Organization and Management of Capital Projects

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Introduction

The art and science of building for colleges and universities continues to be more demanding, and managing all of the inherent issues requires technical knowledge, management expertise, and political skill. Often, increased expectations have to be measured against conflicting interests and competition for resources. Design and construction costs have increased dramatically. Even so, operating costs over a facilities' life cycle add up to many times the initial cost. Competition for the best faculty and students has dramatically increased the requirements for more and better facilities. Technological advances, in both the design and construction phases, have provided new tools, but have also increased expectations for schedule reductions and increased efficiency. Management of cash flow has become an increasingly significant factor. Risk management and litigation are an integral part of the process.

Campuses provide some of our most beautiful and treasured built environments. The constraints imposed by limited land area and the need to preserve the distinct physical and cultural landscape of the traditional campus are difficult to resolve. Pressures to hire prestigious designers for master plans and campus buildings can frequently complicate the process. Debates involving campus interest groups, students, alumni, trustees, and administrators cover a gamut of issues, including preservation, architectural traditions, environmental concerns, security, and accessibility.

Trustees and administrators generally understand the importance of sound planning and high quality construction, and appreciate the associated challenges. And, while it is easy to recognize the need to hire a professional to manage these issues, finding a project manager who possesses the full range of skills necessary is a formidable task in itself. Few professionals are fully trained in these complex and interrelated issues; this chapter delineates some of these issues and provides some assistance.

Ways to Organize Project Oversight

Project management is a complex process that includes effective control of quality, budget, and schedule. The process encompasses a diverse set of tasks ranging from initial programming, budgeting, and schedule development to project commissioning, final closeout, occupancy, and beyond. The owner's project manager serves as agent and primary
representative, coordinating the project team and rendering decisions consistent with predetermined project objectives.

We tend to define the term *project manager* as a single person. In many large institutions, the project management process embodies several individuals and/or departments. This is certainly a logical approach, as the knowledge and skills required for the programming, design, and budgeting phases are different than those required in the construction phase. In these cases it is crucial that the management is carefully meshed so that all the dots between the initiation of a project and its completion are, in fact, connected; this is more easily said than done.

Where the project manager is placed in the owner's organizational structure plays an important role in determining both the focus and effectiveness of the manager. From a pure project management point of view, there are strong advantages to having one person continuously and solely in charge of a project from cradle to grave. This is typically not possible in large organizations where the quantity of work requires many people and managing the process frequently leads to several discrete or somewhat independent departments.

There are many organizational structures, each containing some inherent benefits and concerns. Below several basic approaches:

A. The Planning and Design Department: This department typically focuses on the program development, planning, and design aspects of the project. The project is then turned over to a capital projects construction office at the construction phase. Many of the issues faced directly by this office are discussed in detail in the Chapter on *Design Management*, which focuses on design issues.

B. The Capital Projects Construction Department: This department typically takes management responsibility for the project upon completion of construction documents and handles bidding, contractor selection, and construction coordination. The issues faced in this office and the various construction delivery methods are discussed in the Chapter on *Construction Management*, which focuses on construction issues and construction delivery methods.

C. The Physical Facilities and Maintenance Department: This department frequently has responsibility for the operation and maintenance of the physical facilities. In many smaller institutions, this department contains a division that deals with the responsibilities of A and B, above. The focus of these organizations tends to be on the operating and maintenance issues that drive the majority of their workload, sometimes at the expense of planning and design.
D. The Independent Planning Office: Because of the inherent problems in Organization C, an initial planning and design effort is done by a smaller group that reports directly to a president or provost, outside the business administration side of the university. This office can focus on the design issues, which may not be achievable in Organization C, but perhaps it loses some effectiveness as a result of being somewhat removed from the realities of day-to-day operations that prove to be so central to Organization C’s temperament.

E. The VP or Associate VP for all Physical Facility Matters: Organizations A, B, C, and D can be combined in almost any combination, and typically are the responsibility of the chief business officer of the university. Since business vice presidents are human, they sometimes tire of adjudicating the inevitable conflicts between organizations A, B, C, and D and so establish a super manager to coordinate all facilities efforts. This does not fundamentally change Organizations A, B, C, and D, but is intended to bring them all under the supervision of an individual who is both more familiar and more sympathetic with the complex issues involved than is the business officer.

The issue of how to organize these departments and the various pros and cons of each are well beyond the scope of this chapter, but we point out the different basic management approaches for two reasons. First, doing so vividly demonstrates the wide range of skills and areas of concern that are inherent in planning, designing, constructing, and maintaining facilities. A project manager does not need to be highly skilled in all areas; indeed, being overly skilled or concerned with one area may weaken his or her role as project manager if he or she tends to focus on design or technical issues rather than the whole. It is essential for the project manager to be aware of and sensitive to the broad range of concerns that have to be balanced.

A second reason to consider these organizational issues is that where and how a project manager fits into the overall organizational structure has a major impact on how effective he or she can be. The project manager’s concerns are going to be a reflection of the department out of which he or she operates. When projects are managed across departments, the transitions will focus on the responsibilities of each department. If those transitions are not carefully handled and each department does not truly understand and empathize with the other departments, the project will suffer.

Regardless of how it is organized, effective project management is crucial to the delivery of successful projects that fulfill the essential requirements
of the building program. Furthermore, effective project management enables project participants to contribute without being engulfed in constant crisis management—the nemesis of design professionals, owners, and facilities administrators.

**Characteristics of Project Managers**

A skilled project manager is required to manage all projects, regardless of size. However, the skills that a successful owner's project managers require are not always ingrained in professional designers. Most talented designers display little ability or interest in the business of project management; often the best technicians become project managers by virtue of their proven ability in a selected area of expertise. However, the best technicians may make the poorest project managers, as they have a tendency to focus on those technical aspects of a project that present the greatest interest to them. Appreciation for value of multi-dimensional consideration should trump the project manager's own strongest areas of expertise.

The most important characteristics of an effective project manager are a combination of education and experience. Project managers must possess strong organizational ability that will allow them to recognize and organize the disparate aspects of a project and to give structure to the project team, the process to be performed, and the many details that arise. They must value leadership and team building. The breadth of disciplines a project manager must deal with throughout the course of a project demands an individual who is experienced in handling a variety of unanticipated situations—a true generalist. An effective project manager must be able to examine and prioritize the broad scope of a user's needs without becoming handcuffed by details.

The value of strong communication skills to effective project management cannot be overemphasized. At various stages of programming and design, graphic communication is more important than verbal and traditional written communication. New forms of graphic communication, particularly those that communicate in 3D, can greatly enhance all parties' understanding of proposed conceptual and schematic design. During contract review and negotiation, skill in creating and editing written communication, with a healthy respect for detail, is invaluable. When assimilating project budgets and modeling cash flow projections, an ability to build clear and concise spreadsheets allows a project manager to communicate with university administrators and accountants responsible for funding and tracking project costs. During all interaction with facility users, the project manager must be a skilled verbal communicator. The
The most important aspect of this communication is the project manager’s ability to listen – he or she needs to be able to deduct priorities of need, sometimes based only on the context or inflection of a facility user’s request. The better the listening skills of an owner’s project manager, the greater the match between the programmatic needs of users and the final result in bricks and mortar.

The best project managers are also knowledgeable leaders with high ethical standards who have the confidence to delegate but understand that accountability cannot be delegated. They are decision managers who ensure that the right decisions are made by the proper persons, at the right time.

Recruiting an Effective Project Manager

Most of the qualities and characteristics of a successful project manager center on the ability to work effectively with people, rather than technical capabilities. Although they must possess basic technical skills, overemphasis on these will not necessarily result in a good project manager. Project managers are people managers; they must possess good interpersonal skills and know how to direct, motivate, and manage the project design team, users, contractors, and the campus and community constituencies with whom they interact. The skills of project managers reviewed above are not taught but are gained through experience. Although it is difficult to find someone with all the preferred attributes, qualified individuals may be recruited from local or regional design firms, industry, or the contracting community.

If an institution has a small staff or is just entering a period of major expansion, it is often wise to recruit one knowledgeable manager to be at the center of the program. This individual can provide invaluable assistance by establishing the project management system to be implemented, training younger or inexperienced staff members, and serving as a technical and managerial resource. Whatever the institution’s needs, the emphasis should be on finding a good manager with broad technical knowledge, not just a technical design expert.

Project Team: Roles and Responsibilities

Designing and constructing a capital project is a major task that requires the involvement of many different players. It is critical that the process be led effectively by all participants of each appropriate team. Chapters Design Management and Construction Management address design issues and construction delivery models. Regardless of the contractual
relationships, the three key participants who are responsible for all aspects of the project are the owner, the architect, and the contractor. (For discussion purposes, we will use those three terms exclusively though they may, depending on the type of project, be called something different; for example, depending on the type of project, the architect's role could be filled by an engineer, a planner, or a landscape architect, and the contractor's role could be filled by a construction manager.) The relationship of these three has been frequently described as a three-legged stool, with the metaphor clearly depicting the need for each of these individuals to fulfill their roles and effectively lead their respective organizations. An open and professional relationship among them is essential to take full advantage of their respective skills and obtain a successful outcome. The roles of each may be briefly described as follows:

- **The Owner:** The owner provides the program to be accommodated, establishes objectives, hires the architect and contractor, and provides the financial resources. The owner may sometimes provide additional consultants or expertise to help define and shape the building program. The owner often also needs services of other specialized consultants, such as geotechnical engineers and commissioning agents, to assist the design team and the contractor in formulating and verifying critical elements of a facility’s design or system operation. The owner is ultimately responsible for making decisions and ensuring that the architect and contractor are performing appropriately and efficiently. It is imperative that the owner have a clear line of authority, and it must be routed directly through the project manager. Few things are more detrimental to a project than confusion stemming from conflicting directives given to the architect or contractor. It is not unusual for such directives to come from someone more highly placed in the Institution—a dean, vice president, president. The project manager must be involved in all decisions and serve as a single line of communication for all owner directives and decisions.

- **The Architect:** The architectural or design team consists of the architect and a host of consultants dealing with building engineering—civil, structural, mechanical, communication, and electrical. In addition, he or she may be responsible for coordinating the efforts of specialized consultants who may deal with unique issues such as acoustics, lighting, display, conservation, and environmental aspects. The architectural firm is responsible for its own performance as well as that of its consultants. It is critical that the
individual leading the architect’s effort—usually called the project architect—serve as a single line of communication for his or her team.

- **The Contractor:** The contractor is responsible for all phases of the construction and bears the primary responsibility for all of the ways and means of construction, site safety, the performance of all subcontractors, maintaining the project schedule and budget, and tracking any changes that may require additional funding. The individual leading the contractors—typically the contractor’s project manager on large projects and sometimes the superintendent of smaller ones—should serve as a single line of communication for his or her team.

It should be noted here that the whole thrust of Integrated Project Delivery (IDP) is creating opportunities and alliances, and blurring disparities between designers and builders in ways that are unknown in traditional construction. Traditionally the actual builder, i.e. general contractor, was not even involved in projects until after award of a hard bid contact to the lowest bidder. Most knowledgeable owners have long since recognized the value of construction management and negotiating contracts with general contractors-at-risk. IDP elevates the early involvement of builders to a new level. In IDP, the owner and design team allow not only the general contractor but also key trade contractors to influence the design very early in the process. The goal, of course, is to save time and money by utilizing the scheduling and material procurement and assembly knowledge of these contractors before making design commitments that preempt it. Even so, the basic responsibilities of the three project entities iterated above remain as stated.

As noted above, other chapters deal with some of the intricacies of contractual relationships and the design process. What we wish to emphasize here, in the clearest way possible, is that the efforts of the three key team members must be led clearly and effectively by a single person. Of course, many others will contribute to and participate in the process, and sometimes decisions will be reached without all members present, but it is imperative that these three individuals communicate directly and continuously and lead their respective organizations effectively.

**Managing the Owner's Project**
Managing a major project is a daunting task. Starting with the earliest discussion of the program needs through ongoing occupancy, the project manager must deal with a diverse range of issues and a complex array of
processes. Planning, design, construction, and occupancy will involve a host of characters with differing objectives which must be reconciled—and when reconciliation is not possible, coordinated and resolved. A certain amount of frustration is inherent in the process. The process requires a person who can manage to see the forest while dealing directly and effectively with all the trees.

**Project Purpose and Developing a Building Program**

The initial project program defines what is required of the project in terms of meeting user needs, space requirements, building functions, systems, and desired features. The essence of good program is a statement of the raison d’etre of a project. The accuracy and credibility of the initial project program is essential, since this descriptive information forms the basis for activities to follow. These activities may include selling the need for the project to governing boards or legislative bodies, influencing the method of financing, and instructing the design team regarding the design intent of the facility. The initial project program takes shape early in the process and drives all other aspects of the project throughout its course. Without restricting necessary and sometimes far-reaching creative thinking, the project manager guides the process by providing realistic assessments of the developing program with respect to its ability to meet the documented needs.

One of the most difficult and challenging issues facing the project manager is helping to clarify and define the purpose of the project. It is also one of the most important issues, and one in which a truly effective project manager can help his or her institution to use its resources wisely.

Within educational institutions, there is a broad streak of democracy, and educators, though thoroughly knowledgeable in their respective disciplines, may have inaccurate or misguided views of their spatial needs. Providing a physical solution or granting a request for a specific space is not necessarily the best way to meet every need. Concepts of solving space requests by altering existing operations or sharing spaces are typically greeted with cries of horror. Typically academics are not responsible for funding their project and rarely have sufficient financial incentives to voluntarily pare back space requests. On the other hand, they are highly intelligent, generally rational, and can become open to suggestions about innovative ways to accommodate their fundamental purposes.

As in all human endeavors, sorting out what people want from what they truly need is difficult. Some universities have institutional planning and research offices that try to quantify needs for space. Frequently, the design team will include a programming expert or a consultant who specializes in
institutional analysis and space utilization. The architect and his or her consultants can be very effective at helping to balance academic wish lists—by thinking outside the box, referring to other successful efforts, applying some measurable standards, or referring to quantifiable benchmarks.

While this is one of the more subjective and challenging roles project managers play, they should fully engage in helping to define the fundamental purposes to be accommodated and arriving at a mutually beneficial building program.

**Adhering to Program and Controlling Scope**

As the design team begins to explore the project through the schematic and preliminary design phases, unforeseen or expanded program needs develop. This "program creep" creates pressure on both the project budget and the schedule. The project manager must avoid or appropriately respond to program creep or the resulting unintended, expanded program will make the project size, cost or schedule unfeasible.

The design team should compare the project program to the original intent at each review stage. The designer should deviate from the original program and budget only when authorized by the owner's project manager. The project manager should make sure the design team identifies the need for additional compensation at the time each program change occurs.

The project manager must also control the project scope. Many designers complain that their clients "nickel and dime" them to death with minor requests that accumulate or expand as the project progresses. The project manager must demand that the designer highlight any additional services as soon as they are requested, or at least at each project review stage. The designer deserves fair compensation for all work performed, and there is no reason unrecorded additional services should become an issue at the end of the project.

**Budget and Schedule**

Is it on time? Is it in budget? These two questions are probably asked by university business officers more often than all other questions combined, much to the chagrin of project managers who are laboring to build a university facility uniquely suited to its purpose and that will be an enduring treasure for the campus. However, they are indeed fundamental questions,
and questions generally thought to be completely objective. They comprise the most common complaints levied against architects and contractors.

They are also typical questions that prospective architects and contractors are asked in during interviews. Are your projects on time? Are they in budget? The answers are almost invariably yes and yes. (You very rarely hear a contractor say, "I may be slow, but I’m expensive.") So how do you reconcile the difference between these two worlds?

Well, first, you might say that almost every project is indeed on time and within budget—perhaps not close to the original budget and schedule, but fully meeting the final ones. After all, unless the contractor was fired, or just didn't finish at all, the project was completed within the schedule. The same holds for budget: The owner may have paid significantly more than anticipated, but unless the owner went bankrupt or sued, there was a final budget that paid all the bills.

Of course, that’s a glib and oversimplified analysis. But there is some underlying truth there: Which budget? Which schedule? The truth is, projects frequently get started with budgets and schedules that are simply unrealistic. The original budget is often based on a very preliminary program, using net square foot and gross square foot numbers that are not achievable for the desired program, or unit square foot prices that are inappropriate for the site or building configuration. The same occurs with the schedule.

The pressures on the project manager to produce a budget and schedule very early in the process are enormous. And once those are set—regardless of how many caveats and qualifiers are used—it is difficult to modify them. One of the primary causes underlying difficult or failed projects is the early establishment of project budgets that are too low.

**Establishing the Project Budget**

The establishment of a project budget is a major challenge. Everyone can agree on the importance of developing a budget that is realistic and appropriate, but exactly when that can best be accomplished is subject to debate. The project manager’s experience and comparisons of the project type with those of peer institutions can provide guidance. Yet every project has many particular factors, such as site conditions, utilities, institutional building standards, and phasing requirements, all of which significantly affect costs. It is impossible to identify all those factors, let alone provide meaningful costs for them, before some design work is undertaken. Yet, a preliminary budget is typically a requirement of getting an approval to even start any design process. Frequently, getting agreement on the proposed
Total project costs are more than just the construction cost. It is critical that the project manager identify the comprehensive costs for the project. Such costs include geotechnical analysis and engineering, architect and engineer fees, other consultants, furniture and owner provided equipment, material and building system testing, commissioning, moving expenses, insurance, internal institutional charges, and so forth. Major projects may include financing costs to cover cash flow. And it is critically important for there to be an owner’s contingency for unforeseen conditions that will be the owner’s responsibility. The earlier in the process a budget is formulated the less that is known about the project’s eventual scope and character. The less that is known about the eventual physical reality of a project, the greater the need for an owner’s contingency funds. Costs beyond the estimated cost of construction can add 20 to 30 percent or more to the total project cost. Institutions vary widely in how they budget for these additional project costs, so it is critical that the project manager establish a budget that addresses how all the costs are to be met.

Despite the difficulties, establishing an appropriate project budget is one of the most critical tasks of the project manager. It should be recognized that establishing and maintaining a project budget is a reiterative process, with a preliminary budget subject to continual review and analysis as the project moves through design and cost estimating. This is a part of the process that is difficult; the hierarchy of a university administration requires that budgets be established and maintained. Yet there is a reality to the process that must be faced. It is important for the project manager to establish a level of trust within the institution that can sustain this effort.

**Managing the Users’ Expectations**

Establishing and maintaining realistic user expectations is important. This task should be revisited as soon as the design firm has been selected and must be effectively managed throughout the course of the project. Establishing realistic expectations involves educating users so that they understand that the project will consist of a complex series of interrelated alternatives, choices, and trade-offs, and that the end result cannot be perfect. This somewhat negative disclosure must be presented in a positive and constructive manner to avoid alienating the users. One way to begin this is to explain that a project’s needs must be balanced and rebalanced with the project’s constraints. The owner’s project manager and the project architect should emphasize that their goal is to incorporate as
much of the users’ needs as the project’s site, budget, and schedule will allow.

At the initial design session the project manager, the users, and the design team should discuss and mutually agree on a list of expectations that will define a successful project. Before itemizing this list, the owner’s project manager should challenge the users to be completely candid about those things which are most important to them. Euphemistically, the project manager should state that, in order to have a successful project, “all sacred cows and all land mines” must be identified. Once the users and design team start to document expectations, the list should be phrased in a quantitative, not a qualitative manner. For example, a "highly flexible building design" is a qualitative objective, whereas "the ability to increase the amount of fume hoods by 20 percent without requiring modifications to the building mechanical system" is a quantitative objective. This technique allows the design team to comprehend what is needed and ensures that expectations are reasonable. The stated expectations should cover all important project elements, including budget, schedule, and design considerations.

Managing the users' expectations through the course of the project requires constant vigilance. Users might expect a "highly flexible" science building to be one in which space can be quickly converted from, for example, housing a physics laser experiment to housing a full chemistry research laboratory at little or no cost. The users must understand that "flexibility" has not only a significant first cost, but also an inevitable follow-up cost when the flexibility is actually utilized.

The users should be reminded that the budget affects the quality of the end product, and the quality of the end product affects the budget. An effective way to deal with these expectations is to provide a design basis document. This document is prepared by the design team and records the parameters under which the building was designed and within which it can be expected to function properly. Along with the building’s program, it forms the basis for informed decision making as the building is operated, maintained, and modified throughout its useful life.

Project Cost Control

The owner, architect, and contractor share responsibilities for controlling costs. Each must assume responsibility for costs directly under their management, but there are contractual relationships that will affect all the costs for all three which must be clearly communicated.
The architect’s cost may be based on a lump sum, a percentage of construction cost, or on an hourly basis. Standard American Institute of Architects (AIA) contracts require the identification of the consultants and specific tasks that fall under the architect’s basic services. The internal project design costs should be monitored by the designer to compare expenditures against the design fee budget. If the design firm cannot make a fair profit on the project, detrimental shortcuts may be employed to lessen the shortfall.

It is not unusual for an owner to press the architect for services that go beyond what the architect considers the basic services. The owner's project manager should stress at the outset that any request by any member of the project team that will result in fees for additional services must be approved in writing before that work is undertaken. It is not the owner’s responsibility to determine whether the architect is spending more time than allocated at any stage of the project. It is frequently the case that the architect has accommodated a host of incremental requests or services from the owner and the owner discovers after the fact that the architect has expended significantly more time than allotted. It is always difficult to assess these services after they have been performed; under certain circumstances the owner may elect to compensate the architect for such work. Standard AIA contracts include language that defines when an architect is entitled to charge for additional services, and architects frequently consider this to be sufficient authorization; however, architects are responsible for managing their own budget, and work should be explicitly approved before the architect undertakes work that he or she considers to be an additional service.

The owner or contractor can cause the architect to perform additional work for which he or she is legitimately entitled to more compensation. Delays in reaching or communicating decisions can add to the designer's time spent on any phase of the project. If a project must be put on hold, additional compensation may also be appropriate for stopping and remobilizing at some future date. Unreasonable requests from the contractor can include excessive requests for evaluations or information, repeated inspections, and resubmission of shop drawings, caused by work or materials that do not conform to contract documents, and can cause the architect to incur unanticipated expense. There are sections in standard AIA contracts to address these issues, but ultimately the process relies on open and ongoing communication between the owner, architect, and contractor to avoid "after the fact" expenses.

The contractor assumes responsibility for the construction budget. The
construction contract may take many forms: lump sum, cost of the work plus a fee, or construction manager with or without a guaranteed maximum price; alternative delivery methods are discussed in the chapter on Project Delivery. Regardless of the type of construction contract, the contractor must keep a running tabulation of the project budget that includes the original agreement amount, approved changes to date, and all pending changes. The owner should require a log that tracks all requests for information or evaluation of alternative prices with estimated cost impacts for any pending changes.

Change orders are anathema to most project managers. However, a certain amount of change is inevitable, and there are beneficial changes that can accommodate changed conditions or take advantage of unforeseen opportunities. Regardless of the reason, the owner’s project manager, architect, and contractor need to work together to make sure an orderly evaluation and tracking process is in place so that changes can be implemented in a timely and effective way.

The project manager must be fully informed of the budget for both the design and construction phases as well as all of the associated owner’s costs for which project funds will be expended. The project manager must clearly track all direct owner costs and the project contingency. There may be advantages for the owner to contract for some built-in items directly; these can include some built-in equipment such as carpeting building signage, audiovisual systems, and fixed seating. There are implications to these items, such as taxes, warranties, and responsibility for damages, that should be carefully analyzed before proceeding. The architect and contractor can be valuable allies in assessing the best way to deal with some of these items.

Establishing the Project Schedule

The project schedule is continuously influenced by changes in the project program, design or budget. Therefore, the owner’s project manager should develop an overall project schedule only after the project program and budget have been developed to a point where reasonable scheduling assumptions can be made.

Project Schedule Control

The project manager must track the project schedule at each project stage. The design firm’s schedule should provide for detailed planning of work activities and communicate critical dates and activities to the owner as well as the internal design team. The schedule becomes a useful method for
monitoring percentage of project completion, offers milestones for all involved, and can make meeting deadlines more readily attainable.

The design schedule is usually defined in terms of the design phases to be accomplished, such as conceptual design, schematics, design development, construction documents, and bidding. The information on the schedule will vary from a list of activities to be accomplished to specific time frames, sequences, and individuals responsible. Many computer scheduling programs are available, but care must be taken not to make the schedule overly complicated. The schedule is a communication tool that must be clearly presented and easily understood to achieve its primary purpose. Therefore, the scheduling method and detail level must be properly matched to the size and complexity of the project.

Many scheduling methods exist, and each has its advantages and disadvantages. One of the simplest methods is the milestone chart. In its most basic form, this method consists of identifying a target completion date for each activity or phase. For short projects with few participants, milestone charts work well.

The Gantt chart (or bar chart) offers a slightly more complex scheduling method and overcomes some of the drawbacks of the milestone chart. The Gantt chart, a widely used scheduling tool among design professionals, presents a list of tasks along the left side of the chart with horizontal bars indicating scheduled start and finish dates for each task. However, bar charts do not differentiate the importance of one task over another or indicate the interrelationship among various tasks or which activities are crucial for completing the entire project on schedule. Even so, bar charts remain an effective scheduling method for projects of medium complexity.

For large, complex projects, the critical path method may be used. This method is a form of network scheduling. It is a highly mathematical system in which task interrelationships are defined, durations assigned, and task schedules analyzed. The system calculates the earliest and latest time an event can take place without affecting the completion of the project. This difference between the earliest and latest time an event can occur is called \textit{slack time or float}. The critical path is the series of activities and events that have no slack time. The time required for noncritical tasks becomes irrelevant from the standpoint of total project time. Therefore, only by shortening the time for a task on the critical path can the overall project time be reduced.

None of the available scheduling methods is a panacea. The owner’s project manager should make it the design firm’s responsibility to
present the updated project schedule at each project design meeting and to recommend necessary adjustments to keep the project on track.

**Contract Management**

*Design Team Selection*

The owner’s project manager should be responsible for coordinating the selection of the project’s design consultant. (“Design consultant” refers here to the architect of record and its consulting building engineers.) These duties include developing a list of qualified firms to be considered, coordinating building selection committee meetings, coordinating communications with consultants throughout the interview process, and providing committee members with inside information about potential consultants. This role of providing information about firms can significantly influence the selection process in a positive way and is advised when there is a lay selection committee.

**Scope of Services and Fee Negotiation**

Another important project management responsibility is preparing the proposed scope of services and negotiating an appropriate fee for the delivery of those services. The proposed scope defines what design services are necessary to achieve the project program and is used as the basis for negotiating the contractual scope and professional services fee.

An excellent method for determining the required scope of services is to analyze the activities needed to complete the project. Working from a detailed list of standard and additional project services will help ensure that a comprehensive proposed scope of services is developed. This goes hand in hand with preparation of the contract, and it is critical that this be considered an important way to clearly communicate between the project manager and the architect. Contracts have evolved to contain a lot of ‘legalese’ which can be intimidating. It is tempting to refer that to the owner’s legal counsel to sort out. But the project manager should use it as a tool to clarify the services that will be required and how they will be provided.

A good example of that is included in AIA Document B101, Standard Form of Agreement Between Owner and Architect. Article 4 of this document provides a matrix of a broad list of services, and a methodology to enumerate which are to be provided, who will provide them, and whether those services are to be provided as part of the architect’s base contract or as additional services.
The developed list of activities can be reviewed and a determination made as to services for which the design firm will be responsible and any services that may be performed more efficiently by in-house personnel. However, caution should be exercised if in-house personnel are to be used. Because of project complexities, schedules, and in-house workloads, staff may not respond in a timely manner to project issues, and apparent efficiencies gained by using in-house staff may evaporate and result in a contract or schedule dispute.

For large scale projects, prior to final interviews and selection of the project’s architect (i.e. design consultant), the owner’s project manager should issue a Request for Proposal (RFP) to the finalists being considered for selection. Ideally, the list of finalists should include three or four firms carefully selected for their match with the particular project under consideration. The owner’s RFP should include (1) a written program statement, (2) an estimate of area with a RANGE of probable construction cost, and (3) a copy of the owner’s standard contract for architectural design services. The RFP should not ask for an exact statement of the architect’s proposed fee; however, requiring an estimate of probable design cost for basic services is appropriate. An estimate of the architect’s fee, based on a range of probable construction cost, should provide the owner with adequate information for a meaningful comparison of probable design costs. Note that the owner will only be comparing estimates, not bids, and these estimates will necessarily be based on the owner’s own estimate of a range of construction costs. Such a comparison should not override more important considerations of designers’ qualifications. The Brooks Act, a U.S. federal law enacted in 1972, requires the U.S. government to select architecture and engineering firms based on competency, qualifications, and experience rather than design cost. Some public institutions may be unwilling or unable to request an estimate of design cost prior to final selection. In any case, the highest priority of the selection process should be to select the most qualified design consultant for the specific capital project under consideration. The value of requesting an estimate of design cost lies mainly in broadening the owner’s and the designers’ understanding of their respective financial expectations prior to final interviews and selection.

The delivery of the best possible final product will depend heavily on the services provided throughout the course of the project and the appropriateness of the fee paid for those services. Therefore, even if a project is managed by a state agency, the project manager representing the institution should influence the scope of services as well as the design
Staff from state agencies may not be sensitive to institution issues and complexities, and the institutional representative will have to ensure that all issues are appropriately addressed. Areas that are sometimes targets for fee reductions include predesign and site analysis services, design team travel, value engineering, building commissioning, and site inspection visits. However, these services are essential for a successful project and should be included in the project scope.

**Design Errors**

There are several types of design errors. Simple mistakes are confined to a single building element, ambiguities in the contract documents, and details that are unworkable. By definition, simple errors can be corrected relatively easily with little or no cost to the owner, architect, or contractor. Major errors are of significant financial magnitude, such as failure of a building’s exterior masonry envelope owing to incorrectly specified expansion joints mortar mix. Major errors can take years to manifest and are very costly to rectify. The owner’s project manager can best protect the owner’s interests by verifying in the interview stage and confirming throughout the project that the design firm employs a systematic and thorough approach to quality control and coordination among disciplines. By the time design errors become apparent in the course of construction, it may well be too late to avoid a lengthy and costly solution.

The design profession is presently undergoing its most significant transformation in decades. The use of Building Information Modeling (BIM) has changed how buildings are designed and built in ways that are even more profound than CAD. The advantages of BIM are enormous. A list and examination of these advantages are beyond the scope of this document, but they should be understood by anyone undertaking a large scale capital project. Two advantages are addressed here, as each relates so directly to minimizing errors in design. The early and continuous communication of design ideas in three dimensions is an advantage that can significantly enhance the owner’s, engineers’, and contractors’ understanding of what is being proposed. During later stages of design, using software to highlight conflicts within design documents, i.e. conflict resolution, can significantly increase coordination among all disciplines, particularly architectural, structural and mechanical. Unfortunately, both the development path and the learning curve of much of the software that makes BIM possible are long and steep. Utilizing this software can lead to new types of conflicts and omissions, i.e. design errors, which sometimes are without precedent. Owner’s project managers using BIM should stress the importance of
sharing the building model often among all disciplines; moreover, they should require contractors to understand and participate in conflict resolution.

Another type of design “error” occurs when final contract documents conflict with owner expectations with respect to material or system selection and performance. These errors can be minimized or eliminated by the owner’s publishing a clear and concise set of architectural and engineering guidelines, also commonly known as Design Standards. Such guidelines should set forth what elements are essential to making a new or newly renovated building match the owner’s requirements. The guidelines should be as brief as possible and include only requirements which have proven to add value, not recipes for making some department’s ongoing operations simpler. The guidelines should be rigorously reviewed and revised annually or at least biannually.

**Disputes**

Contract disputes should be prevented if at all possible. Open communication with all parties is the best way to prevent disputes. If a dispute does occur, it should be approached with honesty, integrity, and an earnest desire for settlement.

Owner-architect disputes can arise during the design phase as a result of ineffective management of the program, change in scope of services, project schedule, project budget, or user's expectations. Complaints during construction may be the result of inadequate contract administration, including construction observation and verification. A clear, thorough, well-managed design contract that specifies a full range of services will help prevent conflict.

**Project Review and Approval**

Formal project design reviews should be established and delineated on the project schedule. These formal reviews should be required before proceeding to the next design phase. The number and timing of the reviews will be determined by the size and scope of the project. A small project may require review only at the end of preliminary design and at the completion of construction documents, whereas a large project may require extensive review at the completion of three of four phases of design.

It is the project manager's responsibility to ensure that the appropriate participants take an active role in each review. The list of appropriate
participants may vary as the project progresses and may include user
group representatives, facilities planning and management personnel,
project planning committee members, and architectural or engineering
personnel from a state agency. In some instances, it may be
advantageous to include local building, zoning, health, fire, or historic
preservation officials in some aspect of the review process.

The specific method of review may vary by project, by phase, or in
accordance with the time available. To save time, documents should be
provided to each participant for simultaneous review. One often successful
review technique involves a collaborative review by all members of the
project team at the design firm’s offices. This method allows the owner's
review representatives to complete their review without the normal
workday interruptions, in a location where the design team has immediate
access to all of the project data. This process is also conducive to
addressing problems that may arise. However the review is accomplished,
all pertinent comments should be meticulously compiled onto two record
sets of documents: one for the design team and one for the owner.

For large projects, the services of an independent review consultant may
be beneficial. Consultants specializing in independent contract document
review can provide a valuable second opinion relative to code compliance,
constructability, coordination among contract documents, and legal pitfalls
contained in specifications. Similarly, when contract documents are
nearing completion, some municipal building code authorities may provide
a helpful preliminary plan check for a fee.

Each formal design review should include several areas of focus. The
project should be examined for compliance with the required program and
space utilization guidelines. It should be reviewed for technical correctness
in all areas, including architectural, structural, civil, mechanical, plumbing,
electrical, and code compliance areas. Review for compliance with
established in-house architectural and engineering guidelines,
environmental regulations, zoning requirements, Americans with
Disabilities Act requirements, and even reprographics standards should
also be performed.

It should be noted that utilizing BIM necessarily compresses traditional
phases of design. BIM predisposes the design team and owner to earlier
commitment to design iteration. These early commitments must be subject
to project review and approval prior to the design team believing it has
completed one or more portions of final contract documents. When
preparing BIM documentation, members of the design team must
understand that even though the level of information of a given portion of
design documents may match that of final documents, the design itself is still subject to project review and approval by appropriate parties.

The project review should always include a review of the updated project schedule and projected construction cost. If the design team is being used to help monitor the overall project budget, then the budget should also be examined. Any cost or schedule discrepancies must be addressed, and any change in scope of services should be reviewed.

The final project review must also include an assurance from the design team that the projected construction cost is expected to be within the budget. It may be appropriate to introduce alternates in the bidding process to ensure that the base project is within budget. Care and discipline should be exercised when selecting alternates. The fewer the alternates the better, as an extensive list complicates the bidding and contract award process.

Concise alternates are an effective budget protecting tool. They may be deductive or additive. Additive alternates are usually preferred, as contractors may limit their overhead and profit charged, whereas contractors rarely give overhead and profit credit on deductive alternates. It is also important not to mix additive and deductive alternates in one bid package. Contract awards containing mixed alternates can become very complicated.

The acceptance of alternates out of order can make contract award difficult, particularly if the selection of alternates changes the successful bidder. Therefore, it is recommended that alternates be prioritized before bidding and accepted in the order listed.

Project Management Responsibilities During Construction

Maintaining Continuity

The owner's project manager provides continuity from the design phase into the construction phase. Project managers can help ensure that the original project intent is enforced if they are involved during the project construction. Without their project knowledge, seemingly innocuous decisions made during construction can drastically change the long-term functionality of the facility. Even though actual daily onsite inspection responsibilities may be delegated to another individual, the project manager either should be directly involved in overseeing project construction or should at least review all project changes. In this capacity, the project manager should also protect the users' expectations by explaining the construction process and updating the project progress to the users.
Partnering is a structured process that focuses on developing a team of stakeholders united by a common mission and project objectives. The partnering process is designed to assist all parties in preventing disputes and instilling a spirit of cooperation among the owner, consultant, contractor, and subcontractors. Readers interested in knowing more about partnering are referred to the chapter Project Delivery.

**Construction Change Orders**

Projects are rarely completed without the necessity of making significant changes during the course of construction. It is the project manager's responsibility to review all change order requests to determine their validity, and possible impact on budget, schedule, and the final product. In reviewing the change order request, the project manager should consider the information provided by the contractor and the interpretation and judgment of the design firm. The project manager is the owner's representative and should have the authority to approve or deny a change request.

The project manager must maintain an accurate list of the status of all change requests in progress and must not allow any requests to languish. Most standard contract forms require the contractor to obtain an approved change order prior to executing any change in the work. However, many times the change must occur when the need for the change is discovered to avoid further impacts on the project schedule or budget. Therefore, the final approval of many change orders actually follows the completion of the work described in the change order. Such after-the-fact dealings unfairly increase the owner's leverage in negotiating the cost of a change. Therefore, it is the project manager's responsibility to maintain the integrity of the owner-contractor relationship by ensuring the timely and fair resolution of all change requests. It's worth noting that an owner who takes advantage of timing in order to negotiate an unfair price is providing incentive for the contractor to either extend the schedule or find ways to inflate the cost of the next construction change order.

**Reporting, Documentation, and Communication**

Many project management activities that occur during construction contract administration require detailed procedures that outline the steps to be followed and document routing and approval methods. To avoid costly oversights, standard documents and checklists should be consolidated into a construction procedures manual. Typical items and forms covered in the manual should include the following:
Advertisements for bids
 Builders or plans exchange list
 Pre-bid conference agenda
 Addenda
 Bid opening procedure
 Notice to proceed
 Notice of return of bid bond
 Contract award letter
 Pre-construction conference agenda
 Applications for building and zoning permits
 Notifications to local utilities
 Building Systems Commissioning -- schedule of pre-function and performance tests
 Field reports
 Field directives
 Change order status sheet
 Shop drawing review schedule and status sheet
 Schedule and delegation of responsibility for mockup fabrication and review
 Application and certification for payment
 Closeout punch list form
 Substantial completion form

The form and content of many of these documents may be dictated by state laws or the administrative procedures of a state architecture and engineering agency. However, if latitude exists, these contracts should be based on standard forms provided by organizations such as the AIA or the National Society for Professional Engineers.

Accounting for capital projects presents unique challenges. Because contracts are written that cover long time spans and have multiple invoices, the university’s basic accounting system, which deals with purchase orders, will not work well for the complex records required. The complexity of the accounting records that a project manager must track is daunting, including construction and designer contracts, change orders, additional services, an array of consultants, internal operational expenses, and furniture and equipment purchases.

University accounting systems typically include capital accounting modules, which may allow for the variety of contracting and invoicing procedures that will be required; however, these rarely track all the detailed accounting information the owner’s project manager must maintain. Because of the complexity of the records, it is typical for project managers
to keep their own financial records, which supplement the university accounting system. Software utilized by owners’ project managers must track not only existing encumbrances (signed contracts, purchase orders, work orders, etc.), but also pending change orders and cash flow forecasts. It is imperative that the project manager thoroughly understand how all financial records are to be maintained and review the procedures with the appropriate accounting, purchasing, and internal control departments.

Project Management Alternatives

*The In-House Project Manager*

As evidenced by the previously enumerated responsibilities of the owner's project manager, it is not possible to completely delegate the ultimate authority for the project budget, schedule, and functional design requirements to an outside source. Even if such an attempt is made, the residual right to override decisions made by the contracted project manager remains with the institution, or owner, resulting in the awkward situation of delegating responsibilities but not the corresponding authority. Any significant imbalance in the responsibility/authority equation will seriously impair decision-making ability. Therefore, the owner must exercise some level of project management responsibility for every project.

*Contracting Owner's Project Management Services*

The goal of contracting project management services is to enhance the owner's success by securing knowledgeable and proactive management of the project. Contracting for project management is usually considered when the owner does not have the staff or expertise to manage the project.

Many architectural design firms profess to offer full project management services. These services may include the following:

- Project overview management
- Budget and cost control
- Schedule control
- Site evaluation and selection
- Utility and permit coordination
- Coordination of multiple architects/engineers and contractors
- Value engineering analysis
- Construction delivery process evaluation
- Contractor bidding, negotiation, and selection
• Problem identification, analysis, and resolution
• Building diagnostics
• Acquisition and management of supplemental services
• Monitoring unit cost contracts
• Partnering development and training
• Dispute resolution
• Occupancy planning and logistics
• Commissioning

When parties are contracting for project management services, the project management responsibilities, expectations, and limits of authority should be clearly defined and understood by both parties. The owner usually expects one individual from the contracted firm to remain with the project on a daily basis through completion of construction and final occupancy. However, it is not unusual for the project manager to change between design and construction.

Many third-party professional consultants also provide contracted project management services. These consultants may present the advantage of working directly for the owner in a manner that facilitates the traditional owner-architect relationship. A third-party consultant is removed from the architect-contractor relationship and is free to provide an independent assessment of all aspects of the project in a fashion similar to the in-house project manager.

*Project Management by State Agencies*

Some institutions must rely on a state architect/engineer (A/E) agency to provide project management services. These relationships and division of responsibilities may vary from one state to another. Some states encourage collaboration between the institution's planning department and agency personnel, whereas in other states, A/E agencies have complete autonomy in the execution of their duties.

State agencies that manage college and university design and construction also manage many other state facilities' projects. Therefore, to protect an institution's interest, the institution's project manager should be involved in the process and provide pertinent, practical, and timely information to the state agency.

There are advantages and disadvantages to direct management of design and construction at the institutional level. Direct responsibility allows the institution to expedite the project, to work more closely with the design consultants and the contractor, and to control the funds locally. However, the institution must also accept the risks inherent in any construction
These may include defense against lawsuits, complete financial responsibility for judgments against the institution, and construction claims and liabilities. In addition, delegated authority does not relieve the institution from complying with all state laws.

**Learning More About Project Management**

Project management is an evolving discipline. Architectural and engineering professions have only relatively recently begun to incorporate project management principles and techniques. However, several organizations and publications focus on the field of project management; some of these are listed in the References at the end of this chapter.

The Professional Services Management Association is a growing organization of design professionals whose interests lie in project management. The Project Management Institute is a general-purpose organization with members representing industry, government, and larger engineering and construction firms. Both organizations hold annual conferences, publish newsletters, and sponsor regional seminars. The AIA has published a series of three books, titled *Managing Architectural Projects*, directed toward the architectural consultant. These books contain helpful information relating to establishing effective project management practices. The AIA also offers professional development programs on project management, including seminars, short courses, and correspondence courses.

**References**


The following websites provide information on BIM and other evolving trends and technology that impact project management:

http://www.iu.edu/~vpcpf/consultant-contractor/standards/bim-standards.sht

http://bim.psu.edu/Project/resources/default.aspx