Open-Ended Problems: A Future Chemical Engineering Education Approach. J. Patrick Abulencia and Louis Theodore.

13

Project Management

This chapter is concerned with process project management. As with all the chapters in Part II, there are several sections: overview, several technical topics, illustrative open-ended problems, and open-ended problems. The purpose of the first section is to introduce the reader to the subject of project management. As one might suppose, a comprehensive treatment is not provided although numerous references are included. The second section contains three open-ended problems; the authors' solution (there may be other solutions) are also provided. The third (and final) section contains 37 problems; *no* solutions are provided here.

13.1 Overview

This overview section is concerned—as can be noted from its title—write project management. As one might suppose, it was not possible to address all topics directly or indirectly related to project management. However,

additional details may be obtained from either the references provided at the end of this Overview section and/or at the end of the chapter.

Note: Those readers already familiar with the details associated with this subject may choose to bypass this Overview.

One of the authors [1] has estimated that better than 75% of chemical engineers are involved with project management activities… and this percentage will continue to increase in the future. The need for the traditional chemical engineer who designed heat exchangers, specified pumps, predicted the performance of multi-component distillation columns, etc., has all but disappeared. This is a fact that the profession has difficulty in accepting [2,3]. But, the reality is that chemical engineers in the future will require some understanding of project management.

Project management has come to mean different things to different people in the technical community. The term *project* is a time-constrained endeavor undertaken to create a unique product, service, result or activity; it is temporary in duration, with a defined beginning and end. The term *management* is an activity concerned with bringing a group of people (generally more than two) together to accomplish a desired or set goal. Management can include a host of activities, some of which are discussed in subsequent sections. *Project management* may be viewed as the process of "managing" multiple related projects. Alternately, project management has been defined as a discipline involved with the planning, organizing, securing, and managing resources to achieve specified goals. Thus, the challenge of project management is to achieve all (where possible) of the project goals and objectives. Perhaps key to project management is selecting the right/best projects, the right personnel and then applying appropriate project management techniques and approaches.

Project participants are referred to as the project team. In effect, it is the management team that leads the project and provides all the necessary services to the project. The project manager should be a professional in the field of project management; he/she has the responsibility of the planning, execution, and closing of the project. This individual is primarily responsible for the project plan, defined as the formal, approved document used to guide both *project execution* and *project control*. It documents planning assumptions and decisions, facilitates communication among team members, and documents approved scope, cost, and schedule *baselines*.

Another important element in project management is *risk management*. Its objective is to reduce different risks related to various activities to an acceptable

level. It may be related to numerous other types of risks arising because of the environment, technology, humans, organizations, social constraints, politics, etc. Another important element in project management is the risk management associated with the probability of specific eventualities [1]. The risk may be related to financial or environmental considerations in order to reduce different risks related to a preselected activity to a level accepted by society.

It should be noted that there have been several attempts to develop international management standards. The International Organization for Standardization (ISO) develops ISO standards; ISO 9000 are a family of standards for quality management systems. This group was founded in 1947 and is responsible for standardizing everything from paper size to film speeds. (The American National Standards Institute, ANSI, is the US representative to ISO.) The standards are a voluntary series of guidelines designed to address management. They focus on management on the belief that correct management will lead to better performance.

The chapter consists of 8 additional sections. The presentation to follow will address the following (some of which are noted above) project management topic areas.

1. Managing Project Activities
2. Initiating
3. Planning/Scheduling
4. Gantt Charts
5. Executing/Implementing
6. Monitoring/Controlling
7. Completion/Closing
8. Reports.

13.2 Managing Project Activities

There are a number of approaches to managing project activities, including agile, interactive, incremental, and phased approaches. Each requires careful consideration with respect to overall project objectives, timeline, and cost, as well as the roles and responsibilities of all participants and stakeholders. The traditional phase activity involves a "railroad" approach that consists of 6 developmental components of the project:

1. Initiation
2. Planning and design
3. Execution and construction

4. Monitoring/controlling
5. Completion/closing
6. Reports.

Not all projects will involve every stage, as some projects can be terminated before they reach completion. Some projects may not follow a simple structured (or railroad according to one of the authors) planning and/or monitoring process. Some projects are interactive and will go through steps 2, 3, and 4 multiple times. It should be noted that many industries use variations of this approach. For example, these stages may be supplemented with decisions (go/no go) at which point the project's continuation is defined and decided.

Another relatively simple project management approach could take the following form [1].

1. Develop an overall project schedule, work plan, and task outline(s)
2. Develop project budget estimates
3. Solicit and evaluate equipment vendor proposals
4. Compare capital and operating costs
5. Prepare cost/benefit analyses and understand the sensitivity of these analyses relative to the factors involved
6. Monitor and report project status with respect to both schedule and budget
7. Prepare a (final) report.

13.3 Initiating

The initiating process generally determines the nature and scope of the project. If this stage is not performed well, it is unlikely that the project will be successful in meeting its objectives. Following the selection of the project manager and team members, this stage should include a plan that addresses the following areas:

1. Project objectives
2. Analyzing the business needs/requirements in terms of measurable goals
3. Reviewing present operations
4. Financial analysis of the costs and benefits
5. Stakeholder analysis, including users, and support personnel for the project.

Projects have beginnings and ends. The project schedule or cycle is often a reflection of what should be accomplished and what options are available. Since projects arise out of need, the whole project management process begins when someone or something has a need to be fulfilled. When it comes to project selection, choices have to be made by the group. Some projects are selected, while others are rejected. Decisions are made on the basis of available resources, the number of needs which must be addressed, the cost of fulfilling those needs, and the relative importance of satisfying one set of needs and ignoring others.

The key player during this initiating stage is the aforementioned project manager. Since (in a general sense) project management is the planning, organizing, directing, and controlling of company resources for a relatively short-term objective that has been established to complete specific goals and objectives, the project manager is responsible for coordinating and integrating activities related to the project in question. The two most important roles of the project manager are to select the team and complete the project on time, within budget, and according to any specification(s). His/her basic roles are:

1. Technical supervision
2. Initial project planning
3. Project team organizing
4. Project team direction
5. Controlling technical quality, schedule and costs
6. Early communication with client(s) and vendor(s).

The strong project manager is the nucleus of the project and can ensure the success of the project. However, individual experts must be coordinated accordingly. Team managers are often asked to deal with specified constraints of time and dollars, sometimes under great stress. The project manager needs to give technical guidance, management expertise, plus enthusiasm and support to the team. Interestingly, the project manager often does not have the authority to pick his or her own team, but it is the authors' contention that he/she should be given this directive.

13.4 Planning/Scheduling [1–4]

This obviously is the most important stage of the project, and understandably receives the bulk of the treatment. Planning is conducted throughout

the duration of the project. Project milestones are identified, and tasks are laid out. Many tools exist to assist the project manager in devising the formal project plan: work-breakdown structures, Gantt charts (see next section), network diagrams, resource allocation charts, cumulative cost distributions, etc. As the project is carried out, the plan may undergo considerable modification as it adapts to unanticipated circumstances. Project management plans are *time-variable*, allowing the project staff to manage change in an orderly and systematic fashion.

The primary objective of/at this stage is to plan time, cost, and resources adequately in order to estimate the work required and to effectively manage any potential risk(s) during project execution. As with the initiation step, a failure to adequately plan greatly reduces the project's chances of successfully accomplishing its goals.

Project planning generally includes the following 10 steps:[4]

1. Approval from management to initiate the project
2. Identifying deliverables and creating the work breakdown structure
3. Identifying the activities needed to complete deliverables
4. Networking the activities in a logical order
5. Estimating the resource requirements for the project, including time and cost
6. Developing the project schedule
7. Developing the project budget
8. Investigating potential risks
9. Identifying all roles and responsibilities
10. Conducting an initial get-together meeting.

Any work plan should also include:

1. What is to be done?
2. Who will do it?
3. When is it to be done?
4. How much will it cost?

Time, money, human and material resources all come into play at this time. Time (management) is handled normally through the use of schedules. Money is handled by budgets which indicate how project funds are to be allocated, while human and material resources are concerned with how best to allocate (potentially limited) resources on projects.

13.5 Gantt Charts

An integral part of project planning involves scheduling the project tasks in such a way that the project is carried out both logically and efficiently. The schedule serves as a master plan from which the client, as well as management, can have an up-to-date picture of the progress of the project. Schedules (as noted earlier) normally include lists of tasks and activities, dates when those tasks are to be performed, duration of those tasks, and other information related to the timing of project activities.

The information discussed above can be displayed in several ways. The most popular form is the bar chart, originally developed by Gantt (which carries his name). The Gantt chart is a type of bar chart that illustrates a project schedule. It includes the beginning and ending dates of the terminal elements and summary elements of a project. Terminal elements and summary elements comprise the work breakdown structure of the project. Figure 13.1 is a crude type of Gantt chart. By reading from the horizontal axis, the project staff will know the planned start and finish dates for different tasks. The chart is also useful for project control when actual achievements vary, thereby enabling the determination of schedule variance. Figure 13.1 shows, for example, that the project is off schedule from the very beginning, when Task 1 begins later than planned. Note that the actual duration of Task 1 is equal to the planned duration, so the schedule slippage is entirely accounted for, despite the fact that it started late. With Task 2, it is clear that not only did the task begin late, but it took longer to accomplish than planned. Schedule slippage here could be caused by

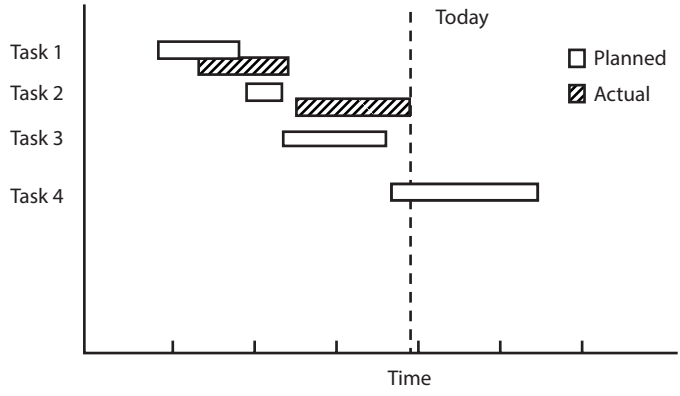

Figure 13.1 Gantt chart

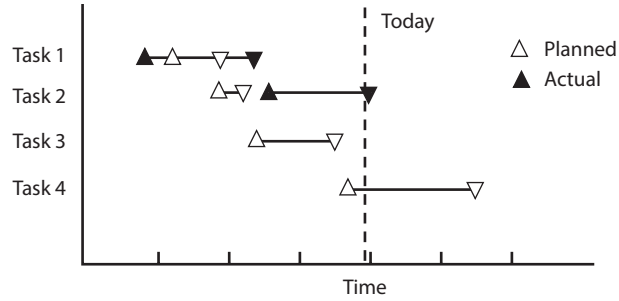

Figure 13.2 Gantt chart, alternate form

both the late start and sluggish performance that stretched out the task's planned duration.

Figure 13.2 presents a slightly different approach to the employment of a Gantt chart. The basic facts here are *identical* to those given in Figure 13.1. However, they are presented in a different manner. With this approach, planned start dates are pictured as hollow upright triangles, and actual finish dates are solid downward-pointing triangles. A comparison of the two charts indicates that they both give the same information.

These Gantt charts are widely used for the planning and control of schedules on projects. Their past and present popularity lies in their simplicity [5].

13.6 Executing/Implementing [1,4]

When a formal plan has been devised, the project is ready to be carried out. In a sense, implementation is at the heart of a project, since it entails doing the things that need to be done, as spelled out in the aforementioned project plan. The executing consists of the processes used to complete the work defined in the project plan in order to accomplish the project's objectives. The execution process involves coordinating people and resources, as well as integrating and performing the activities of the project management plan. The deliverables are produced as outputs from the process(es) performed as defined in the project management plan and other frameworks that might be applicable to the type of project at hand.

This stage also involves direct (or indirect) communication between all members of the project team and with upper-level management. The procurement process must be clearly spelled out and adhere to. Quality assurance/quality control (QA/QC) needs to be implemented and this involves both this and the next stage to be discussed.

The implementation phase of a project essentially consists of performing the actual work to complete the project. It is usually the project manager who performs a variety of functions to ensure the project is effectively implemented, considering the constraints of schedule and budget.

Successful project completion is dependent on a number of factors, including, but not limited to the following eight:

1. Updating the project plan, as necessary
2. Staying within the scope of work specified by the project plan
3. Getting authorization for changes
4. Providing deliverables in stages
5. Conducting project review meetings
6. Frequently checking the technical work being performed in order to provide guidelines and direction as needed
7. Keeping up-to-date project information
8. Reviewing the performance of the project staff in order to assist if help is necessary.

Other techniques to assist in effective project implementation is to conduct regular meetings. Periodic review meetings are an integral component of project implementation and maintaining control over project execution. The general purposes for these project meetings are quality review, schedule review, cost review, and keeping the project team informed. Review meetings with appropriate corporate and functional managers as well as the customer (if applicable) to review the current status of the project are essential.

13.7 Monitoring/Controlling [1,4]

Monitoring and controlling consists of those processes performed to observe project implementation so that any problems can be identified at an early stage and in a timely manner so that corrective action can be taken. The main objective is that project performance is observed and measured regularly to identify any variances from the project management plan. These control systems are required not only for cost, communication, time changes and procurement issues, but also for risk, quality, and human resources. Thus, this stage may be viewed as an independent element in the overall plan. In multi-phase projects, the monitoring and control process also provides feedback between project phases in order to implement

corrective or preventive actions to bring the plan into compliance with the objective of the project management plan.

Project control is based on establishing an effective project plan with cost, time, and technical baselines. During the aforementioned implementation phase, control is accomplished by measuring, evaluating, and reporting actual performance against these baselines. It is important for the chemical engineer to understand and realize that project management is a team effort, and must rely on the project team to successfully complete their project activities; this will help maintain control of the project.

There are many functions that the project manager may perform to help keep project control. These include the following five assignments:

1. Frequently review project team activities
2. Provide the support the team needs to complete assigned activities
3. Inform the project team of the status of the project, and what needs to be done next
4. If necessary, prioritize tasks for team members
5. Communicate problems or changes to the customer, management and/or the project team as soon as possible.

While the basis of project control is based on good project planning and monitoring, project execution and control is facilitated by using effective control methods such as:

1. Updating schedule and cost estimates
2. Conducting project team meetings
3. Using work authorizations.

13.8 Completion/Closing

Projects ultimately come to an end. Sometimes this end is abrupt and premature, as when it is decided to kill a project before its scheduled termination. However, it is always hoped that the project will meet a more positive ending. In any case, when projects end, the project manager's responsibilities almost always continue. There are various closeout duties to be performed. For example, if equipment was used, this equipment must be accounted for and possibly reassigned to new uses. On contracted projects, a determination must be made as to whether the project deliverables satisfy the contract. Final reports may have to be written, a topic discussed in the last section of this chapter.

The closing procedure includes the formal acceptance of the project and the ending thereof. Administrative activities include the archiving of the files and documenting any lessons learned. In fact, this final phase consists of three closures.

1. Finalize all activities across all of the process groups in order to formally close the project or project phase.
2. Complete and settle each contract (including the resolution of any unresolved items) and terminate each contract applicable to the project (or project phase).
3. Release all members of the team from their assignments.

13.9 Reports

The most important project management report is the *final* report. These reports can take any of several forms. As noted in Chapter 11, the most important part of a final report is the ABSTRACT or what some refer to as EXECUTIVE SUMMARY. *This is the most important part of the report.* It should briefly summarize (without referring the body of the report) the project's description and objectives, project activities and the results/findings/inclusions. However, there are other earlier reports, and consideration should be given to appending them to the final report. Those other reports generally fall into three categories: *progress reports*, *contact reports*, and *project status reports*.

Project progress reports are one of the best ways to track the progress of a project; these reports are used to monitor the activities and compare them to schedule and budget. Periodic progress reports should contain the information on the status of project activities, schedule, budget, goals achieved, goals not achieved, goals due, important meetings, correspondence, release or delivery of deliverables, other reports, and (if applicable) equipment specifications and designs.

As noted earlier, contact reports are used to document project related communication with the client. They are particularly useful in documenting any changes in project schedule, feedback on deliverables, and changes in project scope. Contact reports are normally sent to project team members and functional managers. They provide an excellent opportunity to keep everyone abreast of project progress and project status. Contact reports are also used to confirm telephone conversations with clients. When sent to the client, they place in writing an understanding of the client's comments and planned actions. When used in this manner, contact reports minimize misunderstandings. However, it is not necessary or desirable to document

everything in contact reports; to do so can undermine their value. Routine project communication can also be recorded on a contact/telephone log.

A detailed and expanded treatment of project management is available in the following two references.

1. L. Theodore, *Chemical Engineering: The Essential Reference*, McGraw-Hill, New York City, NY, 2014.
2. H. Kerzner, *Project Management*, 2nd edition, Van Nostraud Reinhold, New York City, NY, 1984.

13.10 Illustrative Open-Ended Problems

This and the last section provide open-ended problems. However, solutions *are* provided for the three problems in this section in order for the reader to hopefully obtain a better understanding of these problems which differ from the traditional problems/illustrative examples. The first problem is relatively straightforward while the third (and last problem) is somewhat more difficult and/or complex. Note that solutions are not provided for the 37 open-ended problems in the next section.

Problem 1: Provide a brief description of the potential role(s)/activities of a chemical engineer in a management project.

Solution:

1. Selects the personnel for the technical portion of the proposal work
2. Develops a general scope of work assignment
3. Assigns individuals to specific tasks
4. Develops man-hour estimates
5. Prepares the technical portion of any initial proposal
6. Prepares the technical portion of intern reports
7. Prepares the technical portion of the final report
8. Ensures the completeness and accuracy of any technical responses
9. Reviews cost estimates
10. Assists the project manager in coordinating all technical activities of the project
11. Suggests candidates for any additional technical work
12. Reviews the cost estimate of the project
13. Reviews inquiries from a legal or contractual perspective.

Problem 2: Conflicts. Conflicts. Conflicts. They are almost always an integral part of the project management process. List some of the potential conflicts.

Solution: Kerzner [6] provides a list of some of these conflicts.

1. Technical abilities
2. Managerial abilities
3. Manpower availability
4. Equipment and facilities availability
5. Capital expenditures
6. Peripheral costs
7. Technical opinions
8. Technical trade-offs
9. Project priorities
10. Administrative procedures
11. Schedule
12. Responsibilities
13. Personality clashes
14. Financial compensation
15. Recognition of efforts.

Problem 3: Estimating the time requirements for a project activity occasionally is a difficult task. The general procedure to provide a best-estimate for each activity is relatively simple. This best-estimate is almost always based on past experience and (what has come to be defined as) good engineering judgement. One of the authors [7] has advocated, and previously employed, a Delphi Panel method. (This same author has also modestly referred to this method as the Theodore Panel Approach (TPA).) Describe this approach to estimating risks and suggest a method that *quantitatively* provides information on the variance of the estimate.

Solution: At the simplest level, a group of project members or experts are brought together to discuss a risk valuation in order to reach a consensus as to its most appropriate value. The procedure is iterative, with feedback between iterations, and involves 6 steps once the experts have been chosen. These six steps are as follows: [7]

1. Select, in isolation, independent estimates of the risk *and* reasons/justification for the selected value.
2. Provide these initial results and reasons to the other experts.

3. Allow each expert to reverse his or her initial estimate and to provide the reasoning for any change to the initial value.
4. Repeat Steps 1 through 3 until a "consensus" value is approached.
5. Use the average of the final estimate as the best estimate of the risk.
6. Use the standard deviation of estimates as a measure of the uncertainty.

In effect, the experts get locked in separate rooms, providing independent judgments, until some approach to convergence is achieved. Naturally, the experts (panelists) must be willing to share their knowledge, experience, and information with each other if this effort is to be successful.

Kerzner [6] suggest applying (perhaps in conjunction with the method described above) the following procedure to generate time information

1. *The most optimistic completion time.* That should occur approximately 1 percent of the time.
2. *The most pessimistic completion time.* That should also occur approximately 1 percent of the time.
3. *The most likely completion time.*

The expected time between any project event period can then be found from the expression:

$$\overline{t} = \frac{a + 4t + b}{6} \tag{13.1}$$

where $\overline{t}$ = expected time
a = most optimistic time
b = most pessimistic time
t = most likely time

In order to calculate the probability of completing the project on time, the standard deviation of each activity in the project must be known. This can be found from the expression:

$$s = \frac{b - a}{6} \tag{13.2}$$

where s is the standard deviation associated of the expected time for a particular activity, $\overline{t}$. Another useful expression is the variance, s^2, which is the square of the standard deviation [8]. For a multi-time phase one must

calculate the square root of the sum of the squares of each of the time activity standard deviations. For example, assume there are four phases—A, B, C, D—to a project with corresponding time activities (low, medium, high) in months:

A: 1 – 2 – 3

B: 3 – 4 – 5

C: 6 – 10 – 14

D: 2 – 4 – 6

The best estimate for the project is obtained by first calculating s_i for each activity employing Equation (13.2) and applying Equation (13.3)

Thus

$$s_A = \frac{3-1}{6} = 0.33$$

$$s_B = \frac{5-3}{6} = 0.33$$

$$s_C = \frac{14-6}{6} = 1.33$$

$$s_D = \frac{6-2}{6} = 0.66$$

$$s = \sqrt{\sum (A_i)^2}$$

and

$$\begin{aligned} s &= \sqrt{(0.33)^2 + (0.33)^2 + (1.33)^2 + (0.66)^2} \\ &= \sqrt{0.111 + 0.111 + 1.769 + 0.444} = \sqrt{2.435} \\ &= 1.560 \end{aligned}$$

If the project time is normally distributed, there exists a 68 percent chance of completion within on standard deviation, 95 percent within two standard deviations, and 99 percent within three standard deviations. This is presented in Table 13.1, noting that the initial average estimate is 20, i.e., (2+4+10+4). If there appears the possibility that the project might be extended beyond the expected 20 months, then additional costs will arise with accompanying cost overruns.

Table 13.1 Statistical Estimates of Total Time in Months

	PERCENTAGE	EXPRESSION	RANGE
s	68	20 ± 1.56	18.44 – 21.56
$2s$	95	20 ± 3.12	16.88 – 23.12
$3s$	99	20 ± 4.68	15.32 – 24.68

13.11 Open-Ended Problems

This last section of the chapter contains open-ended problems as they relate to project management. No detailed and/or specific solution is provided; that task is left to the reader, noting that each problem has either a unique solution or a number of solutions or (in some cases) no solution at all. These are characteristics of open-ended problems described earlier.

There are comments associated with some, but not all, of the problems. The comments are included to assist the reader while attempting to solve the problems. However, it is recommended that the solution to each problem should initially be attempted *without* the assistance of the comments.

There are 37 open-ended problems in this section. As stated above, if difficulty is encountered in solving any particular problem, the reader should next refer to the comment, if any is provided with the problem. The reader should also note that the more difficult problems are generally located at or near the end of the section.

1. Describe the early history associated with project management.
2. Discuss the recent advances in project management.
3. Discuss how project management can impact the career of a chemical engineer.
4. Select a refereed, published article on project management from the literature and provide a review.
5. Provide some normal everyday domestic applications involving the general topic of project management.
6. Develop an original problem in project management that would be suitable as an illustrative example in a book.
7. Prepare a list of the various books which have been written on project management. Select the three best and justify your answer. Also select the three weakest books and, once again, justify your answer.

8. One of the major concerns with project management is cost control, particularly as it applies to cost overruns. Cost control is important to all projects, regardless of size. Small projects generally have tighter monetary controls, mainly because of the smaller risk associated with the failure of the project. Large companies may have the luxury to distribute project losses over several projects. Cost control is primarily concerned with the monitoring of costs and it often involves the recording of massive quantities of data. It is recommended that cost control be performed by all personnel who incur costs—not only the project officer.
   Cost control activities generally include:
   - Cost estimating
   - Cost accounting
   - Project cash flow
   - Company cash flow
   - Direct labor and any overhead costing
   - Miscellaneous costs.

   Detail and describe some of these activities
9. Financial compensation and/or rewards are important to the morale and motivation of people in any project management endeavor. However, there are several issues that often make it necessary to treat compensation issues related to project personnel separately from the rest of the organization. Explain why this dilemma exists and outline how it can be best addressed.
10. Refer to Problem 2 in the previous section. Provide procedures/suggestions that can reduce or eliminate the listed conflicts.
11. Refer to Problem 2 in the previous section. As one might suppose, there are numerous other categories of conflict. List some of the other potential conflicts and provide procedures/suggestions that can reduce their impact. In effect, how can conflicts be best managed?
12. Four of the major causes for the failure of a proposed project management include:
    - Selection of a project that is not appropriate for the organization and/or team.
    - Selection of the wrong individual as project manager.
    - Selection of the wrong individual(s) for management staff.
    - Upper management is not supportive.

Discuss how these potential failures can be reduced.

13. Refer to the previous problem. There are obviously other causes for a project to fail. Detail at least four other causes and suggest approaches that can be implemented to reduce the impact of these causes.
14. Kerzner [6] and Avots [9] have indicated that more can often be learned from failure than from success. They list the following 10 lessons that can be learned from project failure.

    - When starting off in project management, plan to go all the way.
    - Don't skimp on the project manager's qualifications.
    - Do not spare time and effort in laying out the project groundwork and defining work.
    - Ensure that the work packages in the project are of proper size.
    - Establish and use network planning techniques, having the network as the focal point of project implementation.
    - Be sure that the information flow related to the project management system is realistic.
    - Be prepared to adjust assignments continually to accommodate frequent changes on dynamic program
    - Whenever possible, tie together responsibility, performance, and rewards.
    - Long before a project ends, provide some means for accommodating the employees' personal goals.
    - If mistakes in project implementation have been made, make a fresh try.

    Provide additional explanatory detail(s) on these lessons.
15. Project management analysis via the matrix approach has received significant attention in this field. Discuss the advantages of employing a matrix-type approach.
    Comment: Refer to the analysis provided by Kerzner [6].
16. Project management analysis via the matrix approach has received significant attention in this field. Discuss the disadvantages of employing a matrix-type approach.
    Comment: Refer to the analysis provided by Kerzner [6].
17. One of the main problems that arises during a project is that a team member (including the project manager) may have more "loyalty" elsewhere within the organization. Discuss how this can best be addressed.

18. Most project managers often request that the project evaluation process be different from how they are usually evaluated. Is this a reasonable response?
19. ISO 21500:2012, *Guidance on Project Management*, was published in 2012. Although ISO (International Organization for Standardization) 10006, *Quality Management Systems—Guide—lines for Quality Management in Projects*, has been around since 2003, it focuses only on the application of quality management practices and principles to project management. ISO 21500 is the first ISO standard to address the complete project management process. Discuss the key features of ISO 21500.
20. The Project Management Institute (PMI) released the 5th Edition of the *A Guide to the Project Management Body of Knowledge* (PMBOK, an ANSI Standard) in early 2013. Although there are some differences between this and earlier editions of PMBOK, this edition is not a rework of the practices detailed in the fourth edition. It has been reported [10] that the fifth edition builds on the fourth edition to add some new material while consolidating and reorganizing select existing material. Provide you review of the 5th edition.
21. Elam [10] has indicated that there is excellent agreement between the 5th edition of PMBOK and ISO 21500:2012, the result of PMI's active involvement in shaping the new ISO standard on project management, and that project managers will find little difference between the two standards. Are his comments reasonable?
22. The company president has requested that you provide a two hour seminar to all technical employees on the merits of the traditional project management approach. Provide a PowerPoint (P2) presentation that you feel would not only satisfy the president but also be beneficial to the organization's employees.
23. There are various codes of ethics for chemical engineers, engineers in general, and scientists. (See also Chapter 22). Prepare a code of ethics for project managers.
24. Describe the difference between project management and product management. Also comment on how these differences will/may change in the future.
25. Suggest how the Gantt "chart" approach can be improved.

26. It has been reported that lifestyles in the U.S. will change drastically in the future. Can this change impact project management? Justify your answer.
27. Describe the role government and government-related activities has, is, and will influence project management.
28. One of the authors [11] has recommended that the following approach be employed in purchasing equipment.

    - Refrain from purchasing any equipment without reviewing *certified independent test data* on its performance under a similar application. Request the manufacturer to provide performance information and design specifications.
    - In the event that sufficient performance data are unavailable, request that the equipment supplier provide a small pilot model for evaluation under existing conditions.
    - Consider requesting participation of an "authority" in the decision-making process.
    - Prepare a good set of specifications. Include a *strong performance guarantee* from the manufacturer to ensure that the control equipment will meet all applicable local, state, and federal codes at specific process conditions.
    - Closely review the process and economic fundamentals.
    - Make a careful material balance study before authorizing or purchasing equipment.
    - Refrain from purchasing any equipment until *firm* installation cost estimates have been added to the equipment cost. *Escalating installation costs are the rule rather than the exception*.
    - Give operation and maintenance costs high priority on the list of equipment selection factors.
    - Refrain from purchasing any equipment until a solid commitment from the supplier(s) is obtained. Make every effort to ensure that the new system will utilize equipment fuel, controllers, filters, motors, etc, that are compatible with those already available at the plant.
    - The specification should include written assurance of *prompt* technical assistance from the equipment supplier. This, together with a complete operating manual

(with parts list and full schematics), is essential and is too often forgotten in the rush to get the equipment operating.
- Schedules, particularly on projects being completed under a court order or consent judgment, can be critical. In such cases, delivery guarantees should be obtained from the manufacturers and penalties identified.
- If applicable, equipment should be of fail-safe design with built-in indicators to show when performance is deteriorating [7].
- Withhold 10 to 15% of the purchase price until satisfaction is clearly demonstrated.

The above procedure was developed nearly a half century ago. You have been assigned the task of both updating and improving the above procurement procedure.

29. As a purchasing agent for D'Aquino Industries, you have been requested to develop a procedure to justify decisions regarding the purchases of equipment. The procedure should be of a *quantifiable* nature. See also the previous problem.
30. As a plant manager, would you consider maintenance or inspection more important?
31. Discuss the role economics plays on OM&I activities.
32. Tiffany, a consultant for Theodore Partners, was recently hired by a cosmetic firm to develop an OM&I procedure for their recently designed and constructed nanotechnology facility. The plant generates nanoparticles for several of their cosmetic products. (See also Chapter 20). Outline a procedure.
33. Discuss the role operation and maintenance plays in the purchase of equipment and equipment parts. (See also Chapter 10).
34. Which of the various mass transfer devices has the greatest OM&I problems? Justify you answer (See also Chapter 7).
35. ATE (Abulencia-Theodore Enterprises) consultants have been assigned to a management project concerned with the development and marketing of a new nanotechnology [12,13] product. After setting the schedule for the project, the consultants are informed that the due date for the two year project has been reduced to one year. Describe in qualitative terms the impact this change could have on the overall success/performance of the project.

36. One of the authors [11] has indicated the following. Many design/procurement/construction/startup problems can be compounded by any one or combination of the following:
    - Unfamiliarity of process engineers with engineering
    - New and changing codes
    - New suppliers with frequently unproven equipment
    - Lack of industry standards in some key areas
    - Interpretations of control agency field personnel
    - Compliance schedules that are too tight
    - Vague specifications
    - Weak guarantees for the new equipment
    - Unreliable delivery schedules
    - Process unreliability problems.

    You have been assigned the task of outlining how to remove or eliminate some of these project-related problems.
37. ATE consultants has developed three possible approaches to satisfying the objectives of a project. The four scenarios from a cost-schedule perspective are presented in Figure 13.3. Quantitatively discuss the pros and cons associated with approaches (A), (B), (C), and (D).

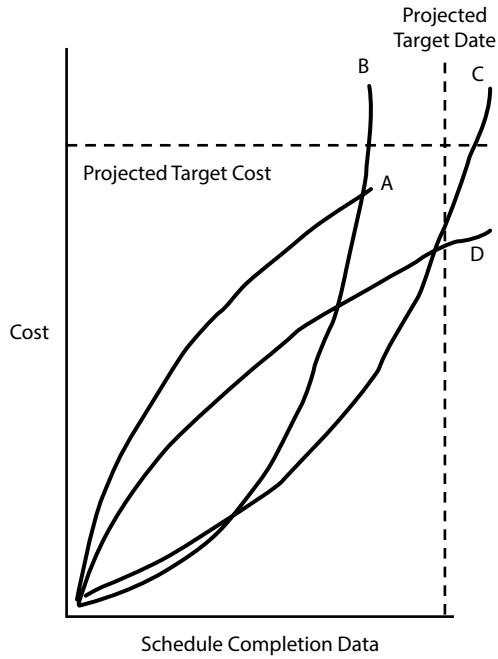

Figure 13.3 Cost-schedule analysis, problem 37.

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