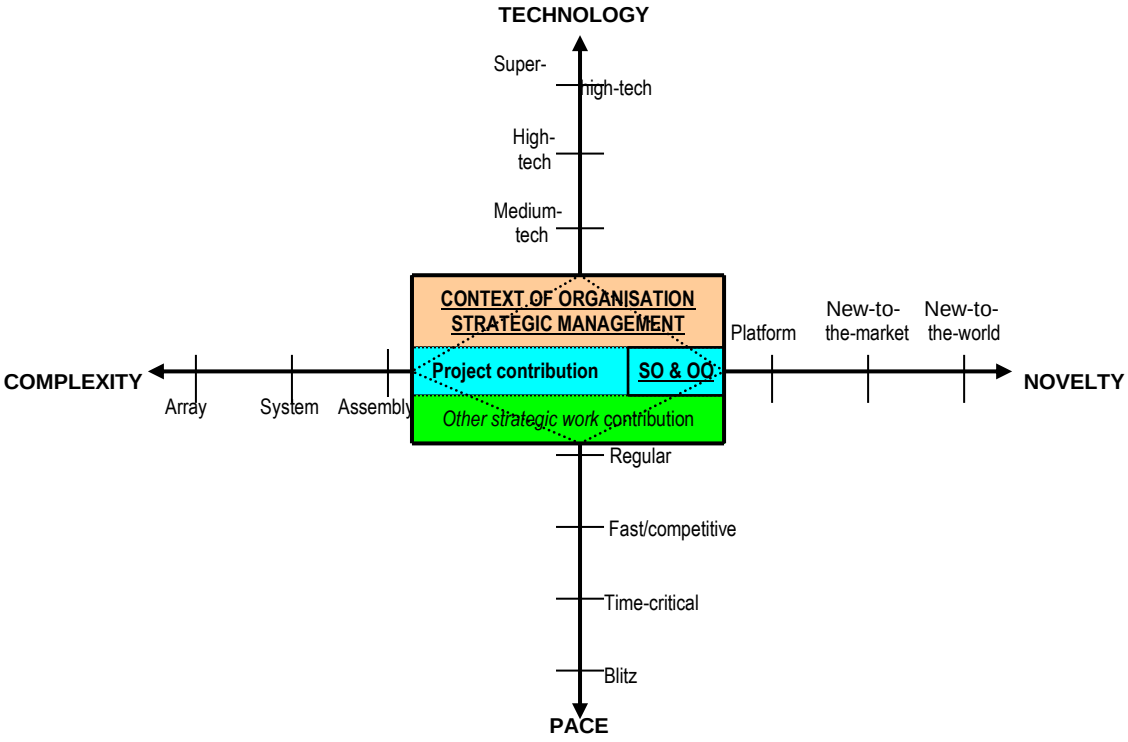

Figure 4: Superimposing the combined organisational strategic and the SO & OO contexts in the approximate position of the diamond on the NTCP model of Figure 2

We then went on to compact this notional pictorial representation of the combination of the three project contexts discussed to date into the abbreviated formal shown in Figure 5 below, to facilitate pictorial additions of other contexts.

Compacting the combined contexts

Figure 5 compacts Figure 4 into a skeleton format, as follows.

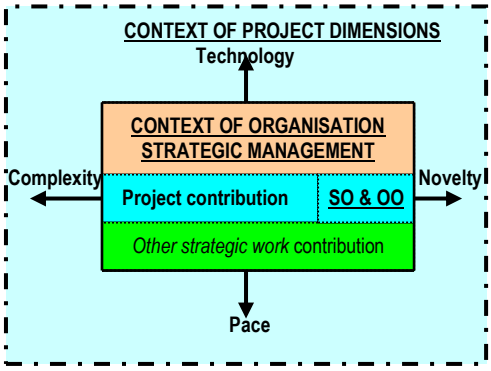

Figure 5: Compacting the three combined contexts to date into skeleton format

We now move on to discuss the context of the NTCP dimensions in more detail.

FURTHER NOTES ON THE CONTEXT OF THE NTCP DIMENSIONS & LEVELS

Management guidelines related to the PMBOK knowledge areas

I do not have permission to reproduce full contents of tables from Shenhar & Dvir 2007. However, we can give an indication of how Shenhar & Dvir depict changes in the recommended ways of managing the various PMBOK Guide knowledge areas as we move from the more "traditional" lower levels to the "non-traditional" higher levels. Figure 6 below shows a skeleton of the relevant table for the technology dimension (Appendix 5B, Table 4) and gives an example which indicates the nature of the progressive guidelines they developed – in this case relating to the scope knowledge area (my bullet points).

DIMENSIONS & Levels / PMBOK Knowledge Areas	DIMENSION: Technology			
	Level: Low-tech	**Level:** Medium-tech	**Level:** High-tech	**Level:** Super-hi-tech
Integration				
Scope	• Tight scope control from project initiation • Allow only changes requested and approved by customer	• Allow changes only before design freeze • Tight scope control after design freeze	• Define top-down work from scratch • Allow more time for design cycles • Tight scope control after design freeze to ensure product integrity	• Flexible scope management to enable changes based on technological feasibility and prototype testing
Time				
Cost				
Quality				
Human resources				

Figure 6: The format of Appendix 5B, Table 4, Shenhar & Dvir 2007, with details re project scope

In this figure I have not coloured the Low-tech segment, to indicate that this level is more in the domain of "traditional" practices (although the latter could be seen as extending into the Medium-tech segment as well).

This series of four tables with management guidelines for each PMBOK knowledge area, for each level of each dimension, comprises well over a hundred individual guidelines, with more than two thirds of these relating to "non-traditional" contexts.

Other management-related guidelines in Shenhar & Dvir 2007

It was noted earlier that each of the four NTCP dimensions also has a separate table which summarises the impact of its various levels on other project management processes that are particularly relevant to that individual dimension.

The broad format of this type of table for the technology dimension is shown in Figure 7, together with an example of the type of guidelines developed by the authors, in this case relating to appropriate management styles and attitudes.

DIMENSION: Technology				
Project Type / Variable	**Level:** Low-tech	**Level:** Medium-tech	**Level:** High-tech	**Level:** Super-hi-tech
Development, testing, and prototypes				
Design cycles and design freeze				
Project reviews				
Management style and attitude	• Firm style • Sticking to the initial plan	• Less firm style • Readiness to accept some changes	• More flexible style • Many changes are. expected	• Highly flexible style • Living with continuous change • "Looking for trouble"
Communication and interaction				
Project manager and project team				

Figure 7: Basic format of part of Table 5-3, Shenhar & Dvir 2007, with details re mgt. styles

There are broadly similar tables with management-related guidelines for the other three dimensions – namely Table 4-3 for the Novelty dimension, Table 6-3 for Complexity, and Table 7-2 for Pace. These add substantially to the above guidelines associated with the PMBOK knowledge areas.

There are also several other management-related tables and guidelines in Shenhar & Dvir. For example, there is Table 4-2: *Project Novelty and project success: What to expect,* which has a corresponding Table 5-2 for the Technology dimension. There are also some broader-based tables, such as Table 9-2: *The impact of project type on project management,* and Table 10-1: *Characteristics of projects for various customers*.

All in all, something of the order of two hundred guidelines emerge from the above, and at least two thirds of these are concerned with the management of "non-traditional" contextual items – i.e. items that are not covered in bodies of knowledge of project management, and similar documents. Combined, these constitute a treasure-trove of guidelines over and above those already existing for more traditional domains.

However, we have not yet explicitly discussed one of the key topics in Shenhar & Dvir's book, namely what is described in its title as the "diamond approach". We will now look at some aspects of this approach of particular relevance to project contexts.

Utilising the context of the NTCP diamond model

As we have seen in Figure 2, the diamond links the particular levels on each dimension which best describe the project's characteristics – i.e. its dimensional context – which we can simply call the project diamond.

Now, with all the guidelines in their book for managing the various levels of each dimension, we can use the same diamond to depict the required project management (PM) style for the most effective management of that project.

However, a good deal of the concern in Shenhar & Dvir's book is with examples of mis-matches between the required PM style for the project under discussion, and the actual PM style used. Figure 8 shows the basic format they use in illustrating such differences.

Shenhar & Dvir discuss over twenty actual cases – many of them well-known, and often quite graphic – of problems, delays, cost overruns and the like, caused by not using project management styles that are appropriate to the contexts of the project's NTCP dimensions, and the levels it occupies on those four dimensions.

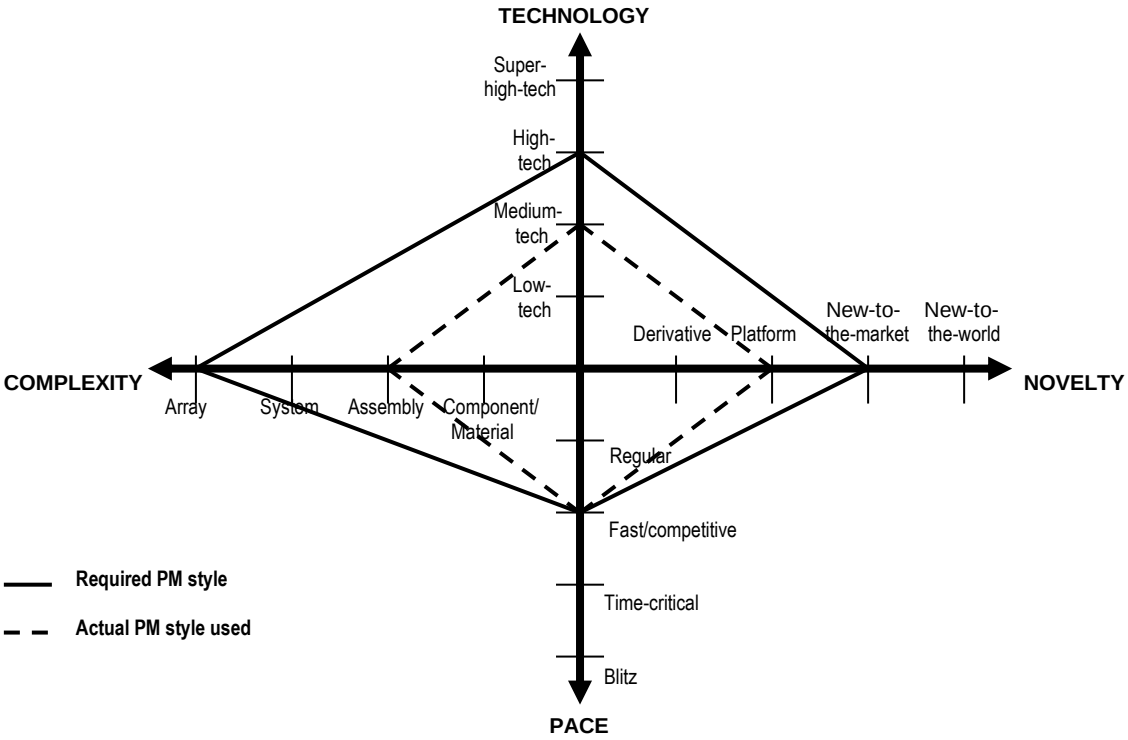

Figure 8: The NTCP model, adapted from Shenhar at al 2016, illustrating a difference between required and actual project management (PM) styles

It is therefore of paramount importance first to accurately depict the context of the project diamond, and then to adopt management styles which are appropriate to that diamond. As we have seen, Shenhar & Dvir have a multitude of guidelines to help in this context.

Concluding this section

It is impossible to adequately represent the very detailed materials in Shenhar & Dvir 2007 in a short article. However, I hope to have represented the materials which appeared to me to be most relevant to the purposes of this series of articles well enough to do them reasonable justice, and to encourage readers who are not familiar with their work to read not only their book, but also the many other materials which Shenhar and his colleagues have published over a very long period of time.

These are extremely important contributions to project management, and I would like to see them given more acknowledgement than they appear to have received to date – at least as far as I can ascertain. Going back to PMI's 26th Annual Seminar/ Symposium in 1995, I remember very well how much favourable discussion so many attendees accorded Shenhar's presentation of his (then) two-dimensional contingent project management framework (Shenhar 1995), which I unfortunately missed. But I made sure I attended his presentation at the following year's Seminar/Symposium, in which he discussed his now three dimensional UCP (Uncertainty, Complexity, Pace) model (Shenhar 1996). This presentation was made to a packed house and was subsequently widely discussed. I suspect that high levels of discussion will have been maintained with the further developments of this model with various colleagues – but unfortunately this does not appear to have translated into formal recognition in bodies of knowledge of project management and similar publications.

I would now like to retrospectively bring together some thoughts which rather naturally occurred to me as I followed the development of the NTCP model from its earlier forms as introduced above to its more recent formats.

POSSIBILITIES FOR GENERALISING DIMENSIONS IN THE NTCP MODEL?

Shenhar and associates have developed the NTCP model in very substantial detail, and have chosen quite specific dimensions in this development. However, they have also recognised that there are other versions of some of their dimensions which may be more appropriate for certain types of projects, as is indicated by the following quotation from Shenhar & Dvir 2007:59.

> Although the NTCP model provides a context-free framework for most projects, in some cases you may need a specific model for your project or organization. It can be based on other types of uncertainty or complexity, or other environment variables

It seems reasonable to question whether the NTCP model is quite as context-free for most projects as the first line of this quotation may suggest. Indeed, the rest of the quotation explicitly acknowledges that there are other types of uncertainty and complexity which are not covered by this particular model. This suggested to me that there may be possibilities for generalising the coverage of one or more of the dimensions to include such other types. We will look further into such possibilities in the following sub-sections, starting with the two uncertainty dimensions.

Uncertainty dimensions

I will start by going back to some earlier contributions by Shenhar, and some subsequent developments, many of them with various colleagues.

An early uncertainty dimension (in the UCP model)

At one stage, the framework which preceded the NTCP model was called the UCP model (Uncertainty, Complexity, Pace). I first saw this model in Shenhar 1996, in which he made the following comment on uncertainty.

> Various types of uncertainty in projects may be noted: technological, environmental, geographical, financial, political, etc.

Later, this early Uncertainty dimension of the UCP model was split into two dimensions, as now discussed.

Splitting the early uncertainty dimension into two dimensions

I first came across the split of the earlier Uncertainty dimension into two dimensions in Shenhar & Dvir 2004. The two new uncertainty dimensions were described as Novelty and Technology, thus converting the UCP model into the NTCP model.

The following explanation of the split-up comes from Shehar & Dvir 2007:41.

> …there are really two major causes of uncertainty: market (or goal) uncertainty, and technological (or task) uncertainty. Thus the NTCP (novelty, technology, complexity, and pace) diamond model emerged. The uncertainty dimension is now split into two parts: novelty is determined by goal or market uncertainty, and technology by technological uncertainty.

Now, it seemed to me that the descriptors chosen by Shenhar and colleagues for both the market (or goal) uncertainty dimension (Novelty), and the technological (or task) dimension (Technology) are not as context-free as their alternative descriptors (in parenthesis in the first sentence of the above quotation), namely *goal uncertainty*, and *task uncertainty.* We will discuss each in turn.

The dimension of Novelty, or Goals Uncertainty?

In the recap of the first article above we used the definition by Shenhar et al 2016:

> NOVELTY: *Market Innovation* **–** How new is the product to the market, users, and customers.

This is basically the same as the definition of Novelty in Shenhar & Dvir 2007, in which they expand on the nature of the Novelty dimension as follows.

> ***Novelty: How new is your product to the market?***
> Product novelty is defined by how new the product is to its markets and potential users. This dimension represents the extent to which customers are familiar with this type of product, the way to use it, and its benefits. It also represents the uncertainty of your project goal – that is, how clearly you can define the requirements and customer needs up front.

The last sentence of this quotation nominates a very specific type of project goal uncertainty - namely "how clearly you can define the requirements and customer needs up front". However, this is only one of many possible types of goal uncertainty that can confront projects of different types.

One of the more prominent examples of a different type of goal uncertainty is that so often associated with software development projects (e.g. Turner & Cochrane 1993). Certain types of research and development projects are also markedly in this category, and uncertainties about project goals would very likely to arise from some of the other sources of uncertainty nominated in an earlier quotation from Shenhar 1996, which included environmental, geographical, financial, and political factors.

These considerations lead me to conclude that *Goals Uncertainty* is a more generic descriptor for this dimension, and that Novelty could be seen as just one of several examples of this particular dimension.

The dimension of Technology, or Task Uncertainty?

In the recap of the first article above we used the definition by Shenhar et al 2016

> TECHNOLOGY: *Technological Innovation* **–** How much new technology is used

Shenhar & Dvir 2007:47 expressed the relationship between technological uncertainty and task uncertainty as follows.

> The major source of task uncertainty is technological uncertainty. (Other sources might be the lack of team experience or tight budget constraints).

This quotation directly examples two other sources of task uncertainty, in addition to technological uncertainty. In my own experience, many of the R&D projects we undertook in Civil & Civic had high levels of task uncertainty, and some other authors (e.g. Turner & Cochrane 1993) have put product development projects into this category. Undoubtedly there are also many others, which could also include task uncertainties which may derive from environmental, geographical, financial, and political factors, as quoted above from Shenhar 1996.

Now, since *Task Uncertainty* does appear to be context-free, it also appears to be an appropriate descriptor to adopt for this dimension of a more generalised model.

Relating these more generalised descriptors with a Turner & Cochrane model

Turner & Cochrane 1993 developed a well-known goals-and-methods matrix in connection with projects with initially ill-defined goals and/or methods of achieving them, shown in outline form in Figure 9 below.

I have added the descriptor *Methods/Task Uncertainty* to Turner & Cochrane's vertical axis "Methods well defined", as methods and tasks appear to be equivalent in this context. Similarly, I have named the horizontal axis of the matrix *Goals Uncertainty*, as this exactly matches with Turner & Cochrane's "Goals well defined".

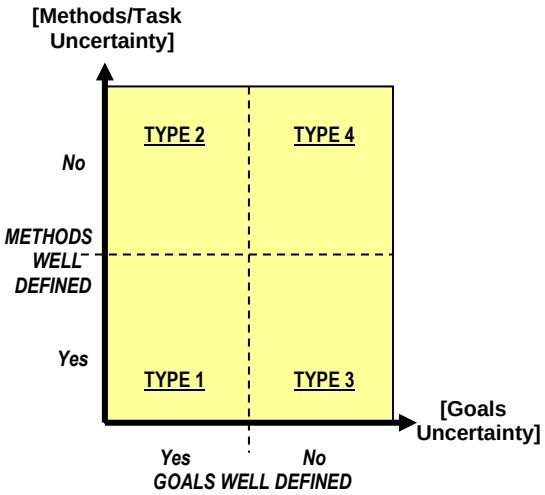

Figure 9: Outline of Turner & Cochrane's goals-and-methods matrix

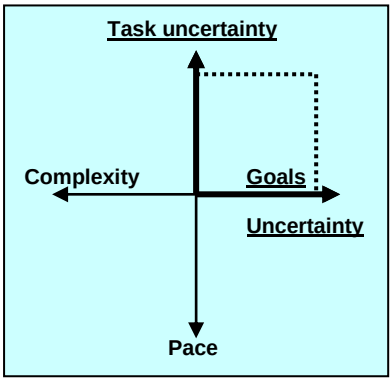

Figure 10: More generalised project dimensions descriptors, adapted from Shenhar & Dvir's NTCP model

If we adopt these more generalised descriptors of the two uncertainty dimensions, the NTCP model would look as outlined in Figure 10. Additionally, I have shown a dashed outline of the Turner & Cochrane 1993 goals-and-methods matrix in Figure 10, to illustrate how the two models relate in the project uncertainty domain.

Although they have similar *goals uncertainty* and *task uncertainty* dimensions, these two models are quite different in the number of levels of uncertainty nominated for each dimension. Turner & Cochrane have only two levels of uncertainty on each dimension, whilst Shenhar and colleagues now have four levels on each (previously three Novelty levels in Shenhar & Dvir 2007).

Modelling both the generalised and more specialised uncertainty dimensions

If we adopt the more generalised uncertainty dimensions suggested above, we can then show projects with market and technological uncertainties as examples of the more generalised goals and task uncertainty dimensions. We can also make provision for other relevant project types – as for example software development projects in the goals uncertainty parameter. The result might then be depicted as follows.

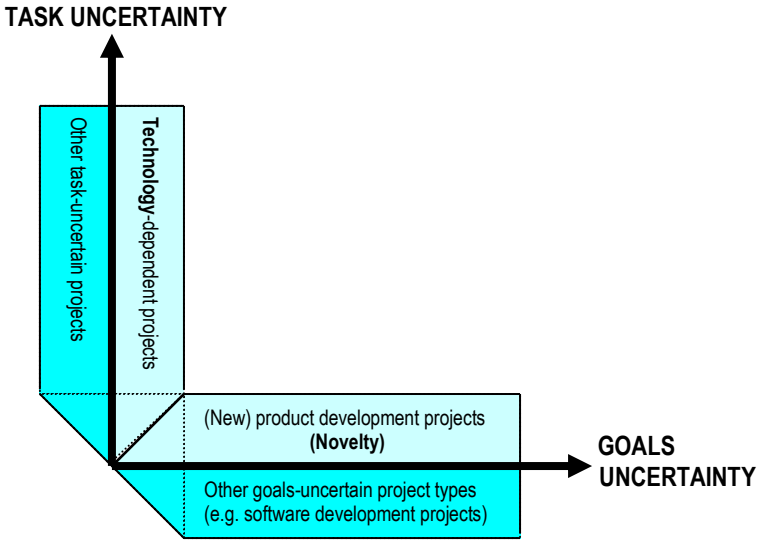

Figure 11: More generalised uncertainty dimensions, plus NTCP components

Finally, as regards the more generalised versions of the two uncertainty dimensions, it could well be that many of the guidelines Shenhar and colleagues have developed for the various levels of the Novelty and Technology dimensions could also be broadly applicable to other types of projects in the more generalised dimensions suggested above. However, I would expect that there would also be many cases where this would not apply, as for example with software development projects in the goals uncertainty dimension, and with associated Agile approaches.

We now turn to the Complexity dimension.

The Complexity dimension

In the recap of the first article above we used the definition by Shenhar et al 2016

> COMPLEXITY: *Level of System Innovation* **–** Represented by the complexity of the product or the organization.

In articles on the earlier UCP model (Shenhar 1995, 1996) and later articles on the NTCP model (Shenhar & Dvir 2004, 2007) the complexity dimension was presented as synonymous with what was originally described as a System Scope dimension. As Shenhar & Dvir 2007:102 say

> The idea is to find a simple, universal way to conceptualise complexity in a context-free framework, regardless of the industry or technology involved. To address this problem we choose to differentiate between the outcome of the project (the product) as a whole and the product in its parts; we use a hierarchy of systems and sub-systems as a natural way to distinguish among the various project complexities.

Repeating an earlier quotation, we again record the qualifying note by Shenhar & Dvir 2007:59 about the context-free aspect of the NTCP framework, as follows.

> Although the NTCP model provides a context-free framework for most projects, in some cases you may need a specific model for your project or organization. It can be based on other types of uncertainty or complexity, or other environment variables

With regard to other types of complexity, it appears to me that many of them are already covered, at least in part, in Table 6-3 in the text, and in Table 7 in Appendix 6B. So, taking account of this qualifying note as well, this complexity dimension appears to cover the possibilities quite adequately.

The Pace dimension

In the recap of the first article above we used the definition by Shenhar et al 2016

> PACE: *Urgency of the Innovation* **–** How critical is your time frame.

The pace dimension appears to have been introduced around 1996, initially with two levels (e.g. Shenhar 1996), then three (e.g Shenhar & Dvir 2004), and then four, as detailed in Shenhar & Dvir 2007, which also has substantial supporting tables in the main body of the text and in Appendix 7.

Concluding this section

I have proposed a more generic framework for the two uncertainty dimensions of the NTCP framework.

I am not sure how useful this generalised project dimension framework might be. But perhaps it could be useful in possible future contexts of the type referred to by Shenhar et al 2016 in the following quotation.

> Once new dimensions and types are offered, another main direction for future studies is identifying management implications for different types of projects on each dimension.

SUMMARY

We started by recapping discussions on the context of the NTCP four-type project dimensions model of Shenhar and associates in the first article of this series. Essentially we re-presented the model, briefly pointed to the many guidelines these authors have developed for managing particularly the non-traditional levels of these dimensions, and then notionally positioned the NTCP model in relation to other project contexts discussed to date in this series.

We then looked in more detail at the format of four tables in the Appendices of Shenhar & Dvir 2007 which list the knowledge areas of the PMBOK Guide down the left hand side, and then, for each of these, propose management guidelines which cover each level of each dimension. We also gave an example of specific guidelines relating to the scope knowledge area for the four levels of the technology dimension.

We also looked at the formal of another group of tables for each of the four NTCP dimensions also which summarise the impact of its various levels on other project management processes that are particularly relevant to that individual dimension. We gave a specific example of different management styles and attitudes appropriate to each level of the technology dimension.

Together with some other management-related guidelines, the above constitute a treasure trove of something of the order of two hundred management-related guidelines, the majority of which relate to contexts not covered by "traditional" sources.

We then looked at utilising this information in the context of the NTCP diamond model, which can be used to identify the levels the project occupies on each dimension (its diamond), and then to adopt the management guidelines which are appropriate for those levels.

Finally, I looked at possibilities for generalising dimensions of this NTCP model, focusing mainly on the two uncertainty dimensions, Novelty and Technology. Following ideas originating in some of the NTCP authors' own contributions over the years, I suggested that the *Novelty* dimension could be generalised to the more generic descriptor *Goals Uncertainty*, and the *Technology* dimension to the more generic descriptor *Task Uncertainty*. I also proposed a model which combines both the generic descriptors, and the Novelty and Technology components.

In concluding this article, I note that the NTCP diamond is one way of describing the type of project we are dealing with. In the following article of this series we will be looking at project types in somewhat different ways.

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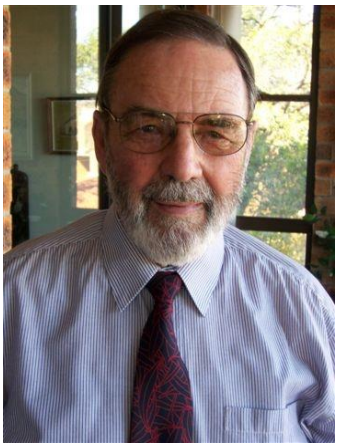

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Alan Stretton is one of the pioneers of modern project management. He is currently a member of the Faculty Corps for the University of Management & Technology (UMT), USA. In 2006 he retired from a position as Adjunct Professor of Project Management in the Faculty of Design, Architecture and Building at the University of Technology, Sydney (UTS), Australia, which he joined in 1988 to develop and deliver a Master of Project Management program. Prior to joining UTS, Mr. Stretton worked in the building and construction industries in Australia, New Zealand and the USA for some 38 years, which included the project management of construction, R&D, introduction of information and control systems, internal management education programs and organizational change projects. He has degrees in Civil Engineering (BE, Tasmania) and Mathematics (MA, Oxford), and an honorary PhD in strategy, programme and project management (ESC, Lille, France). Alan was Chairman of the Standards (PMBOK) Committee of the Project Management Institute (PMI®) from late 1989 to early 1992. He held a similar position with the Australian Institute of Project Management (AIPM), and was elected a Life Fellow of AIPM in 1996. He was a member of the Core Working Group in the development of the Australian National Competency Standards for Project Management. He has published over 200 professional articles and papers. Alan can be contacted at alanailene@bigpond.com.au.

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