

Planning

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<ul style="list-style-type: none"> Quantum Telecom Concrete Masonry Corporation* Margo Company Project Overrun The Two-Boss Problem Denver International Airport (DIA) 	<ul style="list-style-type: none"> The Statement of Work Technology Forecasting The Noncompliance Project Multiple Choice Exam Crossword Puzzle on Scope Management 	<ul style="list-style-type: none"> Scope Management

11.0 INTRODUCTION

PMBOK® Guide, 4th Edition
Chapter 5 Scope Management
5.2 Define Scope

The most important responsibilities of a project manager are planning, integrating, and executing plans. Almost all projects, because of their relatively short duration and often prioritized control of resources, require formal, detailed planning. The integration of the planning activities is

* Case Study also appears in Workbook.

necessary because each functional unit may develop its own planning documentation with little regard for other functional units.

Planning, in general, can best be described as the function of selecting the enterprise objectives and establishing the policies, procedures, and programs necessary for achieving them. Planning in a project environment may be described as establishing a predetermined course of action within a forecasted environment. The project's requirements set the major milestones. If line managers cannot commit because the milestones are perceived as unrealistic, the project manager may have to develop alternatives, one of which may be to move the milestones. Upper-level management must become involved in the selection of alternatives.

The project manager is the key to successful project planning. It is desirable that the project manager be involved from project conception through execution. Project planning must be *systematic*, *flexible* enough to handle unique activities, *disciplined* through reviews and controls, and capable of accepting *multi-functional* inputs. Successful project managers realize that project planning is an iterative process and must be performed throughout the life of the project.

PMBOK® Guide, 4th Edition
5.2 Define Scope

One of the objectives of project planning is to completely define all work required (possibly through the development of a documented project plan) so that it will be readily identifiable to each project participant. This is a necessity in a project environment because:

- If the task is well understood prior to being performed, much of the work can be preplanned.
- If the task is not understood, then during the actual task execution more knowledge is gained that, in turn, leads to changes in resource allocations, schedules, and priorities.
- The more uncertain the task, the greater the amount of information that must be processed in order to ensure effective performance.

These considerations are important in a project environment because each project can be different from the others, requiring a variety of different resources, but having to be performed under time, cost, and performance constraints with little margin for error. Figure 11-1 identifies the type of project planning required to establish an effective monitoring and control system. The boxes at the top represent the planning activities, and the lower boxes identify the "tracking" or monitoring of the planned activities.

There are two proverbs that affect project planning:

- Failing to plan is planning to fail.
- The primary benefit of not planning is that failure will then come as a complete surprise rather than being preceded by periods of worry and depression.

Without proper planning, programs and projects can start off "behind the eight ball." Consequences of poor planning include:

- Project initiation without defined requirements
- Wild enthusiasm
- Disillusionment
- Chaos
- Search for the guilty
- Punishment of the innocent
- Promotion of the nonparticipants

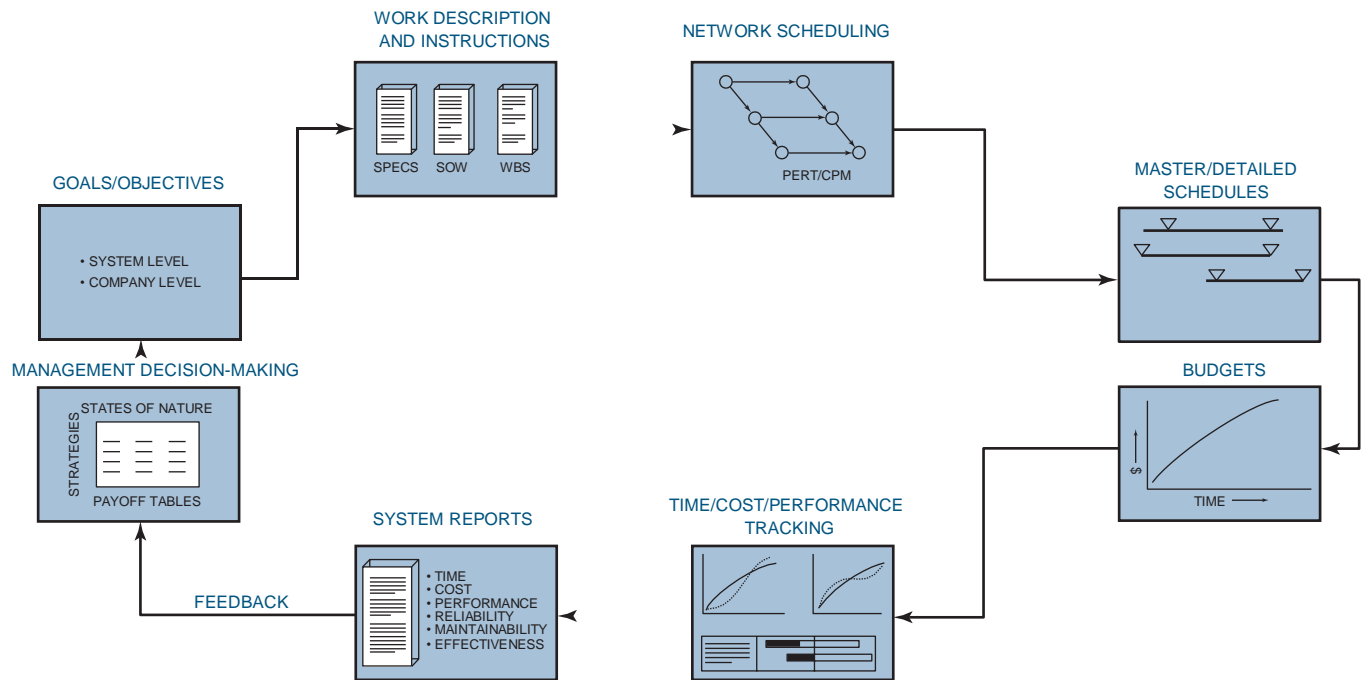


FIGURE 11-1. The project planning and control system.

There are four basic reasons for project planning:

- To eliminate or reduce uncertainty
- To improve efficiency of the operation
- To obtain a better understanding of the objectives
- To provide a basis for monitoring and controlling work

Planning is a continuous process of making entrepreneurial decisions with an eye to the future, and methodically organizing the effort needed to carry out these decisions. Furthermore, systematic planning allows an organization of set goals. The alternative to systematic planning is decision-making based on history. This generally results in reactive management leading to crisis management, conflict management, and fire fighting.

11.1 VALIDATING THE ASSUMPTIONS

Planning begins with an understanding of the assumptions. Quite often, the assumptions are made by marketing and sales personnel and then approved by senior management as part of the project selection and approval process. The expectations for the final results are based upon the assumptions made.

Why is it that, more often than not, the final results of a project do not satisfy senior management's expectations? At the beginning of a project, it is impossible to ensure that the benefits expected by senior management will be realized at project completion. While project length is a critical factor, the real culprit is changing assumptions.

Assumptions must be documented at project initiation using the project charter as a possible means. Throughout the project, the project manager must revalidate and challenge the assumptions. Changing assumptions may mandate that the project be terminated or redirected toward a different set of objectives.

A project management plan is based upon the assumptions described in the project charter. But there are additional assumptions made by the team that are inputs to the project management plan.¹ One of the primary reasons companies use a project charter is that project managers were most often brought on board well after the project selection process and approval process were completed. As a result, project managers were needed to know what assumptions were considered.

Enterprise Environmental Factors

These are assumptions about the external environmental conditions that can affect the success of the project, such as interest rates, market conditions, changing customer demands and requirements, changes in technology, and even government policies.

1. See *A Guide to the Project Management Body of Knowledge*®, 4th ed., 2008, Figure 4-4.

Organizational Process Assets

These are assumptions about present or future company assets that can impact the success of the project such as the capability of your enterprise project management methodology, the project management information system, forms, templates, guidelines, checklists, and the ability to capture and use lessons learned data and best practices.

11.2 GENERAL PLANNING

PMBOK® Guide, 4th Edition
Chapter 5 Scope Management
1.6 General Management
Knowledge and Skills

Planning is determining what needs to be done, by whom, and by when, in order to fulfill one's assigned responsibility. There are nine major components of the planning phase:

- *Objective*: a goal, target, or quota to be achieved by a certain time
- *Program*: the strategy to be followed and major actions to be taken in order to achieve or exceed objectives
- *Schedule*: a plan showing when individual or group activities or accomplishments will be started and/or completed
- *Budget*: planned expenditures required to achieve or exceed objectives
- *Forecast*: a projection of what will happen by a certain time
- *Organization*: design of the number and kinds of positions, along with corresponding duties and responsibilities, required to achieve or exceed objectives
- *Policy*: a general guide for decision-making and individual actions
- *Procedure*: a detailed method for carrying out a policy
- *Standard*: a level of individual or group performance defined as adequate or acceptable

An item that has become important in recent years is documenting assumptions that go into the objectives or the project/subsidiary plans. As projects progress, even for short-term projects, assumptions can change because of the economy, technological advances, or market conditions. These changes can invalidate original assumptions or require that new assumptions be made. These changes could also mandate that projects be canceled. Companies are now validating assumptions during gate review meetings. Project charters now contain sections for documenting assumptions.

Several of these factors require additional comment. Forecasting what will happen may not be easy, especially if predictions of environmental reactions are required. For example, planning is customarily defined as either strategic, tactical, or operational. Strategic planning is generally for five years or more, tactical can be for one to five years, and operational is the here and now of six months to one year. Although most projects are operational, they can be considered as strategic, especially if spin-offs or follow-up work is promising. Forecasting also requires an understanding of strengths and weaknesses as found in:

- The competitive situation
- Marketing

- Research and development
- Production
- Financing
- Personnel
- The management structure

If project planning is strictly operational, then these factors may be clearly definable. However, if strategic or long-range planning is necessary, then the future economic outlook can vary, say, from year to year, and replanning must be done at regular intervals because the goals and objectives can change. (The procedure for this can be seen in Figure 11–1.)

The last three factors, policies, procedures, and standards, can vary from project to project because of their uniqueness. Each project manager can establish project policies, provided that they fall within the broad limits set forth by top management.

Project policies must often conform closely to company policies, and are usually similar in nature from project to project. Procedures, on the other hand, can be drastically different from project to project, even if the same activity is performed. For example, the signing off of manufacturing plans may require different signatures on two selected projects even though the same end-item is being produced.

Planning varies at each level of the organization. At the individual level, planning is required so that cognitive simulation can be established before irrevocable actions are taken. At the working group or functional level, planning must include:

- Agreement on purpose
- Assignment and acceptance of individual responsibilities
- Coordination of work activities
- Increased commitment to group goals
- Lateral communications

At the organizational or project level, planning must include:

- Recognition and resolution of group conflict on goals
- Assignment and acceptance of group responsibilities
- Increased motivation and commitment to organizational goals
- Vertical and lateral communications
- Coordination of activities between groups

The logic of planning requires answers to several questions in order for the alternatives and constraints to be fully understood. A list of questions would include:

- Prepare environmental analysis
 - Where are we?
 - How and why did we get here?

- Set objectives
 - Is this where we want to be?
 - Where would we like to be? In a year? In five years?
- List alternative strategies
 - Where will we go if we continue as before?
 - Is that where we want to go?
 - How could we get to where we want to go?
- List threats and opportunities
 - What might prevent us from getting there?
 - What might help us to get there?
- Prepare forecasts
 - Where are we capable of going?
 - What do we need to take us where we want to go?
- Select strategy portfolio
 - What is the best course for us to take?
 - What are the potential benefits?
 - What are the risks?
- Prepare action programs
 - What do we need to do?
 - When do we need to do it?
 - How will we do it?
 - Who will do it?
- Monitor and control
 - Are we on course? If not, why?
 - What do we need to do to be on course?
 - Can we do it?

One of the most difficult activities in the project environment is to keep the planning on target. These procedures can assist project managers during planning activities:

- Let functional managers do their own planning. Too often operators are operators, planners are planners, and never the twain shall meet.
- Establish goals before you plan. Otherwise short-term thinking takes over.
- Set goals for the planners. This will guard against the nonessentials and places your effort where there is payoff.
- Stay flexible. Use people-to-people contact, and stress fast response.
- Keep a balanced outlook. Don't overreact, and position yourself for an upturn.
- Welcome top-management participation. Top management has the capability to make or break a plan, and may well be the single most important variable.
- Beware of future spending plans. This may eliminate the tendency to underestimate.
- Test the assumptions behind the forecasts. This is necessary because professionals are generally too optimistic. Do not depend solely on one set of data.

- Don't focus on today's problems. Try to get away from crisis management and fire fighting.
- Reward those who dispel illusions. Avoid the Persian messenger syndrome (i.e., beheading the bearer of bad tidings). Reward the first to come forth with bad news.

11.3 LIFE-CYCLE PHASES

PMBOK® Guide, 4th Edition
Chapter 2 Project Life Cycle and Organization
2.1 Characteristics of Project Phases

Project planning takes place at two levels. The first level is the corporate cultural approach; the second method is the individual's approach. The corporate cultural approach breaks the project down into life-cycle phases, such as those shown in Table 2–6. The life-cycle phase approach is *not* an attempt to put handcuffs on the project manager but to provide a methodology for uniformity in project planning. Many companies, including government agencies,

prepare checklists of activities that should be considered in each phase. These checklists are for consistency in planning. The project manager can still exercise his own planning initiatives within each phase.

A second benefit of life-cycle phases is control. At the end of each phase there is a meeting of the project manager, sponsor, senior management, and even the customer, to assess the accomplishments of this life-cycle phase and to get approval for the next phase. These meetings are often called critical design reviews, “on-off ramps,” and “gates.” In some companies, these meetings are used to firm up budgets and schedules for the follow-on phases. In addition to monetary considerations, life-cycle phases can be used for manpower deployment and equipment/facility utilization. Some companies go so far as to prepare project management policy and procedure manuals where all information is subdivided according to life-cycle phasing. Life-cycle phase decision points eliminate the problem where project managers do not ask for phase funding, but rather ask for funds for the whole project before the true scope of the project is known. Several companies have even gone so far as to identify the types of decisions that can be made at each end-of-phase review meeting. They include:

- Proceed with the next phase based on an approved funding level
- Proceed to the next phase but with a new or modified set of objectives
- Postpone approval to proceed based on a need for additional information
- Terminate project

Consider a company that utilizes the following life-cycle phases:

- Conceptualization
- Feasibility
- Preliminary planning
- Detail planning
- Execution
- Testing and commissioning

The conceptualization phase includes brainstorming and common sense and involves two critical factors: (1) identify and define the problem, and (2) identify and define potential solutions.

In a brainstorming session, *all* ideas are recorded and none are discarded. The brainstorming session works best if there is no formal authority present and if it lasts thirty to sixty minutes. Sessions over sixty minutes will produce ideas that may resemble science fiction.

The feasibility study phase considers the technical aspects of the conceptual alternatives and provides a firmer basis on which to decide whether to undertake the project.

The purpose of the feasibility phase is to:

- Plan the project development and implementation activities.
- Estimate the probable elapsed time, staffing, and equipment requirements.
- Identify the probable costs and consequences of investing in the new project.

If practical, the feasibility study results should evaluate the alternative conceptual solutions along with associated benefits and costs.

The objective of this step is to provide management with the predictable results of implementing a specific project and to provide generalized project requirements. This, in the form of a feasibility study report, is used as the basis on which to decide whether to proceed with the costly requirements, development, and implementation phases.

User involvement during the feasibility study is critical. The user must supply much of the required effort and information, and, in addition, must be able to judge the impact of alternative approaches. Solutions must be operationally, technically, and economically feasible. Much of the economic evaluation must be substantiated by the user. Therefore, the primary user must be highly qualified and intimately familiar with the workings of the organization and should come from the line operation.

The feasibility study also deals with the technical aspects of the proposed project and requires the development of conceptual solutions. Considerable experience and technical expertise are required to gather the proper information, analyze it, and reach practical conclusions.

Improper technical or operating decisions made during this step may go undetected or unchallenged throughout the remainder of the process. In the worst case, such an error could result in the termination of a valid project—or the continuation of a project that is not economically or technically feasible.

In the feasibility study phase, it is necessary to define the project's basic approaches and its boundaries or scope. A typical feasibility study checklist might include:

- Summary level
 - Evaluate alternatives
 - Evaluate market potential
 - Evaluate cost effectiveness
 - Evaluate producibility
 - Evaluate technical base
- Detail level
 - A more specific determination of the problem
 - Analysis of the state-of-the-art technology

- Assessment of in-house technical capabilities
- Test validity of alternatives
- Quantify weaknesses and unknowns
- Conduct trade-off analysis on time, cost, and performance
- Prepare initial project goals and objectives
- Prepare preliminary cost estimates and development plan

The end result of the feasibility study is a management decision on whether to terminate the project or to approve its next phase. Although management can stop the project at several later phases, the decision is especially critical at this point, because later phases require a major commitment of resources. All too often, management review committees approve the continuation of projects merely because termination at this point might cast doubt on the group's judgment in giving earlier approval.

The decision made at the end of the feasibility study should identify those projects that are to be terminated. Once a project is deemed feasible and is approved for development, it must be prioritized with previously approved projects waiting for development (given a limited availability of capital or other resources). As development gets under way, management is given a series of checkpoints to monitor the project's actual progress as compared to the plan.

The third life-cycle phase is either preliminary planning or "defining the requirements." This is the phase where the effort is officially defined as a project. In this phase, we should consider the following:

- General scope of the work
- Objectives and related background
- Contractor's tasks
- Contractor end-item performance requirements
- Reference to related studies, documentation, and specifications
- Data items (documentation)
- Support equipment for contract end-item
- Customer-furnished property, facilities, equipment, and services
- Customer-furnished documentation
- Schedule of performance
- Exhibits, attachments, and appendices

These elements can be condensed into four core documents, as will be shown in Section 11.7. Also, it should be noted that the word "customer" can be an internal customer, such as the user group or your own executives.

The table below shows the percentage of *direct* labor hours/dollars that are spent in each phase:

Phase	Percent of Direct Labor Dollars
Conceptualization	5
Feasibility study	10
Preliminary planning	15
Detail planning	20
Execution	40
Commissioning	10

The interesting fact from this table is that as much as 50 percent of the direct labor hours and dollars can be spent before execution begins. The reason for this is simple: Quality must be planned for and designed in. Quality cannot be inspected into the project. Companies that spend less than these percentages usually find quality problems in execution.

11.4 PROPOSAL PREPARATION

There is always a question of what to do with a project manager between assignments. For companies that survive on competitive bidding, the assignment is clear: The project manager writes proposals for future work. This takes place during the feasibility study, when the company must decide whether to bid on the job. There are four ways in which proposal preparation can occur:

- *Project manager prepares entire proposal.* This occurs frequently in small companies. In large organizations, the project manager may not have access to all available data, some of which may be company proprietary, and it may not be in the best interest of the company to have the project manager spend all of his time doing this.
- *Proposal manager prepares entire proposal.* This can work as long as the project manager is allowed to review the proposal before delivery to the customer and feels committed to its direction.
- *Project manager prepares proposal but is assisted by a proposal manager.* This is common, but again places tremendous pressure on the project manager.
- *Proposal manager prepares proposal but is assisted by a project manager.* This is the preferred method. The proposal manager maintains maximum authority and control until such time as the proposal is sent to the customer, at which point the project manager takes charge. The project manager is on board right from the start, although his only effort may be preparing the technical volume of the proposal and perhaps part of the management volume.

11.5 KICKOFF MEETINGS

The typical launch of a project begins with a kickoff meeting involving the major players responsible for planning, including the project manager, assistant project managers for certain areas of knowledge, subject matter experts (SME), and functional leads. A typical sequence is shown in Figure 11–2.

There can be multiple kickoff meetings based upon the size, complexity, and time requirements for the project. The major players are usually authorized by their functional areas to make decisions concerning timing, costs, and resource requirements.

Some of the items discussed in the initial kickoff meeting include:

- Wage and salary administration, if applicable
- Letting the employees know that their boss will be informed as to how well or how poorly they perform

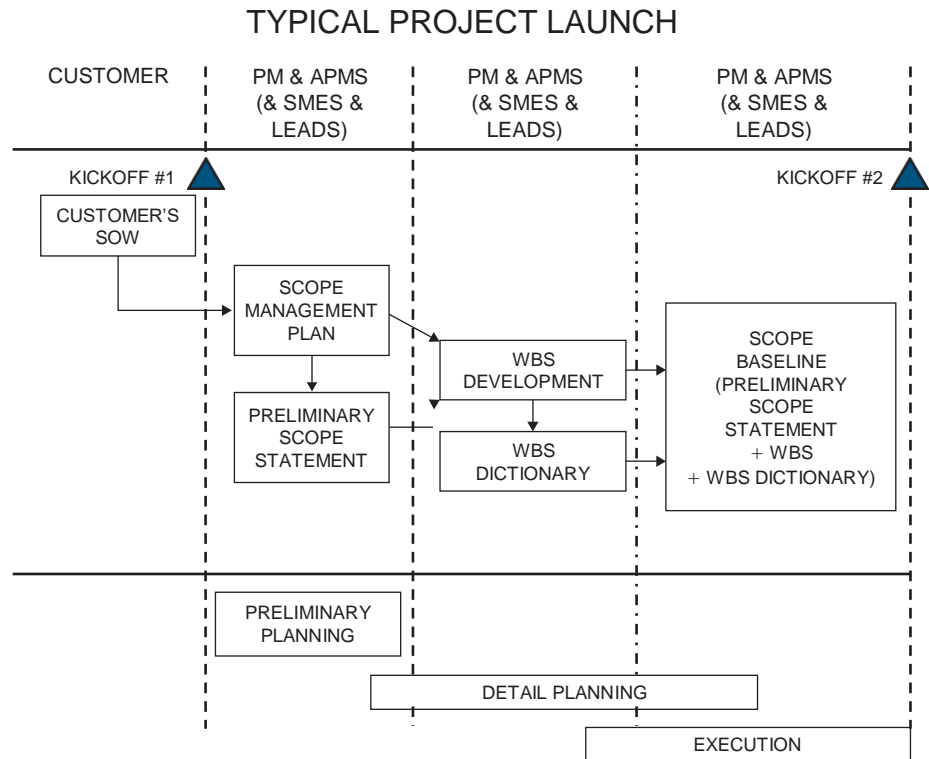


Figure 11–2. Typical project launch.

- Initial discussion of the scope of the project including both the technical objective and the business objective
- The definition of success on this project
- The assumptions and constraints as identified in the project charter
- The project's organizational chart (if known at that time)
- The participants' roles and responsibilities

For a small or short-term project, estimates on cost and duration may be established in the kickoff meeting. In this case, there may be little need to establish a cost estimating schedule. But where the estimating cycle is expected to take several weeks, and where inputs will be required from various organizations and/or disciplines, an essential tool is an estimating schedule. In this case, there may be a need for a prekickoff meeting simply to determine the estimates. The minimum key milestones in a cost estimating schedule are (1) a “kickoff” meeting; (2) a “review of ground rules” meeting; (3) “resources input and review” meeting; and (4) summary meetings and presentations. Descriptions of these meetings and their approximate places in the estimating cycle follow.²

2. R. D. Stewart, *Cost Estimating* (New York: Wiley, 1982), pp. 56–57.

The Prekickoff Meeting

The very first formal milestone in an estimate schedule is the estimate kickoff meeting. This is a meeting of all the individuals who are expected to have an input to the cost estimate. It usually includes individuals who are proficient in technical disciplines involved in the work to be estimated; business-oriented individuals who are aware of the financial factors to be considered in making the estimate; project-oriented individuals who are familiar with the project ground rules and constraints; and, finally, the cost estimator or cost estimating team. The estimating team may not include any of the team members responsible for execution of the project.

Sufficient time should be allowed in the kickoff meeting to describe all project ground rules, constraints, and assumptions; to hand out technical specifications, drawings, schedules, and work element descriptions and resource estimating forms; and to discuss these items and answer any questions that might arise. It is also an appropriate time to clarify estimating assignments among the various disciplines represented in the event that organizational charters are not clear as to who should support which part of the estimate. This kickoff meeting may be 6 weeks to 3 months prior to the estimate completion date to allow sufficient time for the overall estimating process. If the estimate is being made in response to a request for quotation or request for bid, copies of the request for quotation document will be distributed and its salient points discussed.

The Review of Ground Rules Meeting

Several days after the estimate kickoff meeting, when the participants have had the opportunity to study the material, a review of ground rules meeting should be conducted. In this meeting the estimate manager answers questions regarding the conduct of the cost estimate, assumptions, ground rules, and estimating assignments. If the members of the estimating team are experienced in developing resource estimates for their respective disciplines, very little discussion may be needed. However, if this is the first estimating cycle for one or more of the estimating team members, it may be necessary to provide these team members with additional information, guidance, and instruction on estimating tools and methods. If the individuals who will actually perform the work are doing the estimating (which is actually the best arrangement for getting a realistic estimate), more time and support may be needed than would experienced estimators.

The Resources Input and Review Meeting

Several weeks after the kickoff and review of ground rules meetings, each team member that has a resources (man-hour and/or materials) input is asked to present his or her input before the entire estimating team. Thus starts one of the most valuable parts of the estimating process: the interaction of team members to reduce duplications, overlaps, and omissions in resource data.

The most valuable aspect of a team estimate is the synergistic effect of team interaction. In any multidisciplinary activity, it is the synthesis of information and actions that produces wise decisions rather than the mere volume of data. In this review meeting the estimator of each discipline area has the opportunity to justify and explain the rationale for his estimates in view of his peers, an activity that tends to iron out inconsistencies, overstatements, and incompatibilities in resources estimates. Occasionally, inconsistencies, overlaps, duplications, and omissions will be so significant that a second input and review meeting will be required to collect and properly synthesize all inputs for an estimate.

Summary Meetings and Presentations

Once the resources inputs have been collected, adjusted, and “priced,” the cost estimate is presented to the estimating team as a “dry run” for the final presentation to the company’s management or to the requesting organization. This dry run can produce visibility into further inconsistencies or errors that have crept into the estimate during the process of consolidation and reconciliation. The final review with the requesting organization or with the company’s management could also bring about some changes in the estimate due to last minute changes in ground rules or budget-imposed cost ceilings.

11.6 UNDERSTANDING PARTICIPANTS’ ROLES

Companies that have histories of successful plans also have employees who fully understand their roles in the planning process. Good up-front planning may not eliminate the need for changes, but may reduce the number of changes required. The responsibilities of the major players are as follows:

- Project manager will define:
 - Goals and objectives
 - Major milestones
 - Requirements
 - Ground rules and assumptions
 - Time, cost, and performance constraints
 - Operating procedures
 - Administrative policy
 - Reporting requirements
- Line manager will define:
 - Detailed task descriptions to implement objectives, requirements, and milestones
 - Detailed schedules and manpower allocations to support budget and schedule
 - Identification of areas of risk, uncertainty, and conflict
- Senior management (project sponsor) will:
 - Act as the negotiator for disagreements between project and line management
 - Provide clarification of critical issues
 - Provide communication link with customer’s senior management

Successful planning requires that project, line, and senior management are in agreement with the plan.

11.7 PROJECT PLANNING

PMBOK® Guide, 4th Edition

Chapter 5 Project Scope
Management
5.2 Define Scope

Successful project management, whether in response to an in-house project or a customer request, must utilize effective planning techniques. The first step is understanding the project objectives. These goals may be to develop expertise in a given area, to become competitive, to modify an existing facility for later use, or simply to keep key personnel employed.

The objectives are generally not independent; they are all interrelated, both implicitly and explicitly. Many times it is not possible to satisfy all objectives. At this point, management must prioritize the objectives as to which are strategic and which are not. Typical problems with developing objectives include:

- Project objectives/goals are not agreeable to all parties.
- Project objectives are too rigid to accommodate changing priorities.
- Insufficient time exists to define objectives well.
- Objectives are not adequately quantified.
- Objectives are not documented well enough.
- Efforts of client and project personnel are not coordinated.
- Personnel turnover is high.

Once the objectives are clearly defined, four questions must be considered:

- What are the major elements of the work required to satisfy the objectives, and how are these elements interrelated?
- Which functional divisions will assume responsibility for accomplishment of these objectives and the major-element work requirements?
- Are the required corporate and organizational resources available?
- What are the information flow requirements for the project?

If the project is large and complex, then careful planning and analysis must be accomplished by both the direct- and indirect-labor-charging organizational units. The project organizational structure must be designed to fit the project; work plans and schedules must be established so that maximum allocation of resources can be made; resource costing and accounting systems must be developed; and a management information and reporting system must be established.

Effective total program planning cannot be accomplished unless all of the necessary information becomes available at project initiation. These information requirements are:

- The statement of work (SOW)
- The project specifications
- The milestone schedule
- The work breakdown structure (WBS)

The statement of work (SOW) is a narrative description of the work to be accomplished. It includes the objectives of the project, a brief description of the work, the funding constraint if one exists, and the specifications and schedule. The schedule is a “gross” schedule and includes such things as the:

- Start date
- End date
- Major milestones
- Written reports (data items)

Written reports should always be identified so that if functional input is required, the functional manager will assign an individual who has writing skills.

The last major item is the work breakdown structure. The WBS is the breaking down of the statement of work into smaller elements for better visibility and control. Each of these planning items is described in the following sections.

11.8 THE STATEMENT OF WORK

PMBOK® Guide, 4th Edition

5.2.3 Scope Definition

5.2.3.1 Project Scope Statement

12.1.3.2 Contract Statement of Work

The PMBOK® Guide addresses four elements related to scope:

- **Scope:** Scope is the summation of all deliverables required as part of the project. This includes all products, services, and results.
- **Project Scope:** This is the work that must be completed to achieve the final scope of the project, namely the products, services, and end results. (Previously, in Section 2.7, we differentiated between project scope and product scope.)
- **Scope Statement:** This is a document that provides the basis for making future decisions such as scope changes. The intended use of the document is to make sure that all stakeholders have a common knowledge of the project scope. Included in this document are the objectives, description of the deliverables, end result or product, and justification for the project. The scope statement addresses seven questions: who, what, when, why, where, how, and how many. This document validates the project scope against the statement of work provided by the customer.
- **Statement of Work:** This is a narrative description of the end results to be provided under the contract. For the remainder of this section, we will focus our attention on the statement of work.

The statement of work (SOW) is a narrative description of the work required for the project. The complexity of the SOW is determined by the desires of top management, the customer, and/or the user groups. For projects internal to the company, the SOW is prepared by the project office with input from the user groups because the project office is usually composed of personnel with writing skills.

For projects external to the organization, as in competitive bidding, the contractor may have to prepare the SOW for the customer because the customer may not have people trained in SOW preparation. In this case, as before, the contractor would submit the SOW to the customer for approval. It is also quite common for the project manager to rewrite a customer's SOW so that the contractor's line managers can price out the effort.

In a competitive bidding environment, there are two SOWs—the SOW used in the proposal and a contract statement of work (CSOW). There might also be a proposal WBS and a contract work breakdown structure (CWBS). Special care must be taken by contract and negotiation teams to discover all discrepancies between the SOW/WBS and CSOW/CWBS, or additional costs may be incurred. A good (or winning) proposal is *no guarantee* that the customer or contractor understands the SOW. For large projects, fact-finding is usually required before final negotiations because it is *essential* that both the customer and the

contractor understand and agree on the SOW, what work is required, what work is proposed, the factual basis for the costs, and other related elements. In addition, it is imperative that there be agreement between the final CSOW and CWBS.

SOW preparation is not as easy as it sounds. Consider the following:

- The SOW says that you are to conduct a *minimum* of fifteen tests to determine the material properties of a new substance. You price out twenty tests just to “play it safe.” At the end of the fifteenth test, the customer says that the results are inconclusive and that you must run another fifteen tests. The cost overrun is \$40,000.
- The Navy gives you a contract in which the SOW states that the prototype must be tested in “water.” You drop the prototype into a swimming pool to test it. Unfortunately, the Navy’s definition of “water” is the Atlantic Ocean, and it costs you \$1 million to transport all of your test engineers and test equipment to the Atlantic Ocean.
- You receive a contract in which the SOW says that you must transport goods across the country using “aerated” boxcars. You select boxcars that have open tops so that air can flow in. During the trip, the train goes through an area of torrential rains, and the goods are ruined.

These three examples show that misinterpretations of the SOW can result in losses of hundreds of millions of dollars. Common causes of misinterpretation are:

- Mixing tasks, specifications, approvals, and special instructions
- Using imprecise language (“nearly,” “optimum,” “approximately,” etc.)
- No pattern, structure, or chronological order
- Wide variation in size of tasks
- Wide variation in how to describe details of the work
- Failing to get third-party review

Misinterpretations of the statement of work can and will occur no matter how careful everyone has been. The result is creeping scope, or, as one telecommunications company calls it, “creeping elegance.” The best way to control creeping scope is with a good definition of the requirements up front, if possible.

Today, both private industry and government agencies are developing manuals on SOW preparation. The following is adapted from a NASA publication on SOW preparation³:

- The project manager or his designees should review the documents that authorize the project and define its objectives, and also review contracts and studies leading to the present level of development. As a convenience, a bibliography of related studies should be prepared together with samples of any similar SOWs, and compliance specifications.
- A copy of the WBS should be obtained. At this point coordination between the CWBS elements and the SOW should commence. Each task element of the preliminary CWBS should be explained in the SOW, and related coding should be used.

3. Adapted from *Statement of Work Handbook* NHB5600.2, National Aeronautics and Space Administration, February 1975.

- The project manager should establish a SOW preparation team consisting of personnel he deems appropriate from the program or project office who are experts in the technical areas involved, and representatives from procurement, financial management, fabrication, test, logistics, configuration management, operations, safety, reliability, and quality assurance, plus any other area that may be involved in the contemplated procurement.
- Before the team actually starts preparation of the SOW, the project manager should brief program management as to the structure of the preliminary CWBS and the nature of the contemplated SOW. This briefing is used as a baseline from which to proceed further.
- The project manager may assign identified tasks to team members and identify compliance specifications, design criteria, and other requirements documentation that must be included in the SOW and assign them to responsible personnel for preparation. Assigned team members will identify and obtain copies of specifications and technical requirements documents, engineering drawings, and results of preliminary and/or related studies that may apply to various elements of the proposed procurement.
- The project manager should prepare a detailed checklist showing the mandatory items and the selected optional items as they apply to the main body or the appendices of the SOW.
- The project manager should emphasize the use of preferred parts lists; standard subsystem designs, both existing and under development; available hardware in inventory; off-the-shelf equipment; component qualification data; design criteria handbooks; and other technical information available to design engineers to prevent deviations from the best design practices.
- Cost estimates (manning requirements, material costs, software requirements, etc.) developed by the cost estimating specialists should be reviewed by SOW contributors. Such reviews will permit early trade-off consideration on the desirability of requirements that are not directly related to essential technical objectives.
- The project manager should establish schedules for submission of coordinated SOW fragments from each task team member. He must assure that these schedules are compatible with the schedule for the request for proposal (RFP) issuance. The statement of work should be prepared sufficiently early to permit full project coordination and to ensure that all project requirements are included. It should be completed in advance of RFP preparation.

SOW preparation manuals also contain guides for editors and writers⁴:

- Every SOW that exceeds two pages in length should have a table of contents conforming to the CWBS coding structure. There should rarely be items in the SOW that are not shown on the CWBS; however, it is not absolutely necessary to restrict items to those cited in the CWBS.

4. See note 3.

- Clear and precise task descriptions are essential. The SOW writer should realize that his or her efforts will have to be read and interpreted by persons of varied background (such as lawyers, buyers, engineers, cost estimators, accountants, and specialists in production, transportation, security, audit, quality, finance, and contract management). A good SOW states precisely the product or service desired. The clarity of the SOW will affect administration of the contract, since it defines the scope of work to be performed. Any work that falls outside that scope will involve new procurement with probable increased costs.
- The most important thing to keep in mind when writing a SOW is the most likely effect the written work will have upon the reader. Therefore, every effort must be made to avoid ambiguity. All obligations of the government should be carefully spelled out. If approval actions are to be provided by the government, set a time limit. If government-furnished equipment (GFE) and/or services, etc., are to be provided, state the nature, condition, and time of delivery, if feasible.
- Remember that any provision that takes control of the work away from the contractor, even temporarily, may result in relieving the contractor of responsibility.
- In specifying requirements, use active rather than passive terminology. Say that the contractor shall conduct a test rather than that a test should be conducted. In other words, when a firm requirement is intended, use the mandatory term “shall” rather than the permissive term “should.”
- Limit abbreviations to those in common usage. Provide a list of all pertinent abbreviations and acronyms at the beginning of the SOW. When using a term for the first time, spell it out and show the abbreviation or acronym in parentheses following the word or words.
- When it is important to define a division of responsibilities between the contractor, other agencies, etc., a separate section of the SOW (in an appropriate location) should be included and delineate such responsibilities.
- Include procedures. When immediate decisions cannot be made, it may be possible to include a procedure for making them (e.g., “as approved by the contracting officer,” or “the contractor shall submit a report each time a failure occurs”).
- Do not overspecify. Depending upon the nature of the work and the type of contract, the ideal situation may be to specify results required or end-items to be delivered and let the contractor propose his best method.
- Describe requirements in sufficient detail to assure clarity, not only for legal reasons, but for practical application. It is easy to overlook many details. It is equally easy to be repetitious. Beware of doing either. For every piece of deliverable hardware, for every report, for every immediate action, do not specify that something be done “as necessary.” Rather, specify whether the judgment is to be made by the contractor or by the government. Be aware that these types of contingent actions may have an impact on price as well as schedule. Where expensive services, such as technical liaison, are to be furnished, do not say “as required.” Provide a ceiling on the extent of such services, or work out a procedure (e.g., a level of effort, pool of man-hours) that will ensure adequate control.
- Avoid incorporating extraneous material and requirements. They may add unnecessary cost. Data requirements are common examples of problems in this area.

Screen out unnecessary data requirements, and specify only what is essential and when. It is recommended that data requirements be specified separately in a data requirements appendix or equivalent.

- Do not repeat detailed requirements or specifications that are already spelled out in applicable documents. Instead, incorporate them by reference. If amplification, modification, or exceptions are required, make specific reference to the applicable portions and describe the change.

Some preparation documents also contain checklists for SOW preparation.⁵ A checklist is furnished below to provide considerations that SOW writers should keep in mind in preparing statements of work:

- Is the SOW (when used in conjunction with the preliminary CWBS) specific enough to permit a contractor to make a tabulation and summary of manpower and resources needed to accomplish each SOW task element?
- Are specific duties of the contractor stated so he will know what is required, and can the contracting officer's representative, who signs the acceptance report, tell whether the contractor has complied?
- Are all parts of the SOW so written that there is no question as to what the contractor is obligated to do, and when?
- When it is necessary to reference other documents, is the proper reference document described? Is it properly cited? Is all of it really pertinent to the task, or should only portions be referenced? Is it cross-referenced to the applicable SOW task element?
- Are any specifications or exhibits applicable in whole or in part? If so, are they properly cited and referenced to the appropriate SOW element?
- Are directions clearly distinguishable from general information?
- Is there a time-phased data requirement for each deliverable item? If elapsed time is used, does it specify calendar or work days?
- Are proper quantities shown?
- Have headings been checked for format and grammar? Are subheadings comparable? Is the text compatible with the title? Is a multidecimal or alphanumeric numbering system used in the SOW? Can it be cross-referenced with the CWBS?
- Have appropriate portions of procurement regulations been followed?
- Has extraneous material been eliminated?
- Can SOW task/contract line items and configuration item breakouts at lower levels be identified and defined in sufficient detail so they can be summarized to discrete third-level CWBS elements?
- Have all requirements for data been specified separately in a data requirements appendix or its equivalent? Have all extraneous data requirements been eliminated?
- Are security requirements adequately covered if required?
- Has its availability to contractors been specified?

5. See note 3.

Finally, there should be a management review of the SOW preparation interpretation⁶:

During development of the Statement of Work, the project manager should ensure adequacy of content by holding frequent reviews with project and functional specialists to determine that technical and data requirements specified do conform to the guidelines herein and adequately support the common system objective. The CWBS/SOW matrix should be used to analyze the SOW for completeness. After all comments and inputs have been incorporated, a final team review should be held to produce a draft SOW for review by functional and project managers. Specific problems should be resolved and changes made as appropriate. A final draft should then be prepared and reviewed with the program manager, contracting officer, or with higher management if the procurement is a major acquisition. The final review should include a briefing on the total RFP package. If other program offices or other Government agencies will be involved in the procurement, obtain their concurrence also.

11.9 PROJECT SPECIFICATIONS

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5.2 Define Scope

12.1.3.2 Contract Statement of Work

A specification list as shown in Table 11–1 is separately identified or called out as part of the statement of work. Specifications are used for man-hour, equipment, and material estimates. Small changes in a specification can cause large cost overruns.

Another reason for identifying the specifications is to make sure that there are no surprises for the customer downstream. The specifications should be the most current revision. It is not uncommon for a customer to hire outside agencies to evaluate the technical proposal and to make sure that the proper specifications are being used.

Specifications are, in fact, standards for pricing out a proposal. If specifications do not exist or are not necessary, then work standards should be included in the proposal. The work standards can also appear in the cost volume of the proposal. Labor justification backup sheets may or may not be included in the proposal, depending on RFP/RFQ (request for quotation) requirements.

Several years ago, a government agency queried contractors as to why some government programs were costing so much money. The main culprit turned out to be the specifications. Typical specifications contain twice as many pages as necessary, do not stress quality enough, are loaded with unnecessary designs and schematics, are difficult to read and update, and are obsolete before they are published. Streamlining existing specifications is a costly and time-consuming effort. The better alternative is to educate those people involved in specification preparation so that future specifications will be reasonably correct.

6. *Statement of Work Handbook* NHB5600.2, National Aeronautics and Space Administration, February 1975.

TABLE 11–1. SPECIFICATION FOR STATEMENT OF WORK

Description	Specification No.
Civil	100 (Index)
• Concrete	101
• Field equipment	102
• Piling	121
• Roofing and siding	122
• Soil testing	123
• Structural design	124
Electrical	200 (Index)
• Electrical testing	201
• Heat tracing	201
• Motors	209
• Power systems	225
• Switchgear	226
• Synchronous generators	227
HVAC	300 (Index)
• Hazardous environment	301
• Insulation	302
• Refrigeration piping	318
• Sheetmetal ductwork	319
Installation	400 (Index)
• Conveyors and chutes	401
• Fired heaters and boilers	402
• Heat exchangers	403
• Reactors	414
• Towers	415
• Vessels	416
Instruments	500 (Index)
• Alarm systems	501
• Control valves	502
• Flow instruments	503
• Level gages	536
• Pressure instruments	537
• Temperature instruments	538
Mechanical equipment	600 (Index)
• Centrifugal pumps	601
• Compressors	602
• High-speed gears	603
• Material handling equipment	640
• Mechanical agitators	641
• Steam turbines	642
Piping	700 (Index)
• Expansion joints	701
• Field pressure testing	702
• Installation of piping	703
• Pipe fabrication specs	749
• Pipe supports	750
• Steam tracing	751
Project administration	800 (Index)
• Design drawings	801
• Drafting standards	802
• General requirements	803
• Project coordination	841
• Reporting procedure	842
• Vendor data	843

(continues)

**TABLE 11–1. SPECIFICATION FOR STATEMENT OF WORK
(Continued)**

Description	Specification No.
Vessels	900 (Index)
• Fireproofing	901
• Painting	902
• Reinforced tanks	948
• Shell and tube heat exchangers	949
• Steam boilers	950
• Vessel linings	951

11.10 MILESTONE SCHEDULES

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Chapter 6 Time Management

Project milestone schedules contain such information as:

- Project start date
- Project end date
- Other major milestones
- Data items (deliverables or reports)

Project start and end dates, if known, must be included. Other major milestones, such as review meetings, prototype available, procurement, testing, and so on, should also be identified. The last topic, data items, is often overlooked. There are two good reasons for preparing a separate schedule for data items. First, the separate schedule will indicate to line managers that personnel with writing skills may have to be assigned. Second, data items require direct-labor man-hours for writing, typing, editing, retyping, proofing, graphic arts, and reproduction. Many companies identify on the data item schedules the approximate number of pages per data item, and each data item is priced out at a cost per page, say \$500/page. Pricing out data items separately often induces customers to require fewer reports.

The steps required to prepare a report, after the initial discovery work or collection of information, include:

- Organizing the report
- Writing
- Typing
- Editing
- Retyping
- Proofing
- Graphic arts
- Submittal for approvals
- Reproduction and distribution

Typically, 6–8 hours of work are required per page. At a burdened hourly rate of \$80/hour, it is easy for the cost of documentation to become exorbitant.

11.11 WORK BREAKDOWN STRUCTURE

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5.3 Create WBS

The successful accomplishment of both contract and corporate objectives requires a plan that defines all effort to be expended, assigns responsibility to a specially identified organizational element, and establishes schedules and budgets for the accomplishment of the work. The preparation of this plan is the responsibility of the program manager, who is assisted by the program team assigned in accordance with program management system directives. The detailed planning is also established in accordance with company budgeting policy before contractual efforts are initiated.

In planning a project, the project manager must structure the work into small elements that are:

- Manageable, in that specific authority and responsibility can be assigned
- Independent, or with minimum interfacing with and dependence on other ongoing elements
- Integratable so that the total package can be seen
- Measurable in terms of progress

The first major step in the planning process after project requirements definition is the development of the work breakdown structure (WBS). A WBS is a product-oriented family tree subdivision of the hardware, services, and data required to produce the end product. The WBS is structured in accordance with the way the work will be performed and reflects the way in which project costs and data will be summarized and eventually reported. Preparation of the WBS also considers other areas that require structured data, such as scheduling, configuration management, contract funding, and technical performance parameters. The WBS is the single most important element because it provides a common framework from which:

- The total program can be described as a summation of subdivided elements.
- Planning can be performed.
- Costs and budgets can be established.
- Time, cost, and performance can be tracked.
- Objectives can be linked to company resources in a logical manner.
- Schedules and status-reporting procedures can be established.
- Network construction and control planning can be initiated.
- The responsibility assignments for each element can be established.

The work breakdown structure acts as a vehicle for breaking the work down into smaller elements, thus providing a greater probability that every major and minor activity

will be accounted for. Although a variety of work breakdown structures exist, the most common is the six-level indented structure shown below:

	<i>Level</i>	<i>Description</i>
Managerial levels	1	Total program
	2	Project
	3	Task
Technical levels	4	Subtask
	5	Work package
	6	Level of effort

Level 1 is the total program and is composed of a set of projects. The summation of the activities and costs associated with each project must equal the total program. Each project, however, can be broken down into tasks, where the summation of all tasks equals the summation of all projects, which, in turn, comprises the total program. The reason for this subdivision of effort is simply ease of control. Program management therefore becomes synonymous with the integration of activities, and the project manager acts as the integrator, using the work breakdown structure as the common framework.

Careful consideration must be given to the design and development of the WBS. From Figure 11–3, the work breakdown structure can be used to provide the basis for:

- The responsibility matrix
- Network scheduling
- Costing
- Risk analysis
- Organizational structure
- Coordination of objectives
- Control (including contract administration)

The upper three levels of the WBS are normally specified by the customer (if part of an RFP/RFQ) as the summary levels for reporting purposes. The lower levels are generated by the contractor for in-house control. Each level serves a vital purpose: Level 1 is generally used for the authorization and release of all work, budgets are prepared at level 2, and schedules are prepared at level 3. Certain characteristics can now be generalized for these levels:

- The top three levels of the WBS reflect integrated efforts and should not be related to one specific department. Effort required by departments or sections should be defined in subtasks and work packages.
- The summation of all elements in one level must be the sum of all work in the next lower level.
- Each element of work should be assigned to one and only one level of effort. For example, the construction of the foundation of a house should be included in one project (or task), not extended over two or three. (At level 5, the work packages should be identifiable and homogeneous.)

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Figure 5–6 Sample WBS

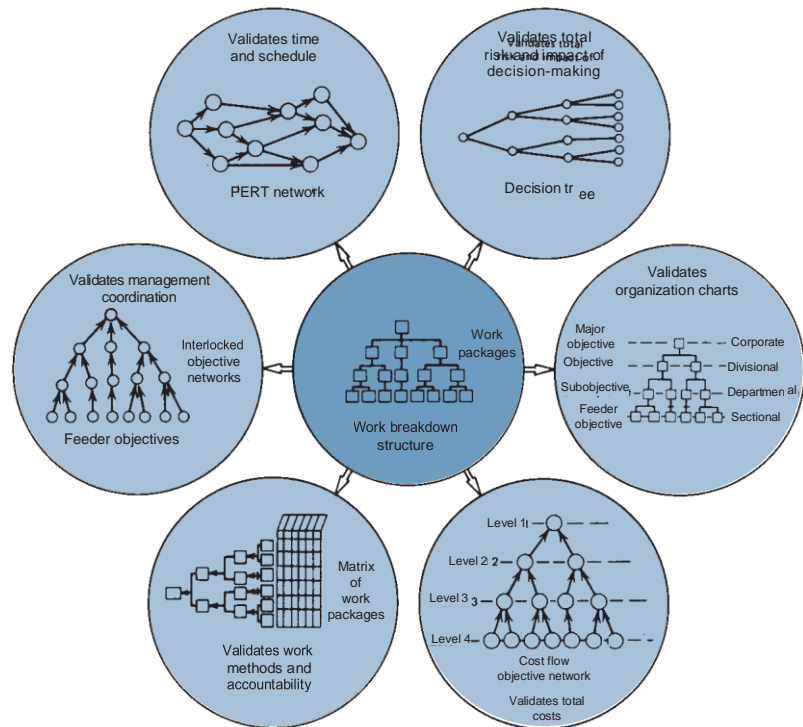


FIGURE 11-3. Work breakdown structure for objective control and evaluation. *Source:* Paul Mali, *Managing by Objectives* (New York: Wiley, 1972), p. 163. Copyright © 1972 by John Wiley & Sons. Reprinted by permission of the publisher.

- The level at which the project is managed is generally called the work package level. Actually, the work package can exist at any level below level one.
- The WBS must be accompanied by a description of the scope of effort required, or else only those individuals who issue the WBS will have a complete understanding of what work has to be accomplished. It is common practice to reproduce the customer's statement of work as the description for the WBS.
- It is often the best policy for the project manager, regardless of his technical expertise, to allow all of the line managers to assess the risks in the SOW. After all, the line managers are usually the recognized experts in the organization.

Project managers normally manage at the top three levels of the WBS and prefer to provide status reports to management at these levels also. Some companies are trying to standardize reporting to management by requiring the top three levels of the WBS to be the same for every project, the only differences being in levels 4–6. For companies with a great deal of similarity among projects, this approach has merit. For most companies, however, the differences between projects make it almost impossible to standardize the top levels of the WBS.

The work package is the critical level for managing a work breakdown structure, as shown in Figure 11–4. However, it is possible that the actual management of the work packages is supervised and performed by the line managers with status reporting provided to the project manager at higher levels of the WBS.

Work packages are natural subdivisions of cost accounts and constitute the basic building blocks used by the contractor in planning, controlling, and measuring contract performance. A work package is simply a low-level task or job assignment. It describes the work to be accomplished by a specific performing organization or a group of cost centers and serves as a vehicle for monitoring and reporting progress of work. Documents that authorize and assign work to a performing organization are designated by various names throughout industry. “Work package” is the generic term used in the criteria to identify discrete tasks that have definable end results. Ideal work packages are 80 hours and 2–4 weeks. However, this may not be possible on large projects.

It is not necessary that work package documentation contain complete, stand-alone descriptions. Supplemental documentation may augment the work package descriptions. However, the work package descriptions must permit cost account managers and work package supervisors to understand and clearly distinguish one work package effort from another. In the review of work package documentation, it may be necessary to obtain explanations from personnel routinely involved in the work, rather than requiring the work package descriptions to be completely self-explanatory.

Short-term work packages may help evaluate accomplishments. Work packages should be natural subdivisions of effort planned according to the way the work will be done. However, when work packages are relatively short, little or no assessment of work-in-process is required and the evaluation of status is possible mainly on the basis of work package completions. The longer the work packages, the more difficult and subjective the work-in-process assessment becomes unless the packages are subdivided by objective indicators such as discrete milestones with preassigned budget values or completion percentages.

In setting up the work breakdown structure, tasks should:

- Have clearly defined start and end dates
- Be usable as a communications tool in which results can be compared with expectations
- Be estimated on a “total” time duration, not when the task must start or end
- Be structured so that a minimum of project office control and documentation (i.e., forms) is necessary

For large projects, planning will be time phased at the work package level of the WBS. The work package has the following characteristics:

- Represents units of work at the level where the work is performed
- Clearly distinguishes one work package from all others assigned to a single functional group
- Contains clearly defined start and end dates that are representative of physical accomplishment (This is accomplished after scheduling has been completed.)

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Figure 5-6 Work Packages
Organizational Procedures Links

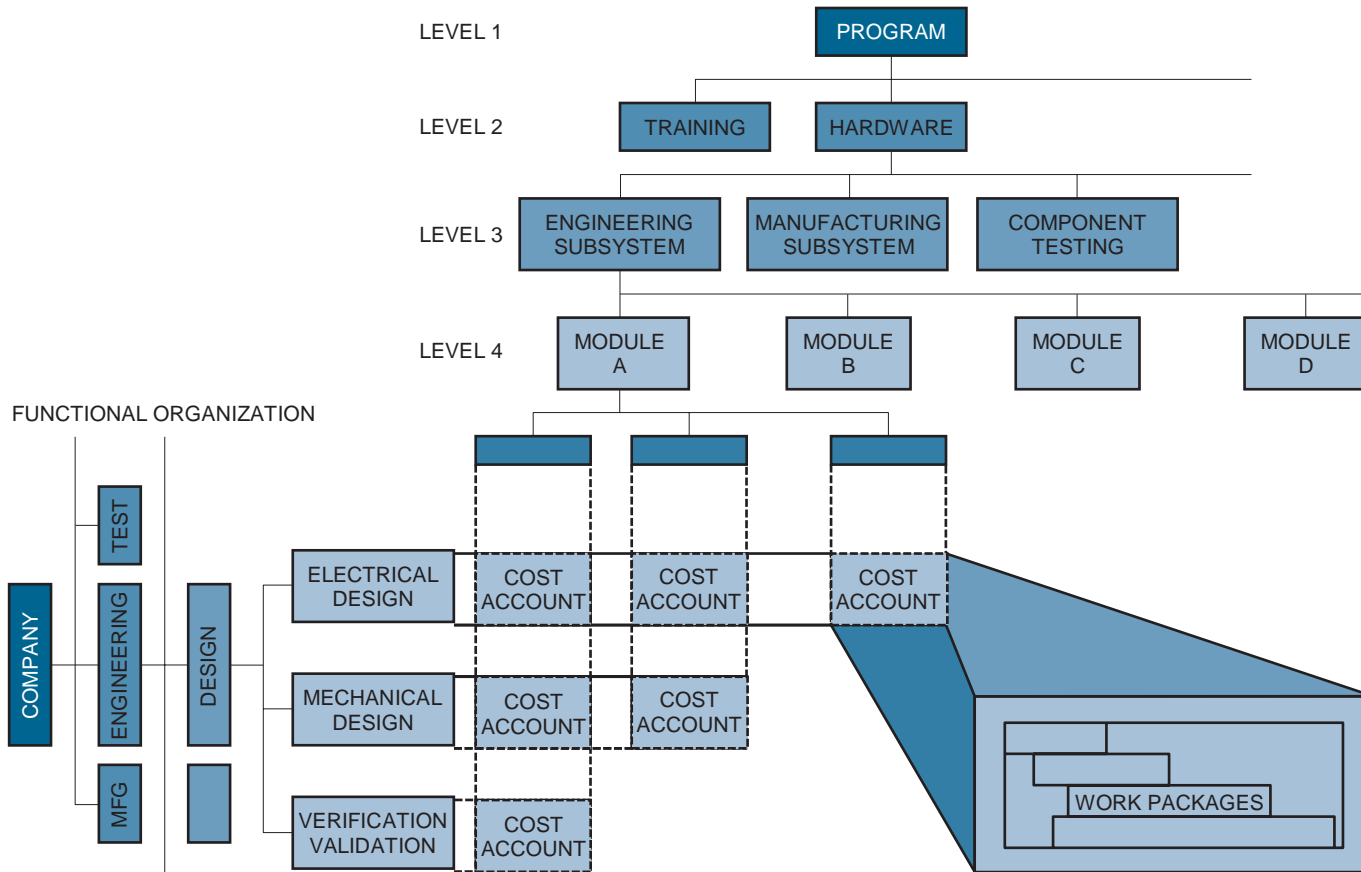


FIGURE 11-4. The cost account intersection.

- Specifies a budget in terms of dollars, man-hours, or other measurable units
- Limits the work to be performed to relatively short periods of time to minimize the work-in-process effort

Table 11–2 shows a simple work breakdown structure with the associated numbering system following the work breakdown. The first number represents the total program (in this case, it is represented by 01), the second number represents the project, and the third number identifies the task. Therefore, number 01-03-00 represents project 3 of program 01, whereas 01-03-02 represents task 2 of project 3. This type of numbering system is not standard; each company may have its own system, depending on how costs are to be controlled.

The preparation of the work breakdown structure is not easy. The WBS is a communications tool, providing detailed information to different levels of management. If it does not contain enough levels, then the integration of activities may prove difficult. If too many levels exist, then unproductive time will be made to have the same number of levels for all projects, tasks, and so on. Each major work element should be considered by itself. Remember, the WBS establishes the number of required networks for cost control.

For many programs, the work breakdown structure is established by the customer. If the contractor is required to develop a WBS, then certain guidelines must be considered including:

- The complexity and technical requirements of the program (i.e., the statement of work)
- The program cost
- The time span of the program
- The contractor's resource requirements
- The contractor's and customer's internal structure for management control and reporting
- The number of subcontracts

TABLE 11–2. WORK BREAKDOWN STRUCTURE FOR NEW PLANT CONSTRUCTION AND START-UP

Program: New Plant Construction and Start-up	01-00-00
Project 1: Analytical Study	01-01-00
Task 1: Marketing/Production Study	01-01-01
Task 2: Cost Effectiveness Analysis	01-01-02
Project 2: Design and Layout	01-02-00
Task 1: Product Processing Sketches	01-02-01
Task 2: Product Processing Blueprints	01-02-02
Project 3: Installation	01-03-00
Task 1: Fabrication	01-03-01
Task 2: Setup	01-03-02
Task 3: Testing and Run	01-03-03
Project 4: Program Support	01-04-00
Task 1: Management	01-04-01
Task 2: Purchasing Raw Materials	01-04-02

Applying these guidelines serves only to identify the complexity of the program. These data must then be subdivided and released, together with detailed information, to the different levels of the organization. The WBS should follow specified criteria because, although preparation of the WBS is performed by the program office, the actual work is performed by the doers, not the planners. Both the doers and the planners must be in agreement as to what is expected. A sample listing of criteria for developing a work breakdown structure is shown below:

- The WBS and work description should be easy to understand.
- All schedules should follow the WBS.
- No attempt should be made to subdivide work arbitrarily to the lowest possible level. The lowest level of work should not end up having a ridiculous cost in comparison to other efforts.
- Since scope of effort can change during a program, every effort should be made to maintain flexibility in the WBS.
- The WBS can act as a list of discrete and tangible milestones so that everyone will know when the milestones were achieved.
- The level of the WBS can reflect the “trust” you have in certain line groups.
- The WBS can be used to segregate recurring from nonrecurring costs.
- Most WBS elements (at the lowest control level) range from 0.5 to 2.5 percent of the total project budget.

11.12 WBS DECOMPOSITION PROBLEMS

There is a common misconception that WBS decomposition is an easy task to perform. In the development of the WBS, the top three levels or management levels are usually roll-up levels. Preparing templates at these levels is becoming common practice. However, at levels 4–6 of the WBS, templates may not be appropriate. There are reasons for this.

- Breaking the work down to extremely small and detailed work packages may require the creation of hundreds or even thousands of cost accounts and charge numbers. This could increase the management, control, and reporting costs of these small packages to a point where the costs exceed the benefits. Although a typical work package may be 200–300 hours and approximately two weeks in duration, consider the impact on a large project, which may have more than one million direct labor hours.
- Breaking the work down to small work packages can provide accurate cost control if, and only if, the line managers can determine the costs at this level of detail. Line managers must be given the right to tell project managers that costs *cannot* be determined at the requested level of detail.
- The work breakdown structure is the basis for scheduling techniques such as the Arrow Diagramming Method and the Precedence Diagramming Method. At low levels of the WBS, the interdependencies between activities can become so complex that meaningful networks cannot be constructed.

One solution to the above problems is to create “hammock” activities, which encompass several activities where exact cost identification cannot or may not be accurately determined. Some projects identify a “hammock” activity called management support (or project office), which includes overall project management, data items, management reserve, and possibly procurement. The advantage of this type of hammock activity is that the charge numbers are under the *direct* control of the project manager.

There is a common misconception that the typical dimensions of a work package are approximately 80 hours and less than two weeks to a month. Although this may be true on small projects, this would necessitate millions of work packages on large jobs and this may be impractical, even if line managers could control work packages of this size.

From a cost control point of view, cost analysis down to the fifth level is advantageous. However, it should be noted that the cost required to prepare cost analysis data to each lower level may increase exponentially, especially if the customer requires data to be presented in a specified format that is not part of the company’s standard operating procedures. The level-5 work packages are normally for in-house control only. Some companies bill customers separately for each level of cost reporting below level 3.

The WBS can be subdivided into subobjectives with finer divisions of effort as we go lower into the WBS. By defining subobjectives, we add greater understanding and, it is hoped, clarity of action for those individuals who will be required to complete the objectives. Whenever work is structured, understood, easily identifiable, and within the capabilities of the individuals, there will almost always exist a high degree of confidence that the objective can be reached.

Work breakdown structures can be used to structure work for reaching such objectives as lowering cost, reducing absenteeism, improving morale, and lowering scrap factors. The lowest subdivision now becomes an end-item or subobjective, not necessarily a work package as described here. However, since we are describing project management, for the remainder of the text we will consider the lowest level as the work package.

Once the WBS is established and the program is “kicked off,” it becomes a very costly procedure to either add or delete activities, or change levels of reporting because of cost control. Many companies do not give careful forethought to the importance of a properly developed WBS, and ultimately they risk cost control problems downstream. One important use of the WBS is that it serves as a cost control standard for any future activities that may follow on or may just be similar. One common mistake made by management is the combining of direct support activities with administrative activities. For example, the department manager for manufacturing engineering may be required to provide administrative support (possibly by attending team meetings) throughout the duration of the program. If the administrative support is spread out over each of the projects, a false picture is obtained as to the actual hours needed to accomplish each project in the program. If one of the projects should be canceled, then the support man-hours for the total program would be reduced when, in fact, the administrative and support functions may be constant, regardless of the number of projects and tasks.

Quite often work breakdown structures accompanying customer RFPs contain much more scope of effort, as specified by the statement of work, than the existing funding will support. This is done intentionally by the customer in hopes that a contractor may be willing to “buy in.” If the contractor’s price exceeds the customer’s funding limitations, then

the scope of effort must be reduced by eliminating activities from the WBS. By developing a separate project for administrative and indirect support activities, the customer can easily modify his costs by eliminating the direct support activities of the canceled effort.

Before we go on, there should be a brief discussion of the usefulness and applicability of the WBS system. Many companies and industries have been successful in managing programs without the use of work breakdown structures, especially on repetitive-type programs. As was the case with the SOW, there are also preparation guides for the WBS⁷:

- Develop the WBS structure by subdividing the total effort into discrete and logical subelements. Usually a program subdivides into projects, major systems, major subsystems, and various lower levels until a manageable-size element level is reached. Wide variations may occur, depending upon the type of effort (e.g., major systems development, support services, etc.). Include more than one cost center and more than one contractor if this reflects the actual situation.
- Check the proposed WBS and the contemplated efforts for completeness, compatibility, and continuity.
- Determine that the WBS satisfies both functional (engineering/manufacturing/test) and program/project (hardware, services, etc.) requirements, including recurring and nonrecurring costs.
- Check to determine if the WBS provides for logical subdivision of all project work.
- Establish assignment of responsibilities for all identified effort to specific organizations.
- Check the proposed WBS against the reporting requirements of the organizations involved.

PMBOK® Guide, 4th Edition
5.3.3.1 WBS

There are also checklists that can be used in the preparation of the WBS⁸:

- Develop a preliminary WBS to not lower than the top three levels for solicitation purposes (or lower if deemed necessary for some special reason).
- Assure that the contractor is required to extend the preliminary WBS in response to the solicitation, to identify and structure all contractor work to be compatible with his organization and management system.
- Following negotiations, the CWBS included in the contract should not normally extend lower than the third level.
- Assure that the negotiated CWBS structure is compatible with reporting requirements.

7. Source: *Handbook for Preparation of Work Breakdown Structures*, NHB5610.1, National Aeronautics and Space Administration, February 1975.

8. See note 7.

- Assure that the negotiated CWBS is compatible with the contractor's organization and management system.
- Review the CWBS elements to ensure correlation with:
 - The specification tree
 - Contract line items
 - End-items of the contract
 - Data items required
 - Work statement tasks
 - Configuration management requirements
- Define CWBS elements down to the level where such definitions are meaningful and necessary for management purposes (WBS dictionary).
- Specify reporting requirements for selected CWBS elements if variations from standard reporting requirements are desired.
- Assure that the CWBS covers measurable effort, level of effort, apportioned effort, and subcontracts, if applicable.
- Assure that the total costs at a particular level will equal the sum of the costs of the constituent elements at the next lower level.

On simple projects, the WBS can be constructed as a “tree diagram” (see Figure 11–5) or according to the logic flow. In Figure 11–5, the tree diagram can follow the work or even the organizational structure of the company (i.e., division, department, section, unit). The second method is to create a logic flow (see Figure 12–21) and cluster certain elements to represent tasks and projects. In the tree method, lower-level functional units may be

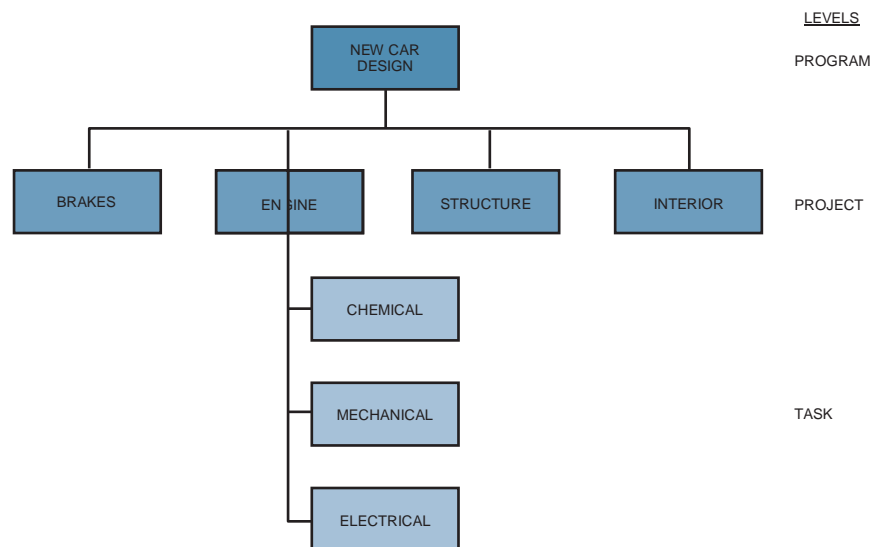


FIGURE 11–5. WBS tree diagram.

assigned to one, and only one, work element, whereas in the logic flow method the lower-level functional units may serve several WBS elements.

A tendency exists to develop guidelines, policies, and procedures for project management, but not for the development of the WBS. Some companies have been marginally successful in developing a “generic” methodology for levels 1, 2, and 3 of the WBS to use on all projects. The differences appear in levels 4, 5, and 6.

The table below shows the three most common methods for structuring the WBS:

Level	Method		
	Flow	Life Cycle	Organization
Program	Program	Program	Program
Project	System	Life cycle	Division
Task	Subsystem	System	Department
Subtask	People	Subsystem	Section
Work package	People	People	People
Level of effort	People	People	People

The flow method breaks the work down into systems and major subsystems. This method is well suited for projects less than two years in length. For longer projects, we use the life-cycle method, which is similar to the flow method. The organization method is used for projects that may be repetitive or require very little integration between functional units.

11.13 ROLE OF THE EXECUTIVE IN PROJECT SELECTION

PMBOK® Guide, 4th Edition

Chapter 4 Integration
4.1.2 Develop Project Charter
Tools and Techniques

A prime responsibility of senior management (and possibly project sponsors) is the selection of projects. Most organizations have an established selection criteria, which can be subjective, objective, quantitative, qualitative, or simply a seat-of-the-pants guess. In any event, there should be a valid reason for selecting the project.

From a financial perspective, project selection is basically a two-part process. First, the organization will conduct a feasibility study to determine whether the project *can* be done. The second part is to perform a benefit-to-cost analysis to see whether the company *should* do it.

The purpose of the feasibility study is to validate that the project meets feasibility of cost, technological, safety, marketability, and ease of execution requirements. The company may use outside consultants or subject matter experts (SMEs) to assist in both feasibility studies and benefit-to-cost analyses. A project manager may not be assigned until after the feasibility study is completed.

As part of the feasibility process during project selection, senior management often solicits input from SMEs and lower-level managers through rating models. The rating models normally identify the business and/or technical criteria against which the ratings

		SCALE				
CRITERIA		-2	-1	0	+1	+2
TOP MANAGEMENT	CAPITAL REQUIREMENTS				X	
	COMPETITIVE REACTION			X		
	RETURN ON INVESTMENT				X	
	PAYOUT TIME				X	
	WALL STREET IMPACTS				X	
ENGINEERING	REQUIRED EQUIPMENT					X
	AVAILABILITY OF PERSONNEL				X	
	KNOW-HOW					X
	DESIGN DIFFICULTY					
	EQUIPMENT AVAILABILITY				X	
	PIPING LAYOUTS				X	
RESEARCH	PATENTABILITY			X		
	LIKELIHOOD OF SUCCESS					X
	KNOW-HOW					X
	PROJECT COSTS		X			
	AVAILABILITY OF PERSONNEL	X				
	AVAILABILITY OF LABORATORY	X				
MARKETING	LENGTH OF PRODUCT LIFE		X			
	PRODUCT ADVANTAGE		X			
	SUITABILITY TO SALESFORCE	X				
	SIZE OF MARKET	X				
	NUMBER OF COMPETITORS	X				
PRODUCTION	PROCESSABILITY					X
	KNOW-HOW					X
	EQUIPMENT AVAILABILITY					X
NUMBER OF Xs		5	3	2	7	7

KEY: +2 = EXCELLENT
 +1 = GOOD
 0 = FAIR
 -1 = BAD
 -2 = UNACCEPTABLE



 = NOT APPLICABLE
 = SCORE FOR PROJECT A

FIGURE 11-6. Illustration of a scaling model for one project, Project A. *Source:* William E. Souder, *Project Selection and Economic Appraisal*, p. 66.

will be made. Figure 11–6 shows a scaling model for a single project. Figure 11–7 shows a checklist rating system to evaluate three projects at once. Figure 11–8 shows a scoring model for multiple projects using weighted averages.

If the project is deemed feasible and a good fit with the strategic plan, then the project is prioritized for development along with other projects. Once feasibility is determined, a benefit-to-cost analysis is performed to validate that the project will, if executed correctly, provide the required financial and nonfinancial benefits.

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5.2.2 Scope Definition

5.2.2.2 Product Analysis

Benefit-to-cost analyses require significantly more information to be scrutinized than is usually available during a feasibility study. This can be an expensive proposition.

Estimating benefits and costs in a timely manner is very difficult. Benefits are often defined as:

- Tangible benefits for which dollars may be reasonably quantified and measured.
- Intangible benefits that may be quantified in units other than dollars or may be identified and described subjectively.

CRITERIA										

FIGURE 11–7. Illustration of a checklist for three projects. *Source:* William Souder, *Project Selection and Economic Appraisal*, p. 68.

CRITERIA	PROFITABILITY	PATENTABILITY	MARKETABILITY	PRODUCEABILITY
CRITERION WEIGHTS	4	3	2	1

<u>PROJECTS</u>	<u>CRITERION SCORES*</u>				<u>TOTAL WEIGHTED SCORE</u>
PROJECT D	10	6	4	3	69
PROJECT E	5	10	10	5	75
PROJECT F	3	7	10	10	63

TOTAL WEIGHTED SCORE = \sum (CRITERION SCORE \times CRITERION WEIGHT)

* SCALE: 10 = EXCELLENT; 1 = UNACCEPTABLE

FIGURE 11–8. Illustration of a scoring model. *Source:* William Souder, *Project Selection and Economic Appraisal*, p. 69.

Costs are significantly more difficult to quantify. The minimum costs that must be determined are those that specifically are used for comparison to the benefits. These include:

- The current operating costs or the cost of operating in today's circumstances.
- Future period costs that are expected and can be planned for.
- Intangible costs that may be difficult to quantify. These costs are often omitted if quantification would contribute little to the decision-making process.

TABLE 11–3. FEASIBILITY STUDY AND BENEFIT-COST ANALYSIS

	Feasibility Study	Benefit-Cost Analysis
<i>Basic Question</i>	<i>Can We Do It?</i>	<i>Should We Do It?</i>
Life-Cycle Phase	Preconceptual	Conceptual
PM Selected	Usually not yet	Usually identified but partial involvement
Analysis	Qualitative	Quantitative
Critical Factors for Go/No-Go	<ul style="list-style-type: none"> • Technical • Cost • Quality • Safety • Ease of performance • Economical • Legal 	<ul style="list-style-type: none"> • Net present value • Discounted cash flow • Internal rate of return • Return on investment • Probability of success • Reality of assumptions and constraints
Executive Decision Criteria	Strategic fit	Benefits exceed costs by required margin

There must be careful documentation of all known constraints and assumptions that were made in developing the costs and the benefits. Unrealistic or unrecognized assumptions are often the cause of unrealistic benefits. The go or no-go decision to continue with a project could very well rest upon the validity of the assumptions.

Table 11–3 shows the major differences between feasibility studies and benefit-to-cost analyses.

Today, the project manager may end up participating in the project selection process. In Chapter 1, we discussed the new breed of project manager, namely a person that has excellent business skills as well as project management skills. These business skills now allow us to bring the project manager on board the project at the beginning of the initiation phase rather than at the end of the initiation phase because the project manager can now make a valuable contribution to the project selection process. The project manager can be of assistance during project selection by providing business case knowledge including:

- Opportunity options (sales volume, market share, and follow-on business)
- Resource requirements (team knowledge requirements and skill set)
- Refined project costs
- Refined savings
- Benefits (financial, strategic, payback)
- Project metrics (key performance indicators and critical success factors)
- Benefits realization (consistency with the corporate business plan)
- Risks
- Exit strategies
- Organizational readiness and strengths
- Schedule/milestones
- Overall complexity
- Technology complexity and constraints, if any⁹

9. For additional factors that can influence project selection decision making, see J. R. Meredith and S. J. Mantel, Jr., *Project Management*, 3rd ed., (New York: Wiley, 1995), pp. 44–46.

11.14 ROLE OF THE EXECUTIVE IN PLANNING

Executives are responsible for selecting the project manager, and the person chosen should have planning expertise. Not all technical specialists are good planners. Likewise, some people that are excellent in execution have minimal planning skills. Executives must make sure that whomever is assigned as the project manager has both planning and execution skills. In addition, executives must take an active role during project planning activities especially if they also function as project sponsors.¹⁰

Executives must not arbitrarily set unrealistic milestones and then “force” line managers to fulfill them. Both project and line managers should try to adhere to unrealistic milestones, but if a line manager says he cannot, executives should comply because the line manager is supposedly the expert.

Executives should interface with project and line personnel during the planning stage in order to define the requirements and establish reasonable deadlines. Executives must realize that creating an unreasonable deadline may require the reestablishment of priorities, and, of course, changing priorities can push milestones backward.

11.15 THE PLANNING CYCLE

Previously, we stated that perhaps the most important reason for structuring projects into life-cycle phases is to provide management with control of the critical decision points in order to:

- Avoid commitment of major resources too early
- Preserve future options
- Maximize benefits of each project in relation to all other projects
- Assess risks

On long-term projects, phasing can be overdone, resulting in extra costs and delays. To prevent this, many project-driven companies resort to other types of systems, such as a management cost and control system (MCCS). No program or project can be efficiently organized and managed without some form of management cost and control system.

Figure 11–9 shows the five phases of a management cost and control system. The first phase constitutes the planning cycle, and the next four phases identify the operating cycle.

Figure 11–10 shows the activities included in the planning cycle. The work break-down structure serves as the initial control from which all planning emanates. The WBS acts as a vital artery for communications and operations in all phases. A comprehensive analysis of management cost and control systems is presented in Chapter 15.

10. Although this section is called “The Role of the Executive in Planning,” it also applies to line management if project sponsorship is pushed down to the middle-management level or lower. This is quite common in highly mature project management organizations where senior management has sufficient faith in line management’s ability to serve as project sponsors.

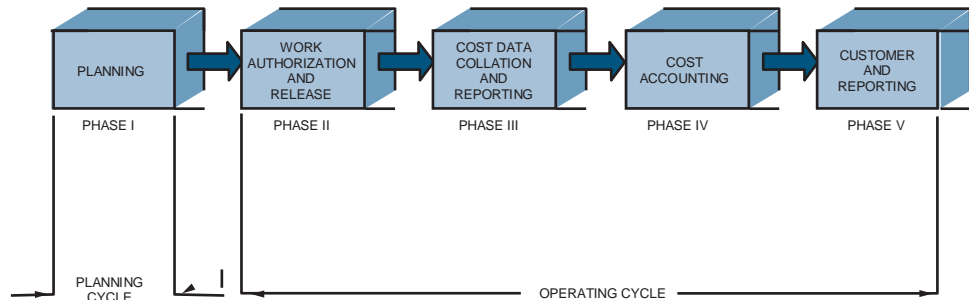


FIGURE 11-9. Phases of a management cost and control system.

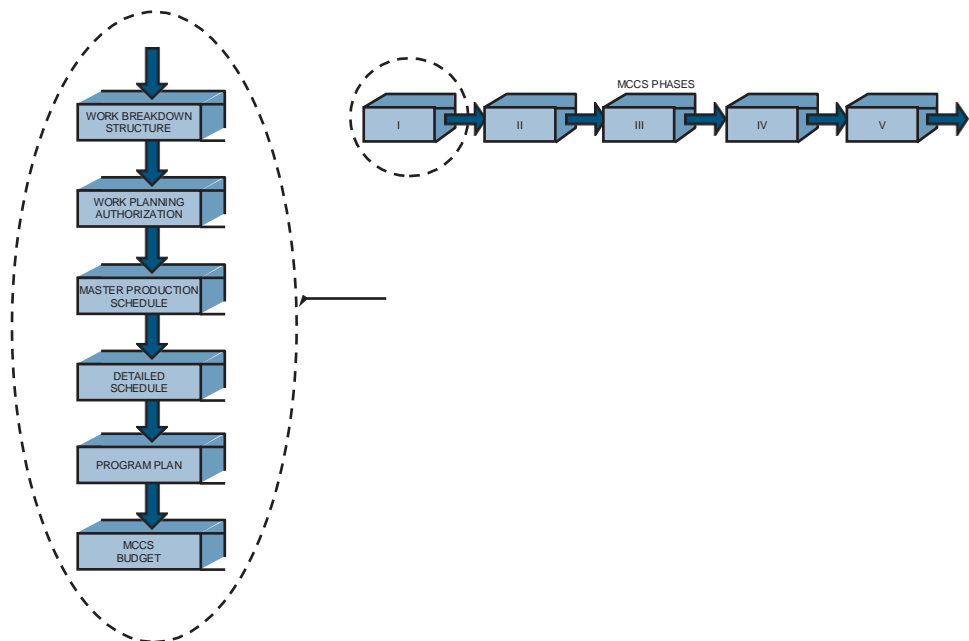


FIGURE 11-10. The planning cycle of a management cost and control system.

11.16 WORK PLANNING AUTHORIZATION

PMBOK® Guide, 4th Edition
4.3.2 Direct and Manage
Project Execution

After receipt of a contract, some form of authorization is needed before work can begin, even in the planning stage. Both work authorization and work planning authorization are used to release funds, but for different purposes. Work planning authorization releases funds (primarily for functional management) so that scheduling, costs, budgets, and all other types of plans can be prepared prior to the release of operational cycle funds, which hereafter shall be referred to simply as work authorization. Both forms of authorization require the same paperwork. In many companies this work authorization is identified as a subdivided work description (SWD), which is a narrative description of the effort to be performed by the cost center

(division-level minimum). This package establishes the work to be performed, the period of performance, and possibly the maximum number of hours available. The SWD is multi-purpose in that it can be used to release contract funds, authorize planning, describe activities as identified in the WBS, and, last but not least, release work.

The SWD is one of the key elements in the planning of a program as shown in Figure 11–10. Contract control and administration releases the contract funds by issuing a SWD, which sets forth general contractual requirements and authorizes program management to proceed. Program management issues the SWD to set forth the contractual guidelines and requirements for the functional units. The SWD specifies how the work will be performed, which functional organizations will be involved, and who has what specific responsibilities, and authorizes the utilization of resources within a given time period.

The SWD authorizes both the program team and functional management to begin work. As shown in Figure 11–10, the SWD provides direct input to Phase II of the MCCC. Phase I and Phase II can and do operate simultaneously because it is generally impossible for program office personnel to establish plans, procedures, and schedules without input from the functional units.

The subdivided work description package is used by the operating organizations to further subdivide the effort defined by the WBS into small segments or work packages.

Many people contend that if the data in the work authorization document are different from what was originally defined in the proposal, the project is in trouble right at the start. This may not be the case, because most projects are priced out assuming “unlimited” resources, whereas the hours and dollars in the work authorization document are based upon “limited” resources. This situation is common for companies that thrive on competitive bidding.

11.17 WHY DO PLANS FAIL?

No matter how hard we try, planning is not perfect, and sometimes plans fail. Typical reasons include:

- Corporate goals are not understood at the lower organizational levels.
- Plans encompass too much in too little time.
- Financial estimates are poor.
- Plans are based on insufficient data.
- No attempt is being made to systematize the planning process.
- Planning is performed by a planning group.
- No one knows the ultimate objective.
- No one knows the staffing requirements.
- No one knows the major milestone dates, including written reports.
- Project estimates are best guesses, and are not based on standards or history.
- Not enough time has been given for proper estimating.
- No one has bothered to see if there will be personnel available with the necessary skills.
- People are not working toward the same specifications.
- People are consistently shuffled in and out of the project with little regard for schedule.

Why do these situations occur? If corporate goals are not understood, it is because corporate executives have been negligent in providing the necessary strategic information and feedback. If a plan fails because of extreme optimism, then the responsibility lies with both the project and line managers for not assessing risk. Project managers should ask the line managers if the estimates are optimistic or pessimistic, and expect an honest answer. Erroneous financial estimates are the responsibility of the line manager. If the project fails because of a poor definition of the requirements, then the project manager is totally at fault.

Sometimes project plans fail because simple details are forgotten or overlooked. Examples of this might be:

- Neglecting to tell a line manager early enough that the prototype is not ready and that rescheduling is necessary.
- Neglecting to see if the line manager can still provide additional employees for the next two weeks because it was possible to do so six months ago.

Sometimes plans fail because the project manager “bites off more than he can chew,” and then something happens, such as his becoming ill. Many projects have failed because the project manager was the only one who knew what was going on and then got sick.

11.18 STOPPING PROJECTS

PMBOK® Guide, 4th Edition
4.6 Close Projects

There are always situations in which projects have to be stopped. Nine reasons for stopping are:

- Final achievement of the objectives
- Poor initial planning and market prognosis
- A better alternative is found
- A change in the company interest and strategy
- Allocated time is exceeded
- Budgeted costs are exceeded
- Key people leave the organization
- Personal whims of management
- Problem too complex for the resources available

Today most of the reasons why projects are not completed on time and within cost are behavioral rather than quantitative. They include:

- Poor morale
- Poor human relations
- Poor labor productivity
- No commitment by those involved in the project

The last item appears to be the cause of the first three items in many situations.

Once the reasons for cancellation are defined, the next problem concerns how to stop the project. Some of the ways are:

- Orderly planned termination
- The “hatchet” (withdrawal of funds and removal of personnel)

- Reassignment of people to higher priority tasks
- Redirection of efforts toward different objectives
- Burying it or letting it die on the vine (i.e., not taking any official action)

There are three major problem areas to be considered in stopping projects:

- Worker morale
- Reassignment of personnel
- Adequate documentation and wrap-up

11.19 HANDLING PROJECT PHASEOUTS AND TRANSFERS

PMBOK® Guide, 4th Edition
4.4 Monitor and Control
Project Work

By definition, projects (and even life cycle phases) have an end point. Closing out is a very important phase in the project life cycle, which should follow particular disciplines and procedures with the objective of:

- Effectively bringing the project to closure according to agreed-on contractual requirements
- Preparing for the transition of the project into the next operational phase, such as from production to field installation, field operation, or training
- Analyzing overall project performance with regard to financial data, schedules, and technical efforts
- Closing the project office, and transferring or selling off all resources originally assigned to the project, including personnel
- Identifying and pursuing follow-on business

Although most project managers are completely cognizant of the necessity for proper planning for project start-up, many project managers neglect planning for project termination. Planning for project termination includes:

- Transferring responsibility
- Completion of project records
 - Historic reports
 - Postproject analysis
- Documenting results to reflect “as built” product or installation
- Acceptance by sponsor/user
- Satisfying contractual requirements
- Releasing resources
 - Reassignment of project office team members
 - Disposition of functional personnel
 - Disposition of materials
- Closing out work orders (financial closeout)
- Preparing for financial payments

Project success or failure often depends on management's ability to handle personnel issues properly during this final phase. If job assignments beyond the current project look undesirable or uncertain to project team members, a great deal of anxiety and conflict may develop that diverts needed energy to job hunting, foot dragging, or even sabotage. Project personnel may engage in job searches on their own and may leave the project prematurely. This creates a glaring void that is often difficult to patch.

Given business realities, it is difficult to transfer project personnel under ideal conditions. The following suggestions may increase organizational effectiveness and minimize personal stress when closing out a project:

- Carefully plan the project closeout on the part of both project and functional managers. Use a checklist to prepare the plan.
- Establish a simple project closeout procedure that identifies the major steps and responsibilities.
- Treat the closeout phase like any other project, with clearly delineated tasks, agreed-on responsibilities, schedules, budgets, and deliverable items or results.
- Understand the interaction of behavioral and organizational elements in order to build an environment conducive to teamwork during this final project phase.
- Emphasize the overall goals, applications, and utilities of the project as well as its business impact.
- Secure top-management involvement and support.
- Be aware of conflict, fatigue, shifting priorities, and technical or logistic problems. Try to identify and deal with these problems when they start to develop. Communicating progress through regularly scheduled status meetings is the key to managing these problems.
- Keep project personnel informed of upcoming job opportunities. Resource managers should discuss and negotiate new assignments with personnel and involve people already in the next project.
- Be aware of rumors. If a reorganization or layoff is inevitable, the situation should be described in a professional manner or people will assume the worst.
- Assign a contract administrator dedicated to company-oriented projects. He will protect your financial position and business interests by following through on customer sign-offs and final payment.

11.20 DETAILED SCHEDULES AND CHARTS

The scheduling of activities is the first major requirement of the program office after program go-ahead. The program office normally assumes full responsibility for activity scheduling if the activity is not too complex. For large programs, functional management input is required before scheduling can be completed. Depending on program size and contractual requirements, the program office may have a staff member whose sole responsibility is to continuously develop and update activity schedules to track program work. The resulting information is supplied to program office personnel, functional management, team members, and the customer.

Activity scheduling is probably the single most important tool for determining how company resources should be integrated. Activity schedules are invaluable for projecting time-phased resource utilization requirements, providing a basis for visually tracking performance and estimating costs. The schedules serve as master plans from which both the customer and management have an up-to-date picture of operations.

Certain guidelines should be followed in the preparation of schedules, regardless of the projected use or complexity:

- All major events and dates must be clearly identified. If a statement of work is supplied by the customer, those dates shown on the accompanying schedules must be included. If for any reason the customer's milestone dates cannot be met, the customer should be notified immediately.
- The exact sequence of work should be defined through a network in which interrelationships between events can be identified.
- Schedules should be directly relatable to the work breakdown structure. If the WBS is developed according to a specific sequence of work, then it becomes an easy task to identify work sequences in schedules using the same numbering system as in the WBS. The minimum requirement should be to show where and when all tasks start and finish.
- All schedules must identify the time constraints and, if possible, should identify those resources required for each event.

Although these four guidelines relate to schedule preparation, they do not define how complex the schedules should be. Before preparing schedules, three questions should be considered:

- How many events or activities should each network have?
- How much of a detailed technical breakdown should be included?
- Who is the intended audience for this schedule?

Most organizations develop multiple schedules: summary schedules for management and planners and detailed schedules for the doers and lower-level control. The detailed schedules may be strictly for interdepartmental activities. Program management must approve all schedules down through the first three levels of the work breakdown structure. For lower-level schedules (i.e., detailed interdepartmental), program management may or may not request a sign of approval.

One of the most difficult problems to identify in schedules is a hedge position. A hedge position is a situation in which the contractor may not be able to meet a customer's milestone date without incurring a risk, or may not be able to meet activity requirements following a milestone date because of contractual requirements. To illustrate a common hedge position, consider Example 11–1 below.

Example 11–1. Condor Corporation is currently working on a project that has three phases: design, development, and qualification of a certain component. Contractual requirements with the customer specify that no components will be fabricated for the development phase until the design review meeting is held following the design phase.

Condor has determined that if it does not begin component fabrication prior to the design review meeting, then the second and third phases will slip. Condor is willing to accept the risk that should specifications be unacceptable during the design review meeting, the costs associated with preauthorization of fabrication will be incurred. How should this be shown on a schedule? (The problems associated with performing unauthorized work are not being considered here.)

The solution is not easy. Condor must show on the master production schedule that component fabrication will begin early, at the contractor's risk. This should be followed up by a contractual letter in which both the customer and contractor understand the risks and implications.

Detailed schedules are prepared for almost every activity. It is the responsibility of the program office to marry all of the detailed schedules into one master schedule to verify that all activities can be completed as planned. The preparation sequence for schedules (and also for program plans) is shown in Figure 11–11. The program office submits a request for detailed schedules to the functional managers and the functional managers prepare summary schedules, detailed schedules, and, if time permits, interdepartmental schedules. Each functional manager then reviews his schedules with the program office. The program office, together with the functional program team members, integrates all of the plans and schedules and verifies that all contractual dates can be met.

Before the schedules are submitted to publications, rough drafts of each schedule and plan should be reviewed with the customer. This procedure accomplishes the following:

- Verifies that nothing has fallen through the cracks
- Prevents immediate revisions to a published document and can prevent embarrassing moments
- Minimizes production costs by reducing the number of early revisions
- Shows customers early in the program that you welcome their help and input into the planning phase

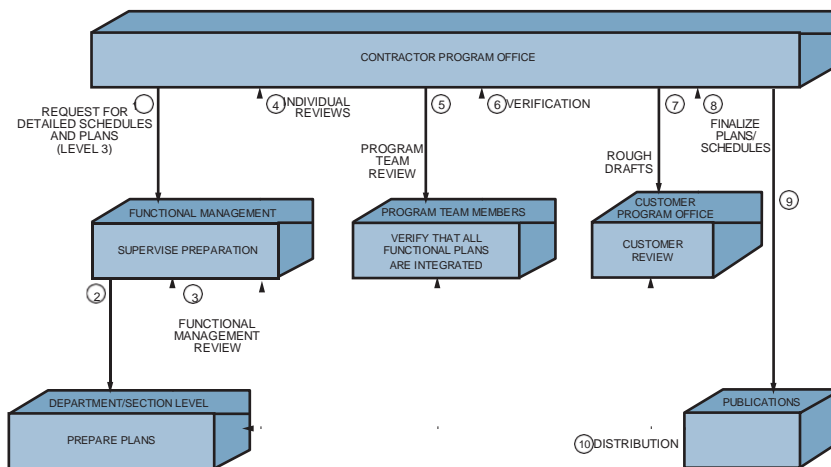


FIGURE 11–11. Preparation sequence for schedules and program plans.

After the document is published, it should be distributed to all program office personnel, functional team members, functional management, and the customer. Examples of detailed schedules are shown in Chapter 13.

In addition to the detailed schedules, the program office, with input provided by functional management, must develop organization charts. The charts show who has responsibility for each activity and display the formal (and often the informal) lines of communication. Examples were shown in Section 4.11.

The program office may also establish linear responsibility charts (LRCs). In spite of the best attempts by management, many functions in an organization may overlap between functional units. Also, management might wish to have the responsibility for a certain activity given to a functional unit that normally would not have that responsibility. This is a common occurrence on short-duration programs where management desires to cut costs and red tape.

Project personnel should keep in mind why the schedule was developed. The primary objective is usually to coordinate activities to complete the project with the:

- Best time
- Least cost
- Least risk

There are also secondary objectives of scheduling:

- Studying alternatives
- Developing an optimal schedule
- Using resources effectively
- Communicating
- Refining the estimating criteria
- Obtaining good project control
- Providing for easy revisions

Large projects, especially long-term efforts, may require a “war room.” War rooms generally have only one door and no windows. All of the walls are covered with large schedules, perhaps printed on blueprint paper, and each wall could have numerous sliding panels. The schedules and charts on each wall could be updated on a daily basis. The room would be used for customer briefings, team meetings, and any other activities related specifically to this project.

11.21 MASTER PRODUCTION SCHEDULING

The release of the planning SWD, as shown in Figure 11–10, authorizes the manufacturing units to prepare a master production schedule from which detailed analysis of the utilization of company resources can be seen and tracked.

Master production scheduling is not a new concept. Earliest material control systems used a “quarterly ordering system” to produce a master production schedule (MPS) for plant production. This system uses customer order backlogs to develop a production plan over a

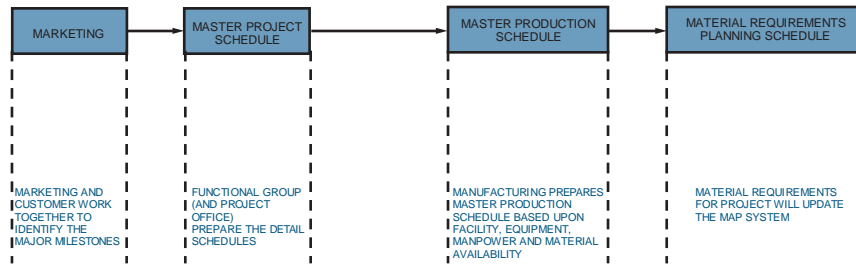


FIGURE 11-12. Material requirements planning interrelationships.

three-month period. The production plan is then exploded manually to determine what parts must be purchased or manufactured at the proper time. However, rapidly changing customer requirements and fluctuating lead times, combined with a slow response to these changes, can result in the disruption of master production scheduling.¹¹

Master Production Schedule Definition

A *master production schedule* is a statement of what will be made, how many units will be made, and when they will be made. It is a production plan, not a sales plan. The MPS considers the total demand on a plant's resources, including finished product sales, spare (repair) part needs, and inter-plant needs. The MPS must also consider the capacity of the plant and the requirements imposed on vendors. Provisions are made in the overall plan for each manufacturing facility's operation. All planning for materials, manpower, plant, equipment, and financing for the facility is driven by the master production schedule.

Objectives of the MPS

Objectives of master production scheduling are:

- To provide top management with a means to authorize and control manpower levels, inventory investment, and cash flow
- To coordinate marketing, manufacturing, engineering, and finance activities by a common performance objective
- To reconcile marketing and manufacturing needs
- To provide an overall measure of performance
- To provide data for material and capacity planning

The development of a master production schedule is a very important step in a planning cycle. Master production schedules directly tie together personnel, materials, equipment, and facilities, as shown in Figure 11-12. Master production schedules also identify key dates to the customer, should he wish to visit the contractor during specific operational periods.

11. The master production schedule is being discussed here because of its importance in the planning cycle. The MPS cannot be fully utilized without effective inventory control procedures.

11.22 PROJECT PLAN

PMBOK® Guide, 4th Edition

Chapter 5 Project Scope

Management

Chapter 4 Integration Management

3.2 Planning Process Group

A project plan is fundamental to the success of any project. For large and often complex projects, customers may require a project plan that documents all activities within the program. The project plan then serves as a guideline for the lifetime of the project and may be revised as often as once a month, depending on the circumstances and the type of project (i.e., research and development projects require more revisions to the project plan than manufacturing or construction projects). The project plan provides the following framework:

- Eliminates conflicts between functional managers
- Eliminates conflicts between functional management and program management
- Provides a standard communications tool throughout the lifetime of the project (It should be geared to the work breakdown structure)
- Provides verification that the contractor understands the customer's objectives and requirements
- Provides a means for identifying inconsistencies in the planning phase
- Provides a means for early identification of problem areas and risks so that no surprises occur downstream
- Contains all of the schedules defined in Section 11.18 as a basis for progress analysis and reporting

Development of a project plan can be time-consuming and costly. All levels of the organization participate. The upper levels provide summary information, and the lower levels provide the details. The project plan, like activity schedules, does not preclude departments from developing their own plans.

The project plan must identify how the company resources will be integrated. The process is similar to the sequence of events for schedule preparation, shown in Figure 11–11. Since the project plan must explain the events in Figure 11–11, additional iterations are required, which can cause changes in a project. This can be seen in Figure 11–13.

The project plan is a standard from which performance can be measured by the customer and the project and functional managers. The plan serves as a cookbook by answering these questions for all personnel identified with the project:

- What will be accomplished?
- How will it be accomplished?
- Where will it be accomplished?
- When will it be accomplished?
- Why will it be accomplished?

The answers to these questions force both the contractor and the customer to take a hard look at:

- Project requirements
- Project management

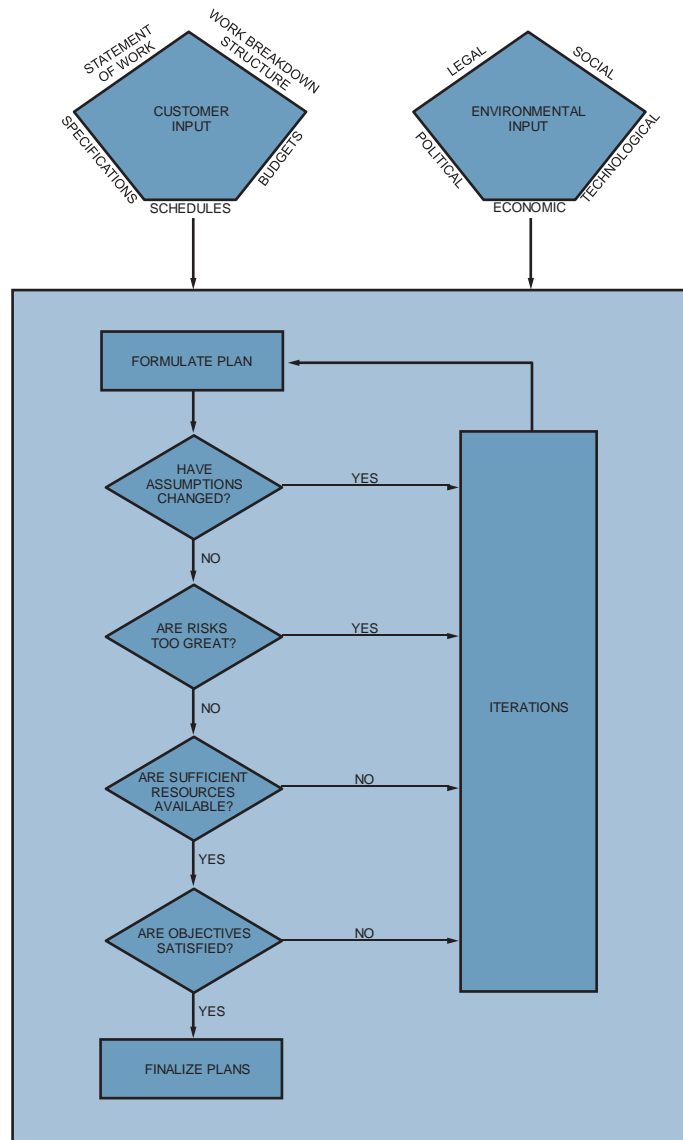


FIGURE 11–13. Iterations for the planning process.

- Project schedules
- Facility requirements
- Logistic support
- Financial support
- Manpower and organization

The project plan is more than just a set of instructions. It is an attempt to eliminate crisis by preventing anything from “falling through the cracks.” The plan is documented and approved by both the customer and the contractor to determine what data, if any, are missing and the probable resulting effect. As the project matures, the project plan is revised to account for new or missing data. The most common reasons for revising a plan are:

- “Crashing” activities to meet end dates
- Trade-off decisions involving manpower, scheduling, and performance
- Adjusting and leveling manpower requests

The makeup of the project plan may vary from contractor to contractor.¹² Most project plans can be subdivided into four main sections: introduction, summary and conclusions, management, and technical. The complexity of the information is usually up to the discretion of the contractor, provided that customer requirements, as may be specified in the statement of work, are satisfied.

The introductory section contains the definition of the project and the major parts involved. If the project follows another, or is an outgrowth of similar activities, this is indicated, together with a brief summary of the background and history behind the project.

The summary and conclusion section identifies the targets and objectives of the project and includes the necessary “lip service” on how successful the project will be and how all problems can be overcome. This section must also include the project master schedule showing how all projects and activities are related. The total project master schedule should include the following:

- An appropriate scheduling system (bar charts, milestone charts, network, etc.)
- A listing of activities at the project level or lower
- The possible interrelationships between activities (can be accomplished by logic networks, critical path networks, or PERT networks)
- Activity time estimates (a natural result of the item above)

The summary and conclusion chapter is usually the second section in the project plan so that upper-level customer management can have a complete overview of the project without having to search through the technical information.

The management section of the project plan contains procedures, charts, and schedules as follows:

- The assignment of key personnel to the project is indicated. This usually refers only to the project office personnel and team members, since under normal operations these will be the only individuals interfacing with customers.

12. Cleland and King define fourteen subsections for a program plan. This detail appears more applicable to the technical and management volumes of a proposal. They do, however, provide a more detailed picture than presented here. See David I. Cleland and William R. King, *Systems Analysis and Project Management* (New York: McGraw-Hill, 1975), pp. 371–380.

- Manpower, planning, and training are discussed to assure customers that qualified people will be available from the functional units.
- A linear responsibility chart might also be included to identify to customers the authority relationships that will exist in the program.

Situations exist in which the management section may be omitted from the proposal. For a follow-up program, the customer may not require this section if management's positions are unchanged. Management sections are also not required if the management information was previously provided in the proposal or if the customer and contractor have continuous business dealings.

The technical section may include as much as 75 to 90 percent of the program plan, especially if the effort includes research and development, and may require constant updating as the project matures. The following items can be included as part of the technical section:

- A detailed breakdown of the charts and schedules used in the project master schedule, possibly including schedule/cost estimates.
- A listing of the testing to be accomplished for each activity. (It is best to include the exact testing matrices.)
- Procedures for accomplishment of the testing. This might also include a description of the key elements in the operations or manufacturing plans, as well as a listing of the facility and logistic requirements.
- Identification of materials and material specifications. (This might also include system specifications.)
- An attempt to identify the risks associated with specific technical requirements (not commonly included). This assessment tends to scare management personnel who are unfamiliar with the technical procedures, so it should be omitted if possible.

The project plan, as used here, contains a description of all phases of the project. For many projects, especially large ones, detailed planning is required for all major events and activities. Table 11-4 identifies the type of individual plans that may be required in place of a (total) project plan. These are often called subsidiary plans.

The project plan, once agreed on by the contractor and customer, is then used to provide project direction. This is shown in Figure 11-14. If the project plan is written clearly, then any functional manager or supervisor should be able to identify what is expected of him. The project plan should be distributed to each member of the project team, all functional managers and supervisors interfacing with the project, and all key functional personnel.

One final note need be mentioned concerning the legality of the project plan. The project plan may be specified contractually to satisfy certain requirements as identified in the customer's statement of work. The contractor retains the right to decide how to accomplish this, unless, of course, this is also identified in the SOW. If the SOW specifies that quality assurance testing will be accomplished on fifteen end-items from the production line, then fifteen is the minimum number that must be tested. The project plan may show that twenty-five items are to be tested. If the contractor develops cost overrun problems, he may wish to revert to the SOW and test only fifteen items. Contractually, he may do this without

TABLE 11–4. TYPES OF PLANS

Type of Plan	Description
Budget	How much money is allocated to each event?
Configuration management	How are technical changes made?
Facilities	What facilities resources are available?
Logistics support	How will replacements be handled?
Management	How is the program office organized?
Manufacturing	What are the time-phase manufacturing events?
Procurement	What are my sources? Should I make or buy? If vendors are not qualified, how shall I qualify them?
Quality assurance	How will I guarantee specifications will be met?
Research/development	What are the technical activities?
Scheduling	Are all critical dates accounted for?
Tooling	What are my time-phased tooling requirements?
Training	How will I maintain qualified personnel?
Transportation	How will goods and services be shipped?

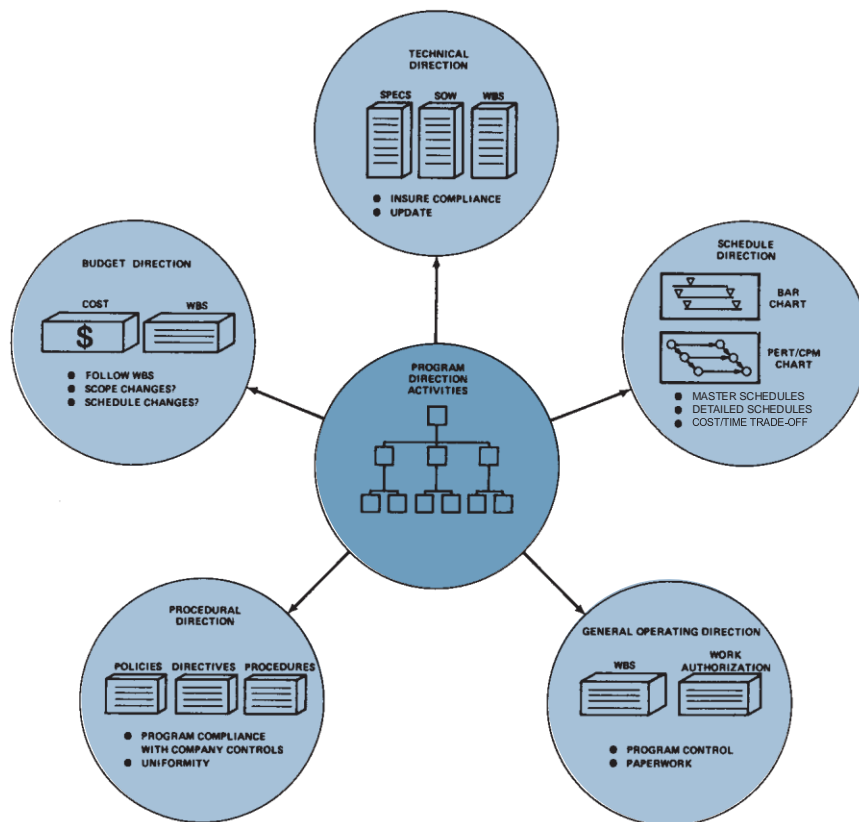


FIGURE 11–14. Project direction activities.

informing the customer. In most cases, however, the customer is notified, and the project is revised.

11.23 TOTAL PROJECT PLANNING

PMBOK® Guide, 4th Edition

Chapter 5 Project Scope
Management

Chapter 4 Integration Management
3.2 Planning Process Group

The difference between the good project manager and the poor project manager is often described in one word: planning. Project planning involves planning for:

- Schedule development
- Budget development
- Project administration (see Section 5.3)
- Leadership styles (interpersonal influences; see Section 5.4)
- Conflict management (see Chapter 7)

The first two items involve the quantitative aspects of planning. Planning for project administration includes the development of the linear responsibility chart.

Although each project manager has the authority and responsibility to establish project policies and procedures, they must fall within the general guidelines established by top management.

Linear responsibility charts can result from customer-imposed requirements above and beyond normal operations. For example, the customer may require as part of his quality control requirements that a specific engineer supervise and approve all testing of a certain item, or that another individual approve all data released to the customer over and above program office approval. Customer requirements similar to those identified above require LRCs and can cause disruptions and conflicts within an organization.

Several key factors affect the delegation of authority and responsibility both from upper-level management to project management, and from project management to functional management. These key factors include:

- The maturity of the project management function
- The size, nature, and business base of the company
- The size and nature of the project
- The life cycle of the project
- The capabilities of management at all levels

Once agreement has been reached on the project manager's authority and responsibility, the results may be documented to delineate that role regarding:

- Focal position
- Conflict between the project manager and functional managers
- Influence to cut across functional and organizational lines
- Participation in major management and technical decisions
- Collaboration in staffing the project
- Control over allocation and expenditure of funds
- Selection of subcontractors

- Rights in resolving conflicts
- Input in maintaining the integrity of the project team
- Establishment of project plans
- Provisions for a cost-effective information system for control
- Provisions for leadership in preparing operational requirements
- Maintenance of prime customer liaison and contact
- Promotion of technological and managerial improvements
- Establishment of project organization for the duration
- Elimination of red tape

Documenting the project manager's authority is necessary in some situations because:

- All interfacing must be kept as simple as possible.
- The project manager must have the authority to "force" functional managers to depart from existing standards and possibly incur risk.
- Gaining authority over those elements of a program that are not under the project manager's control is essential. This is normally achieved by earning the respect of the individuals concerned.
- The project manager should not attempt to fully describe the exact authority and responsibilities of the project office personnel or team members. Problem-solving rather than role definition should be encouraged.

Although documenting project authority is undesirable, it may be necessary, especially if project initiation and planning require a formal project chart. In such a case, a letter such as that shown in Table 11-5 may suffice.

Power and authority are often discussed as though they go hand in hand. Authority comes from people above you, perhaps by delegation, whereas power comes from people below you. You can have authority without power or power without authority.

In a traditional organizational structure, most individuals maintain position power. The higher up you sit, the more power you have. But in project management, the reporting level of the project might be irrelevant, especially if a project sponsor exists. In project management, the project manager's power base emanates from his

- Expertise (technical or managerial)
- Credibility with employees
- Sound decision-making ability

The last item is usually preferred. If the project manager is regarded as a sound decision-maker, then the employees normally give the project manager a great deal of power over them.

Leadership styles refer to the interpersonal influence modes that a project manager can use. Project managers may have to use several different leadership styles, depending on the makeup of the project personnel. Conflict management is important because if the project manager can predict what conflicts will occur and when they are most likely to occur, he may be able to plan for the resolution of the conflicts through project administration.

Figure 11-15 shows the complete project planning phase for the quantitative portions. The object, of course, is to develop a project plan that shows complete distribution of

PMBOK® Guide, 4th Edition

4.1 Develop Project Charter

TABLE 11–5. PROJECT CHARTER

ELECTRODYNAMICS

12 Oak Avenue
Cleveland, Ohio 44114

11 June 2001

To: Distribution
From: L. White, Executive Vice President
Subject: Project Charter for the Acme Project

Mr. Robert L. James has been assigned as the Project Manager for the Acme Project.

Responsibility

Mr. James will be responsible for ensuring that all key milestones are met within the time, cost, and performance constraints of his project, while adhering to proper quality control standards. Furthermore, the project manager must work closely with line managers to ensure that all assigned resources are used effectively and efficiently, and that the project is properly staffed.

Additionally, the project manager will be responsible for:

1. All formal communications between the customer and contractor.
2. Preparation of a project plan that is realistic, and acceptable by both the customer and contractor.
3. Preparation of all project data items.
4. Keeping executive management informed as to project status through weekly (detailed) and monthly (summary) status reporting.
5. Ensuring that all functional employees and managers are kept informed as to their responsibilities on the project and all revisions imposed by the customer or parent organization.
6. Comparing actual to predicted cost and performance, and taking corrective action when necessary.
7. Maintaining a plan that continuously displays the project's time, cost, and performance as well as resource commitments made by the functional managers.

Authority

To ensure that the project meets its objectives, Mr. James is authorized to manage the project and issue directives in accordance to the policies and procedures section of the company's *Project Management Manual*. Additional directives may be issued through the office of the executive vice-president.

The program manager's authority also includes:

1. Direct access to the customer on all matters pertaining to the Acme Project.
2. Direct access to Electrodynamics' executive management on all matters pertaining to the Acme Project.
3. Control and distribution of all project dollars, including procurement, such that company and project cash flow limitations are adhered to.
4. To revise the project plan as needed, and with customer approval.
5. To require periodic functional status reporting.
6. To monitor the time, cost, and performance activities in the functional departments and ensure that all problems are promptly identified, reported, and solved.
7. To cut across all functional lines and to interface with all levels of management as necessary to meet project requirements.
8. To renegotiate with functional managers for changes in personnel assignments.
9. Delegating responsibilities and authority to functional personnel, provided that the line manager is in approval that the employee can handle this authority/responsibility level.

Any questions regarding the above policies should be directed to the undersigned.

L. White
Executive Vice-President

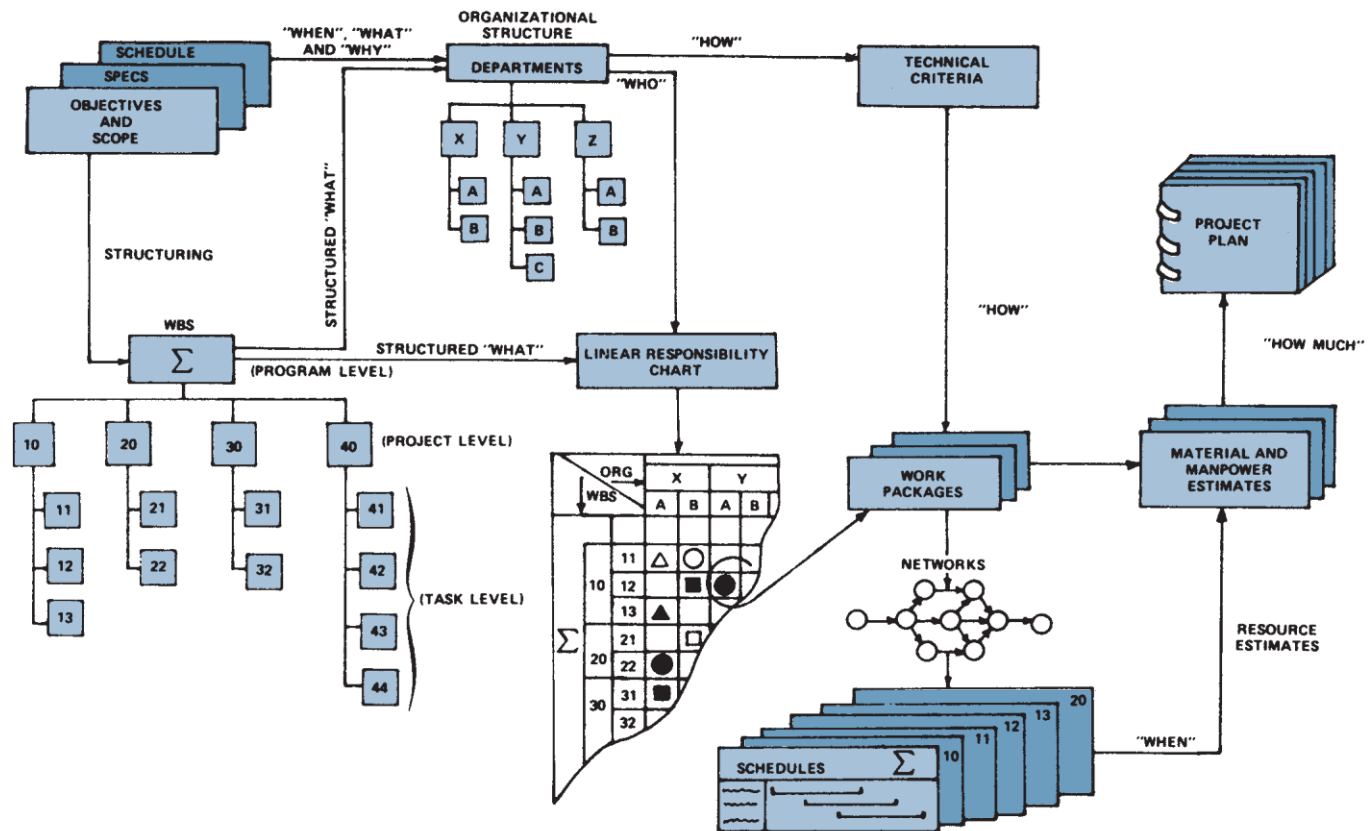


FIGURE 11-15. Project planning.

resources and the corresponding costs. The figure represents an iterative process. The project manager begins with a coarse (arrow diagram) network, and then decides on the work breakdown structure. The WBS is essential to the arrow diagram and should be constructed so that reporting elements and levels are easily identifiable. Eventually, there will be an arrow diagram and detailed chart for each element in the WBS. If there is too much detail, the project manager can refine the diagram by combining all logic into one plan and can then decide on the work assignments. There is a risk here that, by condensing the diagrams as much as possible, there may be a loss of clarity. As shown in Figure 11–15, all the charts and schedules can be integrated into one summary-level figure. This can be accomplished at each WBS level until the desired plan is achieved.

Finally, project, line, and executive management must analyze other internal and external variables before finalizing these schedules. These variables include:

- Introduction or acceptance of the product in the marketplace
- Present or planned manpower availability
- Economic constraints of the project
- Degree of technical difficulty
- Manpower availability
- Availability of personnel training
- Priority of the project

In small companies and projects, certain items in Figure 11–15 may be omitted, such as the LRCs.

11.24 THE PROJECT CHARTER

PMBOK® Guide, 4th Edition 4.1 Develop Project Charter

The original concept behind the project charter was to document the project manager's authority and responsibility, especially for projects implemented away from the home office. Today, the project charter is more of an internal legal document identifying to the line managers and their personnel the project manager's authority and responsibility and the management- and/or customer-approved scope of the project.

Theoretically, the sponsor prepares the charter and affixes his/her signature, but in reality, the project manager may prepare it for the sponsor's signature. At a minimum, the charter should include:

- Identification of the project manager and his/her authority to apply resources to the project
- The business purpose that the project was undertaken to address, including all assumptions and constraints
- Summary of the conditions defining the project
- Description of the project
- Objectives and constraints on the project
- Project scope (inclusions and exclusions)
- Key stakeholders and their roles

- Risks
- Involvement by certain stakeholders

The PMBOK® Guide provides a framework for the project charter. What is somewhat unfortunate is that every company seems to have its own idea of what should be included in a charter. The contents of a charter are often dependent upon where in the evolution and life cycle of a project the charter is prepared. (See *Advanced Project Management: Best Practices on Implementation* by Harold Kerzner, John Wiley & Sons, New York, 2004, pp. 101–102, 120, 629–630.) Some companies such as Computer Associates use both a full charter (closely aligned to the PMBOK® Guide) and an abbreviated charter based upon the size and complexity of the project.

The charter is a “legal” agreement between the project manager and the company. Some companies supplement the charter with a “contract” that functions as an agreement between the project and the line organizations.

Some companies have converted the charter into a highly detailed document containing:

- The scope baseline/scope statement
 - Scope and objectives of the project (SOW)
 - Specifications
 - WBS (template levels)
 - Timing
 - Spending plan (S-curve)
- The management plan
 - Resource requirements and manloading (if known)
 - Resumes of key personnel
 - Organizational relationships and structure
 - Responsibility assignment matrix
 - Support required from other organizations
 - Project policies and procedures
 - Change management plan
 - Management approval of above

When the project charter contains a scope baseline and management plan, the project charter may function as the project plan. This is not really an effective use of the charter, but it may be acceptable on certain types of projects for internal customers.

11.25 MANAGEMENT CONTROL

PMBOK® Guide, 4th Edition 4.5 Integrated Change Control

Because the planning phase provides the fundamental guidelines for the remainder of the project, careful management control must be established.

In addition, since planning is an ongoing activity for a variety of different programs, management guidelines must be established on a company-wide basis in order to achieve unity and coherence.

All functional organizations and individuals working directly or indirectly on a program are responsible for identifying, to the project manager, scheduling and planning

TABLE 11–6. PLANNING AND REQUIREMENTS POLICIES

Program Manager	Functional Manager	Relationship
<p>Requests the preparation of the program master schedules and provides for integration with the division composite schedules.</p> <p>Defines work to be accomplished through preparation of the subdivided work description package.</p> <p>Provides program guidance and direction for the preparation of program plans that establish program cost, schedule, and technical performance; and that define the major events and tasks to ensure the orderly progress of the program.</p>	<p>Develops the details of the program plans and requirements in conjunction with the program manager. Provides proposal action in support of program manager requirements and the program master schedule.</p> <p>With guidance furnished by the program manager, participates in the preparation of program plans, schedules, and work release documents which cover cost, schedule, and technical performance; and which define major events and tasks. Provides supporting detail plans and schedules.</p>	<p>Program planning and scheduling is a functional specialty; the program manager utilizes the services of the specialist organizations. The specialists retain their own channels to the general manager but must keep the program manager informed.</p> <p>Program planning is also a consultative operation and is provided guidelines by the program manager. Functional organizations initiate supporting plans for program manager approval, or react to modify plans to maintain currency. Functional organizations also initiate planning studies involving trade-offs and alternative courses of action for presentation to the program manager.</p>
<p>Establishes priorities within the program. Obtains relative program priorities between programs managed by other programs from the director, program management, manager, marketing and product development, or the general manager as specified by the policy.</p>	<p>Negotiates priorities with program managers for events and tasks to be performed by his organization.</p>	<p>The program manager and program team members are oriented to his program, whereas the functional organizations and the functional managers are “function” and multiprogram oriented. The orientation of each director, manager, and team member</p>

Approves program contractual data requirements.

Remains alert to new contract requirements, government regulations and directives that might affect the work, cost, or management of the program.

Provides early technical requirements definitions, and substantiates make-or-buy recommendations. Participates in the formulation of the make-or-buy plan for the program.

Approves the program bill of material for need and compliance with program need and requirements.

Directs data management including maintenance of current and historical files on programmed contractual data requirements.

Conducts analysis of contractual data requirements. Develops data plans including contractor data requirements list and obtains program manager approval.

Remains alert to new contract requirements, government regulations, and directives that might affect the work, cost, or management of his organization on any program.

Provides the necessary make-or-buy data; substantiates estimates and recommendations in the area of functional specialty.

Prepares the program bill of material.

must be mutually recognized to preclude unreasonable demands and conflicting priorities. Priority conflicts that cannot be resolved must be referred to the general manager.

Make-or-buy concurrence and approvals are obtained in accordance with current Policies and Procedures.

TABLE 11–7. SCHEDULING POLICIES

Program Manager	Functional Manager	Relationship
Provides contractual data requirements and guidance for construction of program master schedules.	The operations directorate shall construct the program master schedule. Data should include but not be limited to engineering plans, manufacturing plans, procurement plans, test plans, quality plans, and provide time spans for accomplishment of work elements defined in the work breakdown structure to the level of definition visible in the planned subdivided work description package.	The operations directorate constructs the program master schedule with data received from functional organizations and direction from the program manager. Operations shall coordinate program master schedule with functional organizations and secure program manager's approval prior to release.
Concurs with detail schedules construction by functional organizations. Provides corrective action decisions and direction as required at any time a functional organization fails to meet program master schedule requirements or when, by analysis, performance indicated by detail schedule monitoring threatens to impact the program master schedule.	Constructs detail program schedules and working schedules in consonance with program manager–approved program master schedule. Secures program manager concurrence and forwards copies to the program manager.	Program manager monitors the functional organization's detail schedules for compliance with program master schedules and reports variance items that may impact division operations to the director, program management.

problems that require corrective action during both the planning cycle and the operating cycle. The program manager bears the ultimate and final responsibility for identifying requirements for corrective actions. Management policies and directives are written specifically to assist the program manager in defining the requirements. Without clear definitions during the planning phase, many projects run off in a variety of directions.

Many companies establish planning and scheduling management policies for the project and functional managers, as well as a brief description of how they should interface. Table 11–6 identifies a typical management policy for planning and requirements, and Table 11–7 describes scheduling management policies.

11.26 THE PROJECT MANAGER–LINE MANAGER INTERFACE

PMBOK® Guide, 4th Edition 1.6 Interpersonal Skills

The utilization of management controls, such as those outlined in Section 11.25, does not necessarily guarantee successful project planning. Good project planning, as well as other project functions, requires a good working relationship between the project and line managers. At this interface:

- The project manager answers these questions:
 - What is to be done? (using the SOW, WBS)

- When will the task be done? (using the summary schedule)
- Why will the task be done? (using the SOW)
- How much money is available? (using the SOW)
- The line manager answers these questions:
 - How will the task be done? (i.e., technical criteria)
 - Where will the task be done? (i.e., technical criteria)
 - Who will do the task? (i.e., staffing)

Project managers may be able to tell line managers “how” and “where,” provided that the information appears in the SOW as a requirement for the project. Even then, the line manager can take exception based on his technical expertise.

Figures 11–16 and 11–17 show what can happen when project managers overstep their bounds. In Figure 11–16, the manufacturing manager built a brick wall to keep the project managers away from his personnel because the project managers were telling his line people how to do their job. In Figure 11–17, the subproject managers (for simplicity’s sake, equivalent to project engineers) would have, as their career path, promotions to assistant project managers (APMs). Unfortunately, the APMs still felt that they were technically

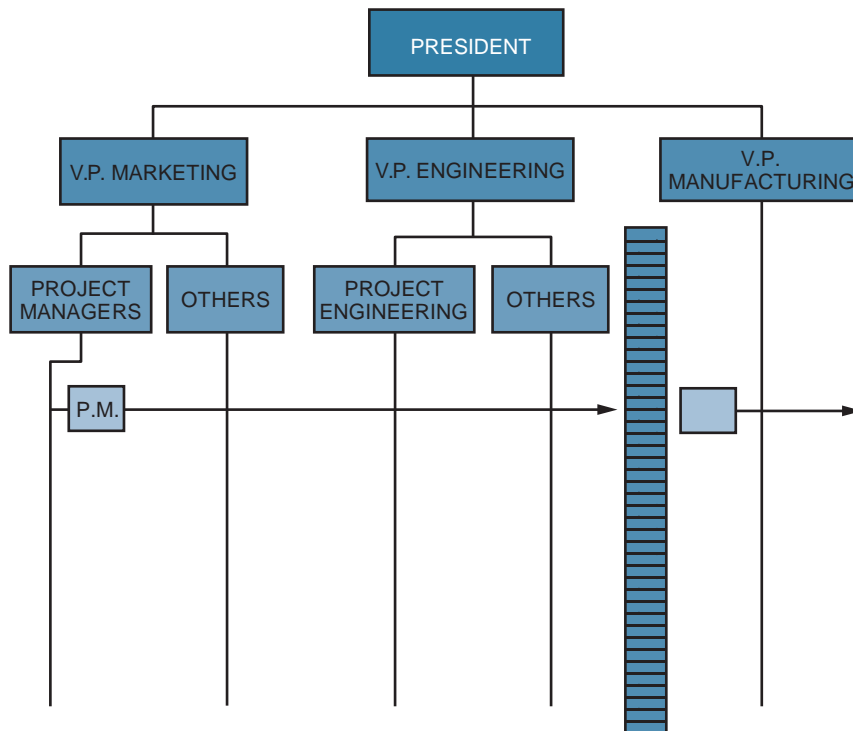


FIGURE 11–16. The brick wall.

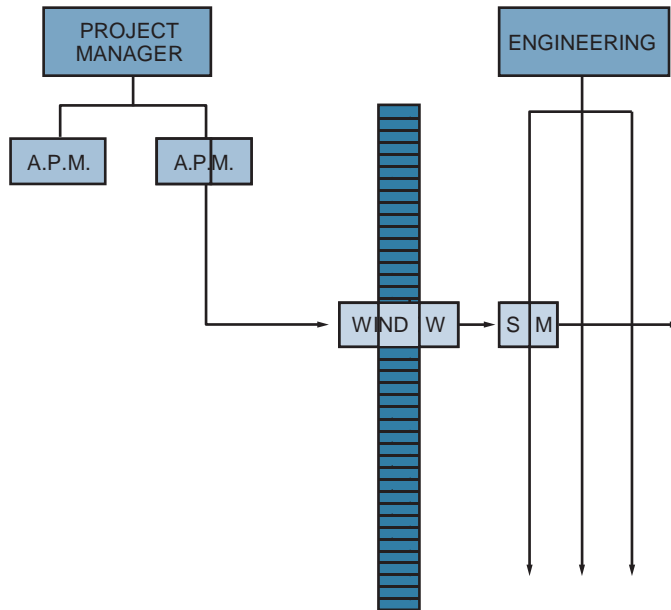


FIGURE 11–17. Modification of the brick wall.

competent enough to give technical direction, and this created havoc for the engineering managers.

The simplest solution to all of these problems is for the project manager to provide the technical direction *through* the line managers. After all, the line managers are supposedly the true technical experts.

11.27 FAST-TRACKING

PMBOK® Guide, 4th Edition
2.1 Characteristics of the Project Life Cycle

Sometimes, no matter how well we plan, something happens that causes havoc on the project. Such is the case when either the customer or management changes the project's constraints. Consider Figure 11–18 and let us assume that the execution time for the construction of the project is one year. To prepare the working drawings and specifications down through level 5 of the WBS would require an additional 35 percent of the expected execution time, and if a feasibility study is required, then an additional 40 percent will be added on. In other words, if the execution phase of the project is one year, then the entire project is almost two years.

Now, let us assume that management wishes to keep the end date fixed but the start date is delayed because of lack of adequate funding. How can this be accomplished *without* sacrificing the quality? The answer is to fast-track the project. Fast-tracking a project means that activities that are normally done in series are done in parallel. An example of

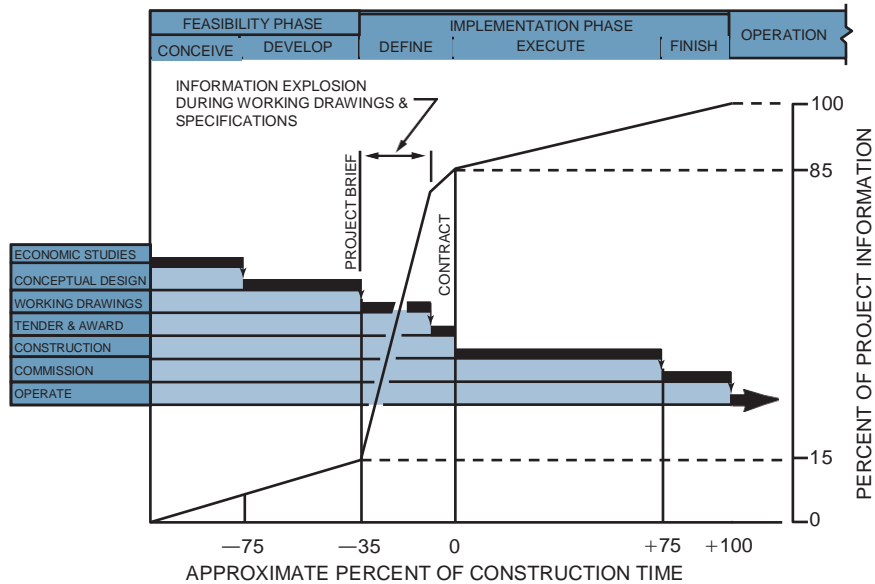


FIGURE 11-18. The information explosion. *Source:* R. M. Wideman, *Cost Control of Capital Projects* (Vancouver, B.C.: A.E.W. Services of Canada, 1983), p. 22.

this is when construction begins before detail design is completed. (See Chapter 2, Table 2-5 on life-cycle phases.)

Fast-tracking a job can accelerate the schedule but requires that additional risks be taken. If the risks materialize, then either the end date will slip or expensive rework will be needed. Almost all project-driven companies fast-track projects, but there is danger when fast-tracking becomes a way of life.

11.28 CONFIGURATION MANAGEMENT

PMBOK® Guide, 4th Edition 4.5 Integrated Change Control

A critical tool employed by a project manager is configuration management or configuration change control. As projects progress downstream through the various life-cycle phases, the cost of engineering changes can grow boundlessly. It is not uncommon for companies to bid on proposals at 40 percent below their own cost hoping to make up the difference downstream with engineering changes. It is also quite common for executives to “encourage” project managers to seek out engineering changes because of their profitability.

Configuration management is a control technique, through an orderly process, for formal review and approval of configuration changes. If properly implemented, configuration management provides

- Appropriate levels of review and approval for changes
- Focal points for those seeking to make changes
- A single point of input to contracting representatives in the customer’s and contractor’s office for approved changes

At a minimum, the configuration control committee should include representation from the customer, contractor, and line group initiating the change. Discussions should answer the following questions:

- What is the cost of the change?
- Do the changes improve quality?
- Is the additional cost for this quality justifiable?
- Is the change necessary?
- Is there an impact on the delivery date?

Changes cost money. Therefore, it is imperative that configuration management be implemented correctly. The following steps can enhance the implementation process:

- Define the starting point or “baseline” configuration
- Define the “classes” of changes
- Define the necessary controls or limitations on both the customer and contractor
- Identify policies and procedures, such as
 - Board chairman
 - Voters/alternatives
 - Meeting time
 - Agenda
 - Approval forums
 - Step-by-step processes
 - Expedition processes in case of emergencies

Effective configuration control pleases both customer and contractor. Overall benefits include:

- Better communication among staff
- Better communication with the customer
- Better technical intelligence
- Reduced confusion for changes
- Screening of frivolous changes
- Providing a paper trail

As a final note, it must be understood that configuration control, as used here, is not a replacement for design review meetings or customer interface meetings. These meetings are still an integral part of all projects.

11.29 ENTERPRISE PROJECT MANAGEMENT METHODOLOGIES ---

Enterprise project management methodologies can enhance the project planning process as well as providing some degree of standardization and consistency.

Companies have come to the realization that enterprise project management methodologies work best if the methodology is based upon templates rather than rigid policies and

procedures. The International Institute for Learning has created a Unified Project Management Methodology (UPMM™) with templates categorized according to the PMBOK® Guide Areas of Knowledge¹³:

Communication

- Project Charter
- Project Procedures Document
- Project Change Requests Log
- Project Status Report
- PM Quality Assurance Report
- Procurement Management Summary
- Project Issues Log
- Project Management Plan
- Project Performance Report

Cost

- Project Schedule
- Risk Response Plan and Register
- Work Breakdown Structure (WBS)
- Work Package
- Cost Estimates Document
- Project Budget
- Project Budget Checklist

Human Resources

- Project Charter
- Work Breakdown Structure (WBS)
- Communications Management Plan
- Project Organization Chart
- Project Team Directory
- Responsibility Assignment Matrix (RAM)
- Project Management Plan
- Project Procedures Document
- Kickoff Meeting Checklist
- Project Team Performance Assessment
- Project Manager Performance Assessment

Integration

- Project Procedures Overview
- Project Proposal
- Communications Management Plan

13. Unified Project Management Methodology (UPMM™) is registered, copyrighted, and owned by International Institute for Learning, Inc., © 2005; reproduced by permission.

- Procurement Plan
- Project Budget
- Project Procedures Document
- Project Schedule
- Responsibility Assignment Matrix (RAM)
- Risk Response Plan and Register
- Scope Statement
- Work Breakdown Structure (WBS)
- Project Management Plan
- Project Change Requests Log
- Project Issues Log
- Project Management Plan Changes Log
- Project Performance Report
- Lessons Learned Document
- Project Performance Feedback
- Product Acceptance Document
- Project Charter
- Closing Process Assessment Checklist
- Project Archives Report

Procurement

- Project Charter
- Scope Statement
- Work Breakdown Structure (WBS)
- Procurement Plan
- Procurement Planning Checklist
- Procurement Statement of Work (SOW)
- Request for Proposal Document Outline
- Project Change Requests Log
- Contract Formation Checklist
- Procurement Management Summary

Quality

- Project Charter
- Project Procedures Overview
- Work Quality Plan
- Project Management Plan
- Work Breakdown Structure (WBS)
- PM Quality Assurance Report
- Lessons Learned Document
- Project Performance Feedback
- Project Team Performance Assessment
- PM Process Improvement Document

Risk

- Procurement Plan
- Project Charter

Project Procedures Document
Work Breakdown Structure (WBS)
Risk Response Plan and Register

Scope

Project Scope Statement
Work Breakdown Structure (WBS)
Work Package
Project Charter

Time

Activity Duration Estimating Worksheet
Cost Estimates Document
Risk Response Plan and Register Medium
Work Breakdown Structure (WBS)
Work Package
Project Schedule
Project Schedule Review Checklist

11.30 PROJECT AUDITS

In recent years, the necessity for a structured independent review of various parts of a business, including projects, has taken on a more important role. Part of this can be attributed to the Sarbanes–Oxley law compliance requirements. These independent reviews are audits that focus on either discovery or decision-making. The audits can be scheduled or random and can be performed by in-house personnel or external examiners.

There are several types of audits. Some common types include:

- **Performance Audits:** These audits are used to appraise the progress and performance of a given project. The project manager, project sponsor, or an executive steering committee can conduct this audit.
- **Compliance Audits:** These audits are usually performed by the project management office (PMO) to validate that the project is using the project management methodology properly. Usually the PMO has the authority to perform the audit but may not have the authority to enforce compliance.
- **Quality Audits:** These audits ensure that the planned project quality is being met and that all laws and regulations are being followed. The quality assurance group performs this audit.
- **Exit Audits:** These audits are usually for projects that are in trouble and may need to be terminated. Personnel external to the project, such as an exit champion or an executive steering committee, conduct the audits.
- **Best Practices Audits:** These audits can be conducted at the end of each life-cycle phase or at the end of the project. Some companies have found that project managers may not be the best individuals to perform the audit. In such situations, the company may have professional facilitators trained in conducting best practices reviews.

11.31 STUDYING TIPS FOR THE PMI® PROJECT MANAGEMENT CERTIFICATION EXAM

This section is applicable as a review of the principles to support the knowledge areas and domain groups in the PMBOK® Guide. This chapter addresses:

- Scope Management
- Initiation
- Planning
- Execution
- Monitoring
- Closure

Understanding the following principles is beneficial if the reader is using this text to study for the PMP® Certification Exam:

- Need for effective planning
- Components of a project plan and subsidiary plans
- Need for and components of a statement of work (both proposal and contractual)
- How to develop a work breakdown structure and advantages and disadvantages of highly detailed levels
- Types of work breakdown structures
- Purpose of a work package
- Purpose of configuration management and role of the change control board
- Need for a project charter and components of a project charter
- Need for the project team to be involved in project-planning activities
- That changes to a plan or baseline need to be managed

In Appendix C, the following Dorale Products mini-case studies are applicable:

- Dorale Products (C) [Scope Management]
- Dorale Products (D) [Scope Management]
- Dorale Products (E) [Scope Management]

The following multiple-choice questions will be helpful in reviewing the principles of this chapter:

1. The document that officially sanctions the project is the:
 - A. Project charter
 - B. Project plan
 - C. Feasibility study
 - D. Cost-benefit analysis
2. The work breakdown structure “control points” for the management of a project are the:
 - A. Milestones
 - B. Work packages
 - C. Activities
 - D. Constraints
3. One of the most common reasons why projects undergo scope changes is:
 - A. Poor work breakdown structure
 - B. Poorly defined statement of work

- C. Lack of resources
- D. Lack of funding

4. Which of the following generally cannot be validated using a work breakdown structure?
- A. Schedule control
 - B. Cost control
 - C. Quality control
 - D. Risk management

Answer questions 5–8 using the work breakdown structure (WBS) shown below (numbers in parentheses show the dollar value for a particular element):

1.00.00	
1.1.0	(\$25K)
1.1.1	
1.1.2	(\$12K)
1.2.0	
1.2.1	(\$16K)
1.2.2.0	
1.2.2.1	(\$20K)
1.2.2.2	(\$30K)

5. The cost of WBS element 1.2.2.0 is:
- A. \$20K
 - B. \$30K
 - C. \$50K
 - D. Cannot be determined
6. The cost of WBS element 1.1.1 is:
- A. \$12K
 - B. \$13K
 - C. \$25K
 - D. Cannot be determined
7. The cost of the entire program (1.00.00) is:
- A. \$25K
 - B. \$66K
 - C. \$91K
 - D. Cannot be determined
8. The work packages in the WBS are at WBS level(s):
- A. 2 only
 - B. 3 only
 - C. 4 only
 - D. 3 and 4
9. One of the outputs of the PMBOK® Scope Planning Process is:
- A. A project charter
 - B. A scope statement and management plan
 - C. A detailed WBS
 - D. None of the above
10. Which of the following is (are) the benefit(s) of developing a WBS to low levels?
- A. Better estimation of costs
 - B. Better control

- C. Less likely that something will “fall through the cracks”
 - D. All of the above
11. The PMBOK® Scope Verification Process is used to verify that:
- A. The budget is correct.
 - B. The scope is correct.
 - C. The schedule is correct.
 - D. A life-cycle phase or the end of the project has been completed successfully.
12. Financial closeout, which is often part of following the Scope Verification Process, is used to:
- A. Close out all charge numbers
 - B. Close out all charge numbers for the work performed and completed
 - C. Amend the work authorization forms
 - D. None of the above
13. One of your contractors has sent you an e-mail requesting that they be allowed to conduct only eight tests rather than the ten tests required by the specification. What should the project manager do first?
- A. Change the scope baseline
 - B. Ask the contractor to put forth a change request
 - C. Look at the penalty clauses in the contract
 - D. Ask your sponsor for his or her opinion
14. One of your contractors sends you an e-mail request to use high quality raw materials in your project stating that this will be value-added and improve quality. What should the project manager do first?
- A. Change the scope baseline
 - B. Ask the contractor to put forth a change request
 - C. Ask your sponsor for his or her opinion
 - D. Change the WBS
15. What are the maximum number of subsidiary plans a program management plan can contain?
- A. 10
 - B. 15
 - C. 20
 - D. Unlimited number
16. The change control board, of which you are a member, approves a significant scope change. The first document that the project manager should update would be the:
- A. Scope baseline
 - B. Schedule
 - C. WBS
 - D. Budget

ANSWERS

- 1. A
- 2. B
- 3. B
- 4. C
- 5. C

- 6. B
- 7. C
- 8. D
- 9. B
- 10. D
- 11. D
- 12. B
- 13. B
- 14. B
- 15. D
- 16. A

PROBLEMS

11-1 Under what conditions would each of the following either not be available or not be necessary for initial planning?

- a. Work breakdown structure
- b. Statement of work
- c. Specifications
- d. Milestone schedules

11-2 What planning steps should precede total program scheduling? What steps are necessary?

11-3 How does a project manager determine how complex to make a program plan or how many schedules to include?

11-4 Can objectives always be identified and scheduled?

11-5 Can a WBS always be established for attaining an objective?

11-6 Who determines the work necessary to accomplish an objective?

11-7 What roles does a functional manager play in establishing the first three levels of the WBS?

11-8 Should the length of a program have an impact on whether to set up a separate project or task for administrative support? How about for raw materials?

11-9 Is it possible for the WBS to be designed so that resource allocation is easier to identify?

11-10 If the scope of effort of a project changes during execution of activities, what should be the role of the functional manager?

11-11 What types of conflicts can occur during the planning cycle, and what modes should be used for their resolution?

11-12 What would be the effectiveness of Figure 11-3 if the work packages were replaced by tasks?

11-13 Under what situations or projects would work planning authorization not be necessary?

11-14 On what types of projects could hedge positions be easily identified on a schedule?

11-15 Can activities 5 and 6 of Figure 11-11 be eliminated? What risks does a project manager incur if these activities are eliminated?

11-16 Where in the planning cycle should responsibility charts be prepared? Can you identify this point in Figure 11-11?

11-17 For each one of the decision points in Figure 11-13, who makes the decision? Who must input information? What is the role of the functional manager and the functional team member? Where are strategic variables identified?

11-18 Consider a project in which all project planning is performed by a group. After all planning is completed, including the program plan and schedules, a project manager is selected. Is there anything wrong with this arrangement? Can it work?

11-19 How do the customer and contractor know if each one completely understands the statement of work, the work breakdown structure, and the program plan?

11-20 Should a good project plan formulate methods for anticipating problems?

11-21 Some project managers schedule staff meetings as the primary means for planning and control. Do you agree with this philosophy?

11-22 Paul Mali (*Management by Objectives*, New York: John Wiley, 1972, p. 12) defines MBO as a five-step process:

- Finding the objective
- Setting the objective
- Validating the objective
- Implementing the objective
- Controlling and reporting status of the objective

How can the work breakdown structure be used to accomplish each of the above steps? Would you agree or disagree that the more levels the WBS contains, the greater the understanding and clarity of those steps necessary to complete the objectives?

11-23 Many textbooks on management state that you should plan like you work, by doing one thing at a time. Can this same practice be applied at the project level, or must a project manager plan all activities at once?

11-24 Is it true that project managers set the milestones and functional managers hope they can meet them?

11-25 You have been asked to develop a work breakdown structure for a project. How should you go about accomplishing this? Should the WBS be time-phased, department-phased, division-phased, or some combination?

11-26 You have just been instructed to develop a schedule for introducing a new product into the marketplace. Below are the elements that must appear in your schedule. Arrange these elements into a work breakdown structure (down through level 3), and then draw the arrow diagram. You may feel free to add additional topics as necessary.

- | | |
|---------------------|-----------------------|
| ● Production layout | ● Review plant costs |
| ● Market testing | ● Select distributors |

- Analyze selling cost
 - Analyze customer reactions
 - Storage and shipping costs
 - Select salespeople
 - Train salespeople
 - Train distributors
 - Literature to salespeople
 - Literature to distributors
 - Print literature
 - Sales promotion
 - Sales manual
 - Trade advertising
 - Lay out artwork
 - Approve artwork
 - Introduce at trade show
 - Distribute to salespeople
 - Establish billing procedure
 - Establish credit procedure
 - Revise cost of production
 - Revise selling cost
 - Approvals*
 - Review meetings*
 - Final specifications
 - Material requisitions
- (* Approvals and review meetings can appear several times.)

11–27 Once a project begins, a good project manager will set up checkpoints. How should this be accomplished? Will the duration of the project matter? Can checkpoints be built into a schedule? If so, how should they be identified?

11–28 Detailed schedules (through WBS levels 3, 4, 5, . . .) are prepared by the functional managers. Should these schedules be shown to the customer?

11–29 The project start-up phase is complete, and you are now ready to finalize the operational plan. Below are six steps that are often part of the finalization procedure. Place them in the appropriate order.

1. Draw diagrams for each individual WBS element.
2. Establish the work breakdown structure and identify the reporting elements and levels.
3. Create a coarse (arrow-diagram) network and decide on the WBS.
4. Refine the diagram by combining all logic into one plan. Then decide on the work assignments.
5. If necessary, try to condense the diagram as much as possible without losing clarity.
6. Integrate diagrams at each level until only one exists. Then begin integration into higher WBS levels until the desired plan is achieved.

11–30 Below are seven factors that must be considered before finalizing a schedule. Explain how a base case schedule can change as a result of each of these:

- Introduction or acceptance of the product in the marketplace
- Present or planned manpower availability
- Economic constraints of the project
- Degree of technical difficulty
- Manpower availability
- Availability of personnel training
- Priority of the project

11–31 You are the project manager of a nine-month effort. You are now in the fifth month of the project and are more than two weeks behind schedule, with very little hope of catching up. The dam breaks in a town near you, and massive flooding and mudslides take place. Fifteen of your key functional people request to take off three days from the following week to help fellow church members dig out. Their functional managers, bless their hearts, have left the entire decision up to you. Should you let them go?

11–32 Once the functional manager and project manager agree on a project schedule, who is responsible for getting the work performed? Who is accountable for getting the work performed? Why the difference, if any?

11–33 Discuss the validity of the following two statements on authority:

- a. A good project manager will have more authority than his responsibility calls for.
- b. A good project manager should not hold a subordinate responsible for duties that he (the project manager) does not have the authority to enforce.

11–34 Below are twelve instructions. Which are best described as planning, and which are best described as forecasting?

- a. Give a complete definition of the work.
- b. Lay out a proposed schedule.
- c. Establish project milestones.
- d. Determine the need for different resources.
- e. Determine the skills required for each WBS task or element.
- f. Change the scope of the effort and obtain new estimates.
- g. Estimate the total time to complete the required work.
- h. Consider changing resources.
- i. Assign appropriate personnel to each WBS element.
- j. Reschedule project resources.
- k. Begin scheduling the WBS elements.
- l. Change the project priorities.

11–35 A major utility company has a planning group that prepares budgets (with the help of functional groups) and selects the projects to be completed within a given time period. You are assigned as a project manager on one of the projects and find out that it should have been started “last month” in order to meet the completion date. What can you, the project manager, do about this? Should you delay the start of the project to replan the work?

11–36 The director of project management calls you into his office and informs you that one of your fellow project managers has had a severe heart attack midway through a project. You will be taking over his project, which is well behind schedule and overrunning costs. The director of project management then “orders” you to complete the project within time and cost. How do you propose to do it? Where do you start? Should you shut down the project to replan it?

11–37 Planning is often described as establishing, budgeting, scheduling, and resource allocation. Identify these four elements in Figure 11–1.

11–38 A company is undertaking a large development project that requires that a massive “blueprint design tree” be developed. What kind of WBS outline would be best to minimize the impact of having two systems, one for blueprints and one for WBS work?

11–39 A company allows each line organization to perform its own procurement activities (through a centralized procurement office) as long as the procurement funds have been allocated during the project planning phase. The project office does not sign off on these functional procurement requisitions and may not even know about them. Can this system work effectively? If so, under what conditions?

11–40 As part of a feasibility study, you are asked to prepare, with the assistance of functional managers, a schedule and cost summary for a project that will occur three years downstream,

if the project is approved at all. Suppose that three years downstream the project is approved. How does the project manager get functional managers to accept the schedule and cost summary that they themselves prepared three years before?

11–41 “Expecting trouble.” Good project managers know what type of trouble can occur at the various stages in the development of a project. The activities in the numbered list below indicate the various stages of a project. The lettered list that follows identifies major problems. For each project stage, select and list all of those problems that are applicable.

- | | |
|---|--|
| 1. Request for proposal _____ | |
| 2. Submittal to customer _____ | |
| 3. Contract award _____ | |
| 4. Design review meetings _____ | |
| 5. Testing the product _____ | |
| 6. Customer acceptance _____ | |
| a. Engineering does not request manufacturing input for end-item producibility. | e. The project–functional interface definition is poor. |
| b. The work breakdown structure is poorly defined. | f. Improper systems integration has created conflicts and a communications breakdown. |
| c. Customer does not fully realize the impact that a technical change will have upon cost and schedule. | g. Several functional managers did not realize that they were responsible for certain risks. |
| d. Time and cost constraints are not compatible with the state of the art. | h. The impact of design changes is not systematically evaluated. |

11–42 Table 11–8 identifies twenty-six steps in project planning and control. Below is a description of each of the twenty-six steps. Using this information, fill in columns 1 and 2 (column 2 is a group response). After your instructor provides you with column 3, fill in the remainder of the table.

1. *Develop the linear responsibility chart.* This chart identifies the work breakdown structure and assigns specific authority/responsibility to various individuals as groups in order to be sure that all WBS elements are accounted for. The linear responsibility chart can be prepared with either the titles or names of individuals. Assume that this is prepared after you negotiate for qualified personnel, so that you know either the names or capabilities of those individuals who will be assigned.
2. *Negotiate for qualified functional personnel.* Once the work is decided on, the project manager tries to identify the qualifications for the desired personnel. This then becomes the basis for the negotiation process.
3. *Develop specifications.* This is one of the four documents needed to initially define the requirements of the project. Assume that these are either performance or material specifications, and are provided to you at the initial planning stage by either the customer or the user.
4. *Determine the means for measuring progress.* Before the project plan is finalized and project execution can begin, the project manager must identify the means for measuring progress; specifically, what is meant by an out-of-tolerance condition and what are the tolerances/variances/thresholds for each WBS base case element?
5. *Prepare the final report.* This is the final report to be prepared at the termination of the project.

TABLE 11-8. STEPS IN PROJECT PLANNING AND CONTROL

Activity	Description	Column 1: Your sequence	Column 2: Group sequence	Column 3: Expert's sequence	Column 4: Difference between 1 & 3	Column 5: Difference between 2 & 3
1.	Develop linear responsibility chart					
2.	Negotiate for qualified functional personnel					
3.	Develop specifications					
4.	Determine means for measuring progress					
5.	Prepare final report					
6.	Authorize departments to begin work					
7.	Develop work breakdown structure					
8.	Close out functional work orders					
9.	Develop scope statement and set objectives					
10.	Develop gross schedule					
11.	Develop priorities for each project element					
12.	Develop alternative courses of action					
13.	Develop PERT network					
14.	Develop detailed schedules					
15.	Establish functional personnel qualifications					
16.	Coordinate ongoing activities					
17.	Determine resource requirements					
18.	Measure progress					
19.	Decide upon a basic course of action					
20.	Establish costs for each WBS element					

(continues)

TABLE 11–8. STEPS IN PROJECT PLANNING AND CONTROL (*Continued*)

Activity	Description	Column 1: Your sequence	Column 2: Group sequence	Column 3: Expert's sequence	Column 4: Difference between 1 & 3	Column 5: Difference between 2 & 3
21.	Review WBS costs with each functional manager					
22.	Establish a project plan					
23.	Establish cost variances for base case elements					
24.	Price out WBS					
25.	Establish logic network with checkpoints					
26.	Review base case costs with director					

6. *Authorize departments to begin work.* This step authorizes departments to begin the actual execution of the project, *not* the planning. This step occurs generally after the project plan has been established, finalized, and perhaps even approved by the customer or user group. This is the initiation of the work orders for project implementation.
7. *Develop the work breakdown structure.* This is one of the four documents required for project definition in the early project planning stage. Assume that WBS is constructed using a bottom-up approach. In other words, the WBS is constructed from the logic network (arrow diagram) and checkpoints which will eventually become the basis for the PERT/CPM charts (see Activity 25).
8. *Close out functional work orders.* This is where the project manager tries to prevent excessive charging to his project by closing out the functional work orders (i.e., Activity 6) as work terminates. This includes canceling all work orders except those needed to administer the termination of the project and the preparation of the final report.
9. *Develop scope statement and set objectives.* This is the statement of work and is one of the four documents needed in order to identify the requirements of the project. Usually, the WBS is the structuring of the statement of work.
10. *Develop gross schedule.* This is the summary or milestone schedule needed at project initiation in order to define the four requirements documents for the project. The gross schedule includes start and end dates (if known), other major milestones, and data items.
11. *Develop priorities for each project element.* After the base case is identified and alternative courses of action are considered (i.e., contingency planning), the project team performs a sensitivity analysis for each element of the WBS. This may require

assigning priorities for each WBS element, and the highest priorities may *not* necessarily be assigned to elements on the critical path.

12. *Develop alternative courses of action.* Once the base case is known and detailed courses of action (i.e., detailed scheduling) are prepared, project managers conduct “what if” games to develop possible contingency plans.
13. *Develop PERT network.* This is the finalization of the PERT/CPM network and becomes the basis from which detailed scheduling will be performed. The logic for the PERT network can be conducted earlier in the planning cycle (see Activity 25), but the finalization of the network, together with the time durations, are usually based on who has been (or will be) assigned, and the resulting authority/-responsibility of the individual. In other words, the activity time duration is a function not only of the performance standard, but also of the individual’s expertise and authority/ responsibility.
14. *Develop detailed schedules.* These are the detailed project schedules, and are constructed from the PERT/CPM chart and the capabilities of the assigned individuals.
15. *Establish functional personnel qualifications.* Once senior management reviews the base case costs and approves the project, the project manager begins the task of conversion from rough to detail planning. This includes identification of the required resources, and then the respective qualifications.
16. *Coordinate ongoing activities.* These are the ongoing activities for project execution, not project planning. These are the activities that were authorized to begin in Activity 6.
17. *Determine resource requirements.* After senior management approves the estimated base case costs obtained during rough planning, detailed planning begins by determining the resource requirements, including human resources.
18. *Measure progress.* As the project team coordinates ongoing activities during project execution, the team monitors progress and prepares status reports.
19. *Decide on a basic course of action.* Once the project manager obtains the rough cost estimates for each WBS element, the project manager puts together all of the pieces and determines the basic course of action.
20. *Establish costs for each WBS element.* After deciding on the base case, the project manager establishes the base case cost for each WBS element in order to prepare for the senior management pricing review meeting. These costs are usually the same as those that were provided by the line managers.
21. *Review WBS costs with each functional manager.* Each functional manager is provided with the WBS and told to determine his role and price out his functional involvement. The project manager then reviews the WBS costs to make sure that everything was accounted for and without duplication of effort.
22. *Establish a project plan.* This is the final step in detail planning. Following this step, project execution begins. (Disregard the situation where project plan development can be run concurrently with project execution.)
23. *Establish cost variances for the base case elements.* Once the priorities are known for each base case element, the project manager establishes the allowable cost variances that will be used as a means for measuring progress. Cost reporting is minimum as long as the actual costs remain within these allowable variances.
24. *Price out the WBS.* This is where the project manager provides each functional manager with the WBS for initial activity pricing.
25. *Establish logic network with checkpoints.* This is the bottom-up approach that is often used as the basis for developing both the WBS and later the PERT/CPM network.

26. *Review base case costs with director.* Here the project manager takes the somewhat rough costs obtained during the WBS functional pricing and review and seeks management's approval to begin detail planning.

11-43 Consider the work breakdown structure shown in Figure 11-19. Can the project be managed from this one sheet of paper assuming that, at the end of each month, the project manager also receives a cost and percent-complete summary?

11-44 During 1992 and 1993, General Motors saved over \$2 billion due to the cost-cutting efforts of Mr. Lopez. Rumors spread throughout the auto industry that General Motors was considering a plan to offer subcontractors ten-year contracts in exchange for a 20 percent cost reduction.

These long-term contracts provided both GM and the subcontractors the chance to develop an informal project management relationship based on trust, effective communications, and minimum documentation requirements.

- Is it conceivable that the cost savings of 20 percent could have been realized entirely from the decrease in formalized documentation?
- Philosophically, what do you think happened when Mr. Lopez departed GM in the spring of 1993 for a senior position at Volkswagen? Did his informal project management system continue without him? Explain your answer.

11-45 During the recession of 1989-1993, the auto industry began taking extreme cost-cutting measures by downsizing its organizations. The downsizing efforts created project

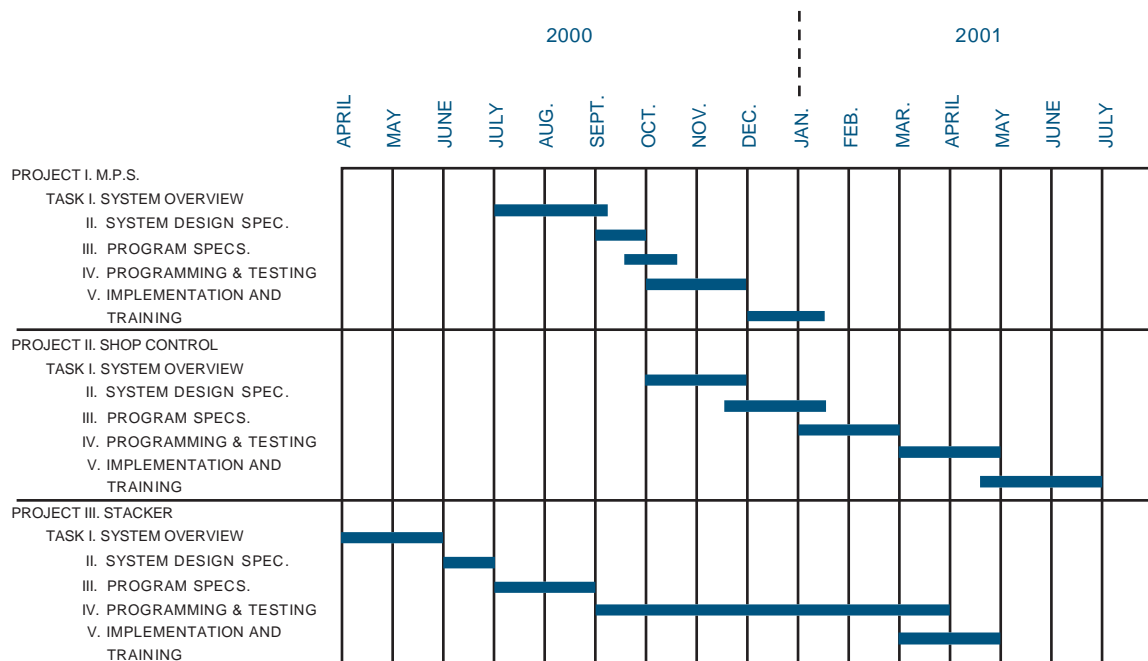


FIGURE 11-19. Work breakdown structure.

management problems for the project engineers in the manufacturing plants. With fewer resources available, more and more of the work had to be outsourced, primarily for services. The manufacturing plants had years of experience in negotiations for parts, but limited experience in negotiations for services. As a result, the service contracts were drastically overrun with engineering changes and schedule slippages. What is the real problem and your recommendation for a solution?

11–46 When to bring the project manager on board has always been a problem. For each of the following situations, identify the advantages and disadvantages.

- a. The project manager is brought on board at the beginning of the conceptual phase but acts only as an observer. The project manager neither answers questions nor provides his ideas until the brainstorming session is completed.
- b. When brainstorming is completed during the conceptual phase, senior management appoints one of the brainstorming team members to serve as the project manager.