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DESIGN MANAGEMENT

Design management is concerned with an engineer's sphere of activity. It is therefore important to consider the variety and types of design activities to which professionals devote their efforts.

The engineer's basic role is to harness scientific principles and other knowledge to practical applications that benefit humanity. In fulfillment of this role, design management is concerned with proper utilization of human labor, energy, and technical skills to serve present and future needs of the economy.

The design manager's goal is to complete a project on schedule and within budget while meeting standards of quality in order to meet the client's needs.

2.1 Where Engineers Are Employed

Principal fields of employment for engineers include:

Academic ▪ For many engineers, the teaching profession is both the first and final career. Many others, however, devote to teaching a few years of their careers or sometimes part of their time, for example, teaching evening courses.

Many educators also serve as advisers to industry and consulting firms. Thus, they move into the designer's sphere of activity. Furthermore, many university departments are retained by government and industry for research projects. As a consequence, the departments, in essence, act as private firms performing professional services. The university administrators have to work within

budgets and have contracts to negotiate, reimbursable expenses to determine, and schedules to meet. They also have to contend with other administrative matters that are part of design management.

Industry ▪ Industrial firms that handle any substantial volume of business have engineers on their staff. The role of such engineers, however, varies. A firm with productive capacity and thus plant facilities must have a plant engineer and staff to ensure proper maintenance and operation of the plant. In many industries, the plant engineers also serve their employers in the design field. For instance, if new equipment is to be installed in an existing plant, not only must space be provided but engineering questions must be addressed. Typical questions include: Are the foundations adequate to carry the added loads? Are new utility services required? Is the present power supply adequate? Furthermore, building may have to be constructed to house the new equipment. Thus, a plant engineer's normal activities and responsibilities often lead to the design field.

Because of their size, growth, and specialized needs, many industries have their own engineering and design departments. Such a department fulfills the same professional function as a private engineering firm, with one basic difference: The industry engineer serves one client, whereas the design firm serves many. Concerned with many of the same administrative matters as a design firm, an engineering department can be organized like a design firm. The engineering department will be organized to operate efficiently in meeting the specialized needs of only its industrial employer.

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Government ■ Like engineers in industry, government engineers serve only one client, their employer. The federal government is the largest single employer of architects and engineers. In addition, most states, counties, cities, towns, and public bodies have engineers and architects on their staffs or in their employ. These professionals perform a variety of functions encompassing both design and administrative activity.

The agencies or authorities maintain engineering and architectural departments that perform basic design work and thus act as in-house professional service firms. Such organizations do not need to retain outside private consultants, except for specialized tasks or when the volume of design work to be performed exceeds their in-house capabilities. In addition, these agencies, whether or not they have in-house design capability, employ professionals who work on a variety of different administrative levels, including administration and supervision of projects as well as review of basic design and construction activities. Administration of the engineering projects requires the services of professionals on all levels, starting with junior staff members and extending up to top-level administrators and officials charged with responsibility for implementation of the public projects.

In public service, the engineer may be either the designer or the client.

Engineer-Contractor ■ The term as used here refers to the construction firm that identifies itself as both an engineer designer and contractor. Although many use the title engineer-contractor and perform only the actual construction, we are concerned here with the firm that truly undertakes either design-build or most frequently “turnkey” projects—both design and construction under a single contract.

Process and utility industries generally use the turnkey contract. These industries are primarily interested in the final product, such as number of barrels of oil refined or number of kilowatthours produced. The engineering staff of the company building a plant establishes design criteria that the engineer-contractor has to meet. Because of the specialized nature of these industries, the engineer-contractor employs designers with knowledge of particular processes to develop the most economical and efficient design. Engineer-contractors

normally bid on performance specifications and prepare the detail designs necessary for construction. Other turnkey operations include those that combine land acquisition, design, and construction for commercial and industrial buildings and can even include financing.

The design is accomplished by the same organization, or division within the organization, that constructs the building or facility. Depending on a variety of factors, there are advantages and disadvantages of this combined service as compared with the division of responsibility between a design firm and a construction company.

Contractor ■ A traditional construction project team consists of three parties: owner, or client; designer; and general contractor (GC). After being awarded a general construction contract by the client, the GC hires the subcontractors and the trades. Some forms of contracting, however, require several “prime” contractors instead of one GC. In such instances, the owner usually contracts directly with the major trades, such as heating, ventilating, and air conditioning (HVAC); electrical; plumbing; and vertical transportation installations. Also, in some situations, such as for a project administered by a construction manager (CM), the owner may engage several prime contractors, whose separate contracts will be coordinated and managed by the CM. Most contractors operate in a regional or limited geographic area.

Whether performing construction as a GC, prime contractor, or subcontractor, these companies employ engineers from a wide variety of disciplines. Engineers may serve as project managers who have responsibility for bringing the project to a successful completion while meeting the time, cost and quality goals; Project Engineers who schedule and coordinate construction; and Superintendents who plan and supervise the work in the field. Hence, there are many employment opportunities for engineers with contractors. Furthermore, the nature of construction contracting is such that it provides many opportunities for engineers to assume proprietorship roles.

Consulting Engineer ■ A consulting engineer has been defined as a “professional experienced in the application of scientific principles to engineering problems.” As professionals, consulting engineers owe a duty to the public as well as to

their clients. In addition to rendering a professional service, the consulting engineer also operates a business. Consulting engineering is practiced by sole practitioners, partnerships, and corporations, many with large staffs of professionals, CAD operators, and other supporting personnel. Regardless of the form of the engineer's organization, the final product a client receives retains the same professional characteristics and meets the same professional standards. Consulting engineers usually have several clients, and they must select methods of operation to suit their own and their clients' needs best.

Consulting engineers are paid a fee by clients to provide professional design services on diverse projects, types including but not limited to transportation, industrial, education, institution and environmental facilities.

Construction Manager (CM) ■ Managing and coordinating construction projects as an agent of owners, i.e., acting as the CM, is the prime specialty or discipline of many firms. Although engineers and architects are the traditional professionals operating or employed by such firms, construction management is a separately defined technical field. The tasks and functions of construction managers, whether part of a professional service agreement or a guaranteed-maximum-price (GMP) contract, are well-established areas of practice.

While the primary goal of construction managers is to construct a project with the time, cost and quality goals established, they are increasingly being hired during the design phase to ensure that the design is constructible and cost effective.

Others ■ There are numerous specialty firms that practice in private industry but limit their activity to specific or specialized fields. These firms or individual practitioners may be appropriately classified under any of the broad definitions above but, as engineers, limit their professional activities. For instance, some specialty firms perform only cost-estimating services (consulting engineers or construction managers); act as construction consultants, serving as troubleshooters; or specialize in one technical area for the sole purpose of serving as expert witnesses in construction litigation.

2.2 Forms of Consulting Engineering Organizations

Consulting engineers may practice as individuals, partnerships, or corporations.

Individual Proprietorship ■ This form of organization is the simplest, has the fewest legal complications, and enables the proprietor to exercise direct control over the operation. As a one-person operation, however, this type of practice has distinct limitations because its activity essentially can be restricted to the efforts of the individual.

Although conducting a business as a sole proprietor, a consulting engineer may have several employees. Thus, as an employer, the consulting engineer is operating a business and has to handle the problems associated with a business enterprise. Also, because consulting engineers represent the legal entities conducting their businesses, they are responsible for all obligations of a business and all contracts are entered into in their names. Consulting engineers are personally responsible for all debts and can be liable for these to the extent of all their assets, business or personal. All profits, however, are earned by the consulting engineers, and they are not required to distribute earnings, as in a partnership, or be concerned with the declaration of dividends, as with a corporation.

Partnership ■ Another form for a consulting engineering organization is a *partnership*, that is, an association of two or more professionals who combine forces and talents to serve their clients on a more comprehensive scale and, by offering more services, to serve a wider clientele. Typically, each partner is responsible for a specific area. The management of the business, depending on its complexity, is assigned to one partner, the *managing partner*.

A partnership retains the identity of the individual professional, and basically its legal structure is similar to that of the individual proprietorship. Instead of one individual assuming all contractual obligations, liabilities, and earnings, all profits are shared by the partners. The partners, however, may not necessarily share equally in the business. Interest can be worked out among the partners as desired. For instance, one partner may own more than 50% and thus have a position

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comparable to that of the majority stockholder of a corporation.

Partnerships, although once predominant in the engineering profession as in other fields, such as architecture, accounting, and law, are rarely used. Most large engineering organizations that operated as partnerships have reorganized into corporations. From the business point of view, partnerships have several disadvantages that cause many firms to incorporate in states where such corporate practice is not restricted.

One disadvantage of partnerships is that each partner is legally liable to the extent of total personal assets for the wrongful act of any partner in the ordinary course of business. Another disadvantage is that a partnership terminates on death or retirement of one partner unless other provisions are made in the partnership agreement. Furthermore, a partnership does not have the flexibility of a corporation for comprehensive employee-benefit programs and provision for key employee participation.

Although a partnership as an entity does not pay taxes, the partners as individuals pay taxes on the profits. This is not necessarily a disadvantage, but it can be a prime consideration in the choice of an operating organization.

Also, although a professional cannot limit personal liability for professional errors or omissions in a corporate structure, the proliferation of litigation in the industry has made it more advantageous for engineers to operate as corporations or as Limited Liability Partnerships (LLPs) or Limited Liability Corporations (LLCs) rather than individual proprietorships or partnerships.

Corporations ■ Most firms with several employees practice either as general or professional corporations (PC), depending on the laws of the state in which they practice. Practitioners who perform engineering in more than one state must take into account the variation in states' requirements, to ensure compliance not only with professional requirements (licensing) but with business practices (registering to do business, certification, and tax filings).

Most states permit the formation of professional engineering corporations. But usually a corporation can be formed for the purpose of practicing engineering only under certain conditions: ownership and management of the company must be

totally vested in professionals or, at least, majority interests be held by professionals. Many states have passed legislation permitting the formation of such corporations to give professionals, not only in engineering but in other professions, the benefits and protection of conducting business as a corporation. Although permitting such corporate practice, the legislation includes requirements so structured that the public is protected from unqualified persons conducting a professional practice under a corporate guise.

With such protective requirements, professional identity can be maintained in corporate practice. Therefore, if conditions warrant and state law permits, engineering organizations should consider the corporate form of practice. The advantages that are attained, however, are mainly business ones. The management structure of the organization is clarified. Responsibility is defined. The area of employee fringe benefits becomes more diversified. Opportunities exist for profit sharing, for realistic retirement plans, and for employees to buy into the firm. Also, the principal's personal liability is limited to the assets of the corporations although the principals continue to be responsible for their own professional acts and cannot use the corporate structure as a shield from liability for professional errors and omissions.

Each form of practice has to be evaluated on its own merits. A corporate structure for an individual practitioner with a small practice may not be warranted, but one with a large volume of business that can be assigned to subordinates may find a corporation advantageous. For some firms, the tax advantages of a corporation may be more beneficial than operating as a partnership. (For federal income tax purposes, a small business corporation, meeting certain requirements, can elect to be taxed as a partnership, a practice advantageous for a small corporation.)

Limited Liability Companies and Partnerships ■ The majority of states provide for the formation of limited liability companies (LLCs) and partnerships (LLPs). Statutes provide for the formation of LLCs for most business purpose except special areas, such as banking and insurance for which there are other controlling statutes. Professional limited liability companies (PLLCs) can also be formed. Members of a PLLC,

however, must be registered professional engineers.

As the name implies the objective of doing business as an LLC and LLP is to “limit liability”. Members, managers and agents of such entities are not personally liable for debts, obligations, and liabilities of the LLC or of each other. However, members, managers and employees of an LLP are personally liable for negligent acts (professional errors and omissions), as in any professional business entity. There is no business shield for any professional for professional misconduct or negligence.

The advantages of limited liability entities as compared with other business forms of organizations are the unique combination of limited liability and pass through taxation. Namely, taxes are only incurred at the ownership level not both for the business entity and for the distribution of profits (dividends).

Organizations conducting business as general or professional partnerships, or S corporations may find LLCs, PLLCs and LLPs to be advantageous business structures. Consideration, however, must be given not only to the laws of the State where the business entity is organized but also to other states where the business is to be conducted.

2.3 Clients for Engineering Services

Each client and each project has particular needs. Clients include:

Federal Government ■ As the largest single employer of engineers and largest contractor for services and products, the federal government is a potential client for most design firms. To qualify for consideration by any government branch, a firm must file periodically with agencies from which work may be obtained a questionnaire detailing the firm’s organization, key personnel (education and experience), special areas of competence, and experience (including completed projects). Preparation of such data is time-consuming, but most agencies have standardized their requirements so that the same form can be used for many filings.

Within the federal government, a standard questionnaire for architects and engineers is used by most of the agencies retaining professional services. This form, identified as standard form S.F.

254, presents, in summary fashion, data describing both the experience and qualifications of individual professionals and the firm, together with project descriptions and areas of expertise. In addition, many agencies have established computerized data banks utilizing the information contained in these standard qualification forms, to simplify both their records and the search for qualified professional firms to service specific needs.

In addition to S.F. 254, these agencies utilize S.F. 255, which is a subsequent submission of qualifications for specific assignments. This form requires identification of key personnel who would be utilized on a specific project and also requires evidence of specific experience related to the planned program or project.

When an agency needs outside design services, it is able to search its qualification file to identify firms that have the particular capabilities and professional expertise necessary for a particular project. All new projects are advertised in the *Commerce Business Daily* (CBD), to give all interested parties the opportunity to submit qualification data for consideration. After review of the qualification data, an agency may request more detailed qualification material from a select list of firms and then follow up with individual interviews prior to consultant selection.

Other-than-Federal Public Work ■ Public work other than that performed for the federal government is in the province of states, counties, cities, and municipalities. The contracting party varies, depending on the nature of the work and its scope. Usually, engineering work is under the jurisdiction of an agency’s engineering department. Sometimes, however, states or cities establish authorities to administer, construct, operate, and maintain projects. Many states, for example, have separate authorities for construction and operation of limited-access toll roads, for ports, for bridges and tunnels, and for public buildings such as schools and colleges. These authorities, as well as the public bodies, have different methods of operation. Some perform all or nearly all design in-house; they engage outside consultants infrequently. Others retain consulting engineers for most design.

Considerable areas of engineering activity lie within public authorities or regional public

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agencies, such as transportation, sewer, or water authorities, established within regions for the implementation of specific tasks. Such agencies either retain consultants to perform the necessary engineering for implementation of their public projects or establish in-house capability to perform the same functions.

Industry, Commerce, Residential, and Institutional ■ Construction for these purposes varies with economic conditions and other factors, and opportunities for employment in these areas vary accordingly. Residential construction constitutes a substantial portion of the U.S. gross domestic product. It provides many employment opportunities for engineers and construction workers. Although single-family houses, which comprise a major segment of the residential market, are constructed by individual builders and small businesses, engineers play a role in this field, either as builders or in related work such as survey, utility, and support services.

Architects and other Professionals ■ Many consulting engineers have architects and other professionals as their primary clients. Architects are employed to design a wide variety of facilities that include but are not limited to buildings, parks and waterfront facilities. Buildings may range from one-story residences to commercial high rise towers. They design the shell of the building including the exterior walls, windows, doors and roofs and the interior including wall, ceiling and floor layouts and finishes. While some architectural firms have in-house engineering capabilities, many have made a business decision not to provide that service and have decided to subcontract it to engineering firms. The consulting engineers who enter contracts with architects typically specialize in providing one facet of engineering although some of the large firms may provide services in more than one specialty. This may include the design of foundations, civil engineering site features such as roads and drainage, structural engineering including building framing systems, and mechanical, electrical and plumbing engineering to provide heating, cooling, fire alarm and sanitary system design.

In addition, professionals serve each other within their own fields of competence. Engineers

may retain other engineers as consultants to supplement their own capabilities, either to take advantage of specialized knowledge or experience or for independent checks on their firm's analysis and calculations. Engineers team together to win large and complex projects. Although a consulting engineering firm may have capability to provide foundation engineering, a project may have difficult and unique subsurface conditions, which warrant the use of a firm specializing in geotechnical and foundation engineering that has provided designs for similar types of conditions.

Contractors ■ Contractors provide a large market for consulting engineering firms. They have utilized the services of consulting engineers to provide the means and methods of construction that may be specifically excluded from the design engineers' scope of services. Means and methods may include the design of temporary support structures such as sheeting to protect excavations or scaffolding to support decks while concrete is being placed. Contractors may also employ engineers to perform re-engineering to provide an alternate system that is more economical to construct than the one included in the design documents, which the contractor bid and is using to build.

Design-Build is a project delivery system that is being used more extensively than in the past. Under this system, contractors provide a proposal to both design and build a project. Since most contractors do not have an in-house engineering staff to provide major design services, they use the services of consulting engineers.

Other Clients ■ Sometimes, an owner may engage an engineer for projects that may require a few hours' attention or for the design of an entire facility. Professionals such as lawyers consult engineers much as engineers seek professional counsel from lawyers. Also, engineers are often called on as expert witnesses to give testimony on technical matters.

2.4 Scope of Engineering Services

The range of activity of engineers in design covers a broad spectrum from brief advice to inspection of construction and includes preparation of plans and

specifications. Many firms, although qualified to render a variety of services, may limit the scope of services offered as well as specialize in a particular field. For example, some engineers offer only structural design services or foundation consulting.

Following is a brief summary of services rendered by engineering firms:

Advice and Consultation ■ This phase may comprise no more than an expression of the consultant's opinion based on experience and technical knowledge. Normally, detailed engineering design is not an element in this phase, but the engineer may advise a client on the merits of undertaking a new project and its related technical consideration; or this phase may just be the rendering of an opinion on the advisability of undertaking further studies to determine the need for repairs or rehabilitation of an existing structure.

Technical Investigation and Analysis ■ After consultation, the engineer may undertake detailed studies, such as physical exploration, including soil borings, topographic surveys, and hydrographic studies. Possible methods of construction may be considered. Preparation of a feasibility report may follow. This report usually considers economic as well as engineering aspects; both aspects have to be explored to enable an owner to decide whether to undertake a project.

Environmental Analysis ■ The National Environmental Protection Act of 1969 caused a dramatic change in engineering practice. As a result of this legislation, an Environmental Impact Statement (EIS) must be filed before design implementation. Preparation of an EIS requires detailed studies and analyses in which the *impact* of the proposed improvement is determined and evaluated. Both short- and long-term impacts have to be considered, in addition to evaluation of a no-build alternative. Preparation and development of an EIS may require the effort of numerous specialists, such as archaeologists, biologists, hydrologists, and economists, for development of all the necessary plans and studies. Conversely, some improvements proceed quickly to the design phase with the filing of a negative impact statement. Such a statement is based on a determination

that there is no impact as a result of the proposed improvement.

Federal and state legislation and regulations as well as court rulings impact development of most sites and new designs. Federal legislation includes the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as the **Superfund** law; the Water Pollution Control Act, known as the Clean Water Act; and the Resource Conservation and Recovery Act. These laws and subsequent regulations not only affect design development for new projects but also may require modifications and alterations of existing facilities, as was the case with the removal of asbestos that had been installed in buildings.

Planning ■ If, on the basis of a feasibility report or other information, the owner decides to proceed with the construction project, the planning phase is started. Planning must be considered separately from design. If, for instance, a plant or complex of structures is being developed, planning includes rough preliminary sketches and a master plan of the proposed project. With master plans, owners can develop a project in stages and schedule construction according to available funds.

Design ■ The scope of engineering services varies depending upon the project delivery system used by the owner. In a typical design-bid-build process, the engineer is charged with preparing a design before the contract is awarded for construction. Under this system, the design is subdivided into schematic, preliminary and final phases. There can be a review with the owner at the end of each phase, or the review can be continuous to enable the owner to visualize the implementation of requirements and allow additions and changes to be made as the need arises. The completed design documents consist of detailed plans and specifications and contracts for construction (Arts. 3.2 and 3.4). The designer's role, however, does not end at completion of final design. Normally, the designer acts as the owner's representative in taking construction bids, awarding contracts, and administering construction contracts.

Fast track design and construction may be used under the construction management delivery system. An engineer may be required to phase the design into bid packages before the entire project

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is completed. An example is that the design of the foundations of a structure may have to be completed and bid for construction while the rest of the building is still being designed. The engineer will have to make accurate assumptions regarding the completion of the design to avoid changes to earlier design packages under this delivery system.

Design-Build ■ This method brings separate challenges. During the competition for these contracts, the engineer provides a preliminary design that the contractor uses as the basis of the construction bid. If successful and the team is awarded the contract, the consulting engineer then completes the design of the project, which is built by the contractor. The design engineer may have additional challenges under this delivery method including fast tracking the design. In addition, there are added pressures on the engineer to provide an extremely economical design to allow the contractor to complete the project within the construction bid price. The engineer is required to provide support services during the construction phase to assure that the project is being built in accordance with the design documents.

Construction Administration and Inspection ■ After the bid and contract award phase, the engineer's role involves general administration of the construction contract and acting as the owner's representative. The scope of services is defined in the design contract general conditions. This phase of the work usually includes limited on-site representation or provision of a full-time resident project engineer, inspector, or representatives. Periodic inspection and consultation during construction are normally part of the designer's obligation under the design contract. These tasks include periodic visits to the site; issuance of clarifying drawings, if required; and checks of equipment catalogs and contractor's shop drawings for compliance with contract documents. Full-time on-site representation, contracted separately as an addition to the design services, consists of an engineer and a staff, the size of which depends on the nature, magnitude, and complexity of the project. The prime function of the site engineer and the staff is to inspect the work for conformance with the contract requirements, documents, and design concept.

Construction Management ■ Due to the growth, complexity, and inflationary costs' spiral of construction, construction management services have evolved both as traditional consulting or contracting services and as management of construction projects. A construction manager, often retained at about the same time as the project designer, may commence tasks at the beginning of design. The services of a construction manager may include basic program review and analysis, design review and evaluation, scheduling (CPM and PERT), cost estimating, value engineering, bid analysis, contractor selection, detailed construction inspection, coordination of trades and separate construction contractors, cost control, and program management. Acting as an owner's agent, the construction manager can perform all or some of these tasks to assure the owner of project and budgetary controls.

Other Services ■ Among the other services rendered by engineering firms are preparation of technical reports; investigation surveys, such as land and property surveys to establish title to property; evaluation and rate studies; appraisal of property and building values; expert testimony in court; and services to industry, financial institutions, and public bodies in the economic field.

2.5 Selection of Consultants

A consultant prefers not to submit bids for services. The logic for this is self-evident. Because consultants render professional services, it is impossible to set a comparative basis for evaluating competitive bids. Furthermore, if consultants were selected on a price basis, the owner, by retaining the lowest bidder regardless of professional qualifications, would risk purchasing an incomplete or incompetent service. Because the fee paid a consultant is a small percentage of the total cost of a project, an owner should pay properly for such services and obtain the best professional services available. For many years, professional organizations published standards and yardsticks for fee schedules. Also, certain municipalities such as New York City continue to maintain fee curves and schedules, which are utilized to establish maximum fees paid to designers and consultants for various types of work.

Fee negotiation and competitive pricing have been studied by various government agencies and challenged in the courts as a result of antitrust administrative rulings issued by the Justice Department. One consequence has been that the American Society of Civil Engineers removed from its Code of Ethics a provision making bidding for the supply of professional services unethical. The following sequence of steps in selection of a professional consultant by an owner, however is preferred:

1. Review the capabilities of several firms and evaluate their qualifications with respect to requirements for the project. Many owners maintain lists of pre-qualified engineering firms, which resulted from invitations or advertisements to provide qualifications to perform the required engineering services. Public agencies use these lists to begin the solicitation process while large private organizations procuring engineering services may use alliances with engineering firms they have had success with in the past. An owner may have knowledge from past experiences of such firms; if not, the owner may contact professional organizations, such as the American Consulting Engineers Council or American Society of Civil Engineers, for a recommended list of firms. Owners without past experience in selecting consultants should confer with associates in their own industries for a list of recommended firms.
2. Select up to six (normally three) firms with the experience and knowledge for undertaking the assignment.
3. Request from the selected firms an indication of interest and detailed data pertaining to their qualifications and ability to undertake the project. With this submission, the firms are also asked to submit information concerning size of staff, availability of personnel to be assigned to the particular project, their understanding, approach and unique insights into the project, and their experience in similar lines of work. The firms are also interviewed.
4. Select the firm most qualified to undertake the project. In addition, the owner should list one or two additional firms, in order of their desirability, in case a contract cannot be negotiated with the first choice.
5. Notify the firm chosen of its selection, negotiate a fee, and execute an agreement for professional services to be rendered. If a mutually agreeable fee cannot be arrived at, negotiation with this firm terminates and negotiations then begin with the no. 2 selection. (For ethical reasons, to avoid conflict of interest, a consultant will not negotiate with a prospective owner if negotiations are still pending with another firm. As a consequence, the negotiations with the first firm must be terminated.)

In many cases, especially in the public sector, the owner may require that cost of services be established before selection of a consultant. Owners typically describe the firm to be selected as the one that provides the best combination of cost and quality. This allows the owner the leeway to select a firm that has provided the most technically outstanding proposal but not necessarily the lowest in price. In such instances, there are many ways in which cost may be included as part of the evaluation process. One approach is to include estimated cost as one of several weighted evaluation factors with other technical and professional qualifications. Another approach is to utilize a two-envelope system. This requires submission to the owner of the cost of services in one envelope and technical qualification data in another envelope. The owner opens the envelope with the technical qualification information first and rates the submission. Then, the owner opens the envelope with cost data and takes cost into account in the total selection process.

When determining the firm most qualified to undertake a project, an owner should consider technical qualifications, ability to absorb the additional workload in relation to the firm's capability and existing workload, experience, reputation, financial standing, and past accomplishments in related fields.

Because the cost of any service is important to an owner, an equitable fee for the services to be rendered has to be established. A caveat for owners is: "You receive only the professional services you pay for." If the fee is cut, services rendered are reduced. In the development of a project, it is important for an owner to receive complete and competent professional advice. If this is done, owners can be assured that their projects will be designed economically and efficiently. The fee paid for proper professional services will be a wise investment.

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2.6 Contracts and Fees for Design Services

The interests of owner, or client, and design professional are reflected in the design contract, or agreement, which should be in writing. It should define the duties and responsibilities of each party to the agreement. It should also describe the overall project requirements.

Several standard agreements are available for contracting for design services—for example, those developed by the American Institute of Architects and those developed under the auspices of several engineering organizations. The latter standard agreements include documents issued by the Engineers Joint Contract Document Committee (EJCDC), formed by the National Society of Professional Engineers (NSPE), American Consulting Engineer's Council (ACEC), and the American Society of Civil Engineers. Representatives of the Construction Specifications Institute (CSI) also participate in the development of these documents and the CSI endorses them.

The basic methods for determining fees for design services are lump sum, cost plus fixed fee, and percentage of construction. The last method is the least often used.

Lump Sum Fee ■ A fixed fee is arrived at by estimating the man-hours and expenses anticipated for rendering the service. When the scope of a project is specifically outlined, the consultant can evaluate anticipated costs for services by analyzing the demands of the project and drawing on experience and knowledge of the firm's capabilities. The consultant can translate the project into man-hours required and compute the cost. To the cost of labor must be added overhead, any expenses beyond those normally included in the overhead factor, any unusual elements that might add to costs, and anticipated profit. Although the fixed fee may be established by using accepted industry percentages as a yardstick, the contract is negotiated for a lump sum regardless of the project's eventual construction cost. Only if there is a change in the scope of services initially agreed on will there be a possible change in the fee.

A variation of this form of payment is the lump-sum fee plus expenses, which is used if there are extraordinary expenses, for instance, a more-than-normal amount of travel to a distant site, or if

subsoil investigation and surveys are included in the consultant's scope of work.

Cost Plus Fee ■ The cost-plus type of contract is normally used when the scope of work cannot be readily defined. Then, the owner agrees to reimburse the consultant for costs plus a fee. The reimbursable costs consist of technical payroll and actual expenditures, such as travel, subsistence while away from home, long-distance telephone calls, and other costs incurred directly for the project. Normally, the fee is determined by a factor applied against payroll cost. The factor compensates the consultant for management, overhead, indirect costs, and fee. Principals, partners, or officers, if engaged in actual production work (technical, as differentiated from administrative), are reimbursed for their services in the same manner as employees on the payroll.

A variation of this payment method uses a time factor (hourly or daily) with wage rates to reimburse a consultant for costs, overhead, and fee. For example, owner and consultant may agree on a rate of pay for a category of employee and multiply this rate by an overhead-and-fee factor. If a designer's average rate were set at \$15 per hour and the overhead factor at 150%, the payment provision in the contract would state that reimbursement to the consultant for the designer's time would be at \$37.50 per hour ($\$15 + 1.5 \times 15$). Rates also would be set for other categories of personnel to be employed on the project.

Additional cost-plus arrangements most commonly used by federal and other public agencies establish both a basis for identifying all allowable costs and for setting a fixed fee at the time of contract negotiation. Although calculated as a percentage (frequently 10%) of estimated costs, this fee remains fixed (a lump sum) for the contract unless there is a change in the scope of work. The fixed fee covers profit and nonallowable costs. Allowable costs are reimbursed as incurred for the prosecution of the work. Such costs include direct labor, direct project costs, and overhead and indirect costs attributed to the labor base. Federal Procurement Regulations spell out in great detail categories of costs, both allowable and nonallowable. All such costs are subject to audit and verification by government audit agencies. Contractors or consultants who contract with the federal government conduct yearly audits in which

they verify and agree on the cost basis to be utilized.

Such cost bases are traditionally labor costs (actual payroll costs) plus indirect costs (allowable overhead) and are translated into a percentage of the technical labor cost base. This percentage is reevaluated and recalculated periodically, normally consistent with the time of an audit or fiscal year.

Percentage of Construction Value ■ This percentage may be used as a guide by parties in determining a fee. If a percentage fee is negotiated between the parties, it is of great importance to define what amount will be used for the construction value. Will it be the estimated value or the actual construction value based on the contractor's low bid? If the fee is to be based on the estimated value, will the preliminary or detailed estimate govern? If the fee is to be based on the low bid, the design contract must state that the contractor's bid be bona fide since contractors sometimes make mistakes and submit improper bids. Furthermore, the design contract should provide for a payment method if, for some reason, construction does not proceed and no bids are available to establish a construction value for fee-payment purposes.

The percentage fee is now rarely used to establish the basis of a designer's compensation. Percentage values remain a viable yardstick for establishing or evaluating design costs. But, thereafter, it is more advantageous to a designer and owner to translate the percentage value to a lump sum fee for contract purposes.

Other Types of Fees ■ Some owners engage consultants on a retainer. However, this reimbursement method is not a substitute for payment of fees as previously described. An owner who has a continuing need for engineering advice and consultation may retain a professional engineer for a period of time, normally annually. The owner is free to call on the consultant for professional assistance on a continuing basis, such as attending periodic planning and development meetings. If, however, the service required becomes more than consultation and design of a project is called for, the retainer would not be sufficient compensation; a separate fee would be negotiated.

2.7 Managing Project Design

Managing the design of a project is similar to managing a business, only on a smaller scale. The design project manager must be able to control the cost to perform the work, the time it takes to complete and the quality of the finished design.

Critical to completion of the work in a professional manner is the development of a project management plan that defines the project and how it will be managed. The project management plan should include the scope of work, the hours by discipline that it will take to perform, the schedule and any milestone deliverables that are required, the budget allocated to perform each phase of the work, and a system for providing quality control. In order to properly prepare the plan, the project manager should review the contract that has been signed with the owner to see how the project has been defined and what services the owner required to be provided in order to complete the project. Budgets should be allocated to perform all facets of the work as defined by the owner in the contract. In addition to preparing the scope of work, areas of concern should be noted (such as unique conditions that exist on the project that must get special design attention) and an approach to managing them.

It is also necessary to identify the project organization and relationships within the organization. If subconsultants are to be used, their scope and costs should be included in the plan. The simplest way to do this is to draw a project organization chart, which defines responsibilities and reporting relationships.

The organization for a new design project generally is drawn from existing staff. Operating procedures depend on the size of the project and management's philosophy.

A professional staff, to function effectively and efficiently, should be able to draw on standardized procedures and up-to-date reference materials. The latter include design codes, standards, and design manuals.

A critical element in maintenance of design standards and design quality is the use of computers. Use of computers is changing the way projects are designed, how information is shared and ultimately how it is transmitted for quality assurance reviews and bidding. Computer programs have for years been used to simplify the drudgery of massive calculations used for design

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purposes. Programs exist to perform a wide diversity of calculations and designs from structural all the way to lighting. The CADD technician has replaced the manual draftsman. Alternatively, engineers prepare design documents on the computer themselves. Recently, the internet has become a great source of information allowing engineers access to the latest codes and standards. To allow engineers working at diverse locations to update drawings, companies have begun using web sites, which simplifies and expedites the coordination process. Owners have begun to require the development of web sites so that they can view progress on the design of their projects. Finally, some owners are now requiring digital copies of their projects on compact discs rather than blueprints. These same owners are providing contractors with a digital copy of their project which allows them to make their own prints.

Value engineering (VE), or value analysis, may be incorporated as part of the design process. Value engineering is a formalized and organized procedure in which a separate design team reviews the design at various stages to assess proposed designs. The team makes recommendations, as appropriate, for revisions that will both improve the design, increase value or affect cost savings. Value engineering often is utilized by some owners before start of construction to identify possibilities for reducing costs.

The earlier value engineering occurs, the more effective it is in reducing costs. If value engineering is performed during the schematic phase, it is relatively simple for the engineer to make changes to the design documents. As the design is developed and coordinated, it becomes more and more difficult to implement value engineering changes as it may affect many different parts or systems already incorporated into the design.

2.8 Project Methods and Standards

For efficient operation, a firm should establish standard methods and systems. This does not mean that once a procedure is established it is inviolate; it is subject to improvement and refinement. But within reason, the standard procedures should be adhered to on all projects. Without standardization, the result would be more than

wasting time: The firm would be unable to operate efficiently within available budgets.

A code number should be assigned to identify each project. A commonly used system identifies the project by a series of numbers, including the year (calendar or fiscal) in which a project is started. This number should be used on all work, whether a final drawing, rough calculation, or correspondence. All costs and charges pertaining to the project should also be identified by this number.

A standard procedure for the performance of all work should be established. This includes a procedure for checking calculations and a system for preparation and approval of drawings, from drafter's work to the final authorized signature. Regardless of what internal procedure is established, the ultimate objective is the same: to operate economically and efficiently. After a design problem has been evaluated and analyzed and a method of solution established, a typical design procedure would be as indicated in Fig. 2.1.

Because many specifications are similar to each other in outline and technical provisions, standardization of specifications can be most useful. This does not necessarily mean that the firm should

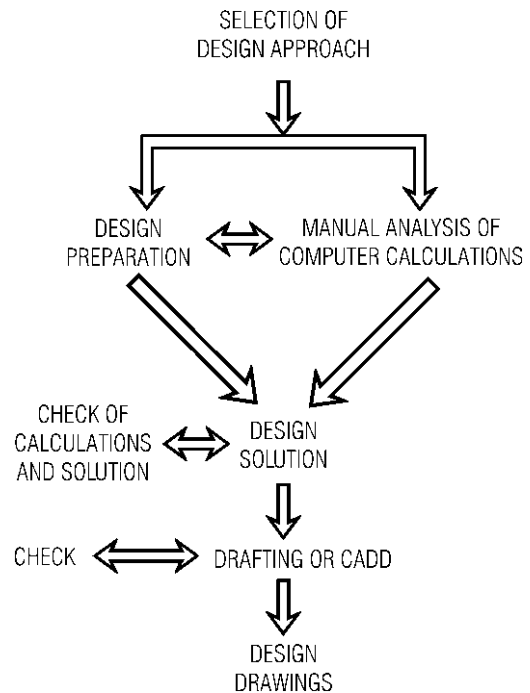


Fig. 2.1 Typical design procedure.

prepare “canned” specifications for use interchangeably on all projects. Each project has different requirements, but the various sections of the specifications should be prepared in a consistent manner on all projects. For instance, in a concrete specification, a typical section might contain the following major paragraphs: scope of work, related work (cross-referenced to other specification sections), general, material (cement, sand, aggregates, and so on), reinforcing steel, formwork, concrete strength and mixing, and concrete placement. Each paragraph has to be tailored to fit the requirements of a project—pier, bridge, or building. Many of the provisions, however, may be essentially the same in many instances, for example, the provisions for the quality of material in one geographic area.

For simplification, the firm may adopt standard specifications prepared by technical societies for an item, such as structural concrete. These specifications require the designer to insert requirements for a specific project but eliminate the necessity of writing anew for each project sections that are substantially the same for all projects.

2.9 Project Quality Control

The quality of a firm’s product should be of continuing concern to all members of the firm. Achievement of quality requires sound engineering practices, especially compliance with codes, standards, and legal regulations.

Quality control (QC) is a continuing process that can be part of a quality-assurance (QA) program. Whether or not formal programs are instituted for the purpose, good engineering practice requires procedures to be established to check product quality. These should comprise reviews at various stages of design development to evaluate the quality of the work.

Interim reviews often are required as part of a designer’s scope of services. Designers generally submit the work formally to the owner at various stages of completion, such as at completion of preliminary plans (30%), design plans and details (75%), and final bid plans (100%). A firm may utilize separate review teams to check work performed by others before issuance and use of design drawings and specifications for construction.

Designers should assure that products comply with applicable codes and standards. This requires

familiarity with the latest statutory requirements and awareness of the latest regulations issued by the various agencies that have jurisdiction. This is especially significant for any work that has potential environmental impact, even though environmental impact statements may have been completed under prior contracts.

To assist in maintenance of quality in construction, engineering societies have promulgated programs such as total-quality management (TQM), which addresses and reviews a firm’s practices. The objective of TQM is to promote quality within a design organization and of its products. TQM is implemented internally through ongoing training of all members of the organization to continuously seek quality in the firm’s work practices and product and thus to achieve desired quality of results.

Many engineering firms and owners are becoming ISO 9000 certified. ISO 9000 is a quality assurance system developed a little more than a decade ago that establishes international standards for producing a high quality project. This is formal recognition that a firm has developed and maintained a Total Quality Management system to perform its design work. In order to maintain ISO 9000 certification, a firm must be regularly audited to demonstrate that it has complied with the standards. Major elements of the system include the preparation and use of a quality assurance manual, active senior management involvement, and implementation of a non-conformance documentation system.

Peer Review ■ This is a procedure employed by a firm for a specific project wherein the firm contracts with an outside group, the “peer”, to review policies and practice for the purpose of achieving the highest level of quality in design of the project.

A peer review is conducted by designers with the same expertise as those who prepared the design and who have no relationship with the designers and are totally independent. Peers can be individuals from other departments of the firm or other organizations. The designer of record, however, is not replaced by the peers. The review should result in a report of the findings of the peers. It should not be considered a criticism of the designers or their work. A peer review, unlike other design reviews, does not have a specific objective

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other than quality, such as cutting construction or life-cycle costs, value engineering, or a constructability review performed as part of construction management.

2.10 Scheduling Design

Without proper scheduling, a firm may find that its operation is as inefficient as if no standard procedures were used. To accomplish a design, the firm is essentially scheduling workforce needs. This task becomes more important with the number of projects to be handled at the same time. A properly run firm should be able to schedule its work so as not to take on more than it can adequately handle with a stable size of staff.

For scheduling total workload, individual project scheduling is essential. The simplest and most common device for this purpose is the **bar chart**, a graphic representation of workforce (represented by bars) plotted against time. By studying such a chart, one can quickly determine job start and completion dates and when and for what workforce needs will be greatest.

Scheduling devices such as the critical-path method (CPM) and program evaluation and review technique (PERT) have a definite place in programming design-workforce requirements. Although the design project for which a complete CPM or PERT study would be employed is unusual, modification or limited use of these programming devices is warranted in many cases. A complete computer CPM program, including scheduling costs as well as time and evaluating the economics of "crash" programs, would be used only on the most complex projects. Because more thorough planning is required, use of the basic CPM and PERT activity diagram can often result in a better scheduled project than if a bar chart were used. With the use of a bar chart, the start or completion of activities represented by a bar can be extended a week or more without affecting the basic schedule. A CPM or PERT diagram does not permit this since the diagramming of the activities interrelates them all and the change in time in one activity can affect all.

2.11 Production Control

Once a project is undertaken, the work involved has to be completed regardless of time or cost. Still,

the firm must operate within a budget so design can be performed efficiently. A designer does not deal with a tangible product for which the firm can establish a cost per unit and operate on a production line basis. Nor should the firm go to the extreme of establishing a control in such a manner that the cost becomes more important than the product.

Cost control in its simplest form is a matter of bookkeeping. The firm should keep records of all costs relating to each project. At the end of a project, therefore, the firm should know the costs and income received and whether the work was done at a profit or loss. When a firm undertakes a new project similar in nature and size to one completed previously, a record is available to guide the new activities. Such cost accounting can be refined to varying degrees.

Also, it is well to know one's financial standing as to work on hand before completion of the work since it may be years before some projects are completed. During the course of a project, the firm should project the costs and income based on percent completion at a particular time to determine whether they are in line. Such projections should be made periodically to gain a picture of the financial condition of the firm's operation at a particular time.

Many engineering firms use computerized financial control systems to monitor costs and help to manage projects. These systems allow a project manager to monitor personnel and expense costs charged to their specific project on a weekly or monthly basis. This allows the project manager to compare the actual cost expended to date versus the budgeted cost. If the actual costs are less than the budgeted costs, the project manager can be assured that the project is in good financial health. However, if the actual costs exceed the budgeted costs then the project manager must determine what elements are over budget and develop a corrective action plan to bring the project back to within budget.

Cost accounting serves an additional purpose: it establishes controls during the programming of the work. These controls enable the firm to determine where productivity and efficiency need improvement before the end of the project when it is too late.

A professional firm, like any business, is concerned with making a profit. Maintaining a proper profit margin is essential to survival and growth. Such a profit margin varies with the size of

a firm and number of principals; whether principals are on a salary, as in a corporation, or not, as in a partnership. Cost control is an important tool for helping managers ensure the required profit margin to keep the firm operating efficiently.

(T. G. Hicks, "Standard Handbook of Consulting Engineering Practice" McGraw-Hill Book Company, New York.)

2.12 Internal Organization of a Design Firm

Basically, an engineering firm consists of technical departments and administrative and support staff. Figures 2.2 to 2.4 illustrate typical consulting firm organizations.

Technical Departments ■ Depending on the size of the firm, the technical department can be divided into divisions, such as structural, civil, mechanical, and electrical engineering and architectural. These divisions can be subdivided and overlapped under the direction of a job

captain, project manager, or project partner for particular projects. (In very small firms, many functions are performed by one individual, including the proprietor.)

There are numerous ways of organizing a technical department (see, for example, Figs. 2.2 to 2.4). The most important consideration in any organization is communication. Whenever a firm is formed or expanded or new departments are established, communication should be considered of prime importance. The flow of information between line levels should be well-defined. Furthermore, there should always be one individual who acts as project manager or captain in a position to coordinate all activities whether they are only those of departments within the organization or those of outside contractors or consultants involved in the project.

Many firms also have a separate construction or construction-management department, which consists of the project and construction managers, resident engineers and inspectors required on a project site, and project engineers rendering field consultation services and coordinating the efforts

SMALL FIRM OR (INDIVIDUAL PROPRIETORSHIP)

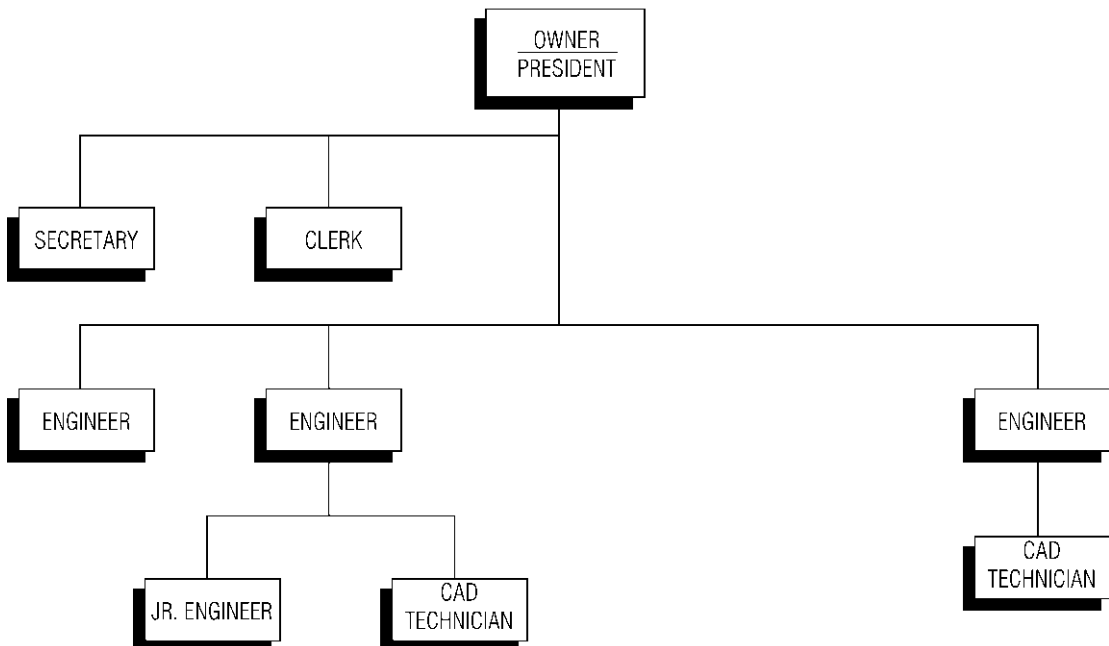


Fig. 2.2 Typical organization of a sole proprietorship.

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CONSULTING FIRM (PARTNERSHIP OR CORPORATION)

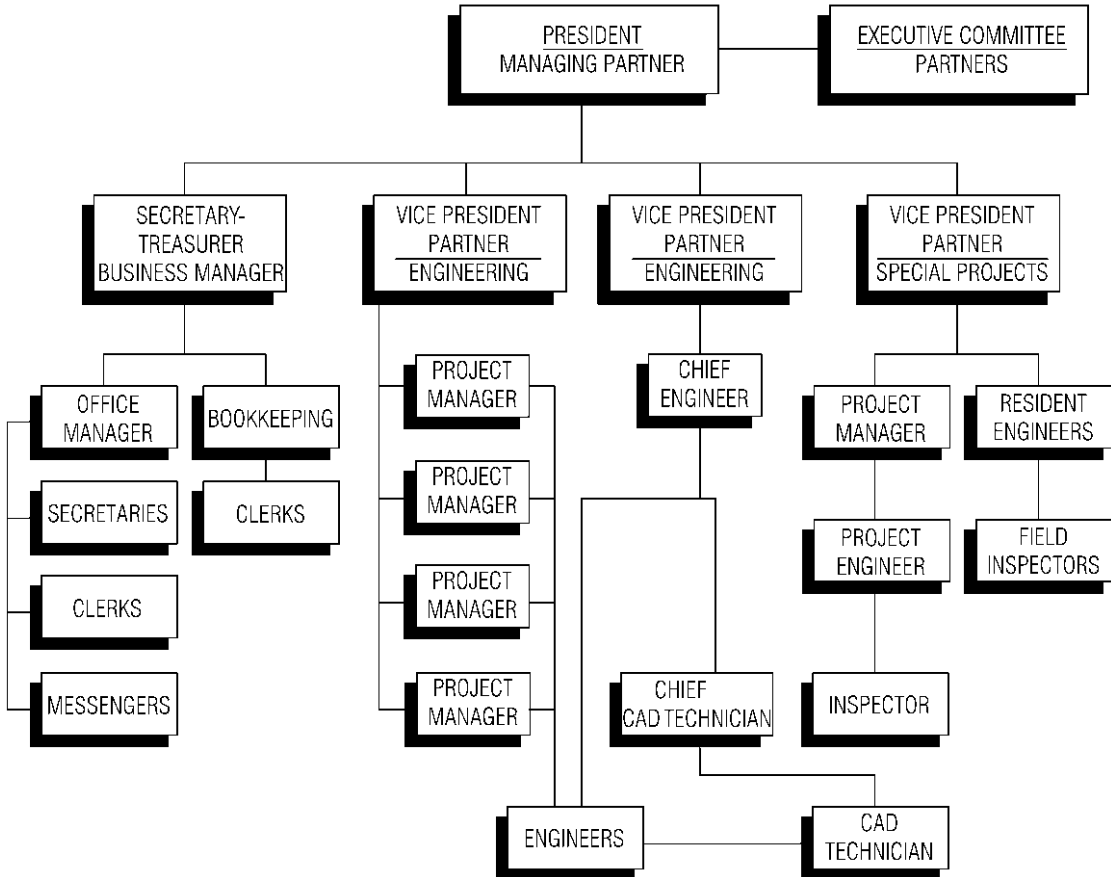


Fig. 2.3 Typical organization for a consulting firm.

of field personnel. Instead of establishing a separate department for this function, some firms have the project engineers for design in the various design divisions continue in the same capacity through the construction phase; they draw on a nucleus of field personnel for backup, as necessary, for on-site inspection.

Computer-aided design and drafting (CADD) offers designers multiple options and flexibility in design organization. Designers can draft their designs at their desks, using appropriate design software, and need not rely on drafting support.

Primary support functions are new business development, human resources, accounting, and office support services.

New Business Development ■ Professionals do not sell services directly; they must apprise the market of their availability. The firm has to prepare qualification data (Arts. 2.3 and 2.5), which can range from completion of standard prequalification forms to preparation of elaborate brochures, supplemented with extensive project descriptions and photographs. Although a new client may make the initial contact and retain a design firm without prior communication, a design organization cannot rely on this manner of receiving new business. As a consequence, client contact is an essential part of an organization's operation.

Client contact can be limited to impersonal contact by mail or range to active sales efforts,

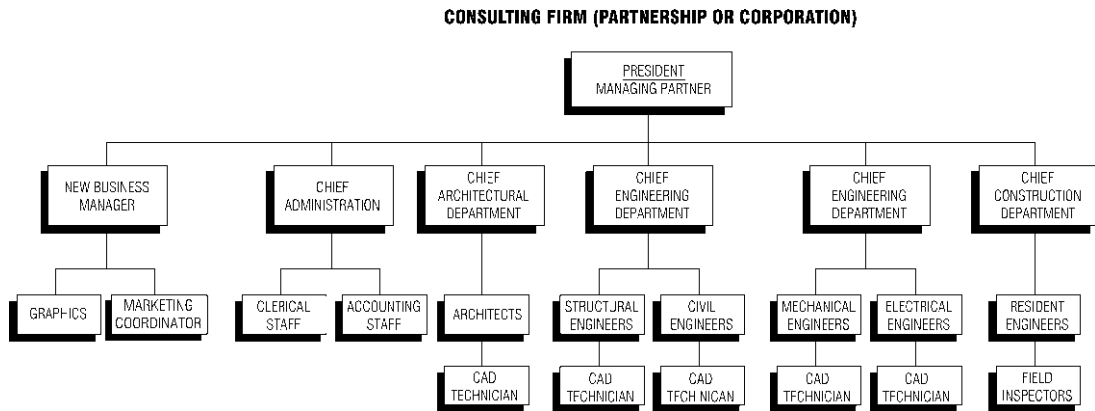


Fig. 2.4 Alternative organization for a consulting firm.

where an employee or principal (or even a staff if the size of the firm warrants it) makes personal calls on potential clients. The name of a firm has to be promoted continuously, which requires good public relations. Sales efforts, however, should not be a substitute for quality of service.

In the face of intense competition and the need for growth and diversity of a firm, the search for new markets and development of new business are vital functions.

Employee Compensation ■ Employers have specific legal obligations. They must pay payroll taxes, such as Social Security and state unemployment and disability, and they must withhold taxes from employees' earnings. These requirements result in administrative burdens involving the filing of forms and reports. There are insurance obligations and statutory requirements, such as workers' compensation. Also, an employer has obligations mandated by federal and state laws, including labor laws affecting minimum wages and overtime and regulations governing working conditions, equal employment, and safety.

Employers may wish to give employees the opportunity to subscribe to medical and other forms of insurance as a group, and they may pay all or part of the costs for other benefits including 401K and pension plans. In the competitive market for skilled personnel, such fringe benefits must be added to the basic wage.

Employers should have firm wage and salary policies. Besides paying a competitive wage, they must establish policies for salary reviews and

increases, salary ranges for various types of positions, bonuses, and whether to include a profit-sharing plan. Primarily, however, employers should give employees opportunity for advancement. Also, they should give recognition for efforts on behalf of the firm. If employers can instill the pride of accomplishment and profession, they will have efficient and happy workforces.

Accounting ■ To operate efficiently, a firm must be able at all times to evaluate and analyze its financial position. For this, the firm has to maintain proper accounts. The compiling and recording of all transactions relating to the financial aspects of a business are the basic responsibility of accounting. The recording of financial transactions has to be orderly for proper interpretation, to make possible preparation of financial statements and to provide information on the economic health of the business. (See also Art. 2.11.)

The method or extent of bookkeeping varies with each firm's size and needs. Normally, the double-entry system (classification of accounts into assets, liabilities, and net worth) is used. Each firm maintains journals and ledgers. The journal is a daily record of all transactions, debits, and credits; the ledgers carry the journal entries in specific accounts. Again, the number and extent of ledgers required vary with the firm.

A consulting firm has to decide how it is going to maintain its books for tax purposes, whether on a cash or accrual basis. On a cash basis, income is recorded when cash is received and expenditures are recorded when they are made. On an accrual

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basis, income is reported when earned and expenditures (or debits) when incurred, regardless of the time the cash transaction takes place. When tax considerations are significant in the business operation, the choice of accounting system is of primary importance; as is evident, a firm's cash and accrued statement at the same time could be quite different.

Although it is poor business practice to take a particular action solely because of the tax consequences, tax considerations are important in a consulting firm's business practice. The initial decision of which form of organization to operate under should take into account the different tax consequences on individuals, partnerships, and corporations. Depending on income, a corporation may pay a large federal income tax; in addition, its dividends are taxed. A partnership pays no tax on its income, but the partners, who receive no salaries, are taxed as individuals on their share of the firm's earnings. State and local taxes should also be considered when establishing and operating a design practice.

Payroll is a consulting firm's largest expenditure. Payroll costs should be identified as direct (technical) and indirect (administrative). Records of direct costs, preferably by department, should be maintained for each project. Also, identifiable direct expenses, such as travel, subsistence, and other allowances, long-distance telephone and telegraph, and reproduction costs, should be accounted for and identified as a job expense. Major indirect or overhead expenses should also be identifiable to enable management to analyze indirect costs and their relation to fees earned during a specified period.

In addition to internal accounting, it is customary and advisable to have an audited financial report prepared by a certified public accounting firm at the end of each fiscal year. For firms of any size and especially those not closely held (public), such certified audits are essential. Also, firms, regardless of size or type of ownership, that work in the public sector must undergo independent and certified audits.

From its inception on, an engineering firm is concerned with finances. For one thing, a consultant is not reimbursed for a firm's services the day after they are rendered. Terms of payment depend on contract conditions. Payments may be monthly, or the first payment may not be due until 25% (or another percentage) of the work has been

completed. Also, the final payment may not be received for a long time after all expenditures have been made. This sums up to one basic need: capital.

Consulting engineers must have capital to start and operate their organizations. The source of capital may be a loan or earnings. But regardless of the source, there must be proper financing to meet financial obligations that cannot be deferred until accounts are paid. In particular, when interest rates are high, financial management becomes a critical aspect of all businesses, including that of a design firm.

Insurance ■ A firm's insurance portfolio normally includes coverage for general liability, property damage, automobile accidents, and professional (errors and omissions) liability. For design firms, all insurance requirements are dominated by the professional coverage. This insurance, which is written by a few insurance carriers, protects a designer from liability resulting from a design error or omission. Because of the extensive litigation prevalent in the construction industry, with designers being named as defendants for alleged design error or as third-party defendants, the cost of this insurance is high. (This is also true in other professions, such as medicine.) This has resulted in a need for many practitioners to reevaluate the extent of their activity, to increase their fees to cover such costs, and, in limited instances, to forego this liability coverage.

Office Support Services ■ The administrative staff's primary function is internal operation of the firm. Personnel on the administrative staff may include an office manager, secretaries, word processors, receptionist, file clerks, and office employees. The number of employees and degrees of responsibility vary with the size of firm. However small the firm may be, the basic administrative duties have to be fulfilled: Letters have to be word processed; so do reports. Files have to be maintained, telephones answered and messages taken, and plans reproduced. Although all the elements that constitute office management are secondary to design, the primary function of the firm, they should not be neglected. Even with electronic communication, an unattractive letter can make a poor first impression on its recipient, who may be a potential client. A first impression of a firm can also be made by the manner in which the

telephone is answered. So although the administrative duties are routine in most offices, they should be handled as competently as the technical work. The administrative positions should be filled by competent, properly trained personnel.

In an engineering firm, there is a substantial amount of reproduction of plans and specifications and duplication of reports. The mechanics of providing the necessary reproductions is best handled by a separate department within the firm. Whether the work is done on office-owned equipment or sent out to a printing company is a matter of economics determined by the firm's volume. In addition, office services must encompass selection of the most economical and efficient office systems for the firm. For efficient, economical operation, a design office should be equipped at least with computers (personal or servers and workstations), plotters, high speed Internet connections, modems, fax (telefax) machines, and copiers, in addition to the usual desks, record-storage facilities, telephones, and good illumination. Office managers should be familiar with current electronic systems, innovations, and be able to judge their applicability to the firm's needs.

2.13 Professional Societies

The role of professional societies, such as the American Society of Civil Engineers and various associations of consulting engineers, initially was determined by their existence as organizations of individuals rather than firms. At first these societies were concerned mainly with technical matters and very little with business affairs. Although the medical, legal, and accounting professions each have one major society that speaks for them, this is not the case for civil engineers, who are generally represented by the American Society of Civil Engineers, American Consulting Engineers Council, or National Society of Professional Engineers. These societies, however, collaborate with each other on matters of common interest.

In a complex and progressive economic society, few firms other than industry giants have the resources to stay abreast of all the latest developments; keep informed of all current legislation, state and federal; and be aware of all administrative rules, regulations, and factors influencing

their day-to-day activities. An association can fill these needs, and by serving these needs, professional associations are playing a more important role than previously.

In prior years also, a design firm was "on its own." It had little knowledge, if any, of the activities of its competitors or even of its closest associates. Today a firm still is on its own in the competitive marketplace, but it can pool its resources in associations that represent the profession and industry. United action and sharing of information advance the interests of individual firms.

Activities of professional groups now include:

Legislation ■ Maintaining database on current legislation; representing and filing position papers with Congress and state legislatures on pending bills in which association members have a vital interest.

Government Relations ■ Liaison with various administrative agencies, federal, state, and municipal. This area could include assistance to member firms interested in capitalizing on opportunities abroad.

Liaison with Industry ■ Maintaining contact with other organizations and establishing joint committees to study and evaluate areas of common interest.

Publications ■ Initiating and distributing to members documents reporting current activities and areas of importance and concern.

Insurance ■ Establishing group insurance policies (life, accident, health, and so on) to give smaller members advantages of larger group plans; advising member firms in fields of common concern, such as professional-liability insurance, an area of increasing concern because of numerous third-party suits against consulting engineers.

Engineering Practice ■ Acting as a pool and distribution center for information on the latest technical developments and areas of interest to the profession; sponsoring continuing education programs.