

MANAGING CONSTRUCTION RISKS

By Ossama A. Abdou¹

ABSTRACT: Construction is a process governed by complicated contracts and involving complex relationships in several tiers, and there are many risks involved in construction projects. Generally, there are three kinds of construction risks. They relate to construction finance, construction time, and design. The present paper addresses these risks in detail in light of the different contractual relationships existing among the functional entities involved in the design, development, and construction of a project, and identifies the proper steps to be taken in the analysis and management of construction risks. Surprisingly, although there are individual contracts between the owner and the contractor and between the architect/engineer and the owner, there exists virtually no official contractual relationship between the architect/engineer and the contractor. Examination of such relationships, or lack thereof, reveals that responsibility is not equally shared among all entities involved in building design and construction. Moreover, the present paper identifies the various entities involved in risk generation and management, and proposes strategies that can curb such risks at different construction phases.

INTRODUCTION

Construction is a process governed by complicated contracts and involving complex relationships in several tiers. In a general sense, there are three functional entities involved in the design, development, and construction of a project, all of which combined make up the construction team. First, there must be an owner/client with specific needs and the resources to meet those needs. Second, a designer is required who can articulate those needs in a technically competent way within the limitation of the client's resources. And third, there must be a constructor to articulate a project strategy with respect to time and cost and to manage the construction endeavor through to its successful completion. A good working relationship—including efficient communications—between these three functional entities is essential to a well executed project. In large-scale projects, an additional entity is usually involved, namely, a materials engineering laboratory, whose primary services consist of materials inspection and testing for the project. Fig. 1 delineates the relationship, i.e., the communication lines existing among all four entities during the construction phase of a project. Although there are individual contracts between the owner and the contractor and between the architect/engineer (A/E) as well as the materials engineering laboratory and the owner, there exists no contractual relationship between the A/E and the contractor. Moreover, no contractual relationship exists between the contractor and the materials engineering laboratory, although there exists quite an interaction between both entities.

Fig. 2 illustrates the contractual relationships among the identified entities of the construction team. The A/E is usually identified as the review and approval entity. The operational relationship among these entities can be illustrated as shown in Fig. 3. Examination of the contractual relationship clearly shows that responsibility is shared (not necessarily equally) by the contractor, the architect, and also the owner who remains the eventual recipient of disputes and claims. The operational relationship may show a linear relationship, but it does not identify the architect as the responsible entity. The illustration simply demonstrates the architect's role as a reviewing conduit for contract information, interpreter of design questions, and arbitrator of possible disputes.

¹Asst. Prof., Dept. of Civ. and Arch. Engrg., Drexel Univ., Philadelphia, PA 19104.

Note. Discussion open until August 1, 1996. To extend the closing date one month, a written request must be filed with the ASCE Manager of Journals. The manuscript for this paper was submitted for review and possible publication on May 18, 1995. This paper is part of the *Journal of Architectural Engineering*, Vol. 2, No. 1, March, 1996. ©ASCE, ISSN 1076-0431/96/0001-0003-0010/\$4.00 + \$.50 per page. Paper No. 10800.

In reality, the client is buying a service, not a product. At one relationship level, the contractor performs an essential service by directing and coordinating the work of a multitude of subcontractors, suppliers, craftsmen, and laborers. At a different level, the contractor or the architect must also coordinate the builder's services with those of the architects, engineers, and various consultants. Finally, someone must take control of the entire process and coordinate the coordinators. At this level, the chief executive officer (CEO) and the board of directors of the client company will either manage the project and its risks or let the risks manage them. There is no substitute for responsibility at the top.

All in all, the risks involved in a construction project are as great as any company normally faces, and these risks are different in nature from the kind companies are used to. Yet, many corporate officers and directors who constantly analyze and manage every other controllable risk fail to use all the tools available to control construction risk. One reason they overlook or underestimate construction risk—and delegate it to subordinates to handle—is that construction is considered old technology. Buildings have been built before—so what's so different about this one? It, therefore, seems foolish not to delegate a procedure that has been repeated so many times throughout history. In addition, it seems, most companies do not go through the building process frequently enough to warrant such a management effort.

It takes an exceptional manager to get beyond the first few summary numbers to understand what services a prospective contractor is really proposing; it is the unusual purchasing agent who can oversee completion of a product containing tens of thousands of parts delivered over a period of up to several years; and facility managers, who most certainly share a vocabulary with the contractor, seldom have the expertise to defend their employers against contractors' claims. Construction skills are simply not part of a normal manager's repertoire.

ANALYSIS OF CONSTRUCTION RISKS

There are a number of steps in the analysis and management of construction risk. These are identified and elaborated on as follows:

1. Understanding the types and phases of risk
2. Assessing the risks of a particular construction project
3. Matching risks with in-house capabilities and building a construction team
4. Defining a building strategy
5. Understanding the bidding process
6. Selecting the right kind of construction contract
7. Selecting the contractor
8. Monitoring construction

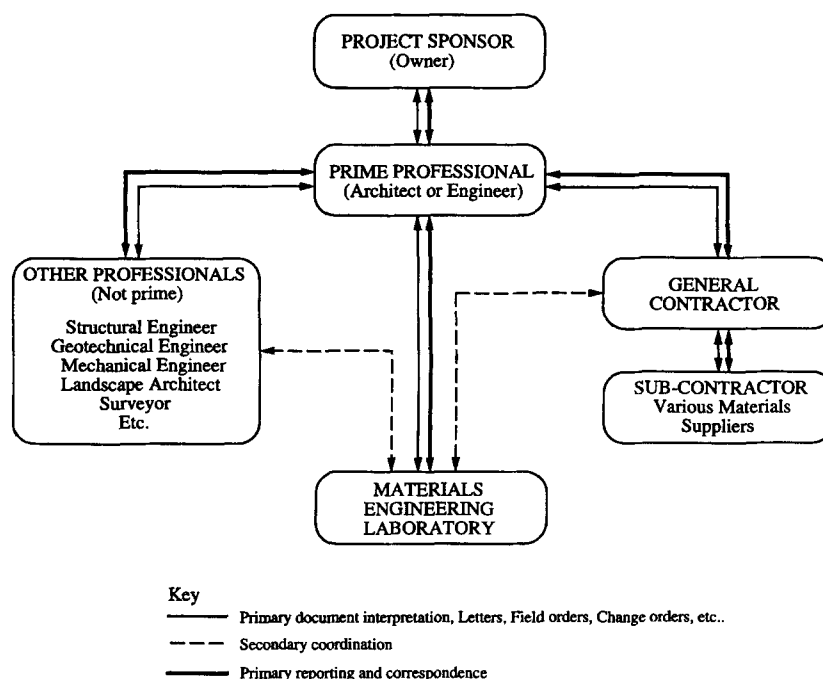


FIG. 1. Communication Lines during Construction Phase

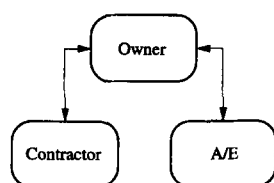


FIG. 2. Contractual Relationship

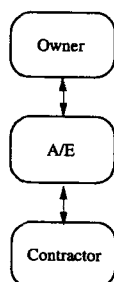


FIG. 3. Operational Relationship

Understanding Types and Phases of Risk

Generally, there are three kinds of construction risks, and they surface in two phases. The first kind of risk is financial; the project exceeds its budget and endangers the financial health of the company. Budget overruns are not always a matter of poor construction supervision. They are often the result of bad planning, wishful pricing, or poor coordination among design professionals and/or construction trades.

The second type of risk has to do with time; the building is finished behind schedule. Apart from image problems, delays can have devastating financial consequences. Can one imagine how much a retail outlet would suffer if its space is ready two months after its scheduled opening time? Or, how will an organization function if the computer room is not ready because no one was ever assigned responsibility for ensuring uninterrupted power? What is the toll in a business if the chief financial official (CFO) has to spend several weeks in a construction arbitration case? Cost and time risks can also be closely interrelated. Cost may increase during the design-and-

permit stage even before the contract is awarded, simply due to inflation.

The third type of risk in construction is design-related; the completed building does not meet the organization's needs. For example, a certain organization with a fixed budget might elect to build a small addition with above-average finishwork and systems, only to discover on design completion that it doesn't really have enough space. (Perhaps it should have built a larger but plainer facility for the same money at the outset.) Or, an office developer might pick an air-conditioning system that allows individual control for each office but turns out to be too noisy. In some instances, the design-related risk is not attributed to the design team, but rather to building officials. For example, the construction of a mortuary is halted or completely scrapped because officials of the health department decide that there is not adequate water supply for the facility.

All three kinds of risk can be addressed in both the preconstruction phase and the construction and settlement phase. The former is often the most grueling for the owner and often the most important. The organization must now make projections about marketing, budget, space, and schedule, and make actual decisions about design, zoning requirements, financing, traffic, and other environmental concerns. The risks in this phase are small in a sense, simply because no one is actually building anything. However, the risks are large in a different sense. For one, consultants are expensive, and, since the construction loan is not yet in place, the company has to pay them out-of-pocket with highly speculative money. Also, a planning mistake or a piece of budgetary wishful thinking at this moment can cause big problems later on.

There is a great deal of uncertainty and ambiguity in the preconstruction phase because the time-design-cost equation is constantly changing. A lot of hands-on specialists deal poorly with this lack of definition, and a poorly managed team can degenerate into chaos if the participants are allowed to hide behind their disciplines and stonewall or ignore each other.

The design-cost picture that emerges from this phase is the foundation on which great construction-period risk will rest; yet the work done now is the most manageable of the whole. Market and financial risks are external and, to a large extent, uncontrollable. Preconstruction risk, on the other hand, is internal to the team and can be controlled. The key to success

in this phase is picking the right team, then providing coordination and central direction. Good use of the architect's and contractor's expertise at this juncture can save lots of problems later on.

In the construction and settlement phase, the risk factors move from planning to supervision. The design is mostly fixed; time risk no longer depends on creating a realistic schedule but on sticking to it; budgetary risk is no longer a matter of pricing but that of cost control. Depending on the contract, cost control is now mostly or entirely the contractor's responsibility provided there are no problems related to design, such as code conformity, or revisions and change orders, or site problems. If the contract specifies liquidated damages for late delivery, then schedule is the contractor's responsibility, too, although most contracts allow several cost and schedule exceptions. Moreover, a construction loan is now in place, so the bank reimburses the contractor directly for construction costs—usually on a monthly basis, always after carefully checking that the work has actually been done and the materials actually delivered, and almost always after holding back 5% to 10% of the total as a kind of performance guarantee until the entire project is complete and final settlement takes place. For an additional cost (approximately 2% of the contract price), the owner may require from the contractor performance and payment bonds to reduce his financial risk.

Assessing Risks of Particular Construction Project

No two projects, no two sites, and no two construction teams are ever exactly the same. In order to pick the right team members, the right group of consultants, the right architect, the right contractor, and the right kind of contract, one needs to understand the risks of the particular project at hand. The crucial consideration is project complexity.

Many questions arise: What are the company's needs for the project? Is there a rush for occupancy? Is there enough time to develop plans and specifications before the project is out for bid, or will document preparation time overlap with start of construction? Are the mechanical systems routine, or will the contractor need to coordinate their design as well as installation? Is the quality of construction critical, or is only a simple shelter needed? What about project financing? Some lenders will not make a commitment until they have seen the contracts and all of the completed drawings.

What about the site? There is a tremendous difference between building on a piece of well-drained farmland and building on a site in the central business district with an uncertain history and unknown conditions. Hazardous waste and the remains of old foundations are only two of the invisible surprises that are entirely the owner's responsibility in most construction contracts.

What about the physical nature of the project? A new building will most likely have many more components than an old one will, but a rehabilitation project will mean more unknowns and greater risks. Evaluating the risk is the first step to controlling it. The following outline lists key risk elements that can be identified in terms of both process and product.

Risk Elements

Process

Financing

- Preconstruction sources
- Permanent financing
- Lender requirements

Time

- Preconstruction time allowed

- Construction pace

Architecture

- Project complexity
- Focus of designer
- Plan completeness
- Compensation to architect

Owner's Decision Structure

- Single person
- Committee
- User input

Need for Cooperative Input

- Rethinking of design option
- Relative number unknowns
- Need for budgeting expertise

Approvals

- Codes and regulations
- Politics

Product

Site

- Maneuvering room
- Neighbors
- Soils
- Traffic
- Previous uses

Foundation

- Excavation
- Technology

Structure

- Design
- Materials

Exterior

- Design
- Materials
- Dimensional tolerance

Mechanical & Electrical

- Heating/cooling plant
- Distribution
- Communications

Finishes

- Complexity
- Materials
- On-site craftsmanship
- Sourcing

End Uses

- Flexibility intended
- Impact on business

Special Situations

- Rehabilitation
- Renovation while space in use

Matching Risks with Capabilities and Building a Construction Team

Once the risks of a project have been estimated, the next step is to assess the organization's capabilities. Building the construction team involves a series of classic make-or-buy decisions: What is needed? Can it be provided in-house? Should

it be bought from outside? To make an assessment of how much outside help an organization will need to get its building built, is dependent on the organization's staff talents. Basically, more in-house talent means less risk. Some of the common assessment criteria of how capable a certain organization is in managing its construction project are delineated below:

- Budgeting talent
- Design talent
- Team-building talent
- Construction-monitoring talent
- Fund resources
- Conflict assessment/management

In order to reduce construction risk at the various phases of a project, it is extremely important to understand the nature of the design process and the role each design professional and consultant is playing. For the purposes of controlling risk, however, the principal players are the organization's own board of directors, CEO and senior staff, one or more of whom will actually oversee the entire project.

The charts referred to previously have a number of important implications. First, they provide a methodology by which the various individual elements of risk can be identified and addressed. Second, they define a strategy for the selection of a contractor and consultants. For example, a concentration of high-risk components may suggest a search for the performance benefits of cooperation and an attempt to find a contractor able to work as a team player. Predominantly low-risk components point instead to the price benefits of competition. Both kinds of contractors are readily available virtually everywhere.

Defining Building Strategy

The construction industry is highly fragmented and, compared to other industries, rather unsophisticated. Company strategies are often more intuitive than deliberate. Construction companies lie somewhere on the spectrum between low-cost product providers at one end of the scale and highly differentiated service providers at the other. The challenge for clients is to identify the objective of each project and to pick the right fit.

If a project consists of a simple, one-story building on a flat piece of land, a low-cost provider is probably appropriate. The builder will not add much value beyond getting the material to the site and erecting it. If, on the other hand, the project is a complicated, fast-paced rehab, the noncraft services offered by a highly differentiated contractor may have great potential value. The project may place special requirements on the contractor, like building one phase while the next is still being designed and priced; anticipating discovery of unknown conditions, like working around existing occupants or doing a good job from inadequate design documents. Contractors who can do this will most definitely charge more, but they will also act more like members of the entire design and construction team.

Another service the differentiated contractor can provide is to help take advantage of the fragmentation of the building business by getting good competition among subcontractors. These small companies tend to be entrepreneurial and fiercely independent, and their fractiousness can be a problem or an asset. Subcontracts and purchase orders can amount to approximately 70% or 80% of the total cost of a commercial building project. Builders skilled at handling competition at the trade level may charge a higher fee for their own services and still produce the lowest total final cost—mostly by being efficient.

Some contractors are also adept at forming value-adding

partnerships with the subcontractors they use most often. Teams like these can gain efficiencies from shared design and production information as well as from a good understanding of each other's work styles. In this kind of cooperative setting, friction, uncertainty, inefficiency, and duplication of effort can be significantly reduced (Macomber 1989). Of course, building teamwork requires energy and trust. As always, the question for management is whether the added value is worth the added cost.

Understanding Bidding Process

In many organizations the contract administrator is an active participant in the bid-review process. In bid proposals that contain a substantial number of alternates and unit price additives, the process of determining the low bidder can be somewhat complex. It is much simpler to determine a low bidder if the contractor or vendor is a low bidder on the base price and all the alternatives. Because the unit price additives may not have quantities, it is difficult to assess the possible total of the additives. In equipment proposals where the manufacturer submits a periodic payment schedule, it is necessary to consider the lost interest of the money paid out in the evaluation of the bid (Ward and Litchfield 1980). These assessments should be made formally, and a chart or table is a clear way of showing the configurations.

Selecting Right Type of Contract

Three main contract types have evolved within the building industry out of the disparities among the levels of service provided. Although all three have been around for many years, many owners do not quite understand their relation to risk control. In most cases, a good evaluation of the kind and level of risk to be anticipated will point clearly to one of these three contracts.

Main Contract Types

Lump-Sum Contract. This type of contract is straightforward and relatively easy to understand. It usually refers to the furnishing of the required labor, materials, and equipment needed to complete a job in accordance with plans and specifications (including code conformity) for a specific sum of money. Under such an arrangement it is advantageous to the owner that the plans and specifications be as complete as possible in order to minimize the potential for extras. Each contractor bidding on the project estimates a total cost, adds profit, and bids a fixed price for the job. The owner picks the lowest bid. If costs go up, the price to the owner remains the same. If costs go down—and the incentive to make them go down by cutting corners can be considerable—the extra margin goes to the contractor alone. The disadvantage under this arrangement is that plans and specifications must be completed before the actual work can begin, and thus lead time cannot be taken advantage of in beginning the work or procuring long-lead materials. However, in such a case, site work can start early under separate contract, and the owner can prepurchase the materials.

With a lump-sum contract, the contractor takes all the visible risk, and the owner apparently takes none. From the outside, this seems like a good bet for high-risk projects. But just the opposite is true. First, should costs rise unexpectedly above the price that was bid and accepted, the contractor's dedication to the job may abruptly vanish. Second, with a lump-sum contract, the price may be fixed, but so is the scope of the work. Completeness of the design and contract documents are essential; even a small change in the project can throw the entire contract out the window, and no renegotiation of that contract

can be afforded once the work is under way. In reality, however, change is recognized by construction contractors, and only cardinal change will negate the contract. By avoiding risk, the client also gives up most of his decision-making power. Put another way, you pay your money and you take your chances. This is, of course, not an optimum way to build a highly differentiated structure such as a hospital or speculative office building. In actuality, however, the owner does take some invisible risk; he becomes financially liable for payments and is subject to contractor bankruptcy risk. Still, the lump-sum contract is the right contract for simple jobs where price is more appreciated than collaboration.

Time and Materials Contracts. Most people are familiar with time and material contracts, which are based on the cost of work plus a fee. Many professionals bill this way, e.g., lawyers, accountants, and engineers. The concept revolves around the builder getting reimbursed for the actual costs of the work (materials, labor, equipment rental, etc.), plus a markup (usually in the form of a percentage fee) for overhead and profit. So, in other words, the owner takes all the risk and the contractor none, the complete opposite of the lump-sum contract principle. Here, the customer can be fairly certain that work will be properly done, because there is no incentive to cut corners. Of course, the more the contractor spends, the more the contractor makes. In addition, the contractor is under no incentive to complete the job on schedule or save the owner money.

Despite the obvious disadvantages in terms of risk, there are many situations in which a time-and-materials contract is the right contract for the owner. The first is when quality—inherently, a function of plans and specifications—matters more than money. The second is when time is limited and the contractor will have to work extensive overtime. The third is when construction documents are incomplete or missing, which leaves the contractor nothing on which to base a bid. Another situation comes up when owners have so much construction expertise and so much time to devote to supervision that they can get exactly what they want and still hold down costs by directing the location and quality of every brick and nail.

Guaranteed Maximum-Price Contract. For most situations, one of the two types of contracts mentioned above will fit the bill. But for many large construction users, a hybrid form referred to as 'guaranteed maximum price' is more appropriate. It is often the best contract for performing the work identified as high risk. Like time-and-materials contracts, guaranteed maximum price contracts are also based on the cost of work plus a fee, but risk is shared. Up to a predetermined maximum price, the contractor passes along all costs to the owner, but once that price is reached, all risk belongs to the contractor. In other words, a ceiling is placed on the amount of money the contractor can affect the total price if written into the contract. Hence, the owner knows what his maximum cost will be, precluding any escalation provisions that protect the contractor.

As in a time-and-materials contract, the owner benefits when direct costs are less than expected. But when costs go up too far, contractors absorb the overrun, as they would in a lump-sum contract. Generally, this arrangement keeps the best features of both other contract types. Most often, the guaranteed maximum price will be set higher than the lump-sum price for the same project because the contractor's profit is capped. The contractor is motivated to complete the job on time, particularly when his contract price approaches the guaranteed maximum limit. The goal in this case is to make contractors team players without giving them a carte blanche. The contractor's profit does not depend on cost cutting but rather on good performance of this service for the owner. What the customer gets is a limit on exposure and a cooperative relationship instead of an adversarial one.

Other Contract Types

The three types of contracts just described assume the traditional configuration of owner-architect-contractor shown in Fig. 2. There are other contracts, however, in which these traditional roles have been reassigned. It is imperative that a contract administrator have a thorough knowledge of the different methods of contracting. Selecting the right type of contract for a particular job requires sound judgement, and the decision should be made only after careful value analysis is performed. Some of the other methods of awarding contracts are described as follows:

Unit-Price Contract. The main advantage of a unit-price contract is that it can be awarded before the quantities are completely determined. Under this method an owner knows what he or she will pay for extras and does not have to worry about the contractor or vendor taking advantage when additional quantities are required. A prime disadvantage of such a contract is that the quantities are estimated well in advance and are often much less than the actual quantities required. This has a twisting effect on the budget. Another disadvantage is that the contractors tend to front-load the payments for the job by using inflated units for the work they know must be performed during the early stages of the project. Such conditions tend to create a large variance between the payment progress and the actual physical progress. The owner cannot control the payment schedule once he or she has accepted the units which are part of the contract.

Convertible Contract. This type of contract usually starts on a time-and-materials contract (also commonly referred to as cost-plus contract) basis, and when the scope of the project becomes more clearly defined, the contract is converted to a lump-sum arrangement. The contractor is able to start the project earlier under this arrangement, thereby contributing to initial cost savings for the client in the process. The disadvantage of this type of contract is that once a contractor gets a foothold on the job, other contractors might be reluctant to offer competitive bids, thereby giving the initial contractor an opportunity to monopolize the job and inflate his offer to the client.

Incentive Contract. The basic philosophy underlying this type of contract is the motivation of the part of the contractor to keep costs as low as possible. Essentially, it is a contract in which efficient, timely, and reasonable contractual execution is rewarded with money. The type of, and reason for, rewards are limited only by one's imagination. A contractor can receive a reward for keeping his or her price below the guaranteed maximum in a cost-plus arrangement, although the incentive contract arrangement is not necessarily limited to a cost-plus contract. Moreover, the bonus can be tied in with the degree of work-time savings; i.e., contractors will receive a bonus for completing a job before the scheduled time. Such an arrangement is the reverse of a liquidated damage clause. The completion of a project ahead of schedule should be worth something to an owner/client.

Turnkey Contract. With a turnkey contract, the owner buys a site, a design, and a finished building as a package. The supplier secures the construction financing and plays the role of owner and contractor—and sometimes even the architect—during construction. Turnkey contracts are suited to situations in which the needs of the user are easily described and well defined.

Design-Build Contract. A design-build contract is like a turnkey contract in that the architect and contractor work under one contract, giving one source of responsibility. This fosters cooperation at the cost of eliminating traditional checks and balances. But in design-build, as opposed to turnkey, the owner is responsible for financing. The design-build company is responsible for the concept, design, and satisfactory completion of the project. Thus, the project is not fragmented nor

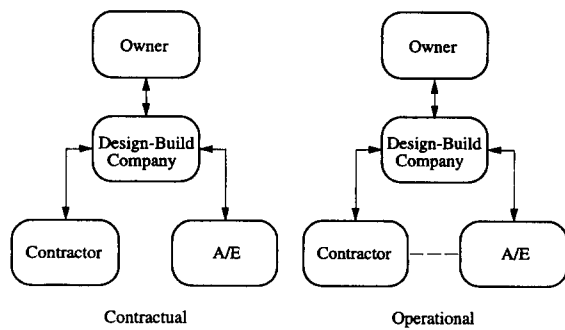


FIG. 4. Design-Build Relationships

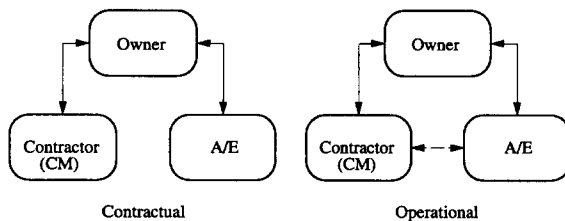


FIG. 5. Relationships under Fast-Track/Construction-Management Method

seemingly left to the devices of separate entities as can often be the case with other methods. Design-build can be compared to a manufacturing process because in both cases, the product is controlled from inception to completion. This control is what makes design-build work.

Fig. 4 illustrates the design-build process from both contractual and operational points-of-view. Comparison of these diagrams with those representing other types of contracts reveals that the design-build method furnishes a single point of responsibility for the success of the project. The design-build company is contractually related to the owner, the contractor, and the architect. Frequently other arrangements are made; a joint venture company can be created by a contractor and an A/E firm, and either the contractor or the A/E firm can take the lead and subcontract to the other.

Fast-Track Approach. As a consequence of high construction interest rates, developers began to demand that the building be completed as quickly as possible so as to become an income producer, converted to the permanent mortgage. The introduction of fast-track construction provided a new approach, which could be used in concert with construction management, the latter elaborated on later. With the fast-track method, construction is started before the design is complete. The fast track approach can only be used under contractual arrangements different from the traditional bidding method. Fig. 5 shows such an arrangement.

The owner is generally in favor of the method because it can produce the building and generate revenue more quickly. The A/E finds that construction management allows him or her to test the cost of the building elements in advance of the final design drawings and thereby avoid potential redesign. It also requires fewer drawings than the number needed for a bid because certain details can be worked out later in sketches, or resolved in shop drawings. On the other hand, the A/E firm also finds some disadvantages in this construction management method. It requires the firm to design certain elements or trade work out of normal sequence, thereby disrupting the flow of the drawings—a typical design risk. The necessity for out-of-sequence design is to accommodate items of work that were in progress and critical components that had to be ordered in advance to ensure delivery to the job site when needed. This represents a high design risk, because design elements designed in such a fashion may not properly fit within the entire

building design envisioned at the outset. The construction management associated with the fast track approach can be advantageous to the contractor in many ways. For one, it relieves him or her of some of the risk (assumed under a traditional bid method) and shares it with the owner (Mueller 1986).

Professional Construction Management. In its simplest form, construction management is merely a consulting service. Construction managers often supplement the owner's in-house construction team by giving advice and providing supervision for a fee. They take no fiduciary responsibility, and they do not guarantee price, results, or schedule. Construction management is the function performed on behalf of an owner directed toward planning, organizing, coordinating, and controlling the physical construction of a facility through the effective use of material and human resources. It involves the coordinating and interfacing of contractors' work, the establishment of field administrative systems and procedures, project planning and scheduling, construction consulting, quality control and inspection, and cost control. Usually, the construction manager does not construct the facility but functions as manager of the construction process (although exceptions do exist, as described as follows). Since he or she is appointed by the client as an agent with defined responsibilities, the client has the option of expanding the scope of a construction manager's services. Therefore, there are instances when a client expands the construction manager's purview to include the decision, design, and bidding phases of a project (Zilly 1971).

The decision phase involves feasibility studies, site selection, sizing of the facility, establishing the project budget, and project-duration determinations. The design phase includes siting studies, reviews of plans and specifications, recommending purchases for long-lead equipment, bid-package review, and budgeting preparation. The bidding phase involves evaluation of the financial capability and experience records of contractors and vendors and the recommendation of contract awards. A major duty of the construction manager is the proper scheduling of construction processes, mostly done by developing a master critical path method (CPM) system, a network arrangement defining the group and combination of construction activities that are critical to the timely completion of the project (Thompson 1982).

As indicated previously, there are two approaches to construction management: one involves a professional construction manager who does no building, but, as outlined earlier, mainly supervises contractors who do the work; and the other requires a construction manager/contractor who is a consultant who also builds. Illustrations of the relationships between the various construction team entities under the professional construction management method is shown in Fig. 6. As can be seen, construction management is a team effort. It lowers the traditional barriers that bid work raises between the contractor and the architect; i.e., the construction manager/contractor and architect are on equal terms, having a cooperative relationship.

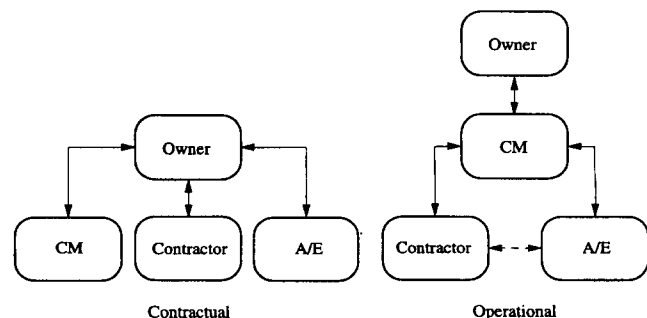


FIG. 6. Professional Construction Management Relationships

It does not, however, provide for a single entity responsible for the successful completion of the project (Branca 1987).

Selecting the Contractor

The way a client chooses a contractor should match its project-risk level and contract type. But the age-old practice of bidding out contracts is so well established that organizations resort to it even when the effort can be spared. Each kind of project and contract have their own selection criteria.

The contractor for a lump-sum contract can be chosen almost entirely by means of an open bid based on construction documents consisting of plans and specifications that clearly define the scope of the work. In this case, if a contractor must be selected before the documents are completed, lump-sum may be the wrong type of contract. Beyond requiring bidders to satisfy some minimum level of experience, reputation, and financial strength, price is really all one cares about. At this juncture a warning is due: many owners take advantage of a very low bid. This temptation should be resisted; it may be a mistake based on misinterpreted construction documents, and the ensuing fight will not be worth it. In some European countries, a contract is awarded to the contractor whose bid is the closest to the average of the high and low bids (Kemahli, personal communication, 1995).

For a time-and-materials contract, reputation, ability, and trust are paramount. References are to be checked, and the assurance of a comfortable working relationship is to be in place. No selection on the basis of some kind of estimated bid is to be made. If the contract has no cap, the bid means nothing. It can only tempt the owner to select the lowest of several meaningless numbers, and that is a good way to pick the least competent candidate (Macomber 1989).

In the guaranteed maximum-price contract, the client's guide should be the contractor's experience, references, and integrity. After all, the client is planning to pay a fee to a company for its competence in managing construction, meeting schedules, maintaining quality, providing construction services, and treating others honestly and fairly. Establishing that competence should then be the primary criterion.

Any construction company in the running for the guaranteed maximum price contract should be able to supply the client with the names of previous customers who can tell how well it performed in the past. Information related to the accuracy of the cost estimates, on-time scheduling, the extent of the savings returned to the owner, or the size of the overrun absorbed by the contractor should also be available to the client. It is further recommended to ask for references from former subcontractors. After all, the client is buying a value-added service; he or she should make sure to get what he or she is paying for.

Monitoring Construction

Here, again, the scope and method of supervision depends on the type of contract. On a lump-sum contract, the developer or owner's representative must monitor both materials and workmanship to make sure the contractor does not pad his or her own profit by delivering less than what was contracted for. This level of attention calls for a construction supervisor who understands specifications, details, workmanship, and materials handling.

On a time-and-materials contract, the construction supervisor's job is to see that the contractor doesn't waste the client's money. The builder will not likely cut corners, but cost control will not be a top priority either. This type of contract calls for a monitor who understands labor productivity, effective use of raw materials, and cost accounting.

In the case of a guaranteed maximum-price contract, the

very structure of the contract reduces the degree of supervision the owner will need, at least in theory. The contractor assumes the risk of a cost overrun and earns a predetermined fee to make sure that the materials and the work are right. Still, a prudent owner will keep an eye on workmanship and accounting. The skills of an experienced construction supervisor would be appreciated, but the need is less urgent (Ward and Litchfield 1980).

CONCLUDING REMARKS

Construction is a major obligation for many growing companies. The initial estimates of cost, time, and trouble are bound to change drastically as work progresses. The construction team itself may be volatile and problematic. But the directors and top management of the client company can identify, analyze, and rationally control these risks by applying certain guidelines, some of which have been outlined in the present paper.

Construction, in many instances, can become a high-risk venture. Each project is unique and has its own specific design to be constructed on a particular site within a special time frame with special materials, equipment and labor. Successful construction requires flawless functioning of the project team comprising the owner, the design team, construction team, and various trades, manufacturers, suppliers, and so on, in a professional and timely manner. Success is measured by three specific criteria:

- On-time completion
- Final cost within budget
- Final product satisfies owner's needs

All entities contribute to construction risk in different ways. The owner may contribute by the following:

- Allowing start of construction prior to the securing of appropriate financing
- Making extensive changes during construction due to lack of prior planning
- Interfering constantly with design and construction teams and changing design criteria thereby causing delays and, possibly, friction among the design and construction teams

The design team's contribution to risks can be summarized as follows:

- Final design documents may not satisfy owner's use and financial requirements.
- Design documents may not fully comply with codes and regulations.
- Design documents may have discrepancies and not be fully coordinated among different design professionals (i.e., architectural, structural, mechanical, etc.).
- Construction supervisor for the design team may be incapable of solving field problems.
- Designers can fail to be objective when reviewing contractor's claims.

The risks attributed to the construction team are outlined as follows:

- It may not have qualified management and the skilled labor body to perform the required task.
- It may not have appropriate financing to complete the task.
- It may not have the required workforce to complete the task on time.

- It may underbid the project and try to cut corners.
- Subcontractors may be chosen based on price alone.

Some risk-reduction strategies/criteria as applicable to the different players of the construction project are delineated as follows:

Owner

- Knows in detail his needs and requirements for the proposed project
- Completes thorough predesign planning
- Knows his financial limitations and provides adequate financial resources
- Familiarizes himself with construction documents in great detail prior to start of construction and responds effectively to design and construction teams

Design/Supervision Team

- Has good knowledge of A/E design practice and applicable codes and regulations
- Has good knowledge and understanding of construction costs and estimating practice
- Has a good record of timely completion of design documents and an aptitude for troubleshooting as well as an ability to respond quickly to general construction field problems and needs

The A/E's role in reducing risk as well as contract provisions and good constructions documents cannot be overemphasized. Selection of the A/E firm can be as important as, if not more important than, contractor selection in reducing owner risk.

Construction Team

- Has good record of managing and completing construction projects

- Has adequate financial resources required to complete the project
- Has adequate skilled labor force

From the previous discussion it is clear that the person who acts as construction supervisor needs experience and expertise. In large client companies, only few CEOs and board members would qualify. In such a case it is worthwhile to hire a construction consultant to coordinate the project. In many cases the project architect is retained for general construction supervision. In general, such a setup has worked well for certain aspects of construction supervision. However, architects are trained primarily to design, and their capacity and willingness to check on all aspects of workmanship, monitor materials, and oversee accounting is rather limited.

On the other hand, as projects grow more complex, the architect has a progressively greater need to work with, not against, the contractor. There is a host of issues such as construction technology, drawings/specifications interpretation, aesthetics, and cost for them to consider together. Architect-contractor cooperation becomes even more crucial in projects comprising unknown risks such as a building with marine foundations, or the renovation of a historic building. The contractor's experience and judgement become indispensable assets for the architect. An owner's insistence on "police duty" on the part of the architect can seriously impair an architect's ability to work with the contractor.

APPENDIX. REFERENCES

- Branca, A. J. (1987). *Cost-effective design/build construction*. R. S. Means Co., Inc., Kingston, Mass.
- Macomber, J. (1989). "You can manage construction risks." *Harvard Business Rev.*, 67(2), 155-165.
- Mueller, F. M. (1986). *Integrated cost and schedule control for construction projects*. Van Nostrand Reinhold, New York, N.Y.
- Thompson, C. B. (1982). *CM: developing, marketing, & delivering construction management services*. McGraw-Hill Book Co., Inc., New York, N.Y.
- Ward, S. A., and Litchfield, T. (1980). *Cost control in design and construction*. McGraw-Hill Book Co., Inc., New York, N.Y.
- Zilly, R. G. (1971). "The construction industry." *Contractor's management handbook*, eds., J. J. O'Brian and R. G. Zilly, eds., McGraw-Hill Book Co., Inc., New York, N.Y.