Design-Build Procurement:
A Framework For Integrated Management Information Systems

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ABSTRACT

Interest in Design-Build contract methods for facility acquisition has intensified in recent years in the US Construction Industry. Owners in both public and private sectors continue to seek effective methods in their building delivery process to control cost, compress time, reduce risk, and enhance quality. Some have turned to Design-Build as a viable alternative from the traditional design-bid-build process. Recent research, including a national symposium on Design-Build sponsored by Georgia Tech, has defined and positioned the Design-Build contract process as a viable framework for the development and application of integrated information technology support based management models, including cost and time control systems, which offer opportunities for the support and development of systems concepts leading to integrated management of information in the successful building delivery process.

Key Words
design-build procurement; interactive information systems; design coordinates; parallel processing; integrated management systems

INTRODUCTION

There are three basic forms of facility acquisition systems employed on a global basis today: (1) Design-Bid-Build; (2) Phased or Fast-track Construction Management approaches; and (3) Design-Build. The choice to employ design-build procurement processes has long been favored in the residential construction industry in the US and is gaining in popularity today in the commercial, industrial and institutional sectors of the industry, both in the US and abroad. The focus of this study is to present the design-build contract approach as an excellent framework for the integration of information into management systems to control project development from the program definition phase, through design development and construction completion.

Any study dealing with successful project delivery processes must define the meaning of "success" related to the various participants in the process. Success for owners involves the delivery of the building to satisfy defined attributes and objectives within established cost, time, and quality-level parameters. Success for designers, both architects and engineers, includes recognition of creative excellence and the achievement of professional standards of care dealing

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with form, function, environmental compatibility, and artistic contributions. Success for builders normally relates to profit margins with a minimum of residual risks, and a good expectation for repeat clients.

Acknowledging the heterogenous mix of participants and objectives, each firmly linked to the single project, this paper will view the opportunities for integrating the project resources and expectations into structured management control support systems. Before examining viable system processes, it is important to acknowledge that design-build as a procurement process is not new. As the late, John Carlson, Jr., founder of the construction consulting firm, the Carlson Group, stated:

> "If Filippo Brunelleschi, father of the Renaissance style of architecture, could eavesdrop on a current discussion of the benefits of 'the design/build' process, he would no doubt walk away completely bewildered. How could the man who masterminded the construction of the Great Dome of Florence's cathedral in 1420 (as a master builder) ever come to understand our modern propensity for separating the design and construction process?"

What is new, challenging, an viable, however, is the emergence of systems technology to gather, analyze, correlate, and report, information for advanced and effective project management resource control methods in the building delivery systems where the designer and builder are finally joined together as one contract entity. This study will focus on generic interactive input and it's advantages in design-build contracting methods, and omit reference to current software packages and trademark operating systems.

Design-Build Process

Design-Build, as opposed to Design-Bid-Build is defined by the American Institute of Architects as a "process in which the owner contracts directly with one entity to provide both design and construction services." Figure 1, *Design-Build Team Organization*, graphically illustrates the organizational matrix for design-build procurement. The approach provides Single-Point Responsibility which offers Owners, in both the public and private sectors, an opportunity to not only participate, but control, to a maximum extent, the building development and delivery process with minimal adversarial relationship between the designer and the contractor.

The basic Design-Build procurement approach in the US has evolved into a linear process which includes the following stages:

Project Definition: A Project Definition is prepared by the Owner, often with the assistance of a special consultant or Architect, which describes the Owner's requirements in terms of space, performance, quality and desired attributes. This is usually accompanied by, as a minimum, a block plan showing the anticipated layout of the functional areas. A full conceptual design may have been completed, should the Owner elect to retain a design architect along with the program consultant. This method leads to the "Bridging Approach."

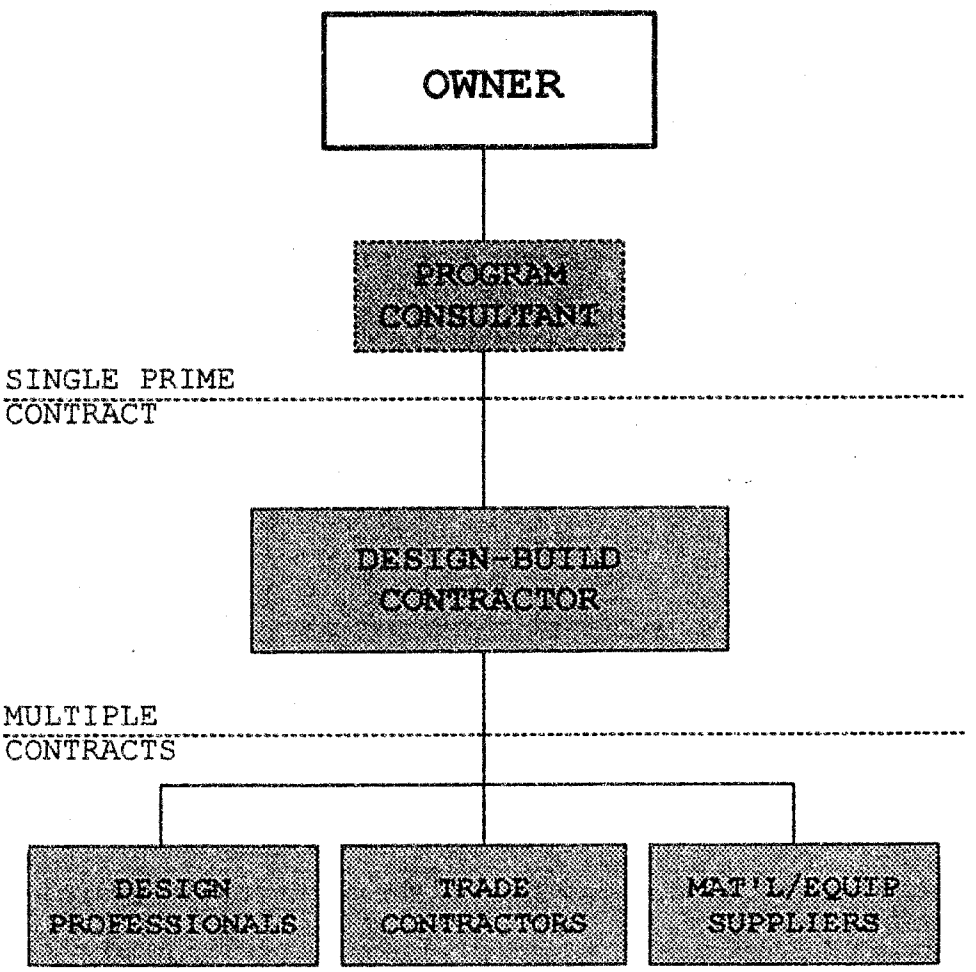

FIGURE 1 DESIGN-BUILD TEAM ORGANIZATION

RFP & Proposal Submittal: Bidders submit a fixed-priced and with it a detailed description of the design which they propose, including drawings of sufficient detail to describe the intent. Presentations often are made along with the written proposals. Bidders are often pre-qualified.

Award: The Owner selects the best offer, not always the lowest price, and a contract is signed. Selection of the best offer may include negotiations with one or all offerers.

Design Build: The work proceeds, initially involving the completion of the design but with an early construction start. Supervision of the work may be by the Owner's own staff, or an independent consultant, usually an Architect, may be retained for this purpose.

The process is relatively straight forward, however, enormous opportunities are inherent for the development and application of information technology support systems as the management processes evolve. Figure 2, *Design-Build Delivery Support System*, graphically illustrates the discrete project delivery phases and the possibility for information technology support system applications.

Bridging Method

An emerging variation of the simplistic Design-Build procurement approach is the Bridging-Method. This alternative method of design-build procurement has been developed primarily to enable the owner and designer to create a more complete conceptual design prior to the introduction of the Design-Build Contractor to the project development and delivery team. Figure 2 indicates where the "Bridging" occurs in the process. The Owner transfers the project conceptual designs from the design A/E to the Design-Build Contractor.

Advocates of the Bridging Method argue that, compared to the traditional Design-Bid-Build method and the more simplistic Design-Build method, the hybrid Bridging Method retains the best features of both while offering an opportunity to reduce risks and costs for the client. Supporters of this method suggests that Bridging has three basic features:

(a) The owner obtains an enforceable fixed price for the construction with the expenditure of about half the funds as in traditional approaches.

(b) Construction costs are significantly reduced in most projects.

(c) The owner's exposure to claims is greatly diminished, both during and after construction.

The advantages, however, for Owners who embark upon the more complex Bridging Method are:

(a) The Owner has the opportunity to select the best design A/E for the project.

(b) The Owner can realize an advantage from the knowledge and experience of the Constructor in construction technology applications, constructablility analysis, and cost-time control during the construction documents development phase and through the construction phase.

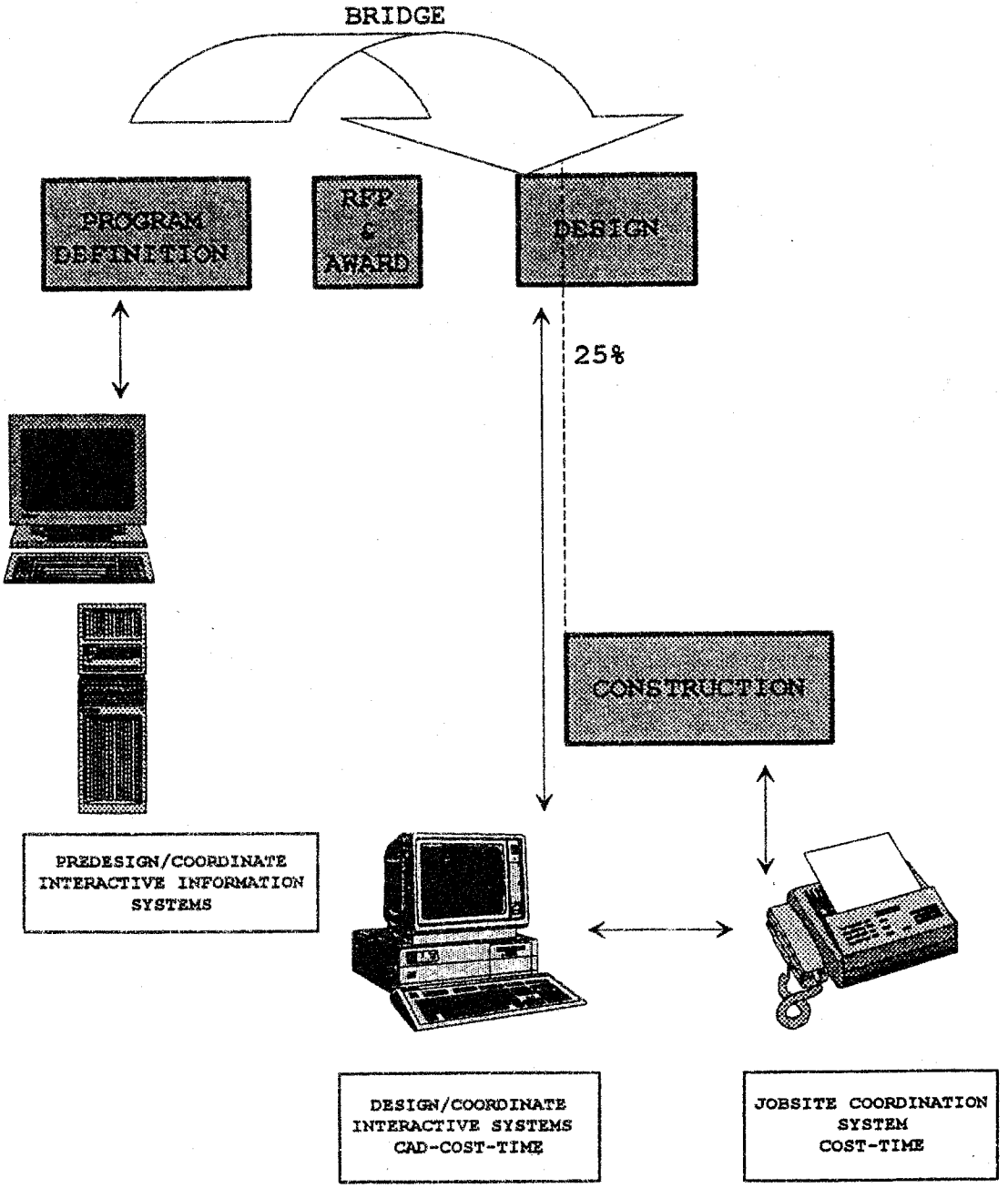

FIGURE 2 DESIGN-BUILD DELIVERY SUPPORT SYSTEM

PROJECT DEFINITION

The single most important aspect of a successful project is the preparation of a clear, complete, and understandable project definition. If the project definition is well-developed, the project has the start for total success. The organizational framework in design-build procurement provides the opportunity to optimize the input of the owner, designer and builder to the maximum extent possible. The project definition stage establishes the project attributes which should be reduced to quantifiable objectives whenever possible. Once desirable quantities are established, the decision making process during the design phase becomes quite manageable. The use of information support systems as a management process during the project definition phase of design-build to identify attributes and establish measurable quantities is graphically illustrated in Figure 3, *Predesign/Coordinate Support System*. It is important to understand that all project attributes are not quantifiable, such as "image projection". Such characteristics are none the less important to both the Owner and Designer if a successful project is to be realized. Use of historic data controlled by the Design-Build Contractor, either in a common database or in a shared and distributed database and parallel processing system gives the contractor the opportunity to access the desired project attributes and objectives in the proper format and at the proper time during the design and construction process.

The cost allocations for each desired project attribute, as well as the cost budget established for the entire facility, will reflect and determine the desired quality levels of the project systems. The identification, quantification, and establishment of project objectives related to desired attributes is perhaps the most difficult task in the programming and design of the project. Well articulated questions must be formulated, asked, and answered if valid owner objectives are to be established. When such dialogue and communication interaction is achieved, the risk associated with faulty programmatic information is all but eliminated. This management technique can be achieved by the introduction of a knowledge-based system in the design phase. An example of such a system is the ICAD Modelling System developed at California Polytechnic State University (Pohl, 1992).

DESIGN DEVELOPMENT

The development of the design documents during the initial stages of the design-build phase should lead toward the incorporation of the owners project definition criteria into the completed construction documents. This phase is particularly suited for the involvement of information support systems to control the attributes and objectives of the project as well as the major factors, such as time, initial cost, constructability, and life cycle cost. Figure 4, *Design Coordinate Support System* illustrates how information management systems can be involved in the decision making process during the design development phase. The integration of CAD programs with cost estimating and scheduling programs offers an excellent opportunity to utilize the expertise of both designer and constructor as the design developments. It is important to employ information support systems which have the capability to correlate variable systems designs into the four major criteria for management control, (1) schedule, (2) initial cost, (3) constructability, and (4) life cycle cost.

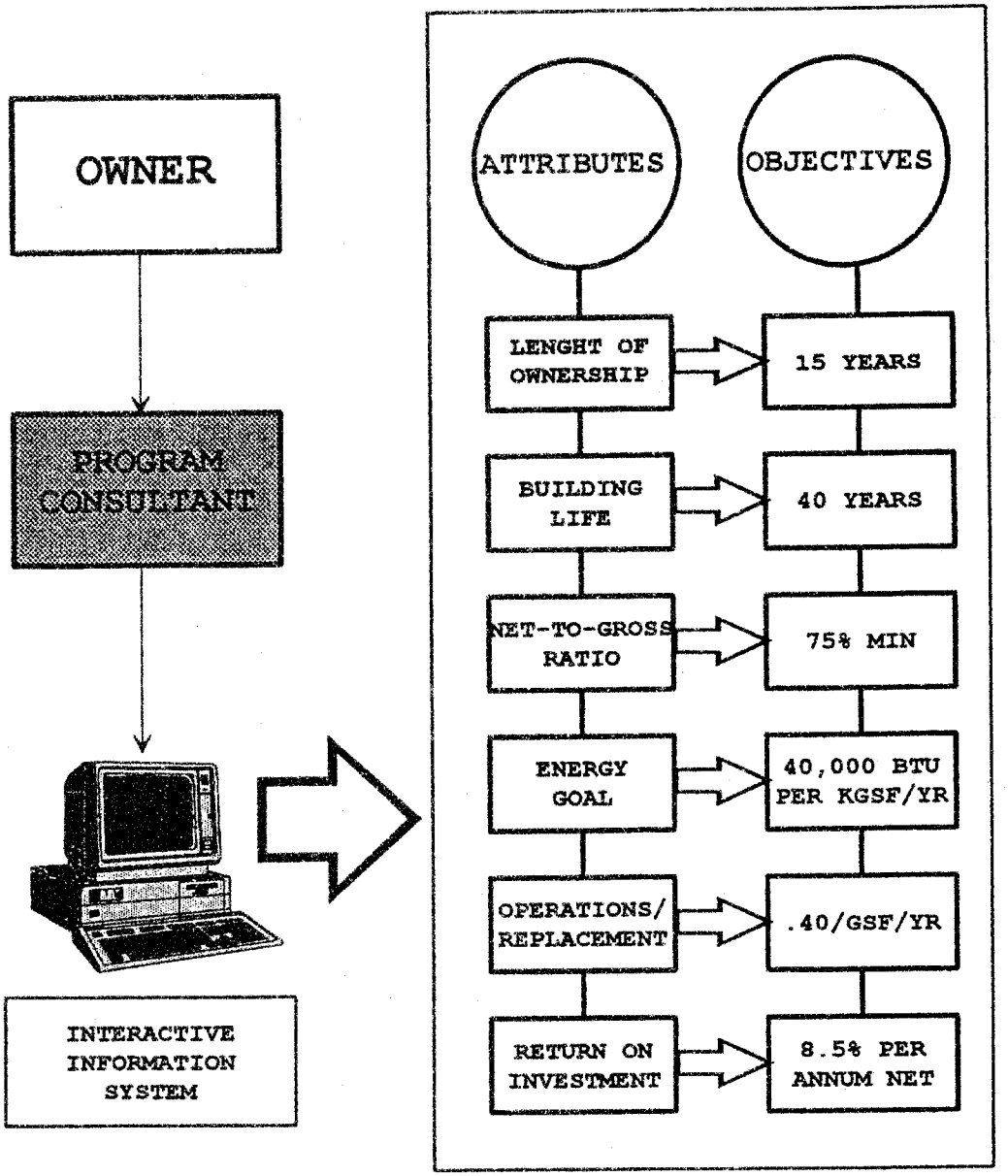

FIGURE 3 PREDESIGN/COORDINATE SUPPORT SYSTEM

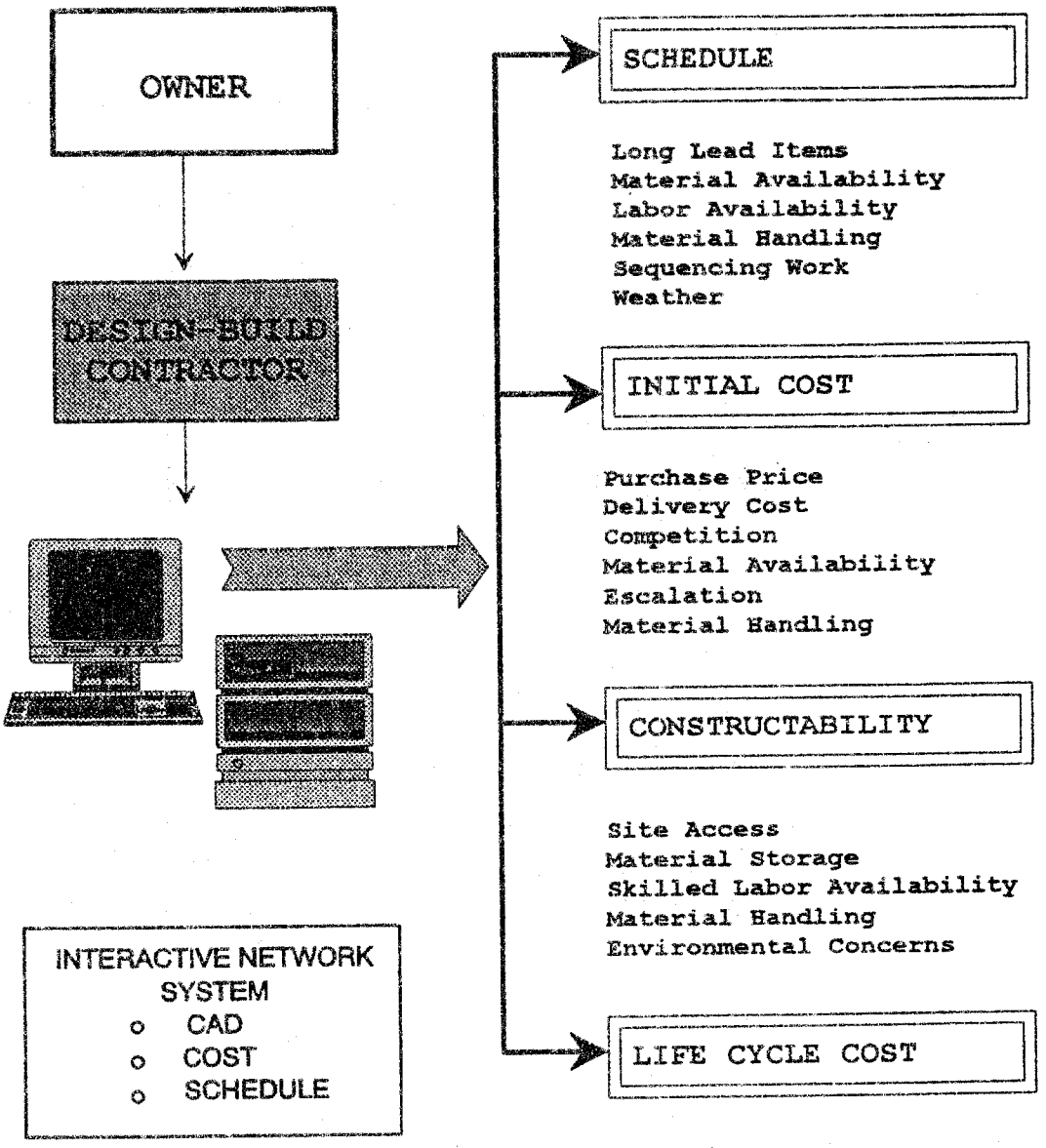

FIGURE 4 DESIGN/COORDINATE SUPPORT SYSTEM

CONSTRUCTION PHASE

As the construction commences, usually on a phased or "fast-track" basis, the involvement of information technology support systems becomes increasingly important to transmit needed data to and from the design-build office and the job site, including change-order drawings, shop drawings, revised cost estimates, schedule revisions, and a myrial of other information submissions. Also, the control of management information systems (MIS) during construction to properly manage cost and time expenditures is accommodated by immediate update and reporting procedures through the use of interactive and data-based management systems. Figure 5, *Cost Coordinate Support System*, illustrates the type of information which can be systemized, controlled, and transmitted during the design and construction phases utilizing integrated support systems. The unique opportunity to utilize and have access to both the designer and constructor during the build phase is capitalized upon with proper integrated information support systems.

CONCLUSION

The orderly and efficient control of any project includes the establishment of management systems for the control and allocation of primary project resources, Time-Money-People. Design-Build procurement with its single source responsibility offers an excellent mechanism for project resource control utilizing automated information technology support systems. Integrated information management systems which will have the capability to encompass and integrate variables in each project development phase, including planning, design, construction, and building operations are currently under development by various researchers in the US. Examples include a study of Engineering Data Modelling (EDM) by Charles Eastman at the University of California, Los Angeles; the research underway by the Center For Integrated Facility Engineering (CIFE) at Stanford University; and the work of several research groups under the auspices of the International Stanford University; and the work of several research groups under the auspices of the International Standard Organization (ISO) for STEP. All of these efforts are based on integration across different disciplines involved in the design, construction, and operation of buildings.

The advantages of Design-Build, when properly applied on properly suited projects far outweigh any real or perceived disadvantages. The Design-Build delivery approach offers the opportunity for the development and application of integrated database models for employment by one contract entity without the fragmentation experienced in the traditional Design-Bid-Build or Construction Manager approaches. Total management control can then be maintained throughout the building delivery process. The challenge of the future includes finding ways and means to advance construction technologies, improve management methods, and the application of the emerging science of integrated information technology into the building delivery process.

Summary cost report

Control account number	Description	Original commitment	Approved changes	Cumulative Total recorded & committed	Estimated Cost — To complete	Estimated Cost — At completion	Prelim. budget estimate	(under) or over budget
1	Site earthwork	206,000		206,000	3,000	209,000	208,000	1,000
2	Foundation & slab concrete	640,000	30,000	670,000	6,000	676,000	616,000	60,000
3	Special floors—interior	560,000		560,000		560,000	548,000	12,000
4	Structured steel	860,000	(5,800)	854,200		854,200	1,048,000	193,800
5	Precast walls	560,000		560,000		560,000	480,000	80,000
6	Plumbing & HVAC				594,200	594,200	380,000	214,200
7	Fire protection				33,200	33,200	300,000	33,200
8	Electrical				330,000		330,000	
9	Roofing				244,000	244,000	298,000	(54,000)
10	Building finish				590,000	590,000	590,000	
	Total direct cost	2,826,000	24,200	2,850,200	2,100,400	4,950,000	4,798,000	152,600
11	Field general conditions			28,400	143,600	172,000	172,000	
12	Home office fixed fee	200,000		200,000		200,000	200,000	
	Total indirect cost	200,000	28,400	228,400	143,600	372,000	372,000	
	Estimated total cost	3,026,000	52,600	3,078,600	2,244,000	5,322,600	5,170,000	152,600
	Contingency				257,400	257,400	482,000	(224,600)
	Total			3,078,600	2,501,400	5,480,000	5,652,000	72,000

FIGURE 5 COST COORDINATE SUPPORT SYSTEM

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