Instructor's Manual

to accompany

PROJECT MANAGEMENT

A SYSTEMS APPROACH TO PLANNING, SCHEDULING, AND CONTROLLING

TWELFTH EDITION

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CHAPTER 1

1–1 There is no correct answer to this problem, just preferred choices.

1. a, b, c, d, f, g, i, k, m, n, p
2. b, d, e, h, i, j, k, m, n, o, p
3. a, c, d, f, g, i, j, m, n, p
4. b, d, e, h, i, j, k, m, n, o, p
5. b, d, h, i, l, m, n, p

Moral: Even in the best companies, differing views of project management are possible. Differing views also occur whether the company is project-driven or non-project-driven. Also, the views can change as the company gets reasonably more mature in project management.

1–2 Project management was originally designed for industries that have complex (as opposed to simple) tasks and that operate in an ever-changing, dynamic (as opposed to static) environment. These include aerospace, defense, construction, computers, high technology, electrical instrumentation, and the like. Companies that have highly repetitive tasks, such as low- technology manufacturing companies, do not need formal project management but can use informal project management for activities such as capital equipment projects. Furthermore, project management works best in situations where activities require the involvement of more than one functional group. Today, project management exists in almost all companies, and some firms believe that they are managing their business by projects.

1–3 In general, the most important attributes of a project manager are communicative skills and interpersonal skills. Individuals cannot be trained to be a project manager simply by taking courses or attending seminars. Project managers can only be developed by on-the-job training, especially under the guidance of an experienced project manager. Some companies prefer to train project managers by first rotating them through the various line organizations (say two weeks to two months each) and then assigning them as an assistant project manager. The question, of course, is how much they can learn in such a short period of time. Promoting from within is best because the first few project managers must know the total organization. If functional employees see promotions from within, then they feel that there are several career paths in the company. However, the new project managers must be able to divorce themselves from the functional organization. It is often best to hire from the outside so that you will have a project manager who does not have any functional ties and does not owe any favors.

1–4 Functional managers would prefer to manage projects which stay entirely

within their functional groups. This greatly reduces authority problems. Sometimes, however, the line manager may be asked to manage an entire project even though only 60% of the work stays within his/her group. This can work if the line manager has good interpersonal skills and must interface with only one or two other departments.

1–5 All three items are more important on the horizontal line than on the vertical line. Because the project manager is under a time constraint, time management is vital. Communications are important because the project manager may be working with functional employees that he/she has never worked with before. Motivation is important because the project manager must try to motivate functional employees without the leverage of controlling their salaries and pay raises.

1–6 In most organizations, power rests with the individuals who control the resources. If the project manager has to negotiate for all resources, and the resources are still attached administratively to the line manager, then project management may very well make line managers more powerful than before. Of course, senior management still retains the right to "glorify" the project management position. There are many forms of power and authority. Power and authority disputes can be easily resolved or even prevented if the functional managers understand project management and the role of the project manager.

1–7 In project-driven organizations, the fastest career path is in project management, with project engineering second and line management third. The major reason for this is because project management and project engineering may be viewed as having direct control and input to corporate profitability since each project has its own profit and loss statement. In non-project-driven organizations, where the profit is measured vertically, the career path opportunities are reversed.

CHAPTER 2

2–1 Systems managers are trained to make decisions for the best interest of an entire system. Project managers should think the same way but sometimes decisions are made that are not optimal decisions. Ideally, all decisions should be made by looking at the big picture.

2–2 (a) Open, closed, or extended
(b) Extended
(c) Closed
(d) Closed
(e) Closed

2–3 Organizational structures, which will be discussed in Chapter 3, focus on control of resources and also (hopefully) timely decision making. Therefore, we must consider the issues of whether the product is strategic or not strategic, how far the product is in the project life cycle, how many full time or part-time resources are needed, and what skills the resources need.

2–4 Projects require funding. There must be decision points in the development of any system to ascertain the program made, the funding needed to continue, and whether the expected benefits and accompanying value will be there. To do this, it is best to use life cycle phases.

2–5 People are accustomed to having some form of guidance when managing projects. The guidance comes in the form of a methodology. However, as project management matures, the methodology is replaced by a flexible framework in which the project team can decide whether the methodology should be used and how much of the methodology should be used. All of this is based upon how much trust the executives have in project management.

2–6 Project management methodologies should have no more than five or six life cycle phases. Too many phases create excessive paperwork and useless meetings. Usually senior management makes the final decision on the number of life cycle phases.

2–7 If a project does not produce the expected results, or even if the project were a total disaster, it could still be considered as a partial success if knowledge were gained that could be used on other downstream projects.

2–8 Project management can work successfully both formally or informally. But for informal project management to be successful, executives must have trust in project management. Therefore, executives may require that project management work formally first and see it in action before allowing informal project management to take place. Trust is the key element.

CHAPTER 3

3–1 Converting from a traditional to a project structure may take between two to three years if employees feel that they cannot effectively report to more than one boss, or if they feel that they will not be evaluated effectively. We are removing people from their comfort zone, and there will be resistance. Any organizational structural change must be married to the wage and salary administration program. Once employees learn how to report to multiple managers, a company can convert from one project organizational form to another, virtually overnight.

3–2 A matrix structure is well suited for each of these.

3–3 Obviously, the capabilities of all levels of management are important. However, the most important criteria is the ability of each manager, regardless of level, to cooperate with one another and make the best possible decisions.

3–4 All three statements are correct. These are the benefits of using a matrix structure.

3–5 Project-driven industries identify all corporate profitability and loss on a project-by-project basis since the entire function of the organization is to support projects. Such industries include aerospace, defense, construction, and divisions within larger companies, such as the MIS groups. Matrix structures are ideal for project-driven industries.

3–6 Project management advocates that there is no one best way to organize under all conditions. Organizations must be dynamic in order to respond rapidly to an ever-changing environment. The needs of the organization should determine the structure and, as needs change, so should the structure.

3–7 Both statements are true and should be considered in developing matrix structures.

3–8 With this many project managers, it is best to set up a dedicated line group for project managers. It is not uncommon for 15 project managers to report to one manager of project managers, because project managers should not require any direct supervision.

3–9 Project management can work here, but a matrix is not practical. Departmental project management may be best.

3–10 Implementation can be done in stages, say from division to division. However, this will take much longer than implementing project management across the entire organization simultaneously. Partial implementation may result in having to solve the same problems over and over again.

CHAPTER 4

4–1 If the project manager must direct an activity that requires the establishment of a project team, then the project manager must have the authority to obtain (or at least request) manpower as necessary provided that the project constraints are not violated. The project manager must work closely with the functional managers to make sure that qualified resources are assigned.

4–2 According to the description given here, project managers appear to be grossly underpaid medical doctors. The job descriptions are the same, except that only the life or death of the project is at stake. The project must be guarded from infection and the project manager must be able to diagnose problems and prescribe cures.

4–3 Paul should pick up these employees early if they are that necessary for success and if the increased costs are not a problem.

4–4 If Frank Boone is the most knowledgeable piping engineer in the company, then there is no question that you would like this man on your project because you have the best available resource. The next question, of course, is whether he has a poor attitude. My recommendation is that you sit down with him first and see what his attitude is really like. In general, you would definitely want this person because he is supposedly the best resource.

4–5 Determining the "how" and "who" is a functional responsibility. Determining "when" is a joint responsibility in that the project manager determines the gross milestones and the functional managers determine the intermediate, detailed milestones. Mobilizing the resources is a project office responsibility.

4–6 Project organizational forms are designed to encourage the systems approach to decision making with group participation.

4–7 The project manager is under a time constraint, and therefore does not have the luxury to train people in the manner in which he would like them to work him and the project office. Therefore, once a project manager develops a good working relationship with other employees, the natural tendency is to want those same employees on every project that the project manager runs.

4–8 Project managers have the right to directly dismiss project of office personnel who are performing unsatisfactorily. For a functional employee, dismissal must come through the line manager. If a functional employee must be removed, it should be made to appear as though the employee was simply reassigned to another activity. Otherwise, if the employee belongs to a strong informal organization, the project manager may get the reputation of having people fired from his project.

4–9 Project managers can create a strong team spirit and project dedication but still be hated (on a personal basis) by the employees. This is a rare situation.

4–10 People can be trained as project managers provided they have a reasonable foundation of communicative and interpersonal skills. Without this, additional training may be futile. But some form of on-the-job training and supervision by an experienced project manager would be helpful.

4-11 This can work, but the serious issue is who is providing technical direction to the worker each day, who will the worker go to for help, who evaluates the worker during performance reviews, and who reviews the workers performance on the project.

4–12 These people are usually found in the line groups as functional employees rather than managers or project office personnel. They are usually "pure doers." There is no set criteria on how to identify these people.

4–13 This system can work and may be mandatory if using union personnel. The check people may be considered as an overmanagement expense, but what is the undermanagement expense if employees are working above their pay grade and a union grievance occurs?

CHAPTER 5

5–1 Project managers normally have indirect reward power. In other words, they can make recommendations to functional managers, whether it be oral or written, confidential or nonconfidential, and then the functional manager takes the project manager's evaluation in hand and makes the final decision.

5–2 (a) Referent
(b) Expert

5–3 Scientists and engineers are more creative if they are given sufficient freedom, provided that they do not become overly creative and try to "reinvent the wheel" in order to show their own creativity. Care must be taken that their freedom does not create cost overrun situations or deviations from the original plan.

5–4 Authority varies with risk. In some cases, the greater the risk, the greater the delegated authority. In other cases, the greater the risk, the less the authority granted to project manager because top management may now be taking a more active role.

5–5 Influence project managers are found quite often in the line- staff organizational form. Here, the project manager does not give any kind of direction, but simply measures progress and reports the results to other managers and executives.

5–6 If the project manager has more reward power than the line man- ager, then a situation of severe conflict will develop because functional employees will build up a strong loyalty to the horizontal line instead of the vertical line. This will threaten the functional manager, and getting his/her support may be difficult.

5–7 Send out a memo that identifies the topics to be discussed and an agenda identifying the time when each topic will be discussed. Sending it out ahead of the meeting allows the participants to think about the topics rather than being surprised.

5–8 There are long-term risks if people are partially successful at biting off too much. What if an employee becomes sick? Who can replace him/her? Can the project then fail? These questions must be considered.

5–9 Erratic or fluctuating manpower levels can be catastrophic if the functional manager cannot adhere to the request. Perhaps manpower smoothing may be necessary.

5–10 Each of these items can provide the project manager with the authority that he needs.

5–11 (a) Project management

(b) Upper-level, functional, and project management

(c) Project and line management

5–12 Yes, if the product manager is full-time and has been in charge of this product line for an extended period of time.

5–13 Most project managers prefer an immediate response to actions.

5–14 Project managers should encourage the flow of all problems to them in a project environment, especially if there is a possibility that any of these problems will have an impact on the time, cost, or performance constraints, and the project manager should be selective in the ones that he actually resolves. Many of the problems can be delegated to assistant project managers; other problems should be handled primarily by the functional managers themselves.

5–15 Yes. Although all projects may be different, there should still exist standardized procedures for planning, scheduling (especially in manufacturing), procurement, cost control, and possibly status reporting. However, as project management matures, some degree of flexibility can be added into project management practices.

5-16 This depends upon the type of standard. If the standard is obtainable, then time robbers should not be included. However, if this standard is the ultimate goal, then you may wish to include time robbers. However, the latter is not a common practice.

5-17 Knowing the employee's energy cycle can be beneficial; for example, scheduling team meetings in the morning when employees are more attentive. The energy cycle can vary as a function of hour of the day, day of the week, and scheduled or unscheduled overtime.

CHAPTER 6

6-1 Yes. The project manager must try to obtain feedback from the employees to make sure that they understood the instructions.

6-2

1. c, e, f
2. g
3. e
4. c
5. b, c, d, e
6. a, c, d, e
7. b, c, e
8. a, c
9. c, g
10. b, c, e, f
11. b, c, d, f
12. g
13. d, e, f
14. c, d, e, h
15. c, d, h
16. d, h
17. d, e, h
18. e, f
19. b, c, e
20. b, c, e
21. g
22. d, e
23. g
24. d, e, g
25. b, c, d, e

6-3 This should become apparent during decision making during team meetings.

6-4 In each case, people hear what they want to hear. This can have a catastrophic effect on horizontal communications and time management.

6-5 Polarization occurs because functional groups neglect to talk to one another, or even to top management.

6-6 This should never be permitted unless you are willing to give up all privacy. Customers always make demands like this but know that there is a good chance that their request will be disapproved.

6-7 It is definitely possible for a project manager to hold too few project review meetings. People that work in a project environment like nothing better than to see how their job relates to the entire picture. Project management thrives on effective communications, and therefore project managers must hold the correct number of team meetings.

CHAPTER 7

7–1 It is definitely possible to establish formal organizational procedures for the resolution of conflicts, provided that the project manager expected conflicts to occur. If the project manager knows what type of conflicts can occur in a project environment, then the project manager can develop a linear responsibility chart aimed primarily at the resolution of these conflicts.

7–2 There are always situations that can develop into meaningful conflict. The most common type is when two technical employees are competing with one another to show that their technical opinions are better. They continuously look for supporting information. Project managers should let this type of situation continue as long as it doesn't produce any bad conflicts and as long as it stays within the time, cost, and performance constraints of the project.

7–3 (a) Traditional, project
(b) Traditional, project
(c) Project, traditional

7–4 Agree

7–5 (a) Here, it might be best if the project manager uses his formal authority and has both people removed from the project. Re- moving only one person will create problems by showing favoritism for the second person.

(b) Manufacturing must be involved in the early stages of a project. This is to prevent the situation in which engineering writes the specifications, but manufacturing cannot live with them.

(c) Since the project manager cannot have functional managers re- moved from the project, he should simply withdraw until that time when the managers can no longer work out the differences themselves.

7–6 Manufacturing wants a high raw material inventory, sales wants a high finished goods inventory, but accounting wants low inventories.

7–7 (a). Conflict intensity may increase if people are afraid that the constraints will not be met.

(b). Conflict intensity will probably decrease because the number of conflicts (i.e., types) will decrease.

(c).Shortening a project life cycle will cause conflict intensity to increase.

(d). Conflict intensity can either increase or decrease depending on whom the conflict is with.

CHAPTER 8

8–1 This technique is doomed to failure if the line managers decide to protect themselves by "padding" all future cost estimates and schedules.

8–2 Employees should have the right to challenge any item, whether it be on the project manager's or line manager's evaluation form.

8–3 Students should do this. It is a good exercise, and there is no right or wrong answer.

8–4 There is no correct answer to this question.

8–5 Planning may be easier because of well-established standards of the union shops, but motivating people to perform at a 110% level can only be accomplished through added incentives.

8–6 All three of these are nonmonetary rewards appealing to levels 4 and 5 of Maslow's hierarchy of needs.

CHAPTER 9

9–1 Project managers should communicate with one another in order to learn from each other and understand what problems may occur downstream such that resource scheduling on projects may be different from planned activities. This is critical if resources must be shared on multiple projects. Many times, this leads to the capturing of best practices.

9–2 Project management is usually more effective if the rules of the game are known by all, and known early on in the project. However, in non-project-driven organizations, nonproject personnel may not understand project management.

9–3 The major reason today for implementing project management is to integrate activities that cut across several functional boundaries. Therefore, a definition of the boundaries must be made.

CHAPTER 10

10–1 This is an executive management problem that needs resolution.

10–2 Yes, if this is what it takes to make project management work effectively.

10–3 Yes, if the in-house representative is disrupting the operations of the company and overstepping his/her bounds.

10–4 Many projects are overmanaged because the cost of undermanagement can be orders of magnitude greater than the cost of overmanagement.

10–5 There should exist a single priority list for all project managers under the same roof, or at least sharing the same resources. With a large number of projects, perhaps only a small number of projects will be prioritized at any one time.

10–6 The client usually prefers one-to-one communications with his or her counterpart in the project office. This should not be prevented from occurring.

10–7 You may have to make the decision for the sponsor. This may be a no-win situation for you, but is the lesser of the evils. You cannot let the project slow down.

CHAPTER 11

11–1 The answer depends on the requirements of the project, levels of the WBS, and cost-reporting procedures.

11–2 Program: New Product Introduction

Project 1: Sales Promotion/Advertising

Task 1: Layout artwork
Task 2: Approve artwork
Task 3: Sales manual
Task 4: Sales promotion
Task 5: Trade advertising
Task 6: Introduce at trade show

Project 2: Pricing

Task 1: Analyze selling costs
Task 2: Analyze customer reactions
Task 3: Storage and shipping costs
Task 4: Review plant costs
Task 5: Review cost of production
Task 6: Revise cost of production
Task 7: Revise selling costs
Task 8: Establish billing procedures
Task 9: Establish credit procedures

Project 3: Market testing

Project 4: Manufacturing

Task 1: Final specifications
Task 2: Production layout
Task 3: Material requisitions

Project 5: Training

Task 1: Select salesman
Task 2: Select distributors
Task 3: Train salesmen
Task 4: Train distributors
Task 5: Print literature
Task 6: Literature to salesmen
Task 7: Literature to distributors

11–3 Correct order is 3, 2, 1, 6, 4, 5

11–4 (a) Some products must be introduced into the marketplace only in specific

months; for example, automobiles.

(b) Problems on other projects may have a serious impact on manpower availability for your project, or a shift in your base case may result in a lack of available manpower when needed.

(c) A shift in the base case may cause a shift in the cash flow of the project and company, and vice versa.

(d) Some companies plan projects knowing that their line groups just do not contain the desired technical expertise.

(e) Personnel training at the beginning of a project, or even before the project begins, may ease problems for the project manager. Project managers are not happy conducting on-the-job training on their projects.

(f) Frequent priority shifts are catastrophic. Some companies go so far as to shift these priorities on a weekly basis.

11–5 Some people contend there are differences; the author contends that, under given circumstances, we can argue for either case.

11–6 1. a, b, d, g
2. a, b, d, e, f, g
3. b, c, d, g
4. a, c, d, e, f, g, h
5. c, d, e, f, g, h
6. d, f, g, h

11–7 Column 3: 14, 13, 2, 20, 26, 22, 5, 25, 1, 3, 18, 17, 15, 16, 12, 23, 11, 24, 8, 9, 7, 21, 19, 6, 4, 10

CHAPTER 12

12–1 PERT/CPM charts can often be used in lieu of written reports.

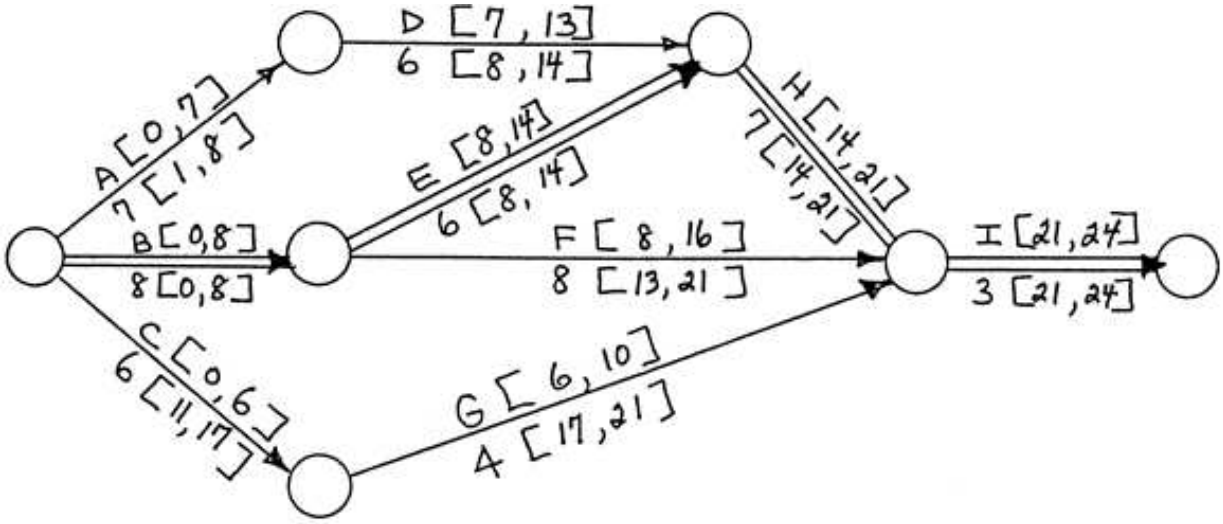
12–2 PERT networks should always follow the work breakdown structure. As a matter of fact, any scheduling techniques should follow the work breakdown structure. If the work is priced out at the task level, then there should be PERT schedules and bar charts for each one of the tasks that you find in the work breakdown structure.

12–3 There should always be key milestones at points where trade-offs are most likely to occur: this is mandatory.

12–4 At completion, accelerating a project may cost more money because it is more difficult to motivate people who are looking for different roles on other projects. Furthermore, key individuals may not be available.

12–5 The major difficulties with PERT are identified in section 12-8. Generally speaking, these difficulties cannot be overcome unless the project manager establishes separate policies, procedures, rules, and guidelines on his/her project. Most good project managers realize these types of problems with PERT scheduling as such and try to overcome them. Most good projects have more than one scheduling technique. They might have PERT, bar charts, and other graphical forms or techniques as precedence networks.

12–6 The figure below is the solution to problem 12-6. Identify the early start, early finish, latest start, and latest finish for each activity.



12–7 (a) Critical path: 1 – 2 – 5 – 6 – 9 – 10

or

1 – 4 – 7 – 9 – 10

(b) Total slack: 11 weeks

(c) No, the critical length will still be 14 weeks.

(d) There will be three critical paths.

12–8 Line managers can carry as much depth as possible into PERT scheduling as long as a commitment is made to the milestones at the project managers level of WBS management. However, the greater the depth, the greater the cost of monitoring and control and performance reporting.

12-9

Activity	Early Start	Early Finish	Latest Start	Latest Finish
A	0	6	0	6
B	0	3	9	12
C	6	12	6	12
D	6	15	9	18
E	12	18	12	18

(a) No impact

(b) The end date slips by 1 week c. No impact

(d) The activities on the critical path are looked at first

12-10

Activity	Duration	ES	EF	LS	LF
A	3	0	3	4	7
B	7	0	7	0	7
C	5	0	5	2	7
D	2	7	9	11	13
E	6	7	13	7	13
F	1	5	6	12	13
G	4	13	17	13	17

CHAPTER 13

13–1 There are several approaches to this problem. One approach is to price out the job incrementally as each phase is defined in more depth. A second technique is to price out the whole project the best you can, hopefully based upon historical estimates; as each phase becomes well defined, the estimates are revised. This problem is quite common because not all projects have well-defined specifications during project definition.

13-2 (a) If the project manager does not have sufficient funding available for pricing the job, or sufficient time, then there is a tendency for the project manager to price out the job himself.

(b) This situation always occurs if top-level executives feel they have more information available to them, or if they feel that a certain price is necessary in order to make them competitive.

(c) This should never happen. This is an indication of poor project management.

(d) Happens all the time. This is one of the privileges of being the chief executive officer.

(e) This situation can happen because top-level executives do not want to get involved in bids that are under a certain value, say $30,000 or $40,000, or if they have complete confidence in the project manager.

13-3 In a project-driven company, management can add the manpower hourly summary on all projects to determine a total company position. Shortages or overabundance are not considered in the short-term.

13-4 If changes take place in midstream, there is no guarantee that project managers have priced the work correctly or that they have checked to see if sufficient resources were available. For example, Project Manager A has 60% of the job and Project Man- ager B has 40%. It is entirely possible that Project Manager B cannot handle more than 40% of the job and, if shifting in the statement of work requirements are necessary, then the project may be elongated.

13-5 There should be a separate clause in the contract permitting you to renegotiate the overhead rates, or you could simply negotiate a cost reimbursable package.

13-6 You should listen to the line manager. The work breakdown structure is developed by the project office in order to be used as a tool by which the project office can communicate with line managers. If line managers feel that the work breakdown structure is inaccurate or that it should be modified somehow,

project managers should always listen to the line managers, since whatever commitment that they make will be a commitment to the work breakdown structure.

13-7 Project managers should always give the final manpower loading curve to the functional managers. These should be given to the functional managers during the planning of the activity to make sure that the function has the resources available that he actually priced out as part of the contract.

13-8 There is no correct answer here. There are basically four ways to prepare a proposal:

(a) By the project manager alone
(b) By the proposal manager alone
(c) The project manager reports to the proposal manager
(d) The proposal manager reports to the project manager

The exact answer depends upon the size of the project, the importance to the company, and the importance to the client.

13-9 Again, there is no correct answer. Every company has its own approaches for cost estimating.

CHAPTER 14

14–1 Cost overruns do not just happen; they are most often caused by improper estimating, improper definition of the requirements, and other such factors. True, there are situations where a cost overrun can occur because you have a higher escalation factor on salaries, or a higher escalation factor on raw materials, but generally speaking, good project managers can plan for this and anticipate it during the perturbation analysis that goes on at the beginning of a project. This does not include situations such as research and development, where it is entirely possible you could be working in the dark.

14-2 Early starts and late starts create havoc for BCWS because a percentage of the allocated budget may already show up as spent when, in fact, the work has not yet begun.

14-3 Line managers will "pad" their estimates in order to protect themselves.

14-4 The management reserve should be used on high-risk activities, and *only* when needed. Otherwise, there may not be any use for the management reserve.

14-5 (a) Yes. Poor status reporting may occur on large tasks.

(b) Not effectively.

(c) To be determined by management—weekly in project-driven companies and monthly in non-project-driven companies.

14-6

	Cumulative Cost (in thousands)			Variance $		
Week	BCWS	BCWP	ACWP	Schedule	Cost	EAC %
1	50	50	25	0	25	50
2	70	60	40	(10)	20	66.6
3	90	80	67	(10)	13	83.7
4	120	105	90	(15)	15	85.7
5	130	120	115	(10)	5	95.8
6	140	135	130	(5)	5	96.3
7	165	150	155	(15)	(5)	100.3
8	200	175	190	(25)	(15)	108.6
9	250	220	230	(30)	(10)	104.5
10	270	260	270	(10)	(10)	103.8
11	300	295	305	(5)	(10)	103.4
12	350	340	340	(10)	0	100.0
13	380	360	370	(20)	(10)	102.8
14	420	395	400	(25)	(5)	101.3
15	460	460	450	0	10	97.8

4-7 Total price variance for direct labor = $6975 (favorable)

Labor rate lost variance = $0.50 (unfavorable)

14-8 (a) 1840 hours per year or 153.33 hrs/month

(b)3000 / 1840 = 1.63 years

(c) 3000 / 12 = 250 hours needed per month

(d)250 / 153.33 = 1.63 people to finish the program in one year

CHAPTER 15

15-1 Traditional metrics tell you where you are today. KPIs are metrics that tell you where you will end up. They are forward-looking metrics.

15-2 There are no standard ways for a metric to be reported. It is based upon the maturity level of a company as to whether they use written reports or dashboards, and there are several types of dashboards.

15-3 The definition of a metric is something that is measurable. Metrics must be informative such that one can determine what action needs to be taken to correct a poor situation and get it back on track.

15-4 Workers are afraid that poor metrics may provide information that is used against them during performance reviews. There may also be fear at the top that the metrics will bring out the true health of the projects, whereas executives do not want the information known or released.

CHAPTER 16

16-1 More metrics will provide more information. More information should make it easier to make trade-offs.

16-2 Definitely yes. Customers often sit on the change control boards and they can approve or reject a scope change. They can also influence the change control board as to the order of the trade-offs.

16-3 For internal projects, the sponsor may be authorized to dictate the order of the trade-offs. For external projects, the sponsor resides on the change control board and may be able to provide recommendations based upon the cost of the trade-off, the risk, the timing and the value added, if any.

CHAPTER 17

17–1 EVs_1 (16K)
EVs_2 (6K)
EVs_3 (11K)
EVs_4 (55K)
EVs_5 0

(a) Do not develop product; that is, S_5
(b) S_4
(c) S_2
(d) S_5

17-2 Lack of understanding of the processes or delivery system (for example, EPM system) that the supplier uses.

17-3 If quantitative numbers can be assigned to each of the axes, then the entries in each cell will be quantitative. However, as is quite often the case, project managers may not be able to assign values quantitatively, and in such cases a qualitative assessment may be necessary, using assigned values of high, moderate or low.

17-4 While it may seem appropriate, pharmaceutical companies would never indicate potential loss of life in a PI matrix.

CHAPTER 18

18–1 On log-log paper, the rate of change is constant. On regular graph paper, the rate of change looks like it is tapering off when, in fact, it simply means that the *magnitude* of the improvement is getting less and less. Improvements cannot occur indefinitely because of worker capability.

18–2 $T_{300} = 620(300)^{-0.235} = 162$

18–3 (a) $85 = T_1 (100)^{-0.415}$
$T_1 = 85(100)^{0.415} = 575$

(b) Not necessarily. The estimate for the 100th unit may be wrong.

18–4 Using the computer program, for a 75% learning curve the total hours are 175,370. For a 77% learning curve, the total hours are 211,889.

$(21{,}1889 - 175{,}370) \times \$65 = \$2{,}373{,}735$

$21{,}1889 - 175{,}370 = 36{,}519$ hours

$36{,}519/175{,}370 = 20.8\%$

Therefore, an error of 2% in the learning curve could generate an error of 20.8% in total hours.

18–5 $315 = 1200(150)^x$

$\log(315) = \log(1200) + x\log(150)$

$$x = \frac{\log\ (31)5 - \log\ (1200)}{\log\ (150)}$$

$$x = \frac{2.4983\ -\ 3.0792}{2.1761} = -0.267$$

Therefore, the learning curve is approximately 83%.

18–6 The next 500 units will require 5376 hours.

$5376/500 = 10.75$ hours/unit

$(5376 \text{ hours}) \times (\$80/\text{hours}) \times (1.12) = \$481{,}690$

18–7 From the computer program the 150th unit of the follow-on pro- gram will be required to reach breakeven.

18–8 On a 75% learning curve, 700 units will be required to reach $475/unit. This answer may be unrealistic. The market leader required $10,719 for the first unit, whereas you require only $7150, which is 33% less cost. The question here is what are the reasons for the lower cost and the better learning curve?

18–9 First of all, 800 units on an 80% learning curve requires 465,579 hours, with the first 200 units requiring 180,069 hours. Therefore, units 201-800 require 285,510 hours.

Installing new equipment, the last 600 units will require 107,278 hours.

(a) 285,510 — 107,278 = 178,232 hours of savings.

(b) At $70/hour, savings = $178232 \times 70 =$ $12,476,240.

If this is simply *one* year's depreciation, then the breakeven point is $62,381,200 for the equipment. This *assumes* that the machinery will be used in years 2-5.

CHAPTER 19

19-1 Although there are pros and cons on every type of contract, most contracts that involve a great deal of uncertainty, where significant scope changes are possible, would use some form of cost-reimbursable contracting. Even with cost-reimbursable contracts, price ceilings can be used.

19-2 Personal conversations can provide one bidder with a competitive advantage. The playing field must be level.

19-3 There are several reasons. First, effective procurement can save the company money, thus increasing profits. For this reason, most companies believe in maintaining a centralized procurement organization. Second, there may be a list of preferred suppliers that the company uses and the project managers many not be knowledgeable about the list. Third, there are forms that must be used to show that the firm is adhering to legal requirements, and the project managers may not be familiar with these forms.

19-4 In this case, all assumptions must be listed, including inclusions and exclusions based upon the interpretation of the SOW.

19-5 Letter contracts or letters of intent can be used for long-lead procurement activities. These types of agreements generally cover only the long-lead procurement activities and possibly some initial planning that must be done.

CHAPTER 20

20-1 All of the tools are not applicable to every type of project. The project team, especially the quality experts on the project, determine which tools to use.

20-2 Regardless which team member performs the work, the project manager has the ultimate responsibility for the overall quality of the project. Quality responsibility cannot be delegated.

20-3 The acceptance criteria for quality is usually defined in the statement of work. For external contracts, the customer provides the acceptance criteria for quality.

20-4 None is the generally accepted answer. However, on some projects where artistic or aesthetic value is part of the definition of quality, inspection may be used.

20-5 Generally speaking, project that may involve health risks go through 100% inspection. This is quite common in the medical profession, but it also applies to other industries such as aircraft manufacturing.