ONE
Concepts of Project Management

Project management is fast becoming an exciting new profession. Project managers are in great demand. They may be required for a publishing house, a university, agricultural rural development, social work or industrial construction projects. It appears they are required wherever there is work. Project management seems to have captured the attention of all those who are looking for results. The prospects were not so bright some years ago. For that matter, even now, none of the universities in India offer a full-fledged degree course in project management. This necessarily poses a problem. What a project manager does in Company 'X' is not the same as what another does in Company 'Y'. Today anyone holding a responsible position in a project is a Project Manager—and if he pursues his own style in discharging his so-called project management responsibilities, he can hardly be blamed.

CONCEPT OF A PROJECT

To understand project management we must first understand what a project really is. We hear of cement projects, power projects, refinery projects, fertilizer projects, etc., but while the term project is common to all of them, the plants are not. In each case the project is for the plant but as soon as the plant is operational, the project is deemed to be completed. Similar is the case with any other project—say a project for methods improvement. The project is complete when methods improvement has been achieved. The explicit use of the term 'project' is not always necessary, even then it could be considered a project—our Lok Sabha election is such an example.

A project, therefore, is not a physical objective, nor is it the end-result—it has something to do with the goings-on in between, which must be same, whether we build a high technology process plant or merely hold an election, to deserve a common name and to be termed as a project.

To understand what a project is, let us study how a project is conceived. In a business setting, whether in the public or private sector, an organisation must grow at least for the sake of its survival. The organisation, therefore, is continuously on the lookout for good business ideas which may require growth, either on the existing lines of business or in diversified areas. But the idea must be technically feasible, economically viable, politically suitable and socially acceptable. Once the ideas pass these tests, an investment proposal is made. When the investment proposal is approved, the project commences.

A project is, thus, initiated to achieve a mission—whatever the mission may be. A project

is completed as soon as the mission is fulfilled. The project lives between these two cut-off points and, therefore, this time-span is known as *project life cycle*.

What then is a project? It starts from scratch with a definite mission, generates activities involving a variety of human and non-human resources all directed towards fulfilment of the mission and stops once the mission is fulfilled. The Project Management Institute, U.S.A. has a good definition for it. A project, according to the Institute, is a one-shot, time-limited, goal-directed, major undertaking, requiring the commitment of varied skills and resources." It also describes a project as "a combination of human and non-human resources pooled together in a temporary organisation to achieve a specific purpose." The purpose and the set of activities which can achieve that purpose distinguish one project from another.

CHARACTERISTICS OF A PROJECT

A project is typified by its various characteristics. To start with, a project is a big work—but it is basically *a work*—one whole thing. This means that while there may be contributions from many different people, it can still be recognised as one whole thing. A comparison can be made with a book to fully understand it. While there may be many chapters in the book, sometimes written by different authors, the book is a single entity and is supposed to serve a single purpose. The various works that constitute the whole are inter-related and together they tell the whole story. In the same way, all works that are inter-related and are being performed to serve a common purpose can be grouped together and termed as a *project*, only if it could be made into a composite affair. When this approach for grouping of work is used in any work environment, we may say that work has been 'projectised'.

With a project, we have seen that there is a concept of wholeness despite diversities of work. The concept of wholeness does, of course, exist in a factory, an office or in any other work situation also. The difference is that in case of a project the *whole* has to be completed in one shot—once and for all. It is not a process that can perpetuate. It can, of course, be repeated but only in blocks of *whole*, similar to *batch* mode of production in a factory.

Also, with a project there is some sort of a missionary zeal, an unknown force, pushing people forward for achievement of something beyond their immediate work. The completion of one's own work, and whatever it may result in, does not seem to be what one is really working for in a project. One would never say that one's project is complete till the *whole thing* is complete and is performing satisfactorily. That is the spirit of the project, which makes everyone feel important, contributing to a big cause, though in reality he may actually be a very small cog in the big wheel of the project.

The special features of a project that would differentiate it from any other ongoing activity, say production, can be summarised as in Table 1.1.

Project Family Tree

A project normally originates from a plan—national plan or corporate plan. In the normal scheme of things, the family tree for a project would be as in Fig. 1.1. Sometimes, however, the term project may be used for what should be termed as programme or work package. This is not quite unexpected in view of their closeness in the hierarchy. A programme is not the same thing as a project; for one thing, it is not time limited like a project and also its scope and boundaries are not so well delineated. It is, however, another thing that the approach for management of programmes may be the same as that for a project.

TABLE 1.1 Characteristic features of a project

S. No.		*Characteristic Features*
1.	Objectives	A project has a fixed set of objectives. Once the objectives have been achieved, the project ceases to exist.
2.	Life span	A project cannot continue endlessly. It has to come to an end. What represents the end would normally be spelt out in the set of objectives.
3.	Single entity	A project is one entity and is normally entrusted to one responsibility centre while the participants in the project are many.
4.	Team work	A project calls for team work—the team again is constituted of members belonging to different disciplines, organisations and even countries.
5.	Life cycle	A project has a life cycle reflected by growth, maturity and decay. It has, naturally, a learning component.
6.	Uniqueness	No two projects are exactly similar even if the plants are exactly identical or are merely duplicated. The location, the infrastructure, the agencies and the people make each project unique.
7.	Change	A project sees many changes throughout its life. While some of these changes may not have any major impact, there can be some changes which will change the entire character or course of the project.
8.	Successive principle	What is going to happen during the life cycle of a project is not fully known at any stage. The details get finalised successively with the passage of time. More is known about a project when it enters the construction phase than what was known, say, during the detailed engineering phase.
9.	Made to order	A project is always made to the order of its customer. The customer stipulates various requirements and puts constraints within which the project must be executed.
10.	Unity in diversity	A project is a complex set of thousands of varieties. The varieties are in terms of technology, equipment and materials, machinery and people, work culture and ethics. But they remain inter-related and unless this is so they either do not belong to the project or will never allow the project to be completed.
11.	High level of sub-contracting	A high percentage of the work in a project is done through contractors. The more the complexity of the project, the more will be the extent of contracting. Normally around 80% of the work in a project is done through sub-contractors.
12	Risk and uncertainty	Every project has risk and uncertainty associated with it. The degree of risk and uncertainty will depend on how a project has passed through its various life-cycle phases. An ill-defined project will have extremely high degree of risk and uncertainty. Risk and uncertainty are not part and parcel of only R & D projects—there simply cannot be a project without any risk and uncertainty.

Plan	National/Corporate plan with targets for growth.
↓	
Programme	Health programme, educational programme, science and technology programme.
↓	
Project	Power plants, schools, hospitals, housing projects.
↓	
Work Package	Water supply and distribution package, power supply and distribution package.
↓	
Task	Award of water supply contract, construction of foundations.
↓	
Activity	Excavation, laying of cable, preparation of drawings, preparation of specifications.

FIG. 1.1 Project family tree

Similarly, a work package is not a project though it may be so treated for the purpose of its management. Several work packages will constitute a project. A work package, however, has to be time limited as there is absolutely no ambiguity regarding its scope and boundaries.

Categories of Project

Much of what the project will comprise and consequently its management will depend on the category it belongs to. The location, type, technology, size, scope and speed are normally the factors which determine the effort needed in executing a project. Figure 1.2 shows the various categories into which industrial projects may be fitted. A grass root mega-high technology project is not the same thing as a modification work in a low technology mini plant--though both will be seen as projects. Therefore, though characteristics of all projects are the same, they cannot be treated alike. An R & D project even though value-wise it may belong to the mini category, it must not receive the same attention as a low-technology mini plant. Recognition of this distinction is important for management of project. Projects are often categorised in terms of their speed of implementation. Management of disaster projects, as in the case of the Bhopal gas tragedy, would not belong to the same category as that of

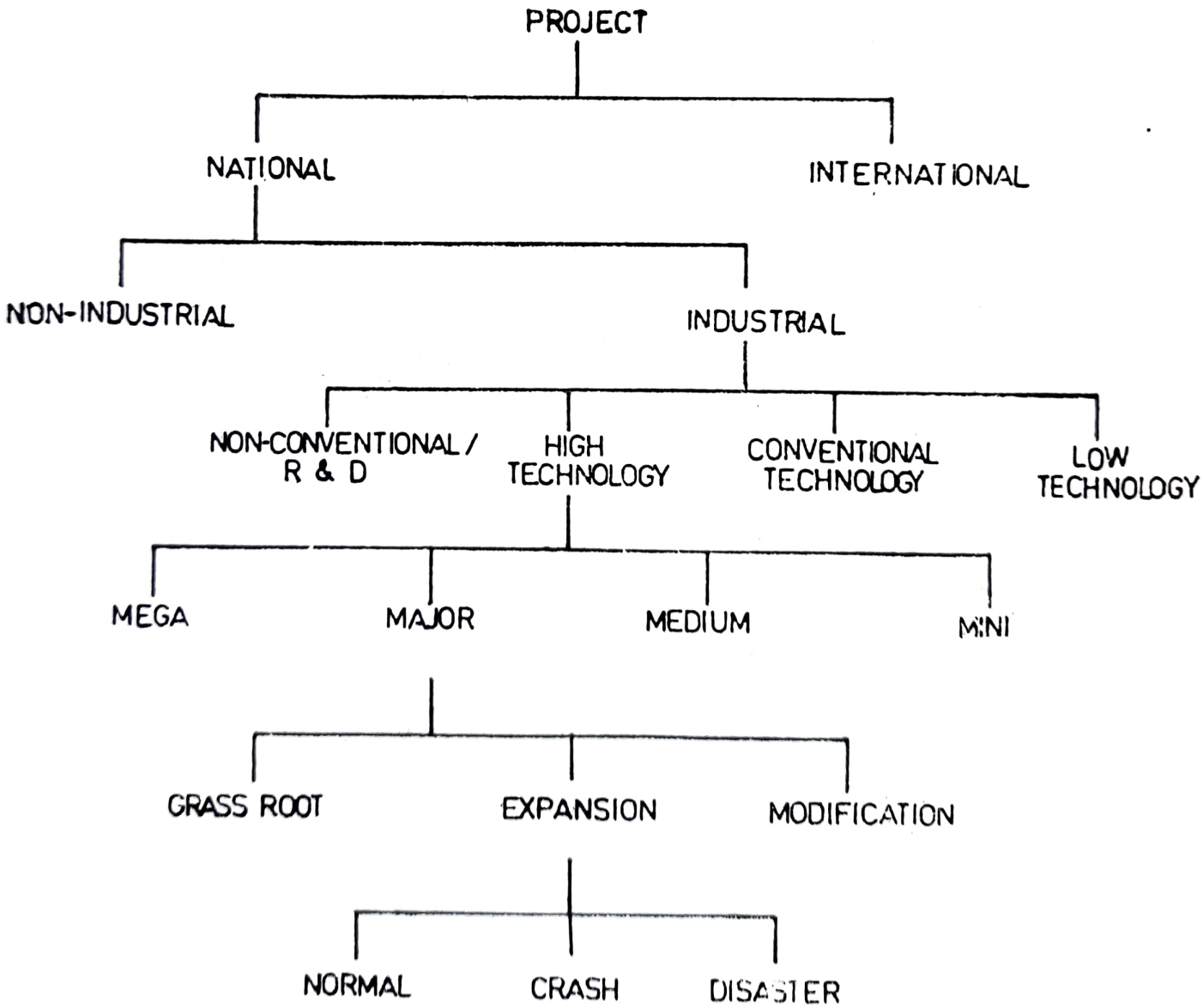


FIG. 1.2 Categories of projects

putting up a plant in a normal situation—say, the same insecticide plant itself. The Asiad project is another example which was not exactly normal and illustrates the point that any another project would not be executed in the same way. Depending on the speed needed for execution of a project, there can be further categorisation as below:

Normal Projects In this category of projects adequate time is allowed for implementation of the project. All the phases in a project are allowed to take the time they should normally take. This type of project will require minimum capital cost and no sacrifice in terms of quality.

Crash Projects In this category of projects additional capital costs are incurred to gain time. Maximum overlapping of phases is encouraged and compromises in terms of quality are also not ruled out. Savings in time are normally achieved in procurement and construction where time is bought from the vendors and contractors by paying extra money to them.

Disaster Projects Anything needed to gain time is allowed in these projects. Engineering is limited to make them work. Vendors who can supply 'yesterday' are selected—irrespective of the cost. Quality short of failure level is accepted. No competitive bidding is resorted to. Round-the-clock work is done at the construction site. Naturally, capital cost will go up very high, but project time will get drastically reduced.

PROJECT LIFE CYCLE PHASES

The attention that a particular project receives is again not uniformly distributed throughout its life span, but varies from phase to phase. At a particular phase of project life, depending on the requirement of that phase, appropriate attention has to be paid. We, therefore, need to know the various phases in the life of a project. By and large, all projects have to pass through the following five phases:

1. Conception phase
2. Definition phase
3. Planning and organising phase
4. Implementation phase
5. Project clean-up phase

While ideally these phases should follow one another in sequence, this rarely happens in real life. Not only do the succeeding phases overlap with the preceding ones, it is also not too uncommon to find complete overlap of all the phases. Sometimes this overlapping is done deliberately in the interest of compressing the overall project schedule. There are others who would encourage natural growth. To understand this aspect fully, we need to discuss the life cycle phases in a little more detail.

Conception Phase

This is the phase during which the project idea germinates. The idea may first come to the mind when one is seriously trying to overcome certain problems. The problems may be non-utilisation of either the available funds, plant capacity, expertise or simply unfulfilled aspirations. When one is seized with the problems, he looks in and around to find out ways of overcoming them. It may so happen that an idea will suddenly come to his mind as he surveys the environment. It is also possible that ideas will be put to him by his well wishers

or those working on the problems for him. Whatever may be the case, the ideas need to be put in black and white and given some shape before they can be considered and compared with competitive ideas.

An operating cement plant may be having low capacity utilisation, high power consumption and consequently higher cost of production. In such a situation it might be a good idea to introduce new technology, replace some critical items selectively or scrap the plant altogether. There may be financial constraints, the existing staff may need to be on roll, limestone deposits may last for limited number of years and so on. The ideas need to be examined in light of objectives and constraints and what finally becomes acceptable may form the future project. All projects are usually conceived this way.

It is easy to appreciate that if this phase is avoided or truncated, the project will have innate defects and may eventually become a liability for the investors. In this phase, however, it is not supposed to be considered as to how the project will be implemented. Considerations of later phases of a project life when the project is not even born will not only prolong this period but may end up in unnecessary arguments. It is just like considering which medical college your child would be admitted to when the child is still in the womb.

A well-conceived project will go a long way for successful implementation and operation of a project. It is quite possible that ideas may undergo some changes as the project progresses. This is understandable since at the conception stage all pertinent data are not available and also the real life scenario may undergo considerable change compared to what may have been assumed initially.

Definition Phase

The definition phase of the project will develop the idea generated during the conception phase and produce a document describing the project in sufficient details covering all aspects necessary for the customer and/or financial institutions to make up their minds on the project idea. The areas to be examined during this phase, say for a cement plant, may be as follows:

1. ***Raw materials*** Qualitative and quantitative evaluation of limestone reserves.

2. ***Plant size/capacity*** Enumeration of plant capacity for the entire plant and for the main departments.

3. ***Location and site*** Description of location supported by a map.

4. ***Technology/process selection*** Selection of optimum technology, reasons for selection and description of the selected technology.

5. ***Project layout*** Selection of optimum layout, reasons for selection and appropriate drawings.

6. ***Plant and Machinery*** Selection of optimum equipment, reasons for selection, description of selected equipment and machinery, stating number, type, specifications, capacity, source and cost.

7. ***Electrical and instrumentation works*** Listing the broad features of the major electrical and instrumentation items, suggesting a broad scheme for power distribution and power grid map.

8. ***Civil engineering works*** Selection of optimum civil works, reasons for selection, description of selected civil work and cost estimates.

9. ***Utilities—fuel, power and water*** Selection and description of utilities stating qualitative properties, quantities, source, availability and unit costs.

10. ***Manpower and organisational pattern*** Selection of labour and staff considering organisational structure/layout, skill requirement and level of training, availability and cost estimates.

11. ***Financial analysis*** Total investment costs, sources of finance, total production costs and evaluation of financial viability.

12. ***Implementation schedule*** This phase, therefore, clears some of the ambiguities and uncertainties associated with the formation made during the conceptual phase. This phase also establishes the risk involved in going ahead with the project in clear terms. A project can either be accepted or get dropped at this stage itself.

But what is the industry practice? In most cases, it may be seen that the effort during this phase is concentrated in protecting the project conceived during the conceptual stage. Anything else would amount to killing an embryo. What, therefore, sometimes comes out at this stage is what will satisfy the customer or the bank authorities. No wonder this phase is repeated—sometimes with different agencies and under different names. Sometimes studies in further depth are also asked for. But it is clear, if this phase is not done properly, it will increase the risk content of the project. Haste makes waste. Further, avoidance of this step or allowing this phase to proceed with the implementation phase can be expensive and often disastrous for the project. This has led the bank authorities to introduce strict appraisal procedures for the clearance of a project. Thus, ideally, a project can be said to have been born only after it has been cleared for implementation at the end of the definition stage. We will discuss more on this subject in Chapter 2.

Planning and Organising Phase

This phase can effectively start only after definition phase but in practice it starts much earlier, almost immediately after the conception phase. This phase overlaps so much with the definition and also with implementation phases that no formal recognition is given to this by most organisations. Some organisations, however, prepare documents such as *Project Execution Plan* to mark this phase.

By and large, organisations, during this phase, deal with the following, and in most cases take necessary action for realisation of the same.

1. Project infrastructure and enabling services
2. System design and basic engineering package
3. Organisation and manpower
4. Schedules and budgets
5. Licensing and governmental clearances
6. Finance
7. Systems and procedure
8. Identification of project manager

9. Design basis, general conditions for purchase and contracts
10. Site preparation and investigations
11. Construction resource and materials
12. Work packaging

Thus, this phase is involved with preparation for the project to take off smoothly. This phase is often taken as a part of the implementation phase since it does not limit itself to paper work and thinking but many activities, including field work, are undertaken during this phase.

Planning, as it is often defined, is making a decision in advance. If this is not done, we will only be resolving crisis after crisis. It is, therefore, essential that this phase is completely gone through before the next phase, namely, the *implementation phase* starts. Many of the decisions and actions taken during this phase relate to project basics, and if the project jumps into the implementation phase without freezing the basics, the project is bound to falter and flounder if not fail altogether. We will discuss more about this phase in Chapter 3.

Implementation Phase

This is a period of hectic activity for the project. It is during this period that something starts growing in the field and people for the first time can see the project. Preparation of specifications for equipment and machinery, ordering of equipment, lining up construction contractors, issue of construction drawings, civil construction and construction of equipment foundations, equipment and machinery erection, plant electricals, piping, instrumentation, testing, checking, trial run and commissioning of the plant take place during this phase. As far as the volume of work is concerned, 80–85% of project work is done in this phase only. Naturally, therefore, people want to start this phase as early as they can. Since the bulk of the work in a project is done during this phase only, people will always want this phase to be completed in as short a time as possible. All techniques of project management, therefore, are applied to this area essentially.

This phase itself being more or less the whole project, every attempt is made to *fast track*, i.e., overlap the various sub-phases such as engineering, procurement, construction and commissioning to the maximum extent. This is besides starting the implementation stage itself in parallel with the earlier phases of the project life cycle. Hardly any project can afford the luxury of completing one implementation sub-phase fully before moving on to the next.

The amount of fast tracking will, however, depend on who is doing the project. If design is done by one agency and construction by another, then the scope for fast-tracking becomes very limited. If, on the other hand, design, supply and construction is contracted out as a total package, then the contractor is in a position to use fast-tracking to the maximum extent possible. It is this and many such requirements of this phase that have given birth to what is considered modern project management.

This phase, because of its peculiarities, has a high need for coordination and control. People may take months and years in taking decision on the project, but once the project is cleared and enters the implementation phase every one will like the time lost in the earlier phases to be made up during this phase only. Such being the case, meticulous coordination and high pressure management and control is required during this phase. Figure 1.3 lists the sub-phases and shows the extent of fast tracking in this phase of project life.

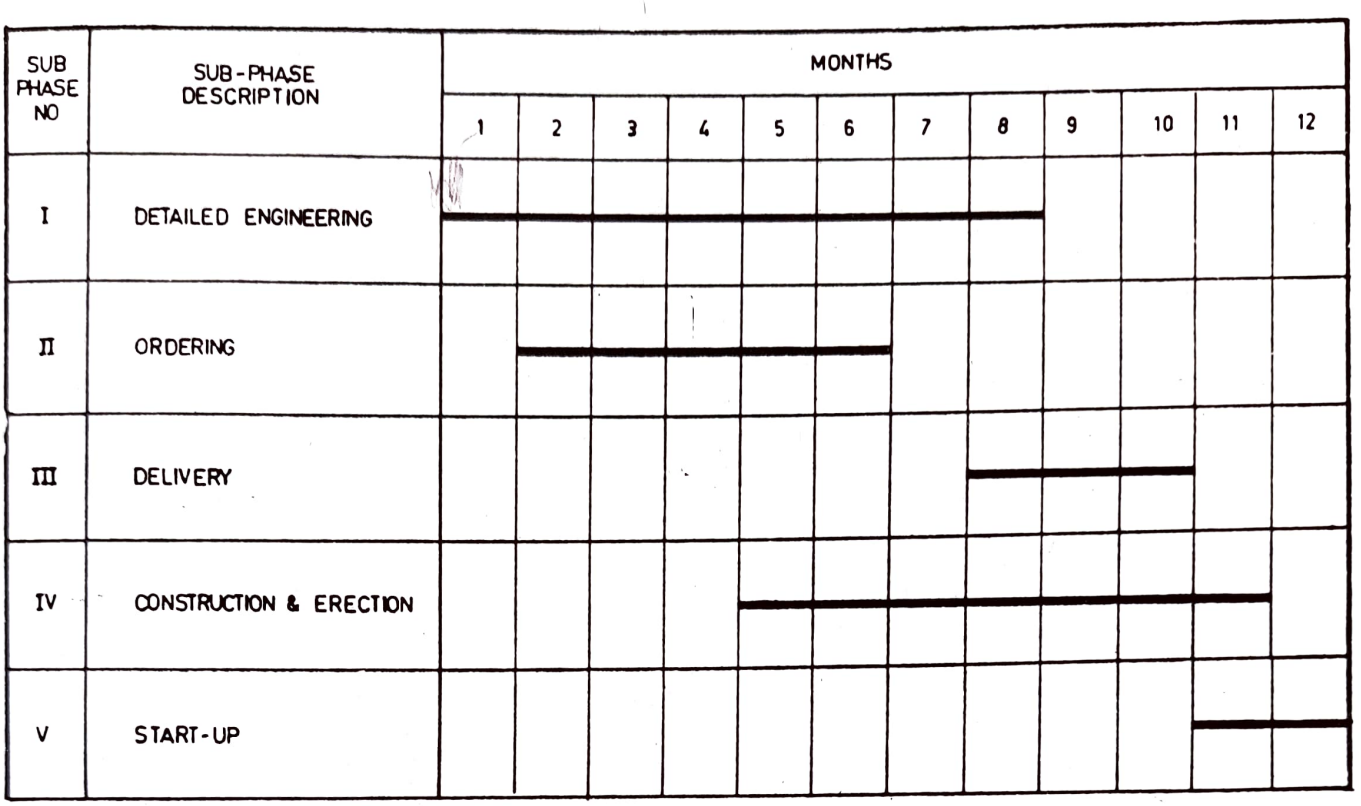


FIG. 1.3 Sub-phases of project implementation for an engineering project

Project Clean-up Phase

This is a transition phase in which the hardware built with the active involvement of various agencies is physically handed over for production to a different agency who was not so involved earlier. For project personnel this phase is basically a clean-up task. Drawing, documents, files, operation and maintenance manuals are catalogued and handed over to the customer. The customer has to be satisfied with guarantee-test runs. Any change required at the last minute for fulfilment of contractual obligations in respect of performance has, therefore, to be completed during this phase to the satisfaction of the customer. Project accounts are closed, materials reconciliation carried out, outstanding payments made, and dues collected during this phase.

The most important issue during this phase is planning of the staff and workers involved in execution of the project. All project personnel cannot be suddenly asked to go. Preparation for project clean-up has, therefore, to start a long time before actual physical handover. The first to go are design engineers and in their place few design engineers may be posted at field for residual engineering. This will be followed by other engineers—most of the time in the order in which they came in. Their places will be taken by customer's engineers who may be either for production or maintenance. The same people will never be required again at that site till a new project comes.

Project Life Cycle Curves

The project life cycle phases form an interesting pattern indicative of growth, maturity and decay almost similar to the human life. Figure 1.4 shows a typical project life cycle curve. The curve shows the various phases in sequence and the approximate effort involved in each phase, though in real life the phases will overlap. It can be seen from the curve that effort

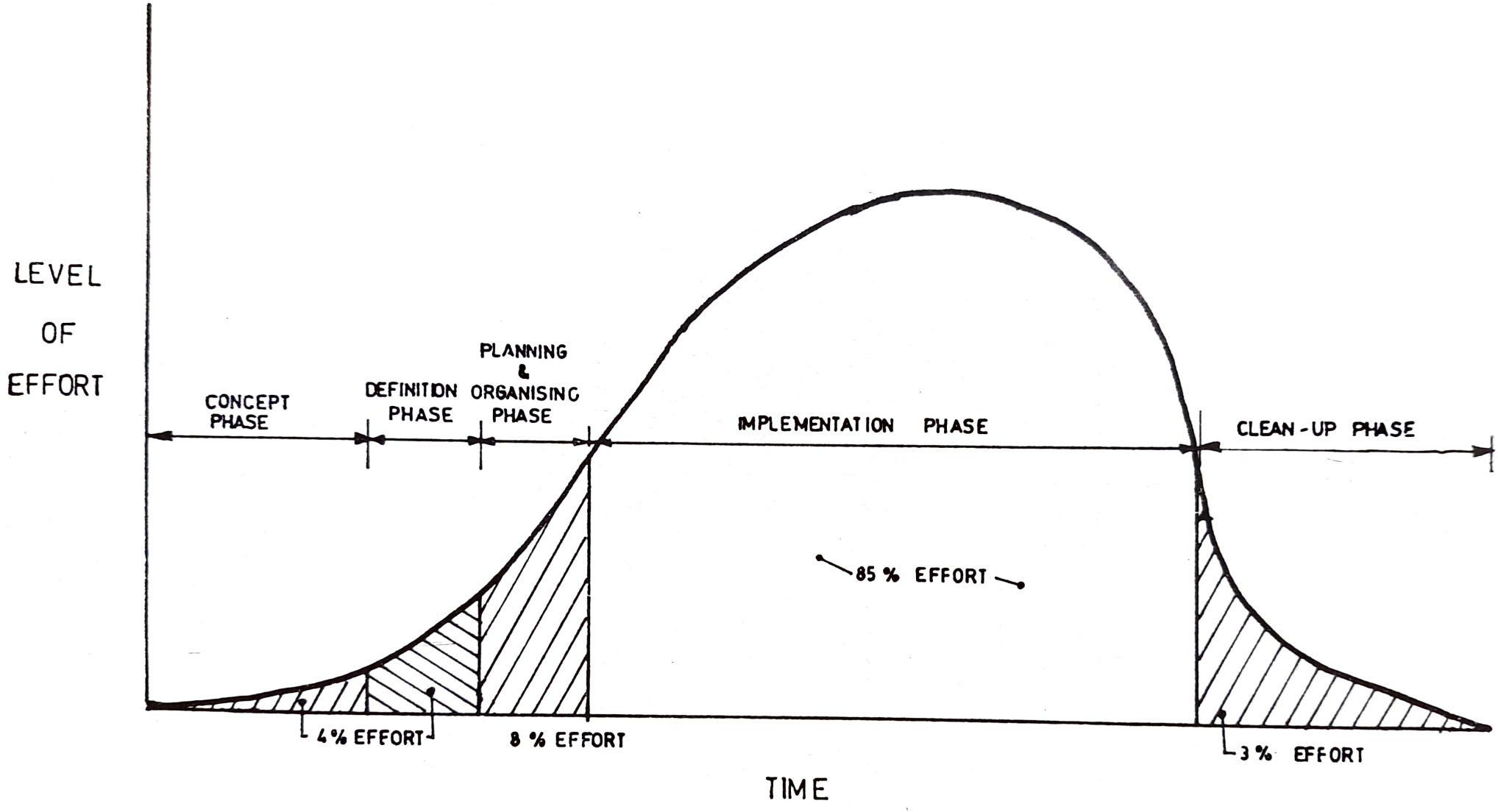


FIG. 1.4 Project life cycle curve

build-up in a project is very slow but effort withdrawal is very sharp. It can also be seen that time taken in the formative and clean-up stages together is more than the implementation stage. While this pattern is true for all projects, the per cent of effort in the different phases would not be the same for all projects. However, for the same class of project the curve may be more or less the same. A life cycle curve can, thus, represent a class of project.

This parabolic pattern of growth, maturity and decay manifests itself in all phases of the project life. Thus, in the implementation phase of a project, the life cycle pattern is evident in detailed engineering, ordering, delivery, construction/erection and start-up. And for a particular class or projects this pattern may be characteristic of that project class. This knowledge of a characteristic life cycle curve enables a project manager to ascertain the state of health of any project at any point of time.

Figure 1.5 shows life cycle curves and associated line of balance. The life cycle curves here have been drawn in 'S' curve form to represent cumulative growth at any time. If the curves are drawn to indicate the minimum growth required for a sub-phase at any point of time to meet the targetted completion date of a project, then a line of balance can be drawn from the same to indicate the state of health of a project.

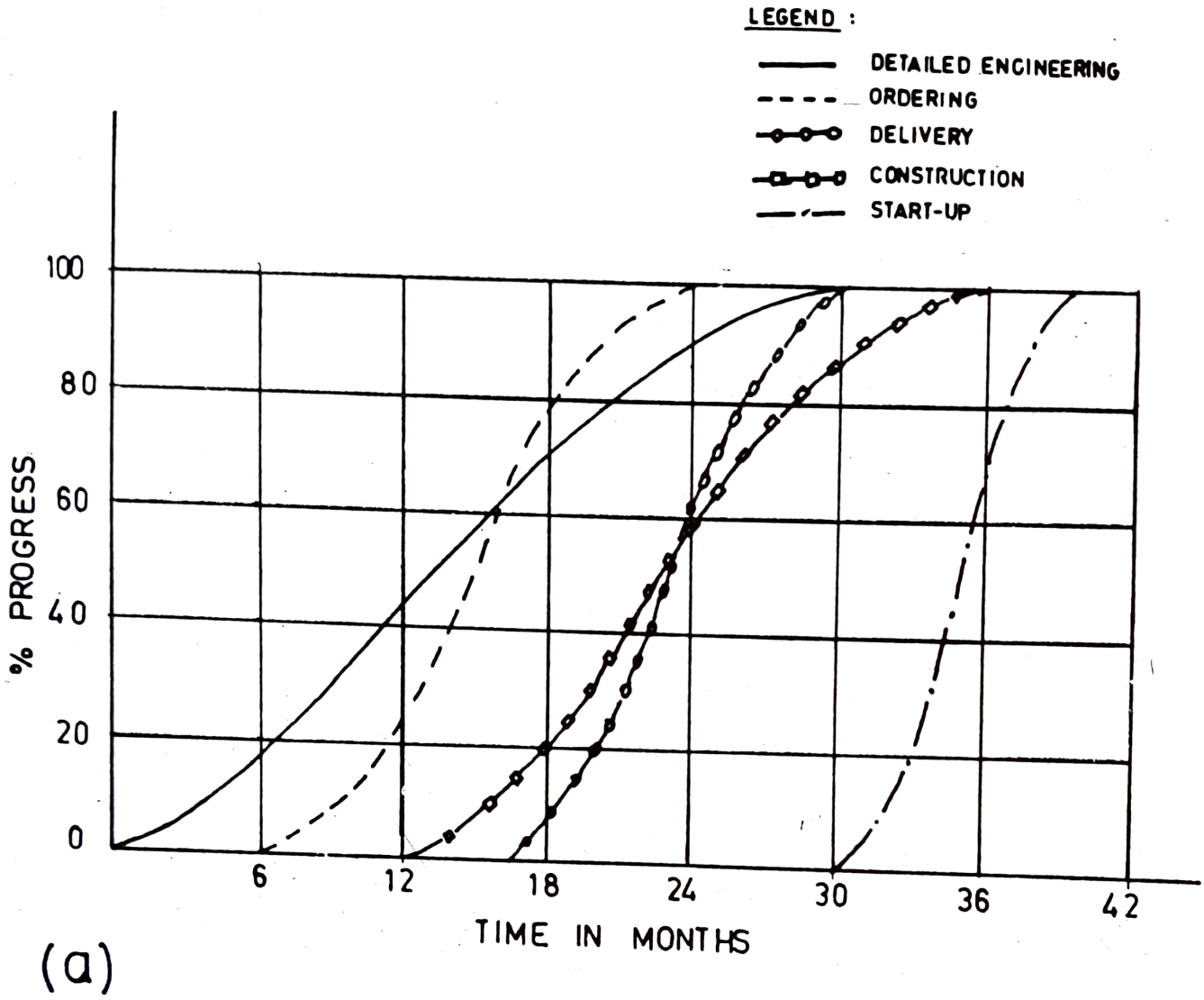
Figure 1.5(b) indicates the qualifying standard of health for a project at the 18th month. This has been drawn by reading the minimum progress prescribed in Fig. 1.5(a). If the actual progress in any of the sub-phases falls short of the qualifying work for that sub-phase, then that sub-phase is sick and requires treatment. Thus the concept of a characteristic life cycle curve for a project phase is very useful for the management of a project. We will discuss more about life cycle curves and line of balance in Chapter 4.

Project Visibility

A project cannot be seen for most of its life time. It starts with everything vague and fluid and for almost half of its life span it shows no concrete benefits. Only towards the end of the project people seem to be seeing the project. Though we have made it clear at the beginning that a project is not a plant, people seem to have problems in accepting the fact. Accountants, in particular, want solid proof of progress before they release payment. While proof of progress can be given, it may not be possible to produce 'solid' evidence for verification.

This non-visibility of a project also causes problems for its management. How to grapple with a thing which is yet to come and be seen? A project becomes visible slowly as it grows. Initially, one can only imagine what it would eventually be, but only the passage of time can give it a concrete shape. At any point in the life cycle something will be clearly visible, something nearly visible, but the rest will still have to be imagined. Figure 1.6 shows the conceptual model explaining this phenomenon. At t_1, visibility is zero—it requires total projection. At t_2 time, part of the project preceding time t_2 becomes visible, and something upto t_3 may become nearly visible—the rest will still have to be a projection. One who wants to know a project has, therefore, to go on projecting all the time to get an idea of the reality—since there is simply no other way. Perhaps this aspect of the project life would justify the term project being used to describe the efforts of multitudes of men and machines engaged in the conversion of an idea into reality.

While visibility demonstrates progress, it may not mean much to some people. To the



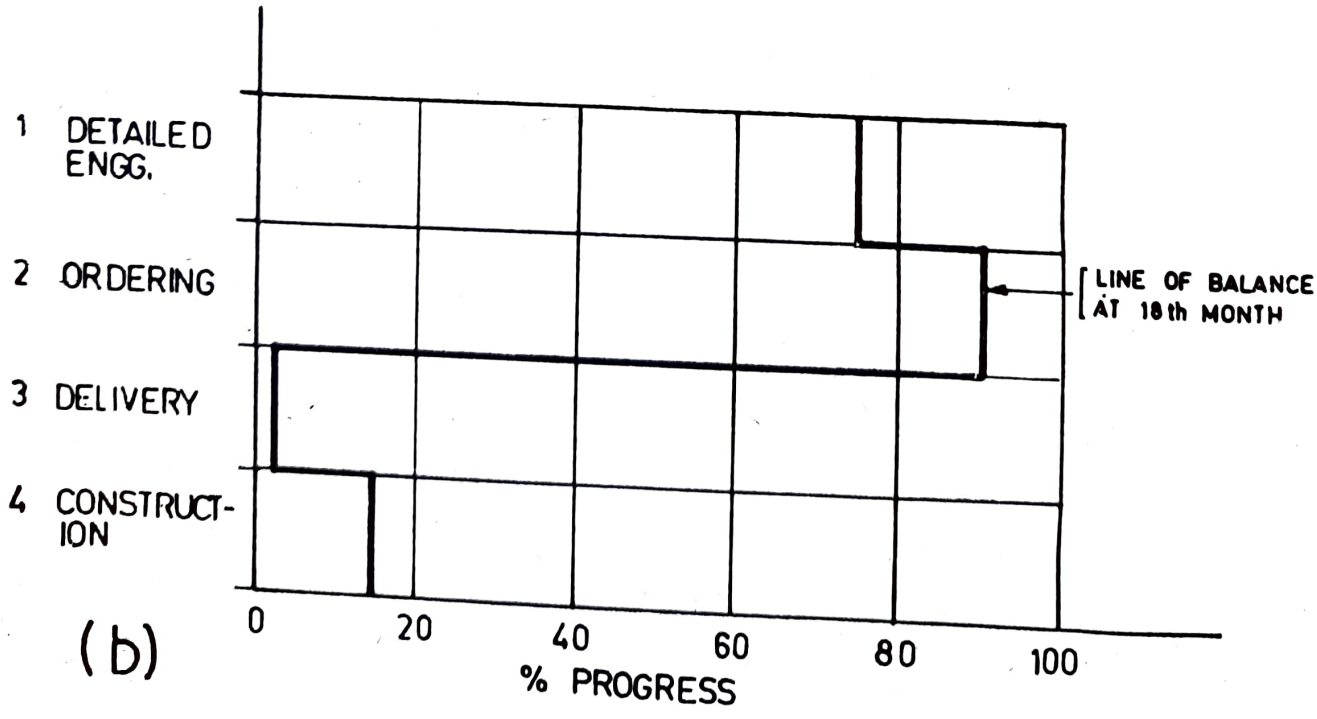


FIG. 1.5 Life cycle curve: (a) Cumulative growth chart (b) Line of balance

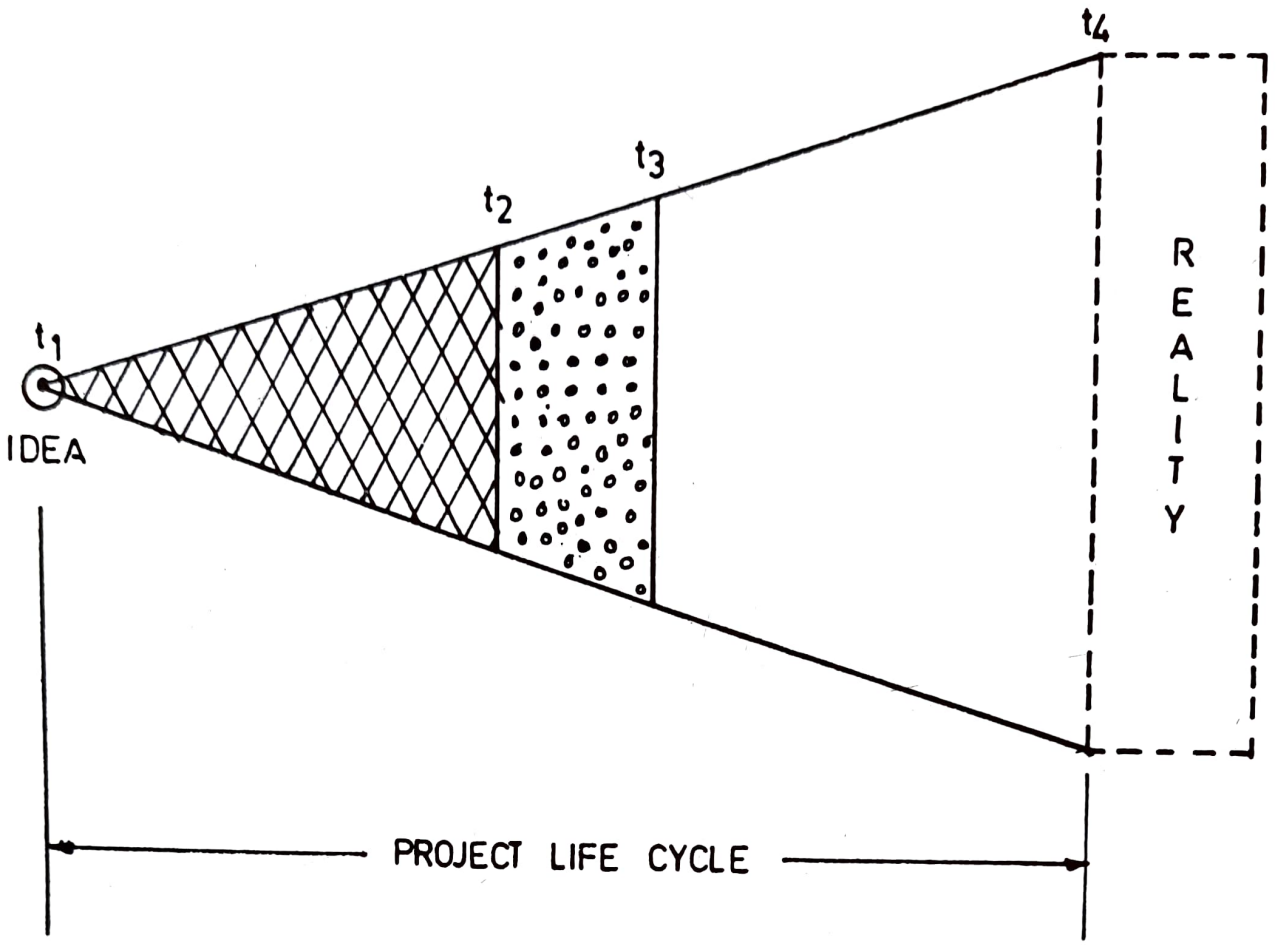


FIG. 1.6 Project conceptual model

user, project value may remain near zero not only at t_1 but throughout the project life. A project abandoned in-between has zero value; the full value of the project is realised only at the end.

PROJECT MANAGEMENT CONCEPTS

The peculiarities described so far about a project require a special approach to ensure the success of the project. We may term this special approach as *project management*. Now success for a project means :

1. It must get completed
2. It must be completed within *budget*
3. It must get completed within allocated *time*
4. It must *perform* to satisfaction

Project management meets these demands.

The success, however, can be achieved only through people. To that extent the principles of general management must apply to project management also. What makes project management different is its approach to *task* which besides its *specification*, is fully bound by *time*, *cost* and *performance* targets.

Steps in Project Management

Project management approach basically consists of the following five steps:

1. Grouping work into packages which acquires the properties of a project. This means that the works so grouped are related to each other, contribute to the same goal(s) and can be bound by definite time, cost and performance targets.
2. Entrusting the whole project to a single responsibility centre known as the *project manager*, for coordinating, directing and controlling the project.
3. Supporting and servicing the project internally within the organisation by matrixing or through total projectisation, and externally through vendors and contractors.
4. Building up commitment through negotiations, coordinating and directing towards goals through schedules, budgets and contracts.
5. Ensuring adherence to goals through continuous monitoring and control using schedule, budgets and contracts as the basis.

Defining what is to be done, maintaining its integrity, and ensuring that it is done and performed as desired, within time and cost budgets fixed for it through a modular work approach, using organisational and extra-organisational resources is what project management has to achieve.

To use project management the first step needed is to create a project. This is possible even in a routine situation. To exemplify when a maintenance organisation involved in routine maintenance decides to go for scheduled maintenance, a scope for using the project management approach is created. The organisation can install a project manager who may take the following steps :

1. Projectise maintenance work as much as possible, i.e. create a number of projects such as daily, weekly, monthly, quarterly, biannual and annual maintenance of the entire plant.
2. Set cost and time targets for each of these projects, i.e. daily, weekly, monthly maintenance, etc.
3. Matrix with the maintenance department which will now provide maintenance still including labour and supervision. The maintenance department may be responsible for breakdown and running maintenance.
4. Line-up vendors and contractors for supply of materials and erection skills.
5. Matrix and coordinate with other departments for preparation of drawings, specifications and procurement of materials.
6. Monitor and control these projects using schedules, budgets and contracts.

The benefits of such an approach are immediately apparent. Total plant shutdown time as also the maintenance cost will be minimum. This is because :

1. The project manager will be wholly concerned with completing the projectized maintenance work within the *budget* and *schedule*. Unlike the maintenance manager he is not concerned with the day-to-day maintenance-related problems. Also, since his performance will be evaluated in terms of *schedule* and *budget*, he will ensure the best possible adherence to the same.
2. All maintenance work will be accommodated within the longest maintenance cycle time known as *critical path* (usually the maintenance time of the critical equipment), thus reducing the total plant down-time to minimum.
3. Each agency will have definite time and cost targets to work to. The work of these agencies will be continuously monitored and, therefore, problems will be reviewed and resolved even before they cause any damage. The agencies will, therefore, be working in an environment conducive to fulfilment of targets.

4. A project manager manages what he projects. He is, therefore, concerned with how to achieve the next target and not to make a fuss as to why the previous targets have not been achieved. This approach makes things *work*, as people then gear themselves for future successes and not prepare *cases* in defence of their past failures.

5. Since the project manager will have the necessary authority to take most of the decisions relating to his project, decisions will be made faster. Project management depends on maximum lateral coordination and this make it possible not only to take fast decisions but also enables fast implementation of decisions.

Project Management v Functional Management

The need for using the project management approach in preference to the functional management approach can be better appreciated if we consider the following two aspects of project work.

1. All work has inter-dependence and inter-relationship with others. Nothing stands alone and isolated. No good decision can be made without considering all inter-related things and no useful thing can be achieved without completing the whole. The importance of any work depends on how it stands in relation to others and to the whole.

2. The work and the inter-relationships are liable to change with time but still the end objective does not change. The future, thus, being uncertain, one needs to always keep an eye on the future and adapt himself very fast to the changed needs of the future. A static plan will not work—quick responses and flexibility are essential for dealing with ever-changing dynamic situations.

Structuring of responsibilities based on specialisation would not meet these basic requirements of a project. To talk of specialisation, a simple house building work itself could be divided into so many specialities. But if one lines up separate specialists for each and every type of work, then the building may never come up. Grouping and generalisation of work, as far as practicable, as opposed to extreme specialisation and too much division of work, is the first need for fast work and hence for managing work by Project Management.

Immediately following this is the need for trade off—accepting lesser than the best, in one or more areas, for an overall benefit. All specialists may be against this, but no project can come up in time or cost without this flexibility. A flexible and generalist approach, rather than a rigid specialist approach, will be needed for adopting the project management approach.

In the name of functional specialisation, the totality of work is often lost sight of. Functional specialisation carried to an extreme could mean that someone only thinks (using the head) and someone else only talks (giving lip service). Real work may be done by a third person by dirtying his hands, and there may be yet another person to do the actual leg work (follow-up). This way only a part of the human being and not the whole person is involved in the execution of a project. Also, with such an arrangement, no single individual, except the chief executive, can be held responsible for a work from A to Z. This necessarily creates problems of communication, coordination, commitment and control.

A work is done better if it is taken up as a whole and assigned to one responsibility centre. Work in the context of a project is not mere processing or conversion of input to output—work is done when the objective for which the work was undertaken in the first instance is achieved. Anything done in between are only time and cost consuming motions.

One has not done any work but merely involved himself in exercising motions till the ultimate objective is achieved. This concern for the ultimate objective is the motivating force for the project Management approach.

To practise project management one must be able to distinguish what is part and what is whole—what is motion and what is work. Unless this is fully driven into everyone's mind, energy will be wasted in useless motions. The project management approach is, therefore, a necessity for all of us whether we are building a multi-billion dollars high technology project or running a simple automobile shop for it simply means *dedicating ourselves to the end objective and keeping the totality in focus all the time.*

Project management, like functional management, will require getting things done through people but with a little difference. The people this time will be more in number from the environment than the people within the organisation. Naturally, they will also not be bound by the organisation's own work ethics and discipline. We may be required to get the work done much the same way we do in our social setting. Many may find this uncomfortable, as it would require a lot of patience and skilled listening and negotiating capability.

Besides, in project management the work gets done mostly through lateral and diagonal contacts, the hierarchical protocol is almost non-existent. Communication is faster, decisions are taken quickly and at a lower level and unnecessary repetition of reports to involve and apprise authorities at higher levels for routine and petty decisions are avoided. But while the freedom exists for communication, sorting out problems and decision making commensurate with responsibilities at lower level, the higher level are always kept informed and involved if the situation so demands. This style of operation is characteristic of project management—whether the structure is purely projectised, matrix or functional. The protocols of the organisational hierarchies, salary levels and designations are all unimportant as far as working relationships are concerned. Project management presupposes that the human organisation is created to manage a physical system which has a natural inter-relationship and interdependence and therefore, the human system must correspond to the physical system and respond to the demands of the physical system without creating another artificial system based on class, creed and colour. Ideally the human organisational system should be a mirror image of the physical system, but this again is not possible no matter how much we may like it to be identical. But we cannot, at the same time, forget that it is the physical system which came first and is the basic issue in hand. We will discuss more on this in Chapter 3.

Many may also not like to projectize their outlook, i.e. look all the time at the future, foregoing the pleasures of digging and delving into the past for finding out whom to apportion blame for any failures in the past. But overriding all this may be the desire, not to be tied down to *targets, budgets, specifications and performance guarantees* which project management demands. Who would like to be chained if it is possible to live free?

TOOLS AND TECHNIQUES FOR PROJECT MANAGEMENT

Project management has a special set of techniques. But project management like any functional management is not technique only. The techniques are the *scientific* part of management—but then there is also the *art* and *politics* of management, and one could ignore them only to one's peril. For quite some time project management was equated with PERT/CPM but it did not take long for them to get disillusioned. This should not mean

that PERT/CPM has failed; what it really reflects is that it would be totally amateurish to assume that techniques however powerful and versatile could scientifically deal with issues of management which are non-scientific in nature.

What the scientific part of management and scientific techniques lack is *human wisdom*, which one may like to term as the art and politics of management. The scientific techniques will only tell what is right, but it will require right understanding of the organisation, the people in the organisation, the mood of the people, an uncanny sense of what will go and what will not and a good sense of timing to achieve its right implementation. The techniques, therefore, may provide only as to *what* is to be done, but it will require additional knowledge as to *how* it should be done and get it done through people. The techniques have no answer for the same—it can be learnt only through practical experience.

Notwithstanding the above limitations, there are several techniques which would contribute significantly towards effective project management. These can be broadly grouped under the following heads:

1. Project selection techniques—
   (a) Cost benefit analysis and
   (b) Risk and sensitivity analysis
2. Project execution planning techniques—
   (a) Work breakdown structure (WBS)
   (b) Project execution plan (PEP)
   (c) Project responsibility matrix and
   (d) Project management manual
3. Project scheduling and coordinating techniques—
   (a) Bar charts
   (b) Life cycle curves
   (c) Line of balance (LOB) and
   (d) Networking techniques (PERT/CPM)
4. Project monitoring and progressing techniques—
   (a) Progress measurement technique (PROMPT)
   (b) Performance monitoring technique (PERMIT) and
   (c) Updating, reviewing and reporting technique (URT)
5. Project cost and productivity control techniques—
   (a) Productivity budgeting technique
   (b) Value engineering (VE) and
   (c) COST/WBS
6. Project communication and clean-up techniques—
   (a) Control room and
   (b) Computerised information systems

There are many such techniques which though without any label have standard application methodology. We will discuss these techniques in the subsequent chapters, not as separate techniques, but in relation to their application for the problems in hand.

There is, however, a risk in listing the techniques in the way it has been done above. Perhaps it is worthwhile to emphasize at this stage itself that while the techniques by themselves are sound and capable of yielding results, they cannot deliver what they are capable of because a project manager has to attend almost eight to ten items at the same time. Think of a stuntman trying to walk across a tight rope—he mostly does it with a bamboo pole. Many of us who know this technique may succeed with considerable training. Now ask the stuntman to cross the same rope swinging in the wind and simultaneously perform other tricks as shown in Fig. 1.7. What do you think will be his chances of success? A superstuntman may still be able to do this. But what about ordinary people? A *Hatha Yogi* can cross a river barefooted—they attribute his success to techniques and training; but as far as we ordinary mortals are concerned, these will be beyond us.

Perfection in all spheres is a feat of divinity—at least it so appears whatever claim the project management companies may make today. The stories of all the so-called successful

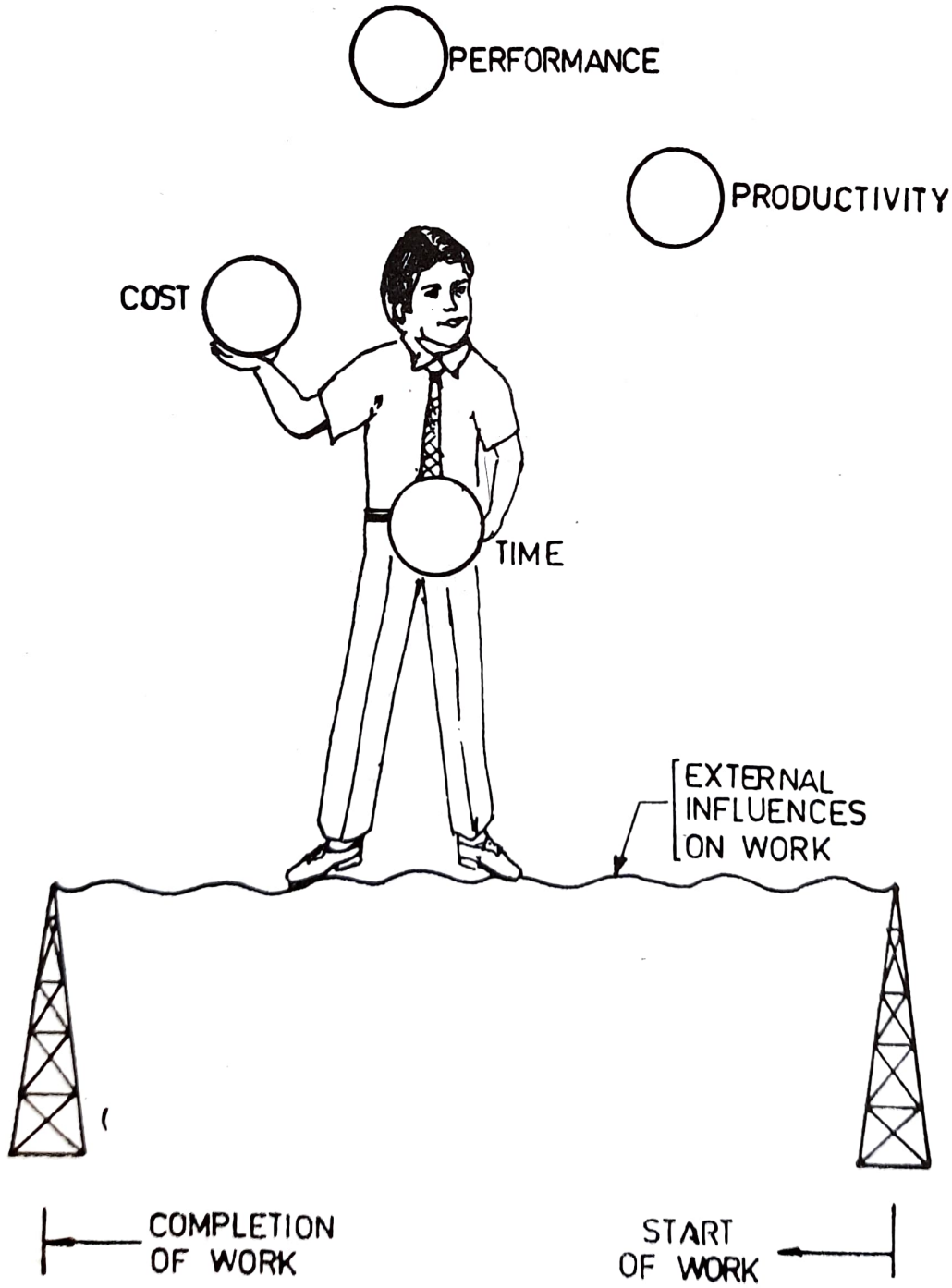


FIG. 1.7 Project management task

projects reveal success in only one or two areas and project managers may earn laurels by completing a project that merely performs. No wonder, therefore, that most project managers are obsessed with the physical completion of a project and take pride if the project produces results, ignoring whatever might have happened in other areas of performance like time, cost or productivity.

So, while we talk of tools and techniques, let it be clear in everybody's mind that even if one masters them all, one will still not have mastered project management. We first talk of *human wisdom* without which any amount of theoretical knowledge will not be of much use. Besides whatever attempts have been made to combine several techniques, no perfection has been achieved so far. Therefore, if one wants to achieve perfect work accomplishment, the techniques of time control cannot be fully blended with it. If, on the other hand, one desires cost control, the techniques of time control would not go well with it. Besides, there is no point in using a technique just for its cosmetic value. As things stand today the project management companies promise so many things and yet very few project managers understand them or are adept in using the same. And those who are adept in using the techniques do not know what it means to *manage* a project. What, therefore, is expected is that project managers should have appreciation of the available techniques and ask for specialised help in areas which are very important. If he wants everything, he may get nothing; the only party who may gain in the process is the management consultant or the software companies.

The message, therefore, is very clear. If you wish to complete the work to near perfection, be prepared to sacrifice the time and cost factors. Similarly, if you wish to complete it in time, you cannot be as rigid on cost and specification. It would be so wonderful if we could have all the good things in life, but no such thing is possible in real life, and a project is no exception. Yet there are so many computer based project management systems which promise almost anything on earth and the public would be inclined to believe that the ultimate thing has already arrived.

Computer Based Project Management Systems

Table 1.2 lists the programmes, their capabilities, inputs, outputs and mode of operation to provide an overall view of the so-called scientific systems available for project management. The list no doubt is impressive and there cannot be any doubt that with such tools and techniques project management can never remain a trick as illustrated in Fig. 1.7. And remember we have not listed even one-tenth of the number of systems readily available in the market. Things must indeed be too bright for the future project managers. But one must admit that it is not so, at least not today. We may look forward to tomorrow when computer terminals will be available at the project manager's table like we have telephones today. But then these telephones must work, as they are supposed to, and not behave like the ones we see today in our country. Science and scientific thinking have progressed quite far—but it will take us a long time to catch up with that or at least develop the desired scientific temperament. And for those who are superstitious, non-believers, peddlers of crafty management or petty politics, these systems may never become a reality even though computer prices may crash to those of telephones or pocket calculators.

Rationale Behind Computerised Project Management Systems

With the proliferation of computerised project management systems, it is possible that

TABLE 1.2 Computerised project management system

Sr. No.	*Name of Programme*	*Programme Description*	*Mode*	*Input*	*Output*
1	2	3	4	5	6
1.	ACTION LIST	Designed for use by project managers in expediting, progress chasing and for document control, the package is used primarily to establish schedules itemising information outstanding, drawing requirements or materials procurement programmes. These define what needs to be done, by whom and when. The programme is then updated regularly and used for progress chasing, recording what has been done and highlighting critical items needing action.	Interactive	Data entry through screen with facilities for retrieving and editing any item of data.	A variety of tabular and bar chart reports on both the screen and the printer.
2.	APECS/8000	An integrated, interactive multi–user project management package based on a true relational data base facilitating top-down, bottom-up planning. The system is modular and can include critical path analysis with I–J or precedence networks, progress updating, resource analyses, resource levelling and cost analysis. It can perform WBS or organisational structure analysis, with implicit/explicit structures and multi-level consolidating. Performance measurement can be carried out using earned value analysis and variance analysis. It has a common field dictionary. The system allows user-defined applications in addition to its integral data management functions.	Interactive	Fixed/free format data entry direct or from file, custom screen formated data entry and modification.	Text/tabular, user-defined, standard, screen or hard copy, summaries/consolidations. Terminal graphics: bar charts, graphs, logic diagrams, platter graphics: Gantt, linked Gantt, S. curves, logic.
3.	ARCHES	Develops a contractor's estimate. The package contains preliminary design procedures for the structure, finishes, HVAC, electrical, plumbing and cost bases for materials, manpower and indirects. This allows the development of design quantities, material costs and installation crews for each field task. The package develops the manhours for each field craft for site development, field erection and installation of each	Interactive and batch	Command driven data input generator available.	Master summary, site development report, building summary report, code of accounts, field manpower summary, manpower and construction schedule, cash flow summary, prime contractor's indirect costs,

	design quantity. It also prepares a management-oriented report, with key costs backed up with detailed reports of quantities, summaries of installation tasks, material and field manpower costs.			equipment rental summary, material and field man-power summary.
4. CAPITAL PROJECTS FINANCIAL PLANNING SYSTEM	Designed to control the phasing of projects within cashflow and resource constraints. System allows phased budgets to be compared with actual and latest estimated expenditure, and permits 'What-if' analysis of the effect of adding, omitting or rescheduling projects in the programme. Features include multiple currency and escalation and deescalation capabilities, user defined cost centres and summary cost centres, multiple user defined accounting periods, and extensive facilities for analysing variances and slippages.	Batch and interactive	Screen forms or files	User defined tabular, bar chart and graphic reports.
5. CBACS-PERT	Functions are to record, review and then re-estimate the status of each task at each stage of a project. To monitor identify areas where time scales, resources demands of project cost targets are in jeopardy. To permit comprehensive reporting by a variety of user criteria to assist with the project planning and control objective. To allow interactive modification of strategies for optimising project progress. Activity time-schedules, resource aggregations and project cost estimates can all be calculated and reported in suitable formats.	Interactive	On-screen edit; disc file merging, on line project data	A variety of report layouts to a wide range of selection and sequencing criteria, output to screen, printer or disc.
6. C–COST	A project control programme that conforms in full to the U.S. Department of Defence cost/ schedule control systems criteria. Although, C-spec techniques are associated, mainly with large defence contracts, they have also been widely applied to projects of all sizes in many other fields. The package is based on the foundation of C-spec with a number of additional features including document management through word	Batch and interactive	Screen forms and files	User defined tabular, bar chart and graphic reports.

(*Contd*)

TABLE 1.2 (*Contd*)

1	2	3	4	5	6
		processor links, user defined calculations, multiple earned value techniques; multiple currencies, rates and inflations profiles.			
7.	CONCEPT PROJECT MANAGEMENT	Comprises project planning, resource management and budgeting programmes. Precedence network analysis creates bar charts that can be modified on the computer screen and stored, and from which resource histograms and cost information can be generated. Multiple calendars allow for seasonal variations in productivity. The budgeting programme produces cost estimates, departmental budgets, current total cost estimates and cash flow information. Detailed costing can be generated from the budgets/based on cost-head allocations. Break even point analysis and cost-to-date analysis are easily produced and can be illustrated graphically.	Real time	Key board entry; editing available at all stages.	Extensive output including user designed formats saved for future use; formats may be tabular or based on bar charts, histograms, curves and diary pages; budgets, financial reports and summaries conform to normal document layout; all output to standard printers.
8.	CRIT PATH	Critical path project management package. Analysis and critical path network, calculating early start/finish and late start/finish dates.	Interactive	Data entry and editing on screen or option from system data file.	Screen output (tabular); printer output (tabular); plotter output (graphical Gantt/bar chart); system data file output.
9.	DIAGONAL NETWORK ANALYSIS	Draws a critical path network to scale on a plotter using simple data entry. Preliminary drawings and calculations are unnecessary since the programme carries out both automatically. Once the chart has been created it can be adjusted by the user to suit his requirements, and if the cost of each activity is entered, the chart will draw a running cost curve. When the project starts, data can be entered to show the difference between planned and actual progress, subsequent activities being adjusted to take account of the difference.	Batch plotting, interactive data entry	Interactive editor	Plotter graphics.

10. DRAWING REGISTER	Package maintains a record of all drawings produced for a project. It can produce a complete history of any drawing or group or drawings. This shows the file, size, initials of persons responsible for drawing, checking and approving, revision date and any notes. The report also shows the dates on which the drawing was issued, the recipients and the quantities. The drawing status report indicates the latest revision and status of each drawing and is the main control document for drawings on the project. The system produces a print delivery note that lists all the drawings required.	Interactive	Data entry through prompted screens with facilities for retrieving and editing any item of data.	A variety of tabular reports on both the screen and the printer.
11. INTERNET 805	A modular suite of programmes that covers operational planning, resource utilisation, procurement performance monitoring, cost analysis and financial forecasting. Included is a system generator that enables new management systems to be created. The package supports precedence and arrow networks and has flexible activity descriptions for complex coding structures. Resource scheduling facilities, skeletonisation and linking are available. Network analysis is carried out by means of paths. There is modelling language for resource or cost calculations.	Batch and interactive	Free format input.	Single or multiple project reporting using user specified formats; tabular bar charts, histogram or plotted network forms; output to screen and hard copy.
12. MANPOWER EXPENDITURE RECORDING	Provides computerised control and analysis of manhours booked to projects and overheads within a company or department. It can be applied in any project or cost centre-oriented organisation. The principal input document is a weekly time-sheet prepared by each person. A range of reports can be generated giving the weekly and cumulative manhour totals by project, overhead, section, activity and staff agency. In addition, project billing and department costing reports can be produced.	Interactive	Data entry through prompted screens.	A variety of tabular reports on both the screen and the printer.

(Contd)

TABLE 1.2 (*Contd*)

1	2	3	4	5	6
13.	MENTOR	Comprises project planning, resource management and bill of quantities programmes. Precedence network analysis creates bar charts that can be modified on the computer screen and stored, and from which resource histograms and cost information can be generated. Multiple calendars allow for seasonal variations in productivity. The billing module produces interim statements from the measured work, approximate valuations and cash flow information. Detailed costing can be generated from the bill, based upon a breakdown of the rates. Bills of quantities can be compiled from a library module of phrases or item descriptions, or the contract documents.	Real time	Key board entry or bill of quantities from library options; editing and full word processing where appropriate.	Extensive output including user designed formats saved for future use; formats may be tabular or based on bar charts, histograms, curves and diary pages; bills of quantities, financial reports, summaries conform to normal documents layout; all output to standard printer.
14.	MISTER	Projects analysed during planning and performance phases. Potential time, resource and cash flow problems identified before their occurrence as alternative options are investigated. The package tracks the progress and shows the impact of changes in the plan or irregular events that might upset the plan. Selective reporting capabilities provide information for the use of all management and operating levels. Schedules sorted in any number of distinct criteria. System is modular; nine modules available in five model sizes.	Interactive and batch	Interactive and direct input.	Printed or plotted graphs; plots; bar charts or histograms; printed or screen reports.
15.	N 5500	Features include handling of precedence and I–J networks, up to 40,000 in user defined hierarchy. Sub-projects, phases, unlimited milestone events, complex network logic and hammocking, multiple calendars and user defined working patterns. Budgeting, cost planning, control and forecasting. Automatic resource allocation, load levelling and resource planning. Progress report-	Batch and interactive	Data entry by screen or paper input; on line file screens and updating full validation against master file.	Fixed format; flexible content reports; bar charts, S-curve, comprehensive network plotting, 14 screen based reports; simulation, on line interrogation, reports up to nine levels of summarisation.

	ing based on a turn-around document is available. Multilevel reporting, historical information and simulation capabilities are available. The needs of matrix organisations are catered for by means of a data base.			
16. PERT 6	Projects are defined in a topdown approach allowing the user to define the level of detail and the number of levels of details and reporting. Each project may use up to 14 user-defined calendars and unlimited resources. Resource levelling is done on a daily basis or on any quantum of time defined by the user. It can communicate with other data bases on the same or separate hardware.	Real time batch and interactive	Input from screen or file; network can be input graphically.	User defined reports include project level, milestone level, activity level, bar charts, earned value curves, network plot.
17. PROJECT MANAGER'S WORK STATION	Provides local data entry and analysis, either as a freestanding data-manager or linked to a company's central project management facilities. Includes micro-to-host communications, software and data base management software that can be tailored to individual applications.	Interactive and batch	Screen forms or files.	User defined reports.
18. PROJECT 2	A modular package consisting of schedule, cost, graphics and relational data base modules. Scheduling establishes network logic, checks for errors and calculates original and current schedules. Multiple calendars, target scheduling, micro-scheduling, discontinuous scheduling, automatic network generation and sequence scheduling are available. Network scheduling based on 'What–If' simulations is possible. The cost processor models a project with multiple-level hierarchies. The user can measure project performance forecast variances, highlight trends and calculate earned value. The graphic processor supports the display of multiple calendars, micro scheduled projects and automatically produces calendars appropriate for each network. A password access security system is used.	Real time batch and interactive	Menu-driven screen; command language.	60 standard reports, customs report writer, screen display of reports; Gantt bar charts, network diagrams, histograms; flow curves.

(Contd)

TABLE 1.2 (*Contd*)

1	2	3	4	5	6
19.	THE PLANNER	A project planning tool employing the principles of critical path analysis with a number of enhancements and extensions. Full resource levelling is included as standard. One feature facilitates the direct construction of a project on screen without recourse to drawing the network diagram. Project models may be plotted graphically providing clear records of the logic structure. Sections of projects may be moved *en bloc* from project to project allowing the establishment of 'logic libraries' containing frequently used data.	Interactive	Keyboard data entry with full editing facilities of network and resource files.	Bar charts, histograms and various reports are sent to printers; optional plots of networks.
20.	VISION	An information package that includes techniques for integrating cost, resource and schedule information. It includes modules for performance measurement to DOD, DOE and NASA standards, and graphical output in the form of networks, bar charts and management graphs.	Interactive	Interactive or batch; can accept files created by other systems.	Colour graphics outputs of charts and plots on screens or plotters; full and concise formated reports from sorted and selected data.
21.	VUE	An interactive project management package designed to help managers establish and monitor project management plans. It uses the critical path method, highlighting the most important activities. The project manager can modify information and see the project from several perspectives, generate several 'What–If' scenarios and respond to unexpected developments with new schedules and strategies.	Interactive	On screen	Output can be on terminals, printer or plotter; graphic options available
22.	ARTEMIS	A fourth generation language with special facilities for project management. The language, which is identical for all applications, uses English-like commands, provides the facility to formulate *ad hoc* enquiries and can be used as menus for inexperienced users. A relational data-base enables the rapid implementation of	Interactive, batch and real time	User definable formated screen; unformated fast entry; offline data preparation.	User definable text/tabular reports, bar charts, histograms, pi-charts, network plots etc.; colour graphic reports available as required; output can be to screen, printer or plotter.

applications; mirroring existing data structures and providing for subsequent modification without the need for reimplementation. It has in-built procedures for network planning and resource scheduling, aggregation across time, and data entry checking and validation. A report writer and project graphics facilities are included.

computers will, in future, manage projects, perhaps even without a project manager. All this talk about the art and politics of management will, consequently, become irrelevant. This more or less resembles the attitude of those belonging to behavioural schools of thought who feel that they have already thrown out the protagonists of scientific management. Without entering into any controversy we can, perhaps, offer some explanation as to why there has been such a proliferation of computerised project management systems, and why in the foreseeable future they may receive increased patronage.

Perhaps, it would not be wrong to say that a project organisation is more information-bound than any other organisation engaged in any individual activity. The individual loyalties here are for the project which is not only a temporary organisation but is also changing continuously. The commitments given in a project are not to any individual but to a cause. The relationships of individuals in a project are again based on contracts, project requirement, information and mutual give and take, financially or otherwise. The relationship between the executing agencies is, therefore, that of the project for which they are responsible. In fact, one could consider the working relationship between the executing agencies as mirror image of the physical relationship that may exist between the physical components of the project. Such being the situation, a network showing the inter-relationship and inter-dependence between the various agencies would offer an excellent model for management of the project. The flow through this model is information—there is no physical flow—same as in the case of a computer. And since the scenario is ever-changing, the model has to adapt itself very fast, and if there is a computer, it can represent the reality in the true shape all the time.

A computer as we all know is an information-bound system. It takes decisions on information and information alone. It can handle volumes of work with extreme varieties, whatever may be the degree of complexity, and yet for the laymen or the uninitiated it can simplify things to the extent desired, easily and quickly without sacrificing any accuracy or quality. It is, therefore, no wonder that network systems and computers have caught the imagination of all those who are concerned with the volume, varieties and complexities of project work. So, when some project management system advertisements mention, 'What-if your secretary could manage your next project', one need not jump from one's seat.

We had mentioned earlier that the art and politics of management are essential but they are not so easy to learn. It is, however, interesting to note that computer and network systems recognise this. Figure 1.8 illustrates the project management system. The network shown in the figure as such is not important, but the messages it conveys are surprisingly refreshing, more so because they come from those who consider management as only a science. Let us consider this in detail.

1. A network shows us that all work is interdependent and interrelated with each other. If it is not, it does not belong to a *set* which in this case is our project. A *project*, therefore, is a system where everyone is related to another and must work hand-in-hand for completing the group goal which is our project. If one does not work, drops out or is delinquent or does not cooperate, the project will never get completed. In a group situation no one can complete a project on one's own; one needs to work together for success.

2. There must be team spirit. The activities that must speed up, must do so at others' expense, if required, i.e., others must assist them with their resources which must be diverted to whoever needs it most. The goalkeeper in a football match cannot be left to defend the

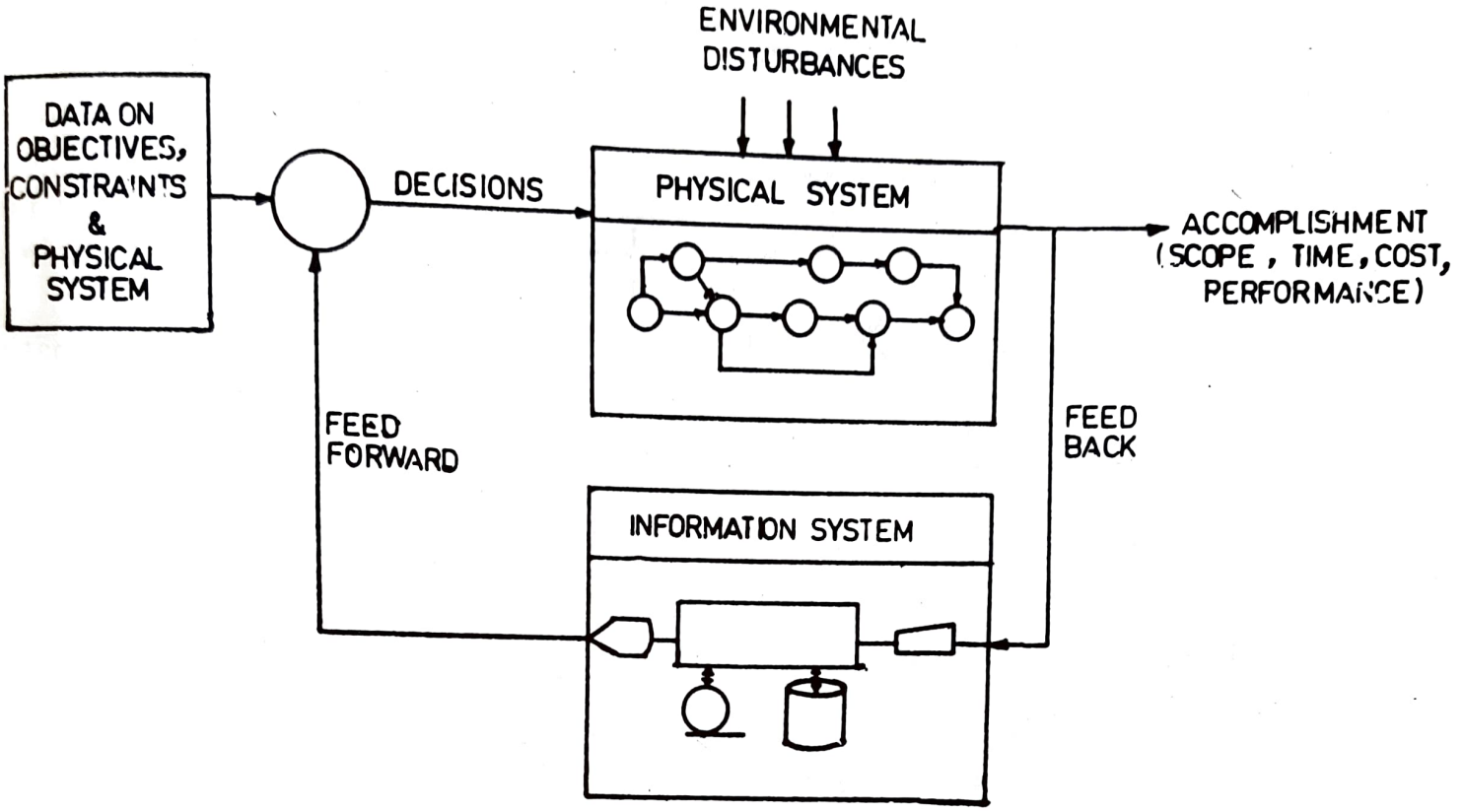


FIG. 1.8 Project management system

goal alone in times of crisis—others in the team must come to his rescue. Besides, there must be a sense of timing—one must speed up or slow down to meet the requirement of the whole team and not to prove one's own excellence. The individual's excellence will have no impact on the overall goal.

3. The activities listed in a network are advanced decisions considering a forecasted scenario. The decisions and the relationship, therefore, have to change as the reality comes to be known. Flexibility in relationship and adaptability to the changed reality is essential for survival. Information on change is essential for adapting to change and if the network can be changed on the basis of information it can always reflect reality. Since a network can be easily updated, particularly when a computer is available, a computerised network system provides an information model which will be a true replica of the physical work system, which in our case is the project itself. Once this is available, the need for changed decisions and required reorganisational arrangements can be seen on the screen of the computer itself.

4. We had discussed earlier that for quite some time there is hardly any visible evidence of a project. The management of the project has, therefore, to depend on the information; some assumed, some projected and others relayed or fed back. When executing agencies can be so locked informationally, without firm visibility or consideration of the hardware, we have a management situation which could be considered information bound. This also happens to be the situation in which a computer works. When a computer works in a process control situation, the fluid does not flow through the computer. All that the computer is provided is a mathematical/graphical analogue of the physical system, operating instructions and sensing and measuring devices for collecting information relating to the operational parameters. The information flows and the computer does the rest thereafter. Figure 1.9 illustrates how a computer is used in a project management system. We have a network analogue of the physical system, the model changes due to external interferences, the feedback is

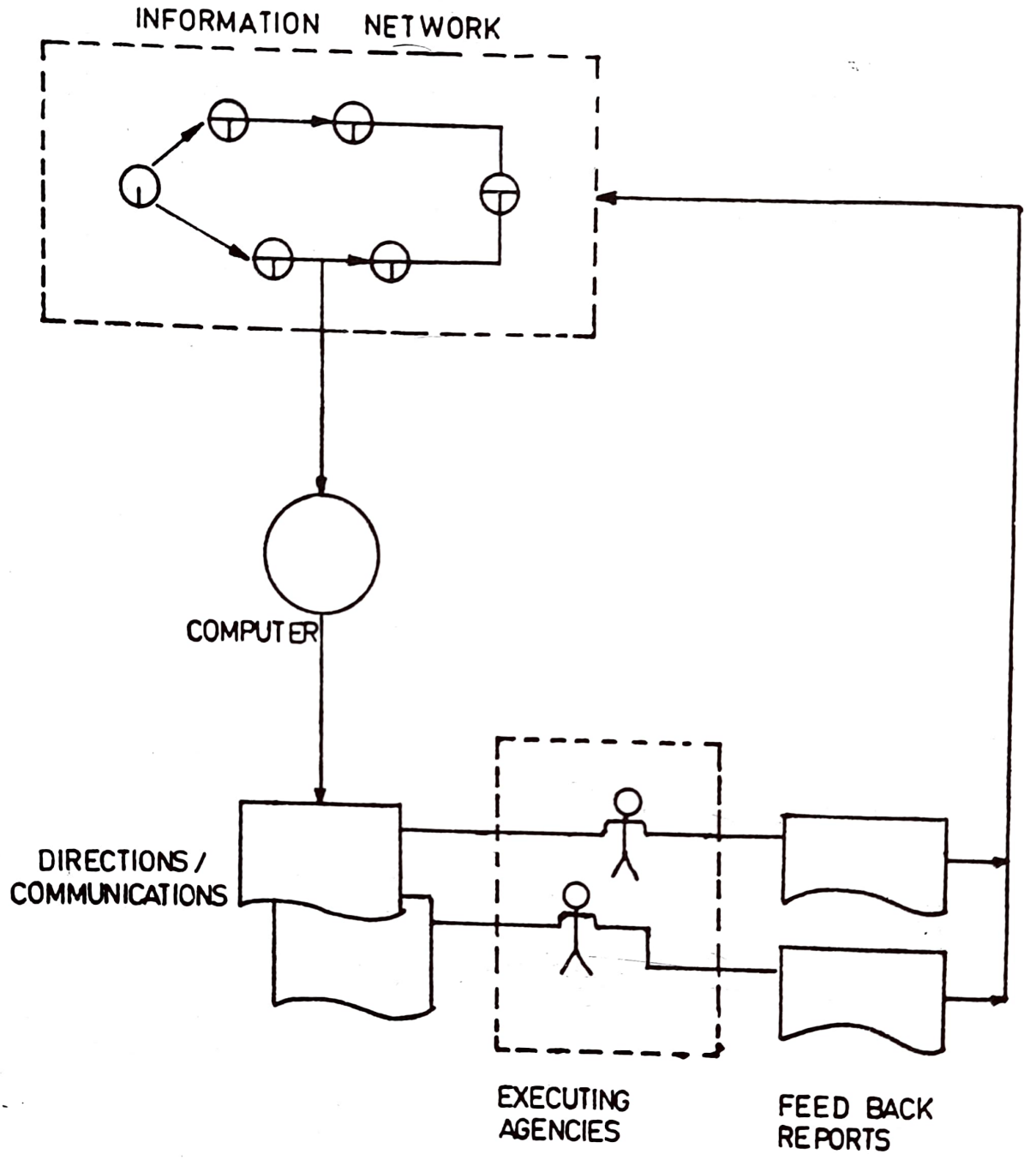


FIG. 1.9 Management system loop

given to the processing scheme in its files, the computer reworks on the model on receipt of the feedback and provides information which enables the decision maker to make new decisions or change the information analogue or whatever else he wants to do.

This process is supposed to work automatically like a closed loop system—at least it does so in a computerised process control situation. But unfortunately, this cannot be done in a project situation. In a project situation the starting information is not as firm, environmental disturbances are far too many, the feedbacks are manual and finally the decision-maker is a human being and, therefore, ultimately things will again depend on *human wisdom* about which we have already talked at great length.

But if for a moment we can assume that human wisdom exists, and also we can make feedback collection automatic or at least unadulterated, we can then operate in a closed loop management system as shown in Fig. 1.10, which is information bound, works as a self-

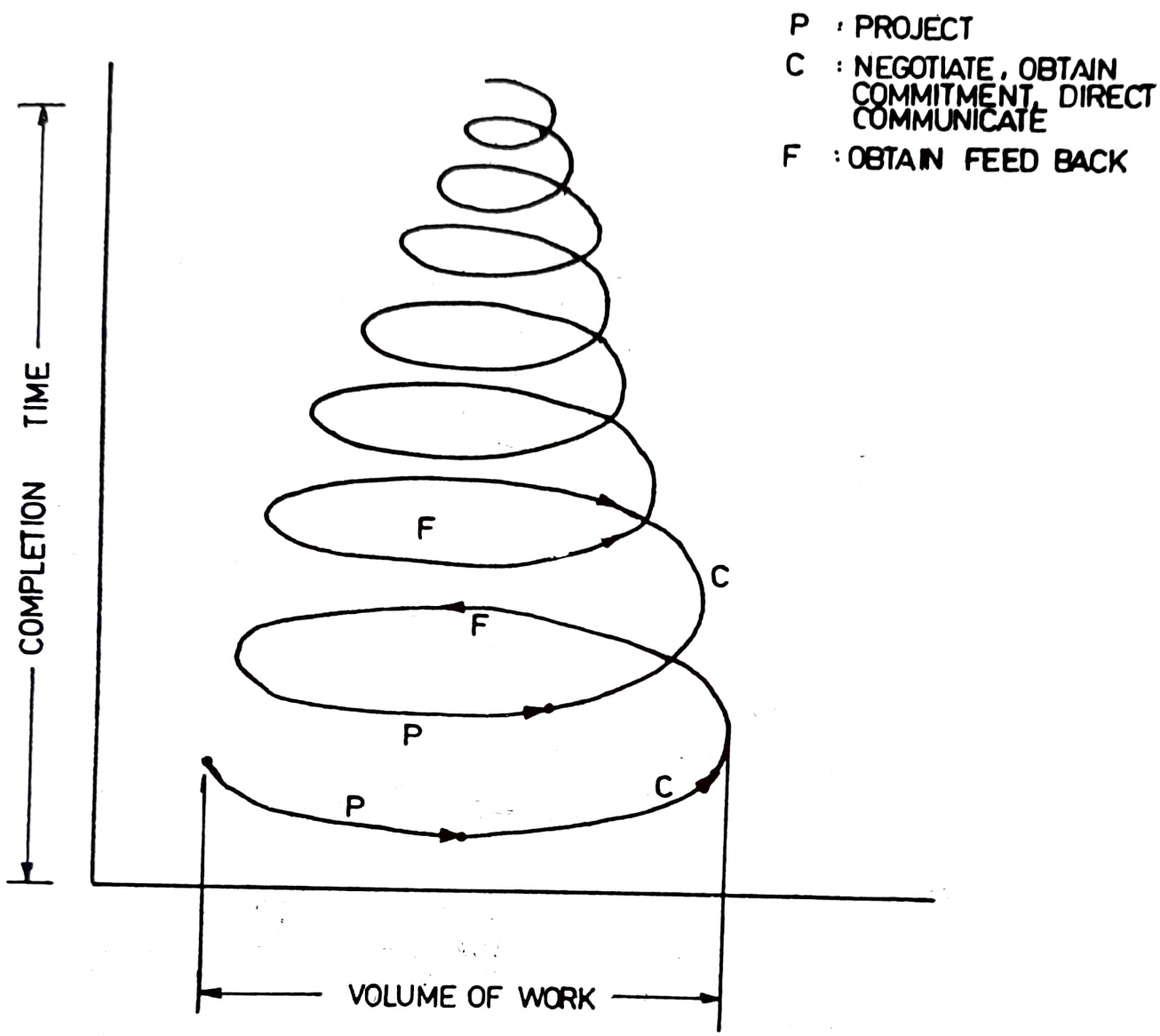


FIG. 1.10 Project management process

regulated system. Such hope has led to the proliferation of computerised project management systems. A project being a system, the management approach should be to identify and organise multitudes of self-regulating systems so that human interventions or so-called external controls could be limited to a minimum inspite of unlimited varieties, and complexities of projects. Project management, with such an approach, would then limit itself to identification of systems, make them self-regulating. If it does not work ideally, one need not despair, for Rome was not built in a day nor in a year. Neither do we need things to work so perfectly, for management, in any case, is not mathematics.

We may then define project management as a process of management through the institution of self-regulating systems which will repeat itself as in case of a helical spring till the task is completed in full within the given parameters of time, budget and performance requirements.

THE PROJECT MANAGER

Inspite of computers and sophisticated software packages we would still need a project

manager to make a project a success. Where do we get him from and what do we expect him to do—are the issues which need immediate discussion. As things stand today, none of the present generation project managers, including the very successful ones, come from any of our management schools. They were just given the job—some succeeded and others did not. Those who succeeded are not many, because only a handful of projects in India were ever completed on time, within budget and performed to expectations. While the failures of these projects had been analysed in many seminars/workshops, the role of project managers and their development did not form the subject of any serious discussion. There could be two reasons for this: (a) Perhaps no one thinks that success or failure of a project depends on the project manager; and (b) It may also be that no one considers them as a special breed of managers. Surprisingly, even some of the practising project managers themselves subscribe to these views.

Project Manager's Problems (5-6 points)

Those subscribing to the first viewpoint argue that in a project everything is unknown and uncertain. Firstly, in a project the scope comes to be clearly known after a passage of long time; and then too no one can guarantee that the project will maintain its shape and size as it has come to be known. There is always scope for change till the project is finally completed. Secondly, those who are to complete the project, i.e. engineers, vendors, contractors, government bodies, etc., are almost strangers with whom the project manager would not have worked in the past, nor may he ever work with them in the future. In any case, they are independent bodies, not accountable to the project manager, nor bound by the corporate discipline which enables managers in all industrial organisations to get things done. And finally regarding the success criteria—i.e. completion of task, time of completion, budget and performance of the hardware being built—in most cases there is no previous experience available. So what can a project manager do? The success of a project, it would appear from the above, depends on the extent of the uncertainties in a project and not on the project manager.

But if, for a moment, we agree to define the project manager as one whose job is to *project* things to happen in a project and manage them, then probably we cannot dissociate him from the success or failure of a project. If it is for the uncertainties that a project tends to fail, then it is for the project manager to *project* the same and manage the same. For those who are conversant with network, which is an important tool for the project manager, this role of the project manager is not difficult to visualise. A project manager first *projects* at zero date what has to come in his way till completion, continuously updates the network to *project* the current scenario, reviews the current scenario, takes corrective actions and then again makes fresh *projections*. Projecting and managing the projections—that's what the role of a project manager should be.

Does it require a special kind of people to do this? It is true that those who are successful do not have a degree in project management (they could not have it anyway, since no university offers it), but all those who have been successful had one thing in common. They were able to introduce *unity in diversity* which is an art of management. A superior leadership has always been able to do this, but then since that type of leadership is a scarce commodity it may be worthwhile to examine if the same can be developed in ordinary mortals. And it appears this is possible—at least so the system thinkers opine.

System thinkers are of the view that uncertainties can be best taken care of by instituting self-regulating systems embracing all the items contributing to uncertainties. A system, for its survival, requires regulation and control, and the survival instinct makes it imperative for a system to be self-controlling. So the speciality of a project manager would consist of identifying and installing viable systems, and intervene only when they tend to disintegrate. The knowledge and skill required for design and management of systems can be imparted easily and, therefore, ordinary mortals can also hope to create *unity in diversity* which only a few gifted individuals were hitherto able to achieve.

The destiny of a project, therefore, can be shaped by a project manager and consequently the education, training and development of a project manager becomes an important subject for all those who are concerned with successful implementation of projects.

BASIC EDUCATION FOR A PROJECT MANAGER

Many would consider that at least for engineering construction projects, the project manager should possess a basic degree in engineering—advanced education in project management and/or training in effective project management could follow. Accordingly, almost all the universities who are thinking of formal education in project management are planning for post-graduate programmes after a basic engineering education. This, one could see, is slightly different from general management education programmes where even arts graduates are admitted.

Perhaps the need for a basic degree in engineering comes from acceptance of the fact that an engineer's main business is design, operation and maintenance of systems, though the emphasis there is mainly on hardware systems. The hardware system forms the core in any project and the concern for effective performance of the hardware is so over-riding that almost all recruitment advertisements for project managers look for an engineer having a basic degree in the hardware system of the project. Whether this is necessary can be debated at length, but the employers as also the educational planners seem to have agreed on one point that a project manager must have basic education in the hardware system which forms the heart of any project.

While analysing the reasons for non-adherence to project schedules in my book on *Project Scheduling and Monitoring in Practice* a point was made that most engineers by virtue of their technical education are incapable of compromising with quality. Usually, they overdo it but when it comes to time and cost, the same concern rarely exists. One often hears of gold plated designs with reference to our engineers lack of concern for cost. And regarding time, the report on *Contrasting Features Between Indians and Japanese at Work* stands as a testimony to our equal lack of concern for the same. A basic education in engineering does not commit a person to time and cost in the same way as it does to quality; but then *commitment* is the essence of professionalism.

Real education is supposed to change the mental make-up of a man, his outlook towards life and things around him, in short, his commitment. If we really possess the shortcomings that have been highlighted in the above referred report, then we need a good education programme and not simply short-term training programmes. The short-term training programmes are good to impart skills in preparation of networks, development of performance budgets, design of systems, performance measurement, project reviews, etc. but they would not prepare a man to accept uncertainties without any grouse, continuously project things he would be required to manage, and above all manage a project through installation of self-controlling systems.

Realising this need, some universities abroad have now started post-graduate programmes in project management. Except for a correspondence course in Punjabi University, Patiala, we do not know of any university offering similar programmes. The Project Management Association, New Delhi, was probably the first organisation in India to realise this need and have so far conducted five part-time post-graduate programmes in project management of one-year's duration each. It appears we will also have to introduce at our universities full-time postgraduate programmes in project management in the not-too-distant future to improve performance of project management.

ROLES AND RESPONSIBILITIES OF PROJECT MANAGER

But then what should be the contents of such a programme? A consensus on the same has not been reached as yet. Meanwhile, it may be worthwhile for us to discuss what are our expectations from the project manager and leave it to the educational planners to design the curriculum for the education and training of project managers.

But can we easily agree on a unique set of roles and responsibilities for a project manager? It would appear that these may vary depending on the agency a project manager represents. Of course, the roles and responsibilities of the owner's project manager would not be exactly the same as that of the prime contractor or that of a project management consultant, but then should we necessarily assume that they are all project managers simply because they are so designated?

Figure 1.11 shows one type of arrangement for the execution of a project. There could be several variations of the execution arrangement and we will discuss some of these in

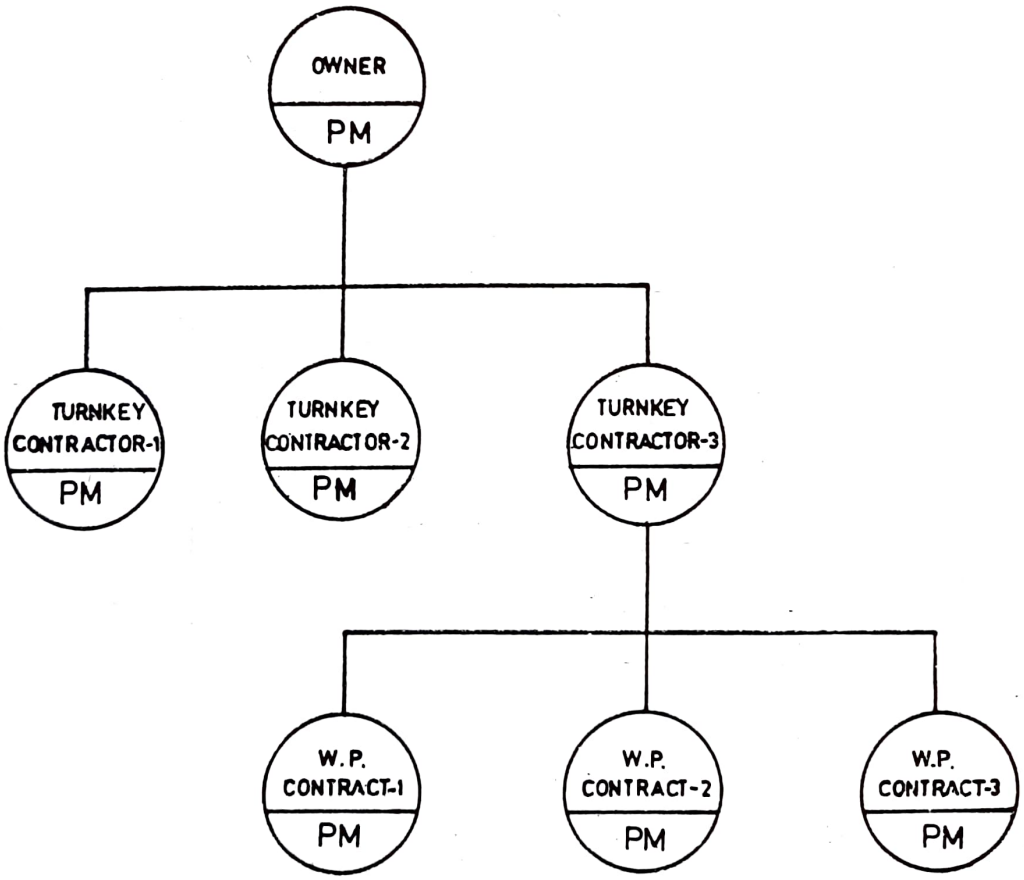


FIG. 1.11 Execution arrangement: responsibility of a project manager

Chapter 3. Figure 1.11 reveals that there could be several project managers in a project and their roles and responsibilities would not be the same. Take, for instance, the owner's project manager. He has a responsibility to ensure that productivity of the capital investment in the project is the highest, i.e. the owner company should be able to build more projects or more saleable products or outputs with same or lesser capital investment. Now the project manager for a work-package contract could not be charged with this responsibility. His job is to complete the scope of work entrusted to his company as per contract specifications. He would really not be interested in proposing relaxation of certain specifications or elimination of certain items of work which merely add to the cost of the project but not to the value just because it would improve capital productivity. Roles and responsibilities of project managers will vary. For that matter, one may also conclude that the scope of project management would depend on the participating agency. Accordingly, there could be different types of project management, namely, project management by owner, project management by consultant, project management by contractor, etc.

To be true to the definition and concept of the project and that of project management, we should not accept such views. Accordingly, while a sub-contractor may designate his manager as project manager, what he performs should not represent the complete roles and responsibilities of a poject manager. In fact, they are only discharging certain limited roles and responsibilities which have been delegated to them; they are not discharging the total function of project management. A project manager should have fixed roles and responsibilities, and if it so happens that due to the design of project execution arrangement, a sub-contractor's manager also performs the same, then and then alone, we should call him a project manager. This approach is necessary to ensure inculcation of professional ethics and development of a body of knowledge which will meet the need of all types of project managers.

The basic roles and responsibilities of a project manager that we are referring to could be grouped under twelve heads:

1. Defining and maintaining the integrity of a project
2. Development of project execution plan
3. Organization for execution of the plan
4. Setting of targets and development of systems and procedures for accomplishment of project objectives and targets
5. Negotiation for commitments
6. Direction, coordination and control of project activities
7. Contract management.
8. Non-human resource management including fiscal matters
9. Projectising and problem-solving
10. Man management
11. Satisfaction of customer, Government and the public
12. Achievement of project objectives, cash surplus and higher productivity

Some of the above roles and responsibilities can be considered as general management capabilities—we, therefore, shall not discuss these in this book. Only the areas which are peculiar to project management need to be discussed—and accordingly we shall discuss these in detail in the subsequent chapters.

PROJECT MANAGEMENT AS A PROFESSION

But before we move to other topics we need to answer whether project management is indeed a viable profession. It is one thing to prepare a long list of roles and responsibilities, but can we really prepare people to discharge the same? Further, if at all we are able to develop the same, would there be a need for these people in the society? These questions are very relevant since some people maintain, as we had discussed earlier, that a project manager must be thorough in the technology of the project. Perhaps this requirement is being talked of in view of the very first role and responsibility we have listed relating to a project's formulation and the maintenance of its integrity throughout its life cycle. If we are to accept that we need a cement technologist for the management of a cement project, a refractory specialist for a refractory project, a ceramic specialist for a glass project and so on, we, perhaps, cannot make project management a viable career proposition. Because in that case we have to pick up only those with years of experience in a cement plant and train or educate them for project management. This would not be a viable proposition since we may not get many individual specialists in all aspects of a cement project from limestone prospecting to cement despatch to meet the requirement of any country. Neither will those individuals be young and alert enough to be trained in any new art and science of management.

We believe that this is not necessary. The reality of life teaches us that no individual in our society, howsoever gifted he might be, can be complete by himself. We all do and need to supplement each other to survive. This holds true for any system, and in project management we talk of management only through system approach. It would be easy to supplement the inadequacies of a project manager if we are prepared to accept the project manager's basic role as that of a *system integrator* and accept with humility that what the world needs, particularly what India needs, is that people must work together and nothing great can be achieved unless people can be made to work together. That is the discipline or specialisation we need for our survival, growth and prosperity. It is the *synergy* that we need to bank upon, and not the *energy* of a few supermen for completing our giant projects or completing the great task of elevating our standard of living through techno-economic projects. If we have been able to achieve success in some of our projects, without proper education or training in project management, we must admit we have been able to do so because of a few supermen. We need education and training in project management, because no country in the world is lucky enough to have such supermen in large numbers.

If we can leave aside the question of technological competence for a moment, it can be seen that it would be rather easy to develop a body of knowledge which will create all other competences that we are looking for, for successful completion of our project. Now coming to technology, it does not require one to be a specialist in the concerned technology to be able to maintain the integrity of some project whose technological requirements have been defined by a technologist. This is not to say that no appreciation of the technology is required. Perhaps a little of that is enough, the rest is a discipline which can be developed through education and training. If we do not needlessly overemphasise the technological knowledge base, we have a perfect case for a full-fledged new discipline called project management, to which we shall address ourselves in this book.