| NEW WORK ITEM PROPOSAL | |
|---|---|
| Date of presentation<br>2006-05-09 | Reference number<br>(to be given by the Secretariat) |
| Proposer<br>**BSI United Kingdom)** | **ISO/TC** **/ SC** N<br>To be decided by TMB |
| Secretariat<br>**BSI** | |

A proposal for a new work item within the scope of an existing committee shall be submitted to the secretariat of that committee with a copy to the Central Secretariat and, in the case of a subcommittee, a copy to the secretariat of the parent technical committee. Proposals not within the scope of an existing committee shall be submitted to the secretariat of the ISO Technical Management Board.

The proposer of a new work item may be a member body of ISO, the secretariat itself, another technical committee or subcommittee, or organization in liaison, the Technical Management Board or one of the advisory groups, or the Secretary-General.

The proposal will be circulated to the P-members of the technical committee or subcommittee for voting, and to the O-members for information.

See overleaf for guidance on when to use this form.

**IMPORTANT NOTE: Proposals without adequate justification risk rejection or referral to originator**.
Guidelines for proposing and justifying a new work item are given overleaf.

**Proposal** (to be completed by the proposer)

**Title of proposal** (in the case of an amendment, revision or a new part of an existing document, show the reference number and current title)

English title: Project Management: Guide to project management

French title (if available):

**Scope of proposed project**

This standard provides generic guidance on the planning and realisation of projects and the application of project management techniques. It has broad relevance to projects in many industries and the public sector. It draws attention to the management problems encountered in different project environments and provides possible solutions to those problems.

It provides generic guidance to the principles and procedures which are relevant to organisations of all sizes although it may not cover all aspects of every type and size of project.

Application of the principles and procedures in different industrial and public sector environments (which may have unique and particular emphases and priorities) may require that the solutions presented should be treated as guidance only and that they may need to be adapted to suit the particular circumstances for which they are being considered.

**Concerns known patented items** (see ISO/IEC Directives Part 1 for important guidance)

☐ Yes ☒ No If "Yes", provide full information as annex

**Envisaged publication type** (indicate one of the following, if possible)

☒ International Standard ☐ Technical Specification ☐ Publicly Available Specification ☐ Technical Report

**Purpose and justification** (attach a separate page as annex, if necessary)

In recent years there has been a proliferation of sector specific standards worldwide which have had no overarching standard to set the generic principles and procedures of Project Management.

In addition the writers of these standards have had no common vocabulary to which they could refer with the result that terms have been used with different definitions and interpretations. This standard therefore provides a vocabulary to enable standards writers to harmonise the principles, procedures and vocabulary in existing and future standards.

It will be used by professionals involved in Project management, Management, Management techniques, Planning, Management operations, Organizations, Organization and methods, Budgeting, Forecasting, Purchasing, and Trading standards.

This proposal relates to a standard which is considered to be a management tool. A Guide 72 justification study is therefore not necessary.

If the proposal is successful, BSI proposes to leave it to the ISO Technical Management Board to decide the type of group which should be created to develop this standard.

**Target date for availability** (date by which publication is considered to be necessary) Sept 2009

**Proposed development track** ☐ 1 (24 months) ☒ 2 (36 months - default) ☐ 3 (48 months)

**Relevant documents to be considered**

Draft attached (will be expanded to include vocabulary)

**Relationship of project to activities of other international bodies**

Other documents can be taken into account during the development process

| **Liaison organizations** | **Need for coordination with:** |
|---|---|
| International Project Management Association;<br>Others when identified | ☒ IEC ☐ CEN ☐ Other (please specify) |

**Preparatory work** (at a minimum an outline should be included with the proposal)

☒ A draft is attached ☐ An outline is attached. It is possible to supply a draft by

The proposer or the proposer's organization is prepared to undertake the preparatory work required ☒ Yes ☐ No

| **Proposed Project Leader** (name and address) | **Name and signature of the Proposer** (include contact information) |
|---|---|
| Jim Gordon (UK) | Trevor Vyze |

**Comments of the TC or SC Secretariat**

**Supplementary information relating to the proposal**

☒ This proposal relates to a new ISO document;

☐ This proposal relates to the amendment/revision of an existing ISO document;

☐ This proposal relates to the adoption as an active project of an item currently registered as a Preliminary Work Item;

☐ This proposal relates to the re-establishment of a cancelled project as an active project.

Other:

**Voting information**

The ballot associated with this proposal comprises a vote on:

☒ Adoption of the proposal as a new project

☒ Adoption of the associated draft as a committee draft (CD) (see ISO Form 5, question 2.3.1)

☐ Adoption of the associated draft for submission for the enquiry vote (DIS or equivalent) (see ISO Form 5, question 2.3.2)

Other:

**Annex(es) are included with this proposal** (give details)

☒ One standard is proposed (a document is attached as an initial draft)

Project Management: Guide to project management (will include vocabulary)

| Date of circulation | Closing date for voting | Signature of the TC or SC Secretary |
|---|---|---|
| 2006-08-28 | 2006-12-01 | |

**Use this form to propose:**

**a)** a new ISO document (including a new part to an existing document), or the amendment/revision of an existing ISO document;

**b)** the establishment as an active project of a preliminary work item, or the re-establishment of a cancelled project;

**c)** the change in the type of an existing document, e.g. conversion of a Technical Specification into an International Standard.

This form is not intended for use to propose an action following a systematic review - use ISO Form 21 for that purpose.

Proposals for correction (i.e. proposals for a Technical Corrigendum) should be submitted in writing directly to the secretariat concerned.

**Guidelines on the completion of a proposal for a new work item**

(see also the ISO/IEC Directives Part 1)

**a) Title:** Indicate the subject of the proposed new work item.

**b) Scope:** Give a clear indication of the coverage of the proposed new work item. Indicate, for example, if this is a proposal for a new document, or a proposed change (amendment/revision). It is often helpful to indicate what is not covered (exclusions).

**c) Envisaged publication type:** Details of the types of ISO deliverable available are given in the ISO/IEC Directives, Part 1 and/or the associated ISO Supplement.

**d) Purpose and justification:** Give details based on a critical study of the following elements wherever practicable. *Wherever possible reference should be made to information contained in the related TC Business Plan.*

1) The specific aims and reason for the standardization activity, with particular emphasis on the aspects of standardization to be covered, the problems it is expected to solve or the difficulties it is intended to overcome.

2) The main interests that might benefit from or be affected by the activity, such as industry, consumers, trade, governments, distributors.

3) Feasibility of the activity: Are there factors that could hinder the successful establishment or global application of the standard?

4) Timeliness of the standard to be produced: Is the technology reasonably stabilized? If not, how much time is likely to be available before advances in technology may render the proposed standard outdated? Is the proposed standard required as a basis for the future development of the technology in question?

5) Urgency of the activity, considering the needs of other fields or organizations. Indicate target date and, when a series of standards is proposed, suggest priorities.

6) The benefits to be gained by the implementation of the proposed standard; alternatively, the loss or disadvantage(s) if no standard is established within a reasonable time. Data such as product volume or value of trade should be included and quantified.

7) If the standardization activity is, or is likely to be, the subject of regulations or to require the harmonization of existing regulations, this should be indicated.

If a series of new work items is proposed having a common purpose and justification, a common proposal may be drafted including all elements to be clarified and enumerating the titles and scopes of each individual item.

**e) Relevant documents and their effects on global relevancy :** List any known relevant documents (such as standards and regulations), regardless of their source. When the proposer considers that an existing well-established document may be acceptable as a standard (with or without amendment), indicate this with appropriate justification and attach a copy to the proposal.

**f) Cooperation and liaison:** List relevant organizations or bodies with which cooperation and liaison should exist.

## Foreword

This British Standard has been prepared by Technical Committee MS/2. It supersedes BS 6079-1:2000 which is withdrawn. BS 6079 is issued in four parts:

— *Part 1: Guide to project management*;

— *Part 2: Vocabulary*;

— *Part 3: Guide to the management of business related project risk*;

— *Part 4: Guide to project management in the construction industry*[1)].

This British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

**Compliance with a British Standard does not in itself confer immunity from legal obligations.**

## Introduction

Project management could be said to be as old as humankind since, by definition, any management activity that introduces a new objective or causes change and has a definite start and finish time is a project.

This standard provides guidance for:

— General managers: in organizations that operate projects: to raise awareness of the problems that are likely to exist within their own environment in the management of projects and to enable them to provide appropriate support for the project manager and team.

— Project managers: responsible for achieving the defined project objectives: to improve their ability to cope with the many problems that occur (only some of which may be foreseen) and encourage better integration between the different disciplines taking part.

— Project support staff: coordinators, planners, designers, cost analysts, quality auditors, technicians etc; to help them to understand the problems that may occur in their project environment, and to provide possible solutions to those problems.

— Educators and trainers: those engaged in the teaching of network-based and other techniques for project management who need to understand the industrial context in which these techniques are used.

This standard aims to draw attention to the management problems encountered in different project environments and to present possible solutions to these problems. Since there are no panaceas in project management, the solutions presented should be treated as guidance only; they may need to be adapted to suit the particular circumstances for which they are being considered. The only certainty in projects is that, without the full support of management for the project team and the

[1)] In the course of preparation

appropriate choice and use of planning and control techniques for the project, it will usually fail to achieve its objectives. The guidance given and the principles of project management described are applicable to all sizes of project.

## 1 Scope

This standard gives guidance on the planning and execution of projects and the application of project management techniques. It has a broad relevance to projects in many industries and the public sector, both at home and abroad. This standard aims primarily to provide guidance for relative newcomers to project management and to act as an aide-mémoire for more experienced practitioners and those who interact with project management teams.

The principles and procedures outlined are relevant to all sizes of organization, although they may not cover all aspects of every conceivable type and size of project.

Application of these principles and procedures in different industries may have unique and particular emphases and priorities.

It is highly recommended that this standard be used in conjunction with BS 6079-2.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 6079-2:2000, *Project management — Vocabulary*.

## Note from BSI - a full section on the terminology and vocabulary in Project Management will be added as part of the project.

## 3 Terms and definitions

For the purposes of this standard the definitions given in BS 6079-2:2000, apply, together with the following.

**3.1**
**configuration management**

technical and organizational activities comprising:

- configuration identification;
- configuration control;
- configuration status accounting;
- configuration auditing.

[BS EN ISO 10007:1997]

**3.2**
**matrix organization**

structure in which individuals, groups and managers continue to work within their specialist functional departments, but are assigned to work full-time or part-time under the direction of a project manager who is not their line manager.

NOTE Such assignees are usually responsible to the project manager for their project work and to their functional manager for other activities.

**3.3**
**project**
unique process, consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements, including the constraints of time, cost and resources

NOTE 1 An individual project may form part of a larger project structure.

NOTE 2 In some projects the objective(s) is (are) refined and the product characteristics defined progressively as the project proceeds.

NOTE 3 The outcome of a project may be one or several units of product.

NOTE 4 The organization is temporary and established for the lifetime of the project.

NOTE 5 The interactions among project activities may be complex.

[BS ISO 10006:1997]

**3.4 project management activity (PMA)**
operation, within a work package of a work breakdown structure (WBS), that is a specific action to be completed to aid the fulfilment of the project as a whole

**3.5 programme manager**
individual or body with responsibility for managing a group of related projects

**3.6 project phase**
part of a project during which consistent activities are performed to attain a designated objective. One of a series of distinct steps in carrying out a project that together constitute the project life cycle

**3.7 variations management**
monitoring, recording and assessing of variations to the scope or timing of a project, irrespective of who generated the change. The objective is to make all parties fully aware of the cost, time and quality implications of implementing such changes

NOTE Variations management is a term used in the construction industry. It is closely related to the more widely used terms change management and configuration management.

## 4 The corporate aspects of project management

### 4.1 General

Projects are the engines of change. The motive for change may stem from a perceived shortage of funds, changing patterns of demand, social pressures, technological advances, competitive and alternative suppliers of goods or services. There is little reason to suppose that the pressures will diminish; indeed some people would argue that the rate of change is likely to increase.

Those with management responsibility have to respond to those changes to survive, those who do it successfully will probably prosper, those who are slow or whose response is inadequate will decline and in due course fail.

As people in management take the series of decisions to move from where they are to where they want to be, or need to be, they will commit resources to the achievement of results they have not previously enjoyed. Each task will be unique in some aspect; opening a bank branch may not be novel to a major clearing bank but some single aspect, or combination of events involved in opening a particular branch will make it a one-off occurrence.

Thus the pace of change is causing corporate management to undertake more tasks with unfamiliar characteristics. Such decisions, for example to run with a series of projects of differing significance and durations, will test management skills. As the projects become more numerous, they are likely to run across departmental boundaries and will tend to become more expensive. Such a bundle of activities creates significant managerial problems and the purpose of this standard is to provide a guide to project management, based on best practices.
Research suggests that the overall track record of organizations in managing projects, including take-overs, leaves much to be desired. The delivery of results on time, within predetermined cost and of the requisite standard within set safety and quality criteria is less frequent than it should be. This standard aims to help people in management to deal with these situations more efficiently and effectively. The principles expounded in the standard are as relevant to small companies and small projects as they are to major enterprises with multi-million pound projects spanning several years.

### 4.2 Nature of projects

Projects may be revenue generating with consequences affecting the profit and loss account or, as more commonly understood, capital projects with the initial impact mainly on the balance sheet. The book-keeping conventions have little bearing on the management process.
The application of sophisticated project management techniques to projects in government and industry has become necessary to ensure the achievement of business, economic, environmental, strategic and political goals. The benefits of project management techniques are not restricted to large projects. Such techniques, like all good management practices, can usefully be applied to a project regardless of its size. It is often the case that major projects are broken down into smaller projects with a subcontractor, who thus becomes part of the project management plan of the parent organization and should be able to demonstrate competence in this area when tendering for the business.
A project is a means to an end. An enterprise may need, for example, to enhance income, and/or reduce costs, and/or improve productivity with reasonably clear ideas of the extent to which change has to be brought about. An understanding of the objective by the appropriate personnel should bring alternative ways of achieving or maybe even exceeding the objective.
Following a review of the alternatives and their respective consequences, senior management will decide on their preferred course of action and issue instructions to a responsible person for work to proceed. In due course, perhaps on time, or early, or late, the project will be declared complete and its outputs will usually become the responsibility of someone else. The ensuing results may or may not justify the expenditure that has taken place, which may or may not have been within agreed limits.
In some cases the time delay in completion leads to such excessive costs that the project in its operational mode will never deliver an adequate return.
Understanding the nature of projects may enhance the ability of people in management to handle them.
There are several attributes of projects, as follows:

a) they are non-repetitive and tend to have significant unique features likely to be novel to the management;

b) they carry risk and uncertainty;

c) they should be approved in return for undertakings to deliver specified (minimum) quantified results within pre-determined quality and safety/health parameters;

d) the authorization should leave no doubt that the results will need to be delivered with firm start and finishing dates, within clearly specified cost and resource constraints;

e) they are usually in the hands of a temporary team and may be subject to change as the work progresses;

f) in a long duration project, events inside and outside the enterprise may affect the outcome.

**4.3 The work to be done**

In any organization, whether private or public sector, service or manufacturing, software or hardware, it is necessary to plan, control and implement tasks to achieve a given objective. Although the concepts and basic principles of project management are universal, they have to be tailored and adapted to suit the particular circumstances of any project. This guide describes a full range of project management procedures, techniques and tools and the user is advised to select those elements that are appropriate to the project being considered.

To ensure success, the management of a project should be entrusted to an individual with a knowledge of the particular requirements of a given project and with certain essential personal attributes. This guide defines the basic skills to look for when selecting a project manager and the project team.

Effective project management may be broken down into five elements:

— planning;

— organizing;

— motivating;

— implementing;

— control by review and accountability.

Senior management is responsible for establishing the objectives and constraints within which the project has to be delivered. They should set realistic criteria and ensure that adequate planning has been done. This should establish the proposed expenditure and test the realism and acceptability of the expected benefits being put forward as justification.

Sub-standard project performance often results from failures at the planning stage causing a series of subsequent alterations/clarifications that pushes up expenditure and creates delays.

Increasingly, projects cut across departmental boundaries, in these cases management has to ensure that the appropriate organization is in place to run a project. This organization will often be a temporary arrangement, but will generally call for a project manager supported by a team of staff with the appropriate skills for the needs of the project.

The authority delegated to the project manager should be clear and because it will cover the team assembled from departments, that authority should be notified throughout the enterprise. Without this authority the project manager may be thwarted by departmental intransigence.
Working in a project team has been found to be an excellent capacity enhancing experience for departmental staff and may be seen as a valuable development method in career planning. On major projects it is not always possible for departmental staff to both make the required contribution and maintain departmental responsibilities, as a result they may be seconded to a project on a full time basis.

Management should consider the motivation of staff when they are taken out of their departmental roles. Tangible rewards related to the achievement of the project within the set constraints may

involve money, but in an appropriate culture other rewards might include the kudos of being selected to work on a project, of promotion to wider responsibilities following success in a project team, etc. Where staff are deployed on a full time basis there should always be an understanding that, as a minimum, a return to previous duties is safe.

Having agreed to run with a project and after an appropriate structure and pattern of motivation has been set up, management should issue instructions to proceed. The work of implementation can then begin. People will be deployed, materials bought and services secured.

Senior staff should, without becoming directly involved in the detail, ensure that proper operational procedures and controls are in place and being used. They should normally insist on reports at predetermined intervals, usually set as a condition of authorization, showing the current state of affairs and the latest expectation of completion in terms of at least cost and time. These reports will typically form the basis of reviews and the exercise of accountability with the project manager. These reviews will close one cycle and lead into the next cycle of replanning, to take account of changed circumstances, deal with problems and exploit opportunities.

## 4.4 The project life cycle

### 4.4.1 *General*

All projects tend to go through a similar life cycle. In large schemes the elements may be very clearly separated, in smaller works they may be linked and/or blurred. Different industries have their own terms. However, in general, it is useful and possible to identify the work that is carried out, as follows:

a) conceptualization and basic ideas;

b) feasibility tests for technical, commercial and financial viability;

c) evaluation and application for funds and stating risks;

d) authorization and setting any conditions;

e) implementation including design, procurement, fabrication, installation etc.;

f) control/accountability, periodic reviews and updates;

g) completion and handover to client;

h) operation and inclusion in normal revenue planning/control procedures;

i) close down and cease operations;

j) termination including disposal of residual assets (liabilities).

Some organizations are very successful in generating ideas for improvements, some are adept at converting those ideas into reality. The most successful do both, often by tapping into the knowledge and experience of their own workforce. Basic concepts will arise from solving current problems and also from identifying opportunities. Management should give encouragement both by tangible and psychological rewards.
For more detailed consideration of the project life cycle, see clause **7**.
Figure 1 shows a typical arrangement of project phases, stages and milestones.

**Figure 1 — Arrangement of project phases, stages and milestones**

### 4.4.2 *Project concept*

Each concept should undergo a screening process to test its viability in at least three different ways. This process should involve establishing:

a) if the project is technically feasible;

b) if it would be commercially and financially acceptable; and

c) if the costs and benefits show a balance that makes the risks of proceeding worthwhile.

This screening process, which will result in a business case being made, should be refined as the project proceeds from one authorization stage to another.

### 4.4.3 *Evaluating the project's feasibility*

In the first instance the feasibility study will be approximate as the prime purpose is to identify those ideas that look promising and separate them for closer attention from those which fail the tests. The schemes that offer promise should then be subjected to more demanding evaluation which will take up rather more of the time of the staff concerned. In many organizations those projects which survive a more rigorous examination will be brought to the notice of a senior manager who can, if so persuaded, champion the project and secure agreement for further progress. The activities in this phase will usually take the form of extended planning and a full evaluation. Organizations often find this is an appropriate time to select someone to run the initial project work. Frequently the person selected will become the project manager if the scheme proceeds. It would be that person's responsibility to assemble an interim team to provide the required inputs from disciplines such as marketing, sales, production, personnel and finance. The output would be collated in financial terms and critically examined. The champion would seek authority to proceed only when satisfied with the plans that had been drawn up. These plans might be expected to incorporate critical path analysis (CPA), an evaluation of net present value (NPV) using appropriate discount factors and a review of the sensitivity of the project to attendant risks.

Larger organizations tend to have tiered authorities, each capable of authorizing projects up to a set value and recommending higher amounts to senior management. In agreeing authorization, management will usually set conditions and constraints. One of the most important means of formalizing these conditions and constraints will be the timetable for reporting progress against key events or milestones. Funds will be earmarked and in large projects they may be released on a cumulative basis and triggered by the receipt of satisfactory progress reports from the project manager.

### 4.4.4 *Project implementation, handover and operation*

As implementation proceeds management will be aware that the only certainty in projects is the consequence of the costs and liabilities being incurred. The promised deliverables can only come later in the implementation phase. Hence there should be competent project progress reports at sensible intervals with review meetings for the exercise of accountability.

When the implementation is complete, management will usually require some degree of formality in handing over the project from the team that handled its completion to those responsible for its future operation. It is not uncommon for this next stage to last for a sustained number of years. Concurrent with the handover, a succinct and honest report on the history of the project up to that stage can be helpful in identifying strengths and weaknesses to aid future project management planning and control procedures.

At handover the project team may be disbanded or switched to other projects. The subject of their efforts will be absorbed into the normal budgeting, revenue planning and control systems until the operation ceases, for example due to technical obsolescence, market changes, simple plant life expiry, etc.

#### 4.4.5 *Terminating the project*

In most cases, closing down the project may be simple and straightforward, but in a minority of instances final termination may be a major event, and probably become a project in its own right. Items such as North Sea oil platforms, nuclear installations in submarines and power stations have major termination consequences. This is why their financial appraisal should be a whole life assessment to allow for what may be massive termination costs.

### 4.5 The benefits of project management

Good project management has proved to be an effective and efficient way of managing change in many types of organization. It allows senior management to accomplish the following:

a) direct scarce resources to what are judged to be the most desirable objectives;

b) focus appropriate management skills on to specific tasks;

c) secure commitments to deliver results from those wishing to proceed with the project;

d) direct major elements of the business without being submerged in detail;

e) keep control of a wide variety of projects running concurrently;

f) ensure that issues such as quality and safety are engineered into projects at the design stage;

g) extend the experience of staff working on projects and help equip them for wider responsibilities;

h) identify and manage risks.

NOTE Later sections of this standard pick up and expand the points made here, in a detailed manner that is more attuned to assisting the operators of project management activities.

## 5 Project and company organizational structures

### 5.1 General

Any group that provides a service or produces a product forms itself into an organization with a structure. This structure, and the size of the organization, will inevitably affect the way the organization can respond to change and the introduction of projects.

The structural form of the organization will normally be hierarchical, apart from organizations set up specifically to provide project services, with an emphasis on the functional operations. With this form, a small organization will always be able to respond more quickly to the need for change than a large one, since the owner or chief executive will have delegated less authority for specialist decision making to the functional areas.

As the organization grows, this traditional form is characterized by comparatively routine and predictable working procedures, a relatively low rate of change, specialized functional staff and, because of this, significant reduction in the need for cross-functional communication and cooperation. This has caused major problems in the current industrial environment as quick response to market demand for new or updated products or services or changes in the level of existing supply or product mix are required. The increasing rate of change, coupled with competitive demand to shorten development cycles, has led to the introduction and growth of project management as an organizational form within the traditional structure and the development of the matrix structure.

Although project management structures are often incorporated within the traditional structure of hierarchical functional organizations, they have many of the same basic characteristics and share the same resources as the other functional areas. Such structures require a much higher degree of flexibility in working procedures because of the unique nature of projects. This flexibility is affected by the size and complexity of the project, its duration, its geographical location and the contract terms and finance.
Figure 2 illustrates the primary forms of organization and how the authority relationships change between them. BS 3375-1 gives further guidance on organization study.

**Figure 2 — Authority relationships in organization structures**

### 5.2 The hierarchical functional organization

In this type of organization, which is the traditional form for most manufacturing and process companies, there is usually no separate project function or organization. This form of organizational structure has existed for a long time and has significant advantages, with its simple reporting and centralized control, so long as the rate of change is slow and any projects are small enough to be contained within and serviced by one functional group. If the project enlarges and crosses functional boundaries, or the sheer number of projects overstretches the functional resources, then the disadvantages of this structural form become apparent. An ever increasing burden may be imposed on the chief executive, in particular due to the lack of cooperation and coordination that occurs between the functional groups.

In these circumstances the project manager may report directly to the chief executive and require the support of some specialist staff in undertaking the project. This of itself can cause problems for the executive as the functional heads will be reluctant to release suitable staff and the project manager will be reluctant to make do with inexperienced people. If or when the number or size of projects increases a permanent project function should be set up and even then there will still be the need to draw specialist assistance from the functional groups for various aspects of the project. For instance, in a hardware project, engineering design work will still be carried out in the appropriate functional groups and the coordination and timing of that work will be the responsibility of the project team in conjunction with the functional heads to whom the design staff report for their professional competence.

### 5.3 The matrix organization

The problem of coordinating project activities does not become serious until functional boundaries are crossed or functional resources are overstretched. Until this happens it is not worth making changes to the organizational structure just to accommodate single projects with what is known to be a limited life. Once it becomes clear that projects will continue to be carried out within the organization and that there may be several running simultaneously, then a different situation arises and a change of organizational structure becomes essential. It also becomes necessary to set up a project management function with its own functional group of project specialists.

Furthermore, if these dedicated functional specialists are required by many of the projects, they will be appointed as part of the group either by withdrawing them from the existing functional groups or by external recruitment. If such specialists are obtained internally, which if at all possible they should be, then it is essential that they be disengaged from their previous positions. Ideally the project group, like any other functional group, should be physically located in its own area, the functional specialists will then still be able to refer to the functional supervisors, but only for quality and functional technical problems.

In multi-project situations this structure is essential and, while it may solve many problems, some will remain; also some new problems are created, in particular that of dual reporting. However firmly a functional specialist is disengaged from a previous supervisor, some loyalty will remain and the supervisor can influence the functional specialist's career. This can often lead to a dual reporting situation: one official and one unofficial. If, for example, a functional specialist has an unresolved technical disagreement with the project manager, any appeal should then be made through to the senior manager who has authority over both the project and the functional specialist's supervisor. There should only be one reporting system for the project that is operated by the project team through the project manager. All communications with the sponsor or client should be through the project manager.

Changes in managerial behaviour required by the move to a matrix structure are far-reaching, stretching to the board itself. To ensure that different project teams and functional groups react in the same way to similar circumstances and that all have the same view or priorities, a strong corporate culture should be developed. This is not an easy or rapid goal to achieve, but without it there may be inconsistent behaviour between project and functional groups with possibly serious consequences. The project manager's challenge is to motivate staff, both those seconded from the different functional areas and those within the matrix, to achieve the required performance in the primary areas of performance, cost and timing of outputs.

Equally, it is essential that motivation and corporate culture are also monitored by the functional manager. The management structure should allow differing views on objectives to be identified and resolved and should encourage peer group discussion on key issues. In a matrix structure several managers may have authority over project work. The functional manager for "how" and "by whom", and the project manager for time, cost and performance. The responsibility remains with the project manager and much tact and patience may be needed from senior management and project sponsors to make the matrix structure work properly. In particular, clear policies should be established for the career paths of those seconded to the project teams, both on long and short term appointments.

### 5.4 The project organization

The pure project form of company organization is not common, however it can be employed with advantage where projects are the normal business of the organization. In this type of organization the project team usually remains as a multidisciplinary unit and is moved from one project to the next as each is completed. This has the disadvantage that there may be a failure to develop functional specialists and general managers within the organization which may result in some projects being starved of adequate specialists. This also means that the project manager and the project team may need to have a high degree of autonomy from the host organization and that the project manager has to be given almost total authority for the project within the constraints of the host organization's general policies and strategies.

This form of organization has the distinct advantage of being able to precisely define and control the project budget, with different policies for different projects. It also reveals the cost of management that is normally contained within the overheads of the organization.

### 5.5 Criteria for reorganization

#### 5.5.1 *General*

Organizational changes involve transition from the current state towards a future state. Experience has shown that the time-scale for transition from, for example, a totally functional organization to a matrix organization can take from three to five years in a large organization.

The effective management of change involves developing an understanding of the current state, developing an image of the desired future state and moving the organization through the transition period. As much care should be devoted to the transition state as to the future state, both are critical. The two basic issues to be addressed in reorganization are what the change should be and how the change should be implemented.

### 5.5.2 *Politics of organizational change*

Political behaviour is a natural and expected feature of organizations. In the transition state these forces become even more intense as the old regime is dismantled and the new regime takes its place. Any significant change can upset or modify the balance of power among various formal and informal interest groups. The uncertainty caused by such changes can lead to ambiguity and increased political activity as individuals try to protect their own interests.

### 5.5.3 *Psychology of organizational change*

Organizational change involves the movement from something known towards something that is unknown and this is usually unsettling for the individuals concerned. Psychological attachment to the former organization should be recognized and time should be provided to disengage from the current state. Change can sometimes create a sense of loss and individuals should be able to work through their detachment from the current state.

Those involved may be concerned whether or not they will be needed in the new organization, whether or not their skills will be valued and whether or not they will be able to cope with the new situation. This stress and anxiety can create performance problems and may lead individuals to resist changes that they might otherwise support. Wherever possible, staff should be given reassurance regarding their roles in the planned reorganization.

A significant change in organization may disrupt the normal course of events within the organization. Such changes may also undermine existing systems of management control and make procedures seem irrelevant. Control is easy to lose during the transition from one state to another. As goals, structures and people shift, it becomes difficult to monitor performance and make correct assumptions that might otherwise be made during a stable period.

### 5.5.4 *Planning the transition*

The transition phase is characterized by great uncertainty and control problems because the current state is disassembled prior to full operation of the future state. Managers should coordinate the transition with the same degree of care, the same resources and the same skills as they manage any other project. The following list summarizes the actions to be taken during the transition state:

a) develop and communicate a clear image of the future state;

b) construct a statement that identifies the impact of the change on different parts of the organization;

c) maintain a stable vision and avoid unnecessary changes and conflicting views;

d) communicate, including information on future decision making and operating procedures.

These actions can be helped by the appointment of a transition (project) manager, allocation of specific resources for the transition, the use of a transition structured management system and a transition plan. The progress of the transition should be monitored and evaluated, with feedback of results via an established communication channel to the interested parties.

### 5.5.5 *Managing the transition*

Most formal organizational arrangements are designed either to manage the current or future states and not the transition state. Problems encountered in the transition state can relate to questions of power, anxiety and control.

Transition implies changes in the power structure of the organization with an inherent need to shape and manage political dynamics. Success depends upon the PM ability to:

a) motivate individuals through good communication;

b) obtain the support of key groups;

c) demonstrate leadership support of the change;

d) communicate using symbols, language and graphics

e) build in stability and reduce anxiety;

f) allow time to prepare for change, send consistent messages, build support and encourage participation.

It is important that managers and team leaders are aware of their role as models, as through their behaviour they provide a vision of the future state and a source of identification for various groups within the organization. They should articulate the vision of the future state and provide support through political influence and needed resources. This can be achieved by creating dissatisfaction with the current state, so that it is recognized that the current state is not perfect and requires change to avoid unwanted economic and business consequences. It should also be achieved by motivating staff and recognizing that their participation, although time-consuming, yields benefits that can lead to improved decision making. The project manager should communicate constantly in this phase and encourage feedback.

## 6 The project management process

### 6.1 General

The project management process described in this standard is different from the traditional hierarchical line management process. Project management is a universal process that is as applicable to the design and construction of a hydro-electric power station as it is to the introduction of an information system for a bank or the design of a public transport system. Characteristically, the project management process is designed to minimize the risk of failure in terms of time, cost and product fitness for purpose.

This standard describes a generic project management process that makes no assumptions about the content, size, phase or organization of the project. The guidance given can therefore be applied to most projects, regardless of industry sector, phase, size, complexity or content. Project management plans are one of the critical outputs from the project management process and they are described in detail in

Figure 3 shows the typical stages in a project sequence. The diagram shows the sequence of major documents that are frequently prepared as part of the successful management of projects. The list does not include the usual management reports relating to progress, exceptions, technical performance, quality, inspection, costs, expediting, commissioning and minutes of meetings.

**Figure 3 — Project documentation sequence**

The sequence starts after the inception phase of the project life cycle and ends at the handover phase, i.e. before operations.

Once a decision has been made to give a project serious consideration, a business case is prepared. This would include the cost/benefit analysis, major risk analysis, financial analysis incorporating a discounted cash flow (DCF) study, and possibly a preliminary feasibility study which can all form part of a preliminary project management plan (PMP).

Once the authority has been given to go ahead with the project, the project manager can augment the PMP (which is a live document). The PMP should include a project life cycle diagram listing the project phases, the project objectives (in terms of cost, time and quality) and the processes and procedures to be employed.

The relevant phases, especially the implementation phase, should be broken down into the work breakdown structure (WBS), cost breakdown structure (CBS) and organization breakdown structure (OBS). The WBS can then be used to carry out a further risk analysis culminating in a risk register.

The stages from the WBS should then be broken down further to enable a critical path network and resource estimation to be produced. These can in turn be converted into Gantt charts, milestone slip charts and resource histograms.

These aids can then be used to produce cumulative resource curves, cash flow tables and curves etc.

### 6.2 The project management process: introduction

Projects do not succeed just by assiduous adherence to a mechanistic process. The successful project should be managed with enthusiasm, vision, single-mindedness and integrity. The project manager should be able to generate these qualities in the whole project team. It should be noted, however, that no amount of misdirected enthusiasm will avoid failure. The project management process described here mitigates this risk.

Project tasks exist at all levels within the project. A WBS helps to describe project tasks in terms that are easily understood by all those involved. At the top of the WBS a single task can represent the complete project while tasks at the base of the WBS may represent detailed work undertaken by an individual. This concept is described later in this section.

The project management process and project management plan described here can be applied at all levels of the WBS. Thus, although the focus of this section is the process and plan used by the project team the guidelines for both process and plan can be used at any level within the project. The project management process can be divided into two parts, project management planning and project control. Project management planning is the development of a workable project management plan that describes project tasks in terms of “who does what”, “when”, “at what cost” and “to what specification”. This integrated plan of the project should be at a level of detail that the project manager considers necessary and sufficient to enable effective and efficient project control. The second part of the process is to use the plan to control and coordinate the progress of the project.

There are further subordinate processes contained within both planning and control and, depending on the circumstances of the project in question, each process will make a greater or lesser contribution. The project management process and its subordinate processes are shown in Figure 4.

The process of creating and using project management plans is usually the responsibility of the project manager, assisted and advised as necessary by the sponsor and project team. Although the need to plan is usually most pressing at the beginning of a project, the plan should be regularly reviewed and updated as necessary during the project life cycle. It should be noted that the more planning done before contractual obligations are established, the less risk there is of failing to meet those obligations.

## 6.3 The project management process: planning

### 6.3.1 *Obtaining authorization to proceed from the project sponsor*

It is essential to apply for and obtain authorization from the sponsor or a board of management to implement the project. Authorization may be given by the project sponsor for the whole project, project phase or in stages for work up to specified milestones, at which point further authorization will usually be dependent upon satisfactory progress.

### 6.3.2 *Establishing the project organization*

Projects may evolve within organizations that already have the structure necessary to support project work. Such organizations may be oriented exclusively towards projects or, more commonly, may adopt a matrix structure with the enterprise giving an equal and balanced emphasis to both the project team and the specialist functional departments that undertake work for different projects. A well designed and managed matrix structure should have the advantage of generating creative tensions between the project and functional disciplines. Functional areas usually demand clear and unambiguous statements of requirement from the project team and project teams usually demand a positive commitment from the functional areas to project duration, costs and performance. Subcontractors may be treated in the same way as an in-house function except that relationships between the subcontractor and the project manager will usually be subject to formal contract. Alternatively, the project may have emerged as a separate entity without the support of an existing organizational structure. This is the case, for example, when a consultancy undertakes a project for a customer and where the work is done by third party agencies.

The project manager should establish mutual accountability between the sponsor, suppliers, task owners and the project team and, if necessary, written terms of reference. The following organizational factors should be defined:

— “Limits of authority”:

The project manager should clearly understand the limits of authority for any action that is initiated. For example, financial limits may be imposed by the sponsor or some organizations may prescribe lists of approved suppliers that limit the freedom of choice of subcontractor. The project manager may also be constrained in the action that may be taken against defaulting suppliers. In order to operate effectively, the project manager should understand clearly how the freedom to act is constrained. Such limits should be stated in writing and form part of the project management plan.

— “Incentive mechanisms”:

Payment for goods and services is a critical part of project management. Payment terms may often be defined by the contract and the project manager should be aware of the leverage that can be exerted by terms that focus suppliers on delivery to time, cost and performance parameters. Because projects are usually bound by strict timescales, the project team should be allowed adequate time to assess the quality of purchases before payment is authorized. It is essential, however, that suppliers are paid promptly and strictly within the timescales stated in the purchase order.

Incentive, or premium payments, designed to accelerate critical activities that have a direct effect on overall project performance, can offer both supplier and project manager mutual benefits. Late delivery, cost overrun or failure to meet specification may therefore be penalized, where appropriate, to focus supplier efforts on project goals. The project manager may also seek the right to retain payment until a period has elapsed during which time the goods and services being purchased can be assessed for fitness for purpose. The purchaser should ensure the supplier has a clear understanding of incentive mechanisms, which should be reflected in the contract. More guidance on procurement functions is given in **6.6.4**.

— "Communication framework":

Success or failure of a project tends to depend on how well various members of the project team communicate with each other. It is essential for the project manager to implement an effective communication network designed to enable all relevant parties to report progress, express concerns and discuss how to achieve the project objectives. The project manager should identify a structure and schedule of meetings, each with their own terms of reference, list of attendees and agendas.
All project management team members should recognize that effective communication is a two-way process. Suppliers should be encouraged to raise concerns at the earliest opportunity, rather than waiting until a problem has matured into an intractable hazard. The project manager should promote an open forum for the discussion of issues. Suppliers and task owners should not be made to feel so intimidated that they are prevented from discussing bad news or raising doubts about their ability to achieve specific objectives.
More guidance on project organization is given in clause **5**.

Figure 4 shows the project management process flow.

**Figure 4 — Project management process flow**

### 6.3.3 *Development of product and WBS*

#### 6.3.3.1 *General*

Once a project organization has been established, the project management planning process should continue with the project manager providing suppliers with a summary statement of requirements so that each supplier can identify the tasks that should be done.

Figure 5 shows how a project can be broken down into individual tasks; although the example given is a specific product-based WBS (a contract to supply gas turbines), the principle is applicable equally to any type of project.

The product-based WBS is the and most useful form; however, there are several other ways in which a project can be broken down, such as by activities or by cost elements.
The techniques described in **6.3.3.2** to **6.3.3.7** should be used when developing a WBS.

**Figure 5 — Model product-based work breakdown structure (WBS)**

#### 6.3.3.2 *Task decomposition*

The project deliverables should be split into manageable units of work to generate a hierarchical structure of tasks. In this hierarchical structure any one task should be the child of a parent task that is higher in the structure and should also be the parent of one or more child tasks lower in the

structure. An existing WBS can be helpful in identifying tasks for new projects, where similar work has been done in the past.

**6.3.3.3** *Task identification*
Task identification should begin by broadly defining tasks outlined in the statement of requirements and then expanding to a level of detail necessary and sufficient for inclusion in the project management plan. At each iteration the estimated workload and costs should be refined as necessary. It is essential that estimates, if not originated by the task owner, are sanctioned by the task owner. The project manager should not accept an estimate for a task from a third party who is not responsible for the task. The project manager should gauge the acceptability of each estimate by comparison with past performance and this may only be possible if previous work has been structured in a similar way.

**6.3.3.4** *Task levels*
The single, top level task of the project WBS will be the project as a whole. Lower levels within the project WBS should describe tasks that, when added together, comprise tasks appearing at higher levels. This hierarchy of tasks should enable task-related information to be summarized and audited to various levels of detail. The hierarchy should also permit exception thresholds and summary reporting requirements to be applied at whatever level the project manager decides is appropriate. An additional benefit of using a project WBS is that it provides a structured definition of tasks that can be reused for future projects. It can also be used to record trends in supplier and task owner estimates and actual performance for similar tasks in different projects.

**6.3.3.5** *Level of detail*
The project manager and project team should be skilled in assessing the “depth” of the project WBS required. For example, if a project WBS is too shallow there will be a risk that tasks are not defined to an adequate level of detail. Conversely, if the project WBS delves too deeply into the task structure there is a risk that the project will be over-managed and the plan will become over-sensitive to change.

**6.3.3.6** *Validation of the task structure*
It is important that any task considered for inclusion in the project WBS is tested for its benefit to the deliverables of the parent task.

The structured decomposition of tasks in the WBS should offer the project manager many opportunities to assess parent/child task relationships using principles of conservation. For example, is some element of the product defined in the parent task lost in the definition of child tasks?

If so, then a child task corresponding to the missing element should be added to the WBS. New task material appearing in a child task should also be explained in terms of its parent task.

**6.3.3.7** *Relating tasks to the project organization*
There is considerable benefit in relating individual lowest level child tasks to specific organization elements, such that the child task is at the intersection of a product based project WBS and an organizational breakdown structure. This relationship enables a responsibility assignment matrix to be developed that has lowest level child tasks along one axis and organizational breakdown structure elements along the other. The name of a task owner in a cell within the responsibility assignment matrix should show task accountability.

The WBS can be product based, cost-centre based, task based and/or function based, but product based is preferred.

**6.3.4** ***Analyse the project tasks***

**6.3.4.1** *Level of task decomposition*

A workable compromise between the extremes of insufficient or excessive levels to WBS should be achieved. The project manager should determine whether or not a task has been defined at an adequate level and ultimately this decision will be governed by experience, intuition and circumstances.

**6.3.4.2** *Single accountability*

Each of the lowest level tasks should have a single owner who is accountable to the project manager for the successful achievement of the task. If a task is shared by two owners then it should be split until unique accountability for the major part of the task can be clearly identified. One person may be the owner of several tasks.

**6.3.4.3** *Performance measurement capability*

Each task should contain within its definition the means to measure the performance of the task owner. Performance of tasks with extended durations and few discrete deliverables can be difficult to assess. Ideally tasks should be defined at a level where objective measures of performance can be applied. Thus short tasks, or long tasks with regular deliverables, should provide an adequate basis for measuring performance.

**6.3.4.4** *Cost element*

The total costs of each task should be expressed in terms of their separate elements, for example in labour or purchases. It is often useful to decompose a task according to its cost elements.

**6.3.4.5** *Criticality*

It should be possible to describe the task as either critical or non-critical. This means that task interdependence needs to be understood accurately. If a critical activity exists within a task then that activity may need to be broken out as a separate task.

**6.3.4.6** *Earned value type*

The method of calculating earned value or performance should be the same for all work contained in the task. The earned value method is described in **6.6.6**. If performance for part of the task is calculated on the basis of the discrete deliverables achieved and another part is calculated on the basis of percentage of planned costs then the task should be split in order to separate the two types of work. This should clarify the means of performance measurement.

**6.3.4.7** *Supplier performance reliability*

The level of detail to which the plan is defined will be influenced by the reliability of the supplier. Tasks assigned to proven suppliers may be defined in less detail than tasks assigned to unproven new suppliers. The project manager should ensure that the plan is set at a level that gives confidence and reassurance that the supplier will deliver in accordance with time, cost and performance parameters. Reliable suppliers and task owners may require less supervision, thus allowing the project manager to concentrate effort on eliminating risks elsewhere.

**6.3.4.8** *Task risk*

The ultimate criterion that the project manager should use to assess whether or not the project WBS is defined at an acceptable level of detail is the degree of risk associated with any task. If there is

significant risk identified with the task the project manager may wish to decompose the task still further in order to isolate the risk and prepare mitigation plans.

**6.3.5** ***Assign a single accountable task owner to project tasks***
The identification of a task owner for each child task is an important step in developing a project management plan. If a single task owner cannot be identified then the project manager may not be able to manage the task. The task owner may be a member of the project team, an individual appointed by a supplier or subcontractor for liasing with the prime contractor or a manager who has resources that could be used to achieve the task objectives. The project manager should be aware that blind application of the "single accountable task owner" rule could lead to an unmanageable number of tasks, each allocated to the individual doing the task. Sensible application of this guideline recognizes that reliable accountability normally exists some way above the individual task doer. The process of identifying the task owner is subtle but vital and depends on how the word "accountable" is interpreted. In this case the accountable task owner should have a duty to the project manager for the successful achievement of the task. This also implies that the project manager has a veto over the appointment of task owners and may, in certain circumstances, exercise the right to disqualify a task owner whose performance is unacceptable.

In a matrix organization where project groups procure goods and services from various functional areas, a distinction between task owner and functional manager should be made. Often a relatively junior worker may be a task owner and have accountability to the project manager for achieving the objectives of the project work, while at the same time reporting to a functional manager for the professional standards of the work. It is vital for the project manager to identify the task owner at the level within the functional organization where the task owner is best able to be accountable for project work. Seniority does not always make for an effective project task owner.

Although ideally the task owner should be in direct control of all the resources needed to execute the task, this is rarely possible. A task owner who needs to subcontract to fulfil the task requirement may be acceptable to the project manager provided the subcontracted element of the task is a minor part of the whole task. In this case the project manager should have the ability to audit the trail of accountability through the task doer to the subcontractor.

**6.3.6** ***Developing a statement of work (SOW) for project tasks***

**6.3.6.1** *General*
Each task should be defined by its SOW, which for parent tasks need not be more than a summary of the work defined in the child tasks. The SOW may contain a qualitative assessment of risk associated with the task. It should also define how and when to issue progress and exception reports and how performance is to be measured. The SOW may not emerge as a result of the task owner's initial response to the project manager's statement of requirement. Useful SOWs, that remain relatively stable throughout the project life cycle, usually result from several iterations between task owner and project manager. This iterative process should improve the quality of both the project manager's understanding of the task owner's needs and the task owner's understanding of the project manager's requirements.

Bypassing this step in the planning process poses a high risk of cost overruns, late deliveries and contract changes. The primary elements of a SOW are as follows and are further described in **6.3.6.2** to **6.3.6.12**:

a) a task reference code;

b) a summary description of the requirement;

c) the name of the person accountable for completion of the task;

d) a list of key deliverables;

e) timescales for the deliverables;

f) a schedule of task dependencies and subsidiary tasks;

g) a schedule of costs by cost element;

h) an assessment of risks associated with the task;

i) performance measurement and task completion criteria;

j) a description of the work content of the task;

k) reporting requirements;

l) the name of task owners (if known).

**6.3.6.2** *Task reference code*
Each task should be assigned a unique reference code. This is an essential and efficient way of summarizing project information and can also be used within monitoring, reporting, accounting and configuration management systems. For large projects WBS dictionaries of task definitions may be compiled where the task code provides a unique reference key. Task reference codes can provide a logical shorthand description of tasks that can instantly convey the relative position of the task in the overall project WBS. More information on configuration management is given in **6.6.2**.
The code for any task should correspond to the code assigned to that task in the project WBS as defined in the WBS section of the project management plan. A parent/child relationship between tasks is implied in the WBS code, for example task 1.1.1 is a subtask of task 1.1.

**6.3.6.3** *Summary description of task*
The SOW should contain a high level description of the work content for the task. The definitive detailed specification of the task requirements, for example, a colour scheme for the internal decoration of a building, should normally be given in reference documents that may be quoted in the contract. Such specifications should not be detailed in the project management plan. A summary description should be sufficient to orient the reader and inform the project manager and task owner of the substance of the task and point to any supporting reference documents that give the full information.

**6.3.6.4** *Named accountable task owner*
The SOW should identify the task owner, who is ultimately accountable to the project manager for the successful achievement of the task, by name. Successful achievement should be measured in terms of cost, performance and timely delivery of all deliverables and the satisfactory performance of all reporting requirements. The task owner should estimate the time and cost of the task and register agreement by signing the “commitment acceptance” section of the project management plan.

**6.3.6.5** *Key deliveries and milestones*
The SOW should contain a list of the key deliverables and the dates by which the task owner has committed to deliver them to the project manager through the life of the task. These deliverables and the task cost schedule should be used for performance measurement. Deliverables should be defined in order to provide the sponsor and project manager with a means of measuring performance, and should, for example, include the start and finish of each subtask within the task and any relevant milestones. The SOW should also record the acceptance criteria to be applied to each deliverable.

**6.3.6.6** *Time-scales for deliverables*
The start and finish dates and duration of the task should be recorded in the project management plan. It may be beneficial to record earliest and latest start and finish dates for the task and to note whether or not the task is on or near to the critical path (see **6.5.6**). This information should be consistent with dates in the schedule section of the project management plan. Where the risk assessment indicates that there is a significant risk then a three point duration assessment (best-worst-most likely) should be included.

**6.3.6.7** *Task dependencies*
Tasks rarely exist in isolation. The project management plan should record those tasks and people on which the current task depend (predecessors) and those tasks and people (successors) that depend, in turn, on the current task. The type of dependency should be recorded, for example, “finish-to-start”, where the successor task cannot begin until the predecessor task has finished. This should enable a network of interrelated tasks to be constructed that can be used to support analysis of the complete project management plan.

> NOTE Most project management planning tools use task start dates, durations and dependencies to calculate how much additional time is available, also known as float, before the task becomes critical, i.e., zero additional time available.

Figure 6 shows two types of network configurations in common use.
(a) = AoA network (b) = AoN network (c) = bar chart (d) = histogram (e) = cumulative “S” c

**Figure 6 — Networks, model bar chart and histogram**

The activity on arrow (AoA), configuration (a), was the method used when network analysis was originally developed and is still useful when large numbers of activities with complex interrelationships have to be drawn manually before inputting into a computer.

The equivalent activity on node (AoN), configuration (b), is now the more prevalent, mainly because it has been adopted as a standard in many of the project management computer programs. Both methods can be quickly converted into a bar chart (c), to which can be added the resources, usually persons or money. When these are added up vertically for each time period, it is possible to draw a resource histogram (d), which shows the distribution of resources over the period of the project.

By adding these resources cumulatively, a cumulative “S” curve (e), can be produced which shows the rate of usage. The bar chart, histogram and “S” curve can be drawn separately, but should always be to the same base.

**6.3.6.8** *Schedule of costs by cost elements*
The planning activity should establish a schedule of costs for the task that differentiates between different cost elements. The effect of changing cost rates should be isolated and understood by the project manager. The SOW may contain a phased profile of expected costs for each task, with contributions from different cost elements identified separately. The integrity of this information is fundamental to the success of the project and time spent at the planning stage in identifying the key factors that influence costs is essential.

An expenditure profile, showing the phased budget for the task over the relevant timescale, should be stated. In order to support earned value calculations, this profile should include increments of planned expenditure corresponding to each deliverable defined in the SOW. The expenditure profile should also show the current limits of authorized expenditure in terms of value and time, together with a risk assessment where necessary.

**6.3.6.9** *Assessment of risks*
The SOW should record the results of qualitative and quantitative risk assessment for the task, where it has been deemed appropriate (see **6.6.3**).

**6.3.6.10** *Performance measurement and task completion criteria*
The most important factor when selecting how to measure performance is to use the best objective measure possible. A list of a combination of cost, schedule and deliverables should provide a robust basis for measuring performance. Earned value or budgeted cost of work performed can be calculated using this combination (see **6.6.6**).

If the task deliverables list provides for an even distribution of deliverables throughout the project and the task expenditure profile has been compiled in line with the deliverables schedule, then these two data should form the basis for sound earned value calculation. Where no deliverables are scheduled during a relatively long period of task activity, then the project manager may impose a subjective method for estimating earned value. For example, earned value may be credited on the basis of 50 % of the planned cost at the start of the task and 50 % of the planned cost at completion. More guidance regarding performance measurement is given in **6.6.6**.

**6.3.6.11** *Detailed description of task work content*
The SOW should contain unambiguous information that describes in adequate detail the work content of the task. Where possible, reference should be made to supporting documents and contracts in order to avoid duplication and possible corruption of information. Where work definitions are contained in reference documents, then these documents need to be subject to the same management disciplines as the project management plan.

**6.3.6.12** *Reporting requirements*
The SOW should define what reports are needed and at what frequency to meet the requirements of the sponsor, contractual obligations and the level of information that the project manager decides is necessary to control the work. In general terms the task owner should be made responsible for informing the project manager of any changes to the information contained in the SOW, for example, changes to risk assessments. The following specific aspects of reporting should be addressed.

a) Performance status: The task owner should report the actual or forecast date of achievement for the deliverables defined for the task. The method by which the task owner calculates and reports the earned value for the work completed to date may be defined by the project manager.

b) Schedule status: The task owner may be required to report the estimated time of completion for each task. This information should be consistent with the progress of deliverables. Forecast start or finish dates that are later than the most recent planned start or finish dates should be shown separately, as any slippage in these dates may affect the project completion date.

c) Cost status: The task owner should report the actual expenditure and committed expenditure to date for each task. The task owner should also report the estimated cost at completion for each task.

d) Status of quality progress: The task owner should report any change that might affect the form, fit or function of the task deliverables.

e) Risk exposure system: The task owner should report any changes in the status of identified threats to the achievement of tasks, together with any newly identified threats or opportunities.

f) Exception thresholds and variance reporting: The rules for triggering exception reports should be based on margins applied to the forecast time or cost at completion, or actual time and cost status and derived earned value statistics. An exception report may contain a statement of the actual or forecast exception, a description of the planned recovery action and an estimate of the threat to the project management plan in terms of the time, cost and performance.

**6.3.7** ***Balancing time, cost, integrity of specification and risk***

The project manager should continuously balance timescales against cost and risk, without undermining the performance of the project. The SOW will be further developed and refined during the project management planning process, usually revealing more information concerning task costs, timescales and risks. The project manager should analyse this information and understand the overall project cost profile, schedule and where the risks lie. This information can be integrated into a cumulative probability distribution for cost and time for the whole project. In this case the uncertainty will have been calculated by random sampling from the individual probability distributions for those tasks where risk has been identified. This task may be mechanized and is usually based on the best current version of the project task network.

The project manager should compare data contained in the SOW with previous data for similar work and, where differences are found, investigate the causes with the task owner. This should reduce the risk of inaccurate forecasting. New information is likely to perturb whatever fragile balance between time, cost, performance and risk the project manager has managed to construct. The critical path, at least during the preliminary project management planning, may wander from task to task with disconcerting ease and unpredictability.

The project manager can often buy time with money or save money by tightening timescales, but should be mindful of the objective to reduce the risk of failure and maximize the chance of success. The project manager should gauge where a task needs more time and seek to lengthen the time available by shortening other tasks. Alternatively some tasks may be allowed to take longer and any resulting cash savings then used to shorten tasks that lie on the critical path. This process is sometimes referred to as “crashing” which involves the project manager in experimenting with the available options. Significant results from such experiments should be recorded systematically, not only to form part of the project manager’s historical records for use in future projects, but also to justify actions and enable informed decision making during the project life cycle.

At this stage in the process the project manager may benefit from using a bar chart representation of project tasks (see Figure 6). If utilized the chart should present tasks as horizontal bars against a horizontal time axis. Its main use is as a graphical method of showing both the current state of the plan and, once the project has started, progress across all tasks simultaneously. The bar chart has great visual power. A large format project bar chart may be used to focus project review meetings on certain issues and, more generally, as the medium for recording issues and comments that occur during the day-to-day running of the project.

### **6.3.8** *Obtaining commitments to do project tasks*

#### **6.3.8.1** *General*

Each task owner should formally agree the appropriate tasks, for example by signing the commitment section of the project management plan. The task owner's commitment should signal that the assigned work can be completed as defined in the plan. If the task owner has objections to the plan, changes should be negotiated with the project manager. If a compromise cannot be reached, it may be necessary to obtain the task owner's commitment, subject to caveats in written form, agreed with the project manager. The process up to this point is likely to require several iterations between the project manager and task owner. Commitment may be qualified by an expiry date beyond which the task owner reserves the right to withdraw a commitment that has not been formally accepted. On reaching the expiry date, the task owner may provide a revised offer of commitment with a new expiry date. Any work delegated by the task owner should be supported by commitment obtained from the organization, individual or subcontractor undertaking the work. The trail of commitment acceptance to the project from the ultimate task owner should be visible to, and auditable by the project manager.

Final agreement between project manager and task owner should be based on the particular issue of the project management plan that defines the contract work. This is necessary for obtaining a firm commitment to any changes to the plan that are identified during negotiation. The form of these negotiations will depend on the legal relationship between project manager and task owner and the agreement is often in the form of a legally binding contract. The project manager may need to select one or more bids from several competing suppliers at this point in the process and in the event of a contest should disclose the selection criteria. The project manager should be aware of the legal obligations relating to supplier selection and the need for the selection process to be non-discriminatory.

#### **6.3.8.2** *Identifying resources required*

The task owner should understand what resources, at what levels of assumed efficiency, are required to perform the task before making a commitment. Resources may be in-house labour or goods and services procured from an external source. (Procurement is covered in **6.6.4**.) Resource management is a related, but separate, discipline to project management and the project manager need not understand the nature of the resource required to undertake a task, only how the application of this resource translates into time, money, performance and risk. This separation of duties might appear unnecessary, but the task owner should be allowed the freedom to apply whatever resource is appropriate to the task, providing the timing, cost and performance of the project deliverables are not jeopardized.

#### **6.3.8.3** *Identifying available resources*

It is the responsibility of the task owner to understand the availability of resource needed to complete the task as described in the SOW. Resource is often not dedicated to specific projects and, in these circumstances, the task owner should know what competing demands there are for the resource, when they will be made and with what priority.

**6.3.8.4** *Balancing load with capacity*
Understanding the resource demand profile based on all sources of demand is the responsibility of the task owner. Time and cost estimates should be given to the project manager when the task owner is satisfied that there are sufficient resources to satisfy the demands of the project.

**6.3.8.5** *Reserving and allocating resource*
In the latter stages of this iterative process the SOW becomes progressively firmer until the point is reached when the project manager accepts the offer from the task owner and asks for resources to be reserved pending a formal instruction to start work. When the instruction to start is given, the task owner has a duty to allocate the resource.

**6.3.9** ***Finalizing agreements***
The iterative process of project management planning is itself a task that is constrained by time and money. The project manager should be given enough time to plan the project to the necessary level of detail, bearing in mind that project management plans that are too detailed will be too sensitive to change and may require continuous formal change procedures during the project life cycle. When the project manager is satisfied that the plan represents the best chance of satisfying the sponsor's requirement the agreements between project manager and task owners can be formalized. The degree of formality may vary depending on the nature of the agreement and the organization in which the work is being managed.

Agreement signals that the project manager accepts offers from the task owners to do work as defined in the plan. Agreement should also signify a bilateral agreement between the project manager and each task owner. This may take the form of several, separate contracts. Thus the task owner commits the resources as planned and the project manager commits to release project funding, conditional upon successful completion of deliverables if necessary in agreed stages. A schedule of funding release dates, corresponding to phased increases in limits of liability, should be described in one of the statements of work under the "manage project" branch of the WBS. Work can then be released.

The project manager should be authorized by the sponsor to agree to plans within the constraints specified. If the plan falls outside these constraints then the project manager should either change the plan in order to conform to the constraints or refer the issue to the sponsor. If the project manager is unable to accept any stated hazard or risk associated with any tasks in the plan, the appropriate task owner should re-plan such tasks so as to eliminate the hazard and to recommit to the revised work prior to agreement. If the risks remain unavoidable and unacceptable to the project manager then the project manager may seek an alternative task owner or refer the issue to the project sponsor. Ultimately, the sponsor may decide to abandon the initiative.

## 6.4 The project management process: control

### 6.4.1 *Controlling the project management plan*

All projects are subject to change and their success depends on how well they are planned in the first instance and how well changes are managed. The project manager should ensure that changes to project objectives and consequent changes to task the SOW are communicated unambiguously and are reflected in the current version of the plan. All changes should be agreed by the project manager and the task owners concerned and this agreement should be registered in the project management plan. Essential changes should be implemented at the earliest opportunity to minimize the impact on time, cost and specification.

The project manager is responsible for the integrity of the project management plan and should ensure that all changes to the project management plan are controlled. Such changes may be requested by the customer, sponsor or task owner. The planning process outlined in **6.3** should be followed as rigorously for a change to an existing plan as for a new plan. It is essential that the project manager ensures that the current version of the project management plan reflects the current contractual requirements in terms of time, cost, performance and specification. The following guidelines should be used to manage changes to the plan effectively and efficiently.

a) The project manager should be responsible for the control of the project management plan and should authorize any changes.

b) Issue of a revised, agreed project management plan should automatically cancel all previous issues.

c) Each issue of the project management plan should be allocated a unique sequential revision code so that previous plans can be easily identified and replaced with the latest version.

d) The reasons for changes to the project management plan should be fully documented and a cross-reference made to the revision codes. A complete history of such changes should be retained by the project manager.

e) Work should not be released from a draft project management plan.

f) No one item of work should be put in more than one project management plan.

g) Where a change to a project management plan is minor and can be contained within the existing commitments of task owners, then the project management plan can be amended without re-issue. Details of the amendment may then be given to all project management plan holders by the project manager. Guidelines for deciding whether a change constitutes an amendment or a re-issue should be documented.

h) The project manager, in consultation with a legal advisor if necessary, should be responsible for ensuring that the revised project management plan does not jeopardize any contractual obligations.

### **6.4.2** ***Managing the project budget***

#### **6.4.2.1** *Setting annual budgets*

Organizations usually budget annually and, because projects may span several years, the project manager should ensure that budgets reflect the funding and cash flow requirements of project work in ensuing years. If this step is not followed, project funding may evaporate or adversely affect the budgets of other parts of the organization. More guidance on financial control techniques is given in **6.6.5**.

#### **6.4.2.2** *Releasing project funds and retaining management reserve*

Funds should be released to the task owners so that project work may start. The project manager should also make allowance for unexpected problems or small changes by retaining some of the project budget as a management reserve (MR). Determining the correct level of this reserve can be a key to the success of the project and the reputation of the project manager. An inadequate management reserve may put the whole project at risk when problems arise. Conversely, if the management reserve is too large the task owners whose budgets have been used to provide MR may use lack of adequate funding as an excuse for late delivery and poor quality of deliverables. Accordingly, a full justification should exist for the level of management reserve retained, where appropriate, referencing specific risks whose mitigation may require proactive funding.

Project funds may be applied according to the risks associated with the work. Where significant risks have been identified, maximum levels of expenditure for the task may be specified. Limits to the levels of both committed and actual expenditure should be identified for tasks that are to be released in stages.

Budget logs, with cross-references made to the tasks in the project management plan, should be used to record all transfers of project funds. The project manager can keep logs for planned profit, total expenditure, management reserve and all task budgets.

The task owner is responsible for ensuring that the costs incurred in performing work for the project are attributable to the correct task in the project WBS and should ensure that all costs attributed to the project can be audited. Task owners should be able to give the project manager a clear statement of those irrevocable costs for which the project would be liable if it was to be terminated. This should include, but not be limited to, the sum of all committed costs. If a legal relationship exists between the project manager and the task owner, for example, where there is a formal contract in place governing the sale of goods and services by the task owner to the project, it will be necessary to state contractually how the project and the task owner should allocate the costs if work is terminated prematurely. This is usually only necessary when the services of third party suppliers are employed. Guidance on procurement functions is given in **6.6.4**.

**6.4.3** ***Instructing work to begin, continue or stop***
The structured nature of the tasks contained in the plan should permit the project manager to control the project by releasing or stopping work in terms of any permutation of task or part of a task. Critical project reviews may be required at specified milestones throughout long lead time projects, in order to give the sponsor and project manager the opportunity to review progress and decide whether to continue or curtail work. The means used by the project manager to start, continue or stop work should be clear and unambiguous in terms of the amount of money released, the nature of the goods and services requested and the individual for whom the money is intended. This process is helped by having a realistic plan and clear SOW.
Usually the project manager is responsible for formal termination of the project. This action should follow the formal acceptance of the final project deliverables by the sponsor, the achievement of all the project completion criteria and the settlement of outstanding debts.

**6.4.4** ***Monitoring progress***
The monitoring and analysis of project data should enable the project manager to address problems at an early stage and take advantage of opportunities that might benefit the project. Time is a vital and non-recoverable asset, the aim should always be to pre-empt situations rather than to respond to problems after they have assumed unmanageable proportions.

Good communications between project manager and task owner are essential. If communication links are weak then problems can escalate, no matter how much information is available. Effective monitoring and analysis should help the project manager and task owners to understand the status of the whole project, the effect of their performance on the project objectives and any risks that lie ahead.

The task owner should fulfil the regular reporting requirements contained in the PMP and submit written exception reports to the project manager if the progress of work deviates significantly from what was originally planned. Exception reports should not only explain the reasons for exceeding or failing to achieve performance thresholds, but also describe how the situation can be recovered.

The task owner is accountable to the project manager for the completion of committed tasks to time, cost and specification and should warn the project manager of any operational issues that affect the work of other task owners. The task owner should ensure that SOW data are kept up-to-date, inform the project manager of tasks in danger of becoming critical and provide a revised risk assessment for the task. Similarly, the project manager is responsible for keeping task owners briefed on the current state of the whole project. Specific project monitoring reports may be required and the vital basic elements of information that all projects require are as follows.

a) Actual costs reported against planned cost and variances: These should be identified and compared to variance thresholds imposed by the project manager. If a threshold is breached then the task owner should provide reasons for the variance and submit a recovery plan stating the impact on cost, time and specification. The impact of current actual cost on project cash flow should be of specific concern to the project manager. This will either ease or increase the financial burden of the project.

b) Time and cost at completion: The task owner should provide a regular estimate of the time and cost at completion for each task. Although it is possible for the project manager to extrapolate existing data to provide such an estimate, the task owner should also be given an opportunity to record a subjective view. Reconciling differences between the project manager's estimate based on actual data and the task owner's opinion provides a useful insight into real and perceived progress.

c) Earned value: The task owner should report performance regularly. Earned value measurement is one of the available methods of reporting performance and it can be used to calculate cost and schedule variances that may in turn be used to calculate performance indices and objective projections of cost, time or some other measurable value such as labour hours or materials usage, at completion. More information on the earned value method is given in **6.6.6**.

### **6.4.5** ***Managing the project***

#### **6.4.5.1** *General*

The project manager is responsible for coordinating reports submitted by task owners and for analysing the information provided. The project manager should ensure that, when appropriate, visual aids such as a consolidated bar chart for the plan, are kept up-to-date. The relevant task owners should be kept informed of changes to the critical path for the contract and the estimated cost and time at completion for all permutations of tasks in the plan. Task owners may not always be aware of, or disclose, potential risks and in such circumstances the project manager may be forced to make a personal assessment of risks. The overall pattern of risk for the project should be analysed continually to decide where to concentrate management effort to best effect.
The project manager should report to task owners any hazards that are identified through analysis of the plan and should ensure that the task owner has appropriate recovery plans in place. The project manager should also coordinate all project reports for the sponsor in accordance with the requirements of the PMP.

The project manager may record statistical data on task owner performance and overall project performance in terms of costs, timing and the quality of deliverables. This information may be used to validate future estimates from task owners for new project work.

The project manager should be responsible for the security of the project management plan. This will require control of the distribution of the plan. Each holder of the project management plan should understand and comply with the rules of disclosure governing the plan. The rules may be

dictated by either commercial sensitivity, national security or professional confidentiality requirements. Where appropriate the plan should be clearly marked to indicate its security level, for example “personal and confidential”, “restricted”, “private data” etc.

**6.4.5.2** *Change control*
Change control is synonymous with the process and management of change and its implications on a project. Change control should not be confused with management of change.
Most projects are subject to changes during their life and it is vital that these are meticulously recorded by the project manager or his support team. Each change should be supported by a clear and complete specification. This specification and relevant documentation should be examined for their cost, time and performance implications. Where a number of departments or interested parties are involved, each should be given the opportunity to add their comments. These interested parties should also be given time to estimate the cost, time and the impact on quality and performance of the proposed change. When fully assessed each proposed change should be sent by the project manager to the sponsor or client with a recommendation for approval or rejection. It is possible that when the full cost, time and performance implications are known, the change may be withdrawn. Although all changes, irrespective of their size, should be subject to the same rigorous examination, only those required by the sponsor or client will affect the contract price. Internally generated changes may affect the project cost but not necessarily the project budget. It is emphasized that changes, which at first sight appear to be minor, can escalate to considerable importance when the comments and implications submitted by all the interested parties have been collated and evaluated. Once a change has been agreed, it should be communicated to all interested parties and operating departments, supported by revised drawings, specifications etc. and, (if sufficiently significant), the relevant amended section of the Project Management Plan.

**6.4.6** ***Assessing risks***
The risk of success or failure should be assessed continuously by means of cost and time estimates of the interdependent network of tasks that make up the project. The overall project risk factor can be analysed by simulating project progress, in a series of tests, using random sampling from the best-worst-most likely time and cost distributions for each task and calculating where the critical path most often lies. This will produce cumulative cost and time distributions around the planned project cost and finish date. It can also produce a list of all project tasks ranked in order of the likelihood that each task will be on the critical path. Thus a task with a 95 % chance of being critical should warrant more attention than a task with only a 5 % chance of being critical. Further guidance is given in **6.6.3**.

**6.4.7** ***Managing risks***
As a result of monitoring and analysing risks, the project manager will be able to identify those tasks where an alternative course of action is needed to mitigate the risk. Using the project management plan the project manager can experiment with various alternative risk avoidance tactics and should select those actions that best contain or avoid the risk. The project manager may need to obtain the support of the project sponsor to follow two parallel courses of action in order to manage an otherwise unavoidable risk.
The project manager should gain the support of task owners when deciding a new course of action. This negotiation is likely to follow the steps in the planning process until agreement is reached when a revised project management plan may be issued.

**6.4.8** ***Motivating task owners***
Projects should, by their nature, be directed towards achieving a definite end result. As a consequence, project managers should have very little trouble focusing task owners on project

objectives. Prudent application of the management reserve should enable the project manager to retain some project funding for bonus payments and, providing these are part of the agreement between the project manager and the task owner, there should be scope for good performance to be rewarded. This is a powerful motivating force. Good communication between the project manager and task owners is an equally powerful motivating force. A well-informed project team will usually perform better than one where information is rationed.

### 6.4.9 *Negotiating*

A project manager succeeds or fails depending on their ability to negotiate effectively. It is essential to recognize two phases to negotiation: pre-contract and post-contract. The project manager should be aware that concessions or changes made during the pre-contract stage will be cheaper and easier to seek than when the project is in full operation. Once the project has started, the pressure on the project manager to complete to time and cost is continuous and task owners may be tempted to exploit their position by seeking additional money in order to keep the project on schedule. It is imperative that the project manager ensures that the scope of work in each task is properly defined at the outset, that risks are spread rather than concentrated and that there is little opportunity for task owners to hold the project manager to ransom. The task owner will naturally be seeking to exploit the position and profit from the project work. A project manager should be capable of convincing task owners that they too are stakeholders in the success of the project and that meeting the objectives of the project subsumes their personal objectives.

## 6.5 The project management plan (PMP)

### 6.5.1 *General*

There may be variation in content, style and volume between one project management plan and another, due to variety in the work and in the circumstances in which the project is to be executed. The key contents of a project management plan are described in **6.5.2** to **6.5.7**. Financial information may be contained in a separate, restricted document.

### 6.5.2 *Project management plan sections*

A basic project management plan should contain the following sections:

a) introduction and summary;

b) commitment acceptance;

c) project work breakdown structure (WBS);

d) schedule;

e) statement of work (SOW).

A sophisticated project management plan, for example, for a major development project may contain the elements shown in Table 1.

### 6.5.3 *Introduction and summary*

This section of the project management plan summarizes the essential elements of the project and makes reference to any information that may affect how tasks should be performed and managed. This preliminary part of the project management plan should include the following information, not necessarily in the order given:

a) project name, reference code, issue number and date of issue;

b) project management plan contents;

c) name of sponsor;

d) summary of the project objectives and the means planned to achieve them;

e) summary of the project completion criteria and how the sponsor decides whether or not the project has succeeded in achieving its objectives;

f) a list of amendments to the project management plan with a project WBS reference to the amendment, a short summary of the amendment including the reasons why the amendment was necessary and the date of its incorporation;

g) reference to mandates and injunctions governing the project, for example, policies, standards, specifications, health, safety and environmental issues;

h) reference to guidelines governing how various elements of project work should be performed, for example, project management, procurement strategy, contract management, configuration and variation management, financial management, quality assurance, reliability management and the project organization, including the project team and task owners;

i) a document circulation and contacts list;

j) a list of associated contracts;

k) reference to the business evaluation on which the original decision to authorize the project was based.

The project manager should ensure that the project team are aware of any relevant assumptions in the business evaluation and that they each have a duty to report to the project manager when these assumptions are at risk. This section of the plan is likely to be confidential and its circulation limited to those who need to know.

### 6.5.4 *Commitment acceptance, agreements, budget releases and budget logs*

The project management plan should contain a commitment and agreement section that records task owner commitments and the project manager's acceptance of such commitments. The task owners should formalize their commitments by signing against the appropriate project WBS reference. The project management plans should contain details of any caveats that were added by task owners to qualify such commitments. Accountability for work in the project management plan should included in the statement of work. As the project progresses documents such as instructions for work to proceed and budget releases should be recorded systematically in the appropriate budget log. Agreement by the project manager or the sponsor gives the project management plan contractual status and responsibilities as described in the plan become binding.

### 6.5.5 *Project WBS and WBS dictionary*

The project WBS and WBS dictionary are hierarchical descriptions of the tasks in the PMP. A project WBS should enable members of the project team to define their tasks at a meaningful level of detail. The use of a graphical project WBS should reduce the possibility of overlooking essential elements of project work and, if past project information is available and structured in a similar way, it allows direct comparison of past performance with current estimates.

The most detailed level of project work defined in the WBS should be that which is considered by the project manager to be necessary and sufficient for the effective and efficient monitoring of deliverables and control of costs such that the requirements of the sponsor are met. A project WBS dictionary, with a short summary description of each task recorded against the task project WBS code, may also be included. A dictionary should provide a useful glossary of task definitions, as well as helping users to locate specific tasks swiftly.

### 6.5.6 *Schedule of work*

The schedule of work required to satisfy the contract may be recorded as a consolidated bar chart that may be based on a critical path analysed task network. A consolidated list of all deliverables ordered by time and by responsible owner should also provide a useful focus for the project team as a whole.

### 6.5.7 *Statement of work (SOW)*

A statement of work should be included in the project management plan.
The project management plan statement of work is not always the vehicle for the definitive technical specification of the project work content. These detailed data may exist in separate reference documents and contracts that may be referred to by the project management plan where appropriate. Reference documents should be subject to the same control disciplines as the project management plan.

Guidance on the contents of a typical SOW is given in **4.3.6**.
Table 1 shows the typical contents of a model project management plan and is presented as a checklist.

**Table 1 — Model project management plan suggested checklist**

| **Project management plan checklist items** | |
|---|---|
| ❑ Foreword | |
| ❑ Contents, distribution and amendment record | |
| ❑ Introduction, including subclauses: | ❑ General description<br>❑ Scope of project<br>❑ Project requirements<br>❑ Project security and privacy |
| ❑ Business case | |
| ❑ Project aims and objectives | |
| ❑ Project policy | |
| ❑ Project approvals required and authorization limits | |
| ❑ Project life cycle | |
| ❑ Project organization, including subclauses: | ❑ Team organization<br>❑ Project staff directory<br>❑ Terms of reference for project manager and staff<br>❑ Directory of interested parties |
| ❑ Project harmonization | |
| ❑ Project management philosophy, including subclauses: | ❑ Implementation plans<br>❑ System integration<br>❑ Completed project work and work by others |
| ❑ Acceptance criteria | ❑ Acceptance procedure |
| ❑ Risk management | |
| ❑ Time management, including subclause: | ❑ Project schedule and milestones |
| ❑ Project resource management and limitations | |
| ❑ Financial management and project account procedures | |
| ❑ Communication management, including subclauses: | ❑ Management reporting system<br>❑ Schedule of meetings |
| ❑ Monitoring and control methods | |
| ❑ Procurement strategy | |

| | |
|---|---|
| ❑ Contract management | |
| ❑ Configuration management and control, including subclauses: | ❑ Configuration management system |
| ❑ Change management and change control | |
| ❑ Integrated logistic support (ILS) management | |
| ❑ Technical management, including subclauses: | ❑ Tests and evaluations |
| ❑ Quality management, including subclauses: | ❑ Reliability management<br>❑ Availability, reliability and maintainability (ARM) |
| ❑ Environmental issues | |
| ❑ Health and safety management | |
| ❑ Legal requirements | |
| ❑ Project diary requirements | |
| ❑ Close out procedure and report including project history | |
| ❑ Document distribution schedule | |

## 6.6 Processes supporting the project management process

### 6.6.1 *Quality assurance*

**6.6.1.1** *General*

The project management objective is to deliver on time, to cost and to specification; this can be made easier and more efficient if the organization implements a sound quality policy.

**6.6.1.2** *Quality system*

It is essential that the host organization has a quality management system that is directed towards the control of those elements of the project that affect the quality of the project deliverables. The project manager can usually gain confidence in the ability of the host organization when the quality management system is certified to a national or international standard.

**6.6.1.3** *Quality objectives*

There are many definitions of quality and one of the best known descriptive phrases is “fitness for purpose”. This should be interpreted for the purposes of project management as meeting the requirements of the customer with respect to time, cost and product specification (including health and safety, see **6.6.1.5**).

**6.6.1.4** *Quality plans*

Quality plans, when required by the customer or the project manager, should form an integral part of the overall project management plan. The quality plan should provide a quantified means of demonstrating that specific quality requirements are being addressed. The quality plan should, for example, detail the steps needed to produce the project deliverables, with the appropriate quantitative acceptance criteria.

Quality plans should be considered in the feasibility phase (see clause **7** for a discussion of project phases) and confirmed at the beginning of the implementation phase. Before it is included in a contract as a technical requirement, the quality plan should be agreed by both the quality manager and project manager.

**6.6.1.5** *Health and safety*

Project work often causes risks in terms of health, safety and the environment. In order to ensure such risks are understood and reduced to an acceptable level, every project should include an audit

of these specific risks before work starts. This audit should be updated throughout the life of the project. Audit updates should be scheduled as part of the overall project management plan.

### 6.6.2 *Configuration management*

#### 6.6.2.1 *General*

A configuration management system should be used to control the physical and functional characteristics of a product or service through documentation, records and data. Good configuration management practice should ensure that changes (variations) are implemented only after being authorized by the supporting documentation and not, as sometimes happens, with the documents being altered to reflect a configuration change that has already been implemented.
The configuration management discipline should be applied throughout the life cycle of a project. During the early project phases this may require an increase in management costs. However, cost savings during the production and in-service phases should follow if configuration management is practised in concert with established project requirements.

#### 6.6.2.2 *Configuration management systems*

The task owner or contracting organization should establish and maintain a configuration management system, to the satisfaction of the project manager, to ensure that technical and administrative direction and surveillance is applied to the following activities:

a) configuration item selection, identification and documentation;

b) configuration control;

c) configuration status accounting; and

d) configuration audit.

#### 6.6.2.3 *Configuration management plan*

The task owner or contracting organization should prepare a configuration management plan that formally describes the scope, organization and procedures for configuration management and the points of contact responsible for configuration management. Where configuration management is a requirement at subcontract level the degree of control and the procedures to be employed should be detailed in the configuration management plan, agreed by the project manager and included in the overall project management plan.

### 6.6.3 *Risk management*

Once a project's goals have been confirmed and clarified, so that what is at risk is understood, the essential next step for the project manager is to ensure the continuation, throughout the project's lifecycle, of the risk assessment activity begun at the project conception stage. As with all forms of planning, risk assessments should be continually up-dated and management plans modified as necessary. The uncertainty accompanying all projects should be accepted and risks managed in a positive way, whether a risk poses a threat or gives rise to an opportunity.

The sponsor of a project can never be certain that the anticipated benefits will be fully realized, however well a market is researched or the project carried out. For example market conditions may change unexpectedly. Even if everything goes according to plan, by the time the project reaches its commissioning stage, the output from whatever has been created may no longer be saleable. For this reason alone, the project sponsor will always be the primary risk-taker. However, projects often exist in unpredictable environments and the project manager will also experience risk in implementing the project process. Risk management, as a key element in project management planning and decision-making and a core function within project management, should therefore be given special emphasis and follow a structured process.

Risk assessments should answer the questions:

a) What and where are the risks?

b) What is known about them?

c) How important are they?

Only then can effective management action be taken to deal with them by means of carefully designed risk treatment measures.

Some risks will require contingency plans to be put in place. Expenditure on contingency plans is often provided for by insurance or through the creation of management reserves under the control of the project manager. Where more than one project is involved, a central contingency pool can be created and by this means a sponsoring organization can wholly or partly insure itself against the unexpected. The risk assessments and management plan should be documented and integrated with the main project management plan. They should detail who is responsible for each risk treatment action and for any other actions such as contingency planning.

Risk management is a significant part of the project management function, even when not openly acknowledged as such. Project management planning and decision-making should be based on realistic assumptions and recognition of the risks inherent in the enterprise.

Figure 7 (reproduced from BS 6079-3:2000) gives an explanation of the processes involved.

**Figure 7 — The risk management process (reproduced from BS 6079-3:2000)**

### 6.6.4 *Procurement processes*

#### 6.6.4.1 *General*

Procurement is a vital element in the success or failure of many projects, particularly those concerned with a hardware product. The commitments for materials, goods or services with a long lead time may have to be made before either the project team or the project manager are in place. These commitments can for good or ill set the course of the project.

The procurement processes aim to acquire hardware, software, processed materials, services or combinations thereof that are necessary for the completion of the project. Thus procurement in projects is much wider than just purchasing or buying, particularly since in many projects the items to be procured are outside the normal experience of the parent organization and may involve special contract conditions. In addition, in many projects, procurement may require the procurement officer to organize activities such as:

— the transport of material to a location distant from the parent organization, possibly overseas;

— the organization of transport, storage and documentation;

— the arrangement of accommodation for staff away from home;

— the hiring of specialists or consultants or other services;

— the renting of equipment and plant not available in the parent organization.

#### 6.6.4.2 *Buying*

There are three main types of buying organization:

a) Routine buying: where a central purchasing department buys all goods and services, based on the requirements of the project organization.

b) Commodity buying: where a buyer or group of buyers specializes in a particular commodity. The buyer becomes very familiar with the product and its sources and is more able to obtain the best prices, discounts and deliveries. Care should be taken that excessively close relationships with suppliers do not develop.

c) Project buying: where a buyer or group of buyers specializes in the purchasing needs of a particular project, dealing with the complete range of bought-in items. This should have the advantage that the buyer is fully committed to the project and is an integrated member of the project team. An experienced project buyer is often able to give valuable advice to the project manager regarding, for example, outstanding purchasing requirements and lead times.

**6.6.4.3** *Ordering of goods and services*
The document issued by a buyer to a supplier, frequently referred to as a purchase order, typically needs to contain the following information:

a) a unique purchase order reference number;

b) general and specific terms and conditions of purchase;

c) specification and reference or part numbers of the items to be purchased;

d) acceptance criteria;

e) value of order;

f) delivery date;

g) terms of payment;

h) delivery address and instructions.

**6.6.4.4** *Vendor selection*
In the first instance, vendors should be ranked and selected for further consideration according to their past quality and performance records. A good working relationship should then be established between the selected vendor and the project team at all levels so that the vendor is effectively absorbed into the culture of the project organization and fully understands its requirements.

**6.6.4.5** *Preferred vendors*
Some advantages, in terms of delivery, cost and performance may be achieved by developing a preferred single source for each major purchased item, particularly for projects in the volume production area. For the vendor this should be an opportunity for long-term business without significant competition. The advantage for the project team is quality and reliability of supply.

**6.6.4.6** *Expediting*
Unless orders are regularly expedited, delivery dates and promises should not be relied upon. Suppliers should be visited or reminded at set intervals to ensure compliance with delivery dates. The project manager should set up an efficient contractual expediting programme and the system in place should ensure that the project manager is advised of every actual or potential slippage, so that remedial action can be taken immediately. This could take the form of high level contacts, premium payments, reprogramming where possible or even cancellation of the order. The imposition of liquidated damages for failure or partial delivery or lateness of requested documentation can be of great help to the expediter, who should be fully aware of the downstream implications of a late delivery.

**6.6.4.7** *Inspection*
Failure to inspect may result in faulty or unfinished items being delivered. The subsequent repair or return to the supplier will usually result in costly delays that far outweigh the cost of inspection and rectification in the supplier's works. Inspection of items within the supplier's organization should be carried out in addition to any other in-house inspection stages specified in the quality plan. Any problem with meeting quality and acceptance criteria should be reported to the project manager, who should approve all concession requests or changes to specification, if necessary having first sought the sponsor's agreement. Details of concessions and changes may also be subject to the configuration management system and details should be approved and recorded as necessary.

**6.6.4.8** *Shipping*
The shipping of items (especially to overseas destinations) requires careful planning and control. It may also be necessary to carry out route surveys when heavy or large loads have to be transported. The shipping function should include custom clearance, obtaining transport permits, chartering vessels or aircraft, coordinating the economical filling of containers and obtaining the necessary documents to comply with export and import regulations. Even when the responsibility for shipping rests with the supplier, the project manager should be satisfied that all the shipping arrangements have been correctly implemented.

**6.6.4.9** *Subcontract administration in construction projects*
The conditions laid down in subcontracts for construction projects can be either general or special as follows:

a) general conditions, as laid down by professional institutions, trade associations, government departments or local authorities;

b) specialist conditions, as issued by the buying authority in accordance with an internal standard or specific project requirement embodied in the contract.

The difference between a subcontract and a purchase order in the construction industry is that the former has a site erection content. Consequently all construction enquiry and contract documents should contain details of the various site agreements with other contractors and trade unions, regulations, restrictions and methods of progress control. Since stage payments can be based on site measurement, a subcontract demands considerably more administrative effort than a purchase order. Whether this work is done in the office or on site, the project manager should be responsible for ensuring that it is done efficiently and regularly by an experienced and trusted person.

**6.6.5** ***Financial control processes***
**6.6.5.1** *Financial evaluation*
Authorization for projects to proceed should be based on formal evaluation of a proposal. A project that has not been subjected to such scrutiny is at much greater risk of failure. The only financial certainty is that the rate of expenditure will escalate as the project progresses to implementation; the project manager should therefore keep a firm control on project finances at all times. The cost of delivering the project will only be justified if the claimed benefits, either in profit or services to society, are subsequently realized.

It is important that as soon as sufficient work has been completed, the disparate threads of a project are brought together in the common measure of money. This is to determine the full cost of development and implementation and the difference anticipated between the operating costs and income over a reasonable period of time. It should be noted that the ability of the project manager to influence the project is inversely proportionate to the percentage completion of the project (see Figure 8). The evaluation should concentrate on cash flow and commitments, rather than

bookkeeping conventions used for financial accounting. The project manager should produce a realistic assessment of the cash needed; capital and associated revenue, bearing in mind the relationship of final cost to cost of design effort (**6.4.6**). This data should be given in time periods, for example three or six monthly intervals, which are appropriate to the duration of the project. The assessment may also show the expected cash receipts throughout the project from initial grants to any close down income at the termination of the project.

Costs are largely set by specifications and procedures built-in during the early phases. After the decision to proceed is taken, these tend to progressively become legal commitments as binding orders. Contracts are placed and actual expenses, as they are fulfilled, are invoiced and paid for. Figure 9 shows how costs tend to build-up before any benefits are delivered. Any review to consider possible abandonment of a project should be concerned with the total committed cost rather than merely the amount actually expended.

**Figure 8 — Ability of the project manager to influence the project**

The project manager should ensure that the financial forecasts are realistic and achievable and that a management reserve is included to cope with unexpected issues. For some projects a substantial part of the full life cash flow may be needed for decommissioning and safely disposing of assets at close-down. The accuracy of data will tend to diminish as the forecasting horizon is extended into the distant future and will become grouped, rounded-off and generally less detailed. Data for the relatively near term should, however, be reasonably accurate and detailed, see Figure 10.

**Figure 9 — Typical cumulative cost pattern**

The project manager should make the most sensible use of the available data, while recognizing that financial evaluation is only one of the elements that will be considered when deciding to approve or reject a project.

In certain situations the quantifiable benefits will be augmented by real but less tangible benefits and wholly subjective benefits. It is essential that these benefits are identified and wherever possible measured and further quantified as the work progresses. In larger projects the initial evaluation will be followed by periodic updated evaluations at predetermined milestones, as part of the monitoring procedures and authorization requirements.

Projects are concerned with the future and always bear a degree of uncertainty and risk. The evaluation should include a full assessment of the principal risks, showing the assumptions made and referring to the consequences of various scenarios. Where possible the sensitivity of the project to these risks should be analysed. In appropriate circumstances risk management will require a full separate statement and contingency plan. It should always be remembered that investment money is usually the scarce resource and the results shown in the financial evaluation may be crucial in obtaining the necessary funding. The consequent application of funds should also be seen as a commitment to the project by the signatories.

Figure 10 shows the typical format of a cash flow forecast.

Figure 10 — Format of cash flow forecast

**6.6.5.2** *Time related value of money*

The purpose of most projects is to enhance profit by some combination of improved income and reduced costs; this can be achieved, for example, by increasing the capacity or utilization of an

asset. The real value of money is constantly changing; one pound of income today is likely to have significantly different buying power from a pound received in ten years' time. To compare the worth of alternative projects competing for scarce funds, the net cash flow figures should be adjusted to a common time base. Using compound interest to reflect the cost of money, it is usual to discount a stream of future cash flows to a net present value (NPV). An NPV calculation puts most weight on near term income and increasingly less weight on receipts stretching out into the more uncertain future. The resultant discounted cash flow (DCF) should then to be compared to the original investment to establish a NPV that is directly comparable from one proposal to another. A similar use of the concept of time adjusted cash flow values seeks to find the internal rate of return (IRR) that will discount the cash flow back to the original investment. If that rate is higher than the cost of borrowing, the proposal should pass the hurdle and may then have to be compared to other draft projects. Under most circumstances, managers should select the project offering the best fit to the criteria being used. Examples of these criteria are speed of pay back, first year return, overall percentage return on investment and annual average rate of return on the original investment. It is being increasingly recognized that financial techniques should deal with whole life projections. DCF techniques should be applied consistently to ensure familiarity with the techniques being used and to ensure comparability between projects competing for scarce resources, with minimum hurdles of returns set for all investments in one-off projects. Table 2 gives the DCF and NPV of two small commercial projects competing in an environment where the cost of investment monies is judged to be 10 % and both projects require an initial investment of £50,000.

**Table 2 — Example of discounted cash flow**

| | **Project A** | **Project B** | **Discount Rate** | **Project A discounted** | **Project B discounted** |
|---|---|---|---|---|---|
| **Years of life** | **4** | **5** | | **4** | **5** |
| **Year** | **Cash Flow £** | | **10 %** | **Discounted Cash Flow £** | |
| 0 | (50,000) | (50,000) | | (50,000) | (50,000) |
| 1 | 32,500 | 20,000 | .9091 | 29,545 | 18,182 |
| 2 | 27,500 | 25,000 | .8264 | 22,726 | 20,660 |
| 3 | 22,500 | 25,000 | .7513 | 16,904 | 18,728 |
| 4 | 19,500 | 30,000 | .6830 | 13,318 | 20,490 |
| 5 | — | 15,000 | .6209 | — | 9,313 |
| Total | 102,200 | 115,000 | — | 82,493 | 87,427 |
| Average P/A | 25,500 | 23,000 | — | — | — |
| Less original investment | | | | (50,000) | (50,000) |
| Net Present Value (NPV) | | | | 32,493 | 47,427 |
| % NPV on investment | | | | 64.8 | 74.8 |
| NOTE The authorizing body would consider these financial projections with other criteria in determining which project, if any, to proceed with. | | | | | |

**6.6.6** ***Earned value management (EVM)***

**6.6.6.1** *General*

Earned value management is an effective and disciplined method for monitoring and providing information for controlling projects.

**6.6.6.2** *Benefits*
The application of EVM brings the following benefits:

— disciplined planning and risk management;

— good programme visibility;

— objective and quantitative performance measurement;

— early indication of problems;

— an ability to accurately predict programme cost and schedule.

**6.6.6.3** *Payment by earned value*
Earned value reflects progress on a project, and as such, can be used to determine the value of progress payments. In general, these payments match the amount of value earned. However, in some instances, payment by earned value is mixed with payments related to the completion of a small number of major, critical milestones, with a percentage of the contract price being allocated to the earned value (for example 70 %) and the remainder to the selected critical milestones.

**6.6.6.4** *EVM Principles*
Earned value is based on assigning a value at the task level to the achievement of project work. Ideally, achievement is determined non-subjectively, on the basis of milestones and deliverables, and is based on the planned cost (in money or hours) of achieving that milestone.
These tasks are grouped and controlled in a control (sometimes called cost) account, for which a dedicated manager is appointed. This individual is empowered to plan and deliver within time and cost constraints the work contained within the control account.

Earned value based performance measurement replaces traditional practice that only compares planned and actual costs. This practice tended to confuse actual costs with actual progress, a confusion that is eliminated by using earned value (see Figure 11).

**Figure 11 — Earned value chart**

**6.6.6.5** *Performance Analysis*
**6.6.6.5.1** *Variances*
Performance analysis should begin at the task owner level, and be overseen by the control account manager. The actual cost of a given task should be compared with the earned value credited at a point in time. The difference is the cost variance:

*cost variance* = earned value – actual cost
Similarly the cost impact of schedule slippage (schedule variance) may be determined. This is derived by comparing the planned cost with the earned value credited at a point in time. The difference is the schedule variance:

*schedule variance* (cost) = earned value – planned cost
At the end of a task, the earned value should always be equal to the planned cost (because earned value is based on planned cost). The use of cost based schedule variance is thus not recommended for work that is nearing completion.
Schedule variance expressed in monetary terms is difficult to visualize. One method for converting schedule variance to a time basis is:

*schedule variance* (time) = the original duration (OD) – actual time expended (ATE)

planned for the work to date  on the work to date

Negative cost or schedule variances are unfavourable, and positive variances favourable.

**6.6.6.5.2** *Efficiency*
Earned value, actual costs and planned costs can be used to determine if the work is proceeding to, better than or worse than plan, as follows:

*cost performance index* (CPI) = earned value
(efficiency)actual costs

*schedule performance index* (SPI) = earned value
(cost)planned costs

A ratio of less than one implies that work is progressing worse than planned; in excess of one implies better than the plan.

**6.6.6.5.3** *Usage*
When calculating these indices only data from the current phase of the project should be used. Materials used in the project should be accounted for separately. Equally, the data should be directly related to the WBS, so that by consolidation, the performance of the whole project, or any part of the project, may be determined at any point in time. Provided an analysis of every task is available at a given milestone, a complete picture of the project performance, together with reasons for variations, should be identifiable. This should focus management attention on the opportunities and problem areas and their effect on the project as a whole.

**6.6.6.6** *Forecasting*
**6.6.6.6.1** *Cost*
The final cost of the project, or a sub-element of it, can be forecast using the following formula:
*final cost* = budgeted cost
cost performance index

NOTE The final cost of a project as discussed in this clause, is only concerned with those items that are controlled by earned value management.

**6.6.6.6.2** *Schedule*
Forecasting the final end date requires the predetermination of a time based Schedule Performance Index. This can be calculated as follows:

*schedule performance index* = original duration planned for work to date
*SPI (time)* actual time expended on the work to date

*final project duration* = planned project duration
time based schedule performance index

**6.6.7** ***Project personnel development***
**6.6.7.1** *General*
The variety of demands placed upon a project manager and the members of the project team is substantial. The list of attributes and skills described in **6.7.2** to **6.7.14** should be developed to ensure the effectiveness of individuals and the project team as a whole.

NOTE Many of these attributes are not exclusive to project management.

**6.6.7.2** *Leadership*
Individuals should be able to stimulate action, progress and change and to get things moving by means of the following attributes:

a) demonstrating initiative and achieving results;

b) displaying strong persuasive skills when dealing with team members;

c) delegating effectively; monitoring the effectiveness of the team as a whole and the contribution of its individual members;

d) being competent at running effective meetings and having the ability to manage and control change.

**6.6.7.3** *Technological understanding*
Individuals should have an adequate, but not a specialist, understanding of the technical requirements of the project so that business needs are addressed and satisfied.

**6.6.7.4** *Evaluation and decision making*
Individuals should be able to evaluate alternatives and make authoritative decisions by means of the following attributes:

a) being able to sift through and understand volumes of project data, identify important material and seek out any missing information, to make an informed decision on the facts presented;

b) getting to the root of project issues, identifying key relationships, political implications and applying a pragmatic cause and effect approach to the decision process;

c) understanding the project objectives, establishing the correct priorities and choosing the most appropriate course of action.

**6.6.7.5** *Management of people*
Individuals should be able to motivate and enthuse colleagues by means of the following attributes:

a) being able to work cooperatively and communicate effectively with people at all levels in the organization;

b) being concerned for and having an understanding of people's needs;

c) showing enthusiasm for the project and a constant personal drive toward achieving its goals;

d) developing the skills of and encouraging the individual project team members.

**6.6.7.6** *Systems design and maintenance skills*
Systems design and maintenance skills include:

a) being computer literate and demonstrating competence in the use of the relevant computer systems and applications;

b) having a working knowledge of the internal administration and systems of organizations within the project environment.

c) having a working knowledge of the systems and environment that the project deliverables will encounter in the operational phase.

**6.6.7.7** *Planning and control skills*
Planning and control skills include:

a) the ability to identify problems and opportunities;

b) making the best use of available resources to achieve the project objectives;

c) encouraging the project team members to set personal objectives with respect to planning, organizing and time management methods;

d) being familiar with modern planning and monitoring techniques;

**6.6.7.8** *Financial awareness*
Financial awareness involves:

a) being familiar with financial and risk management techniques;

b) having a broad based financial knowledge including the ability to understand company accounts;

c) being familiar with cash flow and variance analyses, understanding profit and loss statements and able to develop financial models;

d) being cost conscious and able to control costs to plan.

**6.6.7.9** *Buying and general procurement*
Individuals should have the capability to participate in the development of the procurement strategy.

**6.6.7.10** *Communications skills*
Communications skills should consist of the following:

a) being able to express themselves in a clear, understandable and unambiguous manner;

b) demonstrating skills in verbal and written presentation;

c) using the most appropriate presentation media and methods and tailoring the level of detail to a given audience;

d) thinking on one's feet and giving meaningful responses to questions;

e) dealing effectively with subcontractors, customers and people outside the project environment;

f) giving clear, unambiguous instructions.

**6.6.7.11** *Negotiating skills*
To be effective in negotiation individuals should be:

a) skilful in pre-determining a customer's stated, implied and latent needs;

b) skilful in countering hidden agendas and political objections to the project; proficient in preparing appropriate responses to issues and planning a negotiation strategy in advance;

c) able to convince people, appeal to their interests and counter their technical objections;

d) persuasive in obtaining additional project resources when required.

**6.6.7.12** *Contractual skills*
Contractual skills include:

a) capability in developing a contractual strategy;

b) effective communication of contract terms and conditions to appropriate subcontractors;

c) ability to manage subcontractors;

**6.6.7.13** *Legal awareness*
The individual should have an understanding of contract law and any statutory requirements that could affect the project.

**6.6.7.14** *Character*
Besides these skills, that can all be learnt, there is still one factor that is overriding: the personality of the project manager. Without the personal qualities that are a part of character the other aspects will generate only an average project manager, not a good one. Incorporated in the character should be a mixture of enthusiasm, dedication, drive, determination, integrity, vision and humour.

**6.6.7.15** *Project team blend*
As a project progresses, the project team should gain a variety of functional skills and experience in such fields as marketing, engineering, social services, finance and personnel. These skills may be brought to the project by the people seconded to the team perhaps for the life of the project or for particular phases where the need for a particular talent is dominant.

Besides the functional skills that are important for carrying out the tasks of the project, it has been found desirable to try to ensure a mix of personal characteristics. It may be considered that the project manager should have the ability to link and lead people who between them can:

a) create innovative approaches to the issues;

b) sell the work of the team to the influential third parties;

c) pragmatically test ideas within the team before adoption;

d) secure cooperation from within the organization and know where to go for specific backing and back-up;

e) get things done;

f) insist on progress at acceptable standards;

g) take a semi-detached view of events and see things as they are.

h) maintain composure under pressure and keep calm when things go wrong.

Further information can be found in BS ISO 10006.

## 7 Project lifecycle

### 7.1 General

Projects differ from other enterprises in several ways in particular because of their transient and unique nature. The principal features that characterize projects include the following:

a) their duration is usually predetermined (finite) with definite start and termination dates specified;

b) what happens during the execution of a project invariably affects the subsequent deliverables;

c) the project organization is often temporary and may change from one phase to the next during the execution of the project;

d) all projects will contain some risk and uncertainty;

e) most projects are non-repetitive; they might also include some essentially unique feature or the use of technologies beyond the current state of the art;

f) and finally, although projects are a contained set of tasks they are seldom carried out in isolation, but interact with other projects and organizations; their structures and systems are interactive organizationally, technically, economically and socially.

**7.2 Types of project**

Projects may be categorized in various ways to identify appropriate methods of efficient project management.

Some examples of these project categories are as follows:

a) by duration, for example three months or ten years;

b) by total cost, for example £20,000 or £6 billion;

c) by complexity, for example straight sequence of simple activities or highly interrelated, multi-organizational, multi-disciplined;

d) by method of operating, for example in-house projects, contracted-out or a combination of both;

e) by technical, organizational and administrative features as follows:

— strategic long term;

— research and development (R & D);

— administrative and procedural;

— capital plant manufacture;

— major engineering works on local and/or dispersed sites;

— planning and controlling changeovers;

— one-off or repetitive building construction;

— new product introduction;

— major overhauls and planned maintenance;

— production planning;

— emergency planning;

— plant commissioning and/or operation;

— information technology software;

— office or factory relocation.

**7.3 Project phasing**

**7.3.1** ***General***

Any project, irrespective of size and complexity, will naturally move through a series of distinct phases between its conception and termination. In large projects the phases should be formally identified and separated to enable effective management of the project. Where commitment of substantial resources is required, authorization may be limited and should be reconfirmed at

specific milestones. For small projects the phases are usually less formal, but may still require identification, for example, at management reviews. Figure 12 shows a project phase structure that covers the project whole life cycle.

**Figure 12 — Project management life cycle**

### 7.4 Project phase sequence

Projects of any significant size, duration or cost should benefit from phasing into sequential blocks of related activities. There are a minimum of five fundamental project phases, namely conception, feasibility, implementation, operation and termination, that can be identified in all projects.

The points between phases are often referred to as milestones and they provide a natural opportunity to review, record and report project progress before going forward to the next phase. Checks should be made at each milestone to ensure that the previous phase has been satisfactorily completed and that the project objectives are being fully achieved. Depending on the results, a decision on whether to proceed, modify or stop the project should be taken; in this respect it may be necessary to obtain authorization from the sponsor.

All projects should normally have some preparatory work before they are formally started and it is advisable to appoint a manager possibly in a part-time capacity, at the earliest opportunity, to coordinate such work. This manager may then naturally progress into the role of project manager when the project is formally authorized.

Organizations and sectors of industry tend to develop project life cycles that are phased to enable the use of an agreed methodology between interested parties. In most cases these phases share many features of, and are therefore comparable to, the generic life cycle described in Figure 12. Table 3 gives some examples of project phases that are used in a wide range of industries and the public sector.

### 7.5 Description of phase content

#### 7.5.1 *General*

The five basic phases described in **7.4** may be further subdivided into stages depending on the size, complexity and nature of planned activities, the size and nature of the project. This is particularly true of the implementation phase that could, for example, include product definition, design, development, production and installation stages. Significant milestones, such as project authorization and handover may also be indicated. The content of a typical industrial project is described in **7.5.2** to **7.5.9**.

#### 7.5.2 *Conception phase*

Managers in enterprises should be constantly looking for opportunities to improve the performance of their organizations. Initial ideas are by their nature generally vague and uncertain, but may have sufficient interest to merit further investigation. Concepts that are considered worthy of serious consideration are then taken to the next phase that will test the feasibility of the ideas before a full scale project implementation programme is launched.

Concept formulation is usually the first phase of a project life cycle and should cover the period from the emergence of an idea for a project to an initial formal statement of a user's or sponsor's needs. Ideas for new projects might be expanded by exchanges of views between the customer, sponsor and if necessary specialist advisors; they are derived from factors such as:

a) a change in policy requiring a new capability;

b) the identification of a new actual or latent requirement;

c) outputs from research programme offering new means of meeting a requirement or providing a new capability;

d) replacement of an obsolescent system or an advance in technology;

e) correction of a deficiency in an existing product or service identified in operation, training or research;

f) response to a new opportunity opened up by a competitor;

g) an agreed perception of a need emerging from discussions with customers or other areas of the organization;

h) work being done on an existing project that stimulates the idea for its successor, or some new utilization.

During the conception phase the first basic ideas on how to create or satisfy a need or solve a particular problem should be generated and investigated. The conception phase should be a period when free thinking and the involvement of potential interested parties is encouraged to generate and then build upon many new ideas and solutions.
A functional department or small team of specialists and researchers may manage the tasks until it is deemed that commissioning a full scale project is justified. Although it is not essential to formally appoint the project manager until the project reaches a more advanced stage, a firm candidate for the post should be identified at the earliest opportunity. This person should be consulted during the planning and decision process, pending formal appointment, perhaps on a part-time basis.

**7.5.3** ***Concept-feasibility phase transfer milestone***
At this milestone the project sponsor should apply to the appropriate level of management for authorization to enter the feasibility phase. Development of the concept into a feasible project will almost certainly require the commitment and use of funds and resources.

**7.5.4** ***Feasibility phase***
The objective of this phase is to establish technical and financial feasibility and, where appropriate, commercial feasibility. The studies, experiments and results of test programmes, the initial estimates and appraisals of cost, time-scales and risk, the demand on resources and the impact upon incremental revenues, should then be used to forecast the commercial or social benefits to be expected from the project. Failure to identify inherent deficiencies in a project at this stage can have extensive adverse effects in later phases. It is, therefore, important to invest adequate effort in clearly defining the work to be carried out in the feasibility study.
Work done in the feasibility phase may be confined to paper assessments and evaluation, but technical and experimental work, including modelling, should be carried out where validation of a basic concept or identification of a technical problem is required.
The following work should be completed before a positive recommendation to proceed with the project can be contemplated:

a) a technical study to see if the concepts are practical and can be developed into a useful working product or service;

b) a commercial and/or cost-benefit analysis;

c) market research to determine probable demand and pricing sensitivity of the proposed product or service;

d) preliminary estimates of the financial implications of the project, including an assessment of the probable income generated and the operational costs such as production, distribution and marketing.

These data have to be accurate enough to gauge the acceptability of the project to either commerce or society. If this hurdle is passed, further work should be undertaken to complete a full technical and financial evaluation. The output of the feasibility phase should be a written report typically containing the following information:

a) a technical appraisal of alternative solutions investigated including the results of any research or experiments;

b) an evaluation of the preferred solution(s) showing in broad terms how the project objectives could be met and an outline description of the characteristics, benefits and features of the preferred proposal;

c) a statement of any identified areas of scientific, technical or social difficulty and any special steps needed to overcome these, with an assessment of the risks involved;

d) detailed plans, including specifications, for the implementation phase and plans for subsequent phases;

e) estimates, as thorough and realistic as necessary, of the likely time and costs for development and delivery of a product or establishment of a service together with estimates of support costs. Costs of options should be included as necessary;

f) an assessment of other resources required;

g) operational considerations and potential for future enhancements;

h) end-of-life disposal methods and costs.

The sponsor should decide from an evaluation whether to seek further information or to recommend management to authorize the project moving into the implementation phase.

### **7.5.5** ***Project authorization milestone***

#### **7.5.5.1** *General*

Formal authorization is needed to ensure that funds and resources can be made available and committed to the project. The authorization process usually has three stages: evaluation and application followed by formal authorization. The authorizing body should be informed of any potential risks and disadvantages so that a balanced decision can be made about the project's future. No substantial work, commitment of resources or expenditure should be permitted without prior authorization. Small projects may be approved by a senior manager, but major projects should be submitted to the top management level for authorization. Applications should be presented in writing, in a standard form, for signature by the authorizing body.
Authorization may be conditional upon time and expenditure limits, satisfactory progress reports and further applications for authorization at specified stages of implementation.

#### **7.5.5.2** *Evaluation*

The evaluation should include a forecast of the financial impact of the project in terms of its probable costs and benefits. Because, with few exceptions, the organization will incur significant costs long before the benefits of the project are realized, tight cost controls should be exercised throughout. Where a project has a life of several years or more, the estimated cash flow should be discounted, to offset interest cost factors and derive an estimate of net cash surplus at net present value (NPV) that may be directly compared with the original investment.
The evaluation should assess whole life cycle costs taking account of, for example, major cost implications, such as those in a manufacturing environment where the build-up and financing of tooling, raw materials, manufacturing stock and marketing efforts will consume cash well before any income is received. With certain types of project, such as those in the power industry, the

appraisal should allow for decommissioning, and/or disposal costs that will arise after operations cease. In other words the financial case should encompass all aspects of the project life cycle. It is not enough just to know the respective totals of income and expenditure.

The financial and cash flow information should generally reflect the timing of the various operations and may be presented as a plan or network; information regarding the timing of the expected cash outflows and inflows is essential. The intervals used in the financial plans and assessment will reflect the size and complexity of the project, ranging from perhaps monthly on small schemes, to yearly for the very long term projects.

In undertaking an evaluation it is essential that the sensitivity of the project to the various risks is properly considered so that the authorizing body has a clear idea of the range of results that could be expected. For complex projects a risk management plan is essential and should be maintained throughout the duration of the project. There is, for example, a particular requirement for risk analysis in those projects where there is a high research element and a significant chance of failure, such as the development of pharmaceuticals.

It is necessary to make the most sensible use of all the data available while recognizing that the financial evaluation, although a major element, is only one aspect that should be considered when deciding to approve or reject a project application. In certain situations the readily quantifiable cost benefits will be augmented by real but intangible benefits and as the impact of projects spreads across more functional areas the more elusive benefits should be identified even if measurement is difficult.

**7.5.5.3** *Application*
The project sponsor should make a formal application for approval of a project before commencement of any substantial work, commitment of resources or expenditure. Applications for major projects should be comprehensive and realistic, they should be presented in writing, in a standard form, for signature by the authorizing body. The quality and content of the application can have a significant bearing on whether or not the project is authorized. An application should contain the following types of information:

a) a brief written description of the project and its benefits, using illustrations and models where appropriate;

b) financial data concerning the cost of delivering the project, if necessary broken down by phase;

c) the expected revenues, operating costs, projected return on capital employed and cost-benefit analysis where applicable;

d) the human and physical resources needed;

e) a realistic assessment of the technical and financial risks involved;

f) a forecast of the effect of the project upon the operation and strategic plans of the sponsoring organization;

g) a recommended plan of action;

h) the signatures of the principal interested parties as a commitment to deliver the project in accordance with the projected time, cost and performance criteria.

**7.5.5.4** *Formal authorization*
Given an evaluation that is satisfactory and within the existing policy constraints of the organization, an authorization to start the project implementation phase should follow. It may be the project sponsor or senior managers who should be satisfied that all the financial, technical and other relevant evaluation data have been taken into consideration to provide an audit trail and a clear and unambiguous way ahead. This information should have been properly defined and adequately documented in the application.

It is usually the sponsor or project manager who should present the case for the project to the authorizing authority. In most organizations there will be several levels of authorization, each management level having authority to approve capital expenditure to a pre-set financial limit. Authorization for larger expenditures generally moves higher up the management hierarchy with ultimately all major projects requiring authorization by the main board of directors. In the case of the public sector, such authorization would be by an approving committee, HM Treasury and the Minister of State. The splitting of a large project into smaller projects, so that authorization can be given by a lower level of management, should not be condoned; this practice is ultimately counter-productive.

After due consideration, the authorizing body should decide whether the project should proceed or not, given the funding facilities and competing demands for finance, human and physical resources. The authorization may be conditional upon time and expenditure limits and receipt of satisfactory progress reports. Further applications for authorization may be required at specified stages of implementation, e.g. during the definition stage when a more comprehensive evaluation should be completed.

**7.5.6** ***Implementation phase***
Having secured a formal authorization to proceed with the venture, the project manager should initiate the practical work needed to bring the project to fruition. The implementation phase may need to be fragmented into several stages, depending upon the nature, size and complexity of the implementation tasks. These stages may encompass, for example, the following major tasks:

a) further definition;

b) design;

c) development;

d) procurement;

e) manufacture, construction or assembly;

f) physical completion, commissioning and acceptance testing.

During the implementation phase, a comparison of the physical and financial progress against plan should be made at predetermined intervals. Assessments of the probability of completing the project to time, cost and performance parameters should be made at predetermined intervals and corrective action initiated or progressed as necessary.
A graphical representation of tracking the project costs and schedule variance from a start point ‘A’ to a completion point ‘B’ is given in Figure 13.

**Figure 13 — Periodic estimate of the project cost and finishing date**

Planning for implementation is a key part of the project definition and development stages. This is essential not only to ensure a smooth transition from the feasibility study to implementation, but

also to ensure that the final product conforms to the end user's requirements. For example products should be designed for ease of production, use and maintenance and be dependable in service. Before commencement of implementation, development should have reached the point where there is sufficient confidence that a standard acceptable to the user can be achieved.

It is seldom possible to achieve a clear cut transition from the development stage into production. Usually, for example, it is necessary to order some materials and tooling for production or recruit and train staff in parallel with the last stages of development to ensure the smooth transition and the emergence of a product or service. This involves technical, financial and other risks that should be quantified and the implications assessed. The project management team should identify those risks and advise on alternative courses. Early implementation commitments should normally be entered only on a stage by stage release basis so that the risk is minimized; the use of configuration management becomes important here.

### 7.5.7 *Handover milestone*

At the conclusion of the project implementation phase the product or service should be handed over to the customer; this may involve a commissioning activity plus formal acceptance procedures. Handover may be a phase in its own fight for a large project, or otherwise a key milestone. The handover may be instantaneous or a gradual process taking a considerable period to complete depending on the nature of the deliverables.

The project manager should be required to demonstrate that the deliverables meet the specification and previously agreed quality. The handover should be carefully monitored to ensure that rapid corrective action is taken with respect to potential and actual problems. As the transfer of authority from the project team to the user takes place, unexpected changes in the project may be introduced that cause it to fail to meet the specification in some way, thus exposing the project sponsor to financial penalties or legal action.

As a consequence of handover the project manager and team may be redeployed to functional departments or alternative projects. The handover should be documented by the project manager and the recipient of the deliverables as follows.

a) Before relinquishing responsibilities, the project manager should prepare a report detailing the history of the project and its accomplishments, compared with what was promised at the time of authorization. This handover report should also give reasons for any significant deviations from the project management plan and specifications. As well as providing a justification for handover, the report should also be of benefit to future projects, in helping avoid common problems and the tendency to re-invent the wheel.

b) Before accepting the project, the project manager should ask the customer to prepare a report that explains the circumstances and conditions under which the project is being accepted. This acceptance report should also give details of performance shortfalls, areas of dispute, payment retention mechanisms and action needed to rectify specific problems, if appropriate.

c) Handover documents such as suppliers' guarantees and warranties, operating and maintenance instructions, spares list, lubrication schedules, etc.

### 7.5.8 *Operation phase*

Operation is normally a set of recurrent activities characterized by a relatively low rate of change and is usually the responsibility of a functional manager. The main activities in the operational phase, besides the actual use of the project deliverables, are as follows:

a) the marketing and sale of products and services;

b) performance monitoring

c) further development, as necessary, where there are initial performance limitations;

d) the setting up and implementation of post-design services;

e) in-use support consisting of the provision of training aids, spares, repair, maintenance, modification/enhancement programmes and upkeep facilities.

For certain projects the cost of plant shutdown and decommissioning will be a major expense that should be assessed at the beginning and throughout the project life cycle. Provision for plant shutdown and decommissioning should be made when deciding pricing strategies for products made by plant during its operational phase.

### 7.5.9 *Termination phase*

Termination usually refers to the end of a project; this point, for a project team, could occur when the responsibility is handed over to an operational organization, a customer or when the project is discontinued at the end of its useful life. It may occur at an earlier stage in the life of the project if there is a failure to meet the necessary cost, time, performance or quality criteria. The final phase of the project cycle may involve the disposal of equipment, the withdrawal of a service or the achievement of the project objective.

It is the responsibility of the sponsor or owner of the project deliverables to decide the timing of the disposal of obsolescent or surplus hardware, software and resources, and inform users that a product, service or process has been withdrawn. Adequate effort should be expended to ensure that optimum solutions for disposal are found. The final task should be the preparation of an analysis of the whole project and the documentation of its complete life cycle history. The history of the project should give valuable guidance to others who are embarking on new projects; provide lessons and examples for newcomers and reference documentation for the owners of any remains of the project. The importance of this exercise cannot be over-emphasized for reducing risks in the planning and execution of future project work and handling any issues that might arise, for example, following the disposal of scrap.

NOTE The project life cycle may extend over many years and the final report may be written by staff who were not members of the original project team. In this case relevant information from the project handover and acceptance reports should be referred to as necessary.

Table 3 shows a list of typical project phases.

**Table 3 — List of typical project phases**

| Phase/Stage | Description |
|---|---|
| **Conception** | Usually the start of project work, by translation of ideas and/or identifying requirements. |
| Pilot study | |
| Research | |
| Initiation | |
| **Feasibility** | Establishing the commercial, technical, social and environmental feasibility of project. |
| | Estimating project cost and time-scale, also identifying risks and health and |

| | |
|---|---|
| | safety issues; determining the support and capability of prospective contractors. |
| Evaluation | Evaluation of the whole or part of the project between phases; prospective contractor preparing tender. |
| Application | Making a formal proposal for authorization of a project. |
| Authorization | Getting agreement to proceed with project in whole or in part; by obtaining acceptance of a tender by the customer or board. |
| Definition | Verifying the approach; developing the specification. |
| Development | Designing a product that conforms to the specification. |
| **Implementation** | This phase can include several individual stages: design, procurement, construction, commissioning etc. |
| Realization | |
| Production | |
| Manufacture | |
| Fabrication | |
| Construction | |
| Works | |
| Installation | Installing the plant/product and making it work. |
| Commissioning | |
| Launch | Open up sales to a pilot area, then whole market. |
| Introduction | |
| Branch-Out | |
| Shipping | |
| Handover | Transferring responsibility for the project to a customer or functional department. |
| **Acceptance** | |
| In-use | Maintaining the product. |
| In-service | |
| Operation | |
| Shutdown | |
| Termination | Decommissioning the product; disposal of the project. |
| Disposal | |
| Final report | The last act of project manager, to document the history of the project. |

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[1)] In the course of preparation