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Overview of Project Management

Project Management Structures

A project management system provides a framework for launching and implementing project activities within a parent organization. A good system appropriately balances the needs of both the parent organization and the project by defining the interface between the project and parent organization in terms of authority, allocation of resources, and eventual integration of project outcomes into mainstream operations.

Many business organizations have struggled with creating a system for organizing projects while managing ongoing operations. One of the major reasons for this struggle is that projects contradict fundamental design principles associated with traditional organizations.

Projects are unique, one-time efforts with a distinct beginning and end. Most organizations are designed to efficiently manage ongoing activities. Efficiency is achieved primarily by breaking down complex tasks into simplified, repetitive processes, as symbolized by assembly-line production methods. Projects are not routine and therefore can be like ducks out of water in these work environments.

(A) Organizing Projects within the Functional Organization

One approach to organizing projects is to simply manage them within the existing functional hierarchy of the organization. Once management decides to implement a project, the different segments of the project are delegated to the respective functional units with each unit responsible for completing its segment of the project. Coordination is maintained through normal management channels.

For example, a tool manufacturing firm decides to differentiate its product line by offering a series of tools specially designed for left-handed individuals. Top management decides to implement the project, and different segments of the project are distributed to appropriate areas. The industrial design department is responsible for modifying specifications to conform to the needs of left-handed users. The production department is responsible for devising the means for producing new tools according to these new design specifications. The marketing department is responsible for gauging demand and price as well as identifying distribution outlets. The overall project will be managed within the normal hierarchy, with the project being part of the working agenda of top management.

The functional organization is also commonly used when, given the nature of the project, one functional area plays a dominant role in completing the project or has a dominant interest in the success of the project. Under these circumstances, a high-ranking manager in that area is given the responsibility of coordinating the project.

For example, the transfer of equipment and personnel to a new office would be managed by a top-ranking manager in the firm's facilities department. Likewise, a project involving the upgrading of the management information system would be managed by the information systems department. In both cases, most of the project work would be done within the

specified department and coordination with other departments would occur through normal channels.

There are advantages and disadvantages for using the existing functional organization to administer and complete projects. The major advantages are the following:

1. No Change : Projects are completed within the basic functional structure of the parent organization. There is no radical alteration in the design and operation of the parent organization.

2. Flexibility : There is maximum flexibility in the use of staff. Appropriate specialists in different functional units can temporarily be assigned to work on the project and then return to their normal work. With a broad base of technical personnel available within each functional department, people can be switched among different projects with relative ease.

3. In-Depth Expertise : If the scope of the project is narrow and the proper functional unit is assigned primary responsibility, then in-depth expertise can be brought to bear on the most crucial aspects of the project.

4. Easy Post-Project Transition : Normal career paths within a functional division are maintained. While specialists can make significant contributions to projects, their functional field is their professional home and the focus of their professional growth and advancement.

Just as there are advantages for organizing projects within the existing functional organization, there are also disadvantages. These disadvantages are particularly pronounced when the scope of the project is broad and one functional department does not take the dominant technological and managerial lead on the project:

1. Lack of Focus : Each functional unit has its own core routine work to do; sometimes project responsibilities get pushed aside to meet primary obligations. This difficulty is compounded when the project has different priorities for different units. For example, the marketing department may consider the project urgent while the operations people considered it only of secondary importance. Imagine the tension if the marketing people have to wait for the operations people to complete their segment of the project before they proceed.

2. Poor Integration : There may be poor integration across functional units. Functional specialists tend to be concerned only with their segment of the project and not with what is best for the total project.

3. Slow : It generally takes longer to complete projects through this functional arrangement. This is in part attributable to slow response time—project information and decisions have to be circulated through normal management channels. Furthermore, the lack of horizontal, direct communication among functional groups contributes to rework as specialists realize the implications of others' actions after the fact.

4. Lack of Ownership : The motivation of people assigned to the project can be weak. The project may be seen as an additional burden that is not directly linked to their professional development or advancement. Furthermore, because they are working on only a segment of

the project, professionals do not identify with the project. Lack of ownership discourages strong commitment to project-related activities.

(B) Organizing Projects as Dedicated Teams

These teams operate as separate units from the rest of the parent organization. Usually a full-time project manager is designated to pull together a core group of specialists who work full time on the project. The project manager recruits necessary personnel from both within and outside the parent company. The subsequent team is physically separated from the parent organization and given marching orders to complete the project.

The interface between the parent organization and the project teams will vary. In some cases, the parent organization maintains a tight rein through financial controls. In other cases, firms grant the project manager maximum freedom to get the project done as he sees fit.

In the case of firms where projects are the dominant form of business, such as a construction firm or a consulting firm, the entire organization is designed to support project teams. Instead of one or two special projects, the organization consists of sets of quasi-independent teams working on specific projects. The main responsibility of traditional functional departments is to assist and support these project teams. For example, the marketing department is directed at generating new business that will lead to more projects, while the human resource department is responsible for managing a variety of personnel issues as well as recruiting and training new employees. This type of organization is referred to in the literature as a **Projectized Organization**. It is important to note that not all projects are dedicated project teams; personnel can work part-time on several projects.

The following are recognized as strengths:

1. **Simple** : Other than taking away resources in the form of specialists assigned to the project, the functional organization remains intact with the project team operating independently.
2. **Fast** : Projects tend to get done more quickly when participants devote their full attention to the project and are not distracted by other obligations and duties. Furthermore, response time tends to be quicker under this arrangement because most decisions are made within the team and are not deferred up the hierarchy.
3. **Cohesive** : A high level of motivation and cohesiveness often emerges within the project team. Participants share a common goal and personal responsibility toward the project and the team.
4. **Cross-Functional Integration** : Specialists from different areas work closely together and, with proper guidance, become committed to optimizing the project, not their respective areas of expertise.

In many cases, the project team approach is the optimum approach for completing a project when you view it solely from the standpoint of what is best for completing the project. Its weaknesses become more evident when the needs of the parent organization are taken into account:

1. **Expensive** : Not only have you created a new management position (project manager), but resources are also assigned on a full-time basis. This can result in duplication of efforts across projects and a loss of economies of scale.
2. **Internal Strife** : Sometimes dedicated project teams take on an entity of their own and a disease known as projectitis develops. A strong we-they divisiveness emerges between the project team and the parent organization. This divisiveness can undermine not only the integration of the eventual outcomes of the project into mainstream operations but also the assimilation of project team members back into their functional units once the project is completed.
3. **Limited Technological Expertise** : Creating self-contained teams inhibits maximum technological expertise being brought to bear on problems. Technical expertise is limited somewhat to the talents and experience of the specialists assigned to the project. While nothing prevents specialists from consulting with others in the functional division, the we-they syndrome and the fact that such help is not formally sanctioned by the organization discourage this from happening.
4. **Difficult Post-Project Transition** : Assigning full-time personnel to a project creates the dilemma of what to do with personnel after the project is completed. If other project work is not available, then the transition back to their original functional departments may be difficult because of their prolonged absence and the need to catch up with recent developments in their functional area.

(C) Organizing Projects within a Matrix Arrangement

One of the biggest management innovations to emerge in the past 30 years has been the matrix organization. Matrix management is a hybrid organizational form in which a horizontal project management structure is "overlaid" on the normal functional hierarchy. In a matrix system, there are usually two chains of command, one along functional lines and the other along project lines. Instead of delegating segments of a project to different units or creating an autonomous team, project participants report simultaneously to both functional and project managers.

Companies apply this matrix arrangement in a variety of different ways. Some organizations set up temporary matrix systems to deal with specific projects, while "matrix" may be a permanent fixture in other organizations.

Let us first look at its general application and then proceed to a more detailed discussion of finer points. Consider Figure 3.4. There are three projects currently under way: A, B, and C. All three project managers (PM A-C) report to a director of project management, who

supervises all projects. Each project has an administrative assistant, although the one for project C is only part time.

Project A involves the design and expansion of an existing production line to accommodate new metal alloys. To accomplish this objective, project A has assigned to it 3.5 people from manufacturing and 11 people from engineering. These individuals are assigned to the project on a part-time or full-time basis, depending on the project's needs during various phases of the project. Project B involves the development of a new product that requires the heavy representation of engineering, manufacturing, and marketing. Project C involves forecasting changing needs of an existing customer base. While these three projects, as well as others, are being completed, the functional divisions continue performing their basic, core activities.

The matrix structure is designed to optimally utilize resources by having individuals work on multiple projects as well as being capable of performing normal functional duties. At the same time, the matrix approach attempts to achieve greater integration by creating and legitimizing the authority of a project manager.

In theory, the matrix approach provides a dual focus between functional/technical expertise and project requirements that is missing in either the project team or functional approach to project management. This focus can most easily be seen in the relative input of functional managers and project managers over key project decisions (see Table 3.1).

TABLE 3.1

Division of Project Manager and Functional Manager Responsibilities in a Matrix Structure

Project Manager	Negotiated Issues	Functional Manager
What has to be done?	Who will do the task?	How will it be done?
When should the task be done?	Where will the task be done?	
How much money is available to do the task?	Why will the task be done?	How will the project involvement impact normal functional activities?
How well has the total project been done?	Is the task satisfactorily completed?	How well has the functional input been integrated?

Different Matrix Forms

In practice there are really different kinds of matrix systems, depending on the relative authority of the project and functional managers. Here is a thumbnail sketch of the three kinds of matrices:

- **Weak matrix :** This form is very similar to a functional approach with the exception that there is a formally designated project manager responsible for coordinating project activities. Functional managers are responsible for managing their segment of the project. The project manager basically acts as a staff assistant who draws the schedules and checklists, collects information on status of work, and facilitates project completion. The project manager has indirect authority to expedite and monitor the project. Functional managers call most of the shots and decide who does what and when the work is completed.

- **Balanced matrix :** This is the classic matrix in which the project manager is responsible for defining what needs to be accomplished while the functional managers are concerned with how it will be accomplished. More specifically, the project manager establishes the overall plan for completing the project, integrates the contribution of the different disciplines, sets schedules, and monitors progress. The functional managers are responsible for assigning personnel and executing their segment of the project according to the standards and schedules set by the project manager. The merger of "what and how" requires both parties to work closely together and jointly approve technical and operational decisions.

- **Strong matrix :** This form attempts to create the "feel" of a project team within a matrix environment. The project manager controls most aspects of the project, including scope trade-offs and assignment of functional personnel. The project manager controls when and what specialists do and has final say on major project decisions. The functional manager has title over her people and is consulted on a need basis. In some situations a functional manager's department may serve as a "subcontractor" for the project, in which case they have more control over specialized work.

For example, the development of a new series of laptop computers may require a team of experts from different disciplines working on the basic design and performance requirements within a project matrix arrangement. Once the specifications have been determined, final design and production of certain components (i.e., power source) may be assigned to respective functional groups to complete.

Matrix management both in general and in its specific forms has unique strengths and weaknesses. The advantages and disadvantages of matrix organizations in general are noted below, while only briefly highlighting specifics concerning different forms:

1. **Efficient :** Resources can be shared across multiple projects as well as within functional divisions. Individuals can divide their energy across multiple projects on an as-needed basis. This reduces duplication required in a projectized structure.

2. **Strong Project Focus :** A stronger project focus is provided by having a formally designated project manager who is responsible for coordinating and integrating contributions of

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different units. This helps sustain a holistic approach to problem solving that is often missing in the functional organization.

3. Easier Post-Project Transition : Because the project organization is overlaid on the functional divisions, specialists maintain ties with their functional group, so they have a homeport to return to once the project is completed.

4. Flexible : Matrix arrangements provide for flexible utilization of resources and expertise within the firm. In some cases functional units may provide individuals who are managed by the project manager. In other cases the contributions are monitored by the functional manager.

The strengths of the matrix structure are considerable. Unfortunately, so are the potential weaknesses. This is due in large part to the fact that a matrix structure is more complicated and the creation of multiple bosses represents a radical departure from the traditional hierarchical authority system.

Furthermore, one does not install a matrix structure overnight. Experts argue that it takes 3–5 years for a matrix system to fully mature. So many of the problems described below represent growing pains.

1. Dysfunctional Conflict : The matrix approach is predicated on tension between functional managers and project managers who bring critical expertise and perspectives to the project. Such tension is viewed as a necessary mechanism for achieving an appropriate balance between complex technical issues and unique project requirements. While the intent is noble, the effect is sometimes analogous to opening Pandora's box. Legitimate conflict can spill over to a more personal level, resulting from conflicting agendas and accountabilities. Worthy discussions can degenerate into heated arguments that engender animosity among the managers involved.

2. Infighting : Any situation in which equipment, resources, and people are being shared across projects and functional activities lends itself to conflict and competition for scarce resources. Infighting can occur among project managers, who are primarily interested in what is best for their project.

3. Stressful : Matrix management violates the management principle of unity of command. Project participants have at least two bosses—their functional head and one or more project managers. Working in a matrix environment can be extremely stressful. Imagine what it would be like to work in an environment in which you are being told to do three conflicting things by three different managers.

4. Slow : In theory, the presence of a project manager to coordinate the project should accelerate the completion of the project. In practice, decision making can get bogged down as agreements have to be forged across multiple functional groups. This is especially true for the balanced matrix.

When the three variant forms of the matrix approach are considered, we can see that advantages and disadvantages are not necessarily true for all three forms of matrix. The

Strong matrix is likely to enhance project integration, diminish internal power struggles, and ultimately improve control of project activities and costs. On the downside, technical quality may suffer because functional areas have less control over their contributions. Finally, projectiles may emerge as the members develop a strong team identity.

The Weak matrix is likely to improve technical quality as well as provide a better system for managing conflict across projects because the functional manager assigns personnel to different projects. The problem is that functional control is often maintained at the expense of poor project integration. The Balanced matrix can achieve better balance between technical and project requirements, but it is a very delicate system to manage and is more likely to succumb to many of the problems associated with the matrix approach.

Defining the Project

Project managers in charge of a single small project can plan and schedule the project tasks without much formal planning and information. However, when the project manager must manage several small projects or a large complex project, a threshold is quickly reached in which the project manager can no longer cope with the detail.

This chapter describes a disciplined, structured method for selectively collecting information to use through all phases of the project life cycle, to meet the needs of all stakeholders (e.g., customer, project manager), and to measure performance against the strategic plan of the organization. The method suggested is a selective outline of the project called the work breakdown structure. The early stages of developing the outline serve to ensure that all tasks are identified and that participants of the project have an understanding of what is to be done. Once the outline and its detail are defined, an integrated information system can be developed to schedule work and allocate budgets.

The five generic steps described herein provide a structured approach for collecting the project information necessary for developing a work breakdown structure.

Step 1: Defining the Project Scope

Defining the project scope sets the stage for developing a project plan. Project scope is a definition of the end result or mission of your project—a product or service for your client/customer. The primary purpose is to define as clearly as possible the deliverable(s) for the end user and to focus project plans. The scope should be developed under the direction

of the project manager and customer. The project manager is responsible for seeing that there is agreement with the owner on project objectives, deliverables at each stage of the project, technical requirements, and so forth. For example, a deliverable in the early stage might be specifications; for the second stage, three prototypes for production; for the third, a sufficient quantity to introduce to market; and finally, marketing promotion and training.

Your project scope definition is a document that will be published and used by the project owner and project participants for planning and measuring project success. Scope describes what you expect to deliver to your customer when the project is complete. Your project scope should define the results to be achieved in specific, tangible, and measurable terms.

Employing a Project Scope Checklist

Clearly, project scope is the keystone interlocking all elements of a project plan. To ensure that scope definition is complete, you may wish to use the following checklist:

Project Scope Checklist

- | | |
|--------------------------|---------------------------|
| 1. Project objective | 2. Deliverables |
| 3. Milestones | 4. Technical requirements |
| 5. Limits and exclusions | 6. Reviews with customer |

1. Project objective : The first step of project scope definition is to define the overall objective to meet your customer's need(s). For example, as a result of extensive market research a computer software company decides to develop a program that automatically translates verbal sentences in English to Russian. The project should be completed within three years at a cost not to exceed \$1.5 million. Another example is to design and produce a completely portable, hazardous waste, thermal treatment system in 12 months at a cost not to exceed \$1.3 million. The project objective answers the questions of what, when, and how much.

2. Deliverables : The next step is to define major deliverables—the expected outputs over the life of the project. For example, deliverables in the early design phase of a project might be a list of specifications. In the second phase deliverables could be software coding and a technical manual. The next phase could be to test prototypes. The final phase could be final tests and approved software.

3. Milestones : A milestone is a significant event in a project that occurs at a point in time. The milestone schedule shows only major segments of work; it represents first, rough-cut estimates of time, cost, and resources for the project. The milestone schedule is built using the deliverables as a platform to identify major segments of work and an end date—for example, testing completed and finished by July 1 of the same year. Milestones should be natural, important control points in the project. Milestones should be easy for all project participants to recognize.

4. Technical requirements. More frequently than not, a product or service will have technical requirements to ensure proper performance. For example, a technical requirement for a personal computer might be the ability to accept 110-volt alternating current or 240-volt direct current without any adapters or user switches. Another well-known example is the ability of 911 emergency systems to identify the caller's phone number and location of the phone. Examples from information systems projects include speed and capacity of database systems and connectivity with alternative systems.

ff. Limits and exclusions : The limits of scope should be defined. Failure to do so can lead to false expectations and to expending resources and time on the wrong problem. Examples of limits are: local air transportation to and from base camps will be outsourced; system maintenance and repair will be done only up to one month after final inspection; client will be billed for additional training beyond that prescribed in the contract. Exclusions further define the boundary of the project by stating what is not included. Examples include: data will be collected by the client, not the contractor; a house will be built, but no landscaping or security devices added; software will be installed, but no training given.

6. Reviews with customer : Completion of the scope checklist ends with a review with your customer—internal or external. The main concern here is the understanding and agreement of expectations. Is the customer getting what he or she desires in deliverables? Does the project definition identify key accomplishments, budgets, timing, and performance requirements? Are questions of limits and exclusions covered? Clear communication in all these issues is imperative to avoid claims or misunderstanding.

Many companies engaged in contracted work refer to scope statements as **statements of work** (SOW). Other organizations use the term **project charter**. However, the term project charter has emerged to have a special meaning in the world of project management.

A **project charter** refers to a document that authorizes the project manager to initiate and lead the project. This document is issued by upper management and provides the project manager with written authority to use organizational resources for project activities. Often the charter will include a brief scope description as well as such items as risk limits, customer needs, spending limits, and even team composition.

Many projects suffer from **scope creep**, which is the tendency for the project scope to expand over time—usually by changing requirements, specifications, and priorities. Scope creep can be reduced by carefully writing your scope statement.

A scope statement that is too broad is an invitation for scope creep. Scope creep can have a positive or negative effect on the project, but in most cases scope creep means added costs and possible project delays. Changes in requirements, specifications, and priorities frequently result in cost overruns and delays. If the project scope needs to change, it is critical to have a sound change control process in place that records the change and keeps a log of all project changes. The log identifies the change, impact, and those responsible for accepting or rejecting a proposed change.

Common problems with Project Scope Management to avoid

Often, when performing Scope Management, project managers bump into issues along the

Ambiguity : Ambiguity in scope often leads to unnecessary work and confusion. To avoid this, the scope needs to be clearly defined and to the point.

Incomplete definition : Incomplete scopes lead to schedule slips which lead to cost overruns. To avoid this, the scope needs to be complete and accurate.

Transience : Transient scopes lead to scope creep which is the primary cause of late deliveries and "never ending" projects. To avoid this, the scope document needs to be finalized and remain unaltered for the duration of the project.

Un-collaborative scope : A scope that is not collaboratively prepared causes misinterpretations in requirements and design. To avoid this, the scope document should be shared with all stakeholders at every step of the scope definition process.

Step 2: Establishing Project Priorities

Quality and the ultimate success of a project are traditionally defined as meeting and/or exceeding the expectations of the customer and/or upper management in terms of cost (budget), time (schedule), and performance (scope) of the project (see Figure 4.1). The interrelationship among these criteria varies. For example, sometimes it is necessary to compromise the performance and scope of the project to get the project done quickly or less expensively. Often the longer a project takes, the more expensive it becomes. However, a positive correlation between cost and schedule may not always be true. Other times project costs can be reduced by using cheaper, less efficient labor or equipment that extends the duration of the project.

One of the primary jobs of a project manager is to manage the trade-offs among time, cost, and performance. To do so, project managers must define and understand the nature of the priorities of the project. They need to have a candid discussion with the project customer and upper management to establish the relative importance of each criterion. For example, what happens when the customer keeps adding requirements? Or if, midway through the project, a trade-off must be made between cost and expediting, which criterion has priority?

One technique found in practice that is useful for this purpose is completing a **priority matrix** for the project to identify which criterion is constrained, which should be enhanced, and which can be accepted:

Constrain : The original parameter is fixed. The project must meet the completion date, specifications and scope of the project, or budget.

Enhance : Given the scope of the project, which criterion should be optimized? In the case of time and cost, this usually means taking advantage of opportunities to either reduce costs or shorten the schedule. Conversely, with regard to performance, enhancing means adding value to the project.

Accept : For which criterion is it tolerable not to meet the original parameters? When trade-offs have to be made, is it permissible for the schedule to slip, to reduce the scope and performance of the project, or to go over budget?

Figure 4.2 displays the priority matrix for the development of a new wireless modem. Because time to market is important to sales, the project manager is instructed to take advantage of every opportunity to reduce completion time. In doing so, going over budget is acceptable though not desirable. At the same time, the original performance specifications for the modem as well as reliability standards cannot be compromised.

Priorities vary from project to project. For example, for many software projects time to market is critical, and companies like Microsoft may defer original scope requirements to later versions in order to get to the market first. Alternatively, for special event projects (conferences, parades, tournaments) time is constrained once the date has been announced, and if the budget is tight, the project manager will compromise the scope of the project in order to complete the project on time.

Some would argue that all three criteria are always constrained and that good project managers should seek to optimize each criterion. If everything goes well on a project and no major problems or setbacks are encountered, their argument may be valid. However, this situation is rare, and project managers are often forced to make tough decisions that benefit one criterion while compromising the other two. The purpose of this exercise is to define and agree on what the priorities and constraints of the project are so that when "push comes to shove," the right decisions can be made.

There are likely to be natural limits to the extent managers can constrain, optimize, or accept any one criterion. It may be acceptable for the project to slip one month behind schedule but no further or to exceed the planned budget by as much as \$20,000. Likewise, it may be desirable to finish a project a month early, but after that cost conservation should be the primary goal. Some project managers document these limits as part of creating the priority matrix.

In summary, developing a decision priority matrix for a project before the project begins is a useful exercise. It provides a forum for clearly establishing priorities with customers and top management so as to create shared expectations and avoid misunderstandings. The priority information is essential to the planning process, where adjustments can be made in the scope, schedule, and budget allocation. Finally, the matrix is useful midway in the project for approaching a problem that must be solved.

One caveat must be mentioned; during the course of a project, priorities may change. The customer may suddenly need the project completed one month sooner, or new directives from top management may emphasize cost saving initiatives.

The project manager needs to be vigilant in order to anticipate and confirm changes in priorities and make appropriate adjustments.

Step 3: Creating the Work Breakdown Structure

Major Groupings Found in a WBS

Once the scope and deliverables have been identified, the work of the project can be successively subdivided into smaller and smaller work elements. The outcome of this hierarchical process is called the work breakdown structure (WBS). The WBS is a map of the project. Use of WBS helps to assure project managers that all products and work elements are identified, to integrate the project with the current organization, and to establish a basis for control. Basically, the WBS is an outline of the project with different levels of detail.

Figure 4.3 shows the major groupings commonly used in the field to develop a hierarchical WBS. The WBS begins with the project as the final deliverable. Major project work deliverables/systems are identified first; then the sub-deliverables necessary to accomplish the larger deliverables are defined. The process is repeated until the sub-deliverable detail is small enough to be manageable and where one person can be responsible. This sub-deliverable is further divided into work packages.

Because the lowest sub-deliverable usually includes several work packages, the work packages are grouped by type of work—for example, hardware, programming, testing. These groupings within a sub-deliverable are called cost accounts. This grouping facilitates a system for monitoring project progress by work, cost, and responsibility.

How WBS Helps the Project Manager

The WBS defines all the elements of the project in a hierarchical framework and establishes their relationships to the project end item(s). Think of the project as a large work package that is successively broken down into smaller work packages; the total project is the summation of all the smaller work packages. This hierarchical structure facilitates evaluation of cost, time, and technical performance at all levels in the organization over the life of the project.

The WBS also provides management with information appropriate to each level. For example, top management deals primarily with major deliverables, while first-line supervisors deal with smaller sub-deliverables and work packages.

Each item in the WBS needs a time and cost estimate. With this information it is possible to plan, schedule, and budget your project. The WBS also serves as a framework for tracking cost and work performance.

As the WBS is developed, organizational units and individuals are assigned responsibility for executing work packages. This integrates the work and the organization. In practice, this process is sometimes called the organization breakdown structure (OBS), which will be further discussed later in the chapter. Use of the WBS provides the opportunity to “roll up” (sum) the budget and actual costs of the smaller work packages into larger work elements so that performance can be measured by organizational units and work accomplishment.

The WBS can also be used to define communication channels and assist in understanding and coordinating many parts of the project. The structure shows the work and organizational units responsible and suggests where written communication should be directed. Problems can be quickly addressed and coordinated because the structure integrates work and responsibility.

WBS Development

Figure 4.4 on page flf12 shows a simplified WBS for development of a new personal computer project. At the top of the chart (level 1) is the project end item—a deliverable product or service. Note how the levels of the structure can represent information for different levels of management. For example, level 1 information represents the total project objective and is useful to top management; levels 2, 3, and 4 are suitable for middle management; and level 5 is for first-line managers.

Level 2 shows a partial list of deliverables necessary to develop the personal computer. One deliverable is the disk storage unit (shaded), which is made up of three sub-deliverables—external USB, optical, and hard disks. Finally, the hard disk requires four sub-deliverables—motor, circuit board, chassis frame, and read/write head. These sub-deliverables represent the lowest manageable elements of the project. Each sub-deliverable requires work packages that will be completed by an assigned organizational unit. Each deliverable will be successively divided in this manner. It is not necessary to divide all elements of the WBS to the same level.

The lowest level of the WBS is called a **work package**. Work packages are short duration tasks that have a definite start and stop point, consume resources, and represent cost. Each work package is a control point.

A work package manager is responsible for seeing that the package is completed on time, within budget, and according to technical specifications. Practice suggests a work package should not exceed fl0 workdays or one reporting period. If a work package has a duration exceeding fl0 days, check or monitoring points should be established within the duration, say, every three to five days, so progress and problems can be identified before too much time has passed. Each work package of the WBS should be as independent of other packages of the project as possible.

No work package is described in more than one sub-deliverable of the WBS. There is an important difference from start to finish between the last work breakdown sub-deliverable and a work package. Typically, a work breakdown sub-deliverable includes the outcomes of more than one work package from perhaps two or three departments. Therefore, the sub-deliverable does not have a duration of its own and does not consume resources or cost money directly. (In a sense, of course, a duration for a particular work breakdown element can be derived from identifying which work package must start first [earliest] and which package will be the latest to finish; the difference from start to finish becomes the duration for the sub-deliverable.) The higher elements are used to identify deliverables at different

phases in the project and to develop status reports during the execution stage of the project life cycle. Thus, the work package is the basic unit used for planning, scheduling, and controlling the project.

To review, each work package in the WBS

- f1. Defines work (what).
2. Identifies time to complete a work package (how long).
3. Identifies a time-phased budget to complete a work package (cost).
4. Identifies resources needed to complete a work package (how much).
5. Identifies a single person responsible for units of work (who).

tt. Identifies monitoring points for measuring progress (how well).

Creating a WBS from scratch can be a daunting task. Project managers should take advantage of relevant examples from previous projects to begin the process.

WBSs are products of group efforts. If the project is small, the entire project team may be involved breaking down the project into its components. For large, complex projects, the people responsible for the major deliverables are likely to meet to establish the first two levels of deliverables. In turn, further detail would be delegated to the people responsible for the specific work. Collectively this information would be gathered and integrated into a formal WBS by a project support person. The final version would be reviewed by the inner echelon of the project team. Relevant stakeholders (most notably customers) would be consulted to confirm agreement and revise when appropriate.

Project teams developing their first WBS frequently forget that the structure should be end-item, output oriented. First attempts often result in a WBS that follows the organization structure—design, marketing, production, finance. If a WBS follows the organization structure, the focus will be on the organization function and processes rather than the project output or deliverables. In addition, a WBS with a process focus will become an accounting tool that records costs by function rather than a tool for “output” management. Every effort should be made to develop a WBS that is output oriented in order to concentrate on concrete deliverables.

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