PART I

Projects and Their Management

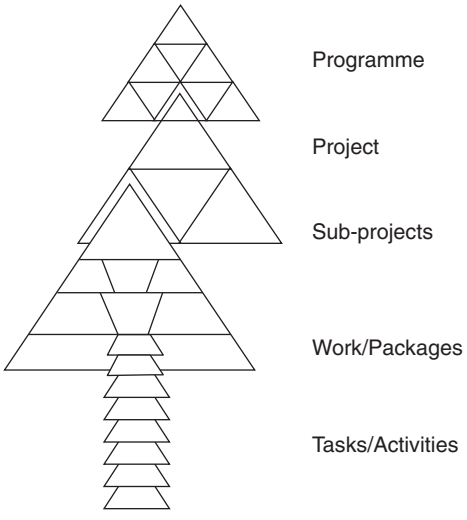
Effective Project Management: Guidance and Checklists for Engineering and Construction,
First Edition. Garth G.F. Ward.

Section A Project Characteristics and Phases[1]

Projects can be anything: a capital facility, an information system, a piece of research, a company merger, an organizational change, launching a product, or decommissioning a facility, and so on. They can range from capital intensive technological and infrastructure investments to labour-intensive health care. All projects types need a description, a scope, and the associated specifications for the quality required, and they cannot be realized without a team of people to develop them. The fundamental characteristic of all projects is that they create and cause change. As such, they come up against resistance. Consequently, leadership is needed in the form of a project manager, and a project management process is required to control them. (See Section B.)

There is a hierarchy to projects determined by their size, complexity, and the inherent risks (see Figure I.A.1). At the lowest hierarchical level are the *routines*, tasks that are so common and so well developed in a function that methods of working have ironed out all the difficulties. Next in the hierarchy are those frequently occurring packages of work – small projects that are very similar and can be developed without too much specialized management and theoretically do not present any significant risks. There are lots of them in an organization and they can be performed without any real difficulty. These are called the *runners*.

Figure I.A.1



At the next level of the hierarchy are larger projects that the organization performs reasonably regularly; they are very similar or replicate previous projects. Naturally, they are called *repeaters*. The development of repeaters has become more specialized, less routine, and more individually project-focused. As a consequence they have a higher risk of failure. They need someone experienced in project management because the real risk with them is that people assume they are repeats. The reality is that they have differences that, if ignored, could cause project failure. Then come the projects that

1 This section is based on Graham Ritchie's first Cranfield lecture note 'Project Management Characteristics and Advantages' and a second note 'Project Phases'.

are infrequent and more unusual, they become *strangers* to an organizations normal method of working. They are large projects and are high risk projects as far as the organization is concerned. As a consequence, they need someone to manage them, who is skilled and experienced in project management. Finally, the mega project, the first of a kind, the once-in-a-career opportunity are the *aliens,* consisting of a programme of large projects. (Part II addresses programme management).

'Every project begins on paper as an ideal, as a vision of perfection and quickly becomes mired in the confusion of budget, size and opposition of NIMBY's'.[2] Consequently, the best way to start a project is to carry out a feasibility study that results in a clear brief and statement of the requirements (see Part III). Nevertheless, there are features that are common to all projects regardless of size.

1 Characteristics

1.1 Unique Non-repetitive

A primary characteristic of projects: a product, a development, a task, or a deliverable is that they are unique and are non-repetitive.

1.2 Phases

Secondly, because projects start with a unique idea or concept, they go through a series of growth phases in order to achieve an outcome.

1.3 Risk

Projects are risky due to the very uniqueness of their nature. The risks are then compounded by the changes that can occur during the project's development. The severity, impact and consequences of the risks incurred are related to the hierarchical position of the project, as described above.

1.4 Business Objectives

Projects come into being because they will provide benefits to an owner and a return on their investment; they have a purpose. The business requirements of a project become the owner's objectives. They then get translated into specific objectives for the management of the project (see Section B).

1.5 Liable to Changes

Projects almost invariably change in scope, often by very large factors, due to changing business requirements and market conditions.

It is typically necessary to reduce the costs involved in order to make the project financially viable and to make the business case acceptable. This will usually mean reducing the scope or specification of the project – see Figure I.A.2. Everyone creating a project has big ideas, but when the budget can't get any bigger, the ideas have to get smaller.

2 Slightly adapted (project for 'House'), introduction to *House of the Year* programme 2016 by Kevin McCloud, TV Channel More 4.

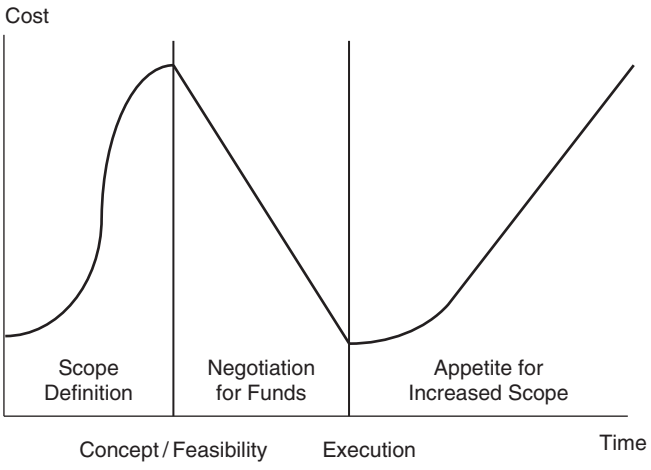


Figure I.A.2

1.5.1

Clients may have limited funds and reduce the budget, but they do not reduce their ambition. In reality, there is no such being as a client who does not make changes. Thus, once the project is approved and has got the go-ahead, there is a natural tendency to want to put back all the features that were removed. These changes are then likely to cause failure of the business objectives. Sometimes it can be almost impossible to match the requirements with the money that has been allocated to a project. This often occurs in the public sector. The correct approach is to deliver the essentials and, if there is anything left in the budget, add the 'nice to haves' when the essentials have been completed.

2 Phases

2.1

The development of a project is modelled by a series of phases or stages. Sometimes the phases they go through are carried out sequentially, but more often they overlap significantly. There are three basic project stages:

Thinking – (Planning) – Doing

2.1.1

The conceptual, creative, thinking phase is a natural process; people enjoy it. The same is true of doing. People like to design, make, and construct – doing is also a natural process. This is not true of planning. Planning is not a natural process. It is imposed on a project's development by the management process. The trouble is that people's natural desire is to jump straight from the thinking stage to the doing stage. If this occurs, project disaster is guaranteed. It is not a flaw in the characteristics of projects; it is a failure in a project's management.

2.1.2

For more complex situations, these basic phases are broken down into more detail. Between each phase, there is an opportunity to assess the viability of the project and decide if one wishes to proceed to the next phase. The objective of breaking the project into phases is to enable one to plan and control the work at the appropriate level of detail.

2.2 Phase Details

The following Figure I.A.3 is a basic model of a typical project, showing the state of development for each phase of the project. These phases are typical for technological projects such as the process and power industries[3], but it is also intended to be generic:

a. Concept: a company, government, or some other body determines that there is a requirement for a new facility, plant, or product.
b. Feasibility: the concept is examined in detail to see whether it is a realistic, viable business proposition. This selection and definition phase is one of value creation.
c. Planning: if it is viable, an execution plan is developed.
d. Basic design: before major funds are committed, the basis of design is carefully agreed.
e. Design: once the basic 'recipe' is firm, detailed drawings for each element or component are produced.
f. Procurement: all the necessary services, materials, and equipment are purchased.
g. Construction or production: the facility or product is assembled from the materials and equipment, using the drawings already prepared.
h. Commissioning or setting to work: the plant or product is thoroughly tested to ensure that it satisfies the requirements of the project.

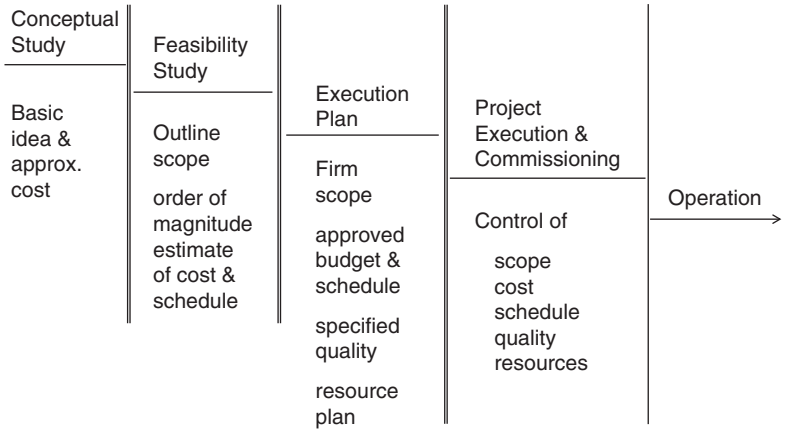


Figure I.A.3

3 The RIBA Plan of Work 2013 comprises eight stages 0–7, detailing tasks and outputs required.

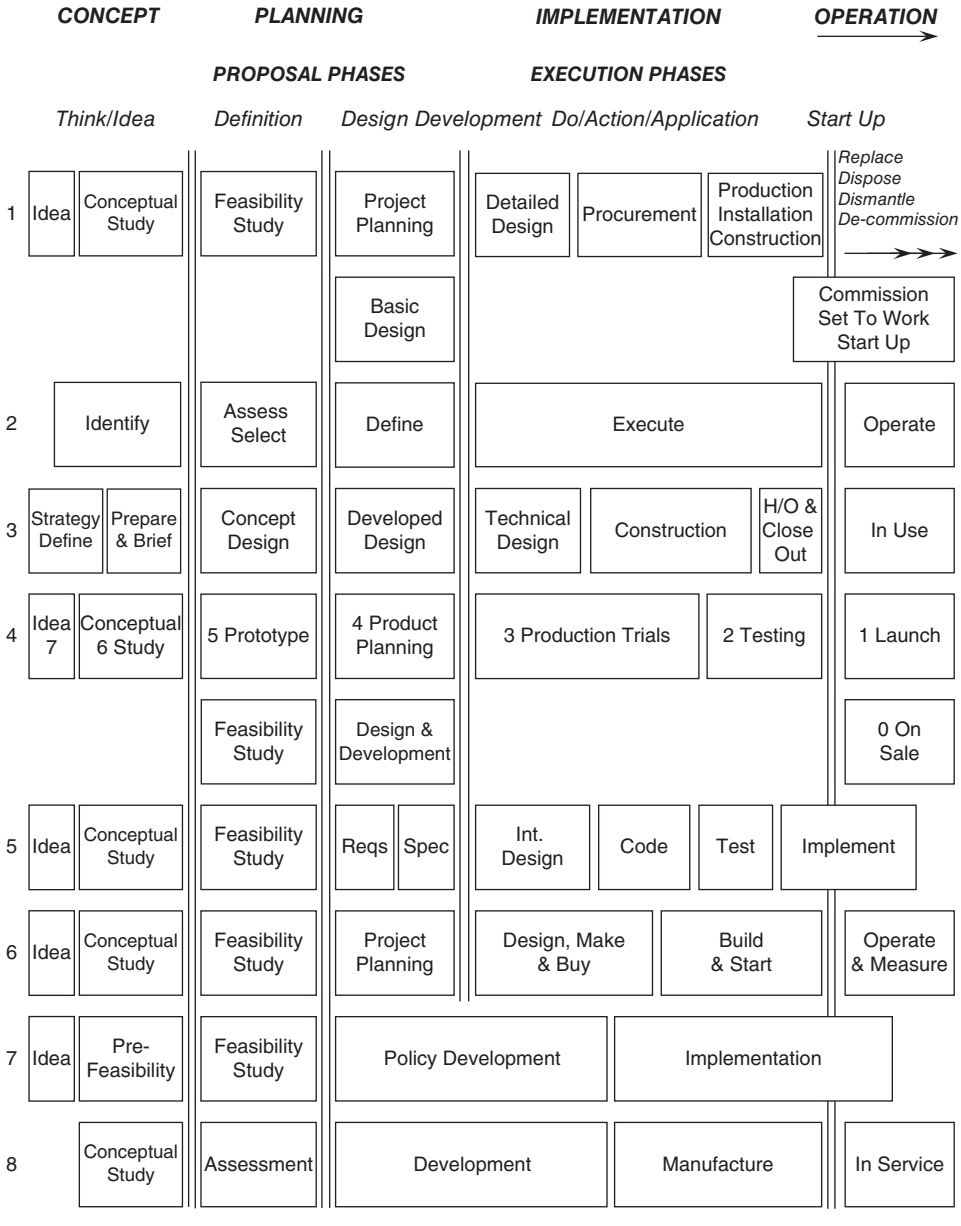


Figure I.A.4

2.2.1

Figure I.A.4 shows the different terminology and phase definitions used in different business environments:

Line 1 is a generic model for technological industries – process and power.
Line 2 is the owner/client perspective of line 1.
Line 3 is an architect-driven building project.
Line 4 represents product development.

Line 5 represents information technology.
Line 6 represents manaufacturing.
Line 7 represents The Civil Service 'Policy' project life cycle.
Line 8 represents the Ministry of Defence smart acquisition process.

2.3 Purchasing and Contracting Phases

There are three positions in the development of the phases where the owner may contract with someone else to perform the work in subsequent phases:

a. At the end of the conceptual study and start of the feasibility study
b. Prior to the development of the basic design and planning stage
c. Prior to the execution phases of the project

The purchasing options available to the owner mean that the stages in Figures I.B.3 or I.B.4 involved in the contracting process have to be integrated into phases shown in Figure I.A.4.

3 Project Patterns

There are important patterns that depend on the phases of the project and give a clearer understanding of the way a project develops.

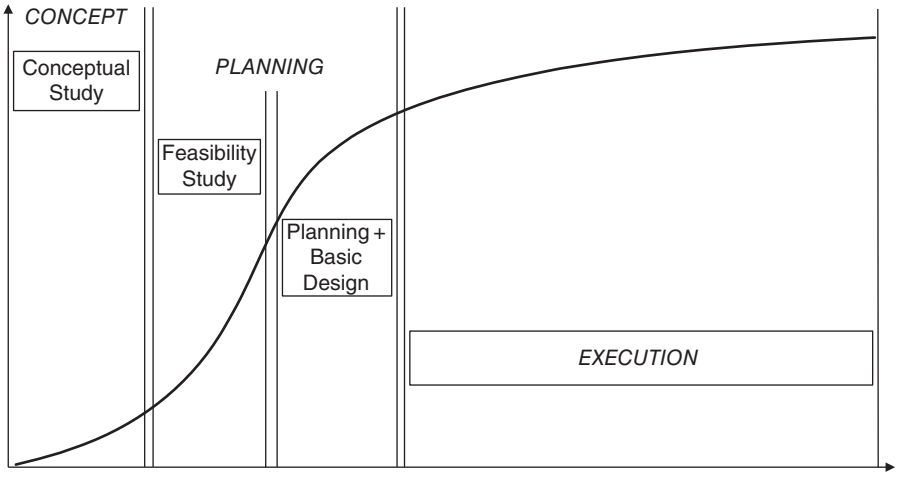


Figure I.A.5

3.1 Cost Impact of Decisions

During the feasibility study, alternative types of projects are being examined, and by the time the final study is accepted by management, the cost of the work is known to within a reasonable margin. Assuming the basic concept does not change, it is extremely difficult and often impossible to make more than a 15 per cent saving. In other words, 85 per cent of the cost impact has been determined during the front end phases (See Figure I.A.5).

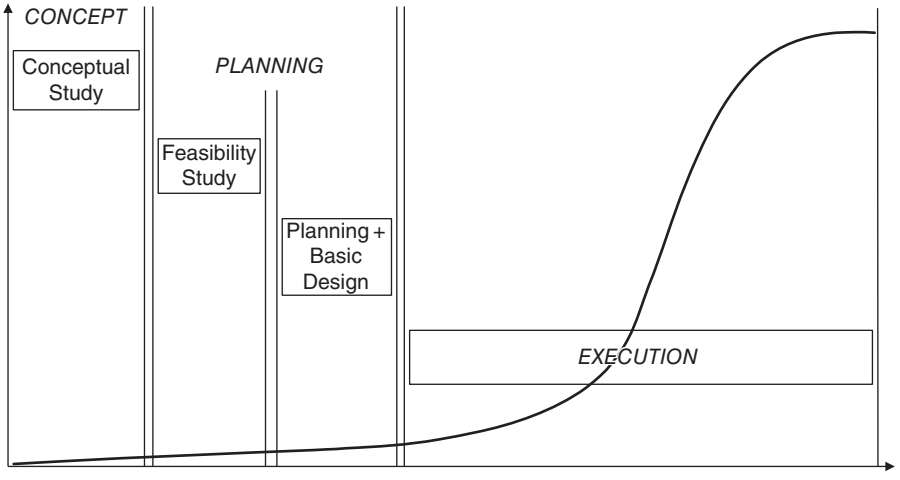


Figure I.A.6

3.2 Commitments

The financial commitment in the early stages of the job is very small compared with the costs once production work commences. It is much cheaper to totally change the approach to the project during the feasibility study phase when all that is involved is a new report than to make a change later when major equipment has been bought and work has started on site. This illustrates why it is important to have the best brains available during the early phases of the project (See Figure I.A.6).

4 Reasons for Projects

There are five reasons for doing projects:

a. Return on investment – only known after the facility is operating.
b. Achieving strategic objectives – both the public and private sectors.
c. Complying with legislation – safety, environmental, financial, and so on.
d. Political and social reasons or critical needs – question their validity.
e. 'Ego/Vanity' projects – particularly dubious internal projects wanted by a senior manager. If you can spot them, avoid them.

5 Project Needs

Projects cannot accomplish anything on their own. To survive they have needs that must be met. Namely:

a. They need clear objectives and complete definition.[4]

4 Software and business change projects need clarity of what is to be achieved, not necessarily their definition.

b. They need reliable finance.
c. They need political stability and certainty.
d. They need the shortest execution programme.
e. They need competent, capable, and experienced project managers.

Section B Project Management Characteristics

At one stage during my time at Cranfield, I thought that it would be a good idea to research the definition of project management. I decided it would not be a difficult task since books on the subject would either provide a definition in their introduction or in chapter 1. Consequently, I looked up all the project management books in the Cranfield library and, to my amazement, they were all different!

For a brief time, as chairman of the Association of Project Management (APM) education and training group, I was involved in the development of the original APM body of knowledge, an excellent document that defines *what* the various subjects are that a project manager needs to know.[5] Theirs was another definition. On a quick glance at the U.S. Project Management Institute, I discovered that they define *how* project management subjects should be performed, with yet another definition. Too many definitions are complex (trying to cover every aspect of project management) and mix up projects and project management. This was when I decided that I needed to provide a definitive definition and, consequently, modified something that I came across in the paperwork in my office.[6]

Project Management is the multidisciplinary process of achieving a satisfactory end result.

The 'multidisciplinary' part (people working together as a team), creates complex relationships and a matrix organizational structure. It is what distinguishes project management from the individual functional disciplines. It is a work *process*. It is not a bunch of tools and techniques. The finite end result is the project, is always unique, and can be anything. Finally, successful project management does not have to produce the best; it just has to create something that is good enough, namely, satisfactory and on time and to budget. The purpose of this book is to help project managers achieve the necessary satisfactory end results.

Project management turns bright ideas into reality and is the means to achieving the end result and not the end in itself. Commitment to the project management concept is vital for the success of the project. Making things up as you go along is a route to financial disaster. Project management is the essential discipline that turns senior management's concepts, visions, goals, and strategies into practice. In June 2000 a survey in *Fortune* magazine showed that the single commonest reason for the failure of chief executives was their failure to implement their plans.

The challenge for the project manager is to manage complexity, ambiguity, uncertainty (risk), and urgency. In order to achieve success, a major effort must be mounted by all involved parties in the front-end planning of the work. Unless studies are carried out thoroughly and unless the planning is comprehensive and competent and unless

---

5 The CIOB has a *Code of Practice for Project Management for Construction and Development*, setting out everything that a multi-institute task force, with representatives from RICS, RIBA, ICE, APM, and CIC, has determined should be performed on a project. Published by Wiley-Blackwell, 2014. ISBN: 978-1-118-37808-3.

6 I have adopted a 'back to basics approach' rather than getting into detailed definitions which are covered by various ISO Standards, e.g.: ISO 21500:2012 Guidance on Project Management. There are similar standards for programme management and portfolio management.

the organization conforms to the standard requirements of the project management process, it is extremely unlikely that the project will be a success.

Language is the first barrier that deserves mention in the project management business. The project world uses the same words but applies them quite differently (see Section A, paragraph 2.2.1; Figure I.A.4). For example, I use project launch for the start of a project since the term *start up* is used in the process industries for the stage when their facility is set to work. However, in the product development business, *product launch* is at the end of the project when the product is being introduced into the marketplace. Similarly, I used *implementation* for the stage when the bulk of the work was carried out, but the information technology world uses implementation for the setting to work stage. Consequently, *execution* has been used for the carrying-out/doing stage. I avoid the use of the word *development* since it tends to bridge the last stage at which the project can be abandoned. (See paragraph 3.2.1 in this part and Figure I.B.5).

The second barrier in the project business is a cultural barrier. This cultural barrier is not just that between the French and the English, but it is between the various project management industries, where there is a reluctance to borrow good methods from each other. There is also a barrier between companies in the same business environment. One company will be design-dominated, another project management-focused, and another will be experienced in pharmaceuticals or in offshore work. Then there will be the companies that are the favourites of a particular client. If that lot is not bad enough, there is the cultural barrier within companies – the different mindset between the front end creative people and the practical back-end applicators. It is now recognised that project management is an attitude of mind, and this is what makes it more of an art than a science.

There is a potential third barrier that requires skilled project management. In the project management process, there are interfaces where conflict can occur quite naturally, namely, between:

- Client and contractor
- The main functional departments of design engineering, procurement, and construction
- The individual design groups
- The line functions and the task force

There are two components to achieving the successful end result. Firstly, the hard subjects, the 'hardware' of project management:

a. Strategy, contract and organizational
b. Financial analysis
c. Planning and scheduling
d. Control techniques
e. The four techniques that are the science of, and special to, project management:
    i. *Product and work breakdown structures* (P&WBS) should, on the whole, always be done manually as a team process.

ii. *Critical path method using network analysis*. The simple time analysis can often be done equally well manually, owing to the intricacies of the multitude of software packages. However, once the network is over a certain size it is safer to use a computer owing to people's ability to add. However, a computer will always be needed for serious project management if the real benefits of iii) are to be achieved.
iii. *Resource analysis and allocation*. Each type of resource (people, materials, money and so on) requires a different 'calendar' (working hours, shift patterns, shipping times, holidays and so on). Consequently, a computer is required for the complex analysis involved.
iv. *Progress measurement using earned value and 'S' curves*. This is the sophisticated part of project management and is avoided by many people. Further, owing to the effort required to implement the process it can often be compromised by simplification. (See Part V Section L).

Secondly, the soft skills, the 'software' of project management:

a. Teambuilding
b. Leadership
c. Communication skills
d. Presentation skills
e. Motivation
f. Influencing
g. Negotiating

These elements have all been borrowed from the toolbox of general management. As we can see, there is a conflict. Is project management an art or a science? The skill of the project manager is to decide where to put the emphasis – onto the hardware or the software – and how to integrate the two. I have absolutely no doubt that the more one is involved in project management, the more one is surprised at the power of these soft skills. Without the software, the hardware will achieve little. However, without the foundations of some of the hardware of project management, the efforts of the software is dissipated, and failure will result.

The clever part of project management is that, as well as modelling the project (the phases), it uses models of the various processes. This enables the project manager to evaluate different options before having to commit to specific actions with their associated costs.

1 Models

1.1

The overall project management process is broken down into the discrete project management fundamentals and modelled, using whatever management tool is appropriate.

Process	*Model*
Defining the scope and scope of work	Product & work breakdown structures (P&WBS)
Identifying the risks	Risk breakdown structure (RBS)
Fitness for purpose	Specifications
Risk and responsibility allocation	Agreement or brief
Forecast of costs	Estimating
Effect of changing variables	Risk and sensitivity analysis
Time value of money	Net present value (NPV)
Execution plan	Critical path network
Timing of activities	Bar charts
Project team	Organization structure (OBS)
Leadership	The project manager

1.2

As well as these individual models, there is an overall project management model (see Figure I.B.1)[7]:

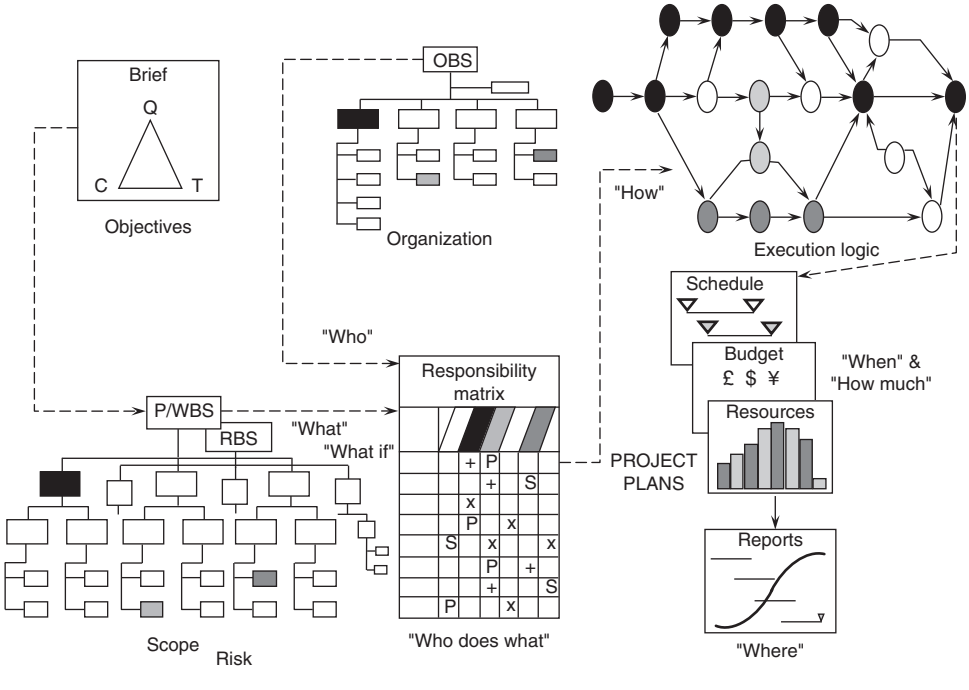


Figure I.B.1

7 The original version of this model was given the title 'The Project Model,' by Stone & Webster. I have developed it further and correctly described it as 'The Project Management Model'.

1.2.1
As can be seen, the model is composed primarily of the hardware techniques; all of the software being in the organization breakdown structure, with the communication links shown by the dotted lines.

1.3

In the model the *Brief,* or contract, defines the requirements and objectives of the project in terms of cost, time, and quality and determines which aspect will dominate the decision process.

1.4

The *What*, the scope of work, is defined by means of the product and work breakdown structures in order to identify manageable packages of work.

1.5

The *What if* identifies the risks using a risk breakdown structure developed using the product and work breakdown structures.

1.6

Who will lead the project, and who will form the team? The organization breakdown structure, is achieved by matching the requirements of the project and the abilities of the individuals.

1.7

Who does what transfers ownership and responsibility to the team (for example: full time – X, part time – P, support function – S) and communicates this through the responsibility matrix.

1.8

How the work should be performed is created through a team consensus for the execution plan and the relationship between the work elements.

1.9

When & how much is determined by the control documents that will provide the data (schedule, budget, and resources) from which trends and deviations from the plan can be identified and reported.

2 Characteristics

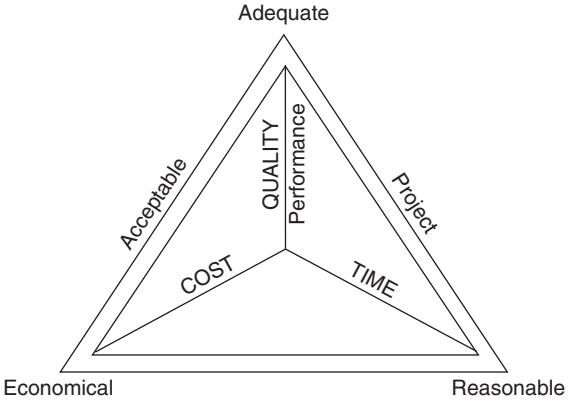
The project management *process* has certain characteristics, which differ from conventional management systems and brings with it certain advantages.

2.1 Project Management Objectives

The project management process takes the owner's or client's business objectives and translates them into specific objectives (Figure I.B.2) for managing the project (scope):

- By a specified time
- Within a specified budget
- To meet a specified standard of performance, which must include safety, other aspects being quality, value, and benefits

Figure I.B.2



Since the prime objective is to complete the scope safely within the constraints of cost, time, and quality, some people put safety and scope at the centre of the triangle.

The natural instinct of owners is to ask for the lowest cost, the client project manager wants the shortest schedule, and the users want the highest quality.

All three of these extremes are not possible all together. The client should be asked to put an 'x' within the objectives triangle to show where the balance is. Do not accept an 'x' in the centre.

An insufficient budget or running out of money or missing schedule targets means that the scope of the project is compromised or cut. This results in a project that fails to achieve its objectives, and the consequence is dissatisfied users.

2.2 One Leader with Responsibility and Authority

A seminal requirement for any endeavour is that there is *one* person in charge; a single point of contact. Thus, senior management delegates the responsibility for managing the project to a project manager. The project manager is responsible for client relations and represents the client within their organization, and represents their organization to the client, as well.

In spite of this, in many organizations, senior management often says: "But we will make the decisions." In these circumstances, you have to ask who is managing the project: you the project manager or senior management. Consequently, you need to manage upwards – "May we have a decision by day x? Otherwise it will cause a delay to the project."

2.3 Multidisciplinary Teamwork

The primary characteristic that distinguishes project management from 'ordinary' management is that it is multidisciplinary. The difficulty is how to get these different disciplines to work together as a team. If it is achieved, there are two significant results:

a. Teamwork.
   The personnel on the project are more motivated and communication is greatly improved.
b. Synergy.
   The use of people with different skills, expertise, and experience to solve complex problems results in greater efficiency and innovation than ordinary groups could achieve.

2.4 Matrix Organization

Because of the temporary nature of projects, a matrix organization is necessary to:

a. Reassign personnel
b. Carry out long-term personnel planning
c. Audit the quality of the work

Organizations vary from the functionally organized with a project coordinator (a weak matrix) to the task force with a project manager (a strong matrix). See Section D, subsection 2.

2.5 Control

Project management achieves control of a project by ensuring that meticulous attention is paid to every aspect of the job.

3 Key Management Decisions and Phases

There are a number of key management decisions relative to the project phases.

3.1

Firstly, the owner may need to purchase additional expertise or resources at different stages (the phase breaks between feasibility, planning, and execution – Figure I.A.3) to perform portions of the work, as mentioned in Section A paragraph 2.3.

3.1.1

The first purchasing/contracting option is to negotiate with a contractor. This will have the minimun impact on the project duration (See Figure I.B.3).

3.1.2

The second purchasing/contracting option is to invite competitive tenders for the performance of the work.

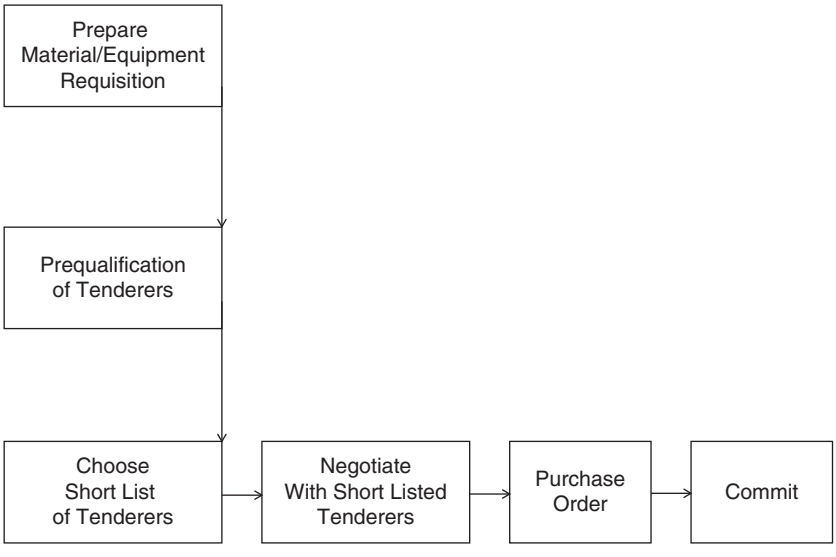


Figure I.B.3

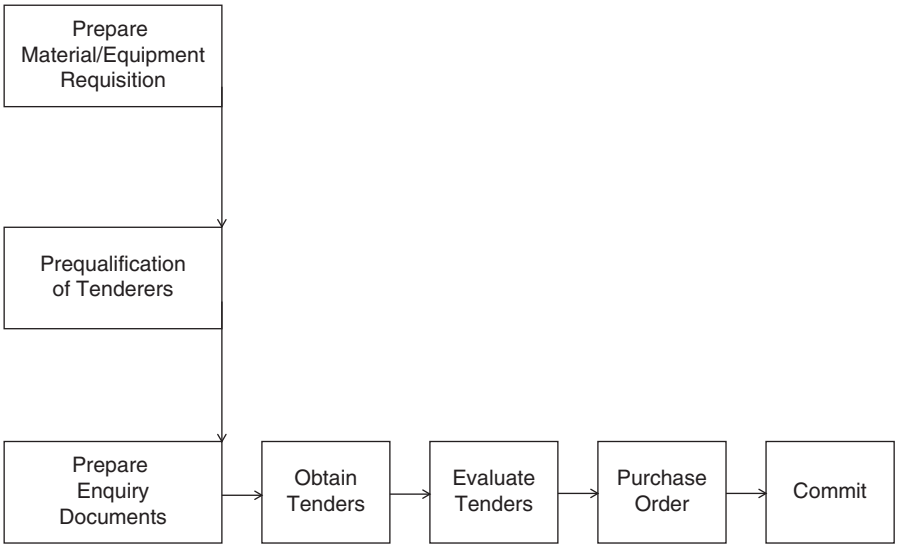


Figure I.B.4

3.1.3

The client may wish to retain complete control over the work by approving the deliverable outputs from each of the stages in Figure I.B.4. Consequently, an *owner approval* stage must be scheduled at the end of each stage. This option will significantly extend the project duration.

3.1.4

The owner/client may use the same contractor for every phase/stage or, alternatively, may use one contractor for the basic design and planning phase and then be tempted to invite competitive tenders for the execution phases. It is crucial for the contractor to maintain good relationships if they are to survive the transition from one phase to the next.

3.2

Project management (as well as deciding the contracting strategy in the early phases), must satisfy the criteria to move from one phase to the next phase, namely:

a. Is the project still appropriate to the company business plan?
b. Is the financial model still viable?
c. Will the project work technically?

3.2.1

The first two sets of vertical lines in Figure I.B.5 indicate where there is a natural break between the phases and an opportunity to stop the project. At the third set of vertical lines, the break is less natural, and the project can drift into the execution stage without proper evaluation. If the project cannot pass these 'decision gates' the project should be killed off. This is one of the most important decisions a project manager has to make and one of the most difficult to implement.

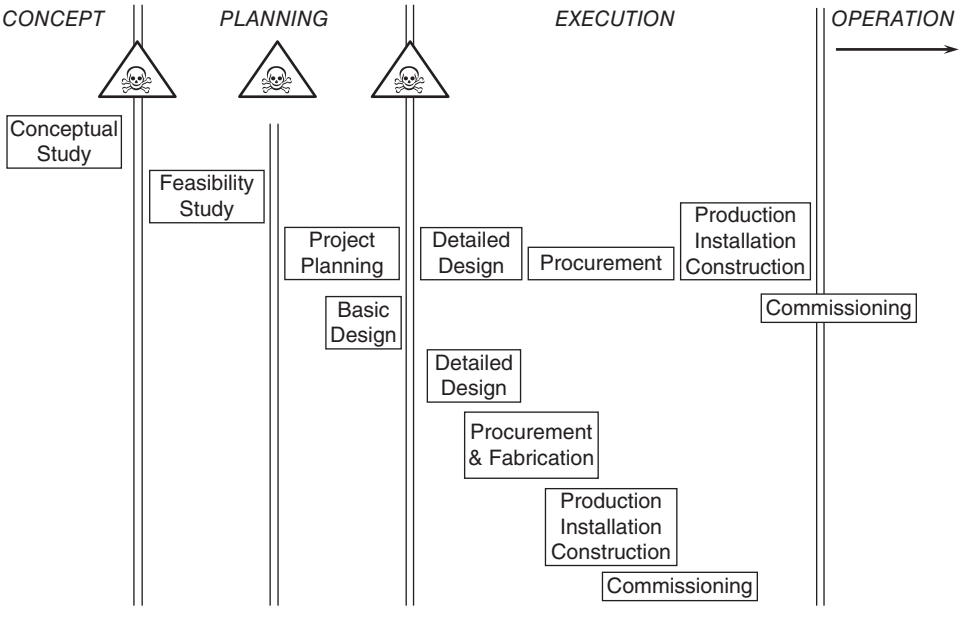


Figure I.B.5

3.2.2
Product development introduces more and more formal senior management gate reviews before the start of each numbered phase shown in Figure I.A.4.

3.2.3
For a client or sponsor, the gate review process starts at the identification of a business opportunity, and the most important gate is the one before any contracting arrangements are implemented. The last gate is a review of the project's success and the lessons learnt.

3.3

Thirdly, at the end of the planning phase, project management must decide how quickly to move into the execution phases and how much overlap of the phases there should be.

3.3.1
Starting the next phase before the previous phase is complete, *fast tracking*, means that rework will be required. The client may perceive this as contractor inefficiency, and yet the client is the person to benefit from an earlier completion date.

3.4

The last key decision is when to start construction. Just because the programme says one should be starting does not mean that one should start if you are not ready.

3.4.1
Some simple rules of thumb:[8]

a. Construction can't start until engineering has reached 30 per cent.
b. Construction can't achieve more than 30 per cent if engineering has not reached 90 per cent.
c. Between 10 per cent and 90 per cent complete construction can achieve 1 per cent progress per week. Less than this means that something is wrong. More than this means the key people in the project's management are deluding themselves. Ask what special plan or short cuts are being implemented, for example, pre-ordering of long lead items, extended working, using dedicated shipping, and so on.

3.4.2
Once construction begins, the construction people start demanding information, often in a different order to that which the home office is working. This must be controlled. Construction must be reminded of how they said they were going to work when their representative was involved in the design process (see Part IV, Section Q Installation and Construction, paragraph 1.3). Otherwise chaos will result.

---

8 Vernon T Evenson, Project Manager.

4 Project Management Patterns

4.1 Number of people involved

Projects have a definite start date before which the staff level is zero. The project manager has to find the resources required to get the project going. Consequently, projects start slowly. Conveniently, the number of people involved in the early phases, that is the study and planning phases, is very small compared with those required during the execution phases, see Figure I.B.6.

Once construction or production starts, the number of people rises very rapidly. The personnel build up to a peak and then fall back to end again at zero at project completion.

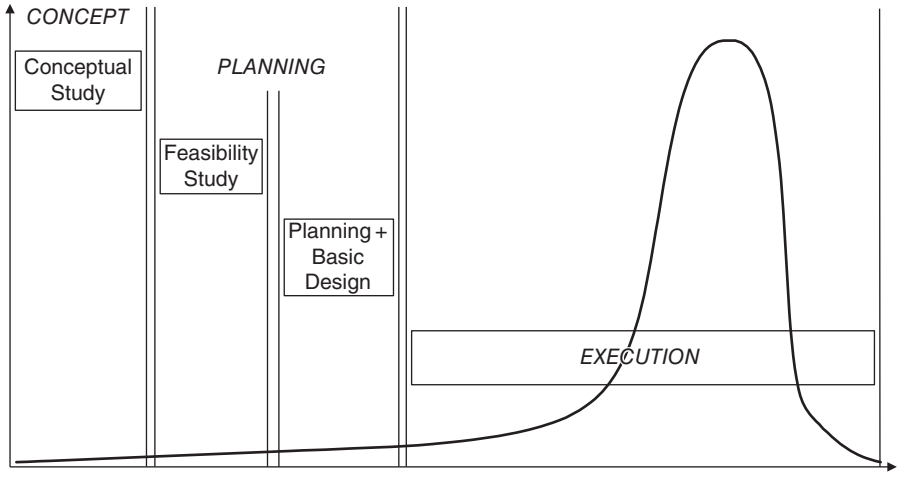


Figure I.B.6

4.2 Increase in costs for one week's delay or cost of accelerating project by one week

If the project is delayed for any reason, the cost of a delay during the early phases is relatively less expensive because fewer people are involved and few, if any, commitments have been made. If the job is delayed when the workforce is at its peak and a major part of the investment has been committed, the cost of a week's delay is very high, see Figure I.B.7. Thus, if a major design error is found, which involves rework, the cost impact can be serious. This highlights the importance of good design quality assurance.

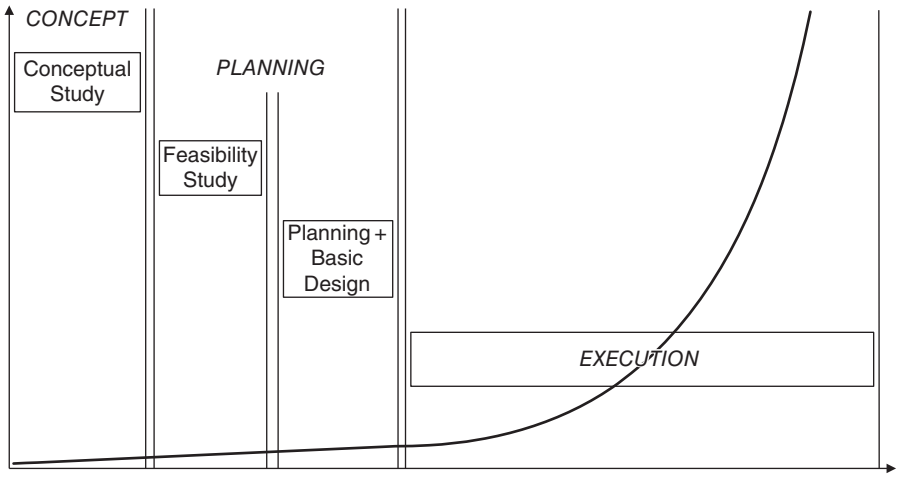

CONCEPT
Conceptual Study
PLANNING
Feasibility Study
Planning + Basic Design
EXECUTION

Figure I.B.7

Section C Execution Planning Influences

As mentioned in the introduction, the concepts, principles, and processes of project management are the same for all projects. However, total flexibility is required in a project's execution.

Technological projects (the primary focus of this book) have a physical end product that is easier to describe and quantify and is easier to see being produced. Their success can also easily be measured. Information technology projects (see paragraph 4.8 below) are more difficult to describe, and the production process is not visible. Business change projects or programmes (see Part II, Section B) are, perhaps, the most difficult to visualise, and it requires considerable committment to realise their benefits.

This section identifies significant inbuilt cultural characteristics, as well as some imposed influences, on how a project is executed in different contexts. The language barrier mentioned in Section B is increased because a different language has to be used to make it acceptable/suitable in that environment. For example, the legal world is uncomfortable with project management but can cope with 'matter management', and risk analysis becomes 'due diligence'. In the medical world, the project manager is a 'consultant'. In the film world, the project manager is the 'director', and a breakdown structure becomes a 'story board'.

1 Project Characteristics, Size, and Complexity

1.1

Firstly, projects with multiple work fronts and access points: power, process plants and many civil and building projects, are ones where the sequencing of work has some flexibility.

1.1.1

Pipelines, railways, and road construction can also have multiple access points although less so. However, there is a very distinct sequencing to the application of different stages of the technology. An undersea pipeline, on the other hand, is more of a single workfront project.

1.2

Projects with 'tower project' characteristics means that the technology forces the sequence of the workfront, as in the initial stages of tall buildings. A true tower project would be climbing a mountain.

1.2.1

The existence of a bottleneck or 'pinch point': environmental or infrastructure limitations that constrain the delivery of materials or the disposal of excavated waste material.

1.3

Mega projects require a more collaborative approach between the contracting parties that may be outside the strict terms of their contracts.

1.4

All projects can be divided into natural components that have different characteristics, namely: the core technology unit, the support elements, and the surrounding facilities. Another approach is to divide the project into its cultural units.

1.5

Runners, repeaters, and strangers. See Section A Project Characteristics and Phases.

2 Strategic Decisions

2.1

Do not try to manage a large project. Break the project into manageable chunks, using a product breakdown structure and manage a collection of smaller projects.

2.1.1
The number of sub-divisions (contracts) should be limited by the same principle as the number of people reporting to a manager (five to seven).

2.1.2
The type of contract (see contract choices paragraph 2.4), competitive tendering and the incentive mechanisms to be used all have a major influence on project execution.

2.2

Who is to be the performing entity for each sub-division? The choice of performing entity is influenced by the organization's maturity, their skills and resources, and any proprietary technology that they own. Choices for the performing entity are:

a. The owner
b. A consultant
c. A joint venture
d. A contractor or subcontractor
e. A vendor

2.3 Organizational Options

Section D, subsection 2 details the different organizational options for the project management role. In summary the different ways for performing the work are:

a. At one end of a spectrum, information flow can be provided by a handover file being passed in a relay through the organization (not an effective option). Consistent communication can be provided more effectively by a project expeditor (the beginning of elements of project management).
b. More sensibly, continuity is provided by one person who is in charge, either full time or part time. A project manager, responsible for several smaller projects, will

naturally be part time. A project coordinator will provide unity of control, and a project manager will provide unity of direction.

c. At the mega project end of the spectrum, unity of command will be provided by a project general manger where the responsibilities will be divided amongst a hierarchy of project managers.

2.4 Contract Choices

2.4.1

The type of contract for performing each sub-division of the project should depend on who is best able to manage and control the risks and who is best able to estimate and carry the risks. The choices are:

Contractor Managed Risk:
Guaranteed Maximum
Lump Sum[9]
Fixed Price
Firm Price
Shared Risk:
Target Cost
Bills of Quantity
Unit Rates
Remeasure
Day-works
Time & Materials
Client Risk:
Cost + Fixed Fee
Cost + percentage Fee

This list of contracts has been itemised, in descending order, of risk to the contractor. From a client perspective, the order in each risk category should be reversed. The analysis is based on the named payment mechanisms being taken as written. Every client will have their own quirky way of administering them so that they can end up being quite different from the name they have been given. On one occasion, a contractor asked for my opinion on a contract that ended up being the complete opposite of what the name implied because of the obligations and consequent liabilities written in the

9 The I Chem E use this term in the same way that I use fixed price; namely, the price is fixed and does not change for a defined scope.

contract document. It cannot be over-emphasized that the true risk category is not revealed by the designated payment labels but is disclosed by the words in the terms of the contract. So read the words.

2.4.2

The choice of contract type involves balancing the degree of client involvement (reimbursable contracts) against the loss of client control (fixed-price contracts).[10]

The characteristics of the different contract types are summarized in Figure I.C.1. The arrows indicate that a particular characteristic is maximized in the direction of the arrow.

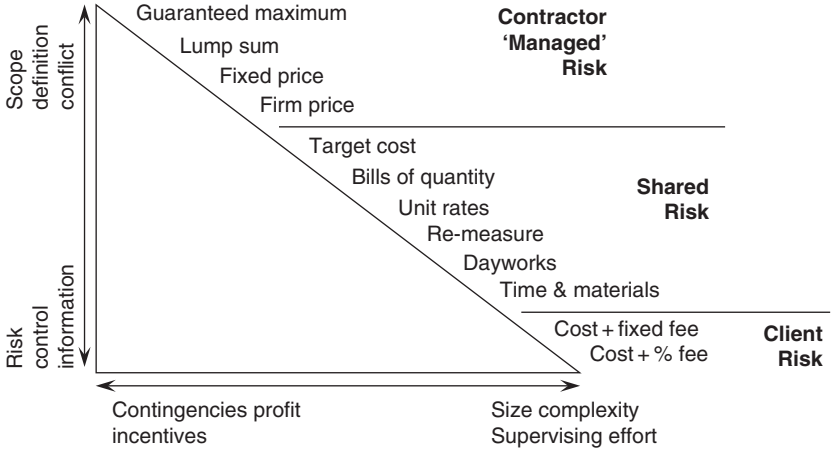


Figure I.C.1

2.4.3

'Tell me how someone is paid, and I will tell you how they will behave'. This is equally true of contracts. All contract forms and incentives have been developed to change people's behaviour. The two basic forms of contract are at the opposite ends of a behavioural spectrum. With a fixed price contract, the contractor will try to cut corners. Whereas with a reimbursable contract, they like to get involved in the detail and over-design in order to expand the man hours.

2.4.4

Traditionally contracting has been confrontational. The fixed-price contract says: "Leave us alone, and we will deliver an end product." The reimbursable contract says: "Tell us what you want us to do, and we will provide you with the necessary service." Today's emphasis is to build on this collaborative approach and work together for mutual benefit. Thus the choice of contract should also be based on inducing the right behaviour.

---

10 The introductory notes of the I Chem E, 'Model Form of Conditions of Contract for Process Plants', provides an excellent comparison between the two basic types of contract at the extremes of this spectrum.

2.4.5
If we take risk as the financial impact to the contractor, then a guaranteed maximum contract is the highest risk since it is in effect a fixed-price contract, but the contractor only keeps 50 per cent of any saving, whereas with a true fixed-price contract, the contractor keeps 100 per cent of any saving. Lump sum, as used by some people, means that you don't get paid your 'fixed' price until the project is completed, as opposed to a conventional fixed price, which can involve progress payments. A firm price removes the significant risk of inflation and as such is the lowest risk of this 'fixed' price, contractor risk category.

2.4.6
In the shared risk category, the client basically says: "We haven't decided on the scope yet, so please provide some rates for the listed work activities and the material quantities. When it is complete we will re-measure the work involved and reimburse you according to the schedule of rates."

2.4.7
The target cost contract is perhaps the only contract type that attempts, if structured correctly, to change behaviour. It can be seen as a lower risk since any overrun is shared with the client. However, any underrun is also shared, and consequently, has a higher financial impact than the other shared-risk contracts in which the contractor gets paid for all the work that they perform. There is not much to choose between the rest of the shared-risk category, apart from a bill of quantities. A bill of quantities is likely to include some additional risks in the words of the document, in addition to the pricing risk. Of course, if the contractor is asked to take any additional risk involving the quantities or scope, then this contract would move into the contractor-risk category. Day works and time and materials are basically the same. They should only be used by a client for unforeseen, unscheduled, and un-priced work. As a consequence, they can be quite lucrative for the contractor; however, the quantity of work should be small.

2.4.8
In the client-risk category, the contractor is reimbursed their costs so that there is no pricing risk as in the other categories. No contractor should be allowed a cost plus percentage fee contract, but I still come across them now and then. If you have one, look after it!

2.4.9
There is also an option to start the project with one of the types of reimbursable contract and then at an appropriate stage, when the scope of work is adequately defined, ask the contractor to convert the costs into a fixed price.

3 The Historic Nature of an Industry

3.1

An example is UK government projects: officialdom likes to pass responsibility but retain control, with a tendency to select the lowest price.

3.2

The culture of the owner's organization. An example is a declared preference for fixed-price contracts but with projects usually executed on a reimbursable basis or clients with a preference for a particular contractor.

3.3

Allowing the architect to be an external professional advisor rather than integrating them into the design team.

4 The Characteristics of the Industry/Business Sector

4.1 Engineering Construction Projects:

4.1.1
These projects are characterised by a visible and physical end product involving heavy capital investment. There is a primary emphasis on safety and the physical environment. A range of multidisciplinary skills are required, using a wide range of materials.

4.1.2
Offshore projects are really process plants mounted on a large support structure. Apart from lifting one onto the other, their prime difference from an onshore plant is that everything has to be prefabricated or modularised due to the exorbitant costs of working offshore.

4.1.3
Construction is different. Although much of the work is similar from job to job, unlike home office design and supplier manufacturing, it does not have a specific workforce or a specific work location. One contractor never builds the same plant at the same site for the same client with the same labour force. For this reason, the concept of progressive, incremental improvement which may be achieved in manufacturing, is not feasible in the field. "When a Japanese car factory has a quality problem, they go solve it; when a British engineering construction project has a quality problem, they write a procedure."[11] At least the implementation of a proper procedure for each activity will lead to steady improvement.

4.2 The Civils and Building Industries:

4.2.1
A key feature is the historic separation of design and construction. The architect defines *what* is required but rarely talks to the builder who is responsible for *how* the work is constructed, thus compromising the outcome. Nevertheless, specific contracting approaches (for example: design and build) are now used in order to address this deficiency.

---

11 Modified quotation from a U.S. manager.

4.2.2
Another key feature is that there is no single point of responsibility. The quantity surveyor is cost focused, and the architect is design focused. Architects aim for the highest architectural standards even when it is inappropriate in corridors and service areas. Further, as professionals, they give advice and do not assume any liability or responsibility. The traditional contract conditions nominate 'the engineer' (a client employee!) as an arbiter. On the other hand, a project manager makes decisions (as in the new engineering contract) for the benefit of the project, balancing aesthetics against practical considerations and cost.

4.2.3
The nature of the work is primarily civil with other disciplines having a reduced input. The emphasis is usually on cost, with attention paid to quality due to the high cost of remedial work. By contrast a modern building, for example Terminal 5 at London's Heathrow airport, can be closer to a process plant with 70 per cent of the cost being mechanical and electrical services.

4.2.4
Comparison of Engineering and Building:

Engineering	Building
Plant 80 per cent	Plant 40 per cent
Measured performance	Perceived performance
Dominance of function	Dominance of architecture
Technical complexity	Aesthetic subjectivity
Setting to work problems	Finishing problems
Expert client	Inexpert client
Centralized management	Decentralised management
High management overhead	Low management overhead
Cost engineers	Quantity surveyors
Man hour control	Cost monitoring
System design	Scheme design
Integrated design	Disintegrated design
Detail design by contractors	Detail design by design team
Low design cost	High design cost

4.3 The Power Industry:

4.3.1
This is a mature industry. Consequently, there is a strong focus on the specification and detailed design. The technology is 'common art' with little development required. The consequence is that open competitive tendering for turnkey, fixed-price or lump-sum contracts is common. There is a heavy client involvement with independent consultants. Projects are usually financed by loans or aid agencies.

4.4 The Utilities:

4.4.1
Historically the pre-privatization water industry in the UK was dominated by a civil engineering culture but has subsequently accepted that it is a process industry. They started with a lack of project management skills and have subsequently developed their project management philosophy from a variety of industry practices.

4.5 Aerospace:

4.5.1
This industry is characterised by progressive development up to a prototype stage on a reimbursable basis using one or two contractors. These contractors then tender fixed prices for the execution phase.

4.5.2
Aerospace tends to be a series of repetitive projects managed as a programme of work. There is, however, the problem of timescale. They are too long for consistent personal commitment to get to the end, and project managers will change.

4.6 Government Projects:

4.6.1
Governments tend to believe that they are purchasing an end product rather than project managing the development of a project. Projects can lack one point of control, and the project management is weakened by the power of a contracts department. There is a tendency to top up their level of ignorance as personnel are moved onto other assignments and new personnel are brought in who have no project management expertise.

4.6.2
Try to avoid what can be termed political projects. The rules of engagement tend to change, and the project manager gets stuck with the problems.

4.7 Armed Forces Projects:

4.7.1
These are usually programmes of incremental capability acquisition as described in Part II, Section A. They are subject to the external influences of politics and have too many internal organizational elements.

4.7.2
A major problem is the advances in military technology that takes place during the long development stages of the project. For example: an armour-piercing projectile is developed. However, the opposition develop better armour or introduce sloping armour, so further development or new concepts are required.

4.7.3
Techniques need to be developed whereby key technology elements can be extracted in modules and changes retrofitted.

4.7.4
The major flaw in defence projects (as with all government work) is that there is too much concentration on the procurement process and not enough on project management.

4.8 Information Technology Projects:

4.8.1
The industry is still relatively young. The characteristic that distinguishes it from other industries is that the hardware involved, the design techniques, and the software languages change very quickly. However, the developments in the software have not kept pace with the potential of hardware. This encourages people to add extra functions to the requirements. It is also poorly understood by management. The project managers are rarely trained, and the creative nature of the project personnel produces organizational behavioural problems. The IT discipline seems unable to accept that conventional project management has anything to contribute to the management of their projects. The discipline has a habit of reinventing 'new' management processes. The biggest problems are not technical but human problems.

4.8.2
There are control problems due to the ongoing nature of the design process and the lack of a visible product. Control is exercised through man hours spent, lines of code written, or modules completed. A problem is that there is a tendency for everything to be 99 per cent complete. Finally, as for many projects, the documentation – operating instructions and so on – tend to be deficient.

4.8.3
The phases are very similar to any engineering project, but software development has some differences:

a. As in many projects, the customer may not know what they want in the initial phase of *analysis,* which produces a *requirements specification*. Further, the customer's ideas may change when they see what is proposed and also during development. Again, as for all projects, their business needs may also change. Consequently, there is a formal process of *validation,* which checks that the requirements specification is correct.
b. During *design,* there is a formal process of *verification* to check whether the design meets the requirements specification. Prototypes of the proposed system may also be produced. The design stage must also include a specification of the hardware requirements.
c. *Implementation* of the actual coding of the programs and the like is probably about one quarter of the total project effort. Similarly *integration and testing* requires at least as much effort as implementation.
d. A *maintenance* process is necessary since it is virtually impossible to test for every eventuality in a major system. Software must also be designed with appropriate

consideration for possible future enhancements. Control of both documentation and change is vitally important.

e. There is no procurement (or none to speak of, though part of the system might be brought in). There is no construction.

4.8.4

Software development has been much concerned with the possibility of software re-use. Thus there is a need to develop standards so that the input/output interfaces and performance of the software component are well-specified. This is like buying a pump; one would buy it based on its performance specification without knowing much about how it does it.

4.8.5

The information technology world is beginning to relearn that large projects cannot be managed. Contrary to conventional wisdom (for physical projects), it is a mistake to try and define the total scope for a large software project. It is clarity of the objectives, of what one is trying to achieve, that is critical. Decide on the division of work by breaking the project into its natural smaller packages. Priortise the component parts that provide the best value for the users and hence the business, and release incremental functionality early. Roll out the various elements slowly in order to find problems before releasing the next component. 'US government statistics show that the majority of [IT] projects that run for longer than a year with no intermediate deliveries never deliver, no matter how convincing their business cases are'.[12]

4.8.6

Start with an extensive feasibility study and a pilot project that is thoroughly tested by a small group of experienced users, and then grow the project as it is released to a wider population of users. This approach was demonstrated and validated with the computerization of pay as you earn (COP) project – 1977 to 1983,[13] The first large government IT project completed on time and under budget.

4.9 Change Projects

4.9.1

The story of a survivor from the Piper Alpha North Sea Platform disaster provides the key to any project involving change. When the survivor was asked, "Why did you jump into the burning sea when you were probably jumping to your death?" His reply was, "There was a chance I would survive, which was better than certain death by staying on the platform."

---

12 Top seven agile behaviours that result in success' by Brian Wernham published in 'The Agile Business' by Raconteur Media 14th October 2014 in The Times and posted in APM Resources as 'How to manage agile' 6th January 2015.

13 *Project Managed* by Steve Matheson. His is a name that should be on the role of honour of the project management world.

4.9.2
The business parallel is to recognise that if the company carries on as it is, it will slowly die, but if it changes, it might survive. Ask the questions: "Where are we and where do we want to be?" The cost of staying where we are is going to be greater than the cost of the process of change. Any project involving a change in cultural values must also involve changing people's behaviour by changing the company's procedures. Both have to be altered to achieve change that will last.

4.9.3
The absolute commitment of the chief executive is essential. They must also stay committed throughout the project. If they are not involved, don't start the project. I was appointed project manager of a productivity improvement programme; it was launched by the chief executive and because of their presence at meetings, even the most negative of the department managers (one in particular) also attended. However, at about meeting four, the chief executive excused themselves because they had to meet a client. The message received by the reluctant attendees was: "Oh, so there is something more important than this time-consuming meeting." The result was that the sales director also had a client to meet at the next meeting. From that point on the whole programme fell apart.

4.10 Manufacturing:

4.10.1
Manufacturing projects are different in that they perform repeat projects for the same client in a constant location with the same labour force.

4.10.2
The key to a manufacturing plant is to identify the constraints (or weakest link) in the chain of activities (the process) that delivers a finished product outside the factory gate. The weakest link (bottlenecks) in the chain of activities (the machine with the longest component manufacturing time) determines the time taken to complete the assembly of the finished product. The focus is on controlling the level of inventory in front of machines (in particular, the bottlenecks) to the throughput (the finished products that have been sold, resulting from market demand).[14]

4.10.3
In the car component industry, the good news is that you have been awarded the contract. The bad news is that in year two we will expect a 10 per cent reduction and in year three a further 10 per cent reduction. We may then have to invite competitive tenders in case you have become too complacent or because of developments in the marketplace. This is the approach that anybody outsourcing services, such as providing canteen facilities or computer services, should adopt.

---

14 For a thorough understanding of these issues read *The Goal* by Eliyahu M. Goldratt and Jeff Cox, published by Gower.

4.11 Research and Development:[15]

4.11.1
It is incorrect to group research and development together. In a development project, a deliverable has been determined (see aerospace above), and thus it conforms to the norms of project management. Research projects, on the other hand, contravene most of the essential principles of project management.

4.11.2
In principle, a research project manager is responsible for supporting creative thinking in small subject-oriented units and making sure that the thinking results in some kind of concrete output. Further, this output should preferably be on time and to budget. However, if there are fixed goals with certainty of the results, then it is not research. Additionally, if there are no failures, it can be argued that the researchers are not doing their job.

4.11.3
Research is more project leadership than management; direction comes from the work itself rather than from a manager. It is to a large degree about influencing and persuading partners.The research leader's task is to present a unifying vision and nurture a project environment where an assembly of individuals can be turned into a committed and effective team. It should feel responsible for, not only their own individual contributions, but for the collective team output. Researchers have a desire for a large degree of autonomy in their work and democracy in decision-making, Hence, a high degree of delegation and attention to interface management is required. A democratic-authoritarian management style is needed. That is, *consensus with qualification*, see Part VI Section B, paragraph 1.2.

4.11.4
Listed below are some of the paradoxes of research project management:

a. There is a need for a risk-taking approach to be innovative. By contrast there is the need to reduce risks abd to ensure the delivery of the desired result on time and to budget.
b. There is task and process uncertainty. There is unpredictability of the research outcome. New research opportunities arise during the course of the project, as against the need for predictability of project output.
c. The quality of any output may improve if deviations from the plan are allowed. Continuous adaption and adjustment is required. Flexibility is necessary in order that the project goals can adjust to future changes in the project. That is, change is a good thing!
d. Focus on getting the right things done, not so much on controlling how and when they are done. Effectiveness is generally more important than efficiency in research projects; the result is more important than the process.
e. Rather than setting one common goal, the first phase should be about juggling several versions of the project in the air at one time.

---

15 This sub-section is largely taken from a paper 'Project Management theory and the management of research projects' by Erik Ernø-kjølhede, Copenhagen Business School, January 2000. ISBN 87-90403-70-3.

f. The phases should not be considered as a deterministic linear process where each phase succeeds the other. They consist of a number of fundamental project tasks that overlap and gradually take turns in dominating during the life of the project. The conceptual phase will continue to influence the project but with diminishing intensity.
g. Participants are more likely to have powerful hidden agendas: co-operating in a project but in competition with each other for acknowledgement of their contribution. They have a need for recognition of their work and to be published.
h. There is a lack of management information and a difficulty of interpreting management information. There is uncertainty of the end product and the process versus the need to act as if there is certainty and making management decisions continuously. Realistic planning is not possible in view of the high level of uncertainty.

4.12 Theatre and Film:

4.12.1

A theatre production is a series of repeat projects that continue for as long as they produce the business benefits for the client (the producer). Each repeat project will be slightly different, depending on the users' (audience) reactions. The business-oriented client tries to control the creative project manager (the director) who often has little interest in cost issues but works to a 'drop dead' (see 5.2 below) opening date. There is almost always an extensive feasibility and protyping stage (rehearsals and provincial tours before a major city launch). It is, in effect, a 'tower project'; it has to start at the begining and continues in sequence (as defined by the specification – the script) until the end is reached. Theatre is led by the creative team (actors) who use the site (stage) first and then the technical team come in to work around the actors, and adjust the scenery in order to complete the scope. Once the execution phase starts, the project manager has no more involvement and the team (cast) is self-managing. A theatre production is a project being produced live – the end product is transitory and, on its own, leaves no permanent physical mark.

4.12.2

By contrast there is a permanent end product for film projects. They are in effect pipeline projects with multiple access points; that is, they can be done in any order. Films sometimes leave out the feasibility stage (rehearsals) and take multiple shots at getting the execution stage right, which is the reason for cost overruns. However, if the quality is right, the business returns swamp the cost overruns. Films set up and do all the technical work first, and then the creative team (actors) come onto a finalized project location (set).

4.12.3

A film will perform a product breakdown geographically with a location focus. Even if the action takes place over hundreds of years, all outdoor sequences, indoor sequences, or all the scenes involving certain features, settings, or actors are grouped together for cost efficency. Film projects also involve large numbers of subcontractors and thus need much more formal and detailed planning. Filming individual scenes takes on the characteristics of a drop-dead date. Conversely, if they meet problems with the setting

availability or resources outside their control, the creative director will change the specification.

The film *The Making of Gone With the Wind* demonstrates that *Gone With the Wind* was completed on time and to budget because it used a significant range of project management techniques and skills. Particularly noteworthy is its use of product and work breakdown structures, taken down to the task level, in the form of story boards.

4.13 The Medical World:

4.13.1

Projects in the medical world are unique in that they form part of the client's own body. For minors, the client and the key stakeholder are separated. The client's cost, time, and quality/performance triangle are totally skewed. In conventional project management, the client sets the objectives that must be achieved. In medical projects, the project manager (the consultant) decides on the objectives for the project, and the balance between time and quality and cost is now also considered. However, this is not done alone but in conjunction with their colleagues, the other project managers/consultants. For the client, the objectives are aspirational, and their whole emphasis is on quality with a secondary interest in time. In the National Health Service (NHS), the client ignores cost. For private work, cost will be a major consideration but will hopefully be covered by a project insurance policy.

4.13.2

The feasibility and planning phases of a medical project, for example a surgical operation, are dominated by intermittant tasks (pre-assessment, tests, and so on) in a multi-project environment. None of these early task performers understand the whole picture (project plan). All the tasks interact with each other, and the interuption takes precedence. In order to complete the interupted task, there is a reassessment and, consequently, the overall duration of the work takes longer.

4.13.3

Somewhere in the organization, there is a programme manger using a multi-project approach juggling availability and allocation of resources. The result is that the client/patient may never see the same team member more than once, performing the same task. Thus the client/patient is totally dependent on a functioning system rather than a single point of contact in charge.

4.13.4

The project (patient) is passed in a relay with a handover file from one specialist technologist to another, with little or no prior knowledge of the project. The handover file grows in size as the interactions accumulate and the project moves from one stage of the process to the next. There is an enormous emphasis on interface management to ensure that the correct project/patient is being addressed.

4.13.5

The execution stages are very similar, if not identical, to the model describing the conventional process in Section B. The main difference is in the people, and in particular, the

project management function. There is a manager of projects (the senior consultant), but they are also the head of a functional department, and they hold meetings with the project managers to agree the plans for the various projects.

4.13.6
Whilst I can make a good case for a project manager not being trained in the technology of the project that they will manage, this does not apply in the medical profession. The project manager/consultant has to have been trained through the route of technologist (the registrar). There may also be an assistant project manager (nurse practitioner) who will be permanently assigned to the project manager on all the projects that they are involved with. Whilst it is theoretically possible for an assistant project manager to eventually qualify as a consultant, this is unlikely. Whereas in the technical industries, this is more than likely. There is not a conventionally understood deputy project manager. The registrar is in effect a project engineer in training to be a project manager. Further, as on small technological projects the consultant project manager may also perform the technology/operation.

4.13.7
Another difference is in the project team for the execution phase. As a generalisation, a team is normally selected from whoever is available; however, for a surgical operation, the theatre team has been pre-selected and has worked together so that team building should not be necessary.

4.13.8
The main part of the project, the operation, is project managed as a *stranger* project with elements of a *repeat* project (see the first paragraphs of Section A). It is reassuring to see that "surgeons will use a pre-operation checklist:

Does everybody on the team know each other's name and role?
Has the surgeon briefed the team on the goals of the operation?
Do you have the right side of the body you're operating on?
Only then do you begin.[16]

4.13.9
The whole approach changes for the necessary postoperative tasks and ongoing support functions – *runner* projects. However, by good definition of the tasks and how they should be performed, many become standardized routines.

4.13.10
At the end of the project, the setting to work stage, the technological and medical projects are very similar. In both cases the project manager discusses with the client any short fall from the 100 per cent performance that the client wants, that can be or may have to be accepted. However, something that the medical world does well, compared

16 From an article in *The Times*, Saturday November 22, 2014. 'How a checklist saved a little girl's life.'

to technological projects, is the postproject completion stage when follow-up projects are discussed.

4.13.11
Accident and emergency projects are totally dependent on a good process (capable of a wide-ranging flexibility in capacity) with good systems and procedures. The first step is a pre-feasibility stage (triage) in order to determine priorities/urgency and filter the various technologies. Is it a pipework job, electrical, software, or is it a piece of machinery that doesn't work? At the feasibility stage, a preliminary assessment is made; is the project a runner, repeater, or stranger? Can it be repaired, do parts need to be substituted, or in the ultimate case, does the machinery need replacing – a major project.

5 Phases and Schedule

5.1

In the ideal project, all of the design is complete, and all of the materials are available before construction starts. However, once a schedule end date is imposed to shorten the schedule, work has to start on the next activity before the previous activity is complete (it has to be 'fast tracked'). The question is: 'how much overlap should there be?'

5.2

With the imposition of an immutable end date – a 'drop-dead' date, such as for the Olympics – the project will be set to work regardless of whether all the final details have been completed or are available. As a result, the project may be launched too early and compromise the planning process. Alternately, it imposes the major risk of urgency on the project process, which in turn is a major cause of project failure.

5.3

As already stated, running out of time means that the scope of the project is compromised or cut. This results in a project that fails to achieve its objectives and the consequence is dissatisfied users.

6 Execution Planning

Detailed execution planning issues are addressed in Part IV. However, some specific project influences, and options where decisions have to be made, are listed and summarised here for completeness.

Division of the Work by Phase	Considerations for the Performance of the Work
Phase:	How much overlap.
Design:	Done in-house. Subcontracted, use consultancy expertise (or an architect!).
	Using local knowledge/resources.
	Technology transfer involved.
	Legal requirements.
Purchasing:	Determine the level/amount of vendor data needed.
	Use proprietary information or catalogue information/data.
	Use vendor standard designed equipment or use own design.
	Buy bulk materials or get subcontractors to supply
	Identify where no expediting is carried out.
Expediting:	Identify where it is done by telephone.
	Identify where visits will be required.
Inspection:	Decide when goods, materials and equipment will be inspected.
	Upon delivery, at the suppliers'
	During fabrication.
Construction Management:	Is it to be cost or schedule dominated?
Construction:	Direct hire labour or subcontracted.
	Use of local resources/contractors
Commissioning, Start up,	Get the users involved early.
Setting to work:	Develop the 'start packs' during construction

7 Generic Influences on Project Execution

a. Competitive tendering and incentives
b. Legal requirements
c. Local knowledge and/or consultancy expertise
d. The need to use local resources/contractors
e. Designed equipment

Section D The Project Management Role

The project management role is complex and can vary a great deal; however, the role of the project manager has fewer options. Both roles can be defined under the following groupings:

- Strategic and contractual
- Organizational and functions
- Responsibilities and orientation
- Competencies and leadership
- Abilities and skills

1 Strategic and Contractual

An owner has a number of management and contracting options for managing a project. They can use:

a. An owner's team to manage a main contractor, using any one of a number of contract variants
b. An owner's team to manage a number of subcontracts, again using similar or different contract arrangements
c. A consultant or architect (not recommended) to act on their behalf, instead of using their own management team
d. A contract for a project management services organization to supplement their own core management personnel

2 Organizational and Functions

Each of the above contracting arrangements can have different organizational options for the project management role.[17] Should the organization face the outside world saying, "This is how we manage our business through disciplines and functional groupings", or should it face its customers saying, "This is how we deliver end products through project management"? These two axes at right angles to each other have different agendas. The axes can then be rotated so that one role is more dominant than the other. Thus a matrix of mixed organizations is formed that can merge into one another as the project team grows and declines. The main structures are as follows:

17 The definitive and seminal work on the subject of 'matrix management' is a paper titled 'Organizational Alternatives for Project Management' by Robert Youker, of the Economic Development Institute, World Bank, Washington, DC. Presented at the 8th Annual Symposium, Project Management Institute, Montreal, Canada, 6 October 1976. Everything that has been written since then has 'borrowed' from this paper. It says almost everything that needs to be said on the subject, although I tried to add to it in a paper I wrote for the Norwegian Institute of Technology 'Nordnet '91' conference, Trondheim, Norway, 3–5 June 1991, titled: 'Project Organization Structures from Logic to Reality'.

2.1 Structure A – Functionally Managed:

The project is divided into segments and assigned to relevant functional areas and or groups within functional areas. The project is coordinated by functional and upper levels of management. However, basically there is no project management as such, though an expeditor may be appointed to *improve communication*.

2.2 Structure B – A Weak Matrix:

A project manager with limited authority is designated to coordinate the project across different functional areas and or groups. The functional managers retain responsibility and authority for their specific segments of the project. The project manager tries to *control* cost and time.

2.3 Structure C – A Balanced Matrix:

A project manager is assigned to oversee the project and shares the responsibility and authority for completing the project with the functional managers. Project and functional managers jointly direct many workflow segments and jointly approve many decisions.

This is probably the most difficult arrangement (but very common in business) in which to exist.

2.4 Structure D – A Strong Matrix:

A project manager is assigned to oversee the project and has primary responsibility and authority to *direct* and complete the project. Functional managers assign personnel as needed to a co-located team and provide technical expertise. This is commonly referred to as a 'task force' but is still strictly a matrix. This structure is the recommended and preferred option for serious project management.

2.5 Structure E – A Task Force:

A project manager or project director has sole responsibility. They are put in *command* of a project team composed of a core group of personnel from several functional areas and or groups, assigned on a full-time basis. The functional managers have no formal involvement. This structure is usually used for mega projects, and the project manager or director will probably divide their responsibilities amongst a hierarchy of project managers with different levels of experience.

2.6 Sub-structures:

There are similar choices at the lower hierarchial level of project management. The project engineering function can be organized in a weak functional matrix with the project engineers coordinating across the design discipline groups. Alternately, the project engineers can be organized as a strong matrix in charge of a group of design disciplines for their individual parts of the project. In some cases a separate technical task force might be set up for a stand alone (a complex equipment package) part of the project.

2.6.1
We lost a competitive tender becaust the client perceived a competitor to have *better* project engineers, managing a strong matrix of co-located designers. Our project engineers were coordinating across the designers in their functional disciplines, in a weak matrix.

2.7

The project manager does not manage alone. There are at least four distinct functions to be performed in each of the organization options:

a. The user or originator of the project
b. The client/owner or sponsor of the project
c. The project manager acting in one of the contracting roles above
d. The project team

Problems occur if any one of these functions is missing or merged.

2.7.1
The role of the users is addressed in Section G Achieving Success, subsection 3.

2.7.2
The client/owner project manager is different in that they take a more strategic, benefits-and-outcome perspective. The role of the client/owner or sponsor of the project is addressed in Section F The Owner and Client.

2.7.3
The project manager is the leader of the team who, regardless of technology, will involve at least the following functions:

a. The manager of the technology – in our context the engineering manager
b. A manager of the commercial aspects – the procurement manager
c. A manager of part of the project manager's function – a project controls manager (or project office manager) responsible for estimating, costs, schedules, and gathering data for reporting
d. A manager of the site execution phase – the installation or construction manager, who eventually hands over leadership of the project on site to the commissioning manager
e. On an international project, with multiple sources of finance, there may be a need for a project accountant

2.8

The project management function can sometimes be expanded with additional roles, such as a deputy project manager, an assistant project manager, and a champion.

2.8.1

A deputy project manager is, in effect, a project manager in training and will stand in for the project manager in their absence. The deputy project manager should be given responsibility for a meaningful part of the project or a stand-alone sub-project to manage. They can also take over from the project manager towards the end of the project. In these circumstances the client may well agree to release the project manager since they will have seen the deputy perform over a long period.

2.8.2

An assistant project manager is basically an administrative assistant role and does not have delegated project management authority.

2.8.3

A champion is needed for internal projects and is someone who has no direct involvement in the project. However, they are of sufficient seniority and experience to advise you, the project manager, on how to manage the superior and difficult stake holders.

2.9

For joint associations/venture projects and projects with significant political stakeholders (internal projects and some public sector projects) the project manager should create a project board or steering committee to act as the client.

Make sure the most anti-political manager (or organization representative) is on the board in order to defuse their antagonism.

3 Responsibilities and Orientation

3.1

The responsibilities of a project manager can be summarized in the following reasons for having a project manager. They are to:

a. Centralize in one person, *who has no other duties*, all the responsibilities for a project. The cost of project failure can be huge. The cost of a full-time project manager is relatively little. So, why compromise the project management function? Nevertheless, a project manager may be responsible for two or three small projects – one starting, one established, and one finishing.
b. Set realistic goals for the project for all participating groups, considering the resources that each can bring to bear.
c. Make decisions on the project quickly enough to meet its needs and benefit it as a whole, not just a portion.
d. Provide a means of anticipating the problems during the course of the project.
e. Give one person the responsibility of quickly developing solutions to problems so that the project will stay on target for programme time and budgeted cost.
f. Consider the ethical view of the project and have sufficient knowledge of ethics and the law to be able to communicate the issues, setting an example through integrity and honesty and projecting the reputation of the business.

3.2

These responsibilities require the project manager to be orientated through 360 degrees, in different directions and different roles.

a. *Up and Down*. Reporting to senior management and managing the team.
b. *Internally and Externally*. Working within the organization and managing the project participants. Interfacing with the client, contractors, and suppliers and other stakeholders.
c. *Backwards and Forwards*. Controlling and measuring what has been completed and planning the next period's work.
d. *Sideways left and Sideways right*. Interacting with functional managers and observing how other projects might affect their project.
e. *Present and Future.* Acting as a spokesperson for the project and anticipating how the finished project will impact the organization or environment.
f. *Take a Short Term View but Little Long Term Perspective*. Project managers are really only interested in completing their own project. However, they will have to work with some of the same people again in their own organization and the client's. The difference with the client project manager is that they take a longer-term view. They are interested in satisfying the business case and delivering the benefits of the project.

4 Competencies and Leadership

I have had over twenty years as a practicing project manager and twenty-five years as a consultant and trainer. Having trained over 4,500 project managers over a wide range of businesses and industries; I have concluded that the following are the primary competencies required by a project manager:

1. Leadership
2. Interpersonal skills
3. Problem solving
4. Personal qualities.

4.1 Leadership:

a. Flexibility
b. Delegation
c. Resolving conflicts
d. Team building

4.2 Interpersonal Skills:

a. Communication
b. Persuasion
c. Negotiation
d. Influencing

4.3 Problem Solving:

a. Analysis
b. Judgement
c. Decisiveness
d. Creativity

4.4 Personal Qualities:

a. Integrity
b. Self-confidence
c. Tolerance of ambiguity
d. Political awareness
e. Helicopter perspective
f. Proactive working style
g. Determination

4.5 Leadership

Leadership is so important that it deserves to be highlighted more than once. See Part VI, Section B for the different leadership and motivation models as follows:

Tannenbaum and Schmidt	One-dimensional continuum model
Blanchard and Hersey	Two-dimensional situational leadership model
John Adair	Action-centred leadership model
MBWA	Management by wandering around.

5 Abilities and Skills

The abilities required of a project manager are many; however, the details of the following four are the dominant ones that distinguish the project manager from the functional manager.

1. Ability to persuade/leadership
2. Commercial business sense/financial
3. Ability to take helicopter view
4. Problem-spotting/solving ability

5.1 Ability to Persuade/Leadership:

a. Sponsor or client relations
    i. Think about an after-sales service
    ii. Keep the client off the project team's back
    iii. Resolve language and communication barriers

b. Company and management relations
   i. Market the project internally
   ii. Get resources
   iii. Get management support
   iv. Act as a change agent
c. Get people to work together
   i. Team building
   ii. Act as a coach.
d. Create a good job climate
   i. Be effective
   ii. Be enthusiastic and have fun
   iii. Protect the team from blame; share the credit

5.2 Commercial business sense:

a. Get a good deal for their company
   i. Change order control
   ii. Negotiate a favourable contact interpretation
   iii. Get value for money from contractors and suppliers.
b. Get a good deal for the client or sponsor
   i. Manage suppliers and subcontractors
   ii. Get good tender prices
   iii. Ensure that work is done for a good price
   iv. Watch back-charges, return surpluses
   v. Judge impact of changes on cost and schedule
   vi. Get value for money from the company

5.3 Ability to take helicopter view:

a. Don't get too involved in detail; delegate
b. Take action; be decisive
c. Monitor everything
   i. Create an early warning system
   ii. Look ahead for potential problems
d. Be objective
e. Be clear thinking
f. Be unemotive

5.4 Problem spotting and solving ability:

(See Part VI, Sections J and K)

a. Spot problems early
b. Discuss and test alternative solutions
c. Choose a solution
d. Implement the solution
e. Check that it works

5.5 Some of the skills required of the project manager:

a. Motivational and interpersonal skills to lead and drive a team to achieve difficult targets
b. An aptitude to resolve conflicts at organizational interfaces through negotiation and diplomatic skills
c. Good communication and presentation skills
d. Good letter-writing and report-writing capability
e. A proficiency at project appraisal and financial techniques
f. Knowledge of the systems and techniques required for effective project control
g. A capability at planning and managing resources, time schedules, and budgets
h. A thorough knowledge of contracts and the contracting process and how to deal with subcontractors
i. Knowledge of the procurement process and how to negotiate with suppliers
j. An understanding of quality and safety programmes

6 The Project Manager

6.1

The importance of the project manager cannot be overemphasized. They can be the reason for a client awarding a contract to their organization and making the difference between success and failure of a project.

6.2

My analogy for the role of the project manager is the conductor of an orchestra. They know musical theory (project management). They have played and even been skilled in one of the instruments (disciplines) and know something about the other instruments. They have studied the score (plan) and decided what emphasis (objective) to give each section (work package). They know when to bring in each group of instruments (functions) and have fun leading the orchestra (team). They create a successful end product, appreciated by their audience (users).

6.3

One could produce a list of the duties of a project manager, but then one would miss something. Consequently, the duties can best be summarized as doing everything and anything necessary to deliver the project scope, safely, on time, to budget, and to the appropriate quality standards, and to have a happy client.

6.4

With good relationships, the project manager's project management can flourish.

6.5

A final thought: project managers are judged on how they performed on their last project. Consequently, our careers depend on better project management, which starts with improvements to ourselves – the project manager. Keep your continuing professional development (CPD) records up to date.

Section E The Manager of Projects

Most projects are required to report on a monthly basis. One's first thought is that this is a monthly report to the client. However, there is a requirement for a separate internal report focusing on the financial aspects and anything that exposes the company to risk.

The data that will be reviewed will usually be in a company standard format in as concise a format as possible. The manager thus gets used to seeing the same information in the same position on the report. This tends to highlight figures that are outside the norm and makes them more obvious.

1 Financial Situation

1.1 Obtain a clear summary of the project's overall cost status and financial position.

a. *Actual cost incurred to date with the current estimate*. Check that actual cost data is up to date. Some company systems can be slow in allocating costs to a specific project.
b. *Change order status*. The value of changes agreed and any that are in dispute with the client. What is happening with the disputed changes?
c. *Cost trends and variances, with explanations*. It is rare that there are no changes, so be suspicious if everything is stated as being on plan.
d. *Forecast cost to complete compared with plan*. This requires careful scrutiny since project managers are optimistic. They tend to show the forecast to complete as the original budget minus the actual costs. For example: is the forecast of productivity or monthly progress figures to complete the work consistent with the experience to date? If not, are they justified?

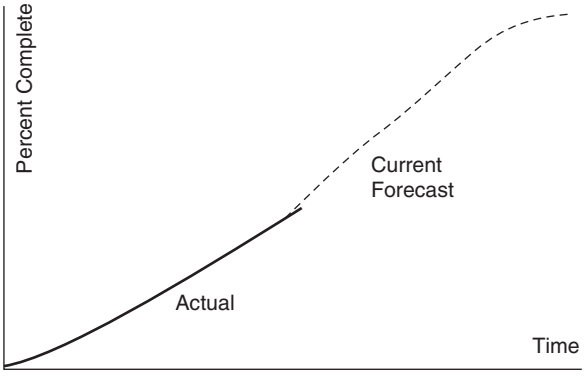
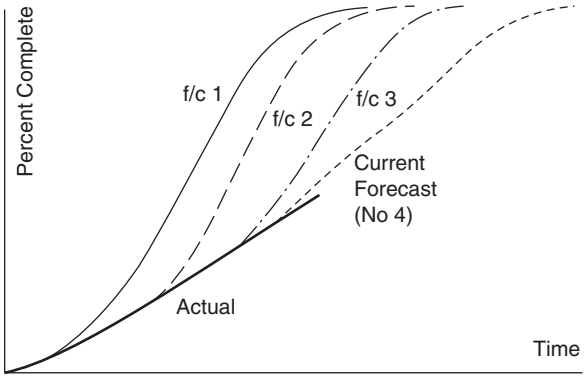


Figure I.E.1

Figure I.E.1 looks a reasonable forecast until you see the history in Figure I.E.2. This is taken from an actual project, and it was my intention to delete forecast f/c 1 since I thought that it might lack credibility. Forecast 1 demonstrates three things: (i) the optimism of project managers mentioned above; (ii) the importance of the launch phase (see Part IV Section A – Figure IV.A.1). and (iii) once the rate of progress is established, it is very difficult to change it. In this instance, the manager of projects

Figure I.E.2



might have accepted f/c 1 on the basis that the project may not have started well, but now that the team has got its act together, progress would take off. However, the rate of progress has not changed, and at f/c 2, the manager of projects must ask, "Tell me what dramatic action are you going to take or what special team building are you going to implement in order to change the rate of progress?" Forecasts 3 and 4 should not be believed, and the forecast project completion can be determined by extrapolating the actual curve.

e. *Contingencies—their status and drawdown plan*. There needs to be a defined and documented basis for retaining contingencies and then releasing surplus contingencies to profit.
f. *Funded liabilities status* (liquidated damages, warranties, plant performance guarantees, and so on). These liabilities can be substantial and can make the difference between a significant profit or a significant loss. They should receive plenty of management attention, especially in the final stages of a project.

1.2 Bonds:

Bonds status, (see Part V Section P, Surety Bonds). Identify the type of bonds that are current. The amount of exposure must be stated together with their expiry dates. However, remember that in some countries, bonds never die.

1.3 Performance incentives status:

Consider the potential for a bonus for achieving targets, as well as the penalties that could be incurred by missing defined objectives. What are the plans for achieving each objective. Are the right team members aware of these objectives?

1.4 Overall payment status:

a. Invoices status; are invoices being submitted on time?
b. What is the amount due for payment, and what is overdue and why? What is the project team doing to expedite the payment from the client?
c. Payment milestones status.
d. If payments are fixed in multiple currencies, how does this compare with the actual mix of currencies in the project cost estimate.

1.5 Profit and cash flow status:

a. Margin or gross margin (overhead and profit) forecast compared with the plan.
b. Cash flow status – if it is negative, when does the project become cash neutral and cash positive?
c. Foreign exchange – Has foreign currency been bought forward? What are the project exchange rates, and what is the variance with actual rates?

2 Scope of Work and Change Orders

2.1

What is the status of client-supplied information that will be relied upon for project execution.

2.2 Changes to scope:

a. Changes identified or requested
b. Changes submitted awaiting approval
c. Changes approved or rejected
d. Cost exposure if work on change orders has commenced ahead of approval. This is a no-no, and the project manager is likely to be reprimanded. Nevertheless, some clients do enforce this in contracts. This situation has to be even more actively managed by the project manager and the implications reported in the monthly report.

2.2.1

Experience shows that the cost of changes is rarely overestimated, and project managers and teams believe they have a greater ability to accommodate changes than is actually the case.

2.2.2

Some contracts may have certain value thresholds, which dictate when change requests must either be started straight away or can allow adjustment to fixed fees. If factors like this exist, then the monthly report needs to identify this status. (See Part III, Section F Contracts, paragraphs 3.7, 3.8 and 3.9.)

3 Project Progress and Status

3.1 Overall project percent complete:

a. Actual percent against plan and compared to the last forecast. This can include performance against early start, late start, contract plan, and internal target plan, depending on company practice.
b. Job to date and incremental monthly progress

c. Main reasons for variance against plan and trends
d. Forecast completion curves and dates

3.1.1
Drill down to a lower level of detail, such as progress by engineering discipline or progress by project area or by process unit. Overall data can mask significant variances and problems at a lower level. (See Part V, Section M 'S' Curves.)

3.2 Resources and Staffing (Home Office and Site):

a. Status of staffing compared to plan
b. Future requirement
c. Critical needs

3.2.1
If additional resources are needed, has the project taken into account the time taken to get these additional resources in planning the future work?

3.3 Technical or engineering status and issues:

a. Key milestones, for example, hazard and operability (HAZOP) review or model reviews
b. Key design parameters, for example, weights and quantities
c. Status of design documentation issued for construction or fabrication
d. Vendor data requirements and status

3.4 Procurement status and issues:

a. Purchase order status (enquired, committed, delivery status, closed out)
b. Equipment delivery status
c. Bulk material delivery status
d. Costs status and trends against budget

3.5 Construction or fabrication status and issues:

a. Construction and other permits status
b. Direct hire progress, productivity, and cost
c. Subcontractors progress, productivity, and cost
d. Subcontractors claims status
e. Cost status and trends against budget
f. Quality control statistics – weld reject rates and so on
g. Labour availability, training, and so on

3.6 Commissioning and plant operations status and issues:

a. Availability of commissioning personnel
b. Number of commissioning/start packs prepared or completed

4 Health, Safety, and Environment

a. Project statistics compared to company targets
b. Leading indicators – accident statistics
c. HS&E programmes/initiatives/training status
d. Safety incentive scheme new initiatives

5 Quality Audits and Status

a. Project set-up, quality, technical and business control audits. Audits have a habit of being put off by project teams due to being too busy. Make sure the project manager schedules them and has them implemented.
b. Engineering office, vendors' work and site.
c. Follow-up and corrective actions.

6 Risk Management

a. Is the risk register maintained and up to date?
b. Risk identification status.
c. Risk memos detailing risk mitigation actions. This should be developed during the proposal phase and then updated during the project. Some 'cold eyes' review may be needed to help the project manager with this. A good approach is to use members of another project to implement this 'cold eyes' review.

7 Client Relations

a. General relationship status. This may be verbal or obtained formally by a scorecard. The project manager needs to be able to provide a summary of the client's opinion or perception as well as their own views.
b. Positioning for future work and projects.
c. Lessons learned. It is important to support future pursuits with the same and different clients and to satisfy third-party quality assessments such as Lloyds insurers, as well as help the company improve its own performance.
d. Claims not covered by the contract change order clause.
e. Other contract issues.

8 Formal Reviews

8.1

There frequently are requirements to provide high level project summaries (commonly called dashboards), which are used at the corporate executive and board meeting level.

Often it is just a sheet or two of key project data. These must be provided in a timely, complete, and accurate manner.

8.2

It is good practice for significant projects (and some 'randomly' chosen others) to have a formal review with a presentation by the project manager and their team. This should take place after about the first six months and then approximately a year later. This can become a significant workload problem for the manager of projects. Delegating this process to the chief executive for major projects helps and smartens up the team. It also becomes a useful mechanism for evaluating the capability of the project manager and their team. Difficult questions that are answered with: "I don't know but will find out and let you know" will be appreciated more than 'waffling'.

9 The Project Management Group

The following two activities give the project management group or department a sense of identity.

9.1

A quarterly project managers' meeting is a useful process for exchanging information, raising internal functional management relationships or conflicts and discussing problems. It also enables the project managers to learn from each other.

9.2

A monthly, bi-monthly, project status description memo (one or two brief paragraphs), covering all projects, helps project managers understand what is going on other projects. In this way they can identify if they are facing similar problems someone else is experiencing and vice versa.

10 Evaluating a Project Manager

10.1

When evaluating a project manager's performance, the project data and performance is only part (albeit a significant part) of the story, and other factors should also be considered.

10.1.1
How is the project performing against the as-sold plan? Is the project performing to plan or even better than plan? If a project is sold with an aggressive cost or schedule, it is possible that even a loss-making project could be a good performance.

10.2 Consider how the project manager interacts with company corporate management.

a. Is the project manager transparent in reporting concerns, issues, and problems? Do they have a tendency to hide project problems and then surprise internal company management or the client when they can no longer hide the problem? It is not uncommon for senior company management to first hear of a problem from the client rather than its own team, which is *never* a good situation.
b. What feedback do you get from a client or your own staff regarding a project manager? Note that complaints about a project manager may not be a bad thing. It may indicate the project manager is doing a good job in protecting the project, so judge the feedback carefully.
c. How does the project manager support other company objectives with their project? Do they support or resist company training requirements, developing people, and providing them with new opportunities? Do they help develop new tools or office capabilities? Ideally, no project should be used as a testing ground for a multiple of new company developments and objectives at the same time. Equally, no project manager should isolate their project from the other needs of the company.
d. What are the project manager's leadership and people management skills like?

11 The Manager of Projects and the Client(s)

11.1

The manager of projects often acts as a corporate sponsor for a project. They interact with a client opposite number at an executive level above the respective project managers.

11.1.1
The biggest danger of this role is that these sponsors start doing the project manager's jobs for them. The manager of projects and their client opposite number need to stay above the day-to-day project issues and activities.

11.2

There should be quarterly sponsors' meetings to review high-level project status, overall business issues and objectives, and so on. The meeting should provide a level of resolution for problems, which could not be reasonably resolved at the project level. Both sets of representatives should be fully briefed and familiar with the current significant issues on the project.

11.3

Issues which can have a significant impact on the outcome of the project or impact the client or contractor's business interests should always be made known to the sponsors.

11.4

The manager of projects role needs to be recognised as one of the key relationship management roles between contractor and client.

Section F The Owner and Client

There is no doubt that the client or owner as initiator of the project bears a major burden in making the project a success. The key initiatives that are essential and that the client project manager must be deeply involved with are:

- To identify very clearly the scope of work for the project and what, exactly, is to be delivered (see Part IV, Section F Scope).
- To determine the most appropriate contracting strategy to be used to effectively deliver the scope of work for the project (see Part III Section B Contracting Strategy Considerations).
- To pick the team, design the organizational structure, and identify the skills required to manage the contracts selected (see Part V, Section Q, subsection1, Selecting the Team).
- The project manager then has to provide the leadership and guidance, which will allow the selected team to deliver the project safely, on schedule, and at the lowest possible cost (see Part VI, Section B Leadership and the earlier Section D on The Project Management Role).

1 Some Fundamentals

1.1

Ensure that the contractor's (and your own) safety culture is aligned to your expectations and actively maintained at all times.

1.2

Agree on the level of contractor resources to be provided. Put penalties in place to ensure key personnel are maintained.

1.3

Clearly identify all deliverables and exactly what form they will take.

1.4

Document control and project reporting are boring subjects to most people but critical to project success. Agree exactly how these will be managed, produce a master document register and determine distribution early in the game.

1.5

Be clear about any special client-imposed studies and when they should be carried out. These might include hazard and operability studies, hazard identification studies (HAZIDS), and project safety and environmental reviews (PHSERS).

1.6

Ensure that operation's (the user's) input is available from the beginning. Get operations personnel in the project team on a full-time basis.

1.7

Where design contractors are concerned, do constructability reviews. Have the construction contractor review the design for 'constructability'. This is very important when you consider that 10 to 15 per cent of a project's budget is in the design cost and 40 per cent to 50 per cent is in construction costs. Thus, it is essential that construction efficiency is at the forefront of the project manager's thoughts. This also reduces construction changes and variation requests.

1.8

A very clear statement of requirements (comprising the scope and the deliverables) must be developed at the beginning of the project.

1.9

A detailed basis of design must also be developed. At this point it is essential to make clear the requirements for standards, codes of practice, and any special owner company requirements in addition to the normal codes. For example, most experienced clients will have their own design practices that have to be used on all their projects. This is in order to facilitate consistent spares and maintenance procedures.

1.10

There must also be a clear understanding of any regulator's requirements, for example: the health and safety executive, Lloyds insurance, and so on. In other countries, say Norway, there is the Petroleum Safety Authority, Petroleum Directorate, and so on. There will be something similar in other countries.

1.11

Make sure you understand exactly what is in the contractor's overheads and what is in the preliminaries. Also, what the ratio is for productive work to nonproductive work.

1.12

Client team members must actively think about the impact of everything they do and evaluate every action in terms of its effect on the money on the bottom line.

1.13

Authority levels, together with roles and responsibilities, must be clearly understood and approved. Individual team members must recognize and comprehend what it means to be professional in whatever role they fulfil, be it an electrical engineer or an accountant.

1.14

Lines of reporting and communication must also be agreed and understood by all concerned. The client team members must listen and learn to hear what is not being said.

2 Cost and Planning

2.1

The cost estimate must be of a high standard prior to project sanction. Most clients normally aim for a + or –15 per cent accuracy pre-sanction.

2.2

A detailed plan is also needed with a clear understanding of the critical path.

2.3

The planners are the people who should really drive the job. They need to be aware of exactly what time and resources are required for every activity to complete the job and should be on everyone's back to make sure the contractor is performing the right actions at any particular moment to keep the project on track.

2.3.1
Many of the planners are not much more than reporters who tell the client what has been done, rather than what needs to be done. The planner should be like the man who sits on the platform at the end of the Roman galley, beating the rhythm for the rowers to get to where they need to be.

3 Things to Watch

3.1

The quality discipline comprises both quality assurance (QA) and quality control (QC). Client personnel can produce new processes like no one else on earth, and they are good at it (even though there is far too much of it). This is the QA piece.

3.2

The QC part is about the application of the QA procedures, and this is the part that clients tend to fail on. There are numerous examples both in manufacture of materials, equipment, and in the fabrication or construction yards of poor quality. The client must tackle this problem. Project managers must have QC very high on their radar.

3.3

Do not place orders for major equipment packages too early. Design development must be sufficiently progressed to allow orders to be placed without the fear of many changes.

These late changes have a serious impact on the construction programme because of late delivery, late vendor data, and so on.

3.4

Do not start construction too early (before the contractor is ready), which again results in changes and variation orders.

3.5

There always seems to be pressure to place orders and start cutting steel (particularly in the offshore industry) as soon as possible. Project managers must have the courage to hold their fire until they can really 'see the whites of the eyes', so to speak.

3.6

It is worth repeating: do not place long lead equipment orders too soon and do not start constructing too soon because both these things lead to delay and extra cost.

3.7

A client project manager, when under pressure, may want to take over the project execution manager's role!

4 Most Important of All – Safety

4.1

This really has to be at the forefront of the project manager's thoughts at all times.

4.2

Good safety is good business.

4.3

A safe team becomes happy team, a happy team becomes a confident team, a confident team becomes an efficient team, and an efficient team is good for business.

4.4

Poor safety (as some client's know well) wrecks lives, is bad for reputation and brand, damages the revenue stream, and costs extra capital.

4.5

Bad safety is bad for business.

Section G Achieving Success

In defining success, one has to distinguish between success of the project and success of the project management function.

In any company with an established project management culture, the success of the project management process will be measured by beating or meeting the project objectives of safety, quality, time and cost (with a happy client). "If you can get safety, quality and schedule right, then cost (and reputation) is largely taken care of."[18] Success of the project will focus on meeting the financial returns and benefits. In other words, does the project perform as expected? From a contractor's perspective, they will want to have made a profit and, in the longer term, have established a good relationship with the client for repeat work. You are most likely to achieve this if you start the job right and do the job right. Nevertheless, owing to the diversity of the views of stakeholders, one is unlikely to satisfy all the people involved.

Project success will be measured differently, depending on the project phase. In the early phases, there will be strong external pressures (see Figure I.G.1), and success will be judged on financial and cost issues. As the project moves into the execution phases (the most sensitive to failure issues), the project and project manager will be judged on meeting time deadlines. Finally at the end of the project, commissioning and setting to work, it will be all about quality. At start up, it either works or it doesn't. Unfortunately, the quality element should have been built in to the early execution stages when the project is under pressure to meet time deadlines.

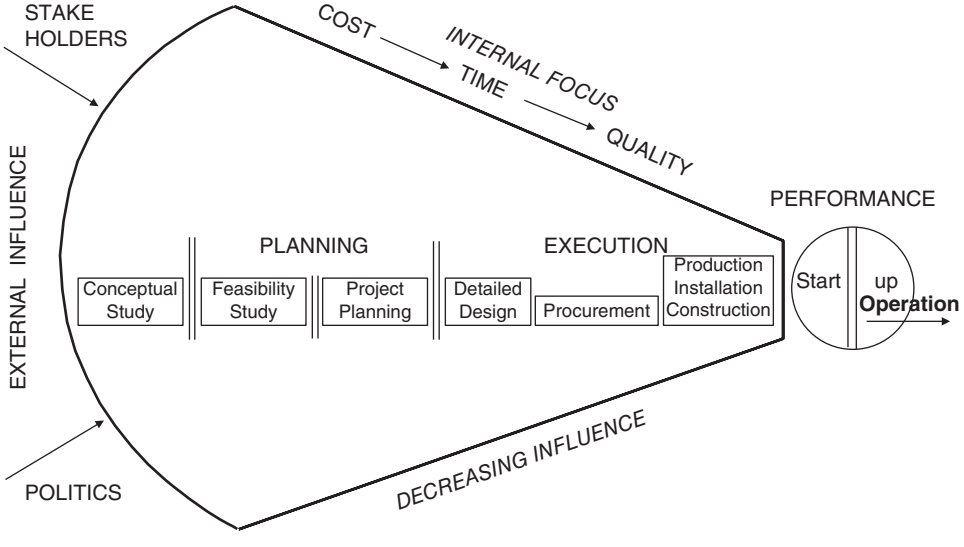


Figure I.G.1

If a project is cancelled or terminated prematurely, then success will be measured by the effectiveness and efficiency of how well the project is closed down: terminating

18 Patrick McHugh, see the Acknowledgements.

expenditure, cancelling purchases, reducing manpower and stopping man hour bookings, and so on.

In January 2000 I wrote a paper ('Disconnected Project Management') for the International Project Management Association 15th World Congress on Project Management, held in London in May of that year. In that paper I wrote:

> Project Management does not always work. Data often quoted by the Industrial Society indicates that 77 per cent of projects in the UK fail. In the U.S. this figure is worse at 83 per cent. For specific sectors the statistics are horrific: only 7 per cent of business process redesign projects and 3 per cent of IT projects succeed. Further, 80 per cent of companies that failed had no Project Management infrastructure. The Industrial Society quotes the following reasons for project failure:

Inadequate definition	Inappropriate team
Poor or no planning	Ineffective controls
Wrong leader	Poor communication.
Scope not defined	Unrealistic timescale

> These are similar, but different, issues to many other lists.[19] For example, The Business Round Table in the U.S. states that the poor definition of project scope is the primary cause of cost over-runs followed by the loss of control during design and execution.
> By contrast, W.Belassi and O.I.Tukel quote seven lists of critical success factors from .... [leading authors on the subject over almost a thirty year period]. Space does not permit providing details of these lists but, broadly, they are the positive and opposites of the causes of failure. The interesting feature of the lists is that there is almost no commonality of issues. Out of a total of 61 issues only 3 appeared in four of the lists and only one was mentioned specifically 5 times. Allowing for the different terminology, this issue - project controls, could be said to have 10 mentions (but despite this did not appear in all of the lists). The author's own primary prerequisite for project success namely: 'Alignment of Objectives' is only mentioned three times in a variety of forms as: 'definition of clear goals and objectives.' Anyone who has played any version of 'The Prisoner's Dilemma' will know how important the 'alignment' part is and that personal objectives will always carry more weight because of the fact that they are in the control of the individual. Thus, whilst the literature has identified the *causes* of project success or failure, it has not satisfactorily explained the *reasons* behind these causes to help us find ways of dealing with the issues.

Having collected lists of success factors from various sources over the years, it is difficult to disagree with any of them. Whilst there is some commonality to the issues in the lists, the emphasis tends to be on the negative side and their description probably reflects the deficiencies and difficulties within the organizations that produced them.

19 Survey results (*The Times Raconteur* supplement, 2/8/2015 – source PMI 2015) for the causes of project failure, in the twelve months prior to publication, show little change in the reasons and their diversity.

Analysis of the lists shows that the reasons for success and the causes of failure can all be grouped into one of John Adair's three elements: task, team, or individual. In projects that fail, one of these elements has been exaggerated at the expense of the other two. Alternatively, one has not been given sufficient attention. Despite this, the conclusion is that it is the basic task issues that are the main problem, which are primarily the project manager's responsibility.

I have been fortunate in that I have spent my hands-on project management experience in organizations with a strong project-management culture, namely, good corporate policies, management procedures, regular thorough reviews and having well-developed systems, tools and techniques. There has always been a total commitment to project success of delivering the client's scope within cost and time targets with the right quality of performance and finally, having a happy client. My career, salary, and bonus depended on achieving these targets, and it was usually challenging, interesting, and fun. I have always regarded a strong project management culture as a prerequisite to success.

Research commissioned by the APM[20] resulted in a report identifying five factors: "As a formula for success; get these right and the rest should follow". Namely:

1. Thorough project planning and review (interestingly this factor was least present in the projects surveyed)
2. Clearly specified and recognised goals and objectives
3. Effective governance with clear reporting and regular communication
4. Project professionals forming a competent project team
5. All parties involved must have commitment to project success.[21]

I think that it is fair to say that the APM research was dominated by systems and services – soft projects. My experience has been primarily physical and technological – hard projects. Now that I have an opportunity[22] to review the APM results with my own experience, it is interesting to see the compelling correlation between them and identify that there is no difference between the success factors for soft or hard projects.

In looking at why some projects succeed and some fail, it is assumed that the prerequisites mentioned above, as well as all the basics, are in place. We know what we are supposed to be creating, by when, and for how much, and (if we are a contractor) we have a contract to do so approved by all the lawyers and senior managers and so on. But still, some go well (succeed) and some don't (fail). Why? What are the essential issues? My analysis in the remainder of this section is on trying to understand what is not usually covered elsewhere, namely the practicalities that shape and influence the achievement of the success factors. It is based on my experience as a hands-on project manager and from what I have learnt as a consultant and from teaching project management, including ten years as director of a master's course.

---

20 'Factors in project success', prepared by BMG Research, November 2014 and 'Conditions for project success, APM research report' 2015.

21 The remaining factors are: capable sponsors [clients] play an active role; A secure funding base; supportive organizations; end users and operators are engaged; competent project teams; aligned supply chain; proven methods and tools; and appropriate standards.

22 I have to emphasize that this section on success (apart from these paragraphs on the APM) was written before the APM report was published.

1 The Project Management

1.1

The primary tool for project success is the project management itself. As already indicated in studying the literature on success and failure, all the failure elements are mostly down to how the project management was implemented.

a. The secret to success of an organization is to break the project down and turn the processes into less-complex types. That is, turn strangers into repeaters, turn repeaters into runners, and turn runners into routines. (See the beginning of Section A).
b. As already mentioned, nobody manages a large project; you should manage a series of small projects. Use the product breakdown structure and delegate sections to different project leaders.

1.2

Each participating entity in the venture (owner, co-owners, contractor, joint venture partners, etc.) must have a person or persons at board level nominated as a sponsor,[23] who stay for the duration of the project. They must have a specific interest and knowledge of the work, and they must make a significant contribution to the success of the project.

1.3

The structure of the project management function can be a major contributing factor to project failure. At one extreme is a project manager reporting to a director of projects who is managing a complex organization. At the other extreme is a similar structure but, in addition, they are also reporting to a steering committee representing different organizations with different objectives as well as trying to get a user committee or handover board to agree amongst themselves. (See paragraphs 3.4 and 3.5, Involvement of Users, below.)

a. "In the view of several of the Computerisation of PAYE's [COP] senior management, the Steering Committee was the single most important reason for the success of the project."[24] Until recently COP was the only large government information technology project that had been successful, due to the project manager and how he fulfilled the project management process.
b. The complexity or the size of the client team influences the communication process and thus the chances of success. Further, some industries and businesses create really complex client/user – contractor interfaces.
c. Do not underestimate the difficulty of the communication process between you, the contractor, and the client. Add to that the difficulty of communicating between

23 The Project Management Institute's 2015 'Pulse of the Profession Study,' confirms that actively engaged sponsors are the top drivers of projects meeting their original goals and business intent.
24 Extract from a case written by Dr Peter W. G. Morris, Major Projects Association, Oxford. See also footnote 13.

the project manager and line management. Do not forget the interface between the project manager and the project team.

d. Experience shows that relatively few businesses understand the roles and responsibilities within the matrix organization. Make sure that the functional managers fulfil their obligations, as part of the matrix organization and accept responsibility for the quality of the technology. Make use of the benefits of project audits.
e. Once construction starts, the role of the project manager can become severely compromised (see Part IV, Section Q Installation & Construction, paragraph 4.2) since construction can take control by being in direct contact with the client. If the project manager wants to maintain control, then they must move to where the client is. This will mean leaving a deputy to finish off work in the home office.

1.4

Naturally, a key element is the project manager. The management style and competence of the project manager will have a big effect on how the team reacts to their leadership. The project manager *must* establish command and trust and inject energy and enthusiasm.

a. Learn to manage upwards. Make sure that your boss clearly understands when you want help and when you do not want them to interfere.
b. Don't hide problems. Tell your boss everything. If you don't, they will talk to their opposite number in the client organization and make decisions that you won't like, through lack of information.
c. If personnel have to be removed, then so should the opposite number in the client team. This is particularly true of the project managers. Otherwise, if only one party is replaced, then the new person is always at a disadvantage.
d. As stated in Section D The Project Management Role, paragraph 2.8.3, a project champion will be needed for internal projects.

1.5

Management may want to have people released for a new prospect or other reasons. Consequently, identify replacements and plan for the second-in-command to take over. If you want to move onwards and upwards, you had better have a fully trained deputy to take over (see Section D, paragraph 2.8.1).

2 Alignment of Objectives and Client-Contractor Relations

2.1

A project that is a war zone will fail. Some conflict is inevitable since contractors and clients do not have common interests – not in the real world anyway. The contract hasn't been written yet that truly merges contractor and client interests. Nevertheless, it must be assumed that at the corporate level there is a common cause for the project to be a success.

2.2

At the project manager level, the client project manager has to demonstrate (to their superiors, of course) that he or she is being tough with the contractor and getting value for money. Conversely, the contractor has to demonstrate (to their superiors) that things are not being given away. However, this can be done professionally without endangering the relationship.

2.3

The project manager must develop a personal relationship with their opposite number. Similarly, the project manager's supervisor must establish a relationship with their opposite number in the client organization. At least at these levels, there can be a common objective to make the project a success. The client project manager is dependent on the contractor for their success, and the contractor needs the client for career enhancement and future business.

2.4

Most individuals will have hidden agendas. As already mentioned the personal objectives will always carry more weight because of the fact that they are in the control of the individual.

2.4.1
Pick a team where the individuals will fulfil their private agenda by completing a specific role or job within a successful project (see Part V, Section Q, subsection 1. Selecting the Team).

2.5

Be sure every team member understands and is committed to the project objectives.

2.6

See Part IV, Section E Client Relations.

3 Involvement of Users

3.1

The term *user* is usually utilized to identify the end-user operators of a facility. However, the term can also be utilized to indicate the next party in the work process chain, who uses the work produced from the previous function. Thus, involvement of the users is necessary to get them to buy into what they will be taking over. For example, manufacturers and the construction people are the users of the design. It is, therefore, crucial that the construction manager is involved in the early design process. See Part IV, Section Q Installation & Construction, paragraph 1.3 and 1.3.1.

3.1.1
For prestigious building projects, the involvement of the users is achieved by having a design competition. The public is then invited to contribute their comments, or alternatively a consultation survey is carried out.

3.1.2
For infrastructure and development projects, it may be necessary to develop an ongoing relationship with the local community. Issue a regular newsletter to demonstrate that you are listening to their concerns.

3.2

Similarly, the commissioning team will need to be involved in the early design stages in order to explain the sequence in which the facility will be set to work.

3.3

Both types of user need to be involved in the early project formulation stage. Using/contracting another party or organization for the execution stage (as is customary) introduces a potential barrier to success.

3.4

For some types of projects (for example, information technology) it is sometimes necessary to create a user committee to represent the views of the various departments and functions that will be operating the system.

3.5

Similarly, for projects with multiple groups of end users, it is necessary to have a handover board made up of representatives from each group. This enables the project management function to defuse complaints from individuals.

3.6

The foregoing paragraphs address involving the users at a management level of the project process. However, the principle also applies at the designer/construction worker level. Problems occur because the person who designs or constructs an item only performs to meet the requirements of their particular task. They don't necessarily care about matching up with or fitting the subsequent step. We try to overcome this problem with combinations of work at the higher level (for example: design, supply, and fabricate; fabricate and install; design and build; and so on), but the problem still exists at the lower trade levels.

3.7

See Section F The Owner and Client, Paragraph 1.6. Also, Part III, Section B Contracting Strategy Considerations, paragraphs 5.7 and 5.13.

4 Get and Build the Right Team with Clear Roles and Responsibilities

4.1

Push for resources – get the right people. Build a team that has the skills, experience, and behaviours required for the job. Your success depends on the teamwork of the people you chose. Without the right people, it will be ten times more difficult.

4.2

The reality is that the functional managers will offload who they can. Get rid of the dead wood. The team must have mutual respect.

4.3

Roles and responsibilities must be clearly defined.

4.3.1

After you have chosen a key team member, explain (on a one-to-one basis) why they were chosen as the right person for the position. Clarify with them your and their understanding of the responsibilities of the role.

4.4

Explain to the individual what your expectations are of them in the project role.

4.5

Find the expert who is the key to the technological issues.

4.6

See Part V, Section Q for Selecting and Building the team. Also see Part IV, Section D, Mobilisation.

5 Clear and Complete Scope Definition

5.1

For internal projects, it is essential to get a clear brief at the start. Software projects need clarity of what is to be achieved. Physical projects need clear and complete scope definition.

5.2

As already stated The Business Round Table in the United States says that the poor definition of project scope is the primary cause of cost overruns.

5.3

Develop the scope using a product breakdown structure and work breakdown structure in a team process.

5.4

Specifications are difficult to write, and technical people need to improve their aptitude with words. Avoid the tendency to use generic language for descriptions. Be more specific. Do not use words that keep options open and allow for improvements as the project develops.

5.5

For clarity, use 'negative specifications' stating what is not included.

5.6

Know the scope of work, and be sure you have all the necessary information, materials, and tools.

5.7

See Part IV, Section F, Scope.

6 Thorough Planning of the Work

6.1

I now think that planning is the overall key to success (and the feasibility stage must be regarded as part of the planning process), firstly, because all the other aspects that I have listed could be said to be encompassed within the holistic concept of planning. Secondly, examination of the evidence indicates that projects that are extensively and thoroughly planned by having an extended planning phase usually start right. If a project starts right, it will more than likely continue successfully.

6.1.1

The Computerisation of PAYE project (mentined in 1.3.a above) carried out a pre-feasibility as well as a full feasibility study that took over two and a half years to complete and 'the feasibility plan contained an implementation plan of unusual detail'.

The Land Speed Record Thrust SSC project achieved its objective in one day but was planned for six years.

Sir Ranulph Fiennes' journey around the earth's polar axis, using only land transport, took three years but was planned for seven years.

6.1.2

The above projects should be contrasted with the United Kingdom's Nimrod Airborne Early Warning System, the AEW project of the 1980s which compromised the feasibility stages in order to save time and consequently was late, overran the budget, and was abandoned.

6.1.3

The problem for commercial projects is the conflict between spending time in the planning phases against the benefits and financial returns to be obtained by finishing earlier.

6.2

Nevertheless, the project manager *must* start out from the assumption that the plan produced in the initial (feasibility study or particularly the tender) stage may well contain dangerous nonsense.

6.3

A project, even at the proposal or feasibility stage, must be planned to a Level 3 network degree of detail.

6.4

Get buy-in to an achievable end date. Review the schedule with all key members of the project team and obtain their agreement to it – preferably in writing. Get their commitment.

6.5

The tricky bit is how to amend the plan, realistically, to what everyone wants. Whatever is done must be written down and incorporated into the contract (and paid for!) – *state that the schedule can be achieved, provided that such and such is done*.

6.6

See Part IV, Section J, Planning and Scheduling.

7 Planning Communications

7.1

Surveys show that communication is the biggest problem in all organizations. This is because they have not been planned. A lawyer will treat an interaction with another party as a project, and they will plan their communication strategy.

7.2

Agree on how each communication mechanism will be used on the project.

7.3

Circulate information religiously and appropriately. Don't clog up people's in-trays (real or virtual) with unnecessary documents.

7.4

See Part VI, Section A Communications and Section E Personal Skills.

8 The Efficiency of the Project Launch Phase

8.1

The challenge is to allow time for planning the launch phase so that overall time is saved. A well-organized project management department will have developed a skeleton project launch programme (many of the issues during the launch phase are common to all projects) in order to save time.

8.2

Persuade the client to issue a letter of intent/instruction (see Part III Section F, Contracts, subsection 1 Starting work) that gives *authorisation* to initiate work and be paid for an agreed list of activities. The list should include pre-ordering/reserving manufacturing capacity for long lead material and equipment items.

8.2.1
Ideally, use members from the winning proposal team to set up the infrastructure of the project whilst the project team is being mobilised.

8.3

Make maximum use of the team's initial motivation and enthusiasm.

8.4

Good team building should enable the straight line portion of the 'progress' curve to be achieved early.

8.5

If the launch phase is effective and efficient, there is a significantly greater chance that the following work will go according to plan.

8.6

Do not use up project float at the front-end. Float is for when it is needed at the end of the project.

8.7

See Part IV, Section A, Project Launch.

9 Change Control

9.1

As already stated The Business Round Table in the United States says that the loss of control during design and execution is the second cause of project cost overruns.

9.2

Changes are inevitable. The business environment will change, and this will impact on the project. However, be rigorous about resisting 'nice-to-have extras' that were eliminated during the initial evaluation of the project's viability (see Section A, paragraph 1.5).

9.3

A *rigorous* and equitable change control procedure is essential for success.

9.3.1
'The management team's approach should be to discourage changes of any sort. Only alterations which are necessary for safety or to make the facility work or essential to facilitate construction should be agreed'.[25] One should add: or which conflict with regulations.

9.3.2
'The great emphasis on change control must be mentioned as key to the success of the Computerisation of PAYE project'.[26]

9.4

See Part IV, Section L, Variations/Changes/Claims.

10 Effective Decision Making

10.1

Project control is achieved by the decisions that the project manager makes.

10.2

Decision-making involves experience and judgement together with pertinent and timely information. The experience and judgement is a function of the capability of the project manager, and the pertinent information will have been determined in setting up the project control system. The timely element is a function of the efficiency of the reporting system.

---

25 Slightly edited extract from 'A case study of the construction of a terephthalic acid plant for Imperial Chemicals Limited, Wilton, UK'. Project Managed by Dr Roy Whittacker. *Construction Management and Economics*, 1983, 1, 57–74.
26 See footnotes 23 and 13.

10.3

Timely information can be provided (to three decimal places!) by crunching mega quantities of data, using artificial intelligence (AI). Just don't lose sight of the rules of thumb that you should be familiar with, and apply to your particular technology.

10.4

An average decision well timed is better than a good decision badly timed.

11 Tackle Things Today – Tomorrow They Will Be Bigger

11.1

Chase progress relentlessly.

11.2

Check costs regularly.

12 Conclusions for Success

Success is the ability to go from failure to failure without losing your enthusiasm.
Winston Churchill

12.1

Understandably, we always know more in the future and are, therefore, more often than not perceived to have failed. Consequently, start promoting the success of the project right from the start of the project. Publicise successful milestone achievements.

12.2

We can deduce from all of the above that project management is a demanding discipline. Putting all people's success and failure lists together; we would find that the final compilation would include every aspect of project management. Consequently, if you fail in any aspect, the project is likely to fail. Conversely, to succeed, you have to do everything right!