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Project Management

Dr William Wallace

PR-A3-engb 2/2016 (1006)

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Edinburgh Business School
Heriot-Watt University
Edinburgh
EH14 4AS
United Kingdom

Tel + 44 (0) 131 451 3090
Fax + 44 (0) 131 451 3002
Email enquiries@ebs.hw.ac.uk
Website www.ebsglobal.net

Project Management

Dr William Wallace BSc (Hons), MSc, PhD.
DBA Programme Director and Senior Teaching Fellow, Edinburgh Business School (EBS), the Graduate School of Business at Heriot-Watt University.

Dr William Wallace holds degrees from Leeds Metropolitan University (1981), Loughborough University (1983) and Heriot-Watt University (1987). He joined Edinburgh Business School in 2000 after 10 years' project management experience in the UK public and private sectors. Dr Wallace is author of the EBS DBA texts *Project Management* and *Alliances and Partnerships*. He is joint author of *Strategic Risk Management* and *Mergers and Acquisitions*. He is also either author or joint author of the EBS DBA texts *Introduction to Business Research 1–3*. He is Chair of the EBS DBA Research Committee and has successfully mentored and supervised numerous EBS DBA students.

First Published in Great Britain in 2002.

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Preface

Project management has evolved from its formative stages in the 1940s to become a leading international and interdisciplinary application. The relevant professional bodies (the International Project Management Association and Project Management Institute) operate globally and across most areas of industry and commerce. Project management practices and procedures operate across a wide range of applications, from agricultural projects in Africa to complex engineering projects in Australia. Project management is, perhaps, the world's first truly international area of professional practice.

The growth of project management as an international discipline has been driven by the growth in the complexity of projects around the world.

People have always developed projects. In their simplest form projects are one-off or unique. They have a single aim and a series of separate definable objectives. They have a finite lifespan and they are usually intended to bring about change. They are usually relatively complex and (because they involve change) they are often relatively risky. Most people are familiar with projects in their everyday lives. An obvious example is building an extension on a house. A less obvious example, perhaps, is a marriage. If you think about it, getting married meets all the basic project criteria mentioned above. The degree of risk involved is perhaps the most variable criterion!

There are numerous cases of major projects from thousands of years ago. The ancient Egyptian pyramids were built around 4000 years ago and the Roman road network across Europe and North Africa dates back around 2000 years. If the ancient Egyptians and Romans had such huge projects why did they not need formal project management tools and techniques? The answer revolves around complexity. The pyramids and Roman roads were big but essentially simple. The Pharaohs and Emperors had plenty of time, lots of money and unlimited slave labour.

In more recent times people have still developed major projects but these projects have become far more complex. A modern engineering project such as building a new suspension bridge typically has to be completed within a range of constraints that did not apply to the ancient Egyptians or Romans. Such a project usually has a strictly imposed cost limit and has to be completed by a specified date. It may have to be designed and built in compliance with numerous environmental and health and safety constraints. There may be certain political and geographical factors that apply, together with other external forces such as changes in national and global economies.

These variable constraints all act to impose tighter and more limiting performance standards, all of which limit what project managers call the range of acceptable outcomes – the target area that satisfies all the various constraints imposed on the project designers and builders. As the target becomes smaller the tolerance and margin of error limits decrease and the need for more rigorous project management increases.

The rapid and global growth in project management therefore has been driven by a corresponding rapid and global growth in the complexity of projects. Everywhere projects have had to be completed within more and more restrictive time, cost and performance constraints, so there has been an ever-increasing demand for the kind of people who can operate under such demanding circumstances – project managers.

This course is an introduction to Project Management for Edinburgh Business School MBA students. It does not aim to turn readers into fully fledged project managers who can go away and run major projects. It rather attempts to introduce the concept of project management and give an insight into some of the various tools and techniques used by project managers on real projects. MBA graduates are almost certain to be involved in projects in their professional life in one form or another, whether it is managing the design and installation of a new IT system or launching a new confectionary product. This course attempts to develop an understanding of how to apply basic project management tools and techniques in such applications.

W A Wallace

Edinburgh Business School

September 2012

List of Abbreviations

AC	actual cost
ACWP	actual cost of the works performed
ADR	alternative dispute resolution
AGAP	all goes as planned
AOA	activity on arrow
AON	activity on node
APM	Association for Project Management
BAC	budget at completion
BC	budgeted cost
BCWP	budgeted cost of the works performed
BCWS	budgeted cost of the works specified or scheduled
BoK	Body of Knowledge
CAC	cost account code
CAD	computer-assisted design
CCRB	change control and review board
CCS	change control section
CCTA	Central Computer Telecommunications Agency
CDES	computerised database estimating system
CE	concurrent engineering
CMS	configuration management system
CPM	critical path method
CV	cost variance
CVI	cost variance index
DMS	draft master schedule
EAC	estimate at completion
ECTC	estimated cost to complete
EET	earliest event time
EFT	earliest finish time
EST	earliest start time
ETTC	estimated time to complete
EV	earned value
EVA	earned value analysis
GERT	graphical evaluation and review technique
HSE	Health and Safety Executive
IMCS	implementation monitoring and control system
IMS	information/interface management system

IPMA	International Project Management Association
ISO	International Organization for Standardization
JCT	Joint Contracts Tribunal
LAI	local authority inspector
LCC	lifecycle costing
LET	latest event time
LFT	latest finish time
LiB	let it be
LST	latest start time
MCP	multiple critical path
OBS	organisational breakdown structure
PCPCS	project cost planning and control system
PCS	project central server
PERT	program evaluation and review technique
PII	professional indemnity insurance
PLE	project logic evaluation
PMI	Project Management Institute
PMP	Project Management Professional
PMS	project master schedule
POER	post-occupancy evaluation and review
PRINCE2	PRojects IN Controlled Environments, version 2
PV	planned value
PVAR	project variance analysis reporting
QAP	quality assurance plan
QAR	quality assurance review
QBS	quality breakdown structure
QV	quality variance
RFD	resource fluctuation driver
RICS	Royal Institute of Chartered Surveyors
RIF	risk interdependency field
SAR	status accounting and reporting
SLA	service-level agreement
SMM	standard method of measurement
SOW	statement of work
SPP	strategic project plan
SV	schedule variance
SVI	schedule variance index
SWOT	strengths, weaknesses, opportunities and threats
TAC	time at completion
TBC	time-based competition

TOC	train operating company
TQM	total quality management
TRM	task responsibility matrix
TRP	team responsibility plan
VAC	variance at completion
WBS	work breakdown structure
WHIF	what happens if?
WP	works performed
WS	works scheduled

Module 1

Introduction

Contents

Learning Objectives

This module introduces some of the main concepts and approaches that are central to project management.

By the time you have completed Module 1 you should understand:

- what is meant by a project;
- the concept of project management;
- how project management can be structured within an organisation;
- the potential benefits and challenges of using a project management approach;
- the history and origins of project management;
- the current state of project management as an international discipline.

1.1 What Is This Course All About?

1.1.1 What Does a Project Manager Do?

Project managers are a bit like Navy pilots.

Navy pilots have to fly aeroplanes on and off of aircraft carriers. The planes themselves are extremely expensive and the pilot has to be very careful not to crash. The plane has to take off and land from an aircraft carrier which has a very small flight deck. In addition, the aircraft carrier is usually moving through the sea, pitching up and down with the swell and making frequent and significant course adjustments depending on changes in wind direction. The flight deck itself is often crowded with naval personnel and other aircraft, which may be taking off or landing at almost the same time.

When landing an aircraft under such circumstances the pilot has to think in advance, develop a plan and then execute it, making adjustments to stay on course as he or she goes along. The pilot has to ensure that the aircraft is descending at the right speed and rate of descent, and that the line of approach is correct, constantly referring to the navigation and flight instruments and making continual adjustments, thinking ahead, to make sure the plane lands safely. The ultimate objective is to land the aircraft on the flight deck, which is the 'target' as far as the pilot is concerned.

A project manager does something similar to the Navy pilot. The plane represents the 'position' of the project at any one time and the carrier flight deck represents the 'target outcome' of the project at completion. These two terms and their applications in this context are considered in more detail below.

The position of the project means the current performance of the work in relation to whatever variables are used to determine performance. Typical measures of performance are time, cost and quality, and there could be others such as risk, safety and so on.

If we were to try to summarise the sequence of actions needed to land the plane, it could be done as shown below.

1. Work out where the carrier is.
2. Set up a navigation line to get the plane from where it is now to the carrier.
3. As the plane approaches the carrier, measure actual position and rate of descent against the navigation line.
4. Compare actual position to required position.
5. Correct for speed, altitude and bearing as required.
6. Follow the navigation line in and land safely.

A project manager would recognise this basic sequence of six stages but would use different terminology, which might be as shown below.

1. Establish success criteria for the work.
2. Develop plans to achieve the success criteria.
3. As the work progresses, measure current performance in relation to the success criteria.
4. Compare current performance with desired performance.
5. Where necessary, set up a plan for corrective action.
6. Implement the corrective action and achieve an acceptable outcome.

This simple six-stage process is the basis of project management. If you can learn to do these six things you can call yourself a project manager, and if you can do them well your abilities as a professionally qualified project manager will be in high demand and rewarded accordingly.

1.1.2 How Does the Project Manager Do It?

Consider each stage very briefly in turn:

1. **Establish success criteria for the work.**
   In most applications the obvious success criteria for any piece of work include time, cost and quality. You want to finish the job on time, within cost and to whatever quality standards have been set.

The classic way to represent the relationship between these criteria is with a triangle, as shown in Figure 1.1. This is sometimes referred to as the 'time–cost–performance triangle' or the 'triple objectives triangle'. Where the project concerns a product, 'quality' may be substituted for 'performance'. It is important to appreciate that the time–cost–quality/performance triangle in various formats and arrangements appears throughout the project management literature. It is an oversimplification but it is easy to understand.

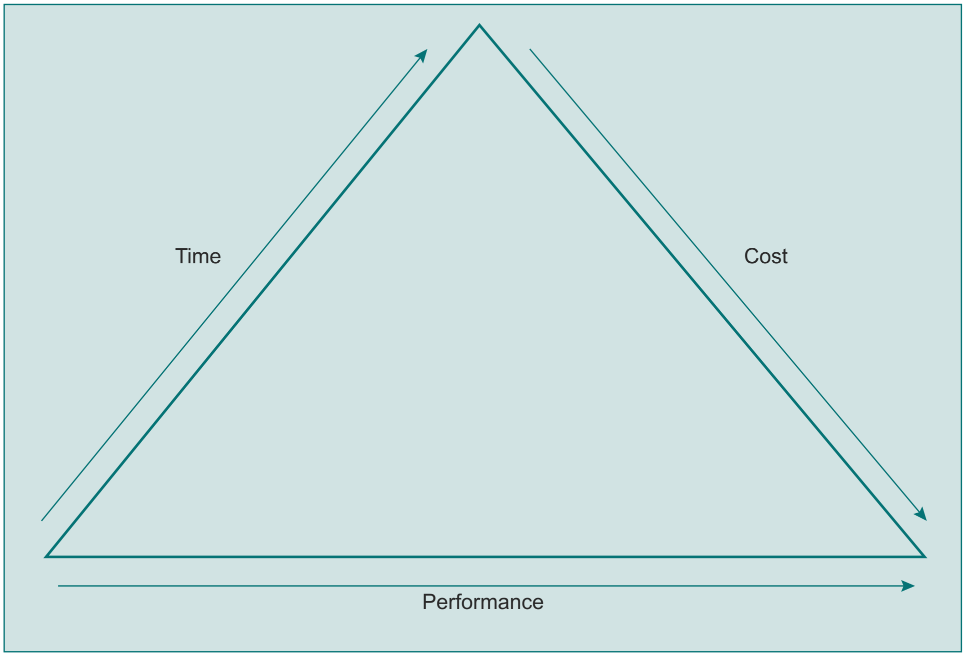

Figure 1.1 The concept of multiple objectives

In Figure 1.2 the shaded area represents the range of acceptable outcomes: outcomes that are below the cost limit, below the time limit and above the minimum quality limit. The project manager has established success criteria for the work and now has a target (the shaded area) to aim at.

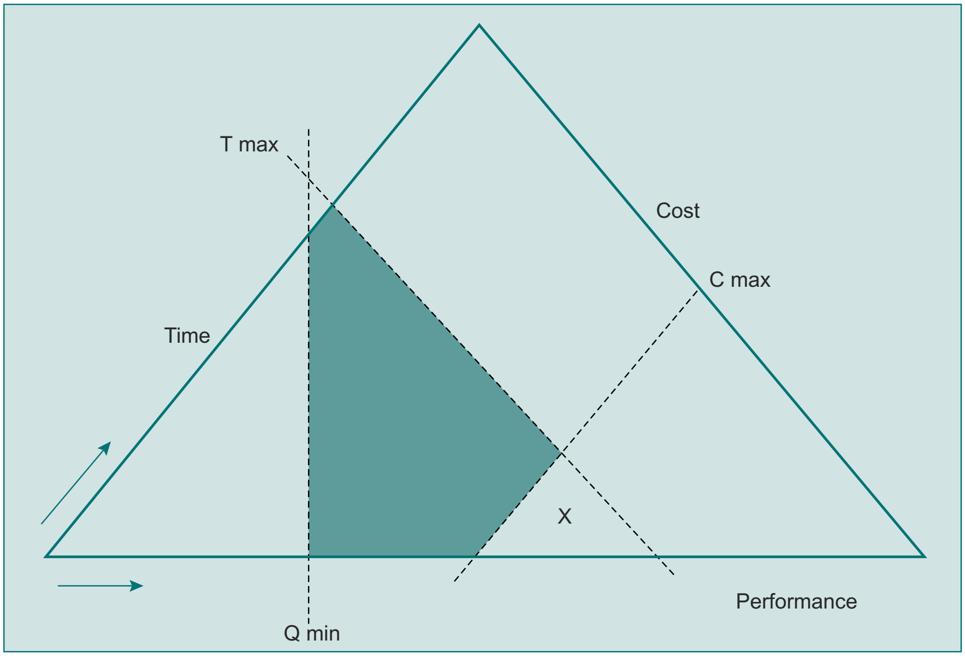

Figure 1.2 **Typical range of acceptable outcomes**

2. **Develop plans to achieve the success criteria.**
   Now that the project manager has a target area to aim at, he or she develops plans to get the work within that target zone. The project manager develops cost plans, time plans and quality plans that define the work and actions required to meet each of the success criteria. These planning processes are covered in Module 5, Module 6 and Module 7 respectively. The plans correspond to the navigation line as discussed in the Navy pilot example.
3. **As the work progresses, measure current performance in relation to the success criteria.**
   Having completed the plans, the project manager then implements them. As the work progresses the project manager uses planning and control tools to isolate the current performance of the project in relation to the range of acceptable outcomes. The project manager then plots the position of the work as at 'time now'. The current position might be at point X in Figure 1.3.

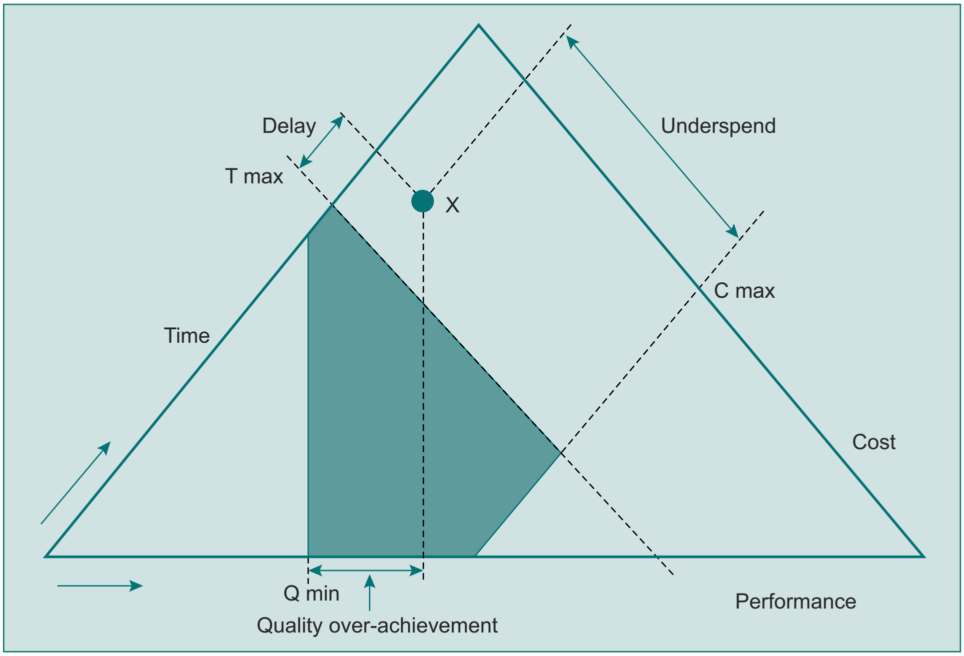

Figure 1.3 **Current position**

4. **Compare current performance with desired performance.**
   From Figure 1.3 it is apparent that the current position X is outside the range of acceptable outcomes. The work is running under budget and above the minimum quality level but it is also running late. If the work continues at this current level of performance it will finish under cost and above the specified quality standard but late. The project manager needs to get the project back into the range of acceptable outcomes.
5. **Where necessary, set up a plan for corrective action.**
   The project manager can now set up a navigation line, as shown in Figure 1.4. This is a kind of navigational course that the project manager will use in pulling the project back into the range of acceptable outcomes. The only requirement for the navigation line is that it must intersect the current position X and it must also intersect the range of acceptable outcomes. If the navigation line meets these two criteria, all the project manager has to do is navigate the work up and down the navigation line until the optimum project outcome is achieved.

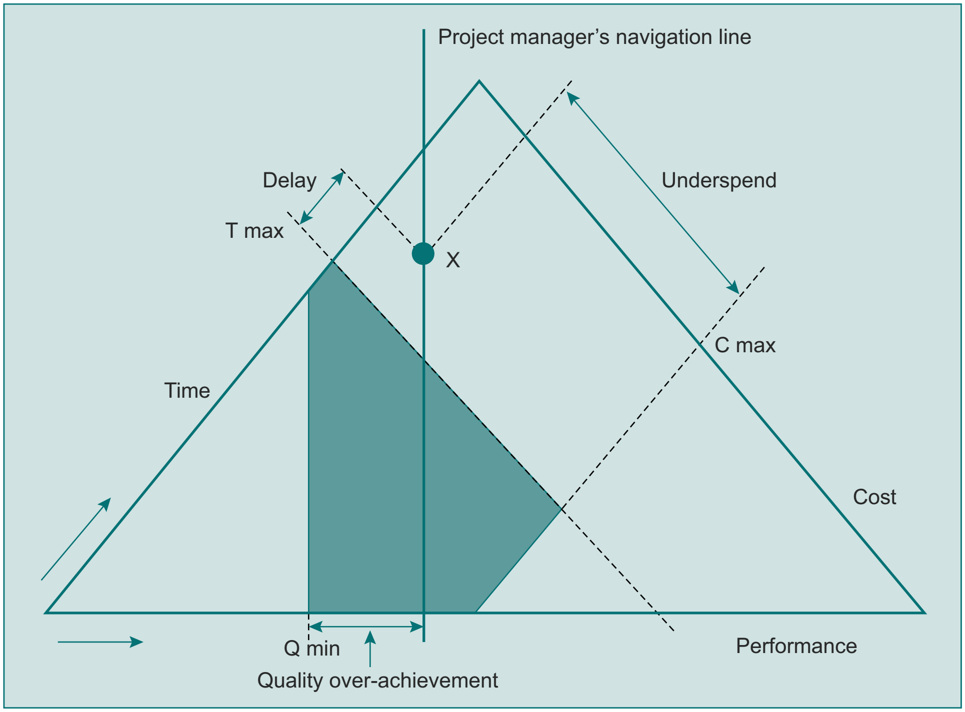

Figure 1.4 Current position and navigation line for corrective action

The obvious question is: how do you navigate up and down the navigation line? The answer lies in the nature of the line itself. The line represents an infinite combination of time and cost values where quality is constant. This is apparent as the line is at 90 degrees to the quality axis. In other words, all points on this line represent constant quality. If the project manager wishes to track the work down the line, therefore, it is necessary to maintain quality at a constant level and decrease time while increasing cost. It is apparent from Figure 1.5 that as the project manager tracks down the line time decreases and cost increases.

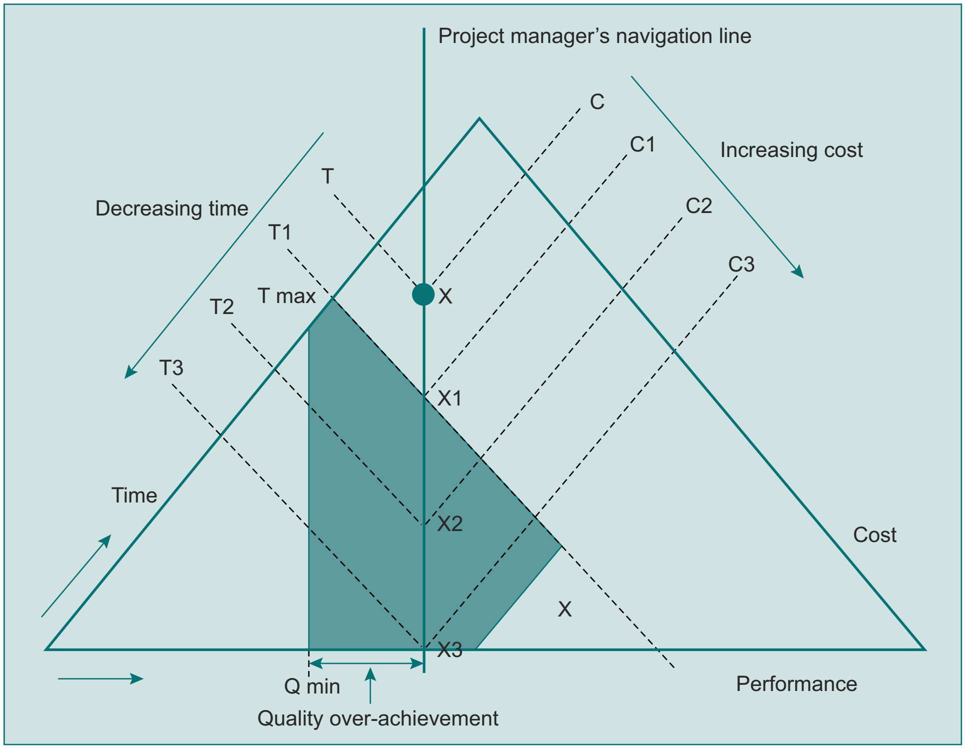

Figure 1.5 **Current position and navigation line showing cost versus time increments**

It can be seen that C to C3 is an increasing progression while T to T3 is a decreasing progression. In other words tracking down the navigation line involves speeding up the work and, in doing so, spending more money.

The project manager can now track down the navigation line until the range of acceptable outcomes is reached. In Figure 1.5, point X1 is right on the edge of the range of acceptable outcomes while points X2 and X3 are both within it.

If we transpose the straight navigation line shown in Figure 1.5 onto a standard representation of cost against time, we are likely to get a curve something like that shown in Figure 1.6. Here the quality level is taken as constant and the axes simply represent cost against time. The curve shown in Figure 1.6 is an alternative representation of the navigation line shown in Figure 1.5 and is usually referred to as a time–cost trade-off curve. The shape of the curve assumes that the cost of speeding up the work is not constant. In this case it is assumed that, when speeding up the work to move it down the navigation line, the project manager speeds up the cheapest work first. It would make sense to proceed this way, as some work might cost half as much to speed up as other work. As a result, the curve in Figure 1.6 is negative and increases more and more steeply as the overall time is reduced.

The project manager can now see a whole range of different outcomes. Outcome X is just on the time limit. It involves a lower cost than X1 but it is more risky in that any further delays will push the work outside the range of acceptable outcomes. Position X2 is more expensive but it is less sensitive to future delays, and so on.

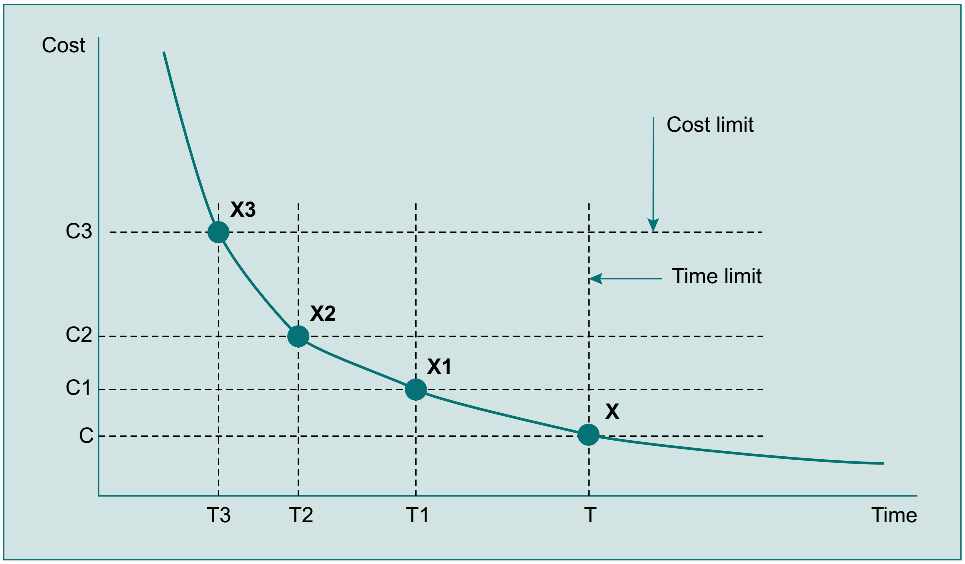

Figure 1.6 **Typical time–cost trade-off curve**

6. **Implement the corrective action and achieve an acceptable outcome.** The final stage is for the project manager to decide on which outcome is required and then speed up the project to that point. If X3 is considered to be the preferred outcome, the cost and time associated with it will be C3 and T3. The project manager might prefer to go for outcome X2 or X1 depending on the preferences and priorities of each individual case.

These six stages are central to the understanding of project management and it is a basic command of these six stages that forms the basis of a career in project management. Project managers use standard project management tools and techniques to execute the six-stage process.

1.2 What Is a Project?

1.2.1 A Project as One Type of Production System

In its simplest form a project is a single, one-off, unique product. It is produced once and the systems and tools that were used to produce it are then used for something else, in many cases to produce other projects.

Most products are produced by some kind of production system. A production system takes some form of non-integrated units and assembles or combines them into an integrated form that represents the end product. The non-integrated units could be raw materials such as water, flour and sugar in the case of baking a cake, or they could be pre-assembled components such as engines and gearboxes in the case of the assembly of automobiles on a production line.

Production systems can also be based on development. For example, students passing through the EBS DBA programme enter and leave as essentially the same people but the knowledge and understanding stored in their brains has increased significantly. In this case the production process involves taking the information contained in the course materials and integrating it in a mental form in such a way that the integration process produces integrative synergies.

In general terms, production systems can be classified into three broad categories based on their main method of production:

- mass production;
- batch production;
- project production.

Mass production systems are based around the production of large numbers of similar items. A typical example is a production line for the manufacture of automobiles. The process runs continuously. All the operatives and their tools are arranged within the production system and the whole process is carefully researched and developed to operate at maximum efficiency. The primary characteristics of such a system are that it is capital-intensive and highly mechanistic, and relatively little active management intervention or control is needed once the system is set up and operating satisfactorily. It is obviously most appropriate for mass production of repetitive units where there is little chance of change to the input requirements and where consumer demand for the end product is likely to be relatively constant.

A manager in charge of such a mass production system has to consider a range of different aspects of production. There are some product variables that he or she is not concerned with. For example, a manager in charge of an automobile assembly line is not directly concerned with the cost of the finished product. The assembly line receives all the components it needs directly from the appropriate stores, and these components are acquired by different parts of the company. The assembly line manager has no control over the purchase price of engine blocks. The assembly line fits the engine blocks irrespective of what they cost from the suppliers. The overriding consideration of the production line manager, therefore, is simply to keep the production line going – not the purchase price of the components, how much the finished automobiles cost, how long it takes to assemble each automobile, or other such considerations. These variables are all pre-set as the components enter the system.

By contrast, *batch production* is used where there is unlikely to be continual high demand for a given product and where some changes or modifications will be needed at intervals. Batch production may also be driven by seasonal and/or time-based considerations.

An example of *demand-driven batch production* is a company that produces wallpaper. The company may win a contract to supply different papers to a large retail outlet. The company tools up for a particular type of wallpaper and runs off perhaps 100 000 rolls of wallpaper called type X. This output may be sufficient to supply the major retailer with 1000 rolls for each of its nationwide stores. It might take the wallpaper company one week to produce this level of output but it might take the retailer an average of three months to sell 1000 rolls of type X in each store. There is, therefore, not enough demand to justify continuous production of type X. Instead, the company produces type X in batches, in this case 100 000 rolls in a single run every three months.

A *cyclic-driven batch* example is wine. A vineyard produces a crop of grapes once each year. In 2004 the vineyard produced a batch that was harvested and made into the wine for that year, the 2004 vintage. There will never be another 2004 batch because the natural seasons dictated that only so many grapes could grow in that year and the characteristics of that particular vintage were set by a whole range of drivers, from ground water supply to general weather conditions.

The batch production manager may be somewhat more concerned with individual production variables than the mass production manager. For example, in making the 2004 vintage the batch production manager had only the 2004 quality of grape to work with. Like the mass production manager, he or she had no control over the quality of the raw materials. The batch production manager may, however, have had control over some variables such as the quality of the storage barrels, the rate of press and the combination of grapes used.

It is reasonable to say that a batch production system is often less mechanistic than a mass production system and the potential requirement for management intervention is greater.

The third alternative is *project production*. This applies to products that are produced on a one-off basis. In this case the product cannot be batch or mass produced. An example is the development of a new prototype aircraft. A government may wish to supply its air force with a new fighter aircraft. Government specialists may stipulate the key performance characteristics of the aircraft, such as operating range and minimum weapons payload. A contract may then be awarded to a specialist military avionics company, which will come up with original designs to meet the stated specification. The basis for design approval in such cases is often a working prototype that demonstrates that the performance standards specified have been achieved. The design and construction of the prototype is a project. No such prototype has been built before and none will be built again. It was built with a single definable purpose, which in this case was to convince a client that the design meets their requirements. It was also, in all likelihood, designed with some kind of production cost and timescale in mind. The government in question will almost certainly want to know how much each aircraft will cost and how long it will take to manufacture each one.

The manager of the project, or project manager, therefore needs to be much more involved in variables such as time, cost and quality. In designing a prototype aero-engine, the engineering designer (working as a project team member under the overall leadership of the project manager) effectively establishes how much the engine will cost, how long it will take to build and maintain, and how well it will perform. The project manager also has to be aware of these variables and in particular how they are related. For example, if the design engineer wants to extract more power from the engine he or she may have to use higher-quality components, thereby increasing the overall cost of the engine. If the overall cost of the engine increases, the overall cost of the prototype will also increase unless the project manager can find savings elsewhere.

It should be apparent that a project is only one type of production system and a project manager is only one type of manager. It should also be apparent that the project manager needs to possess a range of skills different from those required by a manager in charge of a batch production system and different from those required by the manager of a mass production system.

Time Out

Think about it: combined batch, mass and project production systems.

Let us consider a case study where a company uses batch, mass and project production systems. A small company makes paint type Y for a major national retailer. At present, the paint manufacturer makes type Y on a batch basis. As it receives an order from the retailer, it makes 10 000 litres of paint and sells these to the retailer. It takes the company one week to make and pack 10 000 litres of paint. At present the retailer orders 10 000 litres of type Y per month.

The retailer might suddenly open a large number of new shops, thereby quadrupling demand for type Y. The retailer now demands 40 000 litres of type Y per month, which is equivalent to the full production output of the paint manufacturer. It may now be viable for the paint manufacturer to convert to continuous production of type Y to meet the increased demand. The paint manufacturer might decide to invest in a new mass/continuous production system that will produce paint continuously (although at variable rates) in order to meet the new increased demand from the retailer. This represents a strategic switch from batch to mass production.

In this case, the original production system was based on batch manufacturing. As demand increased, a decision was made to switch to mass production. For the paint manufacturer, the switch from batch to mass requires the installation of new equipment and processes. The design, procurement and installation of the new equipment and processes will be managed as a project. The company will have to appoint or commission a manager (the project manager) to be responsible for the project. In switching from batch to mass by the use of a project, the paint manufacturer is an example of all three production types.

Questions:

- Can you identify another example of a system that has mass, batch and project phases or characteristics?
- What would be an example of a system that only ever has a project phase?

Project management should be considered as a tool for managing one-off changes. In real companies these changes can range from internal restructuring exercises to the implementation of large-scale acquisitions of external target companies. Both the internal restructuring and the acquisition are planned changes that are designed to improve the competitive advantage of the organisation in some way. The internal restructuring may be designed to make the company more efficient while the acquisition may be designed to increase the company's market share. In both cases the changes involved are best planned and implemented using project management tools and techniques.

1.2.2 Projects versus Programmes

Before considering what a project is in more detail, it is useful to contrast a *project* with a *programme*. Frequently the terms 'programme management' and 'project management' are (wrongly) used interchangeably. In common usage, a programme is a set of identifiable projects aimed at achieving some goal or aim. Typically a programme is of longer duration than any individual project within it. Some programmes may not have any specified end date and may run until a decision is taken to stop or replace them. An example is a government initiative to reduce greenhouse gas emissions to an agreed level within a set timescale. The overall initiative is a programme, while the individual actions within it, such as decommissioning a given coal-fired power station and constructing a new gas-fired power station, are individual projects. In large companies there are generally both projects and programmes of projects running at any one time.

Programme managers are often highly experienced project managers. In many ways the demands of programme management are similar to those of project management, only on a larger scale.

1.2.3 Project Characteristics

Having considered a project as being one type of production system, it is now appropriate to examine the characteristics of a project. The following list covers some of the classic characteristics of a project.

- **A project usually has a single definable purpose or aim.** An example is a project to acquire and assimilate a target company. The purpose or aim of the project is to produce the acquisition and the desired degree of assimilation. The project effectively terminates when this has been achieved.
- **A project usually has a series of individual operational constraints or performance objectives.** The classic constraints or objectives relate to time, cost, and quality or performance. Most projects have to be completed within an agreed timescale, within cost limits and to a stated standard or level of performance. In the case of an acquisition the target shares may have to be purchased for less than a certain price for the acquisition to be financially viable.
- **Each project team tends to be unique in that it is generally multidisciplinary.** Projects often draw together members from different specialisations. These project team members work together for the duration of the project, after which the team is disbanded and the members either go back to their old jobs or are formed into a new project team. A project team responsible for planning and implementing a major acquisition could include financial experts, management specialists, legal specialists and so on. Multidisciplinary teams are more difficult to manage and develop than single-discipline teams, as we will see in subsequent sections.

- **Each project is unique.** Each project is designed for a specific purpose or aim and no two projects are ever identical. In the case of a company that intends to make a series of acquisitions, each target is different and the design and implementation of each acquisition will be different. There is, however, the possibility of transferring knowledge between acquisitions.
- **Projects tend to be unfamiliar.** They are often designed to bring about change, may involve new approaches and processes, and may generate an unfamiliar end condition. Projects tend to be characterised by a high degree of uncertainty. In the case of an acquisition the target brings a lot of new people into the system and the effect this will have is always difficult to forecast in advance.
- **A project generally has a finite lifespan.** A mass production system is designed and built and when commissioned it runs continuously until a completely new type of product is required. When commissioned, the production line does not have any finite lifespan set on it. It simply runs until demand dictates change. Most functional departments within companies operate on the same basis. A project tends to be established for a set timescale, after which the project team is disbanded and the project no longer exists. In the case of an acquisition, the project terminates once the acquisition has been completed to the required level of assimilation.
- **Projects tend to pass through clear stages of development.** For example, at the highest level there are likely to be separate design and implementation phases. The design phase may contain a series of sub-phases such as concept, feasibility, outline design and detailed design. These sub-phases represent milestones or gateways through which the project must pass as it develops.
- **Projects are often complex.** The multidisciplinary nature of projects generally results in their being more complex and involved than associated functional production systems. Projects are often highly interdependent, in that one part of the process depends on one or more other parts of the process. In the case of an acquisition the valuation process may be strongly influenced by the current share price, which itself is influenced by the acquisition.
- **Projects are characterised by change.** Projects are usually designed to achieve change and they often operate under conditions of change. In an acquisition the aim of the project is to change the structure and characteristics of the acquiring company. In order to do so the acquirer changes both itself and the sector concerned.
- **Projects are often high risk.** Projects are often classified as higher risk than associated functional production systems largely because of the change element. Bringing about change while operating under conditions of change results in a high degree of uncertainty and, more specifically, risk. The degree of risk associated with change is generally much higher in projects than it is in associated functional production systems.
- **Projects tend to be secondary to the main strategic function of the organisation.** For example, a bank may initiate a project to upgrade its IT system. The IT system itself is a support function: it enables the bank to perform its primary strategic financial functions. The project to upgrade the IT system is intended to

improve the support function and improve the overall competitive advantage of the bank. The project is, therefore, secondary to the main functional thrust of the organisation. There are, of course, exceptions. Some organisations, such as research and development establishments, legal practices and consulting engineers/design practices, operate by executing a series of commissions or cases (projects) at any one time as their primary functional focus. In most cases, however, projects have a secondary role and are intended to improve the efficiency and effectiveness of the primary role.

Time Out

Think about it: characteristics of a project involving the installation of a new server.

The installation of a new server in an office is one example of a project. It involves a single, definable purpose, which is to set up a new server-based network for the office. It uses the skills of a number of different people, from individual company users to external specialist IT consultants. Different people will write the software, configure the hardware, install the system and test and commission it. As with many projects, the team itself is multidisciplinary. Installing the server and commissioning it is a unique process for the IT consultants, in that every office is different and the demands of any particular client will be specific to that client. The project will always be somewhat unfamiliar, because new hardware and software are coming onto the market all the time, and hence the resulting system requirements will be constantly changing. The project is highly interdependent, in that the input of each person in the multidisciplinary team must work properly in order for the overall new system to work.

The installation team is also temporary. It works together on the server installation. As soon as the installation is complete and the system is commissioned, the team ceases to exist and each individual either moves onto new installation projects or moves back into their standard or normal functional roles. The installation may be interlinked, in that it may take place in conjunction with hardware or software upgrades. Most IT managers would take advantage of a server upgrade to carry out other network improvement works such as replacing PCs or upgrading software.

The project is designed to bring about change in the form of a new server that presumably will make the company more efficient. The overall level of change risk is high and some form of standby provision is obviously necessary. All obvious precautions such as backing up all data, running duplicate systems, phased commissioning and so on should be put in place to reduce the impact and magnitude of change risk.

Questions:

- Where might the installation of a new server not be regarded as a project?
- How could project objectives (installation of the new server) be accurately coordinated with organisational objectives (general software and hardware upgrade)?

It should be apparent that projects are important to companies in that they provide the opportunity to add value. Projects are also complex and risky and it is clear that a different type of manager is required to manage them. Until recently, projects and project management were considered to be limited to the construction and engineering industries. Today project management is being applied across all industries as change and competitiveness become part of everyday operational life. All companies have to change in order to remain competitive and the best way of managing this change is by using project management. This realisation is reflected in the range and diversity of project management positions advertised in recruitment magazines and newspapers. Currently a job advert headed 'Project Manager' is as likely to refer to a social work or IT post as it is to a construction or engineering post.

1.2.4 Project Manager Characteristics

It should be clear that the job demands of a project manager and a functional manager are very different. A production manager in charge of an automobile assembly line is primarily concerned with keeping that production line running. As long as the line runs at its designed rate, the production manager is doing his job.

Project managers face a much more complex challenge. In most cases they have to achieve the single project aim through a series of conflicting objectives. For example, a project manager may have to design and commission a new MBA course within 12 weeks and at a cost of no more than £400 000. The project manager may have to balance time against cost and cost against performance to achieve the aim while satisfying as many of the objectives as possible. He or she has to achieve this under high-risk conditions of change working with a multidisciplinary team that is highly interdependent. To make matters worse, the team is only temporary and the individuals know that once the project is completed they will be transferred back to their old jobs or be allocated to another project. If they have been seconded from a functional department such as production or IT, they may see that functional department as their first allegiance anyway, as their perceived career path is centred on their long-term functional department role.

Project managers, therefore, need command of a range of different skills. In most cases project managers need detailed technical skills that are relevant to the sector in which they are working. They need applied cost planning and control, time planning and control, and performance planning and control skills in order to allow them to balance project objectives. Project managers also need detailed change management and risk management knowledge as projects operate under conditions of change.

Increasingly project managers are undertaking professional qualifications as a means of showing their ability against nationally and internationally recognised standards. The global body for project management is the International Project Management Association (IPMA), based in Zurich in Switzerland. This body has established standards and procedures for numerous national project management associations around the world, with the exception of the US national body, the Project Management Institute (PMI). In the UK the national body is the Association for Project Management (APM). The PMI and the APM have established *Bodies of*

Knowledge (BoKs), showing areas of expertise and experience that project managers require. The APM BoK has been developed and refined over a number of years and now represents the nearest thing there is to a standard description of the skills and knowledge project managers need for professional practice. The various national bodies also offer different grades of membership, depending on age, qualifications and experience. These reflect standard IPMA grades that are uniform around the world.

Project managers tend to operate in one of two alternative forms. Internal project managers are generally employees of a given company and are put in charge of projects within that company. An example is a functional manager who is selected to run a project to set up a new call centre. The project manager in this case may be seconded to the project for a given period of time, after which he or she transfers back to the appropriate functional department. In other cases the secondment may only be part-time and the manager has to spend 50 per cent of his or her time working on the project while the remaining 50 per cent is allocated to the functional department.

External project managers operate as independent consultants and provide project management services to a client in return for a fee. They are usually appointed using some form of professional services contract, which is a type of agency agreement. External project managers are increasingly offering a range of professional specialisations ranging from construction project management to the project management of large-scale mergers and acquisitions.

1.3 What Is Project Management?

1.3.1 Definition of Project Management

The characteristics of a project have been considered above. It is now possible to develop a definition for project management. Given the relative youth of project management as a discipline, it is not surprising to find that project management has numerous definitions.

The official definition provided by the Project Management Institute (PMI, 2013) is as follows:

> *Project management, then, is the application of knowledge, skills and techniques to execute projects effectively and efficiently. It's a strategic competency for organizations, enabling them to tie project results to business goals – and thus, better compete in their markets.*

The official definition provided by the Association for Project Management (APM, 2013) is as follows:

> *Project management focuses on controlling the introduction of the desired change. This involves:*
> *- understanding the needs of stakeholders;*
> *- planning what needs to be done, when, by whom, and to what standards;*

- building and motivating the team;
- coordinating the work of different people;
- monitoring work being done;
- managing any changes to the plan;
- delivering successful results.

Other typical example definitions include:

The design and implementation processes required to complete a project on time, within cost and to the required level of performance.

The organisation, planning and control of a project required to achieve completion on time, within cost and to the required level of performance.

Most authors of project management literature agree that project management is about setting and then achieving (or beating) targets for time, cost and performance (quality). Increasingly authors are introducing the variable of safety, which is becoming more and more important as a result of increasing statutory provisions on health and safety. Some authors are also introducing the variable of risk, as economic necessity increasingly drives projects towards higher and higher risk states.

One possible definition, therefore, could be:

The planning and control processes and skills required to complete a project using project resources while matching or improving on time, cost, quality and safety limits at an acceptable level of risk.

This is only one possible definition and you might be able to come up with a number of alternatives. The main thing to remember is that project management is about planning, implementation and completing a project within set limits. These limits typically relate to time, cost and performance and increasingly to safety and risk.

Traditional planning and control techniques consider time, cost, and performance planning and control. Traditional approaches, however, often consider these variables as separate entities that are planned and monitored using entirely different systems. For example, traditional cost planning and reporting systems do not necessarily link directly into the relevant resource scheduling systems. In addition, reports have traditionally been prepared by different consultants, who are responsible for different aspects of project delivery. Cost reports have traditionally been produced in isolation by the cost consultant, while implementation progress reports have traditionally been prepared by technical staff. These traditional approaches have worked satisfactorily over the past century or so, but increasingly they are becoming obsolete as projects become larger, more complex and faster moving. On large projects it is imperative that integrated reports are produced where time, cost and performance levels are reported together.

This idea of integrated reporting is central to project management. Project managers have to be able to look at time, cost and performance levels throughout the course of the project and appreciate how these levels relate to each other. Time, cost and quality are often referred to as *project success criteria*, as ultimately these are the variables that determine whether or not a project is successful. In most cases it is not possible to maximise or minimise these criteria and the aim of the project manager is to achieve a satisfactory balance of the three. This concept is shown in Figure 1.7.

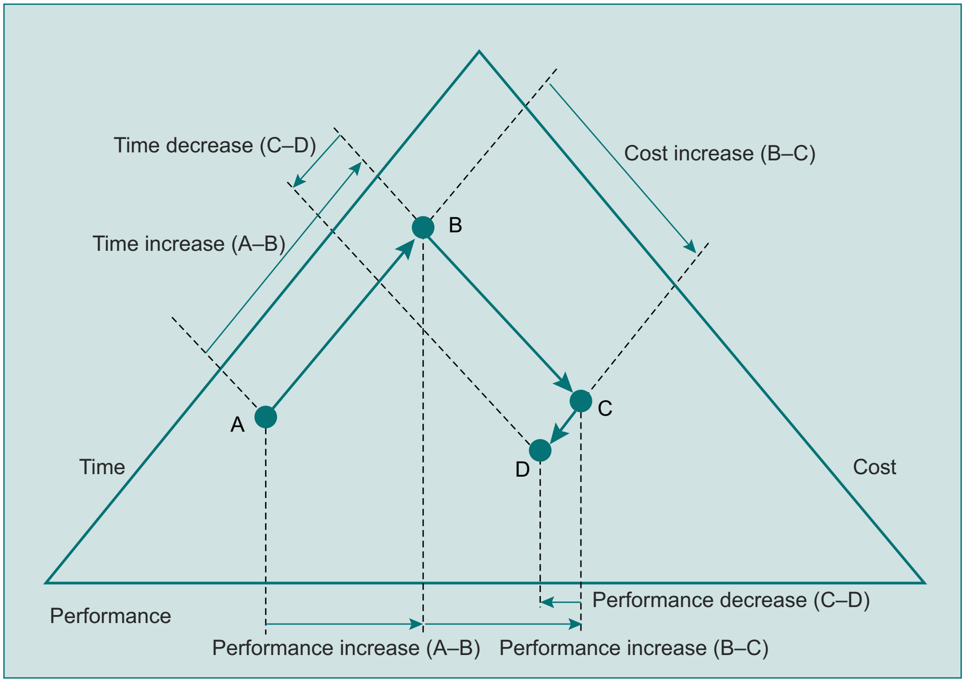

Figure 1.7 **The typical project management time–cost–quality continuum**

Figure 1.7 could represent the balance between time, cost and performance for a projected new product that comprises a series of different components. Point A represents the condition of a product at a given point. This position could represent the production standard with an unacceptably high defect rate. As a result, the overall performance of the system has to be improved. In this case this is done by taking longer to assemble the components involved. The product therefore moves from position A to position B. Time and performance both increase as more careful assembly leads to a more reliable product. The position at B might represent the maximum amount of time that can be spent in assembling this product. The product itself might be part of a larger product for which a minimum assembly time is already fixed.

The only way to increase performance further is to use higher-quality and, therefore, more expensive components. In moving to position C, the product increases performance while production cost goes up significantly. A further requirement may then be issued, saying that the assembly time is already too long and must be reduced by 50 per cent. If no further money is available for increasing costs then performance must be reduced to achieve this time saving.

Project managers have to be able to picture this kind of time–cost–performance balance in their heads and must be able to see what effect a change in one variable has on the others. For example, if additional funding had been available in the example given above, the required production time savings could have been achieved with no reduction in performance. This scenario is shown in Figure 1.8.

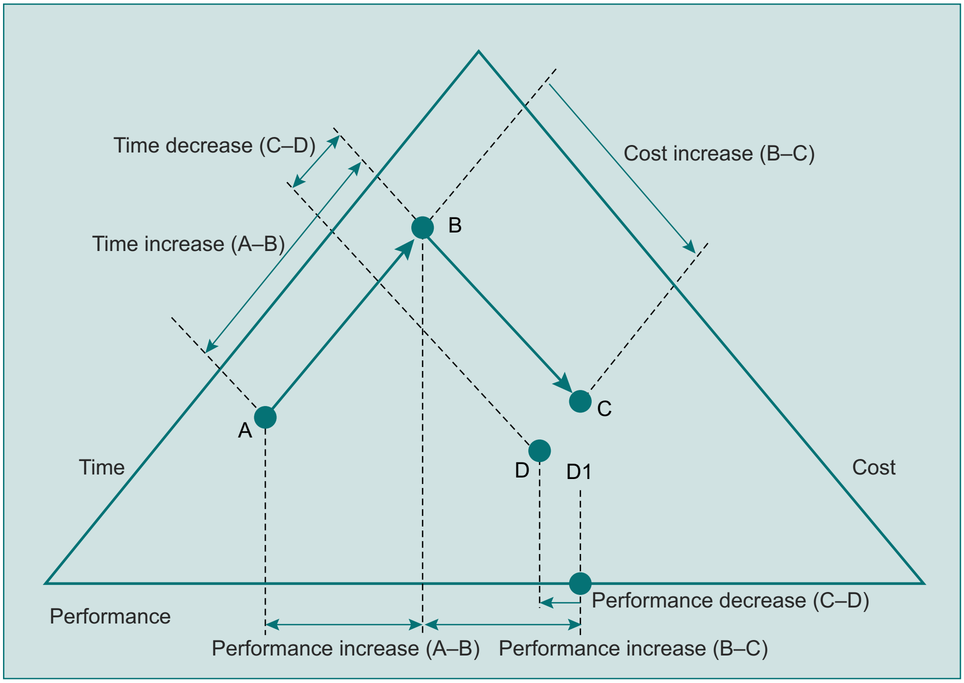

Figure 1.8 **The typical project management time–cost–quality continuum with additional finance available**

In Figure 1.8 additional funds are now available, so the product can move to position D1 rather than D. The move C–D involves a performance reduction with a time reduction and no cost increase, while the move C–D1 involves no performance reduction with a time reduction and a cost increase. At D1 the product is completed earlier than at D. In other words at D1 the product is completed to the same standard of performance as at C but more quickly and at greater cost.

Different success criteria are more important to different individuals or organisations. A company developing and selling new pharmaceuticals is likely to regard performance as its primary success criterion, as the consequences of releasing a defective drug onto the market are potentially catastrophic. No matter how long it takes or what it costs, the company has to be sure that what it releases is safe, because the losses it could suffer as a result of compensation claims and lack of reputation could be disastrous. On the other hand a small to medium-sized supplier who has won a major contract to supply a major retail outlet at a fixed price is likely to be concerned primarily with manufacturing cost, as this will determine whether or not the supply contract makes a profit or a loss. A supplier who stands to lose money might even try to reduce the quality of the product in an effort to save manufacturing costs.

On real projects, the success criteria are usually specified in terms of acceptability envelopes. These represent a range of acceptable levels for each criterion expressed in terms of maximum and minimum acceptable values. This concept is shown in Figure 1.9. In this case the maximum and minimum time limits have been set. These could drive the start and finish times of other activities in a complex process and, therefore, may have to be expressed as maximum and minimum values. In some cases cost may also be specified as maximum and minimum values, although a single maximum value is perhaps more common. A minimum value is shown in Figure 1.9 for clarity. A minimum permissible performance standard is also shown.

The range of acceptable outcomes, therefore, is represented by the shaded area in Figure 1.9. The aim of the project manager is to move the position representing the project into the shaded area and keep it there. If he or she manages to do so the project will meet all its success criteria.

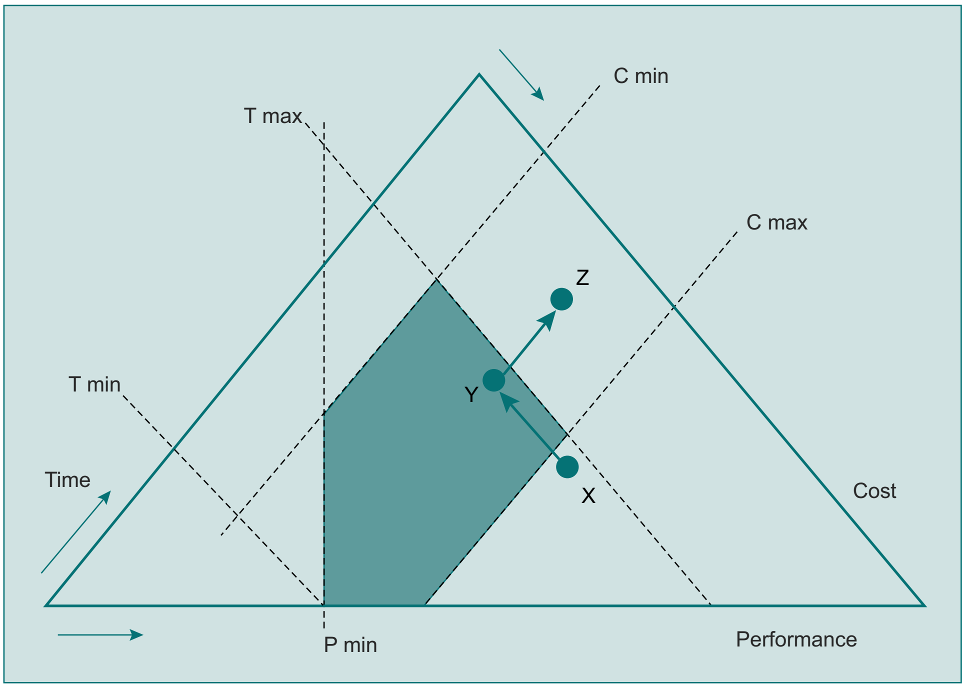

Figure 1.9 The typical acceptability range representation

Point X might represent the starting point for a given project. At point X the project is clearly above the maximum cost allowed, although the time and performance characteristics are acceptable. At point Y the project satisfies all success criteria. At point Z the project satisfies cost and performance criteria but it is taking too long to produce.

Good project management is about being able to develop this kind of *success field* and then monitor how actual progress compares to planned progress and carry out any corrective actions where necessary. For example, in detecting that the project at X is in an unacceptable position, the project manager has to consider how to move the project to position Y. It should be noted that the assembly or production times for X and Y are the same. In other words, the arrow between X and Y represents a line where time is constant. The project manager can track along this line by balancing cost against performance. In this case, by reducing the performance of the product, the project manager can reduce cost to a level where the position of the project falls into the success field.

The project manager could also establish a line running through Y where cost is constant. He or she could then track along this line to point Z by maintaining constant cost while increasing both time and performance.

This ability to establish a target zone and then engineer the characteristics of the project at any given time is central to project management. It is sometimes called the *gun-sight approach* because it is similar in principle to setting up a target and then aiming to hit it.

The need to understand linkages between project success criteria and between decisions and complex outcomes has arisen over the past 50 years as projects have become more complex and as the demands for greater and greater efficiency have steadily increased. Modern *fast-track* projects move so quickly and are so complex that the project manager has to understand the complex interrelationships between decisions and possible multiple outcomes both within the project and outside it. As project complexity increases, single changes can have impacts that generate effects right around the system and cause corresponding impacts at many different points within the project.

Moreover, as societies become ever more sophisticated and complex, the links and interdependencies between different sections of industry and commerce become more pronounced. Expansion and evolution in one area produce a demand for corresponding expansion and development in other sectors. For example, an expansion in the commercial sector generates a demand for expansion in the communications sector, as commerce depends to some extent on communications. As communications expands, the various sub-industries and sectors that supply it also have to increase production.

This increase in complexity and multiple objectives has been and continues to be a significant driving force behind the development of project management. The project manager is concerned with multiple success criteria, but also has to be able to view these within the context of the whole operating system.

It is important to appreciate that engineering a project outcome that falls within the range of acceptable outcomes is not all that project management is about. Project management uses a wide range of specific skills from leadership and teambuilding to risk assessment and risk management. In order to be able to engineer an outcome that falls within the range of acceptable outcomes, the project manager has to be able to manage all aspects of the project from the people to the risk profile. The location of the project within the success field is the end result of a long and complex process involving a wide range of general and specific management skills.

Time Out

Think about it: the development of system complexity and resulting need for effective project management telephone systems.

Only 40 years ago, telephone systems were comprised of a national network of telephone exchanges linked by metal connecting wires. This system was based on the telephone networks first developed in the late nineteenth and early twentieth centuries. The telephone exchanges were manned by operators who directed calls manually. The operator took a call, asked the caller what number he or she wanted, and then made the connection manually. This approach worked reasonably well up to the 1960s because the number of telephones in use was small and the overall demand on the network was manageable. As society developed and commercial and industrial demands on the system escalated, the telephone system was forced into a process of evolution because the old operator-based network could no longer meet the call demand that was placed on it. This evolution was assisted to some extent by corresponding developments in new technology in radio and other communications media.

Commercial radio telephones appeared in the 1960s followed by mass networks involving electronically controlled exchanges. The first mobile telephone handsets appeared in the early 1980s, although their use was limited, largely because of the size and weight of battery required.

Today there is a multiplicity of different telecommunications options. Users can still use cable-linked systems, but these tend to use high-capacity optic fibre rather than metallic conductors. Increasingly, telephone calls are transmitted by radio. International calls can be made by satellite. Most people now have mobile phones that are operated through a series of competing cellular networks. There are large-scale commercial battles and takeovers involving large telephone companies, and the major players have become corporate giants.

The whole telephone system is infinitely more complex than the 1960s system. It is also far more powerful and flexible. These remarkable changes have all been market-driven. Companies have invested in them because the potential benefits have been clearly demonstrable.

Market-driven forces for change required multiple time, cost and quality objectives. Users wanted better handsets at reasonable prices, delivered more quickly than the opposition. This in turn generated a need for advanced project management practice in the rapidly expanding telephone and communications markets. Today, the largest single membership of the Association for Project Management is Information Technology, and the telephone network and equipment companies use some of the most advanced project management techniques in the world.

Questions:

- Why is the telecommunications industry characterised by constant change?
- Why does this constant change generate a need for project management in this industry?

1.3.2 Internal and External Project Management Forms

The next thing to consider is what form the project management system is likely to take. It is important to understand that project teams can be set up and managed in numerous different ways depending on the characteristics of the project and of the organisations concerned. The most basic classification system for project forms comes under two headings:

- internal project management;
- external project management.

1.3.2.1 Internal Project Management

The most common form is for a project team to be created and to operate within an existing organisational structure. This format is commonly known as *internal* or *non-executive* project management. The various organisational forms for project management are considered in more detail in Module 4. This section introduces the idea of project teams operating within functional units in advance of the main discussion in that module.

Most organisations are organised around functional groups that specialise in particular areas. Individual people and groups of people tend naturally to form specialisations. It is easier for the human brain to collect and store related information than non-related information. Most people move into one specific area and then develop their knowledge and experience in that area rather than moving across a number of different specialist disciplines. This natural tendency applies to most aspects of human activity, from preferred playing positions in a football team to specialisation within a rigidly defined hierarchy, such as a military officer specialising in covert surveillance.

Organisations that are based around functional groupings are often referred to as *functional organisations*. Organisations that are wholly based around their functional structures are often referred to as *pure function organisations*. Generally the larger an organisation becomes the more likely it is to adopt a functional structure. This usually happens because the authority and communications systems are generally more clearly defined in functional structures and the roles and responsibilities of individuals and groups are more clearly defined. Typical examples of functional structures include central and local government, the armed forces, the police and fire services, universities and large manufacturing companies. A university, for example, may be split up into schools or faculties at the highest level. Each school or faculty usually comprises a series of specialist departments. Within each department there may be different research and teaching groups. The functional boundaries of each group are clearly defined and the authority structure runs clearly from the top to the bottom of the hierarchy.

An internal project management structure is one that is based entirely within the structure of the organisation. Since most large organisations adopt a functional structure, it follows that most internal project management structures operate within a functional hierarchy. In most cases an internal project management team comprises people who are seconded from the various functional departments to serve for a period of time on the project. In many cases these people become members of the project team while they continue to work for their original functional department. An IT specialist, therefore, may continue to work for the IT function but he or she may be seconded to the project team for a period of three months while, for example, a new product is developed. Alternatively the IT specialist may be instructed to provide 50 per cent of his or her time to the project for the next three months – so functional and project responsibilities run in parallel.

Projects operating within functional structures offer good flexibility in the use of people. Staff are primarily employed to perform a functional task and in most cases their first allegiance is to the functional unit. Staff are, however, temporarily assigned to projects that require their particular expertise. In addition, individual experts can be effectively used across a number of projects. If there is a broad base of expertise within a functional department, it can be employed on different projects with relative ease. The internal system also has the advantage that specialist knowledge can easily be built up and shared within the function. Continuity of expertise, procedures and administration is maintained within the function despite any personnel changes that may occur.

The main characteristics of internal project management can be summarised as follows:

- The project team is staffed by people who are taken either full-time or part-time from the various functional units within the organisation.
- The project manager leads the project team and is responsible for ensuring that the project achieves its aims and objectives.
- The functional managers continue to head the various functions. The functions remain central to the normal everyday objectives of the company.
- Because project team members are drawn from a range of different functions the project team is generally multidisciplinary.
- The project manager is responsible for developing the project team and for altering his or her leadership style to suit the development of the project team.
- The project manager and functional managers generally have the same level of authority within the organisation.
- The aims and objectives of the project manager and the functional managers are different, although both are in the interests of the organisation.
- There is always a potential for conflict between project aims and function aims.
- Project team members effectively have two bosses: the project manager and a functional manager.
- The project is temporary while the functions are generally permanent. The functions are usually seen as the mainstay of the organisation and project team members often see their career path as tied to the function rather than the project.
- Projects get people from different functions working and talking together.

Internal project management still accounts for the majority of project management practice in the UK. The approach is widely used in a range of applications, from universities setting up new multidisciplinary courses to financial companies that are setting up new working groups to address specific development and change issues.

Time Out

Think about it: using existing university functional specialisations to develop a new course in Marine Resource Project Management.

An existing university might have courses already running in Marine Resource Management and in Project Management. These are often both popular courses in their own right. University market researchers might find that there is significant demand for a new course that combines the two existing courses into Marine Resource Project Management. The existing departments of Project Management and Marine Resource Management could combine to develop the new course, which would comprise modules and subjects from each department, delivered by staff from each department. The staff are fixed overheads so there would be no direct cost implication other than establishment costs in setting up the materials for the new course.

The existing heads of department would effectively become functional managers. A new course leader would be appointed to act as project manager in developing and implementing the new course. The project team members would be specialist lecturers from the two teaching departments. The project manager would report directly to senior university management, probably at faculty board or school level.

The staff costs would be charged to the project cost centre. Any time working for the functional departments would be charged to the functional cost centre. Once in operation, the system would effectively operate as a batch production system.

This idea of interdepartmental working has the advantage that it allows the university to develop new courses using existing resources. It has the additional advantage that it opens up communication and joint working between departments, which in turn can lead to enhanced working relationships and greater joint understanding. New multidisciplinary courses sometimes generate unforeseen synergies where the value of the new course is greater than the value of the components put into it. This can happen where two separate subject areas are joined to form a new area that has greater than expected attraction.

Questions:

- Some of the advantages of such an arrangement are outlined above. Can you think of others? What might the disadvantages be?
- What would be the potential dangers to the functional departments under such an arrangement?
- How could these dangers be mitigated from an organisational viewpoint?

1.3.2.2 External Project Management

The main alternative form of project management is *external* project management. This form is sometimes referred to as *executive* project management. In external project management the project manager tends not to be an employee of the organisation concerned, but is usually a private professional consultant who offers professional project management services to the organisation or client in return for a fee. This is a form of agency agreement where the professional project manager agrees to act on behalf of the client and in the best interests of the client. In the US and most EU countries there are significant numbers of professional project management consultancies that offer such professional services. In some cases they offer general project managers while others specialise in specific industries or functions.

A typical external project management arrangement is shown in Figure 1.10.

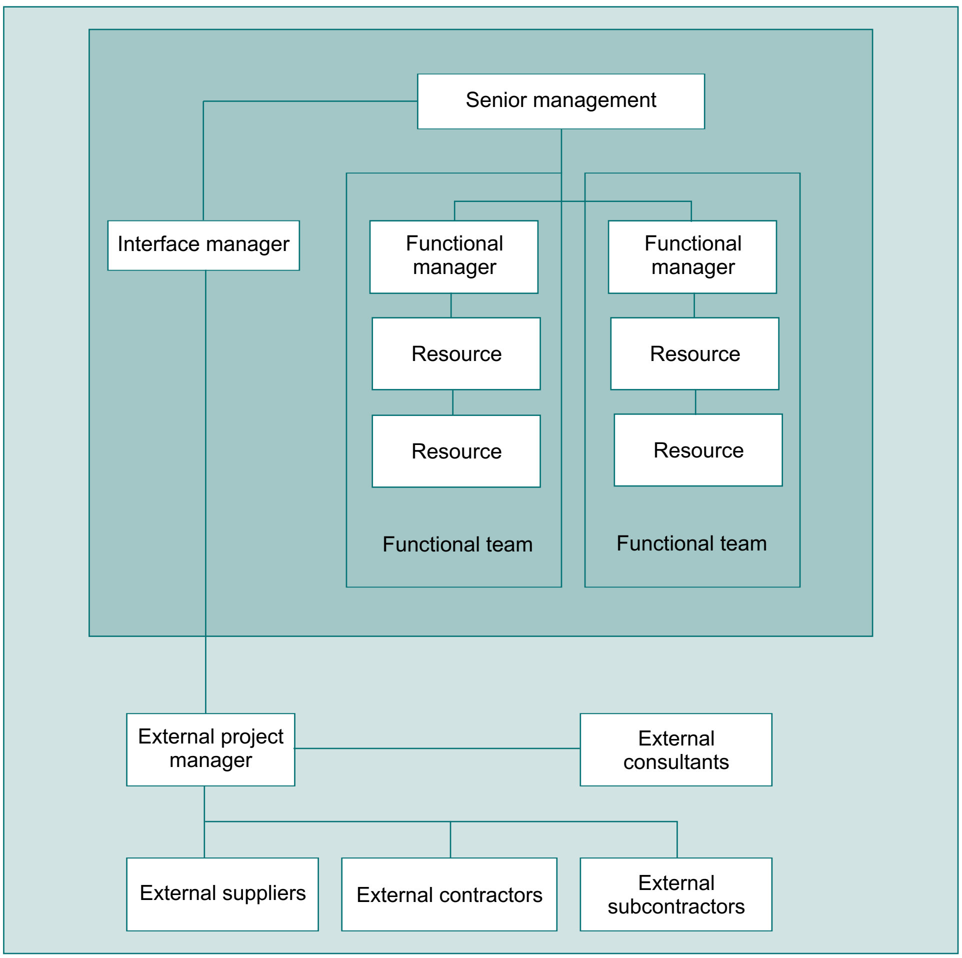

Figure 1.10 Typical external project management arrangement

The main characteristics of an external project management system are as follows:

- The external project manager is hired to act as an agent on behalf of the client.
- This alternative form may be advantageous where the client is seeking certain specialist skills that are not available in-house.
- The approach may also be used to transfer risk outside the organisation.
- The external project manager assumes responsibility for dealing with other external bodies such as suppliers and other consultants.
- The external project manager is usually commissioned through some form of professional services contract.
- Contracts are generally required with all external team members as they represent different organisations.
- All the contracts in the system are generally between the client and the various different consultants.
- External project management is more flexible than internal project management as external consultants can be hired as required.
- Any communication between the client body and the external project manager has to cross the organisational boundary. The organisational boundary usually acts as a direct barrier to effective communication.
- External team members have no loyalty to the client. Unlike employees, consultants have no vested interest in the success of the client organisation. External consultants are primarily concerned with earning fees.

Both internal and external systems are considered in more detail in Module 4.

1.4 Project Management Characteristics

1.4.1 Multiple Objectives

As discussed in Section 1.3.1, project management is concerned with achieving a single definable aim by satisfying a number of different objectives. In order to achieve the aim it is usually necessary to achieve the objectives. In most cases the objectives can be considered as project success criteria because they determine whether or not the eventual outcome of the project can be considered a success.

As we have seen, the most obvious multiple objectives for a large project are:

- time;
- cost;
- performance;
- risk;
- safety.

In most cases the time and cost limits are set by some senior entity before the project starts. In the case of an internal project management system (*see* Section 1.3.2.1.), the time and cost limits may be set by the programme director in consultation with the board. In an external project management system the time and cost limits are likely to be set by the client itself. Performance and safety limits may be set partly by senior management/client and partly by regulation. For example, the quality and standard of different types of material may be set either by the designers or by statute. In the case of structural concrete, for example, the minimum standards are set by statute in the form of national standards and codes of practice. Over and above these statutory minima the designer has some design freedom. In the case of risk, individual companies may make greater provision for risk than that required as a minimum by statute.

In all cases the project manager has to be able to balance these objectives and to arrive at a compromise where each objective is adequately achieved so that the outcome is acceptable. In some cases it is necessary to balance two objectives or even to examine the direct functional relationship between two objectives so that one objective can be *traded off* against the other. An example of this is shown in Figure 1.11.

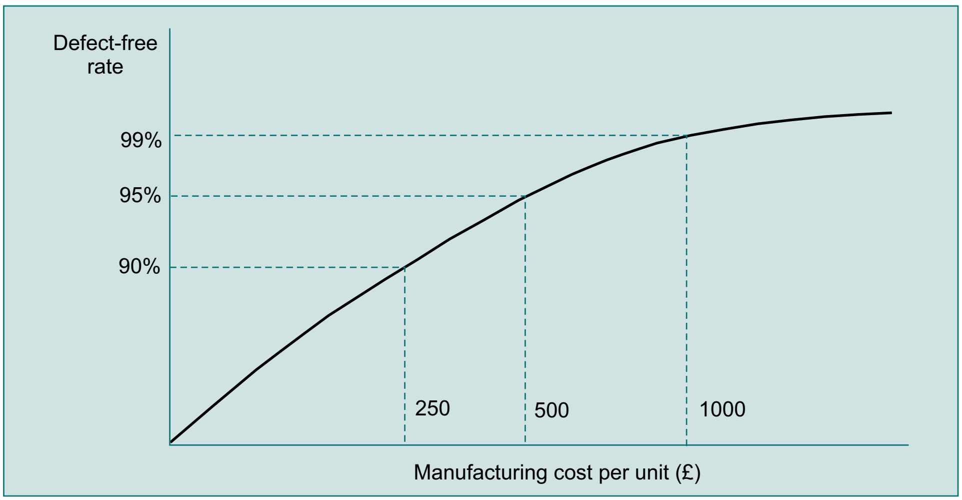

Figure 1.11 **Typical cost–quality curve**

Figure 1.11 shows a hypothetical functional relationship between performance and cost for the manufacture of television sets. Generally, if the manufacturing budget is increased so that sets can be produced more expensively, the designers can use better-quality components and build a more reliable product. In this case performance is measured in terms of the defect rate. If the designers are allowed to spend £250 in assembling each set, the defect rate will be around 10 per cent. If the manufacturing cost can rise to £500, the defect rate can be reduced to 5 per cent. The designers consider that the defect rate can be reduced as low as 1 per cent if the manufacturing cost can increase to £1000.

There is a dilemma in deciding what combination of cost and reliability to go for. People want cheaper television sets but only if they are reasonably reliable. Most people would accept a 5 per cent chance of buying a defective set as long as the set is covered by some form of guarantee or warranty, so that the purchaser can get their money back or have any necessary repair works carried out free of charge. If the defect rate rises to 10 per cent, the product is likely to get a bad name and the manufacturer could lose large numbers of sales because of *market awareness*. Very expensive sets are very reliable but not many people are prepared to pay £1000 for a set.

The balance between performance and cost considered above is an example of a trade-off and the curve shown in Figure 1.11 is an example of a *trade-off curve*. A project manager who is considering a performance–cost trade-off will almost certainly visualise a curve rising steeply at first and levelling out thereafter. This is because the cost-per-unit improvement is likely to increase as performance increases. Once a product is very high performance it costs a great deal of money to squeeze even a small further increase in performance out of it. Generally it is only cost-effective to aim for very high performance standards where the market demands near perfection, such as in aircraft and spacecraft components or new pharmaceuticals. In such cases the consequences of a single defect could be so great that it is worth spending more money on development to reduce the defect rate right down.

Time Out

Think about it: varying cost and quality for a new football grandstand.

A football club might decide to employ a contractor to build a new grandstand. The club might initially state that the stand must cost no more than £3 million and commission designers and employ contractors on that basis. At this point, cost might be the most important success criterion.

Other events might then occur that change the importance of cost in relation to other project success criteria. There may be very bad weather conditions that delay the construction of the stand by three months. At some point the club might realise that the bad weather has caused such delays that it will no longer be able to open the stand by the start of the next football season.

This delayed opening could have significant effects, well beyond the immediate cost viability of the new stand. For example, a delay might result in the loss of ticket sales over the first five home games of the next season. This could amount to £1 million. Under these circumstances, it might be worth spending an extra £0.3 million to speed up the construction process in order to avoid losing the £1 million. In this case, capital cost was the initial success criterion. However, a change in a time-based variable subsequently promoted time to being the primary success criterion because of the linked effects of a time extension on other (environmental) variables. These environmental variables relate to the financial performance of the club as a whole. They are outside the project environment but nevertheless affect it directly.

Questions:

- In what type of projects might weather be a determining factor on whether or not the project is completed on time?
- What other examples are there of external factors that can determine whether or not the project is completed on time, yet are wholly outside the control of the project manager?

1.4.2 International Cooperation and Standards

Another important characteristic of project management is that it is a truly international discipline. Most professions and disciplines develop in relation to the society in which they evolve. In some cases there are common roots but the detail and application of a discipline tends to be a function of the environment. An obvious example is the legal profession. The legal profession and indeed the entire legal system in the US is based on that of the UK, as Great Britain founded the original colonies in North America and established the embryonic legal system within those colonies. Despite this common ancestry, the American and British systems rapidly grew apart. Today the differences between the two are so extensive that a qualified lawyer in one country would find it difficult to practise in the other. Similar *evolutionary differences* have occurred in all the long-established disciplines and professions.

Project management, however, is a relatively new profession. As project management was being founded it was realised that it would be considerably strengthened if procedures were put in place to stop such evolutionary differences taking place within the discipline. As the use and application of project management spread around the world, it was realised that the best way of maintaining international standardisation and unity was by the establishment of a global body for project management practice. This led to the foundation of the International Project Management Association (IPMA), which is the global body for project management professional practice, acting through a series of national bodies.

This approach makes project management unique. It means that project management practice all around the world is standardised to a level that is far beyond that of any other discipline. A qualified project manager in the UK who travels to Canada to look in detail at how project managers operate there would find that not only the basic approaches but also the detailed information used are remarkably similar in both countries. The Bodies of Knowledge produced by the relevant national professional associations would be very similar and the approaches adopted to project planning and control would have a great deal in common. This is important from the point of view of *internationalisation*. As telecommunications and other forms of electronic communications proliferate around the world, project management as a discipline is ideally placed to take advantage of this communications revolution. For example, there is clear evidence that mergers and acquisitions go through historical phases or waves. There was a railroad wave in North America when the railroads linked up eastern and western markets for the first time. There was an automobile wave when automobiles and goods vehicles allowed increased customer mobility and the expansion of retail choice. There is a current globalisation wave driven by the Internet and international communications, and project management is ideally placed to make a great contribution. The wave encourages, for example, UK–US mergers, and because project managers work in the same way in both countries such international mergers and acquisitions can be managed much more easily than if the two countries had non-standard approaches.

1.4.3 Multi-Industry/Multidisciplinary Practitioners

Just as it is international, project management is also interdisciplinary. It is a truly generic profession. The international and national professional bodies make no distinction between the sectors or professions to which project management is applied. As a result, the national professional bodies have diverse memberships ranging from IT to medical sciences. The standards and recommendations of the professional bodies apply just as much to project managers working in forestry as they do to project managers working in IT.

The implications of this are very important. The international and generic nature of the profession means that a Danish marine resource project manager could travel to Australia and look at the project management of the opening and commissioning of a new uranium extraction facility and recognise the basic approaches to time, cost and performance planning and control, risk management, health and safety, organisational design and so on.

1.4.4 Generic Standards

The Bodies of Knowledge (BoKs) produced by the various national professional associations go a long way towards the establishment of global approaches to professional project management practice. It is, however, important to appreciate that there are other standards and benchmarks that contribute towards the national and global standardisation of the discipline.

A good example of a national standard is the British Standard BS 6079:2010, which was developed with the assistance of the APM and a range of public and private sector companies. The standard acts as a set of guidelines and a code of practice that provides guidance on project management with the intention of standardising approaches. It was originally issued as a single standard, but was later extended and in 2010 was re-released in four separate parts:

- BS 6079-1:2010 Part 1: Guide to Project Management;
- BS 6079-2:2010 Part 2: Project Management Vocabulary;
- BS 6079-3:2010 Part 3: Guide to the Management of Business Related Project Risk;
- BS 6079-4:2010 Part 4: Guide to Project Management in the Construction Industry.

BS 6079:2010 Part 1 contains the guidelines. Part 2 defines the terms used in the guidelines, while Part 3 addresses the key related area of project risk management. Part 4 is the most recent extension and is designed for specific application in the construction industry.

An example of a relevant international standard is ISO 21500:2012 Guidance on Project Management. This standard attempts to establish a kind of medium- to high-level generic framework for project management practice. It addresses each of the main project management disciplines, including time planning and control, and cost planning and control.

Another example is ISO 10006:2003 Quality Management Systems: Guidelines for Quality Management in Projects. This standard focuses more specifically on the quality management aspects of project management. As with ISO 21500:2012, it attempts to establish a medium- to high-level generic framework that is applicable to a wide range of different project types.

BS 6079:2010 is an example of a national (British) standard and ISO 21500:2012 and ISO 10006:2003 are examples of international (European) standards. There are also examples of sector- or industry-specific standards that are designed to apply to a more clearly defined range of project types. An example of what was originally a sector-specific standard is PRINCE2 or, more accurately, PRINCE2 Refresh (see below), which is now widely used in large organisations in the UK and internationally. The original PRINCE was developed by the UK government in an attempt at standardising approaches to project management in controlled environments and was aimed primarily at the UK Information Technology (IT) industry. Originally launched in 1989, it was developed in response to a growing need for standardised project management generated by the rapid growth in the IT industry at that time. PRINCE2 is effectively an adaptation and extension of PRINCE and was released in 1996 in response to demand for a more generic project management methodology. An updated version, called PRINCE2 'Refresh', was released in 2009. PRINCE2 is widely used in the UK, especially in government departments and other public bodies, such as police forces, and is registering wider use in European and global organisations, including the United Nations. It still tends, to some extent, to have greatest application in office-based environments. It does not tend to be so widely used in more reactive applications such as construction or heavy engineering.

1.4.5 Specific Provisions

Managers have evolved over time into management specialists and away from the specific field in which they originally trained and qualified. In commerce and industry senior managers and directors are likely to have qualified originally in a subject field other than management, ranging from accountancy or economics to engineering or the natural sciences.

Over the past 20 years or so there has been a proliferation of business- and management-related courses at undergraduate level, but many of these courses are generic in nature and do not necessarily equip graduates for any specific field of management. One exception is courses in project management. The number and range of such courses is expanding rapidly and the courses themselves are aimed specifically at producing project managers. There are other examples of specific management training such as courses in production management, but these are generally aimed at a much more specific audience, comprising those who want to move into a narrow and clearly defined area of management.

Increasingly people are joining university courses in project management so that they can graduate in what is a new and rapidly expanding global discipline. More and more consultancies are being formed offering both general and specific project management expertise. Such consultants are project managers as opposed to general managers. They have been specifically trained to work as project managers and their experience is in this field. This expansion of specific provision in project management is distinctive to the profession and is not mirrored to the same extent in any other management discipline. It could be argued that project management is the 'purest' form of management expertise in terms of specific provision.

1.4.6 Project Lifecycle

Traditionally, consultants have been commissioned to advise on only one or two sections of the overall project lifecycle. For example, a client might commission a consultant to prepare a feasibility study for a major project. The consultant prepares the report and that is the end of the commission. Occasionally the same consultant might go on to prepare some of the contract documentation for the project, or in appropriate cases may have some design responsibilities. In most cases the consultant provides professional assistance for only one of two small phases of the overall lifecycle. A consultant who is involved in the feasibility study is unlikely to be involved in decommissioning, and until recently a feasibility consultant would in most cases not even consider decommissioning. In the case of something like a power station project there could be 50 years between design and decommissioning, and most feasibility study consultants would, unless specifically charged otherwise, consider decommissioning to be beyond their remit.

In fact there are obvious reasons why consultants and client should consider as long a timescale as possible. In some cases, such as the construction of a nuclear power station, the decommissioning costs might be many times the construction cost. In the case of the early pressurised water reactors, for example, the concept would never have been economically viable if the costs of decommissioning had been accurately considered at feasibility stage.

Another example is the choice of materials for items such as automobile bodies. Aluminium might be significantly more expensive than steel in terms of capital cost, but in terms of maintenance it could be far more cost-effective because it does not rust. Depending on the design and assembly of the other automobile components, the use of aluminium for the body might significantly extend the lifespan of the car. In addition, aluminium is lighter, and therefore a light aluminium vehicle will require less fuel than a heavy steel vehicle. This could give rise to considerable fuel savings in the lifecycle of the vehicle.

In general, there are a number of recognised lifecycle phases for projects. The project manager is responsible for giving clients advice that covers the *complete lifecycle*. For example, the project manager should give professional advice on both capital costs and ongoing costs relating to any decision on choices of material. Traditional approaches have used consultants to give advice on design and/or manufacture only, with no significant consideration of longer-term cost implications. Project management as a discipline attempts to correct this by giving professional advice based on the whole picture.

Typical lifecycle phases include:

- **Inception.** In the inception phase, the client decides to develop a project. The inception phase could have been developed years earlier as part of the overall corporate strategic plan of the particular company concerned. Alternatively, it could be a new requirement based on changes in areas such as consumer demand or technology. In the inception phase, the client assembles a basic proposal for the work that is required.

- **Feasibility.** In the feasibility stage the project team seeks to establish the validity of the proposal from all relevant perspectives. These perspectives can be financial, schedule-related, technological and, in some cases, political. The feasibility phase may include extensive market research, in order to evaluate likely consumer or market demand for the end product and/or service. The end result of the feasibility phase is a statement of the viability of the proposal in relation to the variables that have been evaluated.
- **Briefing.** Once the feasibility study has been completed and the project is found to be viable, the next standard stage is to develop a project brief. The project brief is basically a statement of exactly what the client wants from the project. In the case of a new call centre, the brief might stipulate the number of call stations, the handling capacity of the exchanges, maximum holding time, the type and extent of support facilities and so on. The brief is normally passed to the design team, who are responsible for the design phase of the project.
- **Basic or outline proposals.** The next stage is usually to develop a basic set of proposals that reflect the requirements of the brief. These proposals are usually basic-level attempts to comply with the brief while producing a possible design solution that will be commercially viable.
- **Prototype.** In some industries, it is common to develop some kind of prototype that can be fully tested and evaluated prior to full production. The prototype could be tested and refined for significant periods of time before the final design is put into full production. An obvious example would be the design of a new aeroplane, where significant and lengthy prototype evaluation will be necessary before the design can be converted into full production. In some cases prototypes can be very expensive and can take years to develop.
- **Full design development.** Once the prototype has been adjusted and all feedback reflected back into the design system, full production design can commence. In most cases, this involves developing detailed production information. This typically involves the preparation of full production drawings that show all aspects of the design, together with a full specification that defines the required standards of manufacture and assembly for each component.
- **Tendering and contractual arrangements.** Some organisations manufacture all aspects in-house. More commonly, manufacturers have their own production facilities but buy in a lot of manufactured components from external suppliers. An example of this would be Ford cars. Ford employs its own designers and assemblers and puts the cars together on its own production lines, but a significant proportion of the components are bought directly from external suppliers. Other organisations award the whole manufacturing process to external companies and organise things through external consultants. A typical example of this would be the award of a contract for the manufacture of a new ship for the Navy. The Navy would award a contract to an external naval architect to design it,

and another to an external shipbuilder to build it. External works are usually secured through some kind of competitive tender. A tender is a price given by a contractor in return for doing a piece of work that is clearly detailed and described. The tendering process is usually competitive in that several contractors are invited to submit competitive and confidential tenders for the same piece of work. Generally, the lowest-price tender that meets the specification wins the contract.

- **Manufacturing.** The system is assembled during the manufacturing process. This phase could be a single one-off process for a building, or a repetitive process such as for manufactured components.
- **Commissioning.** The commissioning phase involves all aspects of switching the system on. This act may be simple in some systems and far more complex in others. It may take several months to commission a new submarine fully. This may involve weeks of power trials while the boat is in dock, followed by extensive surface and dive trials. Each stage may involve many manoeuvres and simulations, followed by numerous calculations and adjustments. The submarine would only be accepted by the Navy once the contractor has completed all the required commissioning trials.
- **Operation.** The operational phase is where the system is actively used for the purpose for which it was originally intended. For some systems, this could be the longest part of the project lifecycle, while for other systems this may not be the case. Examples of long operational lifespan systems would be new buildings, which may be designed with an operational lifespan of 60 years or more. At the other extreme, the Saturn V moon rockets were developed as one-shot systems. The design and construction process took years, but the whole rocket and capsule was used only once and the operational lifespan was only a few days.
- **Decommissioning.** Decommissioning is the process by which the system is switched off. Again, this act can be simple in some cases and much more complex in others. An old car can be decommissioned at once simply by switching off the engine and leaving it with a recycler. Other systems, such as those that involve toxic processes or nuclear contamination, cannot simply be switched off. The very process of switching off might involve the long-term removal of fuel rods and maintenance of cooling systems for a considerable period of time. Even after the reactor is turned off, it is still radioactive. Decommissioning the reactor and all the other contaminated systems may take many decades with current technology.
- **Removal and recycling.** The last phase is removal and recycling. Legislation in many countries is becoming increasingly strict in relation to the environmental impact of recycling. In future, legislation and environmental concerns will cause more and more products and systems to be designed for ease and completeness of recycling. Ever larger numbers of manufactured goods are being assembled with recycling and reclamation in mind. Increasingly packaging is being manufactured from recycled materials and/or other materials that can be recycled.

Project management is concerned with advice on the above phases so that the client can make informed decisions during design and manufacture on matters that may incur a cost penalty in future. There seems little doubt that some of the older UK nuclear power plants would not have been designed as they were if full consideration of eventual decommissioning and recovery had taken place.

1.5 Potential Benefits and Challenges of Project Management

1.5.1 Potential Benefits of Project Management

Some obvious benefits associated with the use of project management are as follows:

- Projects are necessary for organisational evolution and project management is the set of tools that allows projects to achieve their success criteria.
- Project management can allow an organisation to produce a wider range of products with the same level of resources.
- Internal project management encourages functional people to talk to each other and share a common sense of purpose. It breaks through, at least to some extent, the functional boundaries that separate the various functional units from each other.
- Project management can encourage an organisation to develop new products more quickly. Innovations and research and development can often be developed more quickly where multidisciplinary project teams are present.
- Project managers consider the full lifecycle of the project and advise on all aspects of the lifecycle.
- Project teams and functional teams often compete on a friendly basis. This can be good for morale and motivation provided the competition is light-hearted.
- Project management assists in the effective management of change. It allows organisations to handle complex and low-tolerance projects that would otherwise be too risky.
- The ability to balance multiple success criteria while directing the project towards a target zone of acceptable outcomes gives the project manager tremendous flexibility in trying to find the best project outcome.
- The standardised approaches to project management put forward by standards such as BS 6079:2010 and ISO 21500:2012 go a long way towards regulating approaches across all sectors and industries. This makes the profession more mobile and flexible as project managers in different countries and industries all speak the same project management 'language'.

1.5.2 Potential Challenges to Project Management

Organisations that are regularly involved in projects face some major challenges in relation to their people. Some of these are listed below.

- In order for a project management system to work, staff are taken from functional units for a proportion of their time. If not properly controlled, this could damage the performance of the functional unit, especially where key people are seconded to the project.

- Projects will almost certainly compete, at least to some extent, with functional units for financial and other resources. High-profile projects may be allocated generous resources while lower-profile projects may be starved of resources.
- Functional managers can resent projects as they sometimes see them as diverting resources from the main activities of the organisation.
- Staff sometimes resent being drafted onto project teams because they may see the project as less important than the output of the functional unit they came from.
- Being multidisciplinary, project teams are harder to manage and develop and there is a greater potential for conflict.
- Staff working in an internal project management system generally have to be more flexible than staff working in a pure function system. People generally have to be more adaptable and ready for change.
- Project management is a complex and involved discipline. It cannot be learned quickly or easily and it takes years of experience to develop the necessary skills to be able to significantly engineer project performance.
- Project management relies increasingly on the use of computerised planning and control tools techniques. Some such tools can be very complex and it can take a great deal of staff training and familiarisation before project teams can use them with any confidence.

1.5.3 Summary

Project management has benefits and challenges. The balancing of multiple objectives in the process of achieving an outcome within a range of acceptable limits is extremely powerful and useful in real applications, but it takes years to develop the necessary skills and experience to be able to actually do this on a real project. In general terms, it is reasonable to suggest that the advantages of adopting a project management approach outweigh the disadvantages, which explains the recent proliferation in project management applications around the world.

1.6 The History of Project Management

No one individual or group can be regarded as being responsible for inventing project management and no individual sector or industry can really claim to be the one in which project management first appeared. The appearance of project management as a discipline is often assumed to lie somewhere in the great Apollo space programmes of the late 1960s and early 1970s. In fact the origins of project management go back a couple of decades earlier than this.

It is true that individual aspects of what we now call project management were a feature of very early human endeavours. An obvious example is the ancient Egyptian pyramids, built several thousand years ago without highly developed technology. Another example is the Roman road network that was developed around two thousand years ago and stretched from the River Euphrates as far as Scotland. Many of these roads are still in existence today and much of the current European road layout is strongly influenced by the Roman roads. The pyramids and the Roman roads were both incredible projects in their day. The Roman roads were part of a network that was worked on for hundreds of years and involved hundreds of thousands of slaves and paid labourers. We may well wonder how such large projects could have been constructed without the use of project management.

The main reason is their lack of complexity. The pyramids and the Roman roads were big projects but they were relatively simple. The Roman roads network was not developed as a simple project with a single cost limit and time target, but simply expanded along with the empire and was financed by the plunder of the empire as more and more countries were taken over. The actual processes involved were relatively simple, although they did involve enormous amounts of hard work and considerable ingenuity and innovation. The fact that there were no time and cost constraints, however, meant that there was no need for a management and control tool like project management. As far as the emperors were concerned, there was time and money to spare.

It was not until the Industrial Revolution that there was a significant increase in the complexity of projects as more and more manufacturing processes became industrialised. For example, new processes such as cotton spinning led to the development of large cotton mills powered by belts that were ultimately driven by steam. The steam itself was generated by burning coal. The cotton spinning industry involved a large number of different people, from the slaves in North America who were forced to pick the cotton to the miners of Yorkshire who extracted coal. These processes were interdependent. An interruption to any part of the raw materials or components of the system could result in the whole process collapsing.

Project interdependency increased steadily and so the need for a combined planning and control tool increased. Project management as a discipline first really appeared in the atomic bomb development project based at Los Alamos in the US in the 1940s. The atomic bomb involved entirely new technologies that made use of recently discovered scientific facts. The project involved large numbers of very highly specialised scientists and engineers working together in close proximity on what was an extremely interdependent project. The failure of any component from tens of thousands of possibilities could result in disaster. In addition there was a real-world time limit in place. By 1944 the US had pushed the Japanese back across the Pacific and was in a position to invade Japan. The US military planners estimated that their armed forces would suffer more than a million casualties if they attempted an opposed invasion of the Japanese mainland. They saw no alternative to force a final Japanese surrender other than a new atomic bomb super-weapon. Events in the Pacific dictated that the weapon had to be ready by mid-1945 if it was going to make a strategic impact in the war.

By the mid-1950s the size and complexity of many projects had increased so much that the traditional and well-developed management techniques of many industries were unable to cope. The US defence industry was finding it difficult to control the cost and time schedules of its large-scale weapons systems projects, including strategic nuclear submarines and strategic air command aircraft. Some very large cost and time overruns occurred. The basic problem was that of trying to control complex projects where there are a large number of variables over which the manager has no immediate control. To address these problems two new network-based systems were developed almost simultaneously, by the US Navy and the DuPont Corporation. In 1957 DuPont created the critical path method (CPM), and in 1958 the US Navy launched the program evaluation and review technique (PERT). Both methods originated exclusively for planning, scheduling and controlling large projects with numerous interrelated work activities. About ten years later both methods were combined with computer simulation techniques into a method called graphical evaluation and review technique (GERT) to allow a more realistic analysis of schedules.

Things all began to change again in the late 1960s with the advent of basic mainframe computing technology. This new technology allowed the storage and processing of very large amounts of data. This provided the opportunity for PERT- and CPM-based tools to be computerised. This obviously speeded up calculations and allowed even very large schedules to be rescheduled very quickly. The technology also provided the potential for considering several control levels simultaneously. For example, cost information could be linked to the PERT or CPM programmes, allowing the fast and reliable generation of combined cost and time performance information. The combination of project management tools and techniques and computerisation generated the conditions for a huge expansion in the discipline as companies realised they could have a degree of planning and implementation control that would previously have been unimaginable.

The discipline of project management thrived in this environment and the PMI in the US and the APM in the UK were formally instituted in the late 1960s. Throughout the 1960s additional methods were developed to help project managers. Some enabled managers to specify the type and quantity of resources needed for each activity, and to plan for and allocate resources across a number of projects simultaneously. Although the concept had been around for a while, it was not until the 1970s that planning and costing based on an earned value concept came into widespread use. This concept led to performance measurement systems that not only kept track of funds spent but also related these expenditures to the value of the work that was completed. This led to much more reliable forecasting of what a project would cost at completion and when it would be completed.

The APM produced its BoK in 1988 and assisted in the preparation of British Standard BS 6079:2010 and European standards ISO 10006:2003 and ISO 21500:2012 (*see* Section 1.4.4). These documents are British and international/European standards for project management practice and in many ways mark the frontiers of the development of the discipline as a profession today.

Before the 1980s, project planning and tracking systems were available only for large mainframe computers. Most of the systems were very expensive and the cost and organisation needed to operate the systems restricted their use to only the largest projects. This changed in the 1980s with the advent of the relatively inexpensive microcomputer. Today a wide variety of high-quality project management software programs is readily available. Low-cost software has made it possible to apply sophisticated planning, scheduling, cost analysis, resource planning and performance analysis to projects of all sizes.

1.7 Project Management Today

Project management is now the world's most generic and internationalised discipline. It has established standardised codes of practice across a large number of different countries, and project management tools and techniques are becoming increasingly established as standard management applications.

Project management has evolved into a global generic profession. Provided the correct international standards are observed, project managers all over the world speak the same project 'language'. There is no reason why a project manager in charge of a forestry project in France should not be able to look at the contract documentation and project records of a UK construction project and understand 90 per cent of the information that is presented there.

Project management techniques today allow previously unheard-of opportunities for evaluation and comparison. For example, the use of a strategic project plan (SPP) allows accurate and standard recording and reporting of all aspects of a project's development. This practice of standardisation includes design, execution, implementation and use and allows comparisons to be made that would not previously have been possible. For example, a good SPP allows immediate and direct comparison of the performance of design consultants. SPPs are increasingly being used as an assessment technique to assist in deciding which project management consultancy to employ.

Project management as a profession is proving very successful. The UK and US professional bodies for project management are growing faster than any other comparable professional bodies in either country. Some of the more traditional professional bodies are recognising the impact of project management and are setting up their own divisions to offer specialisations in the subject. Hence we have the Royal Institute of Chartered Surveyors (RICS), which is concerned with training and standards for the professional surveyor, establishing a project management specialisation within one of its professional divisions. In doing so, the RICS has accepted that project management as a profession is impinging on the activities of its members to such an extent that the threat has to be addressed. The RICS has chosen to do this by setting up its own 'surveyors' version' of project management. A number of other professional bodies have done something similar.

Project management has made similar inroads into other professions and disciplines. As a subject it is appearing more and more on the syllabi of degree courses in science and engineering so that an increasing number of graduates are emerging with at least an awareness of what project management is and what it can do. A glance at any quality recruitment newspaper shows large numbers of adverts for project managers in professions and disciplines ranging from social work to oilfield exploration. As competition, accountability and the relentless drive for added value and efficiency continue to pressure organisations, the need for planning and control tools such as project management consistently increases. It could be argued that our drive for competitiveness and best value in everything means that organisations are under such pressure that they can deliver on these only by effectively using project management in their day-to-day operations.

In becoming internationalised and fully generic across industries and sectors, project management is leading the way in terms of the development of professional practice.

Learning Summary

A project is one type of production system. It usually has a single definable aim and a series of separate objectives. The project aim is the overall outcome that the project is intended to achieve. The objectives are a series of individual constraints or stages that have to be achieved if the project aim is to be realised. For example, the aim of the project might be to build a new house to the requirements of the client. The objectives as set by the client might be to build it within six months, spending no more than £500 000, and to the required standards. If the new house is to be built to the client's requirements, the stipulated time, cost and performance objectives must be met.

Projects have other characteristics that differentiate them from other types of production system. For example, projects are unique and tend to be executed by multidisciplinary project teams. Projects are generally designed to bring about change and operate under conditions of change. In consequence they tend to be relatively complex and risky compared to other types of production system. They also tend to have a clear lifecycle, after which they terminate and the project team is disbanded. In the meantime the project develops through clear lifecycle stages and this drives corresponding lifecycle stages in the development of the project team and in the leadership style required of the project manager.

Project managers, therefore, have to be a bit like jugglers walking along a tightrope. They have to be able to balance a series of different and often conflicting objectives as they progress along the lifecycle of the project, constantly adapting to the evolution of the task and the team as the project develops. This means that a project manager faces a unique profile of demands and responsibilities, many of which would be unfamiliar to a traditional functional manager.

Project managers have to satisfy a number of objectives in order to achieve the project aim, and so they tend to think in terms of a range of acceptable outcomes rather than a single definable point. Two different outcomes (in terms of project objectives) could each achieve the project aim.

Projects tend to be structured in a number of fairly standard ways. The two most common are as an internal matrix within an existing organisational structure (internal or non-executive project management) or as an external radial structure (external or executive project management). Internal arrangements are good in that everybody works for the same organisation, so there are no divided loyalty or security issues. An external system may, however, be required where there are no suitably qualified internal staff and where additional expertise is required.

Project management as a discipline is growing rapidly. In order to remain competitive and/or viable, organisations everywhere are usually forced to operate within increasingly onerous time, cost and quality constraints using flexible approaches to production. As a result there has been a steady increase in global demand for qualified and experienced project managers. This in turn has led to a steady increase in the reach and membership of the main project management professional associations. From humble origins just 60 years ago, project management has developed into an international and interdisciplinary profession.

Review Questions

True/False Questions

What Is a Project?

1.1 All types of production system involve projects. T or F?

1.2 Mass production systems comprise a series of individual projects. T or F?

1.3 A mass production system manager generally has more or less the same role and responsibilities as a project manager. T or F?

1.4 Project products tend to be largely repetitive and complex. T or F?

1.5 Knowledge transfer between projects is similar to knowledge transfer between batches. T or F?

1.6 A project generally has a single definable aim and a series of specific objectives. T or F?

1.7 A project is generally a temporary activity, concerned with the achievement of a specific goal. T or F?

1.8 Projects can exist both internally and externally to the parent organisation. T or F?

What Is Project Management?

1.9 Project management is not concerned with the entire lifecycle of the project. T or F?

1.10 Project management is concerned with multiple objectives. T or F?

1.11 The success of most projects can be evaluated in terms of time, cost and quality. T or F?

1.12 Project management has evolved primarily as a result of the increasing complexity of projects. T or F?

1.13 Project success and failure criteria are fixed at the outset of the project and cannot be changed once the project has started. T or F?

1.14 Project management and functional management are mutually exclusive and cannot exist in parallel within an organisation. T or F?

1.15 Research and development work would typically be best suited to a functional organisational structure. T or F?

1.16 Highly rigid functional organisations, such as the armed forces, cannot make effective use of internal project structures. T or F?

1.17 Project managers tend to have more power and status than functional managers. T or F?

1.18 Project managers tend to be selected from within the ranks of the organisation's functional managers. T or F?

1.19 Successful project managers always make the best functional managers. T or F?

1.20 External project management is always more cost-effective than internal project management. T or F?

1.21 Changing success criteria can be managed using trade-off analysis. T or F?

Project Management Characteristics

1.22 The IPMA is the international steering body for global project management practice. T or F?

1.23 BS 6079 is an EU standard for project management practice. T or F?

Potential Benefits and Challenges of Project Management

1.24 Lifecycle phases vary in importance as a function of project type. T or F?

The History of Project Management

1.25 Project management as a discipline originated during the Roman road-building programmes in the first century AD. T or F?

1.26 PERT and CPM methods of project planning and control first appeared as operational tools in the 1940s. T or F?

Project Management Today

1.27 Project management is proliferating through a range of professional disciplines. T or F?

1.28 Project management is a tool for strategy implementation. T or F?

Multiple Choice Questions

What Is a Project?

1.29 Which of the following is correct? Most projects have clear success criteria expressed in terms of

A. time and cost.
B. quality and cost.
C. time and quality.
D. time, cost and quality.

1.30 Which of the following is correct? A typical example of a mass production system is the manufacture of

A. an office building.
B. an automobile.
C. office carpets.
D. All three.

1.31 Which of the following is correct? A typical example of a batch production system is the manufacture of

A. an office building.
B. an automobile.
C. office carpets.
D. All three.

1.32 Which of the following is correct? A typical example of a project production system is the manufacture of

A. an office building.
B. an automobile.
C. office carpets.
D. All three.

1.33 Which of the following is correct? Internal project management systems typically involve projects running within

A. other projects.
B. matrix groupings.
C. functional groups.
D. All three.

1.34 Which of the following is correct? External project management systems typically involve

A. only internal team members.
B. only external team members.
C. mostly external but some internal team members.
D. neither internal nor external team members.

What Is Project Management?

1.35 Which of the following is correct? Project management involves the simultaneous control of time, cost and quality. Another obvious control criterion could be

A. company strategy.
B. dividend levels.
C. human resources.
D. safety.

1.36 Which of the following is correct? In general terms, project and functional short-term objectives are likely to be

A. wholly compatible.
B. generally compatible.
C. generally incompatible.
D. wholly incompatible.

Project Management Characteristics

1.37 Which of the following is correct? The global body for project management practice is

A. APM.
B. PMI.
C. IPMA.
D. BS 6079.

1.38 Which of the following is correct? BS 6079 acts as a

A. global standard.
B. European standard.
C. British standard.
D. Other.

Potential Benefits and Challenges of Project Management

1.39 Which of the following is correct? In corporate terms, the success of the project in relation to the success of the function is likely to be

A. more important.
B. less important.
C. equally important.
D. variable.

The History of Project Management

1.40 Which of the following is correct? Project management evolved largely as a response to increasing

A. project complexity.
B. project costs.
C. project timescales.
D. project team development.

1.41 Which of the following is correct? Project management evolved initially and primarily in

A. the UK.
B. the US.
C. Germany.
D. Japan.

Project Management Today

1.42 Which of the following is correct? Project management as a profession is

A. in decline.
B. static.
C. growing slightly.
D. growing rapidly.

Thought Generators

Thought Generators are designed to encourage you to think in more detail, and in a wider context, about some of the key areas contained in each module. They are intended to provoke thought at a level that integrates the learning outcomes from the course text with direct application in the real world. Thought Generators are not case studies in the usual sense, although they are based on real or theoretical cases.

You must read and understand the course material in each module before you attempt the corresponding Thought Generators. To address them fully, you will also need to think beyond the course material and consider what you would do if you were a project manager in the real world. No external reading or research is required.

Read each Thought Generator and then address the 'Issues to Consider'. Please note these are not direct 'questions' and there are no correct 'answers' as such. In each case some possible considerations are given in response to each issue.

Thought Generator 1.1: Mass and Batch Production Systems

Some large-scale paint manufacturers make paint using a combination of mass and batch production methods.

Manufacture typically starts with the production of a 'base paste'. Synthetic and natural resins are mixed with a range of fillers, solvents and other additives in varying proportions to form a paste. The paste is then fed into a dispersion tank, which is equipped with blades that revolve at high speed. The blades agitate the paint, and the revolving action creates pressure that acts to disperse and thoroughly mix the ingredients. The paste acts as the basic ingredient for most of the paint manufactured by the majority of large paint manufacturers. It is produced on a mass production basis. Manufacturers produce very large quantities of the paste and send some of it on to other parts of the production process (see below) for immediate use; the remainder is put in storage for use in periods of high demand.

The paste is sent on to two different mass production lines, where it receives additional ingredients depending on the type of paint being manufactured. Some paste is used for the production of oil-based (solvent) paint, and some of it for the production of water-based paint. Oil-based paints are generally used for high-durability applications such as metal fences and timber windows and are often referred to as 'gloss paints'. Water-based paints are used for lower-durability and internal applications such as internal ceilings and walls. The oil-based and water-based production lines both produce 'base paint' that is essentially finished paint without colour. Some base paint is sent for 'tinting': it is coloured by the addition of pigments. The rest of the base paint is sent to the canning line, where it is canned and sent for distribution to retailers who add pigment remotely to match the requirements of individual customers at the point of sale.

Tinting or colouration is performed on a batch production line. It is achieved by the addition of small amounts of highly concentrated pigments. Different combinations of pigment are used for different final colours. The pigments are added by dispensers that are carefully controlled to add precisely the correct amount. Very careful control is necessary in order to ensure that the same end shade is achieved every time. The pigments are thoroughly mixed into the base paint, and the resulting final sale paint is sent for canning and distribution to retailers.

Most large manufacturers have a portfolio of standard colours that are designed to match popular taste. They often have romantic-sounding names, such as 'Morning Mist' or 'Inca Gold'. The portfolio may be designed to address, say, 60 per cent (an assumed figure) of normal demand. The other 40 per cent of demand is for paint coloured to individual order at point of sale. Manufacturers typically produce a range of different colour phases (individual shades of a specific colour such as blue) with corresponding pigment combinations. Local mixing facilities are used to produce individual tints based on customer requirements.

Issues to Consider

1 Why use a combination of mass and batch production systems?

2 Why not use a single mass production system and 100 per cent point-of-sale tinting?

Thought Generator 1.2: Balancing Multiple Objectives and Trade-offs in Defence Procurement

In 2007 the UK government placed an order for two new aircraft carriers. These new carriers were intended to replace the existing ageing carriers then in use by the Royal Navy. The new carriers were designated 'Queen Elizabeth class' and are due for completion between 2016 and 2018. They will each be around 65 000 tonnes, making them the largest warships ever constructed for the Royal Navy. Each carrier will be able to carry and fly up to 40 aircraft. The aircraft themselves are likely to be the carrier variant of the F-35 (*see* Thought Generator 7.3).

As with any defence project on this scale, the time, cost and quality constraints and implications are considerable. The original design budget was around £4 billion, with a programme of works of around eight years per ship. This is a significant amount of money by any standards, and strategic expenditure of this kind and level is always subject to government 'intervention' as government strategy changes. The new carriers project has been no exception.

The carriers were originally designated as type (A) configuration. This type is designed to accommodate short-take-off and vertical-landing (STOVL) aircraft. This configuration has the advantage that the flight deck can be shorter and there is no need for expensive steam launch catapults (as would be a requirement with standard catapult-assisted carrier-variant aircraft), which results in a lower capital cost for the aircraft carrier itself but also necessitates buying more expensive STOVL aircraft. In addition, STOVL aircraft use more fuel on take-off and landing than conventional-take-off aircraft. As a result, they tend to have a shorter range and lower payload limit.

The type (A) configuration, therefore, has a lower ship construction cost, and the ship itself can be built and put into service more quickly. However, the aircraft purchase and operational cost is higher and the aircraft themselves are less capable than conventional alternatives. In other words, type (A) is cheaper and faster to build but more expensive to operate and the end product (fighting capability) is reduced.

In 2010 there was a general election in the UK and a new government was elected. The government was forced to seek ways to reduce public expenditure in the wake of the global financial crisis. As one of its first major actions the new UK government carried out a 'strategic defence review' in which it considered, among other things, the cost and value of numerous current and projected military contracts. As part of this review the government looked carefully at the contracts for the construction of the new carriers and decided it would be prohibitively expensive to cancel them. The new government, therefore, committed to completing the carriers, but, in order to maximise the effectiveness of the eventual finished carriers, it was decided to change the configuration of the carriers to type (B) configuration. This type was designed to accommodate standard-take-off aircraft launched by a conventional (and very expensive) steam catapult.

The type (B) configuration, therefore, has higher ship construction costs and takes longer to build and put into service. The aircraft, however, are cheaper to purchase and operate and have a greater fighting capability than the STOVL alternative.

In opting for the type (B) configuration the government made a trade-off between the multiple objectives of capital cost, operational cost, time to enter service and fighting capability (quality).

Over the next two years, however, type (B) construction costs increased alarmingly and by 2012 the projected end cost of the steam catapult design had become prohibitively expensive. As a result the government considered fitting out just one carrier with steam catapults while leaving the other with no catapults and effectively mothballing it as soon as it was complete. Eventually, however, it was decided to revert to the original type (A) configuration and drop the idea of steam catapults altogether.

The government had changed its project objectives priorities so that capital cost became more important than operational cost and fighting capability (quality). The end result was carriers that were cheaper initially but more expensive and less capable in the long term.

Issues to Consider

1. What were the likely project cost success criteria (objectives), and how does each option perform in relation to them?

2. Why did the capital cost objective become more important than the fighting capability (quality) objective?

Thought Generator 1.3: Getting the Lifecycle Balance Right in Submarine Design

Several navies make use of nuclear-powered submarines. Nuclear power has obvious advantages for a submarine. A nuclear reactor is relatively light and produces a tremendous amount of energy. The fuel can last for years, so there is no need for the submarine to return to port or rendezvous with a supply ship to refuel. The reactor does not generate any exhaust and it does not need any oxygen, so there is no need for the submarine to run on the surface. The fuel itself is lightweight and there is no need for large fuel tanks that would otherwise take up valuable space on the submarine. Overall, nuclear power is excellent for submarines, and several naval fleets including those of the US, Russia, the UK, France and China operate nuclear-powered submarines.

The downside is radioactive contamination. The nuclear reactor sits within a small containment vessel. The reactor, containment vessel and a significant amount of high-, medium- and low-pressure pipework become highly radioactive. This is acceptable while the submarine is in service. The problem arises when the submarine is decommissioned. The submarine becomes a floating hulk with a highly radioactive element. If the radioactive element is removed, it has to be securely stored somewhere. If the reactor is defuelled, the fuel itself may be reprocessed, but the highly radioactive core will remain. Depending on the type of fuel, the core may remain highly radioactive for generations and it will have to be maintained, cooled and guarded for the whole of that time.

The Royal Navy has relatively few such decommissioned nuclear submarines, although there are currently seven decommissioned nuclear submarines stored at the Rosyth Naval Dockyard in Fife, which is only about 20 miles from Edinburgh Business School. They are stored there because there are no facilities for removing and/or storing the highly radioactive reactors and associated components. It is considered easier and safer to simply leave the submarines intact as floating hulks until somebody comes up with a way of getting rid of the problem. The problem is much greater for some other countries. The Russian Navy is known to have a large number of decommissioned nuclear-powered submarines.

It should also be appreciated that the problem of storing decommissioned nuclear-powered submarines increases over time. Decommissioned submarines naturally corrode in seawater, and internal corrosion tends to be far higher in decommissioned vessels because of the lack of internal ventilation, which results in high levels of humidity. So the problem is already big and is getting bigger all the time.

Issues to Consider

1 To what extent can the design of a nuclear submarine be considered a project?

2 During the design process, which lifecycle stages are likely to receive priority and which are more likely to be lower priority?

References

APM (2013). *What Is Project Management?* [Online] Available from: www.apm.org.uk/WhatIsPM [Accessed 30 May 2013].

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