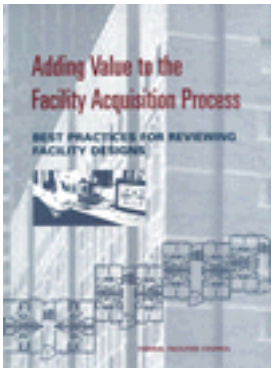

Adding Value to the Facility Acquisition Process: Best Practices for Reviewing Facility Designs

Authored by Ralph S. Spillinger in conjunction with the Federal Facilities Council, Standing Committee on Organizational Performance and Metrics, National Research Council

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Facility Acquisition Process

BEST PRACTICES FOR REVIEWING FACILITY DESIGNS

Authored by Ralph S. Spillinger in conjunction with the Federal Facilities Council Standing Committee on Organizational Performance and Metrics

Federal Facilities Council Technical Report #139

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Adding Value to the Facility Acquisition Process: Best Practices for Reviewing Facility Designs

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Executive Summary

BACKGROUND

The federal government, like private corporations and other organizations, acquires buildings and other facilities to support specific functions and missions and the general conduct of its business. The federal government is, in fact, the nation's largest owner of buildings and spends more than $20 billion per year for facility design and construction (NRC, 1998).

When acquiring a facility, most owners, both public and private, participate in a multiphased process involving conceptual planning, design, procurement, construction, and start-up. Traditionally, design review has been viewed as a discrete component of the facility acquisition process that primarily involves reviewing a facility design that was prepared by others, either an in-house design team or an architect/engineer firm. However, in developing a detailed scope of work for this study, the Federal Facilities Council found that no two of the sponsor agencies defined the design review process and its elements in exactly the same way. Nor was a common start or end point identified for design review.

In view of the lack of a commonly accepted definition of the elements, duration, and substance of the design review process, the Federal Facilities Council determined that it would focus on practices for reviewing facility designs over the entire facility acquisition process, from conceptual planning to start-up. Stated another way, in this study the term design review is used to signify the review of facility designs as part of a multiphased process and is not limited to reviewing designs during the design phase of facility acquisition.

STUDY ISSUES AND OBJECTIVE

The core issues of this study concern the value-added of design review processes and the appropriate role of facilities owners, particularly federal agencies, in such processes. The study objective was to identify a range of best practices and technologies that can be used by federal agencies and other owners to provide adequate management and oversight of design reviews throughout the facility acquisition process.

FINDINGS

Finding 1. Effective design review processes add value by saving time and money over the entire facilities acquisition process. Effective design review processes result in the preparation of more comprehensive and

accurate design and construction documents that, in turn, result in lower project construction costs. Areas of savings include less rework on the part of the construction contractor, fewer change orders to the owner for correction of design errors or omissions and the cost of belatedly adding project upgrade features that should have been addressed in the original design. Indirect cost savings can be realized by avoiding costs associated with loss of productivity during construction-delayed facility start-up, and litigation. In short, effective review of designs maximizes the probability that a business requirement will be successfully supported by a facility that was conceived, designed, constructed, and placed into operation efficiently and effectively.

Finding 2. The team responsible for design oversight should include participants from all project stakeholders: owner, user, architect/engineer, construction contractor, operation and maintenance staff, and major equipment vendors. The team should participate in and contribute to design-related activities associated with each phase of the facility acquisition process, i.e., from conceptual planning through start-up.

Finding 3. The use of metrics by federal agencies to measure the value-added of design review processes is not well established. Although research has been conducted by the Construction Industry Institute and other organizations to identify metrics that may be used to measure both the efficiency and the effectiveness of each phase of the facility acquisition process, the extent to which individual federal agencies measure design review processes and analyze results is highly variable.

Finding 4. To provide effective oversight of design review processes, the owner's interests are best served if the in-house staff can fulfill the functions of a "smart buyer." A smart buyer is one who retains an in-house staff that understands the organization's mission, its requirements, its customer needs, and who can translate those needs and requirements into corporate direction. A smart buyer also retains the requisite capabilities and technical knowledge to lead and conduct teaming activities, accurately define the technical services needed, recognize value during the acquisition of such technical services, and evaluate the quality of services ultimately provided.

As long as the owner retains the in-house capabilities to operate as a smart buyer of facilities, there does not appear to be any greater risk from contracting out a broad range of design review-related functions, so long as such functions are widely available from a competitive commercial marketplace. If the owner does not have the capacity to operate as a smart buyer, the owner risks project schedule and cost overruns and facilities that do not meet performance objectives.

Finding 5. The ongoing revolution in information technology and communications offers opportunities to improve design review processes. Examples include audio and video teleconferencing, immediate and widespread data distribution via the Internet, computer-aided design and drafting, and a wide range of project management software. Emerging technologies such as the use of holographic projection techniques to create three- and four-dimensional models of project designs guarantee a continuing stream of future enhancements.

BEST PRACTICES FOR REVIEWING FACILITY DESIGNS

Research conducted by the Construction Industry Institute, The Business Roundtable, the National Research Council, and the Federal Facilities Council, among other organizations, and interviews conducted for this study resulted in the identification of 18 best practices for the review of designs, summarized as follows:

Role of the Owner: Be a smart buyer. Develop a scope of work that clearly and accurately defines the owner's expectations regarding cost, schedule, performance, and quality. Avoid the temptation to micromanage the design review process.

Teamwork and Collaboration: Use teambuilding and partnering techniques. Ensure that all interested parties participate in design review processes. Use the same architect/engineer throughout the process. Use senior, experienced staff to evaluate the evolving design and guide the review process. Commit for the duration of the activity. Participate in a design awards program.

Advance Planning: Focus attention at the front end during the conceptual planning and design phases where the ability to influence the ultimate cost of the project is the greatest. Do not start the final stage of design until the preliminary engineering is complete.

Process: Tailor the review approach to project specifics. Keep up the pace of the process to maintain momentum. Pay special attention to civil, structural, architectural, electrical, and mechanical interfaces. Exploit technology. Conduct a post occupancy evaluation to develop a lessons-learned document.

Benchmarking: Measure results achieved by the design process. Document both unusually good and bad performance.

OPPORTUNITIES FOR FOLLOW-ON STUDY

Four areas were identified where additional research and discussion could lead to either fundamental new approaches or significant improvements to current practices: (1) establishment of a senior-level advisory group on federal facilities issues; (2) identification of a set of metrics that could be used to measure performance across all phases of the facility acquisition process; (3) an evaluation of current practices of federal agencies with regard to the standards, guidelines and policies supplied to architect/engineers in support of facility acquisition activities; and (4) a study of the potential benefits of establishing a peer review process for agency design review practices.

1

Introduction

Because [design review] is a subjective process, it depends for its success on the quality, reasonableness and experience of the design review panel. As a result, experiences vary dramatically. George M. White, Architect of the Capitol (Brown, 1995)

BACKGROUND

The federal government, like private corporations and other organizations, acquires facilities to support specific functions and missions and the general conduct of its business. The federal government is, in fact, the nation's largest owner of buildings and other constructed facilities and has the largest annual budget for facility design and construction in the United States. Worldwide, the federal government owns more than 500,000 buildings, facilities, and their associated infrastructures (roads, utility plants, distribution systems and the like) valued at more than $300 billion (NRC, 1998). As an owner, the federal government and its agencies are responsible for the stewardship (i.e., responsible care) of these facilities on behalf of the American public.

Confronted with a requirement to acquire a building or other constructed facility, owner organizations, both public and private, traditionally participate in a multiphased process involving conceptual planning, design, procurement, construction, and start-up. Throughout this process, owners usually maintain some level of design oversight to ensure that the acquired facility is an acceptable balance of cost, schedule, quality, and performance.

Until the 1990s, federal agencies often maintained an in-house facilities engineering organization, comprised in part of architects and engineers, responsible for both the technical aspects and the oversight of the planning and design phases of the acquisition process. As a result of executive and legislative initiatives to reduce the size of the government, federal agencies have downsized their design and engineering staff. Agencies are increasingly using outside consultants to provide technical expertise for the planning and design phases of both new projects and major renovations of existing facilities. Although oversight responsibility for the facility planning and design phases generally remains within the agencies, fewer staff resources are being devoted to the effort than in the past.

Concurrent with downsizing, procurement regulations have been modified to allow agencies greater flexibility and choice in selecting contracting methods for acquiring facilities. As recently as five years ago, the design-bid-build method for facility acquisition was used almost exclusively. Today, agencies increasingly rely on design-build, construction management, and program management contracting methods. Further, advances in

computer-aided design and other technologies are occurring simultaneously with process changes in federal agencies, increasing the importance of technology support in the design process.

In this changing facilities acquisition environment, the sponsor agencies of the Federal Facilities Council (FFC) determined that a review of issues, practices, and methods related to the design phase of the acquisition process could be of benefit. The FFC is a cooperative association of federal agencies, each of which requires the acquisition, maintenance, and operation of a significant inventory of buildings and other constructed facilities in support of its mission.[1]

DEFINING DESIGN REVIEW

Because of resource constraints, the FFC initially chose to focus on the design review function of the design process. Prior to developing a detailed scope of work, the sponsor agencies shared information on their own design review processes and the design review processes of some private sector organizations with which they were familiar. Analysis of this information revealed that no two of these organizations defined the design review process and its various elements in exactly the same manner. Nor was a common start or end point identified for design review as an element of the facility acquisition process. For some organizations, design review was limited to reviewing a consultant-prepared schematic design to ensure that it met the owner organization's functional requirements for floor area, functional adjacencies and connections, and budget. For other organizations, design review primarily involved reviewing a more detailed facility design prepared by an in-house design team or a private sector architect/engineer firm under contract. The level of the review and the elements reviewed—for example, architectural reviews, mechanical and electrical interface reviews, or constructability reviews—also varied. Some processes were formal, incorporating design reviews at specific design milestones (e.g., 15, 30, 60 percent design). Others were less formal, relying on periodic meetings between the owner and the design team to review the progress being made toward final preparation of final construction contract plans and specifications.

In view of the lack of a commonly accepted definition of the elements, duration, and substance of the design review process, the FFC determined that it would focus on practices for reviewing facility designs over the entire facility acquisition process, from conceptual planning to start-up. Stated another way, in this study the term design review is used to signify the review of facility designs as part of a multiphased process and is not limited to reviewing designs during the design phase of facility acquisition.

STUDY PURPOSE AND OBJECTIVE

The core issues of this study concern the value-added of design review processes and the appropriate level of oversight for owners of facilities, particularly federal agencies, in such processes. The study objective was to identify a range of best practices and technologies that can be used by federal agencies and other owners to provide adequate management and oversight of design reviews throughout the facility acquisition process. Specifically, the study seeks to provide answers to the following questions:

- What is the value-added of design review processes?
- How do (and how can) federal agencies measure the value-added?
- What is the role of in-house staff, and what value do they add to design review processes?
- What functions are being (and should be) contracted to outside consultants?

[1] The federal agencies that sponsored this study through the FFC are the U.S. Air Force, Air National Guard, U.S. Army, U.S. Department of Energy, U.S. Navy, U.S. Department of Veterans Affairs, Food and Drug Administration, General Services Administration, Indian Health Service, National Aeronautics and Space Administration, National Institutes of Health, National Institute of Standards and Technology, National Science Foundation, Smithsonian Institution, and the U.S. Postal Service.

- What skills and resources do federal agencies need to provide effective oversight of design review processes?
- What risks and liabilities do federal agencies face in outsourcing most or all of their design review functions?
- How can new and emerging technologies be integrated into design review processes?

HOW THE STUDY WAS CONDUCTED

The members of the FFC identified the need for this study in the 1998 Technical Activities Program. The FFC's Standing Committee on Organizational Performance and Metrics had the lead responsibility for the planning, organization, and oversight of the study. The standing committee developed a two-part questionnaire and distributed it to FFC sponsor agencies. Part one was sent to senior facilities engineering program directors at the headquarters level and focused on agencywide policy issues. Part two was sent to randomly selected project managers at the field activity level and focused on design review for individual projects. (Copies of the two questionnaires are included in Appendix C). A total of 44 questionnaires were returned (21 of part one; 23 of part two). The following nine federal agencies answered the questionnaires:

- Air National Guard
- U.S. Department of Energy
- U.S. Department of State
- General Services Administration
- Indian Health Service
- National Aeronautics and Space Administration
- National Institutes of Health
- Naval Facilities Engineering Command
- U.S. Department of Veterans Affairs

The questionnaires were collected and provided to Mr. Ralph Spillinger, the author of this report. Mr. Spillinger is a consultant experienced with federal facility acquisition, the facility project design and construction process, and FFC activities (Appendix D contains Mr. Spillinger's biography). He was asked to analyze the questionnaire responses to compare and contrast design review processes as practiced by the nine responding agencies. Furthermore, he completed a literature search and conducted interviews with other public agencies, private sector facility owners, trade and professional organizations, and A/E firms to characterize the current state of the art from a broader perspective. (Appendix A contains a list of persons interviewed by Mr. Spillinger and their affiliated organizations. Appendix B contains abstracts of publications that were reviewed during the course of the study.)

The FFC and the Standing Committee on Organizational Performance and Metrics reviewed interim drafts of the report. The final draft of the report was reviewed by Dr. Sarah Slaughter, professor of civil engineering at the Massachusetts Institute of Technology and a member of the Board on Infrastructure and the Constructed Environment of the National Research Council.

ORGANIZATION OF THE REPORT

The remaining sections of this report are organized as follows. Chapter 2, Facility Acquisition Practices and Industry Trends, describes the facilities acquisition process; trends related to downsizing, process reengineering, contract methods, and teamwork; and collaborative processes. The roles of conceptual planning, benchmarking, technologies in design reviews, and the costs and benefits of design reviews are addressed. The chapter concludes with findings regarding effective design review processes.

Chapter 3, Design Review Practices in Federal Agencies, summarizes and analyzes the responses received to the questionnaires developed for this report. The results are analyzed at two levels:

- An agency-by-agency review that characterizes each of the nine responding agencies' approach to reviewing facility designs. In the case of those agencies with multiple reporting field activities, the analysis also looks at the process variability among field activities.
- A general overview of all 44 surveys received from the nine responding federal agencies. The analysis contrasts and compares design review practices among agencies.

Chapter 3 also identifies some interesting initiatives.

Chapter 4, Best Practices for Reviewing Facility Designs, summarizes the findings of the study as they relate to the value-added of design reviews, the skills and resources needed to provide effective oversight, and the role of technology. Based on these findings and other information, 17 best practices for design reviews are identified. The chapter concludes by identifying some opportunities for follow-on study.

Appendix A, Record of Interviews, provides the names and affiliations of individuals who were contacted and interviewed during the course of this study.

Appendix B, Literature Search Abstracts, contains abstracts of publications that were reviewed during the course of this study.

Appendix C, Benchmarking Design Review Process Questionnaire, contains copies of parts 1 and 2 of the FFC-developed questionnaire.

Appendix D is the biography of Mr. Ralph Spillinger, the author of this study.

Appendix E is the bibliography.

2

Facility Acquisition Practices and Industry Trends

Reviewers tend to start out with an attitude of general superiority over the applicant. They then proceed immediately into critical "instructive" mode: looking for trouble, in other words, and being satisfied only with pointing out flaws, as opposed to working in a collaborative or respectful advocacy. An inflexible, ham-handed, or uneducated reviewer is the architect's chief nightmare and number one complaint concerning design review boards. Brenda Case Scheer, Associate Professor of Urban Planning, University of Cincinnati (Brown, 1995)

FACILITY ACQUISITION PROCESS

The process of acquiring a facility usually includes five phases that can be generalized as shown in Figure 2.1. The contracting method used will determine whether the five phases occur in sequence or if some phases occur concurrently. The contracting method can also effect who is involved at each phase (architect, engineer, construction contractor, etc.). For example, using the design-bid-build contract method, the five phases generally occur in sequence with the architect/engineer (A/E) involved in the design phase and a construction contractor in the construction phase. A design-build acquisition, in contrast, will use the same contractor for the design and construction phases, thus allowing some phases and activities to occur concurrently. Regardless of the contracting method used, the acquisition of a facility will necessarily involve activities and decisions related to conceptual planning, design, procurement, construction, and start-up. A more complete discussion on contract methods and the role of the owner in the review of designs is provided later in this chapter.

During the **conceptual planning phase** various feasibility studies are conducted to define the scope or statement of work based on the owner's expectations for facility performance, quality, cost, and schedule. Several alternative design solutions can be considered during this phase, leading up to the selection of a single preferred approach. The preferred approach may be a schematic that includes functional requirements such as square footage estimates for various functions and adjacencies or connections of functions that are desirable or required.

The **design phase** usually starts once the statement of work and preferred design approach have been developed. From the schematic, the design matures into final construction documents comprising the plans and specifications from which equipment procurement and construction bids can be solicited. Estimated facility cost and schedule issues receive increasingly intense review during the design phase so that the owner has a high level of

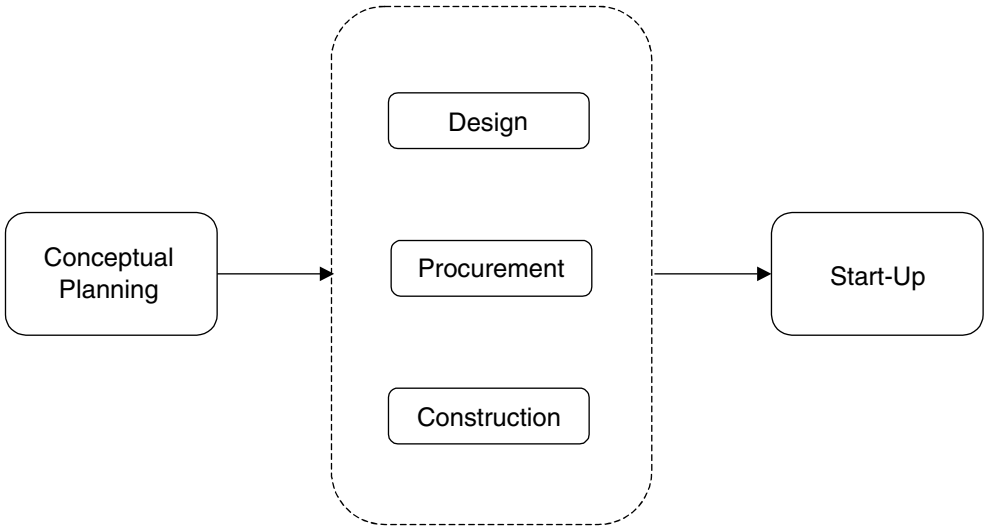

FIGURE 2.1 Generalized facility acquisition process.

confidence prior to bid that the performance, quality, cost, and schedule objectives defined during the conceptual planning phase can be met.

Complex facility projects usually include a **procurement phase** in order to expedite the purchase, manufacture, and delivery of long-lead-time equipment such as unique process machinery, large electrical and mechanical equipment, and sophisticated architectural components. Such equipment procurement may proceed in parallel with construction phase activities, so that the owner ultimately is able to furnish long-lead-time equipment to the construction contractor in a timely manner, thus avoiding construction delays attributable to late equipment delivery.

Early in the **construction phase** a formal construction management plan is developed describing the intended sequence and method of construction activity as well as the relationships, responsibilities, and authorities of all involved parties (owner, user, A/E, construction contractor, speciality contractors, and relevant consultants). The biggest challenge during the construction phase is managing changes resulting from such sources as scope of work changes by the owner, errors and omissions in the construction documents, and unknown or changed site conditions. The construction phase is considered complete when the owner accepts occupancy of the facility, although final completion of construction may continue for months (or even years) until identification and resolution of all discrepancies are mutually agreed upon.

The **start-up phase**, sometimes called commissioning, begins with occupancy of the facility by its user. Building components are tested individually and then in system with other components in order to measure and compare their performance against the original design criteria. Facility operation and maintenance plans are implemented, tested, and refined as appropriate.

A BRIEF HISTORY

During a 1995 seminar sponsored by the National Endowment for the Arts, Robert A. Peck (deputy director, Federal Communications Commission) and David M. Childs (senior partner, Skidmore, Owings & Merrill) spoke of the early days of federal building design and construction. Mr. Peck noted that from the early 1800s through the 1930s, most federal structures were designed by in-house design organizations. Mr. Childs agreed, noting that this period saw unusual excellence in civic buildings during three separate stages:

> The planning and design of Washington DC, the federal city that was to house the great buildings of the American Democracy, is one example. The great city halls and courthouses of the eighteenth and nineteenth centuries—ennobling buildings that were conceived and built when American society lacked the resources it now has—are another. The integration of art, craft, and architecture that characterized the great federal projects of the Works Project Administration (WPA) represents a third pinnacle of accomplishment (Brown, 1995).

Thanks in no small part to those early investments of the Works Project Administration, America's private sector design and construction industry has grown tremendously since the 1930s. As more and more design capability became available within the private sector, government agencies increasingly contracted with them for support services.

The 1980s will be remembered as the period when American society and its business institutions were undergoing what President Carter described as "a great malaise." American business competitiveness seemed to have hit a ceiling above which it could not climb, the economy was in a slump, and the American reputation for innovation and productivity had shifted elsewhere, primarily to Japan. Stung by such competitive failure, America's businesses began to search out and embrace fundamental changes to their business processes. New management theories and processes were tried including Results-Oriented Management, Management by Objective, Total Quality Management, The Deming Principles, and ISO-9000, an international standard. American business also explored the potential for enhancing productivity offered by an accelerating revolution in technology—particularly in the areas of information technology and communications. The result is history as the United States has retaken its world leadership role in business and manufacturing innovation, efficiency, effectiveness, and competitiveness.

Within the design and construction industries, productivity increases have resulted from a number of drivers including:

- New management practices that rely on collaborative processes for problem solving and which emphasize teamwork: close and constant participation by all interested parties, with a focus on aligning these parties to common objectives with mutually beneficial solutions.
- Technology advances such as computers, computer-aided design software, cell phones, and fax machines that have transformed both design and construction management efficiency and effectiveness.
- New construction equipment, especially for materials handling.
- Increasing mechanization of construction tasks.
- New products and systems incorporated into built facilities.

DOWNSIZING OF FACILITY ENGINEERING ORGANIZATIONS

This period of change has been particularly pronounced with regard to how corporate and government owners manage the acquisition of facilities and other projects. As noted by The Business Roundtable in a 1997 white paper,

> Virtually all major firms have reduced the size and scope of work performed by engineering organizations. Many firms are drifting because they are uncertain about the appropriate size and role of their in-house capital projects organization. Nearly every owner's engineering and project management organization in the US has been reorganized, sometimes repeatedly, without achieving a satisfactory result in many cases (TBR, 1997).

The extent of owner engineering downsizing and the resulting increased use of contractors to perform design and construction functions are illustrated by Figures 2.2 and 2.3. The graphs, published by The Business Roundtable, are based on data compiled by Independent Project Analysis (IPA) of Reston, Virginia, for more than 2,000 projects from a variety of industries.

Figure 2.2 shows the decline since 1970 of the percentage of major projects designed by owners' in-house staff. The rate of decline has accelerated since 1985. Many owners originally identified the project definition activity as a core competency (defined as an essential skill that should be retained within the organization in order

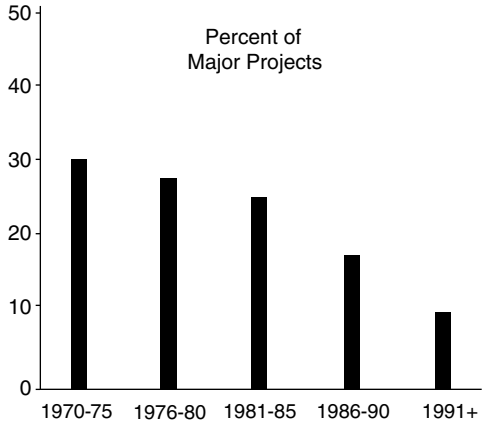

FIGURE 2.2 Owner-detailed engineering has almost disappeared. Source: TBR (1997).

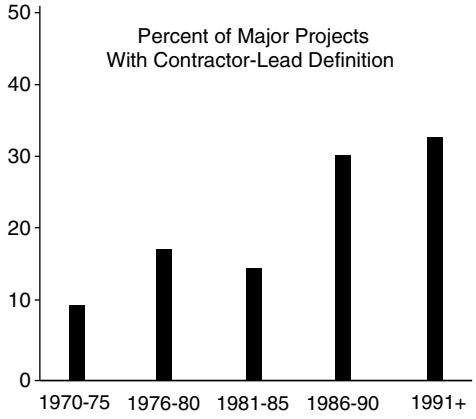

FIGURE 2.3 Engineering contractors are more involved in definition. Source: TBR (1997).

to perform effectively). However, IPA's data indicate that project definition, too, is increasingly being outsourced (Figure 2.3). Data compiled through 1997 by the Construction Industry Institute (CII)[1] , closely correlates with The Business Roundtable data (CII, 1998). Fortunately, an increasingly competitive, productive, sophisticated, and capable facility design and construction industry is capable and willing to take on this increased workload. Unfortunately, this trend has not reduced owners' overall engineering costs as a percent of total project cost (TPC).[2]

Figure 2.4 shows that the engineering share of TPC has increased over the past 20 years from 13 to 20 percent. The interpretation of this increase is controversial: It is not clear if the increase reflects an increased cost of outsourced engineering or simply the cost of increased intensity of engineering required by today's technology-driven projects and more sophisticated design and construction practices.

TRENDS IN PROJECT COST AND SCHEDULE

Ongoing research by CII into construction industry benchmarking and metrics indicates that overall project cost and schedule, as well as postcontract award cost and schedule growth, are being reduced throughout the construction industry. Nearly everyone is enjoying some degree of increasing productivity, a classic case of "a rising tide lifts all ships."

CII's research divides facility owners and construction contractors into four quartiles in terms of cost and schedule growth experienced on completed projects. In comparing results from approximately 1,000 projects of various types, CII found that owners and contractors in the first quartile (top 25 percent) are currently completing their projects with 30 percent cost saving (as measured from the original project budget estimate) whereas owners and contractors in the fourth quartile (bottom 25 percent) are seeing 10 percent cost growth. CII attributes differences in performance between owners and contractors scoring in the first quartile and those scoring in the fourth quartile primarily to the intensity with which they utilize new and innovative project management approaches.

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[1]CII's membership includes several federal agencies, including the General Services Administration, Army Corps of Engineers, Naval Facilities Engineering Command, NASA, U.S. Department of State, Tennessee Valley Authority, and the National Institute of Standards and Technology.

[2]TPC is defined as the sum total of all costs associated with a project's planning, development, design, construction, outfitting, and start-up, not including land costs.

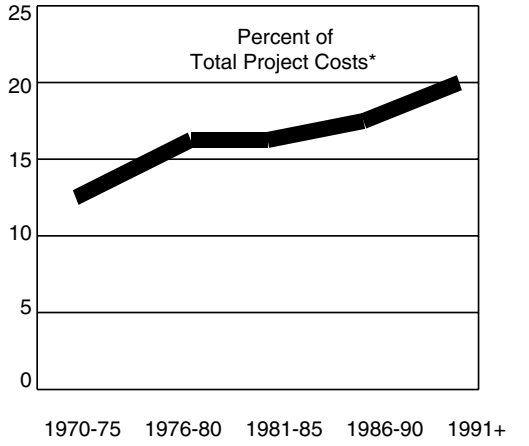

FIGURE 2.4 Overall engineering costs have continued to climb. Source: TBR (1997).

The finding that the gap between contractors and owners in the first and fourth quartiles is increasing over time is also noteworthy. This suggests that owners and contractors that are open to change and innovation of their business practices (and who are able to successfully implement such change) enjoy a competitive advantage that can be further increased (CII, 1998). The Business Roundtable report further corroborates this finding (TBR, 1997).

CONTRACTING METHODS

Since 1993, federal regulations have been modified to allow agencies greater flexibility and choice in the contract method used for acquiring facilities. Downsizing and the increased outsourcing of design and construction services have provided the impetus for selecting methods other than the traditional design-bid-build contract method.

Although there are many variations, current practice recognizes four basic categories of contract types that apply to several facility acquisition systems:

- general contract,
- construction management,
- design-build, and
- program management.

The following discussion is based on data developed by the Associated General Contractors of America and General Motors Corporation. The figures represent generalized concepts of the owner's relationship to the various service providers and may vary in implementation, depending on the project.

The general contract approach, as illustrated in Figure 2.5, assumes that the owner contracts individually for all engineering and construction services required to acquire a facility. This is the traditional approach that most large-scale owners (both public and private) used to design and construct their facilities until the relatively recent growth of interest in outsourcing of design and construction services. It is illustrative of the design-bid-build contract method used by federal agencies.

Under the general contract approach, the owner manages individual contracts with all design, engineering,

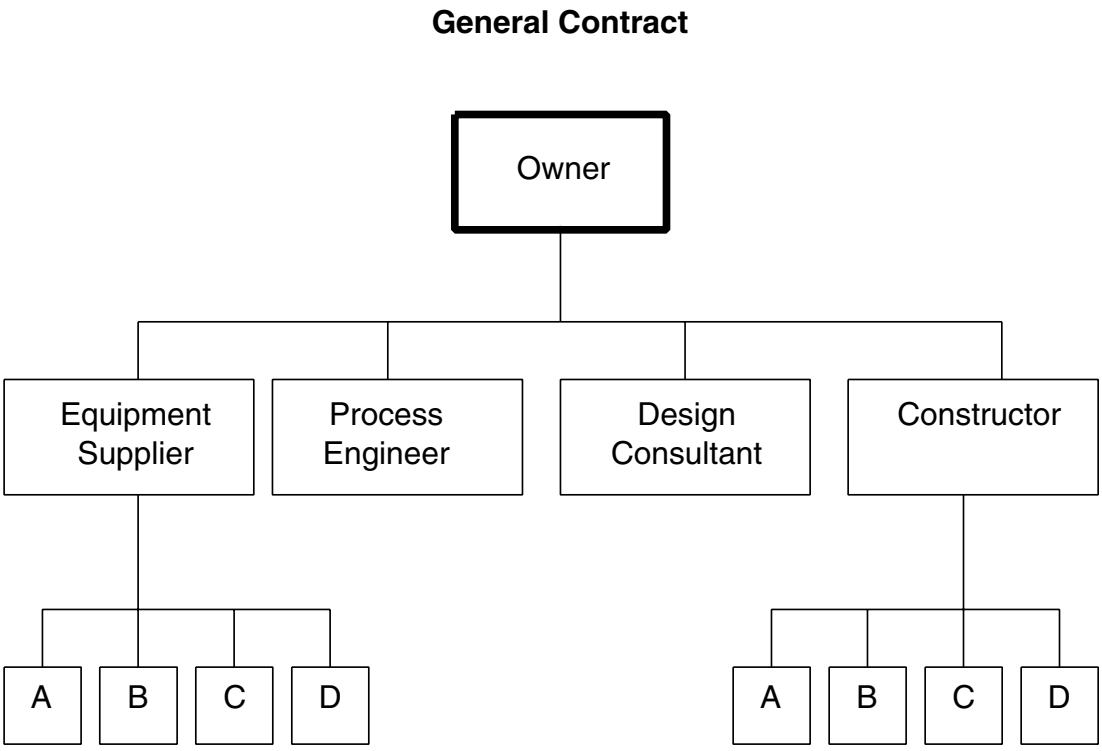

FIGURE 2.5 Generalized concept for general contract approach. Source: AGC (1993).

and construction service providers, implying that the owner must also manage all interfaces between service providers. Under this approach it is common for owners to enlist outside consultants for various functions of the acquisition process. Interface management becomes critical because assessment of accountability for problems incurred during the project's evolution is difficult due to the variety and separation of individual contracts. To succeed, such a process requires a relatively large and experienced facility design, engineering, and management staff within the owner's organization in order to protect the owner's interests.

Construction Management

A first step toward outsourcing construction management services during facility acquisition is reflected in the construction management approach, illustrated in Figure 2.6, wherein the owner contracts with an outside firm to manage the construction of a project. Under the construction management approach, the construction manager (CM) may function either as an "agency" CM, or as an "at-risk" CM:

- Agency CM: The owner holds all individual construction contracts, and the CM functions as the construction contract administrator, acting on behalf of the owner and rendering an account of activities. Actual construction work is performed by others under direct contract to the owner, and the CM is typically not responsible for construction means and methods, nor does the CM guarantee construction cost, time, or quality.
- At-risk CM: The actual construction work is performed by trade contractors under contract to the CM, who then becomes responsible to the owner for construction means and methods and delivery of the completed facility within the owner's scope of work for cost, time, and quality.

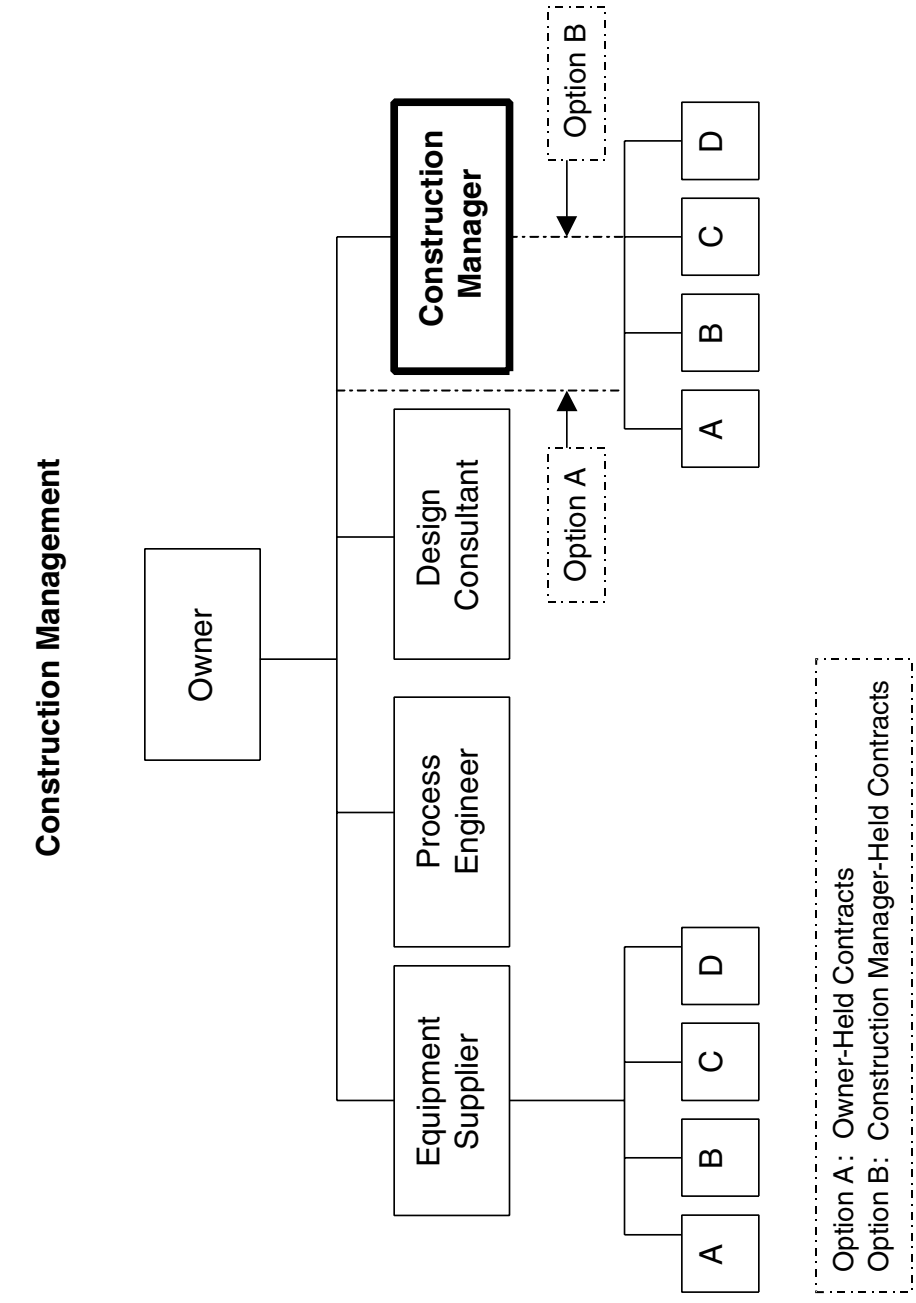

FIGURE 2.6 Generalized concept for construction management contract. Source: AGC (1993).

Under the construction management approach, the owner typically retains responsibility for managing all preconstruction A/E services, and therefore must address all interface issues between service providers.

Design-Build

The design-build contract method, as reflected in Figure 2.7, represents a much larger step toward outsourcing of traditional owner functions than occurs with the above-described construction management contract. Under the design-build approach, an owner prepares a project scope definition and then engages a single entity that will provide all services necessary to complete the design and construct the facility. Generally, the scope definition package represents a design that is between 15 and 35 percent complete, although variations of the design-build approach may begin much earlier, often with a performance specification, or much later with perhaps a 65 percent design package.

Project success under the design-build approach is primarily dependent on the owner's ability to produce a comprehensive, well-defined, and unambiguous scope of work upon which all subsequent design-build activity will be based. Once the design-build contract has been awarded, changes to owner requirements will generally incur heavy penalties to the project cost and schedule. The owner is therefore well advised to ensure that preparation of the project scope definition package accurately and clearly expresses expectations for project performance, quality, cost, and schedule.

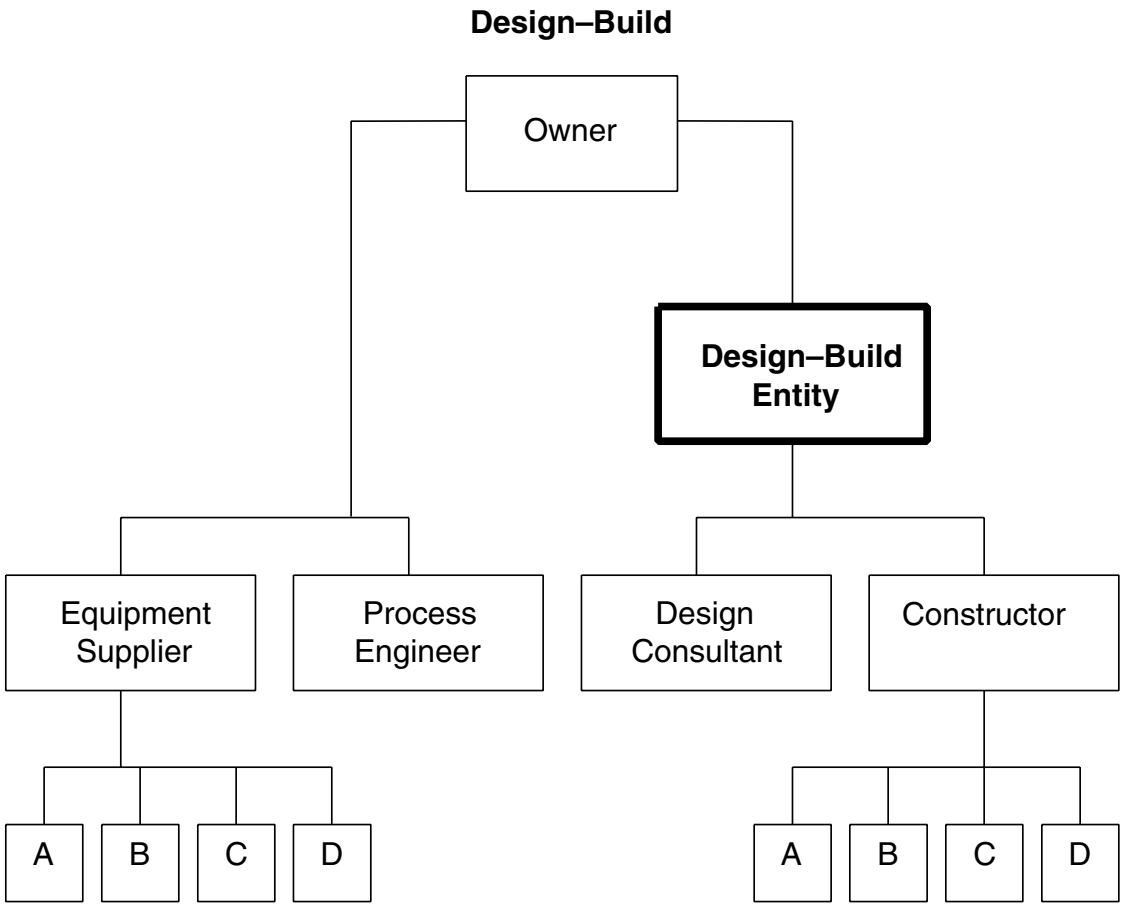

FIGURE 2.7 Generalized concept for design—build contracts. Source: AGC (1993).

Use of the design-build approach for project delivery is growing dramatically in both public and private organizations; the Naval Facilities Engineering Command, the General Services Administration, and the U.S. Postal Service have become particularly strong proponents of this approach, but not without controversy. The Design Build Institute of America recognizes that management processes and owner and contractor relationships must change significantly from the more traditional approaches for design-build to be successful. The Institute therefore recommends that both owners and contractors electing to use this approach thoroughly train those who will either manage or participate in such a process.

Program Management

The program management contract method, as reflected in Figure 2.8, represents the ultimate step in outsourcing of the owner's project management functions. The program manager (PM) is engaged by the owner to exercise oversight of the entire facility delivery process for a multitude of projects, from planning through design, construction, outfitting, start-up, and postoccupancy activities. Similar to the construction management approach, the PM can serve in either an "agency PM" or "at-risk PM" capacity:

- Agency PM: The owner holds all individual contracts, and the PM functions as the contracts administrator, acting on behalf of the owner and rendering an account of activities. All project work is performed by others under

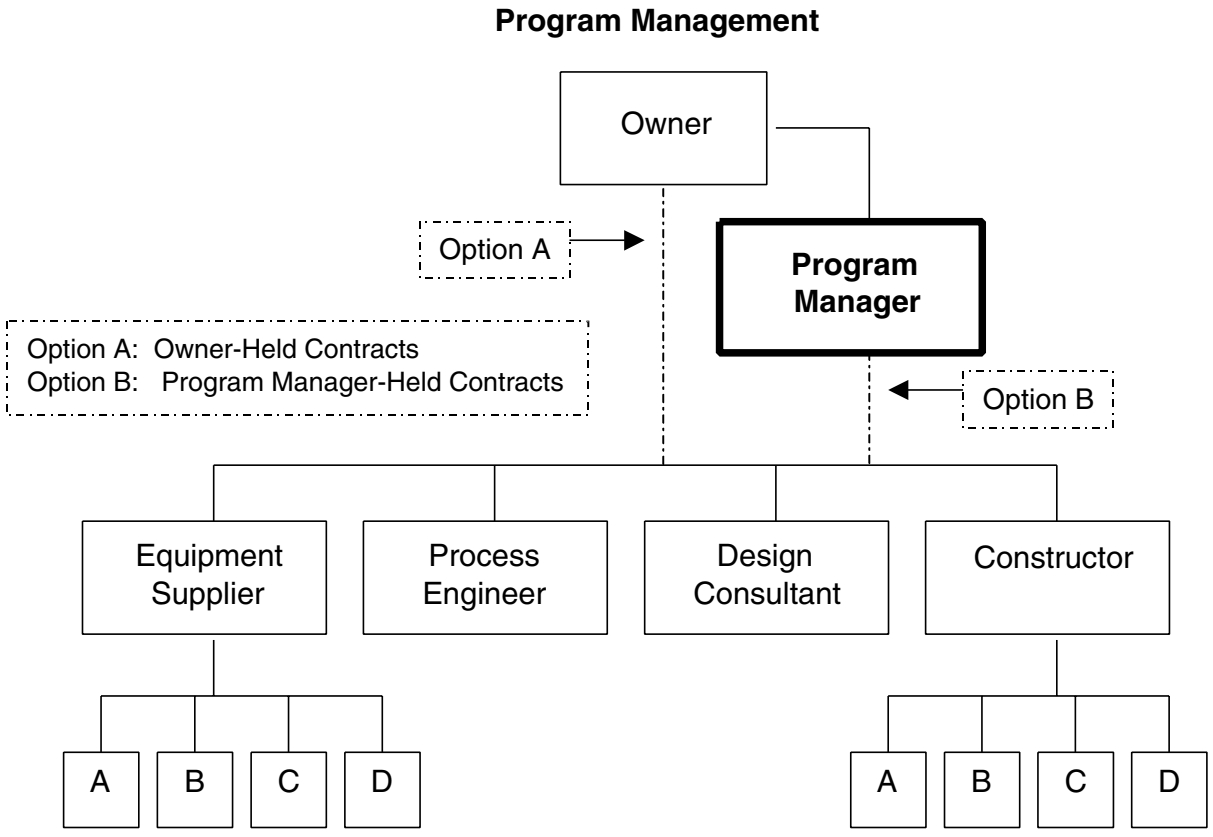

FIGURE 2.8 Generalized concept for program management contracts. Source: AGC (1993).

direct contract to the owner, and the PM is typically not responsible for project means and methods, nor does the PM guarantee cost, time, or quality.

- At-risk PM: All project work is performed by service and trade contractors under contract to the PM, who then becomes responsible to the owner for project means and methods as well as delivery of the completed facility within the owner's objectives of cost, time, and quality.

With the PM responsible for managing the interfaces between all phases of facility acquisition and all parties involved, the owner's personal participation in the facility acquisition process is minimal. Taken to the extreme, some private sector organizations have completely eliminated their in-house facility engineering capability by entering into a long-term (or even permanent) contractual relationship with an outsourced PM. The industry is watching this relatively new approach carefully, and the results to date are inconclusive.

There are many variations to the four basic contract methods. Indeed, each day seems to bring yet another new and innovative adaptation. Nonetheless, the trend is unmistakable: Evolving contract mechanisms and owner and contractor interfaces require a much closer and collaborative relationship between parties than has traditionally been the case with the facility acquisition process.

TEAMWORK AND COLLABORATIVE PROCESSES

The facility acquisition process traditionally has been an adversarial environment, with facility owners, designers, and constructors separated by formal contractual documents and backed up by teams of lawyers. Time and again, conflicting interests between the parties resulted in poor communication, poor problem solving, and poor results. In the early 1980s, several organizations, among them the Army Corps of Engineers and the Arizona State Highway Department, attempted to instill a new philosophy wherein the interested parties to a facility acquisition would collaborate on areas of common interest rather than defend areas of proprietary conflict. These early proponents devised a highly structured process intended to enhance communication, engender trust between the parties, and align all parties toward the common objective of achieving a quality facility. The process is commonly referred to as teambuilding. The techniques underlying teambuilding are applicable to almost any endeavor requiring the cooperation of individuals to achieve a common goal; the team may be wholly internal to an organization, or it may involve participants from unrelated organizations.

When multiple organizations make a commitment to work cooperatively toward a common objective utilizing teambuilding techniques, the practice is called partnering. Partnering may be a relatively short-term relationship in the case of completing a single project, or it may become a longer-term relationship with the committed organizations cooperating for a multitude of projects. Some private sector facility owners have even elected to form permanent and enduring commitments with selected A/E firms and construction contractors with the intent that these firms will be the sole providers of engineering services for the foreseeable future. Such relationships have been commonly referred to as strategic alliances.

The facility acquisition process is inherently a group activity, with participants from a wide variety of perspectives, both internal and external to the owner's organization. Teambuilding and partnering practices are therefore uniquely appropriate for enhancing effectiveness of the facility acquisition process. Teambuilding in general and partnering in particular are not easy to implement. It is not within the scope of this study to provide a treatise on teambuilding and partnering. However, several sources of information on teambuilding and partnering are included in Appendices B and E.

When approached effectively, teambuilding and partnering results can be truly impressive, as noted in NASA's recently published *Partnering Desk Reference Guide*:

> The Arizona Department of Transportation, formerly averaging $5 million annually in litigation costs, did not have a litigated claim on any of the over 400 projects partnered from 1991 to 1997. The Texas Department of Transportation and the U.S. Army Corps of Engineers have both experienced decreases in litigation almost as dramatic. For those organizations that have "Mature" partnering programs, litigation is no longer an issue (NASA, 1999).

OWNER AS A "SMART BUYER"

As noted above, American business has regained its competitive edge by reengineering its business practices to improve their effectiveness and in the process, downsize their in-house staff. However, competitive pressures caused many organizations to approach staff downsizing without adequate planning. Mistakes were made: Reductions were insufficient, or too extensive, or made in the wrong area.

Some government agencies found themselves with an even more difficult staffing challenge where reductions were mandated by arbitrary staff reduction quotas not necessarily linked to process reengineering. The Business Roundtable, in their 1997 white paper *The Business Stake in Effective Project Systems* noted:

> Of particular concern, [retention of] the technical competence to assist the businesses in arriving at the most appropriate project to meet the business need has been lost along with the competence to execute the project effectively (TBR, 1997).

The loss of technical competence through downsizing was sufficiently pervasive that the Federal Facilities Council (FFC), in conjunction with The Business Roundtable and the Naval Facilities Engineering Command, conducted the "Government/Industry Forum on Capital Facilities and Core Competencies" in March 1998. A fundamental finding of this forum was that owner facilities engineering organizations need to identify and retain core competencies—the essential technical and managerial skills that cannot be outsourced without serious risk to an organization's ability to conceive and acquire necessary facilities. The forum participants recognized the advisability of the owner performing as a "smart buyer" of outsourced services. A smart buyer is one who retains an in-house staff capable of

- understanding the organization's business or mission, its requirements, its customer needs, and who can translate those needs and requirements into corporate direction or mission;
- accurately defining the technical services to be contracted;
- evaluating the quality, performance effectiveness, and value of technical work performed by contractors; and
- managing the interface between technical service contractors and the owner's line-of-business managers who will ultimately benefit from services provided (FFC, 1998).

These functions are intrinsic to the entire facility acquisition process and underscore the need for the owner's in-house staff to be intimately involved in these aspects of the process, particularly the leadership role.

CONCEPTUAL OR ADVANCE PLANNING

Research by the National Research Council (NRC), the CII, The Business Roundtable, and others point to the importance of conceptual or advance planning to the entire facility acquisition process. Predesign phases of the decision-making process are critical because it is during these phases that the size, function, general character, location, and budget for a facility are established. Errors made at this stage are usually embodied in the completed facility in such forms as inappropriate space allocations or inadequate equipment capacity (NRC, 1989.)

A 1990 NRC report found that for federal facilities, one of the key factors in design-related growth of construction costs in excess of budget is poor planning and failure to think carefully about foreseeable problems of construction. This report also found that the early stages of the design process are most critical for assuring successful design to budget because the design is still flexible and factors that determine cost are not fixed (NRC, 1990).

Much of the current work to improve design and construction industry business practices is based on the concept illustrated in Figure 2.9.

The cost influence curve (the solid curve in Figure 2.9) indicates that the ability to influence the ultimate cost of a project is greatest at the beginning, during the conceptual planning phase, and decreases rapidly as the project matures. Conversely, a project cash-flow curve (the dashed curve in Figure 2.9) indicates that conceptual planning

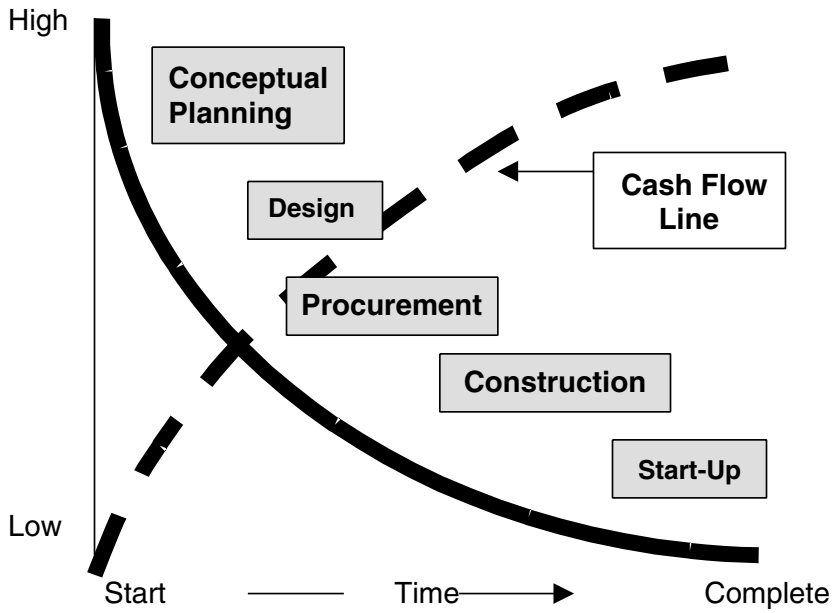

FIGURE 2.9 Cost Influence Curve. Source: CII (1986b).

and design costs are relatively minor and that costs escalate significantly as the project evolves through the procurement, construction, and start-up phases. The implication is obvious: Conceptual planning and design should be as comprehensive and thorough as possible and not driven primarily by cost considerations.

These concepts underscore the critical importance of having intensive owner involvement in the development of the scope of work and conceptual planning processes. The Business Roundtable, in fact, has stated that

> The supply chain of a capital project starts with the identification of a customer need that might be translatable into a business opportunity. The front-end loading process is made up of the critical planning phases of the project. It is called front-end loading because the effective commitment of time and resources at this point dictate the future success of the project. . . . It is because of the central role of front-end loading that project excellence cannot be bought in the market like a commodity (TBR, 1997).

COST IMPLICATIONS OF FACILITY ACQUISITION PRACTICES

It should be intuitive that poor project planning and design practices result in increased total project cost (TPC). These cost growth drivers include

- construction change orders required to correct errors and omissions in the design documents;
- owner-driven construction change orders required to incorporate desirable features overlooked during design;
- inefficient construction resulting from a failure to incorporate construction-enhancing features during design;
- rework resulting from unclear construction documents;
- standby costs incurred while construction is either stopped or slowed to incorporate changes;
- litigation;

- delayed completion of the facility (i.e., lost business revenue, staff standby, nonproductive capital investment costs); and
- a poorly performing facility.

Numerous research reports have been published characterizing cost growth resulting from poor planning and design practices. The following are a few of the key statistics contained in documents abstracted for this study:

- Project design costs average 13 percent of TPC (CII, 1998).
- Total project engineering costs average 20 percent of TPC (in addition to design costs discussed above, includes planning, development, and project management costs) (TBR, 1997).
- Project rework costs average 12.4 percent of TPC. Eighty percent of this rework results from errors and omissions in the design documents. The remaining 20 percent results from poor construction practices (CII, 1989a).
- Fifty percent of construction change orders result from errors in the design documents directly related to improper interfaces between design disciplines (civil, structural, architectural, electrical, and mechanical). These change order costs contribute anywhere from 0.8 to 3.4 percent of TPC (Nigro and Nigro, 1992).
- Comprehensive review of project document development during the design phase of acquisition should cost from 0.2 to 0.5 percent of TPC. Properly done (i.e., using best practices discussed later in this study), such activity should drive down the cost of construction change orders by an average of 3 percent of TPC (CII, 1993).
- To evaluate the value of thorough concept definition, a 1993 CII-led review of 62 projects compared final TPC against the estimated TPC at time of project approval for construction. The 21 projects with the highest degree of definition averaged 4 percent cost underrun. The middle 21 projects averaged 2 percent cost underrun. The 21 projects with the lowest definition averaged 16 percent cost overrun (CII, 1994).
- Indirect costs, the business impact costs discussed above, are highly variable and very difficult to estimate, but are potentially huge. An order-of-magnitude estimate would be 8-15 percent of TPC (CII, 1989b).

The implication of these statistics is that opportunity exists to significantly reduce TPC by conducting an effective design review process. The potential savings range from a minimum of 3 percent to as much as 20 percent, and even higher when indirect savings are taken into account.

Research conducted by Redichek Associates, an A/E firm specializing in outsourced design review, indicates that the single biggest source of construction change orders (approximately 50 percent) is errors in the design documents directly related to improper interfaces between design disciplines (civil, structural, architectural, electrical, and mechanical). Redichek's cost for conducting the discipline interface design review is approximately 0.1 percent of TPC, with a resultant reduction of rework cost ranging from 0.8 to 3.4 percent of TPC. The estimated payback ratio here ranges from $8 to $34 saved for every dollar invested in a discipline interface design review activity.

Intuitively, good design review practices result in the preparation of more comprehensive and accurate construction documents, which in turn result in lower project construction costs. Areas of savings include less rework on the part of the construction contractor, fewer change orders to the owner for correction of design errors or omissions, and the cost of belatedly adding project upgrade features that should have been addressed in the original design. By reducing changes that are required during the construction phase, good design review practices also generate significant indirect cost savings by avoiding costs associated with loss of productivity during construction-delayed facility start-up, and litigation.

BENCHMARKING AND METRICS

One of management guru Edward Demming's fundamental principles is "If you can't measure it, you can't manage it." His method of improving performance of any process first requires identification and documentation of a series of objective criteria ("metrics") that characterize the level of process efficiency. Armed with such data,

the researcher can next compare his or her process efficiency with a similar process as performed by another organization to determine whose process is the most efficient. This process of comparison is called benchmarking. The real value of benchmarking results from follow-up activities:

- Identifying the similarities and differences in competing process practices.
- Understanding which practices in the best process produce such good results.
- Incorporating the best practices into one's own process, measuring the results achieved, and documenting the extent of improvement.

Several organizations have conducted benchmarking activities within the construction industry, including IPA of Reston, Virginia. IPA's database encompasses metrics from over 2,000 individual projects valued at over $300 billion and accomplished by approximately 60 companies. Although the IPA database is proprietary, IPA has collaborated with research studies such as The Business Roundtable white paper *The Business Stake in Effective Project Systems.* IPA also helped the CII implement a benchmarking activity within its membership. Several of the FFC sponsor agencies are also members of the CII and are participating in ongoing CII benchmarking.
The CII benchmarking program uses the following definitions and objectives:

> Benchmarking: A systematic process of measuring one's performance against results from recognized leaders for the purpose of determining best practices that lead to superior performance when adopted and utilized.
>
> Metrics: A quantifiable, simple, and understandable measure, which can be used to compare and improve performance.

The principles of benchmarking are appropriate for those organizations interested in measuring and improving the relative performance of their facility acquisition and design review processes.

TECHNOLOGY AND DESIGN REVIEW

Some philosophers hold that the impact of information science on society is so great that it constitutes a fourth "age"—the information age—ranking with the agricultural age, the iron age, and the industrial age in importance. The information age is all about calculating, validating, documenting, and communicating information. It has already caused a profound transformation of the facility acquisition process, with that transformation continuing to accelerate. Slide rules have given way to calculators and computers. Drafting tables, T-squares, and triangles have been replaced with computer-based automated design and engineering. Construction documents are now stored, published, and distributed electronically rather than through massive paper trails. Today it is common to use computers to construct and display three-dimensional models of projects in order to check for interference fits and visualize architectural and structural features. The newest four-dimensional models are even able to visually "construct" the project over time to identify constructability issues.

Today it is literally possible to conduct design review activities as the design evolves, almost as if standing over the shoulder of the design A/E. Audio conferencing, video conferencing, and Internet connectivity allow design reviews to occur in real time as virtual meetings without the need to assemble teams and documents at designated locations. Indeed, the problem becomes one of information overload—with so much data so easily available, reviewers must become proficient at managing this data flow in order to exploit the opportunity it presents.

This marriage of architecture, engineering, and computer sciences is relatively new, but widely recognized. For example, the American Society of Civil Engineers now publishes a periodical dedicated to this area, *The Journal of Computing in Civil Engineering.* Stanford University has established the Center for Integrated Facility

Engineering encompassing the colleges of Civil Engineering, Architecture, and Computer Sciences. The CII has made Information Technology and Electronic Data Management one of its core research topics. To be successful, today's facility acquisition managers must look beyond mastering the technical details inherent to project performance, quality, cost, and schedule. They must also become information managers, conversant and comfortable with the newest tools by which information is documented and distributed.

EFFECTIVE DESIGN REVIEW PROCESSES: CONCLUSIONS

As the foregoing discussion indicates, during the 1980s and 1990s, a number of business practice studies were conducted by construction trade associations, professional societies, and academic groups to better understand which practices produced better results in terms of facility performance, quality, cost, and schedule. These studies concluded that quality design yields buildings that perform well throughout their service lives (NRC, 1989). Quality design resulted when all interested parties (owner, user, A/E, construction contractor, and specialty consultants) in the facility acquisition process worked together in an intense, collaborative, complex, and multiphased process beginning with conceptual planning and concluding after the start-up phase.

These business practice studies also found that decisions made during the conceptual planning phase will establish initial constraints limiting future design flexibility. These early decisions thus have a disproportionately greater influence on a facility's ultimate performance, quality, cost, and schedule than decisions made later in the process. The conceptual planning phase should therefore be the phase when the review of designs is most intense, with the primary focus upon ensuring the appropriateness, accuracy, and thoroughness of the owner's expectations regarding facility performance, quality, cost, and schedule. This will be especially true when using the design-build and program management contract methods when the owner's involvement in design reviews declines after the conceptual planning phase.

If design review activity during the conceptual planning phase has resulted in a clear scope of work regarding the owner's expectations, design reviews during the design phase are greatly simplified. Those parties involved should focus upon ensuring that the evolving facility design incorporates high standards of professional engineering practice with regard to architectural, civil, structural, electrical, and mechanical systems and their interfaces. Formal reviews may be scheduled periodically during the design phase, at approximately the 35, 60, 90, and/or 100 percent design completion milestones (although these milestones may vary significantly depending on the individual project's size and complexity). Such structured formality helps ensure the widest possible participation of interested parties during the review, including specialists and consultants who bring expertise in such areas as value engineering, constructability[3], biddability[4], operability, maintainability, and environmental compliance.

During the procurement phase, the review of designs can continue to contribute to overall project success by monitoring progress made in ordering the various items of long-lead-time equipment. It is not unusual for suppliers to detect errors in the ordering specifications, or to make substitution recommendations for either greater economy or performance enhancement. The review team should evaluate the impact of these changes on facility performance, quality, cost, and schedule.

It is almost inevitable during the construction phase that scope of work changes by the owner, errors and omissions in the plans, unknown or changed site conditions, and creative initiatives on the part of construction staff will result in recommended changes to the facility design. Design reviews in this phase should focus on assessing the impact and advisability of changes on facility performance, quality, cost, and schedule.

Design reviews should continue into the start-up phase. At this juncture it is important to document the results achieved by conducting what is commonly referred to as a postoccupancy evaluation, whose purpose is to record

[3] In constructability reviews, experienced construction managers look for such items as inappropriate materials, physical barriers, and complex interfaces that will unnecessarily complicate the construction phase.

[4] In biddability reviews, procurement specialists look for conflicts, errors, omissions, and lack of clarity in the construction documents that could create confusion on the part of prospective equipment suppliers or construction contractors.

lessons learned for future reference. Facility performance, quality, cost, and schedule actually achieved should be objectively measured and compared with the owner's original expectations. Lessons learned during the five facility acquisition phases concerning design strengths and weaknesses should be recorded for use in improving future similar project activities. And perhaps most important, the facility users' subjective satisfaction with both the acquisition process as well as the completed facility should be noted.

Based on industry research by the CII, the NRC, the FFC, and similar organizations, interviews conducted for this study and the author's experience, it can be concluded that an effective design review process will be structured to address all of the following topics:

- Owner satisfaction: Does the constructed facility meet the owner's expectations as originally defined by the project scope definition or statement of work (i.e., performance characteristics, architectural statement, level of quality, cost, schedule, and any relevant owner-published standards and/or policies)?
- Sound professional practice: Is the approach taken in each of the specialty areas (architectural, civil, mechanical, and electrical) commensurate with professional standards?
- Code compliance: Does the design comply with all applicable codes such as fire protection, life safety, and access?
- Architectural statement: Is the overall presentation representative of established architectural standards?
- Value engineering: Are there any less expensive methods or materials that could be used in the design without impacting project quality or performance?
- Biddability: Are the construction documents sufficiently clear and comprehensive so construction contractors will have no difficulty developing an accurate bid with minimal allowance for contingency?
- Constructability: Does the design impose any unnecessarily difficult or impossible demands on the construction contractor?
- Operability: Does design of the facility operating systems ensure ease and efficiency of operation during the facility's useful lifetime?
- Maintainability: Does the facility design allow for easy and cost-effective maintenance and repair over the useful life of the facility?
- Life-cycle engineering: Does the design represent the most effective balance of cost to construct, cost to start up, cost to operate and maintain, and (perhaps most important) the user's cost to perform the intended function for which the facility is being acquired over the useful life of the facility?
- Postoccupancy evaluation: Based on a review of the construction, start-up, and ongoing functioning of the facility, could any unexpected difficulty have been avoided by a different design approach?

3

Design Review Practices in Federal Agencies

Together, architects and review boards can improve each other's mission. Many times, review boards have made improvements to our firm's projects. In almost every case, this was possible because the reviewers possessed sufficient professional knowledge to earn our respect as design professionals. George Hartman, Partner, Hartman-Cox Architects (Brown, 1995)

Federal facilities comprise a portfolio of significant, durable assets that have been acquired to support specific functions and missions and the general conduct of the government's business. As noted in Chapter 1, this portfolio contains more than 500,000 facilities and associated infrastructures worldwide. These facilities include military installations, nuclear plants, research and biomedical laboratories, office buildings, embassies, housing, museums, courthouses, prisons, hospitals, space centers, monuments, archives, libraries, and warehouses among others. Thus, in addition to being the nation's largest owner of buildings and facilities, the federal government is also responsible for the stewardship of the most diverse facilities portfolio in the United States.

It is estimated that the government spends approximately $20 billion per year for new facilities and major renovations of existing facilities. Even a relatively small agency such as the Indian Health Service is a major player, with over $265 million of construction activity in planning, design, or construction as of 1999. At the other end of the spectrum are the truly capital-intensive agencies such as the U.S. Department of the Navy, with a $2.5 billion annual construction budget. As missions, priorities, and situations change, agencies may experience wide fluctuations in the scope and budget for their facility acquisition programs. For example, a recent program to upgrade federal courthouses around the country has added billions of dollars to the General Services Administration's construction activity. The U.S. Department of State is facing a similar situation. Following the 1998 bombings of embassies in Africa, legislation requiring rapid and extensive upgrade of embassy security features worldwide was enacted which could require several billion dollars to execute. Given the size of the government's expenditures on facilities, it is important that federal agencies have effective design review processes that result in buildings that perform well throughout their service lives.

DOWNSIZING OF FEDERAL FACILITIES ENGINEERING ORGANIZATIONS

Like private sector corporations, federal agencies' facilities engineering staffs have been considerably downsized in the past 10–15 years. A 1987 report of the Federal Construction Council noted that "due to budget

cuts, agencies have had to reduce the number of project managers, design reviewers, inspectors, and field supervisors they employ" (FCC, 1987). Procurement specialists trained primarily in contract negotiation and review rather than design and construction have been playing increasingly greater roles in facilities development (NRC, 1994).

The federal downsizing trend accelerated after 1991 as a result of a changed global environment, a shift in focus toward smaller and more cost-effective government, and a number of legislative initiatives. In the nine federal agencies that responded to the questionnaire associated with this report, facilities engineering staffs have been reduced on the order of 20 to 65 percent, with the average at about 50 percent. As a consequence of the loss of technical staff, particularly architects and engineers, federal agencies are increasingly outsourcing design and construction-related functions.

DESIGN REVIEW-RELATED TRENDS IN NINE FEDERAL AGENCIES

The Federal Facilities Council's (FFC's) Standing Committee on Organizational Performance and Metrics developed a two-part questionnaire focused on design review processes and distributed it to FFC sponsor agencies. Part one was sent to senior facilities engineering program directors at the headquarters level and focused on agencywide policy issues. Part two was sent to randomly selected project managers at the field activity level and focused on individual project review issues. (Copies of the two questionnaires are included in Appendix C). A total of 44 questionnaires were returned (21 of part one; 23 of part two). The following nine federal agencies answered the questionnaires:

- Air National Guard
- U.S. Department of Energy
- U.S. Department of State
- General Services Administration
- Indian Health Service
- National Aeronautics and Space Administration
- National Institutes of Health
- Naval Facilities Engineering Command
- U.S. Department of Veterans Affairs

Following is a summary and analysis of questionnaires returned from each of the above-listed nine agencies. In those cases in which responses were received from multiple field activities associated with a single agency, the responding field activities have also been identified. Each analysis begins with a description of the agency's current environment and addresses four questions:

- What is the scope of the agency's facilities engineering activity?
- How is the agency's facilities engineering function organized to carry out its mission?
- What has been the impact of downsizing on the agency's facilities engineering organization?
- How has the agency's facilities engineering organization responded to mitigate the impact of downsizing?

Air National Guard

The Air National Guard (ANG) physical plant consists of over 90 military bases located at 160 sites throughout the United States with an aggregate value of approximately $12 billion. The fiscal year (FY) 1999 annual construction and replacement budget is about $250 million.

The National Guard Bureau in Washington, D.C., provides overall guidance to states, territories, and the District of Columbia, which operate ANG units during peacetime. The National Guard Bureau provides design standards and special requirements and monitors the funding, scope, cost, and schedule of major projects. The design process (including design policy, standards, and guidelines) for ANG facilities is managed by the Engineer-

ing Division of the Air National Guard Readiness Center (ANGRC/CEC), located at Andrews Air Force Base, Maryland. ANGRC/CEC is also responsible for management oversight and design approval for all major facility project designs. ANGRC/CEC receives technical assistance from one of its branches, the Civil Engineering Technical Services Center located at Minot, North Dakota.

For new projects, the local engineer at each military base develops the project statement of work based on information provided by the intended facility user or occupant. The base engineer and the facility user or occupant work directly with the design architect/engineering (A/E) firm to develop the project requirements, reviewing them at the 10, 30, and 60 percent milestones. All design work is contracted out to A/E firms. A federal contracting officer in each state contracts for A/E services, manages construction bidding, and awards construction contracts.

Design reviews are performed at the local level by a design working group comprised of the base engineer, representatives of the intended facility users, the base safety office, the base communications group, the base fire department, and the A/E firm. The local base engineer is required to present a project design to the ANGRC/CEC headquarters staff at the 35 and 95 percent milestones. The meetings with headquarters staff are limited to three to four hours in length. The ANG no longer conducts technical design reviews at the headquarters level due to the time involved and a lack of staff resources. ANG holds A/E firms responsible for the completeness and technical adequacy of their designs.

The ANG facility engineering staff has downsized approximately 10 percent since 1994. Additional downsizing is anticipated, thus prompting an ongoing review of current facilities engineering practices and processes. To date, the ANG facilities staff have responded to downsizing impacts through increased use of indefinite delivery type contracts for A/E services as well as increasing the scope of such contracts to reduce the total number of individual contracts requiring oversight. In conjunction with increased reliance on outsourced work, the ANG has emphasized teambuilding as a fundamental practice.

U.S. Department of Energy

The U.S. Department of Energy's (DOE) total physical plant is located at various sites throughout the United States and is valued at approximately $23 billion. The FY 1999 annual construction budget is approximately $1 billion. Due to the Cold War legacy, a major part of the DOE budget is devoted to cleaning up hazardous wastes at individual DOE sites.

The DOE's Washington, D.C., headquarters office provides overall guidance to the field activities in life-cycle asset management. DOE is unique among federal agencies in that its facilities are almost 100 percent government owned and contractor operated. The federal employees basically maintain oversight of the contractors. The contractors, through a variety of contract mechanisms, design, build, and maintain the facilities for the department. The following DOE field offices, all contractor operated, participated in the study:

- Idaho Operations Office, Idaho Falls, Idaho;
- Oakland Operations Office, Oakland, California;
- Oak Ridge Operations Office, Oak Ridge, Tennessee;
- Richland Operations Office, Richland, Washington;
- Golden Field Office, Golden, Colorado;
- Pantex Plant, Amarillo, Texas; and
- Carlsbad Area Office, Carlsbad, New Mexico.

Many of DOE's facilities are world class and unique within the United States and possibly the world. They include atom smashers, test naval reactors, weapons component testing and manufacturing facilities, atomic laboratories, vitrification plants for radioactive high-level waste, and many other facilities for research and environmental cleanup. As stated above, DOE is cleaning up contamination of both land and facilities and is reducing its physical plant by closing sites and transferring some of them to local governments for industrial revitalization parks. Completion of the cleanup effort is not planned to be accomplished until well into the next century.

DOE has responded to staff downsizing by placing more reliance on site operating contractors to carry out the

day-to-day engineering management of various programs. DOE has continued to maintain oversight on a much more limited basis and is trying to concentrate its limited resources on critical activities and projects.

DOE's questionnaire responses indicate a great diversity in the level of construction activity between field offices. This would seem to explain a similar diversity in the level of in-house government oversight of design review processes from one field office to another. For example, field offices with relatively small ongoing construction programs reported that nearly 100 percent of design reviews were delegated to the base operations contractor, with very little if any participation by in-house government personnel. Conversely, those offices with large ongoing construction programs reported significant government participation in design review processes, even though the process was under overall management of the base operations contractor. Nearly all offices voiced concern that lack of participation by government personnel in the review of designs increased project risk.

Five out of seven reporting field offices indicated that their design reviews had changed between 1994 and 1999, but the reasons driving the change varied from one office to another. Downsizing, business process reengineering, review cost, time available for reviews, and change in agency philosophy regarding reviews were all cited as the primary reason for change by at least one office.

Opinions varied widely as to which design review functions added the most or least value. For example, two out of seven field offices reported that value engineering, review of shop drawings, and life-cycle costing coordination were of little overall value. The same number of offices reported that these specific functions added the most value.

One area of strong agreement was the impact of technology. All seven DOE field offices reported intensive and increasing use of technology tools to support design review processes. These included computer-aided design (CAD) software, Internet and Intranet systems, and computer-based data collection.

General Services Administration

The General Services Administration (GSA) is one of three general management agencies within the federal government, the others being the Office of Management and Budget and the Office of Personnel Management. GSA's mission is to provide housing, supplies, transportation, and telecommunications for the executive and judicial branches of government. To deliver these products and services, GSA has been organized into three service organizations: the Federal Supply Service, the Federal Technology Service, and the Public Buildings Service. The Office of Governmentwide Policy has also been established within GSA to work with other federal agencies to develop, advocate, and evaluate policies and guidelines for acquiring, managing, and disposing of real estate and other items.

The Public Buildings Service (PBS) leases, constructs, renovates, operates, and manages GSA's real estate holdings. PBS is generally considered the largest civilian landlord in the nation, comprising an inventory of approximately 300 million square feet of owned and leased space, housing almost 1 million federal employees. The PBS space inventory is comprised of many building types, but is primarily associated with federal office buildings and federal courthouses. Although ongoing construction programs are focused on repair and alterations of existing facilities, there is an $8 billion construction program to deliver 160 new federal courthouses. This, the largest construction program in GSA's history, has been described as GSA's "legacy" construction program.

PBS is GSA's lead organization in delivering sustainable, safe, and productive work environments. PBS is also the source for GSA design criteria and standards and project delivery policies and practices. Associated with these design and construction activities are new initiatives, incorporated within "design excellence" and "construction excellence" programs. In essence, these new program areas address innovative approaches in procurement and in quality assurance practices that are intended to maintain the PBS role, to deliver superior facilities, on time, within budget. These programs also respond to changing conditions.

Over the past 20 years, GSA has implemented many tools and new ideas to improve the performance of its nationwide construction program. Considered innovative at the time, initiatives such as construction management, professional services, indefinite quantity contracting, design programming, value engineering, postoccupancy evaluations, design-build delivery, and partnering all responded to a desire to enhance facility acquisition prac-

tices. Although most of these initiatives addressed some form of quality assurance or quality control practice, most were predicated on streamlining, controlling costs, privatizing, and reducing government in-house staff.

With downsizing, the nature of GSA design and construction delivery has changed. In the 1980s, GSA construction engineers were allowed to rapidly decrease in numbers, with a corresponding increase in the use of contracted construction managers. Gradual reductions in GSA's professional services staff have likewise raised the need for additional outsourcing of services. By the late 1980s, virtually every aspect of facility acquisition was being contracted out, including design programming, project design, construction, construction management, and even postoccupancy evaluations. Only the functions that were considered "inherently governmental" remained for in-house staff, involving such activities as contract scope development, procurement, contract management, and funding obligation decisions.

By the mid-1990s, GSA had evolved to fully embrace project management as the basis of the organization's core competencies. Available professional services staff in most GSA regional offices have also been integrated into project management teams. Correspondingly, there have been even further reductions of available in-house professional resources as professional services staff assumed responsibilities of project management and other duties.

The project management team organizations in effect as of 1999 utilize available in-house technical and professional staff to perform strategic program planning and to scope and manage the various tasks to be executed by private sector designers, contractors, and consultants. Available technical and professional staffs are still expected to review and evaluate the performance of outside contractors and validate the successful completion of tasks for payment. However, based on existing staffing levels, it is now difficult to balance each team with a full complement of architectural and engineering disciplines. Specialized disciplines in such fields as geotechnical support, seismic safety, blast security, fire safety, building automation, elevator, and telecommunications often require supplemental resources. Effective review of designs has become increasingly problematic, forcing some regions to contract out for these services.

In 1997 the PBS responded to staff reductions by establishing Centers of Expertise to consolidate certain professional and program staffs from around the nation to serve as "talent pools," available to all GSA regions and program offices. The centers are operationally intended to be available for consultation services during all facility acquisition phases. The centers are also intended to define and develop "best business practices," national technical standards, and related policies for the nationwide programs. Although technology-based Centers of Expertise can provide some level of design review, outside contract support appears necessary for comprehensive quality assurance measures.

Six of GSA's 11 regions responded to the questionnaire:

- Region 4: Southwest,
- Region 6: the Heartland,
- Region 7: Greater Southwest,
- Region 8: Rocky Mountain,
- Region 10: Northwest/Arctic, and
- Region 11: National Capital.

The most striking feature of the responses involved the degree of variation among regions in such areas as

- Workload (quantity of projects as well as size of projects). Not only does workload vary from region to region, it also varies significantly within a single region when measured from one year to another.
- Staffing (assigned to design review activities). Regions reported that the number of staff assigned to design review activities ranged from zero to ten.
- Reliance on outsourced resources.

Of the six regions responding, three reported that in-house staff performed nearly the entire range of design review activities. The other three reported minimal participation (one limited in-house review solely to scope and budget compliance). Of the three with limited in-house participation, one relied heavily on outsourced engineering

services (the remaining two regions reported little participation in design review from either in-house or outsourced resources).

Responses to questions concerned with purposes for conducting design reviews as well as the most and least important elements of the design review process elicited the widest range of variation of any federal agency with a decentralized facility engineering program. There appear to be several contributors to this observation:

- difference in workload among regions,
- difference in impact of downsizing among regions, and
- difference in regional culture regarding in-house versus outsourced workloads.

One area of strong agreement is that, overall, project quality has increased in recent years with little to no change in the nature and number of change orders and claims. It is an interesting observation in light of the expanded use of outsourced resources as reported by the six regions participating in this study, indicative that outsourcing, per se, has not been a hindrance to performance.

PBS has completed a series of business process reviews in recent years. The 1995–1996 business process review included three highly instructive "roundtable workshops" where industry professionals met with PBS managers to discuss issues and solutions in the areas of code compliance, A/E services, and owner's needs and expectations.

PBS is implementing a series of resulting recommendations with significant potential:

- A Project Management Center of Expertise has been established. PBS's most experienced project and program managers will mentor and otherwise provide advice and counsel to project managers throughout the field.
- An in-house formal training program is evolving into the PBS Learning Center.
- A formal postoccupancy evaluation program has been in place for several years. A business process review published by the PBS in September 1996 contained a strong customer endorsement for the process.

Indian Health Service

The Indian Health Service (IHS) programs, budgets, and executes construction projects for new and replacement health care facilities in support of 540 Indian tribes located throughout the United States. Funding levels fluctuate greatly from year to year, although construction funds in the "pipeline" smooth the workload variation. Although no new projects were approved for several years**,** project approvals have resumed in FYs 1998 and 1999. As of 1999, there is an estimated $235 million of construction in some stage of planning, design, or construction.

Work at the 540 Indian tribe locations is managed from 12 area offices. These area offices maintain direct contact with the tribal representatives for accomplishment of construction activities. Two area offices, Seattle and Dallas, have an engineering services capability with construction contracting and project management responsibility for all major construction projects; smaller projects are accomplished by local (tribal) and area staff. Headquarters staff, located in Rockville, Maryland, are involved in project approvals through the completion of the program of requirements document. Upon approval of the program of requirements, design and construction activities are handled by coordinated efforts of the assigned engineering service and area offices, with headquarters staff maintaining project status for reporting and budgeting purposes. Approval of maintenance and improvement projects (not involving addition of space) is accomplished at the area office level, with design and construction activity carried out either by the Seattle/Dallas engineering services offices or the area office, depending on the magnitude of the project.

Between 1996 and 1998, IHS headquarters facilities engineering staff were downsized by about 50 percent. In 1999, IHS reengineered its facilities organization by reducing the project management staff at the Seattle/Dallas engineering services offices, reallocating positions to the area offices (although continuing to maintain contracting services at the engineering services offices). This plan is driven by recent legislation favoring the principle of tribal self-determination and allows for greater local control and responsibility for facility planning and acquisition by the individual tribes.

The IHS questionnaire response indicates a facilities engineering management process in transition. Prior to 1995, there was a relatively centralized and structured process with intensive design reviews for all major projects, conducted by in-house engineering professionals. The downsizing from 1996 to 1998 and the recently implemented "Tribal Self-Determination" philosophy have resulted in a majority of the engineering review activities migrating to area and tribal offices where in-house engineering professionals are not available. As a result, tribes and area offices are relying on contract engineering services for design review functions to a much greater extent than previously. The IHS questionnaire notes no significant change in project claims, change orders, or delivery time as a result of these changes. The questionnaire does note, however, a higher reported level of quality and customer satisfaction.

National Aeronautics and Space Administration

The National Aeronautics and Space Administration's (NASA) physical plant is located at various dispersed sites, is valued at approximately $18 billion, and supports an additional $30 billion in installed equipment. The FY 1999 annual construction budget is approximately $170 million. NASA's Washington, D.C., headquarters office of Facility Engineering provides overall facility engineering program policy and guidance. Award and management of contracts associated with facilities design and construction is accomplished at the field level by NASA's 10 geographically dispersed centers and 3 additional operating facilities. In addition to the headquarters, 6 of NASA's 13 centers and facilities participated in this study:

- Goddard Space Flight Center, Greenbelt, Maryland;
- NASA Jet Propulsion Laboratory, Pasadena, California;
- NASA Johnson Space Center, Houston, Texas;
- Langley Research Center, Hampton, Virginia;
- Lewis Research Center, Cleveland, Ohio; and
- Michoud Assembly Facility, New Orleans, Louisiana.

Two of the six centers are government owned and contractor operated, with the California Institute of Technology operating the Jet Propulsion Laboratory and Lockheed Martin Corporation operating the Michoud Assembly Facility.

Many of NASA's facilities are considered unique, especially in the areas of wind tunnels, rocket launch complexes, and spacecraft research and assembly laboratories. Maintaining in-house engineering core competencies in such areas as wind tunnel design and operation, high pressure and cryogenic gas storage and distribution, clean room design and operation, and space simulation laboratory design and operation is viewed as essential. This is due not only to the unique nature of the facilities and the limited engineering expertise of private industry in these areas, but also to the risks inherent in catastrophic failure of high-pressure vessels, facilities storing and handling explosives and propellants, and the risks of injury to mission personnel and damage to high-value payloads.

NASA has downsized its agencywide civil service staff on the order of 25 percent since beginning its staff reduction initiative in 1994. NASA headquarters and certain agencywide staff functions, including facility engineering, have been downsized even more. During this period, relatively few new facilities have been designed or built, with the facilities engineering program refocusing instead on repair and upgrade of existing infrastructure.

NASA has responded to this staff downsizing change in three ways:

- Greater use of outsourcing for A/E services, particularly through multiyear engineering support service contracts which allow flexible tasking in areas of engineering studies, preliminary or developmental engineering, and production of construction contract plans and specifications.
- Reengineering its facility engineering processes to improve their efficiency and effectiveness so that more work can be successfully accomplished by fewer staff.
- Terminating some activities where possible to do so without compromising mission success risk levels.

NASA center questionnaire responses indicate a relatively uniform approach to the design review process, with most centers following steps recommended in the NASA facility handbooks *Facility Project Implementation Handbook* and *Facility Engineering Guide* (NASA, 1993, 1986). Five out of seven questionnaire responses indicated that no currently practiced design review functions could be eliminated without risk to project outcome or quality (two respondents proposed eliminating agency and code compliance reviews). Conversely, there was great disagreement as to which design review functions were the most and least valuable, overall. There was also a great difference among the centers in how thoroughly data (i.e., metrics) related to the design review process were tracked to measure overall effectiveness of the various phases of the facility acquisition process.

Three aspects of NASA's facility engineering program are noteworthy for their positive impact on the design review process:

- NASA participates actively in the FFC and the Construction Industry Institute (CII) in both research and implementation efforts, and has begun several process reengineering initiatives based on research recommendations.
- NASA has instituted an effective in-house training program intended to train all facility professionals in state-of-the-art methods to implement such process improvements as partnering, constructability, value engineering, and enhanced preproject planning.
- The NASA Lewis Research Center has completed ISO-9000 registration for its facility design and construction activity. Although the registration was an arduous undertaking, the center notes that it has a far better grasp of its management processes as well as the level of quality resulting from the processes.

National Institutes of Health

The National Institutes of Health (NIH) with its headquarters in Bethesda, Maryland, is one of the world's foremost biomedical research centers and the federal focal point for biomedical research within the United States. As an agency of the U.S. Department of Health and Human Services, NIH is comprised of 25 separate institutes and centers. From a budget of about $300 in 1887, the NIH budget has grown to more than $15.6 billion in FY 1999.

Capital assets for NIH include more than 1,300 acres of land located on seven campuses with more than 190 buildings comprising 11.5 million gross square feet of research and support facilities. The main campus of the NIH is located in Bethesda, Maryland, and comprises more than 75 buildings on more than 300 acres. In addition to the main campus, NIH has research and support facilities at

- the NIH Animal Center, Poolesville, Maryland;
- Frederick Cancer Research Development Center, Ft. Detrick, Frederick, Maryland;
- the Rocky Mountain Laboratory, Hamilton, Montana;
- National Institutes of Environmental Health Sciences, Research Triangle Park, North Carolina;
- Gerontology Research Center, Baltimore, Maryland; and
- New Iberia, Louisiana.

At the NIH, facility services such as planning, design, construction, operations, and maintenance are provided by the Division of Engineering Services (DES), Office of Research Services (http://facilities.nih.gov). The DES specifically provides planning, architectural, engineering, technical, and craft services for the operation, maintenance, alteration, repair, and construction of NIH facilities to ensure the existence and integrity of the physical environment necessary to support the NIH mission.

Since FY 1991, NIH has seen a significant increase in its construction budget. The focus of the construction program has been on rebuilding an aging infrastructure at the Bethesda campus and constructing several major research laboratory facilities to meet the ever-increasing demand for quality research space. This has resulted in a construction program valued at more than $950 million. During this same period of growth in capital funding, DES has been required to downsize because of limited operating budgets, from a staff of 666 in 1994 to a staff of 520 in 1999. To offset this reduction in staff, DES undertook a major reorganization in 1996 and consolidated its five branches into three with a focus on core functions of planning, design and construction, and facility operations.

The current emphasis of DES is to contract out most of its design, construction, and alterations program under the management of government project officers and to utilize other government employees for facilities management and craft-supported maintenance and operation.

Providing quality and timely customer service at a reasonable cost has been an important initiative of DES management. With an increased demand on DES to deliver new state-of-the-art research facilities quickly, and at the same time support the ongoing maintenance and operations of existing facilities, an innovative facilities engineering program has been developed to effectively manage the program with less resources. Several examples of these initiatives include the following:

- NIH Design Policy Guidelines were developed to ensure consistency among projects being constructed. The guidelines include best practices and experience gained from previous projects. The guidelines are published on the Internet (http://facilities.nih.gov/nihpol.htm) for easy access by all design professionals.
- Implementation of ISO 9000 in DES to identify and streamline processes to ensure the delivery of quality services.
- Expanded use of indefinite delivery/ indefinite quantity (ID/IQ) contract mechanisms for design reviews including constructability. This reduces procurement times and oversight requirements by government project officers.
- Utilization of an innovative developer manager approach for major capital projects. This provides services (A/E, construction, inspection, etc.) to ensure successful accomplishment of the project. Under this approach, the developer manager holds all the contracts for the project, thereby outsourcing the traditional responsibilities of design, construction, and contract administration.
- Development of standard laboratory designs that have been preengineered and priced out to expedite the design-build process; this has reduced the level of design review that is required on individual projects.
- Reengineered processes to improve efficiency and effectiveness and to keep pace with customer demands. Benchmarking with best in class of other facilities organizations has resulted in identification of ways to streamline processes and improve quality with a reduced work force.

The DES response to the FFC questionnaire reflects a facilities engineering program that is in the process of delegating the review of generic details to both design A/Es and in-house third-party reviewers (i.e., fire and life safety, occupational safety). However, DES is retaining in-house the responsibility for review of programmatic and technical issues. Basic to the process reengineering currently underway is a desire to make the design review process more proactive than reactive. The questionnaire response also notes that changes to date have resulted in shorter project delivery times, lower costs, and fewer claims. Overall, the questionnaire response indicates a well-organized program, indicative of the fact that the DES has implemented a quality management system for its facility engineering process and is pursuing ISO 9000 certification.

Naval Facilities Engineering Command

The Naval Facilities Engineering Command (NAVFAC) provides facilities engineering services (including planning, project development, design, and construction) to all of the Navy and Marine Corps, to specific other Department of Defense (DoD) services and agencies as directed, and to federal agencies and others on a case-by-case basis when it makes good business sense. NAVFAC, headquartered in Washington, D.C., undertakes about $2.5 billion in construction each year. The work is accomplished through four engineering field divisions located in Norfolk, Virginia; Charleston, South Carolina; San Diego, California; and Pearl Harbor, Hawaii, and their subordinate local offices throughout the United States and many overseas locations. Each of the four engineering field divisions has a particular area of responsibility for a specific geographic area of the world. Each provides a full range of construction services including project management, contracting functions, and construction management.

For most construction projects, NAVFAC also manages the design phase. About 10–15 percent of the designs are accomplished with in-house staff. The remainder of the designs are awarded to A/E firms, some of which are selected on a case-by-case basis and some are awarded as a task order on an ID/IQ-type contract. In these cases,

NAVFAC manages the design contract, manages the interface between the A/E and the end user, and looks out for the Navy's overarching interests, including special criteria and codes.

Following the federal, DoD, and Navy budgets, NAVFAC has been steadily downsizing over the past five years to match workload declines and to take advantage of efficiencies that have been recently developed:

- ID/IQ multiyear A/E contracts (as noted above);
- task order contracts that greatly simplify the contracting process;
- extensive use of design-build contracts—particularly a two-phase method of selecting a few top-quality contractors based on merit and then selecting from among them based on proposals and price;
- PC-based productivity tools focused on one-time data entry and paperless acquisition;
- An up-front, intense design "charrette" to obtain agreement among all stakeholders at the beginning of the design process to effectively transition from planning to design.

Traditionally, the NAVFAC design process has included a lengthy A/E selection process, a formalized 35 percent design review process usually including a meeting of all stakeholders to adjudicate all the written comments, and often a 65 percent design review and a 100 percent design review before design release for procurement. This process is resource intensive, tends to increase the design cycle time, and actually encourages customer-generated changes. As noted above, the NAVFAC is developing and implementing much more efficient and effective tools and processes. The NAVFAC is currently in a state of transition.

In addition to the Washington, D.C., headquarters, six of NAVFAC's field offices completed the questionnaire:

- Southern Division: Charleston, South Carolina;
- Southwest Division: San Diego, California;
- Pacific Division: Honolulu, Hawaii;
- Engineering Field Activity, Chesapeake: Washington, D.C.;
- Engineering Field Activity, Northwest: Poulsbo, Washington; and
- Norfolk Public Works Center: Norfolk, Virginia.

NAVFAC questionnaire responses support the contention that the organization is in a state of transition. All seven respondents indicated that the design review process has changed significantly since 1994, driven primarily by reengineering of business practices mandated by staff downsizing initiatives. Respondents were split as to whether or not project quality, cost, and schedule have remained constant or deteriorated; none thought they had improved.

Further reinforcing the transitional nature of NAVFAC's design review process, questionnaire responses indicate a wide variation among field offices in such areas as use of independent A/Es for design review, process formality (how well the process is documented), and process uniformity (how standardized the process is for different projects). Follow-up conversations with both headquarters and field staff indicate that field activities are indeed becoming more diverse in management styles and philosophies because

- NAVFAC headquarters has pushed a significant amount of responsibility and authority to field offices, thus allowing them a greater degree of local autonomy;
- differences in both type and quantity of work underway at the various field offices has become increasingly variable over the past five years;
- NAVFAC headquarters has encouraged field offices to innovate and accept a greater degree of risk with regard to management practices; and
- the extensive transition discussed above has provided a unique opportunity for experimentation with a variety of business practices throughout the NAVFAC organization, both at headquarters and in the field.

NAVFAC, particularly since 1994, has been aggressively exploring new ways of doing business in all of its areas of responsibility, with four innovative results:

- A/E self-check: At least one field office holds the A/E fully responsible for the technical details of the design and does not review for mistakes. During the A/E selection process, competing A/E firms are asked to document their internal program for objectively reviewing designs to ensure quality, accuracy, and compliance; these procedures are given a heavy weighting relative to final A/E selection. During design, the NAVFAC office evaluates the A/E's compliance with its quality control program. If the program is in compliance, it is presumed that the design itself is compliant.
- NAVFAC has provided extensive technical, management, and leadership training for its military and civil service facilities engineering professionals for over 50 years at its naval school, Civil Engineer Corps Offices, located at Port Hueneme, California. This well-regarded institution conducts wide-ranging classes and seminars in facilities engineering and also develops management solutions and process improvements. Both its courses of instruction and its research output are available to all federal agencies (see the section "Interesting Initiatives" for contact information).
- All NAVFAC offices use the U.S. Army Corps of Engineers' "Architect/Engineer Contract Administration Support System" (ACASS). ACASS is a database containing historical evaluations of A/E performance on past projects. Evaluations can be entered into the database by any federal agency. Similarly, ACASS can be queried by any federal agency interested in evaluating a particular A/E's past performance (see the section "Interesting Initiatives" for contact information).
- Most NAVFAC offices now use variations of design-build and other performance-based contracting models as the preferred mode of project acquisition. This shift away from the traditional design-bid-build model has occurred since 1994, in part because performance-based contracting methods generally require a reduced level of participation on the part of the owner in the design review process.

U.S. Department of State

The Office of Foreign Buildings Operations (FBO), located in Arlington County, Virginia, is the U.S. Department of State (DOS) office responsible for design, construction, and management of diplomatic facilities worldwide. The total replacement value for FBO-managed facilities is more than $10 billion and consists of over 5.4 million gross square meters of government-owned and leased properties. The annual operations and construction budget has averaged less than $400 million over the past three years. However, due to the East Africa embassy bombings in Dar es Salaam and Nairobi in August 1998, there have been substantial increases in funding ($627 million for FY 1999) for security upgrades at existing diplomatic facilities, with additional increases projected for future embassy construction.

The FBO operates as a centralized office and has no other field operating offices other than a facility management officer located in most major diplomatic posts. To accomplish the FBO mission statement "to assure that U.S. Diplomatic Missions abroad are provided appropriate facilities which will assist them in achieving the foreign policy objectives of the United States," FBO was staffed with more than 757 full-time positions in FY 1998 (25 percent were located overseas as facility management officers or construction managers). This reflected a reduction of 262 positions from the FY 1996 staffing level.

For FY 1999, staffing authorization has increased significantly due to the security supplemental funding and corresponding workload. FBO requested temporary staffing assistance from other agencies and currently has some Voice of America detailees (architects and engineers) working under a salary reimbursement arrangement to augment existing staff until new positions are filled.

To expedite the execution of projects in the security supplemental appropriations, FBO is pursuing several contract mechanisms that differ from the design-bid-build process that is traditionally used. There will be several design-build projects for new embassy buildings in which the contractor will be selected by the two-phase selection process legislated in 1997. There are also two recently selected "integration contractors" in which design-build work will be performed on small security upgrades for multiple posts worldwide.

The typical project design review is done by in-house staff. Typical design submittals of schematic 35, 60, and 100 percent milestones are reviewed over a period of 21 days each. There are follow-on review meetings with the contract A/E, most with a resolution of comments and a direction to proceed to the next phase. FBO will be

pursuing alternate and expedited review procedures for upcoming projects in the security supplemental packages. The primary method used for review will be "on-board" reviews in which an FBO project team will visit the A/E's office to review and discuss the design at hand. It is expected that this will result in time savings as well as better understanding of the basis of design due to the face-to-face interactions of the parties involved.

Questionnaire responses from the Department of State FBO differ from those of all other federal agencies in two respects:

- Design review process reengineering is not being driven by downsizing, but primarily by a motivation to improve the efficiency and effectiveness of the process.
- FBO is able to accomplish the design review process without significant use of outsourced resources. Generally, the only review functions outsourced are those relating to value engineering and shop drawings.

FBO questionnaire responses indicate a high degree of use of technology tools such as CAD software, Intranet and Internet applications, and computer-based data management systems.

Looking to the future, DOS anticipates a sharply increasing workload as a result of a 1998 requirement to enhance embassy security features worldwide. Such activity will likely exceed FBO in-house design review capability and require increased reliance on outsourced engineering support services. FBO's approach will be to focus in-house resources on the customer requirements review and outsource more elements of the technical review than previously.

The FBO reported two unique program initiatives:

- Technical design review comments are recorded in a software program "Automated Review Comment System" (ARCS), that collects and archives comments and also provides a method for communication and follow-up with the A/E.
- As a result of specific legislation dating back to the 1920s, DOS is able to contract for engineering support services with a great degree of flexibility. For example, they have been able to structure annually renewable individual self-employment contracts that allow personal service contractors to augment DOS staff as necessary to meet "peak and valley" requirements.

U.S. Department of Veterans Affairs

The U.S. Department of Veterans Affairs (VA) owns, leases, and operates a capital plant that includes more than 22,000 acres of land, 4,700 buildings, and over 140 million square feet of owned and leased space at 1,200 locations across the country. The replacement value of medical center buildings and other health care facilities in the Veterans Health Administration alone is estimated at approximately $35 billion. This infrastructure also supports the VA's 58 regional offices—the VA's Veterans Benefits Administration—and 114 national cemeteries.

The VA's Office of Facilities Management (OFM) is a component of the Veterans Health Administration, but it supports the entire department including the Veterans Benefits Administration, the National Cemetery Administration, and department staff offices. OFM delivers a wide range of services, including managing the VA's major construction program (projects of more than $4 million), lease and real property management, enhanced-use leasing, risk management and claims analysis, environmental programs, technical and engineering and architectural consultation to VA field facilities, and engineering design and construction policy and standards. The VA's health care system is highly decentralized; consequently, management of minor construction (projects of less than $4 million) and nonrecurring maintenance and repairs are accomplished locally by field facilities engineers. The VA's FY 1999 major construction budget is $152 million; the minor project budget is $175 million. There is approximately $1.3 billion of major projects in the pipeline pending completion.

The VA's health care is rapidly changing from an in-patient, hospital-based system to integrated networks with a focus on primary and ambulatory care. These changes are having a profound effect on the VA's building environment. The era of large bed facilities has passed and has been replaced with a new focus on smaller major

construction projects that include ambulatory care centers, renovations of existing facilities, safety and privacy improvements, seismic corrections, and new or expanded VA national cemeteries.

Many VA-constructed medical facilities are world class in terms of application of high technology and seismic design. VA facilities are not only designed to withstand earthquakes, but to remain in operation. The VA's use of seismic base isolation technology at the Long Beach, California, medical center is particularly noteworthy. In addition, OFM's design-build program has been highly successful in bringing projects to completion significantly faster than use of traditional methods without sacrificing quality or increasing cost. This program was a semifinalist in the 1998 "Innovations in American Government Awards" competition.

Since FY 1994, as a result of realignments, use of early-outs and buyouts, and reductions in force, OFM headquarters staff has been reduced nearly 65 percent from 314 employees to a current on-board strength of 107. Reductions have been particularly acute among staff in the engineering and architect specialties. Although the VA's major construction budget has declined during this time in total dollars, the number of projects requiring management and oversight has remained relatively constant.

OFM's construction management element has responded to requirements for downsizing in four ways:

- OFM is outsourcing a larger proportion of its design reviews to A/E firms and relying on these firms to monitor the professional quality of project design and construction. Indefinite quantity contracts are used to procure these services. This allows OFM to write individual delivery orders for a variety of tasks in different locations.
- OFM is in the process of delegating greater project management and contracting authority to its resident engineers in the field. The number of these on-site engineers has not been significantly reduced during the approximately five years of this transition.
- OFM has greatly expanded its use of alternative project delivery methods, including design-build, use of construction management firms, and purchase and hire techniques. The purchase and hire methodology is a procedure to accomplish construction, maintenance, and repair projects where a construction contract is impractical or in conflict with patient care activities.[1]
- OFM has vigorously worked to reengineer all processes to improve timeliness, quality, and cost effectiveness. In addition, OFM has systematically evaluated selected risks in the design and construction process and eliminated steps that are unnecessary, redundant, or add minimum value to the final product.

The VA's questionnaire response indicates that the design review process changed dramatically between 1994 and 1999, driven primarily by downsizing, related business practice reengineering, motivation to reduce the cost and time of design reviews, and much greater reliance on design-build as a project delivery method. Remarkably (given the scope of staff reductions absorbed and process reengineering completed), OFM clients have not reported any loss in quality. There is a sense that the design review process itself is more expensive as a consequence of greater reliance on outsourced resources. However, total design and construction costs have not shown any increase.

During this same timeframe, OFM was able to reduce project delivery times. The questionnaire relates the ability to absorb the downsizing with minimal project impact to two primary drivers:

- the establishment of five ID/IQ contracts for engineering services, which is an effective mechanism for outsourcing much of the detailed technical review; and
- rapidly expanding use of design-build as a contracting method, which dramatically reduced project delivery times.

Questionnaire responses indicate that collection and documentation of design review comments is a relatively

[1] To illustrate, at the San Diego facility, the work to be done required extensive phasing and the areas remained under direct medical control. The medical center contracted for personnel and material directly and directed the accomplishment of work to meet the medical center's needs through a VA senior resident engineer. No contract was issued to hire a general contractor.

informal process. Data relative to design performance (i.e., contract cost and schedule growth, change order rates, number of claims) are also collected.

In the area of noteworthy initiatives, the VA uses a system to document lessons learned from the entire facility acquisition process including the design phase. The system, called Proactive Claims Analysis and Tracking System (ProCATS), provides an excellent tool to identify patterns and trends in A/E errors, design omissions, and the types of changes that occur late in the construction process. ProCATS electronically announces lessons learned throughout the VA through "design alerts." These alerts are archived and remain available to the VA's design and construction professionals to minimize the chance of repeating problems. The VA's OFM also maintains a Technical Information Library (TIL) that can be accessed by anyone on the Internet (http://www.va.gov/facmgt/standard/standard.htm).

The TIL includes A/E information, design guides, design manuals, master specifications, cost estimating design alerts, and related materials. The TIL is updated on a monthly basis and it ensures the quality and operational efficiencies of the original design produced by the Architect of Record. The TIL includes only the latest and proven information applicable to the VA in fulfilling its mission. This fact alone has significantly lessened the task of the design reviewer by knowing that the design under scrutiny includes this proven information and does not require the reviewer or the A/E to "reinvent the wheel."

SUMMARY OF QUESTIONNAIRE RESPONSES

The following discussion compares and contrasts the responses contained in the 44 questionnaries that were returned by the nine federal agencies participating in the study.

How are agency facility engineering functions organized to carry out their missions?

There is no single organizational model for federal agency facilities engineering organizations. The DOE's facilities are government owned but contractor operated. Some agencies, like the VA, have moved to field-based design review and a mix of field-based and headquarters-based project management. Others, like NASA, have a centralized program policy and oversight office, with all program and project management functions conducted at the field activity level. The majority of the responding agencies maintain multiple regional project execution offices.

What has been the extent of downsizing on agency facility engineering organizations?

Seven of the nine responding agencies' facility engineering organizations experienced significant downsizing between 1994 and 1999, on the order of 20 to 50 percent reduction of in-house staff positions (the VA's reduction has been estimated at 65 percent). As of August, 1999, only the DOS and the ANG have been able to maintain a relatively stable situation with regard to staff size.

How are agency facilities engineering organizations responding to mitigate the impacts of downsizing?

During the early stages of downsizing, the responding agencies simply tried to do more with less. However, this adaptation became untenable at a certain point. Agencies then began to reengineer their facility engineering processes and practices. Intensity of this reengineering varies among the responding agencies, reflecting the fact that the speed and extent of downsizing has varied greatly from one agency to another. Impact-reducing strategies reported by various agencies include the following:

- Augmenting in-house staffing voids through personal service contracts. Personal service contracts allow agencies to add contractor staff to in-house staff on a temporary basis to fill voids in specific disciplines, or to address unusual peaks in workload. Procurement policies vary among agencies with regard to allowing use of personal service contracts.

- Outsourcing functions previously accomplished in-house. Nearly all facility acquisition functions except agency policy development and oversight have been considered for outsourcing by one agency or another.
- Reducing the intensity of oversight activities such as design review and construction inspection by either contracting such functions to third parties, or by including the functions within the scope of the design and/or construction primary contracts.
- Eliminating some activities entirely. One NAVFAC field office reported that they have eliminated formal design reviews on many smaller projects, holding A/Es responsible for instituting a self-review process. Similarly, a GSA region reported that they generally only require a single formal progress review during design.
- Using project delivery contracting schemes that shift more responsibility for design and construction oversight to the contractor, such as design-build, construction management, and program management. Indeed, NAVFAC reports that design-build is now the favored contracting strategy and the traditional design-bid-build strategy has become the least favored.

Why and how do federal agencies approach the practice of design review?

Risk management, compliance with user expectations, and reduction of change orders were cited as the primary reasons for conducting design reviews. The least cited reason was to maintain in-house core competencies.

All nine responding agencies reported participation in a design review process. Significant differences were noted, however, as follows:

- All responding agencies reported that they participate in design reviews although not at every field office (a few field offices of decentralized agency engineering organizations reported no or minimal design reviews—they rely on A/Es to self-review their work). Also, the degree to which agencies and their field activities varied the intensity of the design review process between simple and complex projects varied greatly from one agency to another.
- Design review functions identified as having the greatest value-added were scope and budget compliance, constructability, and compliance with client design guides. Functions identified as adding the least value were the discipline reviews—architectural, electrical, mechanical, and structural (although the responses did not support the idea that these functions could be dropped from the review process without risk.)
- Nearly all responding agencies reported conducting formal design reviews at the 30 and 90 percent project design milestones. Only two (NASA and GSA) reported conducting formal reviews routinely earlier than the 30 percent milestone.
- The primary criteria used to determine the intensity of design review are project value, complexity, and the project delivery method. Conversely, these criteria had little impact on the decision to review with in-house or outsourced resources. That decision rested primarily on in-house staff availability.
- When elements of design review are outsourced, all responding agencies still use in-house staff to review project scope and budget compliance. The most consistently outsourced elements included constructability, value engineering, and compliance with building codes.
- Nearly all responding agencies exploit technology tools to support their design review activities including CAD software, Internet and Intranet communication links, and computer software word processing and project management programs.
- Less than half of the agencies measure performance of their design review processes.

How have federal agencies changed their approaches to design review?

Eight of the nine responding agencies reported that they have changed their approach to design reviews since 1994. The primary reasons cited for change are staff downsizing, changes in contract methods, and business process reengineering. The most frequently reported changes included:

- consolidation of agency design guides and standards for simplification,

- increased outsourcing of either parts or all of the design review activity,
- exploitation of technology to assist the process, and
- reduced frequency of formal design reviews.

Several questions related to outsourcing of design review functions. Opinions and experience on this issue were varied, and no conclusions could be reached from the data provided. The following are typical comments:

- "Outsourcing results in a loss of core design capability. This in turn results in a lack of ability to be a Smart Buyer. At some point, we wouldn't even have enough expertise to hire a contractor to conduct design reviews."
- "Outsourcing poses no risk, as long as the contractors are liable for performance."
- "Outsourcing poses a very significant risk, particularly on renovation type work. And it is very difficult to have technically competent contractors in specialty areas."
- "Outsourcing is our present way of doing business, and we have experienced little risk."

Looking to the future, about one-third of the responding agencies reported that they are considering further outsourcing of design review functions.

INTERESTING INITIATIVES

During the course of interviews and an extensive literature search, a number of innovative practices were noted that may have broader implications. These practices are discussed below, with points of contact for further information:

- Partnering and teambuilding training. Although this practice is achieving widespread recognition, some programs have proven more effective than others. The Army Corps of Engineers and the CII have both been recognized for their particular programs, and both offer formal training. Contact: Robert H. Ryan, Associate Director, CII; phone: 512-471-6494.
- In-house training programs. Agencies have developed in-house training programs specializing in program and project management practices for federal agencies. Among the oldest are schools run by the U.S. Army Corps of Engineers (USACE) and the NAVFAC. More recently, NASA has developed two 1-week short courses of facility engineering management practices. Contacts: Lt. Commander Mark Van Vleck, Naval School Civil Engineer Corps Officers, NAVFAC; phone: 805-982-2888. William Stamper, Senior Facilities Engineer, NASA Headquarters; phone: 202-358-1133.
- Review comment documentation. The USACE's latest software program used for documenting, collecting, distributing, and archiving design review comments is called DR CHEKS. It runs on a desktop computer and uses the Internet for communication among design review participants. Perhaps most important, it has features to aid follow-up of actions taken in response to review comments, which is a particularly troublesome area. Contact: William East, Principal Researcher, Construction Engineering Research Laboratories, USACE; phone: 217-373-6710.
- Project Management Center of Expertise. The GSA recently established the GSA Project Management Center of Expertise. The center has been staffed by GSA's most senior and competent project managers to serve two functions:

  1. Actively manage all of GSA's uniquely large, complex, or high-visibility projects, regardless of location.
  2. Provide mentoring, counseling, and training services in the area of project management in support of all of GSA's regional offices. Contact: Myron H. Goldstein, Director, Heartland Region, GSA; phone: 816-926-7421; Internet: http://www.gsa.gov/pbs/centers.

- ISO 9000 certification. Some large A/E firms have secured ISO 9000 certification as a quality control activity. Among federal agencies, several of the USACE's district offices have received ISO 9000 certification for

their design and construction programs. Other agencies, including NASA and NIH are working toward ISO 9000 certification for their facility engineering activities. It should be noted that ISO-9000 does not guarantee a quality product. Rather, it guarantees that the process that produces the product (good or bad) has been carefully structured, documented, and measured. Organizations have found that the process of securing ISO 9000 registration has been a valuable experience in understanding just what they do and how they go about it. Contact: Joe Keith, Louisville District, USACE; phone: 502-582-5701. Calvin Williams, NIH; phone: 301-496-4865.

- Conceptual or advance planning. Most projects that fail to meet their planned objectives do so because of faulty or inadequate predesign development. The CII has recently developed a comprehensive preproject planning approach that allows organizations to measure whether they have adequately addressed all predesign requirements. CII also has developed a training module intended to assist organizations in adopting their recommended approach to preproject planning. Contact: Robert H. Ryan, Associate Director, CII; phone: 512-471-6494.
- Design review lessons learned. Problems identified in the design review process can become a powerful tool to improve performance. The VA uses a method of documenting and publicizing such lessons learned in an innovative program called ProCATS. Its purpose is to identify recurring problems that result in change orders, claims, and delays and then to take positive steps to avoid such problems in the future. The system is the first of its kind in the federal government and was a 1996 winner of the Vice President's Hammer Award. Contact: Satish Sehgal, OFM, VA; phone: 202-565-5032.
- A/E historical performance database. The USACE has, for many years, maintained a database containing historical evaluations of A/E performance on past projects. This database, the ACASS, can be queried by any federal agency interested in a particular A/E's past performance. Information about ACASS is also available at the website http://www.nwp.usace.army.mil/ct/i/. Contact: Ruth Abney, Portland District Contractor Appraisal Information Center, USACE; phone: 503-808-4594.
- NIH contractor performance system. The NIH has developed a multiple agency, shared file system that allows all authorized users to have access to the completed contractor performance evaluations of all subscribing agencies via the Internet. A separate module for each subscribing agency is developed with a unique URL, allowing each agency control of agency data and access authority. Planned future enhancements include automated construction and A/E forms; electronic storage of contractors' rebuttal and comments; electronic and encrypted, transmittal of evaluations to the contractor; and ad hoc reporting. Contact: Ms. Phyllis Donoghue, NIH; phone: 301-496-1783; e-mail: pd3n@nih.gov.

4

Best Practices for Reviewing Facility Designs

The mere existence of a design review process elevates both the work of the architect and the aspirations of his or her clients. In my experience, this has been design review at its best. At its worst, design review can become stylistic tinkering or design by committee. David M. Childs, Senior Design Partner, Skidmore, Owings and Merrill (Brown, 1995)

For purposes of this study, the Federal Facilities Council (FFC) used the term design review to signify the review of facility designs as part of a multifaceted process that begins in conceptual planning and continues in some fashion throughout the facility acquisition process. The core issues of this study concern the value-added portions of design review processes and the appropriate level of oversight for facilities owners, particularly federal agencies, in such processes. The study objective was to identify a range of best practices and technologies that could be used by federal agencies and other owners to provide adequate management and oversight for reviewing facility designs in an era of limited resources.

During the course of this study a literature search was conducted, industry experts and practitioners were consulted, and federal agencies were surveyed. The findings of this report as they relate to the original questions posed by the FFC about the value-added of design review processes and the role of facilities owners are the following:

- **What is the value-added of design review processes?**

Design reviews are an essential component of the facility acquisition process. An effective design review process helps to unify and align all interested parties to a common objective and integrate their knowledge, experience, and skills throughout all phases of the facility acquisition process (conceptual planning, design, procurement, construction, and start-up). In the end, effective review of designs maximizes the probability that a business requirement will be successfully supported by a facility that was conceived, designed, constructed, and placed into operation efficiently and effectively.

Effective design review practices result in the preparation of more comprehensive and accurate design and construction documents which in turn result in lower project construction costs. Areas of savings include less rework on the part of the construction contractor, fewer change orders to the owner for correction of design errors or omissions, and the cost of belatedly adding project upgrade features that should have been addressed in the original design. By reducing changes required during the construction phase, effective design review practices also

generate significant indirect cost savings by avoiding costs associated with loss of productivity during construction-delayed facility startup, and litigation.

- **How do (and how can) federal agencies measure the value-added?**

The nine federal agencies that responded to the FFC's questionnaire indicated that they currently measure the value-added of design review processes primarily from a broad context: Their insight is both subjective (is the user reasonably happy with the completed facility?) as well as objective (how close did the completed facility come to the original cost and schedule objectives?). Sufficient industry research has been conducted in recent years to identify metrics that can be used to measure both the efficiency and the effectiveness of each phase of the facility acquisition process and compare the results to established benchmarks. The extent to which individual federal agencies currently take such measurements and analyze results varies widely.

- **What is the role of in-house staff, and what value do they add to design review processes?**

Within most federal agencies, facilities are a means to support the agency's mission rather than the mission itself. The agency's in-house facility engineering staff exist to support the agency's mission. First and foremost, the in-house staff should be able to identify facility requirements in the context of impact on the agency's mission success and, in so doing, to act as a smart buyer. The staff should be capable of leading a strategic planning process involving representatives of the agency's facility user community where give and take decisions are made balancing the facility's ultimate performance, cost, and schedule. During the tactical facility acquisition phase, in-house facility engineering staff should be capable of providing the overall process leadership, ensuring that all activities proceed in the best interest of the owner. Toward this end, the owner's interests are best served if the in-house staff can also perform in the role of a "smart buyer" of the necessary technical services. A smart buyer is one who retains the requisite technical knowledge to accurately define the technical services needed, recognizes value during the acquisition of such technical services, and can evaluate the quality of services ultimately provided.

- **What functions are being (and should be) contracted to outside consultants?**

Individual and often uncontrollable circumstances have resulted in nearly all facility engineering functions, from conceptual planning to project start-up, being contracted to outside consultants at one time or another. Today's general practice among federal agencies is to outsource design development and, to a lesser extent, certain specialized technical review functions such as shop drawing reviews, value engineering, and constructability.

As long as sufficient skills are retained in-house to meet the smart buyer approach discussed above, there does not appear to be any greater risk from contracting out a broader range of design review functions including such services as construction document discipline reviews and code compliance checks, so long as such functions are widely available from a competitive commercial marketplace. The exception occurs when complex projects include unique and specialized features of high mission relevance and limited skill availability in the commercial marketplace (examples would include NASA wind tunnels, Veterans Affairs medical research facilities, and high-security military facilities). Agencies are well advised to retain such unique specialized skills in-house as core competencies, with design review a primary in-house responsibility.

- **What skills and resources do federal agencies need to provide effective oversight of design review processes?**

Industry-related research and the author's interviews with public and private sector practitioners suggest that agencies should retain the capabilities in-house to:

1. define facility requirements in relation to the agency's mission, assess facility-related mission impacts, and conduct facility-related strategic planning activities;

2. lead and conduct teaming activities involving participants from various interested parties (owner, user, A/E, construction contractor, specialty consultants, etc);
3. develop, implement, and maintain overall policy and direction of the agency's facility engineering function; and
4. perform as a smart buyer of outsourced technical services.

- **What risks and liabilities do federal agencies face in outsourcing most or all of their design review functions?**

The risks and liabilities will vary depending on whether an agency maintains the in-house capabilities to perform the design review-related functions listed above. If an agency does not retain such in-house resources and capabilities, agencies risk the following consequences:

1. Consultant access to agency decision makers may be limited, resulting in difficulty understanding the owner's project performance expectations.
2. Project schedule may be compromised at key decision points due to lack of owner insight.
3. A design review process with little or no owner participation may become ineffective without the owner being aware of the developing process deterioration. An owner with little or no participation in design reviews is less likely to become aware of any breakdowns in the process; the owner may find out too late to remedy the problem or to save the project schedule, and this may result in cost overruns.
4. Consultants may find it difficult to communicate with owner staff regarding technical issues and problem solving.

In the case of unique, unusual, or high-tech facilities, consultants may have limited access to unique skills, potentially resulting in naïve and inappropriate technical solutions.

- **How can new and emerging technologies be integrated into design review processes?**

The ongoing revolution in information technology and communications offers unlimited opportunities to improve design review processes. Examples range from relatively simple practices, such as effective use of audio and video teleconferencing to improve meeting flexibility, to emerging technologies using holographic projection techniques to create three- and four-dimensional models of project designs in order to visualize the impact of proposed changes. The Internet and computer-aided design and drafting can be used for fast, comprehensive, paperless communication between reviewers, managers, and A/Es.

Benchmarking offers one tool to identify which technologies offer the most return for the investment made. Agencies can identify similar organizations that have successfully incorporated desirable technologies and adopt those practices that offer significant improvements in process, cost savings, time, or resources.

Agencies can also consider joining any of the many trade and professional organizations that assist their membership in identifying and implementing appropriate technology-based practices. It is important to recognize that some of the technology practices will cause major changes to established routines, require new equipment and software, and require mastering new sets of skills.

BEST PRACTICES

Effective design review processes require work, some of it obvious and some of it quite subtle. The following list of 18 best practices relies heavily on research conducted by the Construction Industry Institute, The Business Roundtable, the National Research Council, the FFC, and similar organizations. The author's interviews with a wide range of experienced design, construction, and operation professionals, and the author's personal experience also contributed to the compilation of the following list. The best practices are organized into five categories related to the role of the owner, teamwork and collaboration, advance planning, process, and benchmarking.

Role of the Owner

1. Be a smart buyer. Facility acquisition processes (including review of designs) work best when the owner has sufficient in-house expertise to qualify as a smart buyer. A smart buyer is one who retains an in-house staff that understands the organization's mission, its requirements, and its customer needs and who can translate those needs and requirements into a corporate or strategic direction. A smart buyer also retains an in-house staff that includes technical experts who can both articulate the nature of technical services being bought, recognize good value during the negotiation of such services, and evaluate the quality of the services as they are provided.

2. Develop a scope of work that clearly and accurately defines the owner's expectations regarding facility cost, schedule, performance, and quality. The owner's standards, more than those of any other entity involved in the acquisition process, will set the tone for all aspects of design review activity. The owner's scope of work should be used as the yardstick against which to measure performance.

3. Avoid the temptation to micromanage design reviews. A/Es are selected based on their experience and expertise; they should be given wide latitude to bring that expertise to fruition.

Teamwork and Collaboration

4. Use teambuilding and partnering techniques to build good working and communicative relationships among the participants.

5. Ensure that all interested parties participate in design reviews from the planning and design phases, so that all perspectives are represented as the design evolves. Broad participation creates early project endorsement or "buy-in," reducing the potential of later disagreement or need for changes. At a minimum, involve representatives of the owner, the user, the A/E, construction management staff, maintenance and operations staff, and special staff such as procurement, safety, and fire protection. Where possible and appropriate, include the construction contractor, permitting agency staff, and independent specialists for value engineering and independent review. Err on the side of excess participation—it is cost effective protection against unexpected and expensive fixes or oversights.

6. Use the same A/E throughout the facility acquisition process to maximize continuity and allow participants to build and apply their experience baseline. Using the same A/E for conceptual planning, detailed design, construction support engineering services, and start-up takes advantage of the A/E's intimate understanding of both the owner and his project needs, and supports continuity of personnel involved.

7. Use senior, experienced personnel who understand the relationship of a facility to meeting the agency's overall mission and who can effectively evaluate the evolving design and guide the review process.

8. Participants should commit for the duration of the activity to ensure continuity. Changing participants from any of the organizations involved in reviewing the design can disrupt the work flow and threaten the stability of good teaming relationships.

9. Participate in a design awards program in order to recognize and motivate excellence. Nothing succeeds like success! Recognition of a job well done gives visibility to a successful process and motivates all of the participants to continually improve.

Advance Planning

10. Focus attention on the review of designs during the conceptual planning and design phases where the ability to influence the ultimate functionality and cost of the project is the greatest. Effective design review processes start out being very intensive and proactive, with an intensity that declines through the procurement, construction, and start-up phases of the acquisition process.

11. Do not start the final stage of design—preparation of the construction plans and specifications—until the preliminary engineering has been completed. To do otherwise could significantly slow the overall design activity due to frequent interruption and rework caused by incomplete project scope definition.

Process

12. Tailor the design review approach to project specifics. Project complexity, cost, mission criticality, visibility, method of contracting, and schedule are just a few of the variables that can drive aspects of the design review approach such as frequency, intensity, and reliance on outsourced experts and consultants.

13. Keep up the pace to maintain momentum and keep the facility acquisition process on schedule. The review of designs at each phase of the process should not impede progress toward a completed facility. A stop–start or prolonged process impacts the acquisition in many ways, perhaps the most critical being the increased potential that organizations will reassign participants.

14. Pay special attention to the civil, structural, electrical, and mechanical interfaces. Historically, 30-50 percent of all construction change orders result from interference fit problems between trades. Is the power supply appropriate to the specified mechanical equipment? Does the HVAC ducting pass through structural members?

15. Exploit technology. The technological revolution has provided many tools to enhance design review processes, including computer-aided design, three-dimensional modeling, data collection and distribution software programs, and rapid communication systems, including the Internet.

16. Conduct a postoccupancy evaluation to develop a lessons-learned document for future reference. After facility start-up, the design review team should document objective results (how did final cost and schedule compare to planned?) as well as subjective results (is the user pleased with facility performance?). The postoccupancy evaluation should also relate approaches taken during the various phases of the facility acquisition process with the final results.

Benchmarking

17. Measure results achieved by design review processes in order to assess its level of performance. A process cannot be managed if it is not measured. Successful benchmarking requires an organization to identify relevant performance characteristics, measure them, and compare results against either established industrial norms or against similar measured characteristics of other organizations recognized for their excellence.

18. Document both unusually good and bad performance for future reference. Even better, find a way to share such information with other organizations and federal agencies.

OPPORTUNITIES FOR FOLLOW-ON STUDY

In the course of preparing this report, four topics were identified in which additional research and discussion could lead to either fundamental new approaches or significant improvements to current practices.

1. Create a senior-level advisory group on federal facilities issues. Study the alternatives, costs, and benefits of establishing a senior-level policy council within the federal government that would advocate, lead development, and direct implementation of policies and strategies designed to raise and maintain the practice of facility engineering and stewardship of federal facilities at the highest level. Such a council would comprise senior facility engineering executives from all agencies with facility responsibilities as well as representatives from professional organizations, trade associations, and the industry's private sector.

A similar recommendation was made by the Committee to Assess Techniques for Developing Maintenance and Repair Budgets for Federal Facilities. Their recommendation was published in the 1998 National Research Council Report *Stewardship of Federal Facilities: A Proactive Strategy for Managing the Nation's Public Assets* and was focused primarily on improving management of facility maintenance and repair activities. Nonetheless, that committee's recommendation is equally relevant for the facility acquisition process and is therefore reiterated below:

> The authoring committee recommends that an executive level, federal facilities advisory group be appointed to provide policy direction and set priorities for the effective management and maintenance of the facilities portfolio. This group should include senior level federal managers from civilian and military agencies, other public sector managers, and representatives of nonprofit organizations and private sector corporations. . . . An advisory group of senior officials from DOD, DOE, GSA, NASA, other federal agencies responsible for managing facilities portfolios, OMB, GAO, the National Science and Technology Council, and other appropriate agencies and organizations should be appointed to focus on the policy issues related to maintaining and enhancing the functionality and quality of federal facilities. This group should also include representatives of state and local governments, nonprofit organizations, and private sector corporations with facilities-related responsibilities to provide a broad perspective in facilities management. An executive level advisory group will give the issue of federal facilities maintenance, repair and stewardship greater visibility. Initially, this effort may require the investment of more staff time and resources, but, in the long term, it should result in savings of both time and resources through greater cooperation and sharing of facilities management knowledge (NRC, 1998).

2. Identify a set of metrics that can be used to measure performance across all phases of the facility acquisition process. Each phase of the facility acquisition process (conceptual planning, design, procurement, construction, and start-up) contains characteristics that can be objectively identified and measured as an indicator of performance. Such metrics can be effectively used either within a single agency or among different federal agencies to document a level of performance and compare it to recognized benchmarks. A number of individual federal agencies have attempted to develop such a system of measurement for one phase of the process or another, with varying levels of success. But a governmentwide system of measurement addressing all phases of the process and that is applicable as a method of comparison between agencies does not exist. The National Research Council study *Stewardship of Federal Facilities,* mentioned above, also recognized a similar need for governmentwide performance measures for facility maintenance and repair activities. Specifically, the report recommended that "Government-wide performance measures should be established to evaluate the effectiveness of facilities maintenance and repair programs and expenditures" (NRC, 1998).

3. Study current practices of federal agencies with regard to the standards, guidelines, and policies supplied to A/Es in support of facility acquisition activities. Sources cited in this study, both in the literature and through interviews, indicate that the way in which owners' expectations are defined through standards, guidelines, and policies is critical to both the efficiency of the design process as well as the resulting product. Well-prepared guidelines help an A/E understand the general direction the design is expected to take and can save a lot of time getting the project underway. On the other hand, overly prescriptive guidelines can limit the initiative and innova-

tion that the A/E is allowed to contribute to the design. It would be useful to compare and contrast how federal, other public sector agencies, and private sector organizations approach this issue.

4. Study potential benefits of establishing a peer review process for agency design review practices. In a peer review activity, an organization desiring to evaluate its own internal management process and practices requests that another organization with similar products and responsibilities visit in order to conduct an intensive investigation focused on how work gets done at the requesting organization. Normally, the organization invited to conduct the review is recognized for its excellence and is sufficiently independent that its findings and recommendations can be both objective and nonthreatening. The peer review process itself may sound simple and straightforward; however, it has evolved into a sophisticated and highly structured activity with increasingly successful outcomes for both the inspecting as well as the inspected parties. Peer review is much more common in the private sector, but would appear to have application in the federal sector.

Adding Value to the Facility Acquisition Process: Best Practices for Reviewing Facility Designs

Appendixes

Adding Value to the Facility Acquisition Process: Best Practices for Reviewing Facility Designs

A

Record of Interviews

11/17/98	Donald Uzarski and William East, Principal Researchers, U.S. Army Corps of Engineers Construction Engineering Research Laboratories, Champaign, Illinois.
11/19/98	Edd Gibson, Professor of Civil Engineering, University of Texas at Austin.
12/15/98	William Nigro, President, The Redicheck Firm, Peachtree City, Georgia.
12/16/98	Howard Hillinger, Vice President, URS Greiner, Seattle, Washington. Coral DeWilliam, Principal Architect, URS Greiner, Seattle, Washington.
12/17/98	Peter Allen, Director of Facilities, NASA Marshall Space Flight Center, Huntsville, Alabama. Tim Corn, Engineering Director, Facilities Engineering Division, NASA Marshall Space Flight Center, Huntsville, Alabama.
1/4/99	Marla Harrison, Director of Systems Engineering, NASA Ames Research Center, Mountain View, California.
1/19/99	Dwain Warne, retired. Past director of engineering and construction, GSA Capital Area Office, Washington, D.C.
1/21/99	Douglas Holen, Director of Facility Design and Construction, University of Washington, Seattle, Washington.
1/22/99	Captain Charles Navin, Civil Engineer Corps, U.S. Navy, Commanding Officer, U.S. Navy Engineering Field Activity Northwest, Poulsbo, Washington. Commander Stephen Markey, Civil Engineer Corps, U.S. Navy, Executive Officer, U.S. Navy Engineering Field Activity Northwest, Poulsbo, Washington.

	Ron Lavoie, Construction Team Leader, U.S. Navy Engineering Field Activity Northwest, Poulsbo, Washington.
1/26/99	Joseph Keith, Assistant Chief of Engineering, U.S. Army Corps of Engineers Louisville District, Louisville, Kentucky.
1/28/99	Dean Findley, Independent Project Analysis, Inc., Reston, Virginia.
1/29/99	John H. Cable, Logistics Management Institute, McLean, Virginia.
1/29/99	C. Hilton Dunn, Director of Continuous Improvement, BE&K, Inc., Birmingham, Alabama.
2/17/99	Richard Danks, Director of Facility Engineering, NASA Lewis Research Center, Cleveland, Ohio.
2/19/99	Paul Barry, Architectural Projects Coordinator, City of Seattle, Seattle, Washington.
2/23/99	Felix Martinez, Director of Procurement and Government Markets, American Consulting Engineers Council, Washington, D.C.
3/19/99	William Bryan, Director of Public Works, City of Bainbridge Island, Washington.
3/21/99	Clint Odiorne, Construction Support Team Leader, U.S. Navy Engineering Field Division Northwest, Poulsbo, Washington.
3/22/99	Firooz Israel, Vice President, Lockwood Greene Engineers, Atlanta, Georgia.
3/29/99	Tanya Matthews, Chairman, Design Build Institute of America, Washington, D.C.
4/7/99	Martin A. Abbate, Manager of Electrical Design, Morrison Knudsen Corporation, Cleveland, Ohio.

B

Literature Search Abstracts

CONSTRUCTION INDUSTRY INSTITUTE PUBLICATIONS

Benchmarking and Metrics Summary for 1997, Benchmarking and Metrics Committee, Construction Industry Institute, The University of Texas at Austin, Austin, Texas, 1998.

This 1997 annual summation of Construction Industry Institute (CII) benchmarking activity makes several noteworthy observations relating to the facility design process. The summary looks at the extent of use (and resulting benefits) of seven CII-recommended best practices: safety, team building, constructability, preproject planning, design and information technology, project change management, and strategic alliances.

A key finding of the summary is that project success is significantly enhanced when predesign activity is completely and properly addressed prior to start of design. Specifically, the study analyzed results obtained where projects used CII-recommended predesign processes to varying degrees. Projects whose design began with relatively little predesign activity realized an average cost growth of 16 percent whereas projects that maximized the use of CII predesign processes enjoyed a cost underrun averaging 8 percent. The study also quantified the benefit of applying a comprehensive constructability process during the design review phase.

Although the basic philosophy of this report is intuitive ("better planning makes for better projects"), the significant contributions of CII are

- specific and practical recommendations for implementing the best practices cited above and described in user-friendly implementation manuals, and
- objective use of benchmarking techniques to develop metrics that can be used to qualitatively measure results achieved from successful implementation of the CII best practices cited above.

Evaluation of Design Effectiveness, Report RS8-1, Construction Industry Institute, The University of Texas at Austin, Austin, Texas, 1986.

This publication presents a method for determining the effectiveness of a facility design, based on seven evaluation criteria: (1) accuracy of design documents, (2) usability of design documents, (3) cost of design, (4)

constructability, (5) economy of design, (6) performance against schedule, and (7) ease of start-up. The method assigns values and weights to each criterion, thus allowing the calculation of an overall quantifiable score.

Owner/Contractor Work Structure Process Handbook, Report IR111-2, Construction Industry Institute, University of Texas at Austin, Austin, Texas, 1997.

This handbook recognizes the impact that downsizing is having on central engineering organizations and discusses the importance of identifying owner organization core competencies that are required for successful capital asset acquisition. It provides a methodology for identifying core competencies that should be retained as compared with those skills that can be outsourced. It also provides a methodology for establishing a working relationship with contractors who provide outsourced services, with special attention to achieving and maintaining alignment toward common goals.

NATIONAL RESEARCH COUNCIL PUBLICATIONS

Achieving Designs to Budget for Federal Facilities, Committee on Design to Budget for Federal Facilities, Building Research Board, National Research Council, National Academy Press, Washington, D.C., 1990.

Operating from the premise that deviation from a planned budget during acquisition is particularly onerous for federal government facilities, this committee was asked to provide advice and recommendations on how to improve the government's ability to ensure "designs to budget." Several of the committee's findings and recommendations are relevant to the design review process:

- Design-related growth of construction costs in excess of budget is most frequently related to one or more of the following problems:
    1. Poor planning and failure to think carefully about foreseeable problems of construction.
    2. Poor understanding of the difficulties likely to arise in truly unique projects.
    3. Lack of attention to difficulties that may arise from unique conditions associated with otherwise standard projects.
- Inadequately detailed or erroneous design and increases of scope caused by user requests are other sources of failure to meet budgets.

The report also found that the early stages in the design process are most critical for assuring successful designs to budget because the design is still flexible and factors that determine costs are not fixed. To have the greatest impact on the designer's ability to meet the construction budget, the owner's management attention should be focused most strongly on the early stages of design. In addition, such procedures as constructability analysis, value engineering, and peer review may be useful to refine and assure the quality of design and likelihood that budgets will be met. Relevant recommendations are the following:

- The present allocation of design and cost management resources places too much emphasis on later stages of design where the ability to influence costs has been largely lost. The allocation should be shifted or the budget set later in the process, or both.
- The formal cost estimates now used in federal design management should be prepared and reviewed not as a subsidiary task of design, but rather as a separate activity at the completion of each major stage in the design process.
- Agencies should work to reduce the time required to complete the design process for federal projects. The opportunity for cost growth during the 18-24 months typically required for federal projects imposes a substantial burden on the designer seeking to meet budget.

- Agencies should conduct postoccupancy evaluations of all new facilities so that experience on how actual utilization and cost compare with program and budget used in design could be used to make planning and design of future facilities more effective.
- Designers seeking federal projects should be invited to include in their statements of qualifications descriptions of their cost planning and monitoring systems and their experience with these systems in previous assignments. Alternatively, agencies should assure responsible cost and control through explicit assignment of qualified staff or consultants.

Government/Industry Forum on Capital Facilities and Core Competencies. Federal Facilities Council Report No. 136, National Academy Press, Washington, D.C., 1998.

The report summarizes presentations made at a forum cosponsored by the Naval Facilities Engineering Command, The Business Roundtable, and the Federal Facilities Council in March 1998. The forum recognized that most federal agencies are dealing with unprecedented budget reductions, staff reductions, and wholesale organization reengineering. Experienced professionals from both the public and the private sectors were asked to discuss the challenges, strategies, and results they have encountered while responding to these kinds of changes.

The following are key points made during the relevant presentations:

- "The Business Stake in Effective Project Systems," Ron Howard, Director-Construction, The Business Roundtable. Mr. Howard's presentation summarizes a white paper published by The Business Roundtable in 1997. The white paper makes a number of highly relevant points and is reviewed more comprehensively later in this appendix.

- "Corporate Owners Perspectives on Capital Facilities Engineering Function and Core Competencies," David A. Skiven, Executive Director, Worldwide Facilities Group, General Motors Corporation. Mr. Skiven's organization, the Worldwide Facilities Group (WFG) of the General Motors Corporation, was formed in 1994 through a consolidation of 20 organizations. He describes WFG's process of establishing a new vision focusing on serving General Motors' various business units in such a manner that the business units are free to focus on business strategy rather than overhead function management. He also lays out WFG's approach to defining core competencies and their relationship to outsourcing. Key to outsourcing, is maintaining a "smart buyer" on staff. That smart buyer must be someone who understands the business, its requirements, and customer needs, and who can translate those needs and requirements into a corporate direction.

- "Amoco Corporation's Worldwide Engineering and Construction Division," Terry Brandt Wood, Manager of Project Development. Ms. Wood describes the process of dealing with a 35 percent staff downsizing of Amoco's engineering and construction staff during a period of increasing corporate revenue and capital investment. The process involved developing a mission and vision that focused on value-added to the corporate bottom line, developing a common process for capital projects and its adoption corporatewide, applying a "value-to-cost" ratio to help differentiate core competencies that should be retained in-house versus those that could be cost-effectively outsourced, and focusing in-house staff more intensively in the advance planning or front-loading activities involved with capital project acquisition.

- "General Services Administration," Robert A. Peck, Commissioner of the Public Building Service, and Myron H. Goldstein, Director of the Project Management Center of Expertise. Mr. Peck and Mr. Goldstein noted that the General Services Administration (GSA's) Public Buildings Service has downsized from 20,000 to approximately 7,000 staff over a 20-year period. Simultaneously, its inventory of managed facilities is expanding, although not uniformly at each region. Recognizing that it is not

practical for each region to perform all tasks, GSA's response has been to establish 12 Centers of Expertise around the country to ensure that core competencies are identified and retained at least somewhere within the system. Key to this approach is the Project Management Center of Expertise headed by Mr. Goldstein that will institutionalize the best attributes of project management. The center will also directly manage GSA's most expensive and complex projects, regardless of location. In an interesting initiative, GSA plans to create a learning center where less-experienced project managers will have access to information and training from GSA's most experienced and senior professionals who will provide mentoring.

Improving the Design Quality of Federal Buildings, Committee on Improving the Design Quality of Federal Buildings, Building Research Board, National Research Council, National Academy Press, Washington, D.C., 1989.

This report by an eminent group of academics and architect/engineering (A/E) professionals looked at methods to improve two aspects of facility design quality in federal facility acquisition:

1. The magnificence of the architecture presented in the final plans and specifications.
2. A process that provides appropriate and error-free building programs, plans, drawings and specifications.

The report makes a series of recommendations regarding

1. greater focus on the predesign planning and programming stages;
2. a more flexible approach to A/E selection, contracting mechanisms, and the design management mechanism;
3. greater participation during design and construction by knowledgeable owner and A/E personnel;
4. more intensive postdesign evaluations, both during and after construction; and
5. less-restrictive design criteria, standards, and guidelines on the part of owners.

The study committee also recommended that Congress and its committees that oversee federal design and construction consider the merits of establishing more centralized federal advocacy for quality in design.

On the Responsibilities of Architects and Engineers and Their Clients in Federal Facilities Development, Committee on Architect-Engineer Responsibilities, Building Research Board, National Research Council, National Academy Press, Washington, D.C., 1994.

This committee, told that many federal agencies were dissatisfied with the quality and thoroughness of work performed by private A/E firms, evaluated current methods of assessing the quality of design work and identified issues for determining what constitutes satisfactory professional work by an A&E firm.

The report's findings and recommendations include the following:

1. The designer must be given a realistic task and appropriate compensation, the task must be well understood by all parties, and the designer's intent must be effectively realized in the constructed facility. Otherwise, owners and users will almost certainly question whether the A/E professional has fulfilled his or her responsibilities. In general, all parties—designers, owners, and users—must work together to achieve quality facilities.
2. The federal process for procuring A/E services is often more complex and time-consuming, requires more formal document preparation, and is more prone to fostering adversarial relationships among the participants in facility development than procedures used for comparable projects in the private sector.
3. Interim design reviews should be substantive and conducted by experienced professionals familiar with the

agency's needs, the user's needs, and the practical aspects of facility development. Ideally, the reviews should be conducted in similar fashion and by the same staff at each stage in the design process. If experienced agency personnel are not available, consideration should be given to utilizing an A/E consultant, distinct from the designer but fully familiar with the type of facility and the agency needs, to provide effective peer review.

4. Realistic, uniform, experience-based measures and benchmarks of A/E performance would be a valuable management tool that could be used by both A/E firms and government agencies to improve planning and design management.

5. Agencies of the Federal Facilities Council should convene professional organizations such as the American Institute of Architects, the American Consulting Engineers Council, the Associated General Contractors, and others to work with the agencies to develop a study design, collect data on project development, and analyze those data to develop meaningful measures and benchmarks of A/E performance.

In the interim, the committee recommended a series of guidelines as follows:

1. A/E professionals can be expected to perform their tasks more responsibly if they are involved on a continuing basis in more stages of the facility development process.

2. Construction change orders due to unanticipated site or market conditions or shifts in user and owner needs are to be expected during the long time required for the planning, design, and construction of any facility. Construction cost growth of as much as 5 percent over bid estimates is not abnormal.

3. As the time required to develop a facility increases from initial planning through the end of construction, so does the likelihood of change orders, cost growth, and loss of quality.

4. Changes in the requirements tend to cause changes in design. If the agency changes its requirements, cost changes often ensue through no fault of the designer. If requirements have changed, it is more difficult to determine that A/E performance is wanting.

5. Conventional design-bid-build projects that experience construction changes that increase costs more than 10 percent over construction contract award value should be thoroughly reviewed. Changes due to A/E errors, oversights, or omissions should not increase costs more than 5 percent. If an agency is experiencing such cases on a recurring basis, the agency's programming or A/E firm selection processes may be at fault.

Quality Control on Federal Construction Projects, Technical Report No. 84, Federal Construction Council Consulting Committee on Contract Management, National Academy Press, Washington, D.C., 1987.

This report summarizes responses to a questionnaire focused on five areas associated with construction quality control: (1) definition of terms, (2) general approaches to construction quality control, (3) views of agencies on trends in construction quality, (4) recent actions taken to improve construction quality control, and (5) additional actions being considered to improve construction quality control. Responses were received from five federal agencies: (1) U.S. Army Corps of Engineers, (2) Naval Facilities Engineering Command, (3) Veterans Administration, (4) General Services Administration, and (5) Public Health Service.

The report was one of the earliest to note the impact of staff downsizing on the design review process. It recognized the relationship between quality results and good design and compares and contrasts differing agency approaches to design review processes, noting several best practices. Points receiving the most emphasis include the following:

- The design review process is critical to project outcome; more attention needs to be placed on this phase of the project acquisition cycle.
- Constructability issues need more attention during the design review process.
- Facility maintainability issues (especially participation by the owner's maintenance experts) need to be increased during the design review process.

Quality Planning in Times of Tight Budgets: Summary of a Symposium, Technical Report No. 97, Federal Construction Council, National Academy Press, Washington, D.C., 1990.

This report comprises synopses of 11 talks presented by both public and private sector facilities managers. The topics are generally concerned with the predesign planning and programming phase of facility acquisition. However, one presentation is particularly noteworthy by providing an unusual perspective: "Quality Planning in the Marriott Organization," by Rene Gautschi, Vice President of Marriott Corporation. Ms. Gautschi relates the difficulty faced by an owner who must focus primarily on schedule aspects of facility acquisition in a business where a large staff is on payroll prior to opening and convention users are often booked before construction is even started. In such an event, the temptation to delay start of construction until every last detail has been wrung out of the concept plan and construction drawings can be catastrophic. Ms. Gautschi therefore describes a facility acquisition process focused on minimizing up-front planning activity, eschewing alternative design studies, avoiding construction change orders, and accelerating start-up activities.

Stewardship of Federal Facilities: A Proactive Strategy for Managing the Nation's Public Assets, Committee to Assess Techniques for Developing Maintenance and Repair Budgets for Federal Facilities, National Research Council, National Academy Press, Washington D.C., 1998.

Although primarily oriented toward facilities operation, maintenance, and repair activities, many of the committee's findings and recommendations are relevant to facility acquisition issues.

Relevant findings include the following:

- Federal facilities program managers are being encouraged to be more businesslike and innovative, but current management, budgeting and financial processes have disincentives and institutional barriers to cost-effective facilities management and maintenance practices.
- Organizational downsizing has forced facilities program managers to look increasingly to technology solutions to provide facilities-related data for decision making and for performing condition assessments.
- Training for staff is a key component of effective decision making, condition assessments, and the development of maintenance and repair budgets.

Relevant recommendations include the following:

- Governmentwide performance measures should be established to evaluate the effectiveness of facility maintenance and repair programs and expenditures.
- Facilities program managers should be empowered to operate in a more business-like manner by removing institutional barriers and providing incentives for improving cost-effective use of maintenance and repair funds.
- The government should provide appropriate and continuous training for staff that perform condition assessments and develop and review maintenance and repair budgets to foster informed decision making on issues related to the stewardship of federal facilities and the total costs of facilities ownership.
- At the executive level, an advisory group of senior-level federal managers, other public sector managers, and representatives of the nonprofit and private sectors should be established to develop policies and strategies to foster accountability for the stewardship of facilities and to allocate resources strategically for their maintenance and repair.

OTHER RELEVANT PUBLICATIONS

Glenn R. Bell, Frank W. Kan, and David R. Wright, *"Project Peer Review: Results of the Structural Failures II Conference," Journal of Performance of Constructed Facilities,* Vol. 3, No. 4, November 1989.

The authors note that review of structural design for integrity and compliance with applicable building codes

is highly variable across the country. They also note that, to a great extent, review characteristics are anecdotally based, with tightly enforced jurisdictions usually traceable to a highly visible failure incident. They briefly describe current practices in Belgium, France, and Germany where structural design public safety reviews are tightly structured, conducted by specialized and licensed engineer firms, and funded either by code-enforcing municipalities or by building insurance associations. The authors conclude that project design peer reviews of certain building types and threshold limits should be made mandatory for public safety, although definition of types and thresholds requires further study. The authors also recommend that such review be made by an independent third-party reviewer, and that care be taken in the selection of such a reviewer to ensure competence and lack of conflict of interest.

Richard Bender, and Todd Bressi, *Design Review: A Review of Processes, Procedures and Potential,* Center for Environmental Design Research, University of California, Berkeley, 1989.

The University of California (Berkeley) offers a seminar on design review for individuals selected to serve on public sector design review boards concerned with selecting and grading appropriate design solutions for the urban environment. This publication is based upon the course materials. Chapter 5 contains a discussion comparing and contrasting various approaches to using the following types of guidelines:

- strict guidelines contained within zoning requirements that must be met,
- specific prescriptive guidelines that describe the desired design solution in specific terms,
- descriptive guidelines that are statements of intentions and less specific about possible design solutions, and
- performance guidelines stated in terms of performance objectives that the designer can meet in any way seen fit.

J. Carter Brown, ed. *Federal Buildings in Context: The Role of Design Review*, University Press of New England, Hanover, N.H., 1995. (Proceedings of the symposium sponsored by the Center for Advanced Study in the Visual Arts, National Gallery of Art and the National Building Museum, Washington, D.C., March 5, 1993).

This symposium of 12 papers and a panel session was arranged around three case studies: The Boston Federal Office Building, American embassies abroad, and the Boston Federal Courthouse. Abstracts of relevant papers include the following:

- Brenda Case Scheer, "A Design Review Primer." Professor Scheer explores strengths and weaknesses of various approaches to architectural design oversight of landmark public buildings. Her preferred approach uses the review process to advocate good design rather than stifle it by focusing on negative criticism. Although primarily concerned with high architectural-impact structures such as courthouses, museums, and monuments, her analysis is relevant to the architectural aspects of any public or private project.

- Robert J. Diluchio, "Design Management at the United States General Services Administration." Mr. Diluchio describes the GSA process of managing its facility portfolio designs from the perspective of the Assistant Commissioner of Public Buildings. The focus is primarily on landmark architecture with high-impact architectural considerations. He describes a process that must also ensure a high-quality and safe workplace, functional efficiency and effectiveness, compliance with budget limitations, and compliance with legislative requirements such as the 1972 Brooks Architect-Engineer Act. In summation, he describes the GSA design review process as an interpretation and expansion of Senator Daniel P. Moynihan's publication, "The Guiding Principles of Federal Architecture."

- George M. White, "Notes on the Design of Federal Buildings." Mr. White, writing from his perspective as

the Architect of the Capitol, provides unequivocal support for the concept of "owner" review of an A/E's effort. He recommends development of design guidelines for use by both designers and reviewers to remove arbitrariness from the process. Mr. White commends the Commission of Fine Arts and the U.S. State Department for having uniquely successful design review processes and recommends adoption of similar processes by other federal agencies.

• David M. Childs, "The Role of Design Review in Achieving Excellence of Design." Mr. Childs explores how to create and operate an "office of design" at the highest level of each federal agency with facility engineering responsibilities. Such an office would oversee predesign activities, A/E selection, and the design review process. Mr. Childs emphasizes the importance of design review by stating that ". . . the mere existence of a design review process elevates both the work of architect and the aspirations of his or her clients."

• Robert A. Peck, "Reviving Design Quality in Federal Projects." Mr. Peck (at the time Deputy Director for Intergovernmental Affairs of the Federal Communications Commission) recommends that a senior government position, "The Office of the Supervisory Architect," be reinstated. The office existed from 1840 to 1939, and he believes its reinstatement would raise the visibility and quality of federal design and construction activity to historic levels of achievement with the overall process much less regimented and benefiting more from intensive oversight by independent and respected design professionals. Mr. Peck notes that "things are terribly amiss with regard to design quality in the federal government's public building programs. . . " and he directs his criticism across the board to military commissaries and exchanges as well as landmark projects. He notes a downward trend in quality beginning in the 1930s, prior to which over one-half of all public buildings were designed by federal employees. To counter this trend, he recommends increased involvement of competent and independent peer review groups, while simultaneously minimizing guidelines, rules, and regulations to which such groups would be subject.

The Business Stake in Effective Project Systems, A White Paper from The Business Roundtable, Washington, D.C., 1997.

This paper provides a remarkably succinct, focused, and practical look at how large private sector corporations have transformed their approach to engineering and management of capital projects, with widely varying results. Data for the analysis are based on 2,000 projects totaling over $300 billion in investment value. The following three key points are raised:

1. The best companies bring their facilities online 30 percent faster and at 27 percent less cost than average companies, and the facilities are generally more effective in meeting their intended purpose than those of average companies.
2. In-house detailed engineering has declined to one-third the level it was in the 1970s; similarly, conduct of the critical predesign project definition phase by outsourced contractors has increased threefold.
3. Total project engineering costs, as a percent of total project cost, have nearly doubled during this same timeframe. This may be an indication of engineering inefficiency, or it may indicate increased project planning activity.

Research has identified the following universal characteristics of the best capital project systems:

• Cross-functional teams develop projects. These teams are led by the owner and involve all interested parties to the project (A/E, construction contractors, subcontractors, vendors, users, maintainers, etc).
• Active and project-knowledgeable business representatives take the lead, especially on the front end.
• Engineering and project functions report to the businesses, not to the plant management.
• Continuous improvement systems are used throughout.

- Systematic performance measurements are frequently taken during the life of the project.
- All necessary in-house resources required to develop and shape projects are provided until such time as projects are ready for detailed design.

John H., Cable, and Gerald W. Westerbeck, *Assessment of ISO 9000 Pilot Program, US Army Corps of Engineers,* Publication CE607R1, Logistics Management Institute, McLean, Va., 1998.

This report discusses the U.S. Army Corps of Engineers pilot program to test the concept of operating under the ISO 9000 quality management system. ISO 9000 is an internationally recognized 20-step system for controlling process quality that essentially requires the user to "Say what you plan to do; do what you said you would do; measure what you did; adjust your process if you're unhappy with the measure, and repeat. And periodically conduct an independent audit of the whole process using an ISO 9000 process expert." Although generally thought to apply more appropriately to the manufacturing industry, ISO 9000 techniques are every bit as applicable to service industries such as A/E and construction. Indeed, some of the most recognized names have achieved ISO-9000 registration: Bechtel Group, Brown and Root, Fluor Daniel, Jacobs Engineering Group, Raytheon Engineers and Constructors, and Stone and Webster Engineering Corporation, among others.

In 1995, six organizations (four engineering divisions and two construction divisions) at four sites were chosen to implement ISO 9000. The time from inception to final registration was expected to take 12-14 months. Four of the six organizations completed registration (requiring from 15 to 33 months) at time of report publication. Pilot organizations reported that their postregistration operations are streamlined, more efficient, and consistent with the operation of an engineering and construction organization. The rigor of maintaining registration is of value as well; it forces organizational self-examination in preparation for external audits. Organizations report improved internal communication, increased teamwork, reduced time to deal with routine procedures, clarified responsibilities, and reduced errors and rework. Although organizations participating in the pilot program were enthusiastic about the experience and the results of the ISO 9000 certification process, some viewed the time and cost of the process as unduly great. With experience, ISO 9000 implementation should become a much more efficient process as additional Corps districts are brought on line.

National Government/Industry Forum on Design-Build Plus, Summary of a workshop held September 9, 1998, at the National Academy of Sciences, Washington D.C.

This workshop was cosponsored by the Naval Facilities Engineering Command, the Design Build Institute of America, the CII, the American Road and Transportation Builders Association, the Society of American Military Engineers, and the Federal Facilities Council. Presentations by the sponsors and invited guests addressed the following issues:

- The need for better, cheaper, faster project delivery.
- How private owners have aligned facility and business objectives.
- Why the industry has been evolving toward design-build delivery.
- How the industry has adapted to owner requirements, for better or worse.
- How design-builders recommend owners prepare their solicitations.
- Why the planning, funding, and management cycle is interdependent and not independent.
- What constitutes sustainable design for integrated facilities providers.
- The major public barriers preventing wholesale adoption of design-build.
- How innovative materials and processes can be put into practice.
- The future of facilities acquisition, including operation and maintenance.
- The public-private alliances that would allow projects to move forward.
- What is needed to implement design-build and other owner tools.

Sue Dyer, *Partner Your Project,* Pendulum Publishing, Livermore, California. 1997.

This report walks through the partnering process. It offers a step-by-step guide for successfully partnering a project, answering questions concerning the partnering decision, overcoming objections, getting project stakeholders on board, the partnering session, and follow through.

E. William East, Tim Roessler, and Mark Lustig, "Improving the Design Review Process: The Reviewer's Assistant," Journal of Computing in Civil Engineering, American Society of Civil Engineers, Washington, D.C., 1995.

This paper reports the results of an analysis of the design review process and the development of a tool to assist design reviewers. The tool, called the "Reviewer's Assistant," assists reviewers by capturing, storing, and retrieving design review comments and by compiling lessons learned. The storage of comments and compilation of lessons learned enable future reviewers to benefit from the experience gained on past reviews of similar projects.

E. William East. *Web-Enabled Design Review and Lessons Learned.* USACERL Technical Report 98/31, U.S. Army Corps of Engineers Construction Engineering Research Laboratories, Champaign, Illinois, 1998.

Mr. East and the Construction Engineering Research Laboratories have been involved for several years in the development and adoption of a series of computer-based systems intended to facilitate the design review process. The Automated Review Management System, developed in the early 1980s, required mainframe computer support, but it evolved into Reviewer's Assistant which can be run on relatively simpler net server systems. This report announces the third-generation improvement: Document Review and Checking System (DrChecks), which can be run on desktop PCs and uses the worldwide web to communicate between various participants of the design review process. DrChecks also exploits the ability of the World Wide Web and Internet to access other material relevant to the design review process, such as multimedia knowledge base for building systems, standard sets of computer-aided design and drafting details, and U.S. Army Corps of Engineers guide specifications.

Kneeland A. Godfrey, *Partnering in Design and Construction*, New York, McGraw Hill, 1995.

The author shows how to build a relationship between the general contractor, subcontractors, and designers in construction projects, featuring case histories of real projects and chapters by construction professionals. Topics include the origins of partnering, including lawyers as team members; alternative dispute resolution; partnering with foreign coworkers; and safety and quality issues.

Jeffrey G. Kirby, Douglas A. Furry, and Donald A. Hicks, "Improvements in Design Review Management," *Journal of Construction Engineering and Management,* Vol. 114, No. 1, 1988.

The benefits of a formal design review program depend on the ability to efficiently manage many simultaneous review efforts and effectively incorporate the resulting comments into the final contract documents. Research into the U.S. Army Corps of Engineers design review program identified areas of needed improvement which resulted in the development of the Automated Review Management System (ARMS). ARMS is a computer-based program that fosters increased communication and interaction among all review participants and provides a mechanism for data collection, collation, distribution, and incorporation into contract documents.

This paper makes a number of relevant points, including the following:

- Fifty-six percent of all contract modifications are to correct design deficiencies.
- Industry research indicates that savings on the order of 6-23 percent of original estimates are achievable through proper constructability reviews.
- Too many traditional design review activities are conducted as individual efforts with little interaction between reviewers.
- Traditional design-bid-build practice separates the A/E from the construction contractor, intensifying the need for error-free documents amenable to a variety of construction techniques.
- Recent U.S. Army Corps of Engineers experience in design review indicates that there will be well over 600 comments per project, on average—an intensity that would be well served by an automated system for the documentation, analysis, and resolution of comments.
- Most design review comments are not tracked adequately—final resolution status and archival availability need improvement.

Roy Mendelsohn, "The Constructability Review Process: A Contractor's Perspective." *Journal of Management in Engineering*, Vol. 13, No. 3, 1997.

Mr. Mendelsohn estimates that 75 percent of the problems encountered during construction are generated in the design phase, and they could be avoided by incorporating an appropriate constructability review into the design review process. He defines such a process, emphasizing that it must begin as early in the design process as possible, indeed "before any design is put to paper." Selection of a construction expert, without conflict of interest, is of crucial importance. Rather than relying on traditional sources (in-house construction inspectors or third-party contractors who may or may not have subsequent involvement with actual project construction), he recommends selection of an individual or firm specializing in construction management services (i.e., firms that do not perform construction with their own forces, but rather manage construction on behalf of owners.

William T. Nigro, and Martha W. Nigro, *Redicheck Interdisciplinary Coordination*. 3rd ed., The REDICHECK Firm, Peachtree City, Ga., 1992.

Based on research, the authors concluded that the average construction project generated 8.4 percent cost growth from change orders. Furthermore, approximately 50 percent of these change orders were due to coordination errors in project plans and specifications. Examples include ceiling heights incompatible with above-ceiling mechanical components; variance between electrical and mechanical requirements concerning voltage, horsepower, or phase; and mechanical ducts and building structural members occupying the same space. The authors estimate that the average project contains five coordination errors per contract drawing; and a large project of 500 drawings will typically contain 2,500 coordination errors!

The authors developed a systematic approach to check the interface of disciplines (civil, structural, architectural, mechanical/plumbing, electrical, kitchen/dietary, and specifications). Although their firm (The REDICHECK Firm) will perform an interdisciplinary check under contract, their manual is intended as a checklist that will allow an owner or an A/E to perform the service internally.

The authors' most recent research, encompassing over $1 billion in construction work submitted to REDICHECK review, resulted in a 50 percent reduction in cost growth due to change orders. With the cost of the REDICHECK review averaging 0.125 percent of project construction cost, this translates to an average 30:1 payback ratio.

Partnering and Changing Attitudes in Construction, Associated General Contractors of America, Washington, D.C., 1995.

This volume provides case studies, with good coverage on the facilitator's involvement and approach to workshops.

Quality in the Constructed Project: A Guide for Owners, Designers and Constructors, Vol. 1, Manuals and Reports on Engineering Practice, No. 73, American Society of Civil Engineers, New York, 1990.

This is a perceptive and well-written manual intended to guide the owner, design professional, and constructor of a given project into and through a mutually supportive relationship which will result in the highest probability of ultimate project success. The manual provides guidance for establishing roles, responsibilities, relationships, and limits of authority for project participants and stresses the importance of concepts and practices that enhance quality in the constructed project. Relevant topics discussed include

1. definition and assignment of responsibility,
2. importance of teamwork,
3. importance of concise contractual provisions,
4. principles of good communication,
5. owner's selection process for project team members, and
6. procedures for design and construction.

Anyone involved with the acquisition of capital facilities, regardless of their area of expertise or depth of skill, will likely find some new and practical insight into improving individual and team effectiveness.

J. Mark Schuster, *Design Review: The View from the Architecture Profession,* Design and Development Group, Massachusetts Institute of Technology, Cambridge, 1990.

This report summarizes a Boston-area survey of architects that solicited information concerning their experience with design review boards whose responsibilities ranged from code compliance to architectural aesthetics. Responses to questions relating to "value-added" or "value-subtracted" by the review process are of particular interest. The more generally supported positions included the following:

- Overall, the process is beneficial to both architect and facility owner or developer.
- The process is enhanced by use of written guidelines and standards, as opposed to hard-requirement rules and regulations.
- Board constituency is critical:

1. All interested parties need to be represented (owner, developer, architect, construction contractor, maintenance staff, users, community representatives, permit agencies, and code reviewers).
2. Continuity of participation of the part of board members is essential.
3. Participants should be versed in subject matter (i.e., facility intent, community standards, facility design and construction technology) and relatively senior in terms of experience.
4. If laymen participate, prior training in architectural engineering fundamentals and semantics, as well as board functioning, is appropriate.

Ralph J. Stephenson, *Project Partnering for the Design and Construction Industry*. John Wiley & Sons, New York, 1996.

This volume is a one-stop resource that contains all the steps, procedures, and guidelines needed to build effective partnering project systems.

Rubin M. Zallen, "Proposal for Structural Design Peer Review," Journal of Performance of Constructed Facilities, Vol. 4, No. 4, 1996.

Mr. Zallen proposes a mandatory peer review of structural review that could be incorporated into a government regulation. Such review, he posits, should be conducted by the building code authority rather than by the A/E or owner, both of whom he believes represent a conflict of interest.

America's Conference on Project Delivery Systems for Building Construction, presentation material for the Conference of the Associated General Contractors of America, Atlanta, Georgia., September 9-10, 1993.

The conference support materials focused on the definitions, strengths, and weaknesses of the four major methods of construction project delivery, identified as

- general contract,
- design-build,
- construction management, and
- program management.

Material is included addressing several best practices including partnering, alternative dispute resolution, total quality management, and variations and hybrids of the above-listed construction project delivery methods.

C

BENCHMARKING DESIGN REVIEW PROCESSES QUESTIONNAIRE—PART 1

Background and Objective: The Federal Facilities Council of the National Research Council is undertaking a study to benchmark Design Review Processes for Facilities. The FFC's objective is to identify a range of best practices and technologies that could be used by federal agencies to improve the design review process. For purposes of this study, the design review process applies to both new construction and major renovation projects

The study methodology will include a literature search, interviews with industry and federal staff, and information gathered through this questionnaire which is being sent to facilities program and project managers in federal agencies. The final report will be published in the Winter of 1999. A follow up workshop/conference on best practices in design review processes is planned for the Spring/Summer of 1999. All persons completing a questionnaire will receive a copy of the final report and an invitation to the workshop.

Structure: The questionnaire is divided into two parts. Part 1 is designed to elicit information on agencies' policies and practices related to design review and should be completed by the facilities program manager or a designated representative. Part I addresses the purposes of design review, process changes that have occurred over the last five fiscal years, anticipated future changes, if any, and performance measures used. Part 2 of the questionnaire is structured to gather more technical information about how design reviews are typically conducted for new construction and renovation projects. It should to be completed by agency project managers responsible for coordinating individual design reviews. To the extent possible, checklists have been provided to minimize the time and effort involved in completing either Part 1 or Part 2 of the questionnaire.

Deadlines: The questionnaires are being distributed electronically to minimize the time and effort involved in completing them. Questionnaires should be returned by e-mail to lstanley@nas.edu, by **Friday, January 15, 1999.**

If you have any questions about the study or the Federal Facilities Council, please send an e-mail to lstanley@nas.edu or call Lynda Stanley at (202) 334-3374.

PART 1- TO BE COMPLETED BY FACILITIES PROGRAM MANAGER OR HIS DESIGNEE

A. Design Review Process

1. Briefly describe in general terms how the design review process is performed within your agency (attach or send a process flow diagram, if available).

2. In your agency, what milestones mark the beginning and the end of the design review process?
   Design review begins when:
   Design review ends when:

3. What intermediate milestones are incorporated into the design review process? Please check all that apply.
   - ❑ 15%
   - ❑ 30%
   - ❑ 50%
   - ❑ 60%
   - ❑ 90%
   - ❑ 100%
   - ❑ Other:

4. Approximately how many full time equivalent (FTE) positions are allocated to performing the design review function?

5. On average, approximately how many projects (new construction and renovations) are reviewed per year with this level of staffing? Please provide data for the following categories if possible.

   Total number of projects (new construction and renovations)
   Number of projects valued at $1 million or less
   Number of projects valued at $1 million to $10 million
   Number of projects valued at $10 million or more

6. For what types of projects are design reviews typically conducted (e.g., new structures over a certain dollar value, renovations over a certain dollar value)?

7. Does your agency conduct the same level of design review for projects valued at less than $1 million as it does for projects valued at $10 million or more?
   - ❑ Yes
   - ❑ No

   If no, how does the level of review vary?

8. Are there projects (new construction or renovations) for which no design review is undertaken?
   - ❑ Yes
   - ❑ No

   If yes, what are the characteristics of such projects (e.g. type of facility, dollar value)?

9. What are the criteria for determining the level of design review required for a project? Please check all that apply.

- ❏ Project value
- ❏ Project complexity
- ❏ Relation of project to agency mission
- ❏ Political sensitivity
- ❏ Staff resources available
- ❏ Project schedule
- ❏ Project delivery method
- ❏ Other (please explain):

10. What functions of the design review process are typically **performed by in-house staff for projects valued at $1 -$10 million**? Please check all that apply.
    - ❏ Scope and budget compliance
    - ❏ Compliance with agency design guides
    - ❏ Compliance with client/tenant design guides
    - ❏ Interface with existing systems (renovation projects)
    - ❏ Building code compliance
    - ❏ Discipline coordination
    - ❏ Architectural reviews
    - ❏ Mechanical reviews
    - ❏ Electrical reviews
    - ❏ Structural reviews
    - ❏ Constructability reviews
    - ❏ Value engineering reviews
    - ❏ Review of shop drawings
    - ❏ Maintenance/life cycle costing coordination
    - ❏ Other:

11. What functions of the design review process are **typically performed by in-house staff for projects valued at more than $10 million?** Please check all that apply.
    - ❏ Scope and budget compliance
    - ❏ Compliance with agency design guides
    - ❏ Compliance with client/tenant design guides
    - ❏ Interface with existing systems (renovation projects)
    - ❏ Building code compliance
    - ❏ Discipline coordination
    - ❏ Architectural reviews
    - ❏ Mechanical reviews
    - ❏ Electrical reviews
    - ❏ Structural reviews
    - ❏ Constructability reviews
    - ❏ Value engineering
    - ❏ Review of shop drawings
    - ❏ Maintenance/life cycle costing coordination
    - ❏ Other:

12. What functions of the design review process are **typically outsourced to contractors for projects valued at $1-$10 million?** Please check all that apply**.**
    - ❏ Scope and budget compliance
    - ❏ Compliance with agency design guides
    - ❏ Compliance with client/tenant design guides

- ❏ Interface with existing systems (renovation projects)
- ❏ Building code compliance
- ❏ Discipline coordination
- ❏ Architectural reviews
- ❏ Mechanical reviews
- ❏ Electrical reviews
- ❏ Structural reviews
- ❏ Constructability reviews
- ❏ Value engineering
- ❏ Review of shop drawings
- ❏ Maintenance/life cycle costing coordination
- ❏ Other:

13. What functions of the design review process are **typically outsourced to contractors for projects of more than $10 million?** Please check all that apply.
    - ❏ Scope and budget compliance
    - ❏ Compliance with agency design guides
    - ❏ Compliance with client/tenant design guides
    - ❏ Interface with existing systems (renovation projects)
    - ❏ Building code compliance
    - ❏ Discipline coordination
    - ❏ Architectural reviews
    - ❏ Mechanical reviews
    - ❏ Electrical reviews
    - ❏ Structural reviews
    - ❏ Constructability reviews
    - ❏ Value engineering
    - ❏ Review of shop drawings
    - ❏ Maintenance/life cycle costing coordination
    - ❏ Other:

14. What types of technologies (e.g., CADD, the Internet, Intranet) are used to support the design review process and how are they used?

15. How does your agency document comments/changes generated through the design review process?

B. Purposes of Design Review

16. Why does your agency manage and/or conduct design reviews? Please check all that apply:
    - ❏ Legal requirements. Please explain:
    - ❏ Administrative/policy requirements. Please explain:
    - ❏ Code reviews
    - ❏ To manage risk. Please explain:

    Quality control to manage:

    - ❏ Design deficiency claims
    - ❏ Design amendments
    - ❏ Change orders
    - ❏ Project delivery time

- ❏ To retain in-house technical expertise. Please explain:
- ❏ Other factors (Please explain).

17. Please rank the following from most important to least important as reasons your agency conducts design review (1 = most important, 6 = least important, 0 = not applicable)
    - ❏ Legal/administrative/policy requirements
    - ❏ Quality control
    - ❏ Assure user requirements are met
    - ❏ Maintain core competencies
    - ❏ Manage risk
    - ❏ Other (please explain briefly):

18. From your perspective, what five functions of the design review process add the greatest value? Please check a maximum of five items.
    - ❏ Scope and budget compliance
    - ❏ Compliance with agency design guides
    - ❏ Compliance with client/tenant design guides
    - ❏ Interface with existing systems (renovation projects)
    - ❏ Building code compliance
    - ❏ Discipline coordination
    - ❏ Architectural reviews
    - ❏ Mechanical reviews
    - ❏ Electrical reviews
    - ❏ Structural reviews
    - ❏ Constructability reviews
    - ❏ Value engineering
    - ❏ Review of shop drawings
    - ❏ Maintenance/life cycle costing coordination
    - ❏ Other:

19. What functions of the design review process add the least value, from your perspective? Please check a maximum of five items.
    - ❏ Scope and budget compliance
    - ❏ Compliance with agency design guides
    - ❏ Compliance with client/tenant design guides
    - ❏ Interface with existing systems (renovation projects)
    - ❏ Building code compliance
    - ❏ Discipline coordination
    - ❏ Architectural reviews
    - ❏ Mechanical reviews
    - ❏ Electrical reviews
    - ❏ Structural reviews
    - ❏ Constructability reviews
    - ❏ Value engineering
    - ❏ Review of shop drawings
    - ❏ Maintenance/life cycle costing coordination
    - ❏ Other:

20. Are there any functions of the design review process that could be eliminated with little or no risk to the quality and/or outcome of projects, from your perspective? Please check all that apply.

- ❏ Scope and budget compliance
- ❏ Compliance with agency design guides
- ❏ Compliance with client/tenant design guides
- ❏ Interface with existing systems (renovation projects)
- ❏ Building code compliance
- ❏ Discipline coordination
- ❏ Architectural reviews
- ❏ Mechanical reviews
- ❏ Electrical reviews
- ❏ Structural reviews
- ❏ Constructability reviews
- ❏ Value engineering
- ❏ Review of shop drawings
- ❏ Maintenance/life cycle costing coordination
- ❏ Other:

21. If the design review process was outsourced entirely to private contractors for all projects, what risks and liabilities would your agency face, from your perspective?

C. Design Review Process Changes

22. How has your agency's design review process changed in the last 5 fiscal years, in terms of functions of in-house staff, functions of outside consultants, level of review, use of technology (CADD, Internet, Intranet)? Please provide a brief description of trends observed.

23. What were the driving factors behind those changes? Please rank the following from most important to least important (1=most important, 6=least important, 0=not applicable).
    - ❏ Downsizing of agency staff
    - ❏ Business process reengineering
    - ❏ Cost of design review
    - ❏ Time involved with design review
    - ❏ Change in agency philosophy or emphasis regarding design review
    - ❏ Change in project delivery processes (e.g., increased use of design/build)
    - ❏ Other (Please explain):

24. Over the last 5 fiscal years what changes have been observed or quantified? Please check the answers that most closely reflect trends in your agency.
    - ❏ Number of projects reviewed has increased by 10% or more
    - ❏ Number of projects reviewed has decreased by 10% or more
    - ❏ Number of projects reviewed has remained approximately the same
    - ❏ Data not available

    - ❏ Staff time involved in review has increased by 10% or more
    - ❏ Staff time involved in review has decreased by 10% or more
    - ❏ Staff time involved in review has remained approximately the same
    - ❏ Data not available

    - ❏ The use of technology to support design review has increased
    - ❏ The use of technology to support design review has decreased

- ❏ The use of technology to support design review has not changed significantly
- ❏ Data not available

- ❏ The quality of projects has increased
- ❏ The quality of projects has decreased
- ❏ The quality of projects has remained approximately the same
- ❏ Data not available

- ❏ Project delivery time has increased
- ❏ Project delivery time has decreased
- ❏ Project delivery time has remained approximately the same
- ❏ Data not available

- ❏ The number of change orders has increased by 10% or more
- ❏ The number of change orders has decreased by 10% or more
- ❏ The number of change orders has remained relatively unchanged
- ❏ Data not available

- ❏ The nature of change orders has changed significantly
- ❏ The nature of change orders has not changed significantly
- ❏ Data not available

- ❏ The number of design deficiency claims has increased by 10% or more
- ❏ The number of design deficiency claims has decreased by 10% or more
- ❏ The number of design deficiency claims has remained relatively unchanged
- ❏ Data not available

- ❏ Client satisfaction has increased
- ❏ Client satisfaction has decreased
- ❏ Client satisfaction has remained relatively unchanged
- ❏ Data not available

25. Is your agency considering future changes in the design review process?
    - ❏ Yes
    - ❏ No

26. If yes, what might those changes be and what are the driving factors behind them?

D. Performance Measures

27. What categories of data related to the design review process does your agency track? Please check all that apply.
    - ❏ Number of design projects contracted to private A/E firms
    - ❏ Number of design projects completed by in-house staff
    - ❏ Total funds obligated for private A/E firm fees, by project
    - ❏ Number and nature of change orders per project
    - ❏ Cost of change orders per project
    - ❏ Cause of change orders per project (e.g., errors and omissions by staff)
    - ❏ Number of claims per project

- ❏ Value of claims per project
- ❏ Cause of claims per project
- ❏ In-house personnel time spent on design review
- ❏ Client/user satisfaction
- ❏ Other:

28. Please provide any other information that is important to understanding your agency's design review process that is not captured by this questionnaire.

29. Comments/suggestions on the design review process and/or the study that may be useful to the FFC Standing Committee on Organizational Performance and Metrics:

30. Name, title, and phone number of person who completed this survey (for call back purposes only; individual's name will not appear in final report although references to the agency may be included):

BENCHMARKING DESIGN REVIEW PROCESSES QUESTIONNAIRE—PART 2

Background and Objective: The Federal Facilities Council of the National Research Council is undertaking a study to benchmark Design Review Processes for Facilities. The FFC's objective is to identify a range of best practices and technologies that could be used by federal agencies to improve the design review process. For purposes of this study, the design review process applies to both new construction and major renovation projects.

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Deadlines: The questionnaires are being distributed electronically to minimize the time and effort involved in completing them. Completed questionnaires should be returned by e-mail to lstanley@nas.edu by **Friday, January 15, 1999.**

If you have questions about the study, the Federal Facilities Council or the questionnaire, please send an e-mail to lstanley@nas.edu or call Lynda Stanley at (202) 334-3374.

PART 2- TO BE COMPLETED BY AGENCY PROJECT MANAGERS

A. Design Review Process

1. Briefly describe the design review process that is typically followed for a project (if a process flow chart is available, please attach or send).

2. What milestones mark the beginning and the end of the design review process?
   - ❏ Design review begins when:
   - ❏ Design review ends when:

3. What intermediate milestones are incorporated into the process? Please check all the apply.
   - ❏ 15%
   - ❏ 30%
   - ❏ 50%
   - ❏ 60%
   - ❏ 90%
   - ❏ 100%
   - ❏ Other:

4. What functions of the design review process **are typically performed by in-house staff for projects valued at $1-10 million**? Please check all that apply.
   - ❏ Scope and budget compliance
   - ❏ Compliance with agency design guides
   - ❏ Compliance with client/tenant design guides
   - ❏ Interface with existing systems (renovation projects)
   - ❏ Building code compliance
   - ❏ Discipline coordination
   - ❏ Architectural reviews
   - ❏ Mechanical reviews
   - ❏ Electrical reviews
   - ❏ Structural reviews
   - ❏ Constructability reviews
   - ❏ Value engineering
   - ❏ Review of shop drawings
   - ❏ Maintenance/life cycle costing coordination
   - ❏ Other:

5. What functions of the design review process **are typically performed by in-house staff for projects valued at more than $10 million?** Please check all that apply.
   - ❏ Scope and budget compliance
   - ❏ Compliance with agency design guides
   - ❏ Compliance with client/tenant design guides
   - ❏ Interface with existing systems (renovation projects)
   - ❏ Building code compliance
   - ❏ Discipline coordination
   - ❏ Architectural reviews

- ❏ Mechanical reviews
- ❏ Electrical reviews
- ❏ Structural reviews
- ❏ Constructability reviews
- ❏ Value engineering
- ❏ Review of shop drawings
- ❏ Maintenance/life cycle costing coordination
- ❏ Other:

6. What functions of the design review process **are typically outsourced to contractors for projects valued at $1-$10 million**? Please check all that apply.
   - ❏ Scope and budget compliance
   - ❏ Compliance with agency design guides
   - ❏ Compliance with client/tenant design guides
   - ❏ Interface with existing systems (renovation projects)
   - ❏ Building code compliance
   - ❏ Discipline coordination
   - ❏ Architectural reviews
   - ❏ Mechanical reviews
   - ❏ Electrical reviews
   - ❏ Structural reviews
   - ❏ Constructability reviews
   - ❏ Value engineering
   - ❏ Review of shop drawings
   - ❏ Maintenance/life cycle costing coordination
   - ❏ Other:

7. What functions of the design review process **are typically outsourced to contractors for projects valued at more than $10 million?** Please check all that apply.
   - ❏ Scope and budget compliance
   - ❏ Compliance with agency design guides
   - ❏ Compliance with client/tenant design guides
   - ❏ Interface with existing systems (renovation projects)
   - ❏ Building code compliance
   - ❏ Discipline coordination
   - ❏ Architectural reviews
   - ❏ Mechanical reviews
   - ❏ Electrical reviews
   - ❏ Structural reviews
   - ❏ Constructability reviews
   - ❏ Value engineering
   - ❏ Review of shop drawings
   - ❏ Maintenance/life cycle costing coordination
   - ❏ Other:

8. What types of technologies (e.g. CADD, the Internet, Intranet) are used to support the design review process and how are they used?

9. How are comments/changes generated through the design review process documented?

B. Value of Design Review

10. From your perspective, what functions of the design review process add the greatest value? Please check a maximum of five items.
    - ❑ Scope and budget compliance
    - ❑ Compliance with agency design guides
    - ❑ Compliance with client/tenant design guides
    - ❑ Interface with existing systems (renovation projects)
    - ❑ Building code compliance
    - ❑ Discipline coordination
    - ❑ Architectural reviews
    - ❑ Mechanical reviews
    - ❑ Electrical reviews
    - ❑ Structural reviews
    - ❑ Constructability reviews
    - ❑ Value engineering
    - ❑ Review of shop drawings
    - ❑ Maintenance/life cycle costing coordination
    - ❑ Other:

11. What functions of the design review process add the least value, from your perspective? Please check a maximum of five items.
    - ❑ Scope and budget compliance
    - ❑ Compliance with agency design guides
    - ❑ Compliance with client/tenant design guides
    - ❑ Interface with existing systems (renovation projects)
    - ❑ Building code compliance
    - ❑ Discipline coordination
    - ❑ Architectural reviews
    - ❑ Mechanical reviews
    - ❑ Electrical reviews
    - ❑ Structural reviews
    - ❑ Constructability reviews
    - ❑ Value engineering
    - ❑ Review of shop drawings
    - ❑ Maintenance/life cycle costing coordination
    - ❑ Other:

12. Are there any functions of the design review process as currently practiced that could be eliminated with little or no risk to the quality and/or outcome of projects, from your perspective? Please check all that apply.
    - ❑ Scope and budget compliance
    - ❑ Compliance with agency design guides
    - ❑ Compliance with client/tenant design guides
    - ❑ Interface with existing systems (renovation projects)
    - ❑ Building code compliance
    - ❑ Discipline coordination
    - ❑ Architectural reviews
    - ❑ Mechanical reviews
    - ❑ Electrical reviews

- ❏ Structural reviews
- ❏ Constructability reviews
- ❏ Value engineering
- ❏ Review of shop drawings
- ❏ Maintenance/life cycle costing coordination
- ❏ Other:

C. Performance Measures

13. What types of data related to the design review process are tracked? Please check all that apply.
    - ❏ Number of design projects contracted to private A-E firms
    - ❏ Number of design projects completed by in-house staff
    - ❏ Total funds obligated for private A-E firm fees, by project
    - ❏ Number and nature of change orders per project
    - ❏ Cost of change orders per project
    - ❏ Cause of change orders per project (e.g. errors and omissions by staff)
    - ❏ Number of claims per project
    - ❏ Value of claims per project
    - ❏ Cause of claims per project
    - ❏ In-house personnel time spent on design review
    - ❏ Client/user satisfaction
    - ❏ Other:

14. Please provide any other information that is important to understanding your group's design review process that is not captured by this questionnaire.

15. Comments/suggestions on design review processes and/or the study that may be useful to the FFC Standing Committee on Organizational Performance and Metrics:

16. Name, title, and phone number of person who completed this survey (for call back purposes only; individual's names will not appear in the final report although references to the agency may be included):

D

Biography of the Author

Ralph Swinton Spillinger graduated from Washington State University with a B.S. degree in civil engineering. He also holds a Master's degree in engineering administration from The George Washington University, and is a graduate of Cornell University's Executive Development Program.

Mr. Spillinger's 30-year career with the federal government included active and reserve duty in the Navy (he is a retired captain, Civil Engineer Corps), as well as U.S. Navy civil service (planning, design, and construction of large-scale shipyard, missile, and rocket assembly facilities). From 1987-1997, he worked at NASA Headquarters where he was responsible for managing the facility design and construction program for NASA's space flight facilities.

From 1995 though 1997, Mr. Spillinger was NASA's senior representative to the National Research Council's Federal Facilities Council, and served as NASA's alternate member to the Construction Industry Institute Board of Advisors. Following his retirement from the Federal Government, Mr. Spillinger established a consulting practice in Bainbridge Island, Washington, focusing on facility engineering management.

E

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