Goals-and-methods matrix: coping with projects with ill defined goals and/or methods of achieving them

J R Turner and R A Cochrane*

Projects can be judged against two parameters: how well defined are the goals, and how well defined are the methods of achieving them. This leads to four types of projects. A definition of projects is given which encompasses all four types. This implies three breakdown structures: the product-breakdown structure (PBS) (the bill of materials for the project), the organization-breakdown structure (OBS) (the range of skill types available), and the work-breakdown structure (WBS) (the task matrix defining the involvement of each skill type in the delivery of each goal at a given level of breakdown). The OBS is usually well defined; the range of skill types is known. However, the PBS, or WBS, or both, may not be. Methods of project startup and the use of milestone planning and configuration management to cope with these situations is described.

Keywords: startup techniques, milestone planning, configuration management

Many traditional definitions view a project as a complex sequence of activities to deliver clearly defined objectives. The assumption is that both the goals and the method of achieving them are well understood at the start of a project, or at least at the start of its execution stage. The resulting methodologies rely heavily on this assumption, and, in particular, the project is planned in terms of the activities to be done, and authors suggest freezing the design of the project at an early stage.

However, on some projects, the objectives and/or the methods of achieving them are not clearly defined at the start of the execution stages. Projects can be judged against two parameters: how well defined are the goals, and how well defined are the methods. The resulting 2×2 matrix, which is called in this paper the goals-and-methods matrix, implies four types of project:

- *Type-1 projects:* for which the goals and methods of achieving the project are well defined,
- *Type-2 projects:* for which the goals are well defined but the methods are not,
- *Type-3 projects:* for which the goals are not well defined but the methods are,
- *Type-4 projects:* for which neither the goals nor the methods are well defined.

(The spectrum of projects introduced by Briner and Geddes[1] spans projects of Types 1, 3 and 4. Similar matrices exist in the fields of numerical analysis and innovation management. In numerical analysis, the numerical solution to a mathematical or engineering problem can be judged against two parameters: whether the solution exists, and whether the numerical approximation converges[2]. Pearson[3] describes a similar matrix for managing innovation.)

A new definition of projects is introduced which encompasses all four types. This definition differentiates between the objectives of a project (the facility it will produce) and the purpose of a project (the benefit expected from operating that facility after completion of the project), and it implies three types of breakdown structure for a project: the product-breakdown structure

Henley Management College, Greenlands, Henley-on-Thames, Oxfordshire RG9 3AU, UK
* Coopers & Lybrand Management Consultants Ltd, Sunning Plaza, 10 Hysan Avenue, Hong Kong

 0263–7863/93/020093–10

(or bill of materials for the facility produced), the organization breakdown structure (the resource or skill types available to undertake the work of the project), and the work-breakdown structure (the cascade of 2-dimensional matrices defining the involvement of each skill type in the delivery of each element of the facility at a given level of breakdown).

On almost all projects, the OBS is well defined; it is known what skill types are available to do work. However, the goals-and-methods matrix implies that, on some projects, the PBS, or WBS, or both, are ill defined. To cope with this situation, project managers must use methodologies which acknowledge that this may be the case. This paper describes appropriate startup and implementation techniques to cope with the four types of project.

A bottom-up approach to project startup can be used when both the goals and methods are well defined. However, as either or both become less certain, a top-down approach becomes appropriate. When the methods are uncertain, the startup process should involve multidisciplinary teams to reach the best solution. When the goals are uncertain, the startup should involve a facilitator to negotiate agreement between the parties involved in the project.

Similarly, appropriate implementation techniques should be chosen depending on the type of project. It is shown how milestone planning techniques[4,5], can be used for planning Type-2, Type-3 and Type-4 projects. These define the plan in terms of known control points, independently of the method of achieving them, allowing the methods and precise definition of the goals to be devised as the project progresses. We also show that configuration management[4] can be used to refine the definition of the goals and methods as the project progresses.

TRADITIONAL DEFINITIONS OF PROJECTS

Many traditional definitions of projects assume that the objectives of a project, and the methods of achieving them, are well understood throughout the project. For instance, in its body of knowledge, the UK Association of Project Managers defines a project as 'an undertaking to achieve a defined objective'[6], and goes on to state that 'generally all projects evolve through a similar "life-cycle" sequence during which there should be recognised start and finish points'.

Other definitions similarly imply clearly defined objectives and methods: 'an activity defined by a clear aim, appropriate objectives and supporting activities, undertaken to define start and completion criteria'[7], and 'a human activity that achieves a clear objective against a time-scale'[8].

This assumption that the objectives and methods can be clearly defined at an early stage of a project leads to a belief that the project's design should be frozen as early as possible. The frozen objectives become part of the definition of the quality of the project, and project managers are said to be successful if they deliver them on time and within budget, regardless of whether or not the product is useful or beneficial to the owners and users.

In reality, the project is only successful if it produces a worthwhile product which can be operated beneficially for some time after the completion of the project to repay the investment in it (see Reference 4, Chapters 3 and 5). In some cases, this can require the objectives or methods of achieving them to be changed right up to the completion of the project as new information becomes available about what will be beneficial or worthwhile. Configuration management is a technique for controlling this process.

Similarly, the assumption of well defined methods means that projects are usually planned in terms of the activities, or work, to be done. This can result in plans changing almost continuously as early work changes the requirements for later work. This requires the plan to be expressed in terms of milestones or deliverables which are known, with rolling-wave planning[4] being used to plan the detail of the work as it progresses.

GOALS-AND-METHODS MATRIX

It can therefore be seen that projects can be judged against two parameters:

- whether the goals are well defined,
- whether the methods of achieving them are well defined.

This concept leads to the definition of four types of project (see Figure 1):

- *Type-1 projects:* In these projects, the goals and methods are well defined. They are typified by large engineering projects, and are the type of project on which many of the authors have gained experience, and hence the definitions above. (The four types of project have been named after the four traditional elements. These projects have been called the earth projects; they are well defined, with a solid foundation.)
- *Type-2 projects:* In these projects, the goals are well defined, but the methods of achieving them are not. They are typified by product-development projects. Many of the early projects, through which modern project management was developed[9], e.g. Atlas, Polaris and Apollo, were of this type. (These are water projects; like a turbulent stream, they flow with a sense of purpose, but in an apparently haphazard way.)
- *Type-3 projects:* In these projects, the goals are not well defined, but the methods are. These are typified by software-development projects, in which it is notoriously difficult to specify the users' requirements. The goals are known to exist, but cannot be specified precisely until users begin to see what can be produced, often during the testing stages. Many people believe that the definition of the goals should be frozen at an early stage of the project, and hence they have the dilemma of knowing that the goals should be changed, but believing that good project-management practice means they should remain frozen. (These are fire projects; much heat can be generated in the definition of the work, but they can burn with no apparent purpose.)

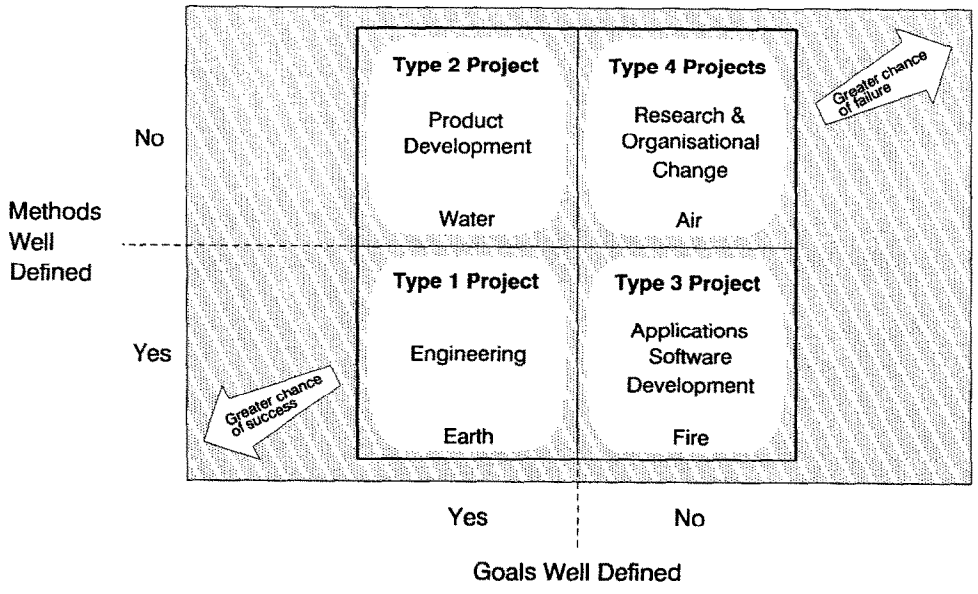


Figure 1. Goals-and-methods matrix

- *Type-4 projects:* In these projects, neither the goals, nor the method of achieving them, are well defined. They are typified by organizational-development projects. (These are air projects; they are very difficult to catch hold of, and deliver 'blue-sky' research objectives.)

A definition of projects which encompasses all four types of project, and methods of startup and management that are appropriate in each case, are therefore required.

NEW DEFINITION OF PROJECTS

Definition

Turner[4] suggests a definition of a project which can encompass all four types of project. A project is defined (see Figure 2) as follows:

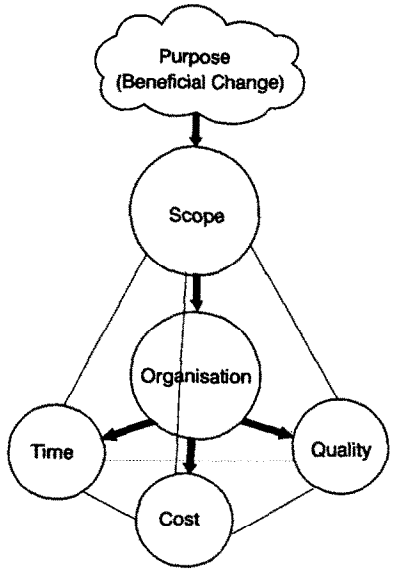


Figure 2. Five project objectives

> an endeavour in which human material and financial resources are organised in a novel way, to undertake a unique scope of work of given specification, within constraints of cost and time, so as to achieve unitary, beneficial change, through the delivery of quantitative and qualitative objectives.

This definition implies that projects have three essential features which differentiate them from day-to-day operations:

- the work is unique,
- the organization is novel,
- the change is unitary, being achieved once, on a certain day, although the benefit of the change is long-lasting.

It also implies that projects have quality, cost and time constraints (the golden icons beloved by project managers), but projects share these constraints with day-to-day operations.

Three breakdown structures

The three essential features imply the existence of three breakdown structures, which define the goals of a project, and the method of achieving them. In reverse order, they are as follows:

- *Product breakdown structure:* This is a cascade of deliverables, in which the overall product or objective of the project is broken into subproducts, assemblages and components. It is a bill of materials for the project.
- *Organization breakdown structure:* This is a cascade of resource types, skill types or activities. At high levels, the names may be similar to what are often called the 'phases' of a project: design, development, procurement, production, assembly, and testing. At lower levels, they are specific resource types: mechanical engineers, COBOL programmers etc.
- *Work breakdown structure:* At any level of breakdown, the 2-dimensional matrix of products and activities define a task matrix, the sequence of activities required to deliver each product. The cascade of task matrices is the work breakdown structure for a project.

These definitions of WBS and OBS differ in emphasis from those developed 40 years ago by the US Department of Defense in their C/SCSC methodology[10]. However, the authors believe that this changed emphasis reflects the more modern approach to project management implied by the definition above.

On most projects, the OBS will be given, that is, the available resource or skill types will be well defined. However, the PBS and/or the cascade of task matrices, the WBS, may not be:

- On Type-1 projects, the PBS, OBS and WBS are all well defined, and so managers of traditional projects can be lax in drawing a distinction between them. Indeed, the PBS and WBS are often treated as the same thing; that is, people do not differentiate between the goals or deliverables and the method of achieving them. (Indeed, a careful interpretation of the early definitions of WBS[10] implies that it is more a bill of materials for the project than a task list.)
- On Type-2 projects, the PBS is well defined, but the WBS is not, that is, the task matrices, or precise sequence of activities involved in achieving each deliverable, are uncertain. The work is often identified with the deliverables, as with Type-1 projects.
- On Type-3 projects, the PBS is ill defined, but the WBS is partially defined; the typical sequences of tasks required to achieve the deliverables are well known, but the precise form of those deliverables (and hence the precise balance or sequence of tasks) is not. Because, in this environment, the OBS is well defined, people are often lax in drawing a distinction between the OBS and the WBS. They apply the word 'activity' to both skill types, and work to achieve products. For example, 'systems analysis' is both a skill type and a phase in the project lifecycle. Often, on Type-3 projects, the structure of the PBS is known, that is, the existence of elements in the structure (configuration items as they are called) can be predicted. It is only their precise specification, or configuration, that cannot be predicted.
- On Type-4 projects, neither the PBS nor the WBS are well defined.

Project, facility, purpose

The definition of a project above also draws the distinction between the project, the facility that it produces, and the purpose of the project (see Figure 3):

- The *project* is the work undertaken. It is a collection of tasks, the WBS, undertaken by all the skill types involved, the OBS.
- The *facility* is the project's product. The work is not done for its own sake, but to produce the facility. It is all the goals and deliverables in the PBS.
- The *purpose* is the benefit obtained from operating the facility. The facility is also not produced for its own sake, but to achieve beneficial change. The purpose is the *raison d'etre* of the project.

On some projects, it is the project itself, the WBS, which is ill defined, and on others it is the facility, the PBS. However, beyond the prefeasibility stage, the purpose or benefit of the project should be well defined, or the project is pointless. This then becomes the focus for milestone planning and configuration management to manage Type-2, Type-3 and Type-4 projects.

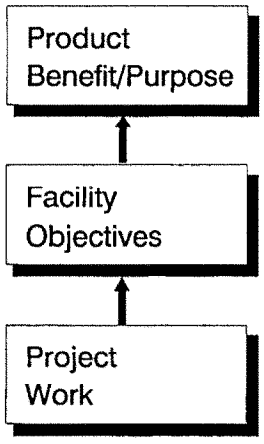


Figure 3. Project–facility–purpose model

STARTUP TECHNIQUES

Techniques are now considered which can be used for managing all four types of project, and in particular Type-2, Type-3 and Type-4 projects. Startup techniques are described first. Briner and Geddes[1] propose leadership qualities for Type-1, Type-3 and Type-4 projects, and it is shown where their proposals match the authors' startup techniques.

Fangel defines the objectives of project startup as[4,11] follows:

- to create a shared vision for the project, by identifying the project's context, its purpose and its objectives,
- to focus the attention of the project team on the project's purpose and the method of achieving it,
- to gain acceptance of the plans, by defining the scope of work, the project organization, and the constraints of quality, cost and time,
- to get the project team functioning, by agreeing its mode of operation and the channels of communication.

On Type-1 projects, where the goals and methods are well defined, and are perhaps based on considerable historical experience, these four objectives will already be satisfied at a high level, and so the startup process will quickly slip to ratifying them at a detail level. The planning process will therefore appear to be bottom-up. On the other hand, on Type-4 projects, where the goals and methods are not well defined, and there is perhaps little previous experience, the startup process must focus on ensuring that the project's context and purpose is well defined from the start, and only then develop the objectives and methods from this firm basis. Without this firm basis, it will not be possible to make progress; effectively, there will be no project. This makes the planning process strictly top-down in nature. The emphasis on Type-2 and Type-3 projects lies between these two extremes.

It can therefore be seen that the project manager must adopt an appropriate startup process that is dependent on the type of project (see Figure 4):

- *Type-1 projects:* Because the goals and methods are well understood, the startup process focuses on refining their definition at a low level. A client-requirements definition or project-definition report[4] sets the basis for the project. Specialists, who bring with them historical experience, help to launch the project team within clearly defined project organization structures which are known to work. Briner and Geddes[1] consider the leadership role to be that of a conductor: leading skilled resources in well defined activities. The conductor follows a score, interpreting it but not changing it.
- *Type-2 projects:* Here, the purpose and objectives are well defined, perhaps through a project-definition report. The startup process therefore focuses on the third and fourth objectives, defining especially the scope of work and the mode of operation of the project team. This requires the project manager to pull together a multidisciplinary group who are likely to have the breadth of knowledge required to define the project's methods. The group need to start with brain-storming techniques to ensure that all possible avenues are explored. An independent facilitator can now help to ensure that the members of the team are not too constrained by their experience or skill base. Once the methods have been defined, the project-organization structure can be frozen, and the projects implemented, as in Type-1 projects. Briner and Geddes[1] do not consider the leadership role in this case. However, it can perhaps be compared to that of a football coach: the goals are well defined, but the players are on their own during the game. The coach can improve the skills of competent personnel, and train them in set pieces, but cannot predict the course of the game.
- *Type-3 projects:* Here, the goals are not well understood, and so the startup process must focus on the first two objectives, defining the purpose and objectives of the project, and converting those into the design of a facility which will deliver the required benefits. This requires considerable negotiation within the project team, and between the team and the project's sponsor, and there may be a role for a facilitator to mediate in this negotiation. Once the purpose and objectives have been defined, the project is implemented as a Type-1 project, using the well defined methods, within clearly defined organization structures. Briner and Geddes[1] consider the leadership role here to be that of a sculptor: using well defined methods to make the sculpture, but adapting the final shape according to the material worked on.
- *Type-4 projects:* Here, the startup process focuses on all four objectives, requiring a mixture of inspiration and creativity to define the methods, and negotiation to define the goals. (Which is defined first depends on which is better defined at the outset and is therefore more likely to provide a firmer basis.) The process is inevitably iterative, cycling between goals and methods, and between purpose and objectives, as the level of definition improves. As it does, the project is likely to move through either the Type-2 or Type-3 quadrant, and preferably the former, as the project is more likely to be successful if the objectives are defined at an early stage. Briner and Geddes[1] consider the leadership role in this case to be that of a mole. The authors understand their point, but consider an eagle to be a better analogy. The project manager must be able to soar above the project, and to see it in its context (purpose), but be able to move down into the project to solve problems as they occur.

IMPLEMENTATION TECHNIQUES

Similarly, the management of the four types of project during implementation requires the use of a balance of techniques. The use of milestone planning and configuration management for this purpose is described below. These two techniques are briefly described, and it is considered how they would be applied to the management of the four types of project.

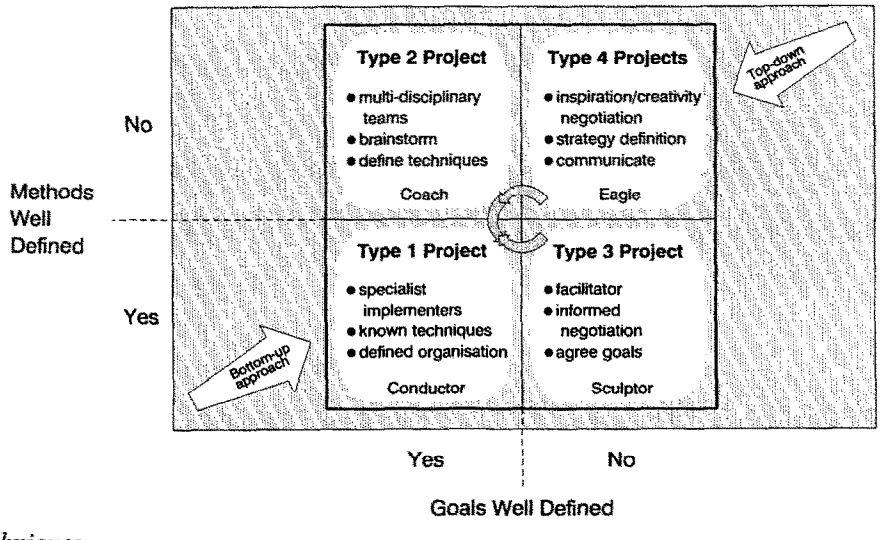


Figure 4. Startup techniques

Milestone planning

Only on Type-1 projects is it possible to plan the project in terms of the activities to be undertaken. It was seen that, on the other types of project, the WBS is ill defined (to a greater or lesser extent). On Type-2 projects, one knows the goals, but cannot say precisely how they will be achieved. On Type-3 projects, it is known what types of activities will be undertaken, but, because the goals are not well defined, it is not known in precisely what sequence or balance the activities will occur. Type-4 projects, of course, suffer both these problems. To cope with these situations in which it is not possible to express the plan in terms of a sequence of activities, it is necessary to use milestone planning[4,5]. The plan is expressed instead in terms of control points, or milestones. On Type-2 (and Type-1) projects, these milestones can be the achievement of the well defined goals or objectives. The tasks required to achieve each milestone, the methods, are planned on a rolling-wave basis: that is, the detail planning is only done as work is about to start, when all possible information is available. It is shown below that configuration management can be used to manage the refinement of the methods. On Type-3 and Type-4 projects, the milestones must instead be decision points where the definition of the goals is refined and rebaselined. Configuration management is used to manage this refinement.

Figure 5 is a milestone plan for a project to rationalize office accommodation using modern technology to change the way of working within the offices. This project in fact mixes three types of project within one. The accommodation work, being of an engineering nature, has well defined goals and well defined methods. The technology work, being of a systems-development nature, has well defined methods, but the precise specification of the goals delivered at each milestone is uncertain, being dependent on the interpretation of user requirements. The operations work, on the other hand, has well defined goals (of people in place), but the method of achieving them, whether by recruitment, redeployment or retraining, may not be fully defined until all the people are in place.

Configuration management

Configuration management is a tool that can be used in conjunction with milestone planning to monitor and control the evolution of the specification of the goals (Type-3), or the activity plans to achieve the goals (Type-2), or both (Type-4). Through configuration management, the specifications or activity plans are rebaselined at successive stages of the project (see Figure 6). There are essentially four steps in configuration management[4]:

- configuration identification,
- configuration reviews,
- configuration control,
- status accounting.

The steps are detailed below.

- *Configuration identification:* The configuration is identified through the PBS. Each element in the PBS is called a configuration item. At the start of each stage of the project, there is some uncertainty about the definition of the configuration item, or goal (the lateral dimension in Figure 6) and the method of achieving it (the longitudinal dimension). Configuration management is the process by which the reduction of this uncertainty is managed.
- *Configuration reviews:* This reduction in uncertainty is managed through a formal review process conducted at each milestone. At the first review, at the start of the definition stage, the goals and methods of the configuration items are baselined at the current level of definition: that is, they are defined as lying within the large rectangle. During the later stages, the definition is refined, and, at subsequent reviews, the new definition is compared with the previous baseline. If the new definition falls within the envelope of the previous baseline (the tinted rectangles in Figure 6), the new definition is frozen as the new baseline. If it falls outside (the crosshatched rectangle in Figure 6), then all the parties involved in the project must decide whether the previous baseline was incorrect or the refinement was incorrect.
- *Configuration control:* If the latter is the case, then the work of the previous stage of the project must be repeated. If the former is the case, then the new baseline must be accepted, but only after a process of change control, to demonstrate why the previous baseline was incorrect, and to accept the new. The purpose of the project must at all times remain the focus of this configuration control.
- *Status accounting:* For the process to be effective, it is vital to record the current configuration. Status accounting must record not only the current baseline configuration of all the elements in the PBS, but also all previous baselines and the reasons for any changes. This can help in two ways:
  - by keeping people informed of the current configuration in volatile projects,
  - by ensuring that people joining the project understand the reasoning behind the current configuration, and do not follow previous blind alleys.

Applying concepts to four types of project

How milestone planning and configuration management can be applied to each type of project can now be summarized (see Figure 7):

- *Type-1 projects:* Milestone planning may be used for planning the project, but, as with startup, a more bottom-up approach may be taken. The plan is usually expressed in terms of well defined sequences of activities derived from historical experience. Configuration management need not be used during implementation, but may be used to control the definition and design of the facility during the feasibility and design stages. Down the accommodation path of Figure 5, quite detailed activity plans and specifications can be developed at the start of the project.

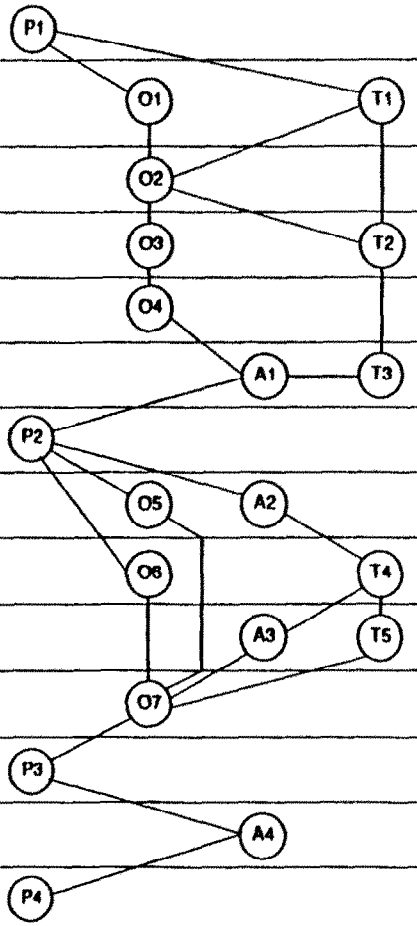
MILESTONE PLAN		Company: DANA COMMUNICATIONS BV	Project Manager: SVK	Contractor:	Contract No:
	Project Operations Accommo- dation Technology	Project description: RATIONALISATION OF THE CUSTOMER REPAIR AND MAINTENANCE ORGANISATION (CRMO)	Plan issue: A	Approved by: JRT	Date: 4 Feb
Planned date:	P O A T	Milestone:	Date:		Report:
		P1: When the project definition is complete, including benefit criteria milestone plan and responsibility charts.			
		O1: When a plan for communicating the changes to the CRM Organisation has been agreed. T1: When the technical solution, including appropriate networking and switching technology has been designed and agreed.			
		O2: When the operational procedures for the new CRM offices has been agreed.			
		O3: When the job design and management design is complete and agreed. T2: When the functional specification for the supporting management information system (MIS) has been agreed.			
		O4: When the allocation of staff to the new offices, and recruitment and redeployment requirements, have been defined and agreed.			
		A1: When the estates plan and roll-out strategy has been defined and agreed and T3: When the technical roll-out strategy has been defined and agreed.			
		P2: When the budget for implementation has been determined, and (provisional) financial authority obtained.			
		O5: When the management changes for sites 1 and 2 are in place (first call receipt and first diagnostic centres). A2: When sites 1 and 2 are available.			
		O6: When a minimum number of staff have been recruited and redeployed and their training is complete. T4: When the system is ready for service in sites 1 and 2.			
		A3: When sites 1 and 2 are ready for occupation. T5: When the MIS system has been delivered.			
		O7: When sites 1 and 2 are operational and procedures implemented.			
		P3: When a successful intermediate review has been conducted and the roll-out plans revised and agreed.			
		A4: When the last site is operational with the procedures fully implemented.			
		P4: When it has been shown through a post-implementation audit that the criteria have been met.			

Figure 5. Milestone plan for project to rationalize office accommodation

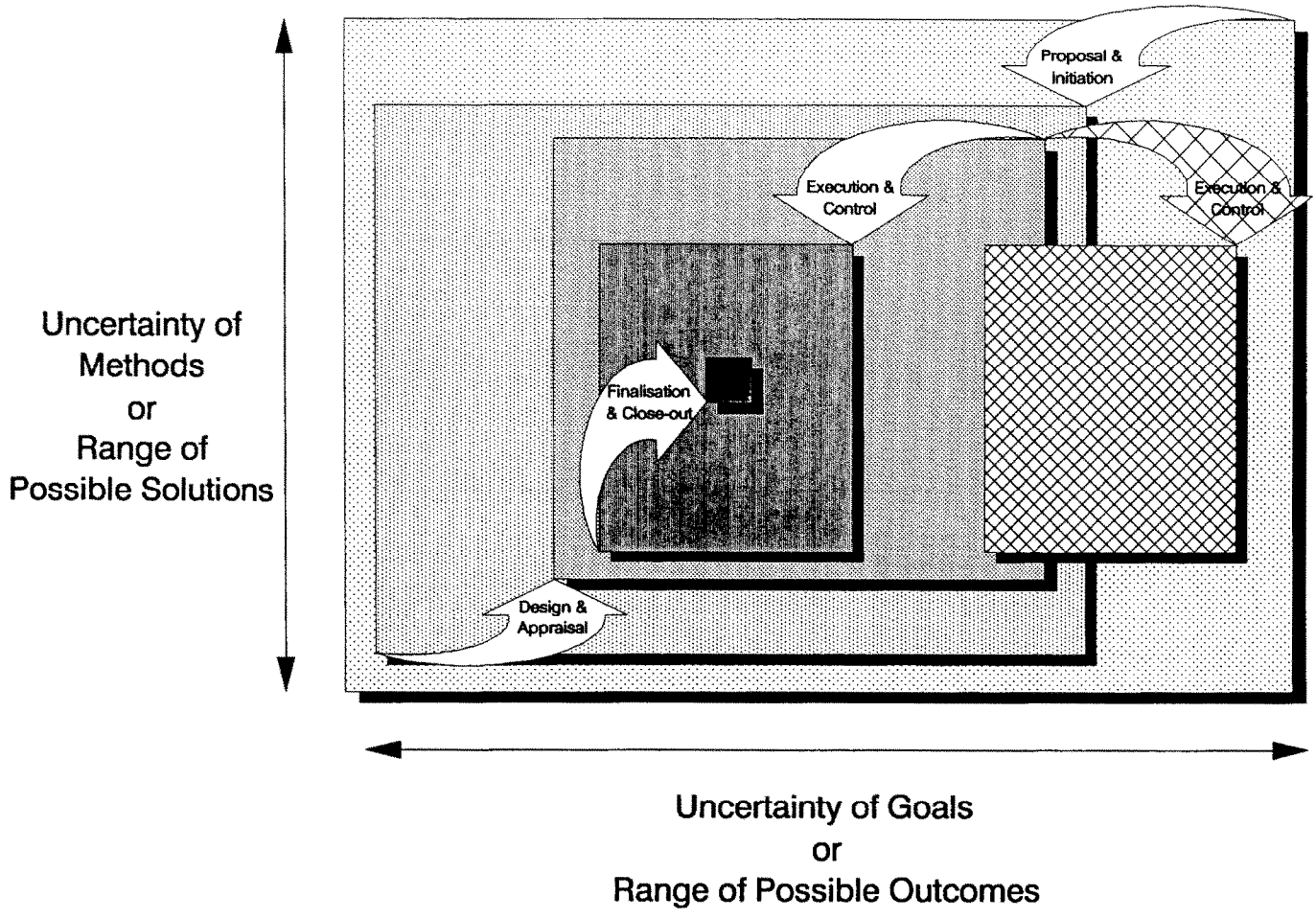


Figure 6. Configuration management

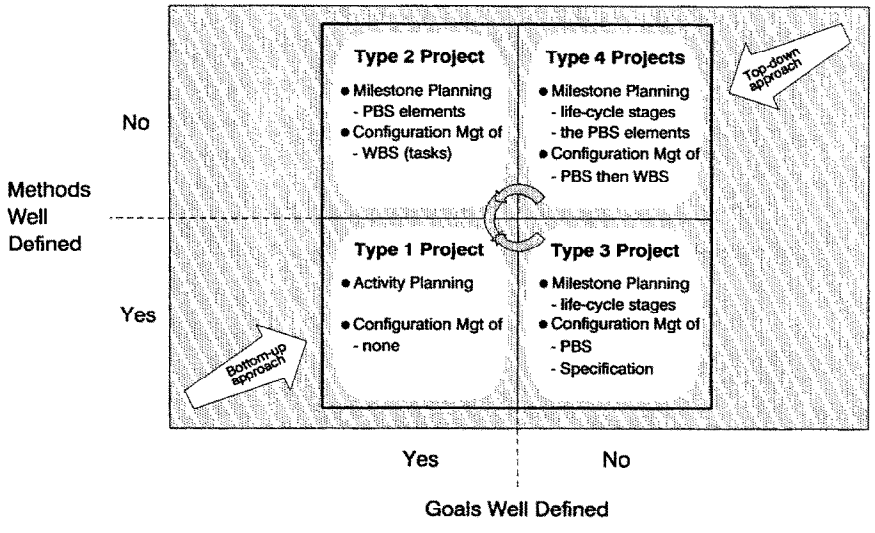


Figure 7. Implementation techniques

- *Type-2 projects:* These projects are ideal for the use of milestone planning. The PBS is well defined, at least down to a certain level of breakdown, and so these configuration items at the higher levels can themselves form the milestones. What is not known is the sequence of tasks required to deliver each item or milestone, and so it is the definitions of these task matrices which are controlled using configuration management. Each task itself results in a deliverable, which can be viewed as a subcomponent of the milestone, and so this can be viewed as controlling the evolution of the PBS to lower levels. Down the operations path in Figure 5, the specification of the goals can be drawn up at an early stage, but the

evolution of the activity plans must be managed using configuration management.

- *Type-3 projects:* Here, the PBS is not well defined. In the early stages of the project, its actual structure is uncertain; at later stages, the structure is known, but the specification of the individual configuration items is poorly defined. The evolution of the PBS and the development of the specifications is controlled using configuration management. As the configuration items are unknown at the early stages, the milestones must be expressed as more generic control points, derived from the known, typical sequences of activities. At later stages, the delivery of configuration items can become milestones, even though their specification is unknown. Down the technology path in Figure 5, it is known that the goals exist, although they cannot be precisely specified (they are not well defined). Activity plans can therefore be drawn up at the start of the project, but the evolution of the specification must be managed using configuration management.
- *Type-4 projects:* Here, there is very little to use as a basis for either milestone planning or configuration management. It is for this reason that it was suggested above that the startup processes should try very quickly to convert these into Type-2 projects, at least to produce a draft PBS to be used as the basis for management. It might be said that the operations path in Figure 5 is, in fact, a Type-4 project: it is known that people must be in place, but it is not known what their skills (specification) should be until the earlier stages of the project have been completed.

SUMMARY

It has been shown that the conventional view of projects as complex, but well defined, sequences of activities to deliver clearly defined goals and objectives may be invalid for a large number, if not the majority, of projects. Indeed four types of projects can be defined, judged against two parameters:

- the level of certainty of the goals,
- the level of certainty of the method of achieving the goals.

These different types of project require different startup techniques:

- to negotiate agreement of the goals where they are ill defined,
- to brainstorm methods of achieving them where they are ill defined.

Where the goals or the methods or both are poorly defined, it is not possible to plan projects in the conventional way, in terms of the activities to be undertaken. The project must instead be planned in terms of major milestones, deliverables or control points. The technique of configuration management can be used to monitor and control the definition of these milestones, the specification of the deliverables to be achieved at these points, and the work to be undertaken to achieve these milestones.

ACKNOWLEDGEMENTS

The authors thank Arnon Speiser, of IBM's Warwick Laboratory, UK, for his help in preparing this paper, as this work arose through a joint project on defining the information systems requirements of programme managers. They also thank Richard Morreale, of Life-Cycle Management Systems Ltd, UK, for guidance on configuration management.

Rodney Turner is the Director of the Project Management Unit at Henley Management College, UK, where he runs the qualifications programmes and short courses in project management. His research interests focus on developing project management as a structured discipline and approach, rather than as a collection of tools and techniques. He also undertakes consultancy work, and lectures internationally on project management. He is a Council member of the UK Association of Project Managers. Previously, he was a project-management consultant with Coopers and Lybrand, where he developed audit procedures for conducting project health checks, and an engineering project manager with ICI in the petrochemicals industry. Before joining ICI, Dr Turner was a postdoctoral research fellow at Oxford University, where he gained a DPhil.

Robert Cochrane's career has spanned the fields of engineering design, transport management and management consultancy in Australia, the UK and the Far East. His experience of project management includes civil-engineering construction, new product introduction, major defence projects, and the management of organizational change in large corporations. He is currently the managing director of Cooper & Lybrand's consultancy practice in Hong Kong.

REFERENCES

1 **Briner, W and Geddes, M** 'Linking project leadership to a project continuum: different types of project require leaders to concentrate on different dimensions of their role' *in* **Gareis, R (Ed.)** *The Handbook of Management by Projects* Manz (1990)
2 **Carnahan, B, Luther, H A and Wilkes, J O** *Applied Numerical Methods* John Wiley (1968)
3 **Pearson, A W** 'Managing innovation: an uncertainty reduction process' *in* **Henry, J and Walker, D (Eds.)** *Managing Innovation* Sage (1991)
4 **Turner, J R** *The Handbook of Project Based Management: Improving the Processes for Achieving Your Strategic Objectives* McGraw-Hill (1992)
5 **Andersen, E S, Grude, K V, Haug, T and Turner, J R** *Goal Directed Project Management* Kogan Page (1987)

6 **Morris, P W G (Ed.)** *APM Body of Knowledge and Experience* Association of Project Managers, UK (1992)
7 **Gower, D G** 'Project management — an overview' Association of Project Managers, UK (1992) (UK Institution of Electrical Engineers professional brief)
8 **Reiss, G** *Project Management Demystified* E & F Spon (1992)
9 **Morris, P W G** *The Management of Projects: Lessons From the Last Fifty Years* (manuscript in preparation)
10 'Cost/Schedule Control Systems Criteria (C/SCSC)' *DOD Instruction 7000.2* US Department of Defense, USA
11 **Fangel, M** 'The essence of project start-up: the concept, timing, results, methods, schedule and application' *in* **Fangel, M (Ed.)** *Handbook of Project Start-up: How to Launch Projects Effectively* INTERNET (1987)