Chapter 1

Introduction

Interstate 4 and 17/92 intersection in Sanford, Florida

PLANNING AND SCHEDULING

Planning and *scheduling* are two terms that are often thought of as synonymous. However, they are not. Scheduling is just one part of the planning effort. The term *planning* is used in many ways and different contexts. We commonly hear about *financial planning,* such as retirement planning and college education planning. Although these types of planning may include other aspects (such as what to do after retirement or which college to choose for your child), the main focus is on finance. Government organizations, as well as large corporations, have planning units or teams in almost every department. All plans in the individual units must be aligned with the organization's "*strategic plan,*" which is the long-term plan for the organization itself in terms of operations and growth. At the individual level, a young person may have plans for marriage, a career, and so forth. However, in the context of this book, the term *planning* is restricted to mean project planning, with an emphasis on construction projects.

What Is a Project?

Before we define project planning, we need to define a project. The Project Management Institute (PMI) defines a **project** as "a temporary endeavor undertaken to create a unique product, service, or result" (PMI, 2013, p. 573). The key words in this definition are *temporary* and *unique*: any project must have a starting point and an ending point, and it must have a deliverable product, service, or result that is unique. As a generic example, a secretary of education saying "we need to improve our students' SAT scores" does not constitute a project. However, saying "we need to improve our students' SAT scores by an average of 15 points in five years" may qualify as a project. Another example: a newlywed couple may decide on saving money to buy a house. This is not a project, but saying "we are planning to save $50,000 in the next five years" may qualify as a project.

Tip Box 1.1

Every project must have a start point, a finish point, and a deliverable.

Some government agencies have specific but ongoing work that they call a project, such as maintenance of a certain facility or park compliance with the Americans with Disabilities Act or other regulation. Technically, these are not projects because they have no well-defined deliverable product or service and/or starting and ending points. Each could be called a *program*, instead, with several projects within each program. Basically, we need to distinguish between a program and a project:

- *Program*: A *program* may mean different things to different people, depending on the context. In project management, a program usually is a group of

related projects and/or services intended to meet a common objective and usually managed by one entity. A program can also indicate a large and complex project that is divided into several projects for more effective management. The PMI defines a program as "a group of related projects, subprograms, and program activities managed in coordinated way to obtain benefits not available from managing them individually" (PMI, 2013). Programs may include elements of related work outside the scope of the discrete projects in the program.

Programs may be temporary/one-time or ongoing:

- *Temporary/one-time programs*: For example, the City of Rio de Janeiro (Brazil) may include all of the construction projects for the 2016 Summer Olympics under one program. Once this program culminates with the completion of the projects, by the opening of the 2016 Summer Olympic Games, it will be completed and closed. However, the future maintenance of these facilities is a different matter.
- *Ongoing (usually periodic/annual) programs*: These include projects such as road maintenance and storm water programs for a public works department in many municipalities. Many private and public institutions have maintenance programs for their existing facilities. Such programs usually have an annual budget and cover numerous small projects—as many as the budget allows. The programs usually live as long the facility does.

One important note: in the United Kingdom, as well as in some other countries that use British terminology, the schedule (timeline) of the project is called *program* (spelled *programme*). This is *not* the same type of program that we are discussing.

- *Portfolio*: This is a group of projects, not necessarily related or dependent, that is, usually under one project manager or department. The PMI defines it as "projects, programs, subportfolios, and operations managed as a group to achieve strategic objectives" (PMI, 2013).
- *Project*: Defined earlier.
- *Subprojects*: These are segments of the original project that are divided according to specialty, responsibility, phase, area, or other criteria. To the person in charge of a subproject, the subproject is a project, except that the person has to consider not only the internal relationships among the activities but the external relationships as well (with activities in other subprojects in the same project). For example, in a residential or commercial development project, building the infrastructure may be regarded as a subproject. In fact, building the sewer system in the development can be a subproject (to the entire development project) or even a sub-subproject (to the infrastructure subproject).

  Figure 1.1 *demonstrates the structure of programs, portfolios, projects; and the relationships among them.*

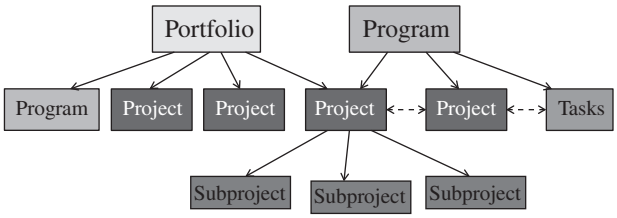

Figure 1.1 Programs, Portfolios, and Projects

Are Projects Unique?

Some people may think of two construction projects as being identical just because they have the same design. In project management, we may have similar projects, but every project is unique. Differences may occur because of location (soil type, weather conditions, labor market, building codes, unforeseen conditions, etc.), labor skill level, management type and experience, or for other circumstances (and how much Murphy's Law was involved).

> **Tip Box 1.2**
>
> Just because two projects have exactly the same design and perhaps were built by the same contractor doesn't make them *identical*. They are similar but differences can come from site, location (building code, weather, etc.), workforce, execution conditions, and so on.

Project planning has been defined as "the process of choosing the one method and order of work to be adopted for a project from all the various ways and sequences in which it could be done" (Antill and Woodhead, 1990, p. 8; Callahan, Quackenbush, and Rowings, 1992, p. 2). The PMI defines the Planning Process Group as "those processes required to establish the scope of the project, refine the objectives, and define the course of action required to attain the objectives that the project was undertaken to achieve" (PMI, 2013). Project planning serves as a foundation for several related functions, such as cost estimating, scheduling, project control, quality control, safety management, and others.

Scheduling is the determination of the *timing* and *sequence* of operations in the project and their assembly to give the overall completion time. As mentioned previously, scheduling focuses on one part of the planning effort.

Project planning answers the questions: *What* is going to be done? *How*? *How much*? *Where*? By *whom*? *When?* (in general terms, the project's start and end). Scheduling deals with *when* on a detailed level. Figure 1.2 graphically demonstrates this concept. (See Figure 1.2.)

In fact, scholars have generally separated planning from scheduling: "CPM separates planning and scheduling, and once project information is collected and expressed

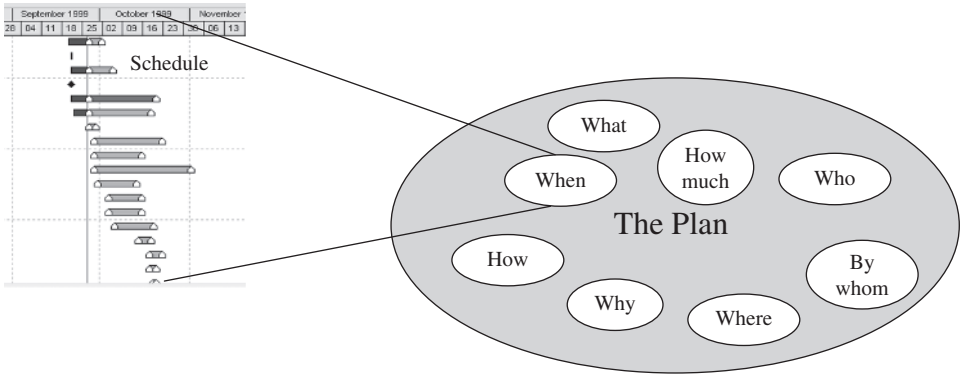

Figure 1.2 Planning and scheduling

as a network plan and activity time estimates assigned, CPM calculations can be made. Planning ceases and scheduling starts when the first computation is performed that shows a project duration. The project duration is then compared with the desired schedule and scheduling begins" (O'Brien and Plotnick, 2009, p. 417).

To get an idea about the relationship between project planning and scheduling, assume that you are planning a family vacation "project" for next summer. Your *plan* may include considerations such as the following:

- Who will go on the trip?
- Which places do you want to visit? (You would like to visit many places, but your time and monetary resources are limited.)
- What is the time frame for the vacation (just the starting and ending dates)?
- What is the total budget for the "project" (including the contingency you did not tell other family members about)?
- What types of activities do you want to participate in during the trip? (Are there sharp differences among the family members?)
- What means of transportation do you plan to use (your car, a rental car, air, train, bus, RV, etc.)?
- What other issues, such as accommodations, food, and clothing, need to be addressed?

The project *schedule* is simply the itinerary, such as the following:

- Leave home in Tampa, Florida, on June 8, 2015.
- Arrive in Panama City, Florida, on June 8, 2015.
- Leave Panama City on June 15, 2015.
- Arrive in Atlanta, Georgia, on June 15, 2015.

- Leave Atlanta on June 22, 2015.
- Arrive in Gatlinburg, Tennessee, on June 22, 2015.
- Return home to Tampa on July 7, 2015.

Note that not only are the plan and the schedule related, but also many of the activities and elements of the plan are interrelated. For example, most of the choices in the plan (length of stay, type of accommodations, type of activities, means of transportation, food, etc.) affect the budget. Since different means of transportation have longer time durations than others, they may affect not only the cost but also the schedule. Clearly, a lack of clarity of scope before the project starts may lead to heated arguments and dissatisfaction among team members later on. In real projects, it may lead to huge budget overruns, schedule delays, different parties' dissatisfaction, and a potential loss of business. Therefore, it is important to have a clear understanding of the project's scope, its constraints and requirements, and the decision-making process.[1] Many issues are at stake in this example, but demonstrating the concept of planning and scheduling is the objective.

It has been proven that good planning results in a high "rate of return" in terms of saving time, money, effort, change orders, claims and disputes, and headaches. In fact, there are many construction professionals who assert that there is an inverse relationship between the time of planning and the time of execution. Many owners rush the design and construction process because "they don't have time for planning." In fact, this is, in most cases, self-defeating and causes additional delays, costs, and headaches. An old carpenters' saying, "Measure twice and cut once," embodies this concept well.

Tip Box 1.3

Plan first: Measure twice and cut once!

Project Management Plan:

In the context of construction projects, a typical plan for an office building project may include the following:

- A *scope definition*, such as a five-story building for commercial use (offices) with a total area of about 30,000 square feet. The location is also part of the planning, although, in some cases, the exact location may be selected later or a few sites may be mentioned as candidates.
- A *schematic* or *conceptual design*. This is not a must but will help in visualizing the project. Also, deciding on the level of finish (economy, average, or luxury)

[1] There is more discussion on this issue in Chapter 10.

will help in making financial arrangements. The final design may later differ significantly.

- A *budget number* (e.g., $6 million). The planner must be aware of all project-related expenses, such as the cost of land, permits, design fees, construction, and so forth.
- A *time frame* (i.e., when the project is expected to start and end).
- *Other pertinent information* that may be used to justify the project or clarify some of its aspects. If an investor is doing the planning, a **pro forma** helps predict the rate of return and helps in making the decision as to whether or not to build the project.

PMI (PMI, 2013) defines a **project management plan** as "the document that describes how the project will be executed, monitored, and controlled." It may be summary or detailed and may be composed of one or more subsidiary management plans and other planning documents. The objective of a project management plan is to define the approach to be used by the project team to deliver the intended project management scope of the project.[2] It captures the entire project, covering all project phases, from initiation through planning, execution, and closure.

The level of details of the project management plan depends on several factors: the purpose of the plan, the timing of the plan, and the detailed information available (which is, in part, a function of the timing).

The project manager creates the project management plan following input from the project team and key stakeholders. The plan should be agreed on and approved by at least the project team and key stakeholders. It is a good practice, used by professional project management and consulting firms, to have a formal project management plan approved in the early stages of the project and applied throughout the project. Many owners (clients) require the contractor to submit a project management plan and have it approved as part of the contract documents.

Many professional organizations have an office dedicated to the project management planning and effort, called a *project management office (PMO)*, which is defined by the PMI as "an organizational structure that standardizes the project-related governance processes and facilitates the sharing of resources, methodologies, tools, and techniques" (PMI, 2013).

Tip Box 1.4

Have you ever thought of applying project management principles to your own life?

[2] This paragraph was taken from the PMI *PMBOK Guide,* 5th edition, 2013.

PROJECT CONTROL

Once a project starts, certain aspects can easily deviate or go astray. This deviation can be overspending, a schedule slippage, a departure from the objective/scope, or something else. It is of the utmost importance to know at all times where you stand in comparison with where you planned to be (the baseline) at this time. If you find any variance, you must know the amount and causes of the variance and then take corrective action to get back on track or, at the very least, to minimize the variance. If the variance is positive (i.e., the project is ahead of schedule or under budget), actual performance was probably better than that expected in the baseline plan. This process exemplifies **project control**. Although the concept of project control may cover all aspects of the plan (budget, schedule, quality, etc.), our main focus in this book is on schedule and budget control, which are related. (Extensive coverage of project control is provided in Chapter 7.)

WHY SCHEDULE PROJECTS?

There are several parties involved in any project (stakeholders). They all need and use project schedules but from different perspectives. Following is a group of reasons why project schedules are needed, from two different perspectives: contractors and owners.

Contractors need project scheduling to:

1. *Calculate the project completion date*: In most construction projects, the general contractor (GC), including subcontractors and other team members, is obligated to finish the project by a certain date that is specified in the contract. The contractor has to make sure that the schedule meets this date or otherwise has to accelerate the project. Some contracts contain clauses for penalties for finishing the project later than contractually required and/or incentives (financial or other) for finishing earlier. Also, the schedule may show the stage of **substantial completion**, when the owner may start occupying and using the facility, while the contractor is still doing some final touches.
2. *Calculate the start or end of a specific activity*: Specific activities may require special attention, such as ordering and delivering materials or equipment. For instance, the project manager may need special and expensive equipment to be delivered just in time for installation. Long-lead items may have to be ordered several months in advance. Delivery of very large items may need coordination or a special permit from the city so that the delivery does not disrupt traffic during rush hour. The schedule must show such important dates.
3. *Coordinate among trades and subcontractors, and expose and adjust conflicts*: In today's construction, the GC's role is mostly to coordinate different subcontractors. The responsibility of the GC may be to allocate the time of use of a tower crane among subcontractors or just to ensure that adequate work space is provided to all workers and personnel on-site. These tasks are in addition

to coordinating logical relationships, such as when a subcontractor's activity depends on the completion of another subcontractor's activity. For example, the drywall contractor cannot start until the framing has been done; once the drywall is installed, the painter can start painting; and so on.

4. *Predict and calculate the cash flow*: The timing of an activity has an impact on the cash flow, which may be an important factor for the contractor (or the owner) to consider. The contractor (or the owner) must know his or her total spending in any month or time period. He or she may delay the start of certain activities within the available *float* (this term is explained subsequently) to make sure that the cash flow does not exceed a certain cap.
5. *Improve work efficiency*: By properly distributing workers and equipment and having efficient materials management (which is explained in Chapter 6), the GC can save time and money.
6. *Serve as an effective project control tool*: Project control must have a solid and sound baseline with which current performance can be compared. Project control is achieved by comparing the actual schedule and budget with the baseline (as planned) schedule and budget (this subject is explained in Chapter 7).
7. *Evaluate the effect of changes*: **Change orders (CO)**[3] are usually inevitable, but well-planned projects may have few or minor ones. Change orders may come in the form of a directive, that is, an order to the contractor to make a change, or a request for evaluation before authorization. This change may be an addition, a deletion, or a substitution. Change orders may have an impact on the budget, schedule, or both. Cost estimators estimate the cost of change orders (including the impact on the overhead cost as a result of the schedule change), but schedulers calculate the impact of the change on the project schedule. It is the contractor's responsibility to inform the owner of such an impact on the budget or schedule and obtain the owner's approval.
8. *Prove delay claims*: Construction **delay claims** are common. Contractors must be able to accurately prove their claims against owners (or other parties) using project schedules. In most cases, only a **critical path method (CPM)** schedule can prove or disprove a delay claim, which can be a multimillion dollar one.

Project owners and developers need project scheduling to:

1. *Get an idea of a project's expected finish date*: Before an owner demands that the GC complete the project by a certain date, the owner needs to make sure that it is a feasible and reasonable date. This date is calculated by a CPM schedule, prepared by the owner or the designer, or a consultant hired by the owner. This date is also important to the owner, even before selecting a contractor, to conduct feasibility studies and financial planning.

[3] Also called *variation orders* in other countries, such as the United Kingdom.

2. *Ensure contractor's proper planning for timely finish*: Owners may demand a project schedule from the prospective or bidding contractor; however, it is very important for the owner to review such a schedule and make sure that it is reasonably accurate and realistic. The owner's approval of the contractor's prepared schedule may imply a liability on the owner's side.
3. *Predict and calculate the cash flow*: The owner is obligated to make timely progress payments to the contractor and other parties during the life of the project. Failure to do so not only may delay the project and/or incur additional cost but also may—at a certain point—be deemed a breach of contract.
4. *Serve as an effective project monitoring tool*: Both the owner and the contractor must monitor the progress of the work and compare the actual progress (schedule and cost) with the baseline (as-planned) schedule and budget. The contractor uses this process to detect and correct any deviations and also to prepare progress payments. The owner uses this process to verify the actual work progress and the contractor's payment requests.
5. *Evaluate the effect of changes*: Owners may desire or require change orders. In many instances, owners don't expect or fully appreciate the impact these change orders may have on the schedule and/or budget. It is wise for an owner to determine this impact before making a decision regarding a change order. It is also recommended that owners analyze the contractor's assessment of the change order to make sure that it is fair and reasonable.
6. *Verify delay claims*: Owners use CPM schedules to analyze, verify, and/or dispute contractors' delay claims. Although most delay claims are initiated by contractors against owners, it is possible to have an owner's claim initiated against the contractor and/or have other parties involved. In either case, a CPM schedule is vital for the owner to prove his or her case.

Other parties involved in the project may also need a CPM schedule, such as the designer, project management consultant, and financial (lending) institution.

The need for a CPM schedule varies with several factors. In general, it increases with the increase in size and complexity of the project. For example, a home builder who has built tens or hundreds of almost identical homes may not have a need for a CPM schedule as much as a high-rise building contractor does. Project control is still needed for all projects but may be conducted through simpler methods by the home builder.

THE SCHEDULER

Is the scheduler a civil engineer, an architect, a computer whiz, a mathematician, a project manager, an artist, or a communicator? In reality, the answer is a combination of all of these! Using computer software and other high-tech tools has been an increasing trend in all industries. Software packages include generic types, such as word

processors and spreadsheets, that everyone uses, as well as specialized types that require knowledge in both the software and the specific technical discipline. Scheduling is no exception to this rule.

Let us distinguish among three types of knowledge that a scheduler must have:

1. Knowledge of computer software (and perhaps hardware as well) in project scheduling specifically but also project management and other related (e.g., cost estimating) software
2. Knowledge of the principles and concepts of project scheduling and control (as part of project management)
3. Knowledge of the specific technical field, such as commercial building, industrial, transportation, and so forth

To efficiently operate a scheduling and control program, such as Oracle Primavera Project Manager (P6) (Oracle Primavera Systems, Inc., Bala Cynwyd, Pennsylvania), the scheduler must have the first two types of knowledge. The third type is a big plus. Just because an individual knows computers and can do "computer stuff" does not mean that he or she can operate a scheduling and project control program. Even if the individual can operate it, he or she may not understand its language and may have problems relating to and interpreting the technical information.

Currently, many high-tech innovations such as PCs/laptops, tablets, cell/mobile phones, digital cameras, and the Internet are available. They have become useful tools and an essential part of our daily life. Nevertheless, the human factor should never be underestimated. The combination of good tools and an educated and experienced operator is the only path to success in project management.

Certification

Several organizations now have a process and examination that lead to certification in project scheduling. The most prominent ones are:

- The AACE International's Planning & Scheduling Professional (PSP)
- The PMI's Scheduling Professional (PMI-SP)

Usually, an applicant for certification in project scheduling has to fulfill certain conditions:

1. Achieve minimum education requirements
2. Achieve minimum experience requirements
3. Pass the certification examination
4. Submit application and pay fees

Such certification is important in showing the qualifications of the scheduler, particularly to a potential employer. A certification from a reputable organization,

however, cannot alone guarantee good results. It just provides a minimum level of confidence in the qualifications of the person (usually the job applicant).

Unfortunately, the author knew people who carried the title "scheduler" but lacked the fundamental requirements for the position. In one incident, the author met a "scheduler" from a construction company who had no education or experience that was relevant to his job. He was chosen for that position because of his computer skills!

The Tripod of a Good Scheduling System

1. *The human factor*: A proficient scheduler or scheduling team that understands the concepts, definitions, and applications of project scheduling and control
2. *Technology*: A good scheduling computer system (software and hardware), along with capable IT support
3. *Management*: A dynamic, responsive, and supportive management team that believes in the use of scheduling as part of the management effort

If anyone of these three "legs" of the tripod is missing, the system will fail.

SCHEDULING AND PROJECT MANAGEMENT

Planning, scheduling, and project control are extremely important components of project management. However, project management includes other components, such as cost estimating and management, procurement, project/contract administration, quality management, safety management, HSE (health, safety, and the environment) management, among others. These components are all interrelated in different ways. The group of people representing all these disciplines is called the **project management team**. It is usually headed by the **project manager (PM)**. In Chapter 10, we discuss the relationships between scheduling and other project management components.

CHAPTER 1 EXERCISES

1. Define *project planning* and *scheduling*. Differentiate between the two terms.
2. Define *project*. What makes planning and scheduling construction projects different from general planning? (*Hint*: Think of the key words in the definition of *project*.)
3. Are the following projects? If no, make modifications that would qualify them as projects:
   a. Repair of a broken diesel generator
   b. Raising my two kids to be the best
   c. Cooking daily for my family
   d. Preparing for my son's wedding
   e. Investing in the stock market

f. Periodically backing up the data on my hard drive

g. Converting my garage to a play room

4. Define *portfolio* and *program* in the context of project management. Give examples of each.
5. What is a *project management plan*? Give an example.
6. What is *project control*? Why is it important?
7. Think of a construction project in which you participated or that you observed. Write down the steps involved in its planning and the steps involved in its scheduling (without much specificity).
8. List the benefits of CPM scheduling in construction projects from the contractor's perspective.
9. List the benefits of CPM scheduling in construction projects from the owner's perspective.
10. Do all construction projects have the same need for CPM scheduling? Why or why not? Give examples.
11. What characteristics must a scheduler of a building project have? Can the same person be a scheduler for an industrial project? Why or why not?
12. Meet with a project manager for a construction project. Ask whether he or she uses CPM scheduling. If so, discuss the benefits obtained from such scheduling. If not, politely ask why CPM scheduling is not being used.
13. Search for an article on a CPM scheduling topic (*ENR*, *Civil Engineering*, *PM Network*, and *Cost Engineering* are magazines that are good sources; avoid scholarly journals). Summarize and discuss the article.