

**AN EMPIRICAL ANALYSIS OF UNITED STATES NAVY DESIGN/BUILD
CONTRACTS**

by

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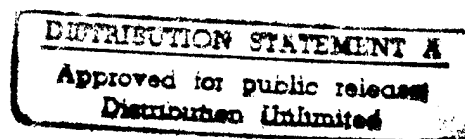
THESIS

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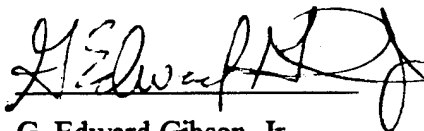
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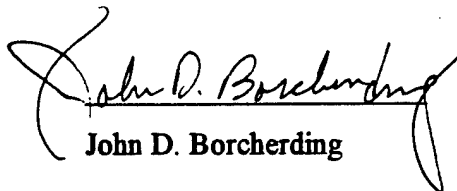
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ABSTRACT

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by

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The University of Texas at Austin, 1995

Supervisor: G. Edward Gibson, Jr.

This thesis will study a select group of US Naval Facilities Engineering Command capital projects procured via Design/Build contracts and a comparison group constructed through traditional Design/Bid/Build contracts. It will compare design, construction and administrative costs, cost growth, contract modifications, claims, and the procurement time frame. Upon completion of the comparative analysis, the thesis will attempt to validate the hypothesized superiority of design/build contracts over design/bid/build contracts within the areas of comparison.

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1.0 Introduction

1.1 Purpose of this Thesis and It's Objectives

In recent years, as budgetary constraints within the Department of Defense have continued to grow, a great interest has emerged in the development and use of innovative construction contracting strategies. Within the private sector, a similar environment of budget constraints, coupled with a demand for reduced litigation and faster project delivery, has led to a remarkable increase in the use of the Design/Build procurement method. Public sector experimentation with this form of project delivery is still somewhat limited but is beginning to yield some interesting results. The General Accounting Office, United States Postal Service, the Department of Defense, and various state agencies are expanding their Design/Build pilot programs and reviewing internal procurement guidelines to facilitate its use. The focus of the following discussion, is the United States Navy's relatively modest experiment with Design/Build and its impact on various measures of importance.

The purpose of this thesis is to perform an empirical analysis of critical program success criteria on a selected set of Naval Facilities Engineering Command (NAVFAC) capital projects procured via Design/Build contracts. NAVFAC information for all construction and design activities is assembled throughout it's five Engineering Field Divisions (EFD's) and five Engineering Field Activities (EFA's) using a relational database collection system known as the Facilities Information System (FIS). Downloaded information from FIS will be used to objectively analyze a sample of specific Design/Build projects, contrasting their performance to a comparison sample of Design/Bid/Build projects of similar size and scope.

The empirical analysis will compare the design, construction and administrative costs, cost growth, contract modifications, and the procurement time frame for the two data samples. Upon completion of the comparative analysis, the thesis will attempt to validate the hypothesized superiority of Design/Build contracts over Design/Bid/Build contracts within the areas of comparison. A brief presentation of subjective comments and suggestions made by program personnel directly involved with the administration of the projects included in the Design/Build data set will also be presented and discussed.

1.2 Scope

This thesis will analyze the performance of six selected Design/Build projects constructed by NAVFAC within the Continental United States (CONUS) and completed between FY1990 to FY1993. These six projects were all child care facilities constructed under the Military Construction Program (MILCON) and were selected because they presented a cluster of contracts with a similar scope and size large enough to evaluate. A comparison set of 6 Design/Bid/Build child care facilities were also selected from NAVFAC's extensive MILCON program completed between FY1987 and FY1994.

1.3 Summary

The following chapters of this study are structured to accomplish the objectives established above. To assist in understanding their composition, an outline of their contents follows:

- Chapter 2 focuses on the historical background of the Design/Build concept and its implementation in the private sector, public sector and within NAVFAC.
- Chapter 3 presents a detailed description of the research methodology developed for data acquisition.
- Chapter 4 is a presentation of the data obtained for the study and its analysis.
- Chapter 5 is a discussion of the conclusions to be drawn from this study.
- Chapter 6 details specific recommendations based upon the analysis of research data and recommendations for future research.

2.0 Background

2.1 Design/Build Defined

Although the basic concepts associated with all Design/Build contracts are similar, the terms used to describe the numerous contract variations do not have universally-accepted meanings. Therefore, a brief description of the terms used within this thesis is useful to this discussion. They are defined as follows:

Definition

Design/Build - This is a broad descriptive term used to characterize any project in which a single party is responsible to the owner for the design and construction of a project. Figure 1 below is a general diagram of the process (Songer, 1992).

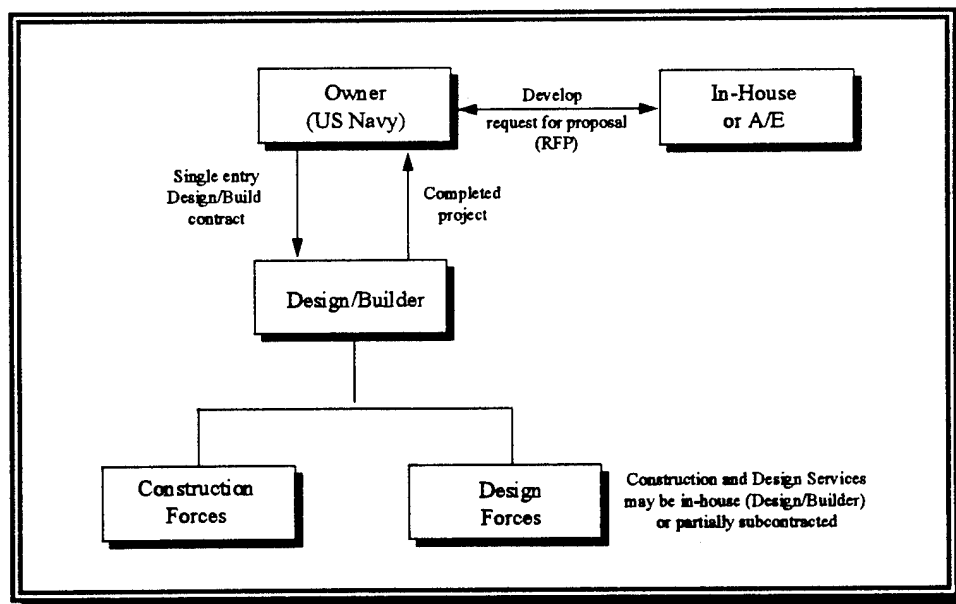


Figure 1 General Diagram of the Design Build Process

Design/Build Variations

Source Selection - A contracting method which involves the selection of a contractor through competitive negotiations. The procedure involves the use of selection boards for proposal evaluation in which the contractor responds to an Invitation For Bid (IFB) based on performance specifications for the facility to be constructed. The contractor's proposal is evaluated on the technical merits of the design concept submitted and its business elements, such as price and time to complete. The contract is awarded to the proposal which best meets the owners requirements.

Two-Step Sealed Bidding - This method is a combination of source selection and sealed bidding. Contractor proposals are evaluated in two stages. Step-One involves an evaluation of contractor proposals based upon their satisfying the performance specifications included in the IFB and on their technical merit. If proposals are judged to be in conformance with the requirements of the IFB, they are then included in Step-Two, which involves the submission of sealed bids. The lowest priced Design/Build proposer is awarded the contract and proceeds with design and construction of the facility.

Bridging - This contracting method awards the contract to the proposer based exclusively on a sealed bid. It differs from standard lump sum sealed bidding in that Design/Build contractors submit proposals on an IFB which includes both prescriptive and performance specifications. The Owner's IFB includes a design which is approximately 35 percent complete and the contractor's bid includes a price for completion of the design and a fixed cost for construction of the facility.

2.2 History of the Design/Build Concept

Although Design/Build contracting is seen by many as a relatively recent phenomenon, it has its contextual foundation in ancient history. Design/Build construction was the classical form of control for all of the great civil works projects built throughout ancient times. Most of the world's historically recognized engineering feats such as the Pyramids, the Great Wall of China and Europe's Baroque cathedrals of the 15th century, were constructed by master builders, hired in a Design/Build capacity (Architect, Engineer and Contractor). This combining of construction and engineering services was actually the traditional method of construction until the early 20th century (McManamy, 1994).

As construction techniques became standardized and project duration's became more predictable, various formats of competition for construction services inevitably evolved. The newer concept of lump sum bidding gained acceptance as the number of experienced builders capable of producing reasonable proposals increased. In an extremely competitive economy, focusing on price alone, the lump sum bid method became the standard used throughout the industry. As this type of arrangement grew in popularity, architects were independently commissioned to provide designs and act in a controlling capacity, establishing a level of value for themselves (Branca, 1987). The increasing complexity of construction further intensified this separation of Contractor and Architect resulting in a trend towards Architectural/Specialty consulting.

Although it performed well in most situations, by the early 1960's the shortcomings of the standard lump sum bid system began to manifest themselves as real problems for the industry. The effects of rising material and labor costs, a focus

on reduced construction time and the beginnings of increased litigation tended to accentuate the inefficiencies of lump sum contracts. Because of this atmosphere, modern Design/Build contracting concepts were formulated and began to reemerge as methods for addressing these problems.

2.3 Reemergence of Design/Build Contracts

Although Design/Build contracting began its resurrection in the late 1960's, significant growth in its use did not occur until some twenty years later. Market forces in the 1980's focused attention on Design/Build due in large part to its identification of a single point of responsibility for architectural, engineering and construction services. As an explosion of litigation has overtaken the construction industry, Design/Build has been seen as a contracting strategy which significantly reduces claims and disputes. In assuming full responsibility for the delivery of the project, the Design/Build contractor leaves the construction relationship between the owner and the builder relatively unchanged but it radically changes the position, composition and responsibility of the design team. There is considerable incentive for the contractor to ensure excellent constructability reviews, reduce the occurrence of variations and errors, and minimize the late supply of documentation in design. Although this arrangement imposes a greater risk on the contractor, it also provides a contractual and practical means for managing it (Tieder, 1989). In most cases, design problems are now the responsibility of the contractor but he is also empowered to control them.

Design/Build's consolidation of architectural, engineering and construction responsibility also provides a flexibility which allows for the incorporation of innovative construction management techniques (Schriener, 1995). Just-in-time delivery, total quality management, constructability, partnering, team building and alternate dispute resolution procedures are some of the more common techniques facilitated by the direct

contractual and organizational flow of responsibilities outlined within a Design/Build setting (see Figure 2).

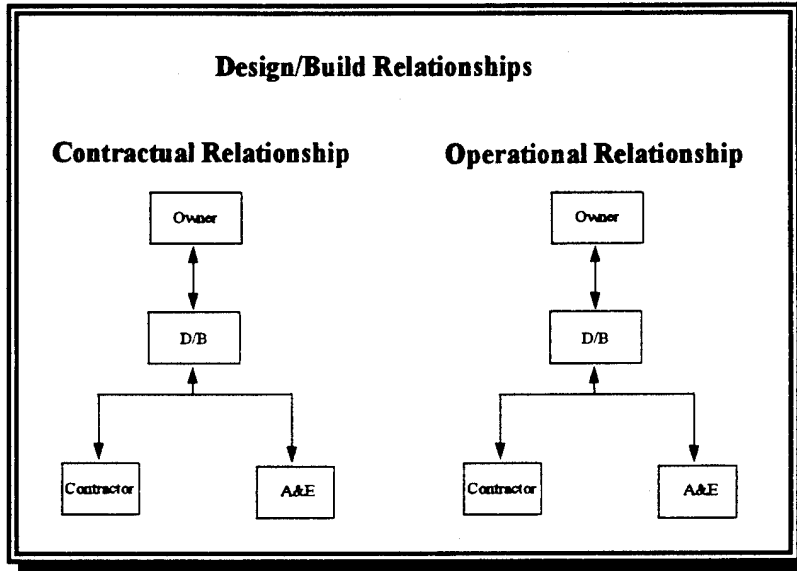


Figure 2 Design/Build Relationships

In contrast, a diagram of the standard Design/Bid/Build relationships, highlights the owners separate contractual ties with both the construction contractor and the architect. This separation is often the cause complex litigation concerning third party indemnification and contributes to finger-pointing and blame laying when problems emerge. The standard lump sum contract (see Figure 3) also incorporates operational control mechanisms which hinder the appropriate use of some of the management innovations discussed above and it often restrains open communication between stake-holders.

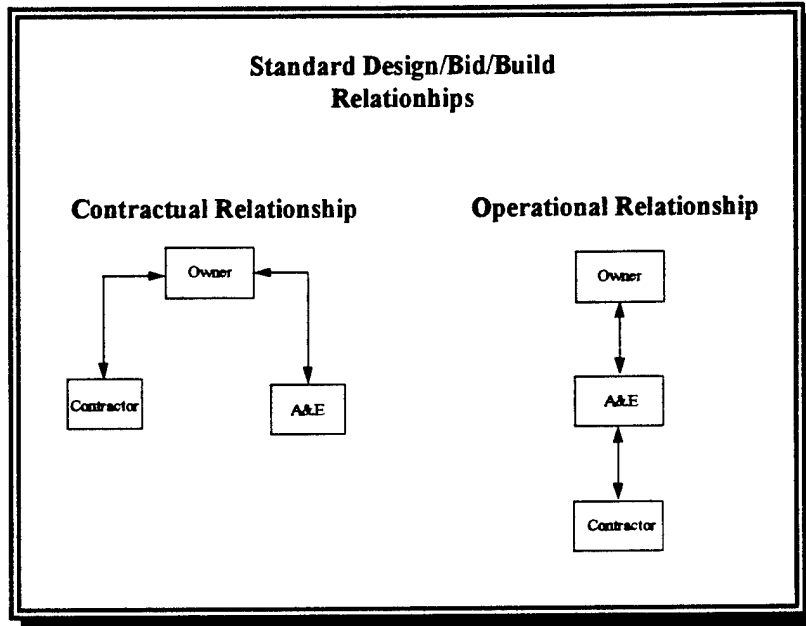


Figure 3 Standard Design/Bid/Build Relationships

Although Design/Build contracts are not a guarantee for the effective control and management of these relationships, their structure seems to facilitate proper control.

2.4 Design/Build's Use In The Private Sector

The Owners' Perspective

Owner demand for Design/Build contracts has increased dramatically over the last decade. Driven by a lack of confidence in the perceived ability of Contractors and A/E's to effectively communicate, properly coordinate activities, and control budgets within a standard contract setting, owners began to utilize Design/Build projects which quickly establish a price cap and a fixed schedule. This remarkable growth, as tracked by Engineering News Record's (ENR) statistics on the nations Top 400 Contractors, identifies the increase as both a permanent and major industry trend (See Figures 4 & 5).

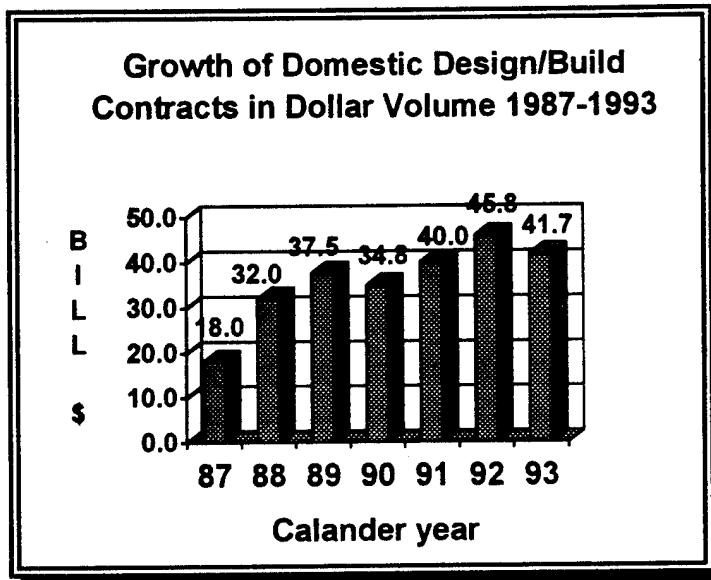


Figure 4 Increase in D/B Contract Dollar Volume for ENR's Top 400

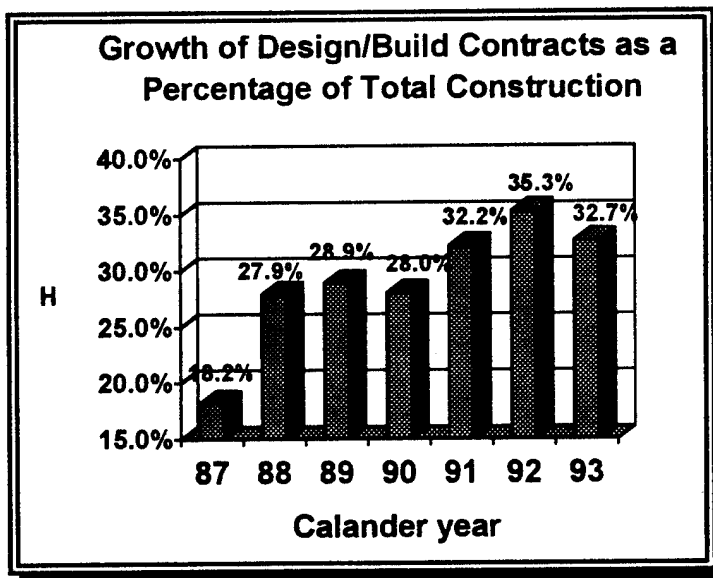


Figure 5 Growth of Design/Build Contracts as a Percentage of Total Construction for ENR's Top 400

Although the ability of the method to produce a single source of responsibility for control of the project is definitely singled out as the most important reason for Design/Build's surge in popularity, it is not the sole reason. To quickly identify some of these other reasons, a review of attributable Design/Build advantages, that have been subjectively defined by industry experts, is useful. Table 1 below is a list of advantages and their areas of impact as discovered by the author during the literature review for this study. It is important to note that although these advantages tend to apply to the Owner's position, they can benefit the Contractor and A/E in many ways as well.

Table 1 Design/Build Advantages

Area of Impact	Design/Build Advantages
Time	<ul style="list-style-type: none"> • Use of fast-track concepts allows project to be completed more quickly. (Denning, 1992) • Project can be prepared for solicitation and awarded quickly. (Potter, 1994) • Design/Build has been proven to be 30% faster at delivering the project in some studies (McManamy, 1994).
Cost	<ul style="list-style-type: none"> • Guaranteed maximum price is established early in the process (McKee, 1994). • Number of modifications significantly reduced (Terricone, 1993). • In-house staff can be effectively used for IFB development (Spaulding 1994, Bradford, 1991, Hazel, 1991). • Method recognizes the increased importance of the time-value of financing and incorporates fast-track well (NAVFACENGCM, 1994). • Method enhances the effectiveness and incorporation of TQM, partnering, team-building and fast-tracking concepts (Schriener, 1995 Terricone, 1993).
Coordination	<ul style="list-style-type: none"> • Single entity responsible for design and construction (McKee, 1994, Branca, 1987) • Close coordination inherently required by all parties leads to quick problem resolution (McKee, 1994). • Close coordination between A/E and Contractor occurs regarding design feasibility and constructability issues (Courtelet, 1992). • Design/Build involves Subcontractors earlier in the process obtaining valuable design input (Potter, 1994). • A/E designs to contractor's strengths facilitating construction (Denning, 1992).

Table 1 Design/Build Advantages (Cont.)

Area of Impact	Design/Build Advantages
Coordination (Cont.)	<ul style="list-style-type: none"> • The new organizational make up within Design/Build organization maximizes the respective talents and experience of all the project players (Potter, 1994).
Litigation	<ul style="list-style-type: none"> • Claims and litigation are limited through proper risk allocation and assignment of responsibilities (Tieder, 1993). • Method accommodates multi-parameter bidding schemes which allow for award based on factors other than price (Herbsman, 1992). • Contractual relationship between the Owner and Design/Build entity is significantly simplified (Branca, 1987) • Owner is insulated from liability for design errors and omissions. Although the Design/Build contractor assumes responsibility, he is empowered with the ability to manage them directly (ASCE, 1992).

Contractor and A/E's Perspective

The increased demand for Design/Build contracts was met with great skepticism by Contractors and overt hostility by Architects in the early 1980's. Although a small number of Design/Build Contractors recognized the advantages outlined in Table 1 and aggressively pursued these projects as a niche market, many viewed Design/Build as an attempt by owners at risk shifting (improper assignment of indemnification responsibility). The architectural community's view of Design/Build was initially so negative that the American Institute of Architects (AIA) actually had an ethical prohibition against its use until 1978. Their two major concerns centered around an unjustified belief that Design/Build was an attempt to undermine the selection of design firms on the basis of professional qualifications and that it eliminated the fiduciary role of the architect to the owner. In spite of the AIA's strong opposition, the demand for Design/Build projects continued to rise. Eventually, the AIA endorsed the method as an acceptable and inevitable method of project delivery

(McKee, 1994). By 1985, the Institute had developed three standard Design/Build contracts to be used as template contracts for its members as more A/E firms began to participate in these projects.

Although many of the initial objections to the use of Design/Build projects were developed from uneducated assumptions about the process, there are some aspects of the method that should be carefully considered before a decision is made to utilize the Design/Build format. These aspects can be termed as disadvantages for the process and are presented in a similar format as the advantages listed above (see Table 2). As noted before, these observations were discovered by the author during the literature review for this study, and consist of comments subjectively defined by industry experts. It is also important to understand that these disadvantages can apply to any of the stake-holders included within a project.

Table 2 Design/Build Disadvantages

Area of Impact	Design/Build Disadvantages
Time	<ul style="list-style-type: none"> • Design/Build contracts may take longer to award because of the complexity of the award process (McKee, 1994) • Design/Build process is more dynamic and requires more stakeholder participation (Potter, 1994).
Cost	<ul style="list-style-type: none"> • Cost of responding to IFB and developing proposal can be extremely expensive. This tends to limit competition and eliminate small firms (Hazel, 1991). • Bonding costs for A/E and Contractor can be up to 50% higher (Denning, 1992). • Proposal cost is a sunk-cost, recovered only if contractor is awarded contract (Setzer, 1992). • Modifications made after award can be extremely expensive if not made in a timely manner (Denning, 1992). • Increased responsibility of the Design/Build Contractor carries increased risk, therefore, he may increase his bid price for contingencies (Hutchens, 1992).

Table 2 Design/Build Disadvantages (Cont.)

Area of Impact	Design/Build Disadvantages
<p align="center">Coordination</p>	<ul style="list-style-type: none"> • A/E's direct link of communication with owner is removed (Branca, 1987). • A/E's first allegiance is to the contractor not the owner. A/E's feel their fiduciary role is changed (Hoyt, 1993). • Project scope must be defined extremely early in the process (Spaulding, 1995). • Process can be a real risk for unsophisticated owners not familiar with their administration (Coxe, 1994). • Knowledgeable in-house staff must closely monitor project (Edmunds, 1992, Setzer, 1991). • Importance of selecting an excellent project team is increased (Potter, 1994). • Inexperienced Subcontractors dislike the uncertainty of the process (Denning, 1992).
<p align="center">Legal</p>	<ul style="list-style-type: none"> • Design/Build contracts are prohibited in some states (McManamy, 1994). • Litigation may develop if the scope of work defined in the IFB is not absolutely clear (Setzer, 1992).

In spite of the initial controversy that surrounded it, the number and size of Design/Build projects is growing, and contractors are taking advantage of this trend in the industry (Schriener, 1995). As Design/Build's popularity continues to increase, however, a careful review of the advantages and disadvantages of the process must be realistically evaluated by all project participants. Although some industry experts predict that by the year 2000, most buildings constructed in the US will be built by Design/Build, the method can not be universally applied in all situations.

2.5 Design Build's Emergence in the Public Sector

The use of various Design/Build methods for public sector projects, especially federal government and DOD projects, is a relatively recent development within the construction industry. Initially, licensing laws and regulations controlling the use of Design/Build varied significantly on both federal and state levels. These controls

ranged from modest limitations in some jurisdictions to outright bans in others. However, public-sector owners began to rethink their traditional low-bid mentality, as Design/Build's application in the private sector began to produce successful results (Tarricone, 1993). Funding cutbacks and market forces pressured organizations such as the General Services Administration (GSA), Federal Highway Administration, DOD and various state departments of transportation to consider Design/Build's innovative advantages. The serious interest by the federal government acted as a sort of galvanizing force for increased public implementation throughout the country. After an initial series of challenging pilot project awards, the GSA is now enjoying a series of successful completions within their program. The United States Army Corps of Engineers, United States Air Force and NAVFAC are also receiving positive results from their limited programs utilizing Design/Build (Thorburn, 1994). In spite of these encouraging signs, federal implementation is struggling with administrative problems generated by acquisition policy. Recognizing these issues, Congress is considering various procurement reform bills to streamline the Design/Build process, set criteria for its use, and establish clear award procedures (McKee, 1994).

2.6 Evolution of NAVFAC Design Build Contracting

Limited testing by NAVFAC of the Design/Build process was first begun in the late 1960's during the Vietnam War as part of the Navy's Family Housing (FHN) Program. Although Design/Build was quite successful and continued to be implemented within the FHN program, its use was prohibited in all other military construction programs

This situation changed, however, during fiscal year 1984 when congressional committees expressed a strong interest in alternative construction and contracting methods (Spaulding, 1988). To pursue this interest, the Defense Armed Services

Committee requested that both the Army and the Navy each identify two FY 1985 projects for completion under performance (Design/Build) specifications. Upon review of the successes associated with these projects, Congress gave NAVFAC and the Army Corps of Engineers authorization to execute three Design/Build projects per fiscal year out of their Military Construction (MILCON) programs. This action gave rise to a pilot program of construction projects which is continuing to expand. (see Appendix 1 for a NAVFAC listing of all Design/Build projects constructed since 1985). In 1992, the House of Representatives passed a Pentagon Authorizations Bill which lifted the 3 project per year restriction, giving approval authority for the initiation of Design/Build projects respective agency heads (i.e. Chief of Civil Engineers, Commander, NAVFAC). Although this has encouraged the increased use of Design/Build, there is still some confusion with regards to their administration and some federal procurement guidelines as outlined by Federal Acquisition Regulations (FAR). Currently legislators are considering federal procurement reform provisions to streamline the Design/Build process and establish clear selection criteria. This should lay to rest some of the controversy surrounding the issue of federal implementation and perceived conflicts with the Brooks Act, which requires the negotiated procurement of architectural and engineering services based on competence and qualification (McKee, 1994).

To-date, NAVFAC has completed over 30 Design/Build construction projects, with another 21 scheduled for award by FY 1997. Although construction of these projects has been accomplished via a combination of the three Design/Build techniques discussed above in Section 2.1, most have been completed using the Navy's variation of the bridging technique known as Newport Design/Build (see Table 3 below).

Table 3 Construction Status of NAVFAC Design/Build Program

Delivery Method	# of Completed Project	Projects Scheduled (- FY1997)
Source Selection	6	3
Two Step	3	0
Newport Design/Build (Bridging)	22	17

NAVFAC's reasoning behind the selection of a specific delivery method is based upon several variables. To gain a better understanding of how it is done, a briefing sheet used by NAVFAC headquarters to describe the selection process is included for review in Appendix B.

Although Design/Build program typically accounts for only 3 percent of the Navy's annual MILCON budget, NAVFAC is committed to its expanded use. Beyond its obvious advantages, NAVFAC sees it as a way to utilize its large in-house engineering staff (Bradford, 1991). The Navy's most prevalent delivery method, the Newport Design/Build process, allows for very effective use of in-house personnel for the development of the 35 percent design that is included as part of the IFB (Briggs, 1993). Beyond this reason, there are many other advantages that have been subjectively identified by NAVFAC, which uniquely apply to its program. Some of these include:

Administrative:

- The method results in the earlier obligation of funds and faster project delivery.
- It reduces the time required to get the contract awarded. This is especially important in utilizing funds which must be obligated by the end of the fiscal year.

Administrative (Cont.) :

- It reduces project management time required at both the field and program level.
- It minimizes conflicts in responsibility internally within the organization.

Technical:

- The method encourages process innovations.
- It allows for true partnering between designer and builder.
- It allows for great savings in the specification of details. The contractors specification of brand names simplifies procurement and construction.

Cost:

- The method quickly defines the full scope, achieving it at a lower cost.
- Field modifications from errors and omissions are virtually eliminated.
- It reduces the design modification rate.

There is also one major disadvantage to the Design/Build method that the NAVFAC organizational system tends to neutralize. Design/Build requires the owner to have a knowledgeable engineering staff competent enough to control the Contractor (Coxe, 1994). As stated by Mr. Harry Zimmerman, the Assistant Commander for Engineering and Design at NAVFAC: "Our construction management organization is so fully cable of doing this, that the Navy has no fear of losing control in the administration of Design/Build projects" (Edmunds, 1992).

2.7 Previous Design/Build Studies

Although there have been numerous anecdotal reports of the success of Design/Build projects within the Federal Sector, the literature review performed by the author revealed only one study performed to date which compared project

performance factors. This 1993 U. S. Navy study compared the cost performance of the 6 NAVFAC Design/Build child care centers identified for author's current study with a different comparison group of Design/Bid/Build child care centers procured in FY 1990 (Moritsen, 1993). Although the Moritsen study revealed some interesting trends, it failed to consider the impact of the comparison projects size and scope on results and test them for statistical significance. The study also based its cost performance conclusions on the project's initial program estimate used for funding authorization purposes. Because of the way in which this program estimate is developed, it tends to yield a statistic of questionable value. Therefore, this study was undertaken.

3.0 RESEARCH METHODOLOGY

3.1 Project Data Source: Naval Facilities Engineering Command

All research data for this thesis was gathered with the assistance of Naval Facilities Engineering Command Headquarters located in Alexandria Virginia. In October of 1994, a research proposal was presented to the Director of Facilities Programs and Construction, NAVFAC Code 30, for review and approval.

Subsequently, the author was sent a packet of information related to NAVFAC's Design/Build effort and a list of 51 Military Construction (MILCON) Program projects completed or scheduled for construction through fiscal year 1997. Of these 51 MILCON projects, 30 have been completed to date. These 30 contracts were used by the author as the starting point for this study. The contracts were reviewed in great detail for similarities upon which a sample for the study could be based. Although the contracts included in this initial sample were quite diverse, a comprehensive examination of the projects revealed a cluster of 8 child care facilities constructed between 1990 and 1995. Therefore, these projects were selected for analysis.

Information to conduct this research was needed from various levels of NAVFAC's organizational hierarchy (see Figure 5). Detailed information from the various Engineering Field Divisions, Engineering Field Activities and the specific Resident Officers in Charge of Construction (ROICC) for each project was required. Because of this, the author worked to obtain approval from NAVFAC for permission to access the Navy's computerized construction database, the Facilities Information System, located in Port Hueneme, California.

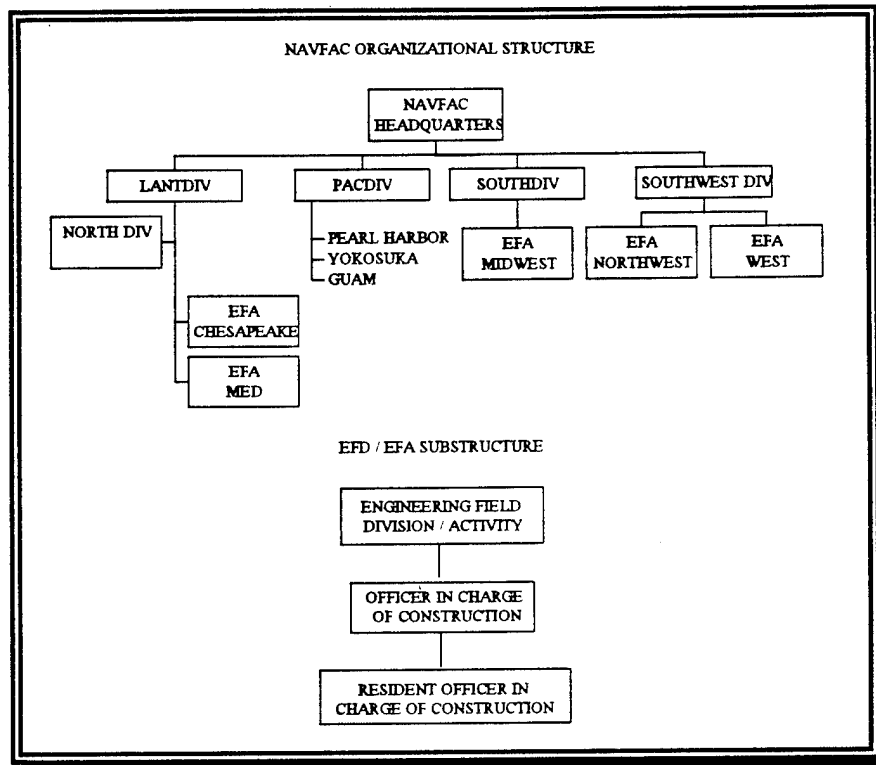


Figure 6 NAVFAC Organizational Structure

3.2 Facilities Information System (FIS)

NAVFAC's Facilities Information System (FIS) is a computerized management information system which electronically supports and archives all NAVFAC Headquarters, EFD, EFA and ROICC program and project management data. It also provides the framework for the documentation of all construction contract management and financial management activities within NAVFAC's span of control.

FIS, version 2.0, is organized as an extremely large relational database which is maintained by the Navy on an IBM mainframe computer. The system was chosen for data collection because it is highly interactive, continually updated by field

representatives, and contains multifaceted project information (funding, schedule and modification data) concerning facility design and construction.

3.3 Accessing the System

Data collection was first started by accessing the system via the Internet and logging on as an authorized user. Accessing FIS requires the use of an IBM TN3270 emulation program for establishing contact with the mainframe (a detailed outline of specific access instructions is included in Appendix C). Once communications were established, various system modules within FIS were used to view and evaluate project data and establish its location within the database. Below are two downloaded examples of screens within the construction module of the system used during this evaluation.

```
1 OF 1                                UIEW CONTRACT STATUS                95JUL02 18:43:26
                                         H47C3U51

USER CODE:          N
CONTRACT NUMBER:   N62472 89 C 0004   OR   FUND USAGE NUMBER: 64376

DESCRIPTION:       CHILD DEVELOPMENT CENTER P-993 DESIGN/BUILD
FND USAGE STATUS: COMPLETED
PCO CODE:          022
ACO CODE:          ME.BRUNS
SBSA INDICATOR:
PURPOSE CODE:      CON   PROC TYPE CODE: FP   8A CODE: N
DD 350 CODE:      D
CNT SPECIALIST:    MCHENRY, CHARLES T.

CONTRACTOR:        A11406             SHERIDAN CORP.

UIEW CONTRACT:     - SCHEDULE   - FUNDING     - MIP           - CHANGES
                  - CLAIMS     - TERMINATIONS - RELATED CNT
                  - NOTEBOOK  - CONTACT LIST

'X' SELECT ITEMS YOU WISH TO VIEW AND PRESS ENTER OR EXIT.
PROC: B35 SUC 1
```

Figure 7 FIS 2.0 Construction Module Screen

1 OF 1		VIEW CONTRACT STATUS (CON/WGT HANDLING)	95JUL02 18:48:27 H47C3U52
CONTRACT NUMBER:	N62472 89 C 0004	FUND USAGE NUMBER:	64376
ACO CODE:	ME. BRUNS	IFB ISSUE PLAN:	000001
PERCENT COMPL:	100	IFB ISSUE ACTUAL:	000001
FUNDED ACCRUED:	771,495.67	BID OPEN PLAN:	001001
UNFUNDED ACCRUED:	0.00	BID OPEN ACTUAL:	001001
		AWARD ORIG PLAN:	900329
		AWARD PLAN:	900129
AWARD AMOUNT:	727,930.00	AWARD ACTUAL:	900123
CURRENT PRICE:	771,495.67	CCD ORIG PLAN:	901229
CME FOR CONTRACT:	771,495.67	CCD PLAN:	910129
EFD PROJECT MGR:	9A03	CCD ORIG LEGAL:	
		CCD LEGAL:	910202
BOD ORIG PLAN:		BOD PLAN:	910202
ASB REVIEWED:	910122	BOD ACTUAL:	901217
TERMINATION APUL:		FINAL RELEASE:	910517
		TERMINATION:	
PRESS ENTER TO CONTINUE.			
PROC: B35 SUC: 1			

Figure 8 Schedule Information from the FIS Construction Module

3.4 Retrieving Project Data

Once the Design/Build contracts were identified, research information was extracted through the use of query programs written to retrieve specific data. These programs were constructed in a section of FIS called Data Query and were used to obtain information from the numerous source files which are related to each other by data keys (see Appendix C for an example of the Data Queries used). After data extraction, the project information was downloaded through the Internet to a personal computer via a File Transfer Protocol (FTP) program for final data presentation and analysis.

Although FIS contained most of the information required for this study, some fields within the database were not complete. Specifically, project information contained in the CNT-REC file of the database typically was missing field entries for the project's original legal contract completion date and the beneficial occupancy date.

To capture these missing data, telephone interviews were conducted by the author with various individual EFD, EFA and ROICC office personnel. These phone conversations were also used as an opportunity to obtain subjective information on the Design/Build process. (Missing data poses a significant problem for NAVFAC. Solutions for resolving this problem are included in the recommendations section of this study, Chapter 6.)

FIS was also used to select a group of projects for comparison with the Design/Build sample. A data query was constructed to extract all child care related MILCON projects executed by NAVFAC and completed since 1987. The comparison sample was limited to projects located within the continental United States (CONUS) to closely align the sample with the Design/Build data set which contained only CONUS projects. A total of 20 construction projects were identified for comparison and research information was extracted for these projects using a data query similar to the one used for the Design/Build sample.

3.5 Project Data Analysis

The collection of these data allowed for an empirical analysis of performance for the Design/Build and Design/Bid/Build projects. The analysis differentiates the design, construction and administrative costs, contract modification cost growth, the contract modifications rate, and procurement time for the two data sets. The comparison was accomplished by evaluating the mean value of each criterion and a student t-test was also performed on the mean values of the cost data to determine if the findings revealed were statistically significant and valid.

3.6 Subjective Data

A brief presentation of the subjective comments and suggestions made by program personnel directly involved with the administration of the projects was also included for the Design/Build sample. A discussion of these comments will be presented as a measure of the satisfaction NAVFAC personnel have with the Design/Build program.

4.0 Presentation of Data and Data Analysis

This chapter will present in tabular form the data retrieved from the Facilities Information System used for this study. It will also present a comparison of the mean criterion values of the Design/Build projects and Design/Bid/Build projects selected for analysis, examining the statistical significance of the results obtained using an analysis of means test.

4.1 Design/Build Data

Eight projects were originally extracted from the FIS database for review by the author. (Table 4 below is a summary of this information). However, two of the eight projects identified for the study were removed from the sample because they contained information atypical of the remaining projects.

The first project removed was a child care facility located at the Naval Medical Center in Bethesda, Maryland. The square footage (SF) for this facility was approximately 21,000 SF. Because the remaining projects in the Design/Build sample were approximately 6400 SF in size, including this larger project in the sample may have tended to skew cost data because of the projects economy of scale with regards to design and construction costs.

The second project removed from the sample was a facility located at the Naval Education and Training Center in Newport, Rhode Island. A detailed review of the project history for this contract revealed that the scope as defined in the IFB for the contract was significantly deficient. Large design modifications were required to complete the contract for which the Navy was completely responsible. The facility had over \$200,000 in design modifications (a problem the Design/Build method should

eliminate) and experienced over 30 percent cost growth in contract modifications. Finally, the constructed cost for the facility exceeded \$243/SF which is approximately 150 percent of the average SF cost for the remaining sample projects gathered for analysis. For these reasons, the project was removed and a final sample of 6 projects was assembled (see table 5 below).

As shown in these tables, the normalized cost growth for construction (column 8) for each of the projects was computed by dividing the total value of all contract modifications for the project by the original construction contract award price. The cost per square foot (cost / SF) for each sample project was prepared for final cost analysis by applying an inflation factor. By establishing a base year of 1990 and using ENR's Construction Cost Index, all design and construction costs were converted into 1990 dollar cost figures (Grogan, 1995). Table 5 shows the original cost / SF (column 9), the year the project was completed (column 10), and the revised cost / SF adjusted for inflation (column 11). Doing this allowed for a direct comparison of all cost data.

The raw data for the 8 Design/Build projects extracted from the FIS database is included in Appendix D for review purposes.

Table 4 Original Design/Build Projects Selected for Review

PROJECT NUMBER (1)	ACTIVITY LOCATION (2)	CONTRACT AWARD AMOUNT (3)	TOTAL VALUE OF MOD (4)	SCOPE (5)	UNIT OF MEASURE (6)	COMPLETED TOTAL COST (7)	NORMALIZED COST GROWTH (8)	COST / SF (9)	YEAR OF AWD (10)	COST / SF ADJ FOR INFLATION (11)	
1	BRUNSWICK ME NAS	\$727,930	\$43,566	6400	SF	\$963,990.08	5.98%	\$151	90	\$151	
2	NEW LONDON CT NSB	\$776,800	\$66,015	6400	SF	\$1,061,188.75	8.50%	\$166	90	\$166	
3	KITTERY ME	\$716,173	\$131,902	6400	SF	\$973,619.86	18.42%	\$152	90	\$152	
4 *	NEWPORT RI NETC	\$1,368,000	\$411,477	8000	SF	\$2,046,063.42	30.08%	\$256	92	\$243	
5	BREMERTON WA	\$908,212	\$8,357	6400	SF	\$1,106,824.00	0.92%	\$173	91	\$169	
6	FALLON NV NAS	\$989,423	\$45,000	6400	SF	\$1,214,449.06	4.55%	\$190	91	\$186	
7	DAHLGREN VA	\$972,325	\$6,667	6400	SF	\$1,172,766.89	0.69%	\$183	91	\$179	
8 *	BETHESDA MD	\$2,735,000	\$177,884	21500	SF	\$3,267,938.76	6.50%	\$152	94	\$133	
AVG COST GROWTH							6.51%				
AVERAGE COST / SF								\$169			
AVERAGE COST / SF AFTER INFLATION											\$167

* Project 4 removed because of scope design problems as described above

* Project 8 removed because of significant size and scope difference as described above

Table 5 Design/Build Research Sample

PROJECT NUMBER (1)	ACTIVITY LOCATION (2)	CONTRACT AWARD AMOUNT (3)	TOTAL VALUE OF MOD (4)	SCOPE (5)	UNIT OF MEASURE (6)	COMPLETED TOTAL COST (7)	NORMALIZED COST GROWTH (8)	COST / SF (9)	YEAR OF AWD (10)	COST / SF ADJ FOR INFLATION (11)	
1	BRUNSWICK ME NAS	\$727,930	\$43,566	6400	SF	\$963,990.08	5.98%	\$151	90	\$151	
2	NEW LONDON CT NSB	\$776,800	\$66,015	6400	SF	\$1,061,188.75	8.50%	\$166	90	\$166	
3	KITTERY ME	\$716,173	\$131,902	6400	SF	\$973,619.86	18.42%	\$152	90	\$152	
4	BREMERTON WA	\$908,212	\$8,357	6400	SF	\$1,106,824.00	0.92%	\$173	91	\$169	
5	FALLON NV NAS	\$989,423	\$45,000	6400	SF	\$1,214,449.06	4.55%	\$190	91	\$186	
6	DAHLGREN VA	\$972,325	\$6,667	6400	SF	\$1,172,766.89	0.69%	\$183	91	\$179	
AVG COST GROWTH							6.51%				
AVERAGE COST / SF								\$169			
AVERAGE COST / SF AFTER INFLATION											\$167

4.2 Design/Bid/Build Data

Table 6 below is a summary of the original Design/Bid/Build data sample retrieved from FIS. The projects included within this original sample, range from approximately 4,000 SF to 23,000 SF in size. After careful examination, this 20 project group was reduced to a sample of six Design/Bid/Build projects. This was necessary to provide a sample for comparison which contained projects of similar size and scope. All Design/Bid/Build projects exceeding 8500 SF in size were eliminated from the data sample to accomplish this. The resulting comparison sample is summarized in Table 7.

The 6 comparison projects selected were subjected to the same scope and change evaluation criteria as the Design/Build sample and the inflation factors applied to the cost / SF for each project and normalized cost growth computations, were completed in a similar manner.

The raw data for the 20 Design/Bid/Build projects extracted from the FIS database is included in Appendix D for review purposes

Table 6 Original Design/Bid/Build Projects Selected for Review

PROJECT NUMBER (1)	ACTIVITY LOCATION (2)	CONTRACT AWARD AMOUNT (3)	TOTAL VALUE OF MOD (4)	SCOPE (5)	UNIT OF MEASURE (6)	COMPLETED TOTAL COST (7)	NORMALIZED COST GROWTH (8)	COST / SF (9)	YEAR OF AWD (10)	COST / SF ADJ FOR INFLATION (11)
1 *	CHASE FIELD TX NAS	\$484,645	\$7,729	3975	SF	\$606,599.48	1.59%	\$153	85	\$172
2	MAYPORT FL NS	\$1,701,447	\$68,670	16810	SF	\$2,173,941.47	4.04%	\$129	92	\$123
3 *	BEAUFORT SC MCAS	\$959,999	\$258,777	8113	SF	\$1,415,710.95	26.96%	\$174	90	\$174
4	CHERRY POINT NC	\$1,609,137	\$2,663	17200	SF	\$2,024,704.65	0.17%	\$118	88	\$123
5 *	CAMP LEJEUNE NC	\$651,436	\$69,049	6000	SF	\$1,146,083.16	10.60%	\$191	90	\$191
6 *	EARLE NJ NWS	\$1,033,000	\$149,449	8500	SF	\$1,604,756.39	14.47%	\$189	92	\$179
7	CAMP PENDLETON CA	\$1,497,000	\$4,887	10500	SF	\$1,890,644.94	0.33%	\$180	86	\$198
8	LONG BEACH CA NS	\$918,700	\$165,539	10000	SF	\$1,418,097.02	18.02%	\$142	86	\$156
9	MONTEREY CA NPGS	\$1,615,000	\$262,814	14000	SF	\$2,463,686.91	16.27%	\$176	91	\$172
10 *	BARSTOW CA MCLB	\$706,100	\$61,032	5625	SF	\$982,835.54	8.64%	\$175	89	\$179
11	TUSTIN CA MCAS	\$2,026,000	\$224,388	18900	SF	\$2,299,872.83	11.08%	\$122	89	\$125
12	EL TORO CA MCAS	\$2,225,000	\$174,814	23380	SF	\$2,936,312.13	7.86%	\$126	89	\$129
13	PORT HUENEME CA	\$1,193,800	\$445,234	15000	SF	\$2,094,490.91	37.30%	\$140	89	\$143

Table 6 Original Design/Bid/Build Projects (CONT.)

PROJECT NUMBER	ACTIVITY LOCATION	CONTRACT AWARD AMOUNT	TOTAL VALUE OF MOD	SCOPE	UNIT OF MEASURE	COMPLETED TOTAL COST	NORMALIZED COST GROWTH	COST / SF	YEAR OF AWD	COST / SF ADJ FOR INFLATION	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	
14	QUANTICO VA	\$3,525,396	\$47,310	18750	SF	\$3,289,402.99	1.34%	\$175	92	\$167	
15	WASH DC COMNVDIST	\$3,870,000	\$119,682	23000	SF	\$4,541,048.55	3.09%	\$197	94	\$173	
16	KINGS BAY GA NSB	\$1,197,700	\$30,919	10300	SF	\$1,320,008.44	2.58%	\$128	94	\$112	
17 *	SAN DIEGO CA NS	\$877,765	\$51,640	6565	SF	\$1,448,223.62	5.88%	\$221	88	\$231	
18	SAN DIEGO CA NTC	\$1,920,000	\$153,106	20400	SF	\$2,947,868.25	7.97%	\$145	91	\$141	
19	SAN DIEGO CA NSB	\$2,961,747	\$396,570	20670	SF	\$4,433,092.47	13.39%	\$214	90	\$214	
20	TWENTYNINE PALMS CA	\$1,647,775	\$184,275	13480	SF	\$2,376,544.63	11.18%	\$176	93	\$160	
							AVG COST GROWTH				
							AVERAGE COST / SF	\$152			
							AVERAGE COST / SF AFTER INFLATION				\$159

* Project selected for comparison sample

Table 7 Design/Bid/Build Research Sample

PROJECT NUMBER (1)	ACTIVITY LOCATION (2)	CONTRACT AWARD AMOUNT (3)	TOTAL VALUE OF MOD (4)	SCOPE (5)	UNIT OF MEASURE (6)	COMPLETED TOTAL COST (7)	NORMALIZED COST GROWTH (8)	COST / SF (9)	YEAR OF AWD (10)	COST / SF ADJ FOR INFLATION (11)
1	CHASE FIELD TX NAS	\$484,645	\$7,729	3975	SF	\$606,599.48	1.59%	\$153	85	\$172
2	BEAUFORT SC MCAS	\$959,999	\$258,777	8113	SF	\$1,415,710.95	26.96%	\$174	90	\$174
3	CAMP LEJEUNE NC	\$651,436	\$69,049	6000	SF	\$1,146,083.16	10.60%	\$191	90	\$191
4	EARLE NJ NWS	\$1,033,000	\$149,449	8500	SF	\$1,604,756.39	14.47%	\$189	92	\$179
5	BARSTOW CA MCLB	\$706,100	\$61,032	5625	SF	\$982,835.54	8.64%	\$175	89	\$179
6	SAN DIEGO CA NS	\$877,765	\$51,640	6565	SF	\$1,448,223.62	5.88%	\$221	88	\$231
AVG COST GROWTH										
AVERAGE COST / SF										\$184
AVERAGE COST / SF AFTER INFLATION										\$188

4.3 Project Cost Information and Analysis

As shown in Tables 5 and 7 above in column 11, a comparison of mean values for the Design/Build sample and Design/Bid/Build sample of construction projects shows an average cost saving of approximately \$20 / SF for projects delivered by the Design/Build method (\$167 vs. \$188 respectively). Although this is a monetarily significant cost savings, a simple comparison of these values would not be appropriate until the statistical significance of the results are confirmed. Because the available sample size of comparison projects is relatively small, an evaluation must be completed to confirm the fact that the sample means observed are statistically significant. To accomplish this, a t-test was used to compare the sample means. This test confirms statistical significance through the use of a null hypothesis. Analysis of the null hypothesis within the parameters of the test, confirms statistical significance, enabling evaluation of the sample in terms of NAVFAC projects within the study's size and scope.

The computations included within the t-test are useful in that they establish a statistically based probability for the occurrence of what is known as a Type I or a Type II error (Miller, 1997). Figure 9 below describes how Type I and Type II errors are defined for a specific null hypothesis (H_0).

Reality	Decision	
	Reject H_0	Accept H_0
H_0 true	Type I error	Correct
H_0 false	Correct	Type II error
Type I error: Reject a true H_0 Type II error: Accept a false H_0		

Figure 9 Defining a Type I and II Statistical Error (Miller, 1997)

For the test, the author assumed a null hypothesis that the sample means of the Design/Build and Design/Bid/Build samples were actually statistically equal ($H_0: \mu_{D/B} = \mu_{D/B/B}$). Table 8 below is a display of results from a t-test analysis for the data in terms of project cost data. The computed probability for a Type I or II error

Table 8 Statistical Test of Means for Project Cost /SF

t-Test: Two-Sample Paired (Level of Significance = 8.5%)		
	Variable 1	Variable 2
Mean	\$167.15	\$187.84
Variance	199.66	489.36
Observations	6	6
Pooled Variance	344.51	
Hypothesized Mean Difference	0	
df	10	
t Stat	-1.93	
P(T<=t) two-tail	8.23%	
t Critical two-tail	1.91	

(P(T<=t) two-tail) is 8.23 percent. Therefore, we can reject the null hypothesis with a statistical probability of 92 percent (1.0 - 0.0823), confirming the statistical significance of the average cost savings per square foot. In other words, the sample means are significantly different.

An additional review of the specific cost information above (see Tables 5 and 7, column 9) shows that the Design/Build contracts selected for this sample have a normalized average cost growth of approximately 6.5 percent after contract award. In comparison, the Design/Bid/Build project sample yielded an average cost growth of approximately 11.4 percent. This 4.9 percent average cost savings between the two methods is quite substantial and would provide a notable savings to the customer after project award. Once again, however, because the available sample size of comparison projects is relatively small, a t-test must be performed to determine the significance of the findings ($H_0: \mu_{D/B} = \mu_{D/B/B}$). Table 9 below shows the results of a two-tailed t-test computed for the samples. The computed probability for a Type I or II error ($P(T \leq t)$ two-tail) is 30.42 percent. Therefore, we can reject the null hypothesis with a statistical a probability of approximately 70 percent, confirming that there is some , though not conclusive statistical significance to the discovered reduction in project cost growth.

Table 9 Statistical Test of Means for Project Cost Growth

t-Test: Two-Sample Assuming Equal Variances (Level of Significance = 30.5%)		
	Variable 1	Variable 2
Mean	6.51%	11.36%
Variance	0.0043	0.0077
Observations	6	6
Pooled Variance	0.0060	
Hypothesized Mean Difference	0	
df	10	
t Stat	-1.0830	
P(T<=t) two-tail	30.42%	
t Critical two-tail	1.0812	

4.4 Project Modification Information

Modification information for the contracts extracted from FIS for the research samples is presented below in Tables 9 and 10. It is important to note that administrative modifications were excluded from the count totals because of their contractual insignificance. These modifications are typically used to amend things such as a contractor's change of address or update a contract's prevailing wage rate as required by law and are not an indication of substantive changes required for design or construction purposes.

A comparison of the modification information (see Tables 9 and 10, columns 3 and 4) revealed an average modification rate of 7 per contract for the Design/Build projects versus 10 per contract for the Design/Bid/Build projects within the data sample. Although this is an encouraging statistic, the 30 percent reduction is somewhat overshadowed by a remarkable 75 percent reduction in the average number of design related modifications (1 per contract for Design/Bid/Build versus 4 per contract for Design/Build).

The use of the Design/Build method failed to impact or reduce the number of claims for the evaluated data sample. Although the data are inconclusive, it may have even increased the claims environment. Of the 6 projects contained within the Design/Build sample, 2 had claims associated with their projects. No claims were associated with the projects contained within the Design/Bid/Build sample (see Tables 9 and 10, column 5).

Table 10 Design/Build Research Sample: Modification Information

PROJECT NUMBER (1)	ACTIVITY LOCATION (2)	MODIFICATIONS (3)	DESIGN RELATED MODIFICATIONS (4)	CLAIMS (5)
1	BRUNSWICK ME NAS	13	3	
2	NEW LONDON CT NSB	12	0	
3	KITTERY ME	8	1	1
4	BREMERTON WA	1	1	
5	FALLON NV NAS	0	0	1
6	DAHLGREN VA	7	1	
AVERAGE # OF MODIFICATIONS		7	1	TOTAL 2

Table 11 Design/Bid/Build Research Sample: Modification Information

PROJECT NUMBER (1)	ACTIVITY LOCATION (2)	MODIFICATIONS (3)	DESIGN RELATED MODIFICATIONS (4)	CLAIMS (5)
1	CHASE FIELD TX NAS	3	0	0
2	BEAUFORT SC MCAS	8	2	0
3	CAMP LEJEUNE NC MCB	10	1	0
4	EARLE NJ NWS	12	7	0
5	BARSTOW CA MCLB	4	0	0
6	SAN DIEGO CA NS	23	15	0
AVERAGE # OF MODIFICATIONS		10	4	TOTAL 0

4.5 Project Time Calculations

Tables 11 and 12 below are summaries of the project time involved for design and construction of the selected facilities. Data retrieved from FIS for the design start date and design completion date and the construction award date and beneficial occupancy date were used to determine the total calendar days for each respective function. Although the construction dates were relatively easy to obtain within the system, the design information was unavailable for two of the projects within the Design/Bid/Build sample. Attempts were made to obtain this information from the design project managers for these projects but the information was not available. Therefore, the mean design time per SF was determined from the remaining 4 projects within the sample and was applied to the square footage for these projects to estimate their duration.

Analysis of these data reveal that the Design/Build projects included within this study are completed approximately 8 months quicker than the Design/Bid/Build projects. Once again, because the available sample size of comparison projects is relatively small, a statistical evaluation of the sample means through the use of a t-test was performed to determine the statistical significance of the findings. Table 13 below shows the results of a two-tailed t-test computed for the samples ($H_0: \mu_{D/B} = \mu_{D/B/B}$). The computed probability for a Type I or II error ($P(T \leq t)$ two-tail) is 2.30 percent. Therefore, we can reject the null hypothesis with a statistical a probability of approximately 98 percent, confirming the significance of the difference in sample means. In other words, the Design/Build sample projects are completed faster than the Design/Bid/Build projects.

Table 12 Design/Build Research Sample: Time Analysis

PROJECT NUMBER	ACTIVITY LOCATION	DESIGN TIME CALENDAR DAYS	CONSTRUCTION TIME CALENDAR DAYS	TOTAL
(1)	(2)	(3)	(4)	(5)
1	BRUNSWICK ME NAS	240	328	568
2	NEW LONDON CT NSB	240	471	711
3	KITTERY ME	240	578	818
4	BREMERTON WA	118	421	539
5	FALLON NV NAS	118	332	450
6	DAHLGREN VA NSWCTR DIV	350	625	975
AVERAGE		218	459	677
			MONTHS	22.5

Table 13 Design/Bid/Build Research Sample: Time Analysis

PROJECT NUMBER	ACTIVITY LOCATION	DESIGN TIME CALENDAR DAYS	CONSTRUCTION TIME CALENDAR DAYS	TOTAL
(1)	(2)	(3)	(4)	(5)
1	CHASE FIELD TX NAS	362	658	1020
2	BEAUFORT SC MCAS	500	476	976
3	CAMP LEJEUNE NC MCB	619	325	944
4	EARLE NJ NWS	304	541	845
5 *	BARSTOW CA MCLB	347	724	1170
6 *	SAN DIEGO CA NS	405	284	730
AVERAGE # OF MODIFICATIONS		423	501	924
* Design information for these projects was not available within FIS. The quantities were estimated as described above.			MONTHS	30.8

Table 14 Statistical Test of Means for Project Time Duration

t-Test: Two-Sample Paired		
	Variable 1	Variable 2
Mean	677	948
Variance	38458.97	22702.16
Observations	6	6
Pooled Variance	30580.56	
Hypothesized Mean Difference	0	
df	10	
t Stat	-2.68	
P(T<=t) two-tail	2.30%	
t Critical two-tail	2.23	

4.6 Subjective Comments Concerning the use of Design/Build

In the course of collecting missing data needed for the completion of this study, the author contacted 8 design project managers, construction engineers and construction inspectors involved in the administration of the projects and asked them a series of subjective questions. The vast majority of the comments were very positive, however, some negative comments were received. A selective list of these comments is presented below for review.

Positive Comments:

“I would highly recommend D/B as a contract vehicle to our customers. Our customers really loved it because it got them very involved early in the project while we were establishing project requirements.”

“The entire process facilitates communications between the various stake-holders on the project. The submittal process for the job was very smooth, because the majority of coordination resides with the contractor. Submittals reviewed by the government were also turned around very quickly because we worked well together as a team.”

“The process places a lower administrative burden on the ROICC during the construction phase. There is significantly more time required up front during the design phase but this is good in my opinion because it gets the ROICC involved early in the project and we’re not picking it up cold. This provides some continuity for us that we don’t have on our other projects and we really seem to have less changes of the job.”

“I have a very positive opinion concerning the process if its done right with lots of up front planning.”

“Although Design/Build takes allot of time up front with the contractor (with design meetings) it really helped us manage the job. Constructability and value engineering were a key focus of the entire project team.”

“I feel that Design/Build saved us at least 1 year in the delivery of the project.”

Negative Comments:

“Design/Build can really be a “mixed bag”. If the IFB is not done well, problems surface early and can delay the start of things. My experience is that once these jobs get out of the dirt they go great.”

“A lot of time must be spent explaining to the customer exactly what they are going to get at completion. This can be very difficult to do.”

“Design/Build will not eliminate problems that occur with our preparation of the contract. The IFB must be very accurate. If proper site investigations are not done, you are going to have problems.”

“I felt like the EFD was not very responsive to our comments concerning the IFB packet. I knew that there were some problems that would resurface later in the job.”

The results of this survey indicate that the majority of those interviewed were very positive about the use of Design/Build contracts and were satisfied with their experience. All negative comments received seemed to center around the preparation of the IFB and pre-project planning aspects of the jobs which should improve as NAVFAC gains more experience with this contract type.

5.0 CONCLUSIONS

5.1 Conclusions To Be Drawn From This Study

As pressure continues to grow for the use of innovative facility procurement methods within NAVFAC, the use of Design/Build contracts will steadily increase. NAVFAC's progress at implementation of Design/Build projects within their Military Construction program, although relatively small, is showing positive results. As experience with this method of contract delivery continues to expand at the EFD level, further quantifiable benefits should continue to emerge. Design/Build is being received at the field level with great enthusiasm and its use should be expanded to deliver projects in situations where its benefits can be capitalized upon.

The data collected by the author, together with the success Design/Build is enjoying on other public and private sector projects, indicates the method is an effective tool for delivering projects quickly and at a reduced cost when compared to conventional methods of procurement. Specific conclusions as a result of this study are as follows:

- The use of Design/Build contracts within a selected sample of NAVFAC's MILCON program is significantly reducing combined design and construction costs. A \$20 per square foot (SF) cost savings was realized by NAVFAC on child care facilities of similar size and scope (approximately 6000 SF) between fiscal years 1987 and 1994. Finally, the statistical comparison of sample means for the projects included within this study show the cost / SF for Design/Build projects is less than that for Design/Bid/Build at a statistical level of significance of 92 percent.

- Design/Build contracts, within a selected sample of NAVFAC's MILCON program, show a reduction in cost growth by modification of approximately 4.9 percent. The comparison of sample means for the project's completion time included within this study support this reduction in cost growth but only at a statistical level of significance of 70 percent.
- Design/Build contracts within NAVFAC's MILCON program are being completed approximately 8 months earlier than similar Design/Bid/Build projects. The comparison of sample means for the project's completion time included within this study support this early completion at a statistical level of significance of 98 percent.
- The Design/Build projects contained within the sample for this study show a 30 percent reduction in the number of modifications and a 75 percent reduction in the number of design related modification over similar Design/Bid/Build projects. Because of the small sample size and spread of the collected data, these figures cannot be determined as statistically significant.
- A subjective analysis of survey data for the study indicates that the majority of those interviewed were very positive about the use of Design/Build contracts within NAVFAC and were satisfied with their experience. The negative comments received seemed to focus on problems with IFB preparation and pre-project planning issues and should decline as NAVFAC gains more experience with this contract method.

The results of this study indicate that NAVFAC is successfully implementing its Design/Build contracting strategy and obtaining positive results with regards to its

associated cost and time savings on child care centers in the range of 6000 SF. As experience is gained in administering other Design/Build contracts, positive results similar to those identified within this study should emerge within projects properly selected for procurement by the Design/Build method.

6.0 RECOMMENDATIONS

6.1 Recommendations Based on Analysis of this Research

The results of this study indicate that NAVFAC has successfully implemented the use of Design/Build contracts for certain types of projects within their Military Construction program. To assist in furthering efforts towards Design/Build's continued success and its expanded use, the following recommendations are offered for consideration:

- Based on this study, NAVFAC should procure child care facilities in the 6000 SF range, through Design/Build as often as possible.
- NAVFAC should expand its efforts towards the development of guideline specifications and standard contract documents for Design/Build projects. Great progress has been made at NAVFAC's North East Engineering Field Activity towards this effort and this information should be shared with other organizations.
- A lessons-learned data base of administrative success stories and challenges should be maintained and made available for access by the various EFD's and EFA's.
- The development of a just-in-time training program for administrative personnel preparing to engage in Design/Build contracts developed at headquarters level would be helpful in standardizing control of these projects.

- NAVFAC should develop specific criteria to monitor and evaluate the success of Design/Build contracts, capturing this data within FIS. The current contract information being entered into the system is oriented more towards traditional procurement making the data analysis of comparison studies difficult. Information such as the contractor's construction release date, and payments for design services accomplished by the Design/Build contractor should be captured for analysis.
- NAVFAC should reevaluate the data entry procedures for the FIS database. Currently, information necessary for analytical study of completed projects is unavailable because it has not been entered. Information such as the Original Legal Contract Completion Date, and the Actual Contract Completion Date are vital to the analytical time analysis of completed projects. Establishing these fields as mandatory (preventing further progress within the program until data is entered) or outlining an audit process for project information at the completion of construction should be accomplished. Design project time information is also not being documented in a usable format. Individual design start dates for numerous projects conducted under indefinite quantity delivery contracts should be documented clearly.
- NAVFAC should use FIS data to evaluate the effectiveness of Design/Build contracts in a continuous or "real time" mode. Evaluations such as this one are often more difficult to complete because they are done years after the projects are complete.

6.2 Recommendations for Future Research.

This study considered the only data sample of similar projects available within NAVFAC's Military Construction program, completed child care facilities. As new Design/Build program projects are completed, similar studies of projects constructed with comparable size and scope should be conducted. NAVFAC currently has 7 Bachelor Enlisted Quarters scheduled for completion by Fiscal Year 1997. This set of projects could be easily compared to an extremely large sample of Design/Bid/Build projects for analysis.

Appendices

Appendix A: NAVFAC's Programmed Design/Build Projects

MILITARY CONSTRUCTION PROGRAM
 PROJECTS USING DESIGN/BUILD METHODS
 (DSGNBLD) JAN 95

FY	PNO	ACTIVITY	DESCRIPTION	PROGRAM AMOUNT (\$000)	AWARD DATE	CMPL DATE	NOTES
85	317	NEWPORT NETC	FAMILY SERVICES CTR	690	86/06/11	67/07/11	
85	819	CHARLESTON NWS	POTABLE WATER STOR TANK	1630	05/07/30	86/10/16	
86	210	CECIL FIELD NAS	AIR COMBAT TRNG RANGE	1200	87/07/01	88/02/12	
86	421	PORT HUENEME CA NCBC	SEABEE MATL TRANSIT FAC	6960	87/11/09	89/03/01	
86	612	CAMP ELMORE VA MCCD	COMBAT VEHICLE MAINT FAC	715	87/09/04	89/10/10	
86	614	CAMP ELMORE VA MCCD	FLEET MARINE SPT WHSE	3260	67/09/04	89/10/10	
86	179	MIRAMAR CA NAS	BEQ	9200	67/09/01	89/05/02	(1)
87	181	ANNAPOLIS NAVACAD	FIRE STATION	400	87/05/05	88/04/12	
87	905	CAMP PENDLETON CA MCB	BEQ	12300	67/09/01	e9/05/02	(1)
88	356	LITTLE CREEK VA NAVPHBSE	SEALIFT SUPPORT	6600	92/06/03	94/02/08	(2)
88	083	QUANTICO VA MCCOMBDEV CMD	BEQ	2950	68/06/23	69/12/24	(1)
89	368	GREAT LAKES IL PWC	WATER STORAGE TANKS	1930	88/12/23	90/08/19	
90	847	EARLE NJ NWS	FAMILY SERVICES CENTER	570	91/08/08	92/08/08	
90	106	LEMOORE CA NAS	CENTRIFUGE TRAINING FA	2100	92/06/14	93/07/00	(1)
90	995	FALLON NV NAS	CHILD DEVELOPMENT CENT	1000	91/12/03	93/01/17	(1)
90	997	BREMERTON PUGETSND WA NSY	CHILD DEVELOPMENT CENT	1000	91/12/03	93/01/17	(1)
90	993	BRUNSWICK ME NAS	CHILD DEVELOPMENT CTR	1000	90/01/23	91/02/02	
90	991	NEW LONDON CT NSB	CHILD DEVELOPMENT CENT	1000	90/10/23	92/05/13	
90	994	KITTERY ME PORTSMOUTH NSY	CHILD DEVELOPMENT CENT	1000	90/10/23	92/01/01	
90	996	DAHLGREN VA NSWCTR DIV	CHILD DEVELOPMENT CENT	1000	91/09/04	93/03/21	
90	606	SAN DIEGO CA NMC SW REGN	PARKING STRUCTURE	7500	90/10/17	92/08/21	
91	407	NEWPORT RI NETC	CHILD DEVELOPMENT CENT	1700	92/04/15	93/06/24	
92	202	ORLANDO FL NTC	COLD STORAGE WAREHOUSE	2150	92/08/13	93/10/12	(2)
92	175	ORLANDO FL NTC	CHILD DEVELOPMENT CENT	4000	92/11/25	94/02/16	
92	271	PENSACOLA FL FISC	COLD STORAGE WAREHOUSE	5700	93/03/10	94/07/08	(2)
93	297	BREMERTON PUGETSND WA NSY	BEQ	13300	94/12/23	96/07/11	
94	705	ALBANY GA MCLB	CHILD DEVELOPMENT CENT	950	94/09/20	95/09/30	
94	467	JACKSONVILLE FL NAS	BEQ	14500	94/05/26	97/05/25	
94	202	BARBERS POINT HI NAS	CHILD DEVELOPMENT CENT	2710	94/08/18	95/12/26	
94	101	BETHESDA MD NATNAVMEDCEN	CHILD DEVELOPMENT CENT	3300	94/04/12	95/04/23	
94	083T	EVERETT NS	BEQ	7450	94/05/24	95/09/01	(1)
94	156T	LEMOORE NAS	WAREHOUSE	25000	94/08/16	96/06/07	
94	352	NEWPORT NETC	BEQ	7500	94/09/24	96/03/00	
94	012T	PORT HUENEME NCBC	NAVFAC ENGINEERING CTR	9600	94/05/16	95/11/06	(1)
94	276	SAN DIEGO CA MCRD	WAREHOUSE	1130	93/12/30	95/01/21	
94	003	SAN DIEGO CA FISC	FIRE PROTECTION SYSTEM	2270	93/12/30	95/03/01	
94	313	WASHINGTON DC COMNAVDIST	CHILD DEVELOPMENT CENT	1500	95/03/00	96/03/00	
94	9325	WILLOW GROVE NAS	USMC RESERVE CTR	4600	94/07/20	95/08/03	
94	554	PHILADELPHIA NSY	ASBESTOS REMOVAL FAC	2300	95/08/00	96/07/00	
94	5915	PHILADELPHIA NSY	UTILITY RECONFIGURATION	3060	95/11/00	97/05/00	
96	5975	PHILADELPHIA NSY	UTILITY RECONFIGURATION	13000	96/03/00	96/12/00	
95	288	SAN DIEGO CA MCRD	PERSONAL HYGIENE FAC	1090	95/02/00	95/12/00	
95	160T	LEMOORE NAS	BEQ	9100	95/09/00	96/12/00	
95	623	KANEOHE BAY HI MCAS	CHILD DEVELOPMENT CENT	4900	95/04/00	97/05/00	
95	951T	PATUXENT R NAWC	ADMIN HQ FAC	40300	95/01/00	97/07/00	(1)
95	310	PARRIS ISLAND SC MCRD	CHILD DEVELOPMENT CENT	2350	95/04/00	96/01/00	
96	116	PENSACOLA FL NTTC	CHILD DEVELOPMENT CENT	2450	96/04/00	97/06/00	
97	774	CECIL FIELD FL NAS	CHILD DEVELOPMENT CENT	2200	97/01/00	98/05/00	
97	039	WASHINGTON DC NAVSECSTA	CHILD DEVELOPMENT CENT	1270	97/04/00	96/03/00	
97	141	PARRIS ISLAND SC MCRD	SECURITY HEADQUARTERS	1250	97/04/00	98/02/00	
97	387	NEWPORT RI NETC	CHILD DEVELOPMENT CENT	2200	97/04/00	98/06/00	

NOTES: DESIGN/BUILD TYPE
 (1) SOURCE SELECTION
 (2) 2-STEP
 REMAINING ARE NEWPORT

Appendix B: NAVFAC Selection Criteria for Design/Build Projects

**NAVAL FACILITIES
ENGINEERING COMMAND**

DESIGN/BUILD CONSTRUCTION METHODS USED BY NAVFAC

- TWO-STEP SEALED BIDDING
 - USE PERFORMANCE SPEC. TO OBTAIN & EVALUATE PROPOSAL
 - STEP ONE: EVALUATE TECHNICAL PROPOSALS
 - STEP TWO: AWARD TO LOWEST RESPONSIVE/RESPONSIVE BIDDER
- GOOD METHOD TO OBTAIN BENEFIT OF SEALED BIDDING WHEN SEEKING INNOVATIVE SOLUTION TO REQUIREMENTS
- SOURCE SELECTION (COMPETITIVE NEGOTIATION)
 - USE PERFORMANCE SPEC. FOR DESIGN / CONSTRUCTION
 - AWARD BASE ON PRICE & TECHNICAL EVALUATION CRITERIA
 - GOOD METHOD FOR HIGH COST COMPLEX FACILITIES WHERE FACTORS OTHER THAN PRICE ARE TO BE CONSIDERED, (TIMELINESS, QUALITY, INNOVATION, ETC.) OR ESTABLISHED D/B INDUSTRIES (HOUSING)

DESIGN/BUILD CONSTRUCTION METHODS USED BY NAVFAC

- NEWPORT D/B (NEW METHOD STILL BEING TESTED)
 - USE PERFORMANCE SPEC. AND SITE WORK DRAWINGS FOR DESIGN/CONSTRUCTION REQUIREMENTS
 - AWARD TO LOWEST RESPONSIVE /RESPONSIBLE BIDDER
 - NO TECHNICAL PROPOSALS SUITED PRIOR TO AWARD
 - GOOD METHOD FOR SMALL UNSOPHISTICATED TYPE FACILITIES WITH FIRM RQMT'S, E.G. CHILD CARE CENTERS, FAMILY SERVICE CENTERS, WATER STORAGE TANKS, WAREHOUSED, ETC.
 - EXPERIENCING AN AVERAGE COST SAVINGS OF 19% BELOW PROJECT PROGRAMMED AMOUNT

SUMMARY OF POINTS COVERED REGARDING NAVFAC'S D/B PROGRAMS

- D/B PROJECTS RANGE FROM COMPLEX FACILITIES TO LOW TECH FEDERAL USE FACILITIES
- SPECIFIC D/B CONTRACTING METHOD USED IS DEPENDENT UPON THE CHARACTERISTICS OF THE FACILITY AND DECIDED BY THE ACQUISITION TEAM
- OUTLOOK REGARDING CONTINUED USE OF D/B METHOD, IS THAT NAVFAC WILL CONTINUE TO USE VARIOUS D/B CONTRACTION METHODS IN CASES WHERE IT MAKES GOOD BUSINESS SENSE

ADVANTAGES

- ADMINISTRATIVE: (REDIRECTING RESPONSIBILITIES)
 - HOLD ONE PARTY ACCOUNTABLE
 - MINIMIZE CONFLICTS IN RESPONSIBILITY
 - REDUCE PROJECT MANAGEMENT TIME
 - DESIGNER AND BUILDER IN PARTNERSHIP
- TECHNICAL: (PERFORMANCE SPEC.)
 - ENCOURAGES PROCESS INNOVATIONS
 - ALLOWS FOR MOST COST EFFECTIVE DESIGN SOLUTION
 - GREAT SAVINGS ON DETAILS WITHIN CONSTRUCTION DOCUMENTS (BRAND NAMES/PRIVATE PRACTICE)
 - ALLOWS USE OF LOCAL CODES

ADVANTAGES (CONTINUED)

- TIME (TASK & PERFORMANCE SPEC.):
 - REDUCES RESPONSE TIME FOR GETTING THE DESIGN TO THE STREET
 - DO NOT HAVE TO CONTINUE TO REINVENT THE WHEEL
 - PERFORMANCE SPEC.
- COST:
 - ENCOURAGES AND ALLOWS MORE INNOVATION
 - REDUCES DESIGN CHANGE ORDER RATE

DESIGN/BUILD AT NAVFAC

- D/B CONTRACTING STRATEGIES USED BY NAVFAC
 - TWO-STEP SEALED BIDDING
 - SOURCE SELECTION (COMPETITIVE NEGOTIATION)
 - NEWPORT D/B (NEW METHOD)
- SPECIFIC METHOD USED DETERMINED BY ACQUISITION PLANNING PROCESS

MOST COMMON ACQUISITION METHOD USED BY NAVFAC

- SINGLE A-E CONTRACT FOR A PROJECT
 - SYNOPSIS, SLATE, SELECT
 - NEGOTIATE, AWARD
- SINGLE CONSTRUCTION CONTRACT
 - LUMP SUM COMPETITIVE BID (IFB)
 - AWARD TO LOWEST RESPONSIVE, RESPONSIBLE BIDDER

NAVFAC'S USE OF D/B CONSTRUCTION

- LESS THAN THREE PERCENT OF MCON CONSTRUCTION
- MOST PROJECTS HAVE SUFFICIENT TIME FOR DELIVERY BY CONVENTIONAL METHODS
- USE OF D/B:
 - USED FOR DELIVERY OF CERTAIN PROJECTS MANDATED BY CONGRESS
 - USED FOR EXECUTION OF LATE ADD PROJECTS
 - USED TO DEVELOP AND MAINTAIN EXPERTISE IN INNOVATIVE ACQUISITION METHODS

Appendix C: Access Instructions for NAVFAC's Facilities Information System

ACCESSING THE FACILITIES INFORMATION DATABASE

OBTAINING AUTHORIZATION

To obtain authorization to access the database, personnel assigned to independent duty at graduate school must obtain a sponsor within NAVFAC. The author was sponsored by the Director of Facilities Programs and Construction, NAVFAC Code 30. An access request application was then sent to the Data Base Support Branch at NAVFAC, listing the various elements of the system needed for research (see enclosure 1). Upon approval of the application, a CICS FIS 2.0 Password Verification Document was forwarded to the author. This document contained a specific user-id and temporary password.

LOGGING ON TO THE SYSTEM.

FIS 2.0 is organized as an extremely large relational database which is maintained by the Navy on an IBM mainframe computer. The computer is located in Port Hueneme, CA and is operated by the Facilities Systems Office (FACSO) at the Naval Construction Battalion Center. Accessing FIS on the Internet requires the use of an IBM TN3270 terminal emulation program to connect with the mainframe. Although there are a number of emulation programs available, only one program worked effectively because of interface problems. The program is part of the standard package received with Microsoft Windows 3.1 and is called Microsoft Terminal, its filename is terminal.exe and should be located in the windows directory of any computer running Windows 3.1. FACSO's mainframe's Internet IP address is FACSO.CBCPH.NAVY.MIL. Logging on at this address using a TN3270 emulator connects you to the system.

Once communications are established with the mainframe, various system modules can be used. Figure 1 below is a downloaded picture of the various system elements available.

```
Commands available to Telnet users of the FACSO SMS/TCPaces System:

A1 = TSO           DQ = CICS FIS DATAQUERY   R1 = ROSCOE
BB = DENIX         D1 = CICS DEVELOPMENT       SU = CICS SUPMIS
B1 = CICS FIS      F1 = CICS ACCEPTANCE    US = WANG REVERSE LOGON
B3 = CICS PRODUCTION K1 = CICS KEYMASTER   F2 = CICS FIS 2.0

BYE ..... Cause Telnet connection to close.
CLOSE ..... Same as BYE.
END ..... Same as BYE.
QUIT ..... Same as BYE.

Enter Command Or 'HELP':
```

Figure 1. System Commands Available on the Mainframe

The services useful for this study were FIS 2.0, FIS DataQuery and TSO. To log into one of these services within the user simply types the appropriate command (i.e. F2, DQ, A1 etc.) and hits the return key.

USING FIS

After the F2 command is typed into the system, a logon screen appears which queries the user for his password (see Figure 2). Upon completion of this, the user is logged onto FIS and can access the system.

```

          CICS FIS 2.0
    SCHEDULED TIME AVAILABLE: 0400 - 2300 PACIFIC TIME

    USER-ID: ehambz      PASSWORD:      NEW PASSWORD:

*****
* UNAUTHORIZED ACCESS TO THIS U.S. GOVERNMENT COMPUTER SYSTEM AND SOFTWARE *
* IS PROHIBITED BY TITLE 18, U.S. CODE, SECTION 1030, FRAUD AND RELATED *
* ACTIVITY IN CONNECTION WITH COMPUTERS. *
* *
* FOR ASSISTANCE, CONTACT THE FACSO HELP DESK - A/U 551-2555 OR *
* COMMERCIAL (805) 982-2555. *
* *
*****
                                TERMINAL-ID: A03ULT02

INSTRUCTIONS:  ENTER YOUR USER-ID AND PASSWORD.
                OPTIONALLY ENTER A FUNCTION NUMBER AND KEY(S) IF KNOWN.
                WHEN NOT IN USE PLEASE SIGN OFF BY PRESSING PA2.

FN:   KEY:
USERID UNKNOWN FOR APPLICATION F2 - REENTER OR TRY B3      09JUL95 20:19:33

```

Figure 2. Logon Screen for FIS 2.0

FIS has numerous modules which display the project information contained within the database (see Figure 3).

```

1 OF 1                                95JUL09 20:40:49
          FACILITIES INFORMATION SYSTEM                                H4700U00

PROC  MODULE NAME                      PROC  MODULE NAME
A00  MANAGE CONTRACTORS                J00  MANAGE AD BUDGETING
B00  MANAGE PROJECTS/AUTHS             K00  MANAGE FUND ADMN (FA) CONTROL
C00  MANAGE CONTRACTS                  L00  MANAGE FA BUDGETING
D00  MANAGE DESIGNS                    M00  MANAGE FUND USAGE
E00  MANAGE JOB ORDER                   N00  MANAGE PAYROLL/LABOR DIST
F00  MANAGE ENGINEERING CRITERIA        P00  MANAGE WORK PACKAGE/LINKS
G00  MANAGE CONSTRUCTION/ENU/OTHER      W00  MESSAGE BOARD/BATCH CHG RQT
H00  MANAGE HISTORICAL COST ESTIMATE    X00  MANAGE PERSONNEL/WORK CENTER
I00  MANAGE GENERAL LEDGERS             Z00  MANAGE ADMINISTRATION

-----
INSTRUCTIONS:  TO INITIATE A MODULE ENTER THE CORRESPONDING PROC NUMBER.
PROC:  ___  SUC:  __

```

Figure 3 FIS Module Screen

The modules used for this study were the Design, Contracts, and Projects / Auth modules. To initiate a module, a procedure number is entered (i.e. C00, for the contracts module) and a secondary screen listing the various services contained with in the module is displayed (see Figure 4). Once a service is

```
1 OF 1                                95JUL10 11:53:49
CONTRACTS MODULE                       H47C0U00

C01  MANAGE PCO TABLE
C02  MANAGE CONTRACT LOG
C03  MANAGE CONTRACTS
C04  MANAGE AE SLATE/SELECTION
C05  MANAGE BIDDING PROCESS
C06  MANAGE DD 350
C07  MANAGE CONTRACT PROPOSED CHANGES
C09  MANAGE CONTRACT MODIFICATIONS
C10  MANAGE CONTRACT CLAIMS
C11  MANAGE CONTRACT CLOSEOUT
C12  MANAGE TERMINATED CONTRACTS
C14  MANAGE DELIVERY ORDERS
C15  MANAGE CONTRACT OPTIONS
C17  MANAGE CIVIL WORKS CONTRACTS
C35  MANAGE CONTRACT REPORTS

PLEASE ENTER THE NUMBER OF A VALID PROCEDURE FROM THIS MENU
PROC: C00  SVC:
```

Figure 4 Contracts Module Components

selected, the system prompts the user for some identifying information and relational database information associated with the identifying data is displayed. Figure 5 is a download example of construction information (PROC: C03 SVC: 05) for a child care facility constructed by North Div with a Contract # N62472-89-C-0004. All other modules within FIS are used in the same

```

1 OF 1                                95JUL18 11:58:42
                                VIEW CONTRACT STATUS                H47C3U51

USER CODE:      N
CONTRACT NUMBER: N62472 89 C 0004   OR   FUND USAGE NUMBER: 64376

DESCRIPTION:    CHILD DEVELOPMENT CENTER P-993 DESIGN/BUILD
FND USAGE STATUS: COMPLETED
PCO CODE:      022
ACO CODE:      ME.BRUNS
SBSA INDICATOR:
PURPOSE CODE:  CON   PROC TYPE CODE: FP   SA CODE: N
DD 358 CODE:   D
CNT SPECIALIST: MCHENRY, CHARLES T.

CONTRACTOR:    A11406           SHERIDAN CORP.

VIEW CONTRACT:  - SCHEDULE   - FUNDING   - WIP           - CHANGES
                 - CLAIMS    - TERMINATIONS - RELATED CNT
                 - NOTEBOOK - CONTACT LIST

'X' SELECT ITEMS YOU WISH TO VIEW PRESS ENTER OR ENTER A NEW KEY OR EXIT.
PROC: C03  SVC 05

```

Figure 5 FIS View Screen, PROC: C03 SVC: 05

manner. The best way to become familiar with the what FIS can do is to simply experiment with the various modules and evaluate their usefulness. Figure 6 is an example of the _ SCHEDULE view.

```

1 OF 1                                95JUL18 12:03:12
                                VIEW CONTRACT STATUS                H47C3U52
                                (CON/WGT HANDLING)

CONTRACT NUMBER:  N62472 89 C 0004   FUND USAGE NUMBER:  64376

ACO CODE:          ME.BRUNS           IFB ISSUE PLAN:     880901
PERCENT COMPL:    100                IFB ISSUE ACTUAL:   880901
FUNDED ACCRUED:   771,495.67         BID OPEN PLAN:      881001
UNFUNDED ACCRUED: 0.00               BID OPEN ACTUAL:    881001
                                     AWARD ORIG PLAN:    900329
                                     AWARD PLAN:         900129
AWARD AMOUNT:     727,930.00         AWARD ACTUAL:       900123
CURRENT PRICE:    771,495.67         CCD ORIG PLAN:      901229
CWE FOR CONTRACT: 771,495.67         CCD PLAN:           910129
                                     CCD ORIG LEGAL:     910202
EFD PROJECT MGR:  9AD3              CCD LEGAL:          910202
                                     BOD PLAN:           910202
BOD ORIG PLAN:    910122            BOD ACTUAL:         901217
ASB REVIEWED:    910122            FINAL RELEASE:      910517
TERMINATION APUL:                                     TERMINATION:

PRESS ENTER TO CONTINUE.
PROC: C03  SVC: 5

```

Figure 6 Schedule View Screen

USING DataQuery

FIS's DataQuery (DQ) service is also an excellent tool for selecting projects for analysis. By constructing a query program, users can request specific information and display it in serial fashion. DataQuery was used in two principle ways during this study. First, it was used to identify all child care facilities completed by NAVFAC after calendar year 1987 and then it was used to gather construction completion and modification information on specific contracts. The following paragraphs outline how DQ is accessed and how data queries are constructed within it.

After connecting to the host computer as described above, the system command DQ is entered to logon. The main menu for DQ then appears and the user is allowed to select a desired function (see Figure 7). The DIRECTORIES function and the CREATE function were the two principally used for this study. The Directories

```
-----DQ240
DATAQUERY:  MAIN MENU

ENTER THE NUMBER OF THE DESIRED FUNCTION ===>  _

 1. DIRECTORIES      - Lists of Queries, Terms, Tables, and Saved Sets
 2. CREATE           - Query, Dialog or Term creation
 3. GUIDE            - Structured query creation
 4. ADMINISTRATION  - DATAQUERY system management
 5. HELP             - Display Help Information
 6. OFF              - DATAQUERY session termination
```

Figure 7 DataQuery Main Menu

function lists all the saved queries and relational database tables accessible by the user. Existing queries stored within the system for public use and individual private query programs (created by a user) are accessed by entering a 1 on this screen.

A directory selection menu (Figure 8) focuses the users request to a specific area. Figure 8 below, calls up the personal DataQuery archive of the author which is displayed in Figure 9.

```

-----DQA00
DATAQUERY:  DIRECTORY SELECTION
-----

_ Queries and Terms      - List all queries and terms accessible to you.
_ Queries Only          - List queries accessible to you.
_ Terms Only            - List terms accessible to you.
_ Dialogs               - List Dialogs accessible to you.
_ Public Queries        - List public queries.
x Queries and Terms     - List queries and terms created by user:
                        chambr
-----

_ Tables                 - List the tables accessible to you.
                        Start Table Directory with Letter:  _

_ Saved Sets            - List the saved sets.

-----
<PF1> HELP              <PF2> RETURN
  
```

Figure 8 Directory Selection Input Menu

```

-----DQA30
DATAQUERY:  DIRECTORY OF QUERIES AND TERMS      START WITH:
-----

```

QUERY NAME	TYPE	CREATED	USED	DESCRIPTION
AUT	QUERY	06/15/95	06/15/95	DATA; CONTRACTS W/O MODS
COMP1	QUERY	05/17/95	05/22/95	DATA CHILD CARE CONTRACTS
COMP2	QUERY	05/17/95	05/22/95	DATA CHILD CARE CONTRACTS
COMP3	QUERY	05/17/95	05/22/95	DATA CHILD CARE CONTRACTS
COMP4	QUERY	05/17/95	05/22/95	DATA CHILD CARE CONTRACTS
DATA1	QUERY	04/18/95	04/18/95	THESIS1
FLAT1	QUERY	05/22/95	07/09/95	N DIU NON-RMS FLAT FILES
FLAT1B	QUERY	05/22/95	05/24/95	B DIU NON-RMS FLAT FILES
FLAT1BEQ	QUERY	05/25/95	05/26/95	N DIU NON-RMS FLAT FILES
FLAT1DESIGN	QUERY	05/26/95	05/26/95	N DIU NON-RMS FLAT FILES
FLAT11	QUERY	05/22/95	05/24/95	LANT DIU NONRM FLAT FILES
FLAT111	QUERY	06/08/95		N DIU NON-RMS FLAT FILES
FLAT12	QUERY	05/22/95	05/24/95	H FILES NON-RMS FLAT FILES F

```

-----
==>
<PF1> HELP              <PF2> RETURN          <PF3> EXECUTE          <PF4> EDIT
<PF5> NOT USED          <PF6> DELETE           <PF7> BACKWARD         <PF8> FORWARD
<PF9> SUBMIT            <PF10> EXTENDED DEF   <PF11> NOT USED        <PF12> RIGHT
  
```

Figure 9 Private DataQuery Listing of the Author

New data queries can be added to the library by choosing either Function 2 or 3 in the DataQuery Main Menu shown in Figure 7. Function 3 provides a Guide to assist the user with step by step instructions for query creation. However, once experience is gained with the programming language, Function 2, the regular creation function allows for quicker query development. Figure 10, is an example of one of the many Data Queries constructed by the author to down load construction data. This DataQuery finds all FIS records from NAVFAC's Northern Division, with the specific contract numbers, obtaining basic contract information by relating two data files with a common data element. Because this DataQuery is a public query it can be accessed by any user authorized to use the system.

```

-----DD010
DATAQUERY:  EDITOR
-----
NAME:          FLAT1                                TYPE: QUERY  STATUS: PUBLIC
DESCRIPTION:   N DIU  NON-RMS FLAT FILES
.....+.....1.....+.....2.....+.....3.....+.....4.....+.....5.....+.....6.....+.....7.....+
...
===== T O P =====
01 FIND ALL NON-RMS-BAS-FFL
02 WITH USR-CDE EQ 'N' AND CNT-NUM EQ 'N6247287C0348', 'N6247287C0051'
03 'N6247289C0011', 'N6247289C0004', 'N6247289C0005', 'N6247291C0009'
04 RELATED BY CNT-NUM TO NON-RMS-SUB-FFL WITH FU-MOD-AMD-NUM EQ 'PH' OR 'AH'
05 PRINT      TITLE1 'FLAT FILE INFORMATION'
06           NON-RMS-BAS-FFL CNT-NUM
07           'CNT-NUM'
08           NON-RMS-BAS-FFL AUT-NUM
09           'AUT-NUM'
10           USR-CDE
11           NON-RMS-BAS-FFL CNT-UIC
-----
<PF1> HELP      <PF2> RETURN    <PF3> EXECUTE   <PF4> SAVE
<PF5> DIALOG DEF <PF6> DELETE   <PF7> BACKWARD  <PF8> FORWARD
<PF9> UPDATE    <PF10> UALIDATE  <PF11> RIGHT/LEFT <PF12> CREATE MODE

```

Figure 10 FIS DataQuery to Assemble Contract Data for Specific Northern Division Contracts

Once the DataQuery library is open (Figure 9), various program queries can be executed by highlighting the desired program and selecting the <PF3> key. PF keys are simulated in this program by striking the escape key + the required # (i.e. ESC +

3, for <PF3>). An on-line execution screen appears as shown in Figure 11, which is initiated by striking the <PF3> key strokes.

```
-----DQE10
DATAQUERY:  ONLINE EXECUTION
-----
EXECUTE QUERY NAMED => ACTIVE-QUERY

EXECUTE STEP                The first query step to execute
X SELECTION                 - Read and collect the data
- COMPUTATION              - Perform the user defined calculations
- SORTING                  - Order the collected data
- REPORTING                - Produce the report

REPORT FORMAT               The report format
X COLUMNAR                 - Show the data arranged one row per line
- LIST                     - Show the data arranged one row per page

REPORT DESTINATION         The destination for the report
X VIDEO TERMINAL           - Produce the report on the terminal
- NETWORK PRINTER _____ - Produce the report on a network printer
- SYSTEM PRINTER           - Produce the report on the system printer

-----
<PF1> HELP      <PF2> RETURN    <PF3> EXECUTE    <PF4> TOTALING OPTIONS
```

Figure 11 DataQuery On-Line Execution Screen

FIS returns the database information meeting the general requirements of the DataQuery to a view screen as shown in Figure 12. The information retrieved usually exceeds the size of this screen and so the PF7, PF8, PF11 and PF12 keys are used to scroll through the data not presented

=> submit

07/09/95
21:19:42

NAUFACENCOM DO FIS 2.0
FLAT FILE INFORMATION

PAGE 1A
DETAIL

CNT-NUM	AUT-NUM	USR-CDE	CNT-UIC	CNT-FY
N6247287C0051	002612	N	N62472	87
N6247287C0051	002612	N	N62472	87
N6247287C0051	002612	N	N62472	87
N6247287C0051	002612	N	N62472	87
N6247287C0051	002612	N	N62472	87
N6247287C0348	003702	N	N62472	87
N6247287C0348	003702	N	N62472	87
N6247287C0348	003702	N	N62472	87
N6247287C0348	003702	N	N62472	87
N6247287C0348	003702	N	N62472	87
N6247287C0348	003702	N	N62472	87
N6247287C0348	003702	N	N62472	87
N6247287C0348	003702	N	N62472	87

MORE

----- =>
<PF1> HELP <PF2> RETURN <PF3> TOTALS ONLY <PF4> DETAIL
<PF5> NO TOTALS <PF6> STATS <PF7> BACKWARD <PF8> FORWARD
<PF9> GRAPH <PF10> SEND <PF11> LEFT <PF12> RIGHT

Figure 12 FIS Information Retrieved through the use of a DataQuery

After data was retrieved from FIS through the use of a DataQuery, it was often necessary to save the information and convert it to a form in which it could be analyzed. The author accomplished this by exporting the contents of the needed DataQuery to a TSO dataset stored on the mainframe computer. By typing Submit at the command prompt of the information screen shown in Figure 12, a set of batch execution screens appear (see Tables 13 and 14) which allow the user export the information to a TSO dataset and name it.

```
=>
To send EMAIL report press PF4 SEND before SUBMIT
-----DOE40
DATAQUERY: BATCH EXECUTION
-----
Enter name of query to submit:      ACTIVE-QUERY
Select the type of execution:      X Immediate
                                   _ Defer execution until time __ : __

Enter the name of the JCL member to use: EXPJCL
Select the report type:            X Detail and totals
                                   _ Detail only (no totals)
                                   _ Totals only (summary)
                                   X Suppress report

Enter the name for an output set to export print data to a sequential file
or leave blank for no export:     FILE B_____
Select the export output type:     _ Detail
                                   _ Totals

-----
<PF1> HELP      <PF2> RETURN      <PF3> SUBMIT      <PF4> SEND EMAIL REPORT
```

Figure 13 Batch Execution Screen for TSO Export

```
=>
SCROLL VALUES WITH PF7 OR PF8 AND CHANGE THEM IF DESIRED FOR THIS EXECUTION
-----DOEX0

EXPORT JCL PROC

ENTER YOUR USERID, DONAME, AND SPACE ALLOCATION
USERID=OHANBR,DONAME=TESTFILE,SPACE=5

- LAST PAGE -----
<PF1> HELP           <PF2> RETURN       <PF3> CONTINUE     <PF4> NOT USED
<PF5> RANGE/LIST    <PF6> NOT USED     <PF7> BACKWARD    <PF8> FORWARD
```

Figure 14 Batch Execution Screen for TSO Export

Once these screens are completed and continued (<PF3>), the dataset is saved within TSO and is available for downloading.

USING TSO

Table 15 below is an example of the logon screen for FACSO's Time Sharing Option (TSO) program which controls the mainframe computer. By typing A1 after connecting to the mainframe, TSO can be accessed and used to preview any

```
----- TSO/E LOGON -----
PF1/PF13 ==> Help   PF3/PF15 ==> Logoff   PA1 ==> Attention   PA2 ==> Reshow
You may request specific HELP information by entering a '?' in any entry field.
ENTER LOGON PARAMETERS BELOW:                RACF LOGON PARAMETERS:

USERID    ==> OHAMBR
PASSWORD  ==>
NEW PASSWORD ==>
PROCEDURE ==> @FIRST
GROUP IDENT ==>
ACCT NMBR ==> 021000
SIZE      ==> 4096
PERFORM   ==>
COMMAND   ==>

ENTER AN 'S' BEFORE EACH OPTION DESIRED BELOW:
-NOMAIL      -NONOTICE      -RECONNECT      -OIDCARD
```

Figure 15 TSO Logon Screen

ASCII text, delimited files exported from the DataQuery section of FIS. By typing the command DSAT at the screens ready prompt, a index of all the users datasets is displayed with their associated filenames (see Figure 16). These filenames

READY									
DSAT									
SERIAL	ALLOC	FREE	EX	DSORG	-DCB	ATTRIBUTES-	CR.	DATE	-DSNAME-
TS0902	1	0	1	A-PS	UB	4096	4088	05/11/95	OHAMBR.BACHENLQ.DATA
TS0904	1	0	1	A-PS	UB	4096	4088	05/12/95	OHAMBR.BEQCOMPA.DATA
TS0904	1	0	1	A-PS	UB	4096	4088	05/12/95	OHAMBR.CHILDCON.DATA
TS0902	1	0	1	A-PS	UB	4096	4088	05/12/95	OHAMBR.COLDCOMP.DATA
TS0902	1	0	1	A-PS	UB	4096	4088	05/17/95	OHAMBR.COMP1111.DATA
TS0902	1	0	1	A-PS	UB	4096	4088	05/17/95	OHAMBR.COMP2222.DATA
TS0904	1	0	1	A-PS	UB	4096	4088	05/17/95	OHAMBR.COMP3333.DATA
TS0903	1	0	1	A-PS	UB	4096	4088	05/17/95	OHAMBR.COMP4444.DATA
TS0901	1	0	1	A-PS	UB	4096	4088	05/12/95	OHAMBR.DBEQCONT.DATA
TS0903	1	0	1	A-PS	UB	4096	4088	05/12/95	OHAMBR.DCHILDCO.DATA
TS0904	1	0	1	A-PS	UB	4096	4088	05/12/95	OHAMBR.DCOLDCON.DATA
TS0904	1	0	1	A-PS	UB	4096	4088	05/12/95	OHAMBR.DFAMCONT.DATA
TS0903	1	0	1	A-PS	UB	4096	4088	05/12/95	OHAMBR.DRENAND1.DATA
TS0904	1	0	1	A-PS	UB	4096	4088	05/12/95	OHAMBR.FAMCOMPA.DATA
TS0904	3	0	1	A-PS	FBM	4256	133	06/14/95	OHAMBR.H4082R01.DATA
TS0902	4	3	1	A-PO	FB	9040	80	05/11/95	OHAMBR.ISPF.ISPPROF
TS0903	1	0	1	A-PS	UB	4096	4088	05/24/95	OHAMBR.PTESTB01.DATA
TS0903	1	0	1	A-PS	UB	4096	4088	05/24/95	OHAMBR.PTESTC01.DATA
TS0904	1	0	1	A-PS	UB	4096	4088	05/24/95	OHAMBR.PTESTL01.DATA
TS0904	1	0	1	A-PS	UB	4096	4088	06/08/95	OHAMBR.PTESTNNN.DATA

XXXX

Figure 16 Archived TSO Dataset Listing for the Author

can be used with the TSO LIST command to preview the dataset in its text delimited form prior to downloading (see Table 17). This shows exactly how the file will be transferred when the mainframe is accessed by a File Transfer Protocol (FTP) program to transfer data. Although there are many FTP programs available, it is important to note that FACSO's system would only respond to UNIX based FTP programs.

```

'CHAMBR.TESTFILE.DATA'                                NONUM
ASI11510098 Invalid line number, NONUM assumed
-----10-----20-----30-----40-----50-----60-----70-----8
<PF>                                                    SEPC ;
HEADER,FILE,DETAIL,070995,213004,RECORD,NON-RMS-BAS-FFL,BAS,243,FIELD,CNT-NUM,C,
DATA,"N6247287C0051",2612,"N","N62472","87","CHILD CARE CENTER","910721","910826
DATA,"N6247287C0051",2612,"N","N62472","87","CHILD CARE CENTER","910721","910826
DATA,"N6247287C0051",2612,"N","N62472","87","CHILD CARE CENTER","910721","910826
DATA,"N6247287C0051",2612,"N","N62472","87","CHILD CARE CENTER","910721","910826
DATA,"N6247287C0348",3782,"N","N62472","87","CHILD CARE CENTER","940214","EARLE
DATA,"N6247287C0348",3782,"N","N62472","87","CHILD CARE CENTER","940214","EARLE
DATA,"N6247287C0348",3782,"N","N62472","87","CHILD CARE CENTER","940214","EARLE
DATA,"N6247287C0348",3782,"N","N62472","87","CHILD CARE CENTER","940214","EARLE
DATA,"N6247287C0348",3782,"N","N62472","87","CHILD CARE CENTER","940214","EARLE
DATA,"N6247287C0348",3782,"N","N62472","87","CHILD CARE CENTER","940214","EARLE
DATA,"N6247287C0348",3782,"N","N62472","87","CHILD CARE CENTER","940214","EARLE
DATA,"N6247287C0348",3782,"N","N62472","87","CHILD CARE CENTER","940214","EARLE
DATA,"N6247287C0348",3782,"N","N62472","87","CHILD CARE CENTER","940214","EARLE
DATA,"N6247287C0348",3782,"N","N62472","87","CHILD CARE CENTER","940214","EARLE
DATA,"N6247287C0348",3782,"N","N62472","87","CHILD CARE CENTER","940214","EARLE
DATA,"N6247287C0348",3782,"N","N62472","87","CHILD CARE CENTER","940214","EARLE
DATA,"N6247287C0348",3782,"N","N62472","87","CHILD CARE CENTER","940214","EARL

```

Figure 17 Example Text Delimited File as Previewed by TSO's List Command

Appendix D: Research Data Downloaded from the Facilities Information System

Design/Build Dataset

CONTRACT NUMBER	PRER CODE	WORK DESCRIPTION	ACTIVITY LOCATION	AWARD DATE	LEGAL CCD	ACTUAL MOD	ORIGINAL LEGAL CCD	CONTRACT AWARD AMOUNT	TOTAL CONTRACT COST	LIQUIDATED DAMAGES TO-DATE	MOD NUMBER	MOD REASON CODE	MOD AMOUNT	TOTAL MOD VOLUME	TIME TO COMPLETE	PROJECT AWARD SCOPE	SCOPE UNIT OF MEASURE
1	NS247298C0759	S	CHILD CARE CENTER	DUNLAW FL NTC	11/25/82	2/7/84	CANX	\$1,192,200	\$1,192,200	\$0	P00001	TIME	\$0	\$0		34780	SF
2	NS247298C0304	N	CHILD DEVELOPMENT CENTER	BUNSWICK MENAS	12/2/80	2/2/81	12/7/80	\$727,930	\$771,495	\$0	P00001	DSGN	\$4,352	\$43,988	328	6400	SF
											P00002	DSGN	\$3,944				
											P00003	CREQ	\$1,182				
											P00004	DSGN	\$19,231				
											P00005	CRIT	\$3,379				
											P00006	CRIT	\$3,546				
											P00007	CRIT	\$0				
											P00008	ADMIN	\$0				
											P00009	UNFO	\$823				
											P00010	UNFO	\$1,654				
											P00011	PLAN	\$1,878				
											P00012	UNFO	\$6,611				
											P00013	UNFO	\$4,324				
											P00014	CRIT	\$3,355				
3	NS247298C0305	N	CHILD DEVELOPMENT CENTER	NEW LONDON CT USB	10/2/80	5/13/82	2/8/82	\$778,800	\$842,815	\$0	P00001	CRIT	\$0,399	\$85,016	471	6400	SF
											P00002	UNFO	\$10,000				
											P00003	CRIT	\$0				
											P00004	CRIT	\$17,451				
											P00005	UNFL	\$0				
											P00006	UNFO	\$2,989				
											P00007	UNFO	\$2,543				
											P00008	UNFO	\$852				
											P00009	CRIT	\$2,497				
											P00010	CRIT	\$1,946				
											P00011	CRIT	\$10,852				
											P00012	CRIT	\$12,201				
4	NS247298C0311	N	CHILD DEVELOPMENT CENTER	ATTERTY ME PORTSMOUTH NS	10/2/80	1/1/82	5/2/82	\$716,173	\$848,075	\$0	P00001	CRIT	\$2,119	\$131,902	678	6400	SF
											P00002	DSGN	\$16,608				
											P00003	CRIT	\$19,000				
											P00004	PLAN	\$20,951				
											P00005	DSGN	\$43,655				
											P00006	UNFO	\$9,800				
											P00007	UNFO	\$5,000				
											P00008	CLMN	\$21,299				
5	NS247298C0309	N	CHILD DEVELOPMENT & PERS	NEWPORT RI N ETC	4/15/82	12/24/83	1/8/84	\$1,398,000	\$1,295,529	\$0	P00001	UNFO	\$22,167	\$411,477	631	8000	SF
											P00002	UNFO	\$0,100				
											P00003	DSGN	\$139,008				
											P00004	CREQ	\$942				
											P00005	ADMIN	\$0				
											P00006	UNFO	\$58,725				
											P00007	UNFO	\$22,143				
											P00008	UNFO	\$4,000				
											P00009	UNFO	\$19,000				
											P00010	UNFO	\$61,438				
											P00011	UNFO	\$10,522				
											P00012	UNFO	\$2,469				
											P00013	UNFO	\$5,350				
											P00014	CREQ	\$3,927				
6	NS247298C0372	W	CHILD DEVELOPMENT CENTER	BREMERTON VA	12/2/81	10/27/82	2/27/82	\$909,212	\$919,599	\$0	P00010	ADMIN	\$0	\$9,357	88	6400	SF
											P00002	ADMIN	\$0				
											P00003	ADMIN	\$0				
											P00004	CREQ	\$8,357				
											P00005	ADMIN	\$0				

Design/Build Dataset

CONTRACT NUMBER	USER CODE	WORK DESCRIPTION	ACTIVITY LOCATION	AWARD DATE	LEGAL CCD	ACTUAL BOD	ORIGINAL LEGAL CCD	CONTRACT AWARD AMOUNT	TOTAL CONTRACT COST	LIQUIDATED DAMAGES TO-DATE	MOD NUMBER	MOD REASON CODE	MOD AMOUNT	TOTAL MOD VOLUME	TIME TO COMPLETE	PROJECT AWARD SCOPE	SCOPE UNIT OF MEASURE
7	NR247786C0072	CHILD DEVELOPMENT CENTER	FALLON/NAS	12/06/01	10/27/02	10/06/02		\$989,423	\$1,034,423	\$0	P00001	ADMIN	\$0	\$45,000	332	6400	SF
											P00002	ADMIN	\$0				
											P00003	ADMIN	\$0				
											P00005	ADMIN	\$0				
											P00006	ADMIN	\$0				
											P00007	CLMP	\$45,000				
8	NR247786C0003	CHILD DEVELOPMENT CENTER	DAHLGREN VANSVCTR DIV	04/01	3/21/03	5/21/03	8/29/02	\$972,325	\$978,982	\$0	P00005	UNFO	(\$13,782)	\$9,087	626	6400	SF
											P00006	DSGN	\$1,495				
											P00007	UNFO	\$2,495				
											P00008	UNFO	\$6,000				
											P00009	UNFO	\$2,495				
											P00010	UNFO	\$2,495				
											P00012	DSGN	\$1,095				
											P00015	UNFO	\$1,074				
											P00016	UNFO	\$3,983				
9	NR247791C0187	CHILD DEVELOPMENT CENTER	BETHESDA MD NATI/MEDCEN	4/7/04	4/22/05	5/7/05		\$2,755,000	\$2,977,884	\$0	P00001	CREO	\$73,052	\$177,884	368	21000	SF
											A00002	CREO	\$1,663				
											A00003	UNFO	\$4,577				
											A00005	DSGN	\$10,424				
											A00004	CREO	\$11,538				
											A00005	UNFO	\$7,255				
											A00007	CREO	\$55,754				
											A00008	CREO	\$12,431				

Design/Bid/Build Dataset

CONTRACT NUMBER	USER CODE	WORK DESCRIPTION	ACTIVITY LOCATION	AWARD DATE	LEGAL CCD	ACTUAL BOO	ORIGINAL LEGAL CCD	CONTRACT AWARD AMOUNT	TOTAL CONTRACT COST	CONDATED DAMAGES TO-DATE	MOD NUMBER	MOD REASON CODE	MOD AMOUNT	TOTAL MOD VOLUME	TIME TO COMPLETE	PROJECT AWARD SCOPE	SCOPE UNIT OF MEASURE
1	NS24781C0807	S	CHILD CARE CENTER	CHASE FIELD TXNAS	5/14/87	7/20/87		\$484,845	\$482,374	\$4,355	P0002	UNFO	\$1,423	7728.95	591	3975	SF
											P0004	UNFO	\$1,791				
											P0005	ADMIN	\$0				
											P0006	ADMIN	\$0				
											P0008	UNFO	\$54	68670	413	10810	SF
											P0002	UNFO	\$3,784				
											P0003	UNFO	\$2,650				
											P0004	UNFO	\$2,229				
											P0005	UNFO	\$1,102				
											P0006	UNFO	\$189				
											P0007	CREG	\$11,146				
											P0008	CREG	\$2,718				
											P0009	UNFO	\$4,950				
											P0010	UNFO	\$5,128				
											P0011	UNFO	\$2,695				
											P0012	UNFO	\$973				
											P0013	UNFO	\$3,050				
											P0014	UNFO	\$12,469				
											P0015	ADMIN	\$0				
											P0016	ADMIN	\$997				
											P0017	UNFO	\$9,821				
											P0018	UNFO	\$4,344				
											P0019	UNFO	\$903	289777	351	8113	SF
											P0002	UNFO	\$9,195				
											P0003	CRIT	\$50,000				
											P0004	UNFO	\$2,074				
											P0005	CREG	\$2,359				
											P0006	UNFO	\$1,382				
											P0007	UNFO	\$1,940				
											P0008	UNFO	\$190,987				
											P0001	VECP	\$2,253	2953	518	17200	SF
											P0002	UNFO	\$2,520				
											P0003	TIME	\$0				
											P0004	UNFO	\$4,480				
											P0005	CRIT	\$2,024				
											P0001	ADMIN	\$0	60049	462	6000	SF
											P0002	UNFO	\$10,974		0	6000	SF
											P0003	ADMIN	\$0				
											P0004	UNFO	\$5,195				
											P0005	UNFO	\$4,268				
											P0006	CRIT	\$9,888				
											P0007	UNFO	\$9,540				
											P0008	CRIT	\$15,747				
											P0009	UNFO	\$7,000				
											P0010	UNFO	\$3,224				
											P0011	UNFO	\$5,281				
											P0012	UNFO	\$5,420				
											P0001	UNFO	\$9,380	14649	595	6500	SF
											P0002	CREG	\$14,237				
											P0003	UNFO	\$2,411				
											P0004	UNFO	\$17,271				
											P0005	UNFO	\$2,000				
											P0006	ADMIN	\$0				
											P0007	EROM	\$2,000				

Design/Bid/Build Dataset

CONTRACT NUMBER	WBS CODE	WORK DESCRIPTION	ACTIVITY LOCATION	AWARD DATE	LEGAL CDD	ACTUAL BOB	ORIGINAL LEGAL CDD	CONTRACT AWARD AMOUNT	TOTAL CONTRACT COST	UNRATED DAMAGES TO-DATE	MOD NUMBER	MOD REASON CODE	MOD AMOUNT \$	TOTAL MOD VOLUME	TIME TO COMPLETE	PROJECT AWARD SCOPE	SCOPE UNIT OF MEASURE				
7	NBS2748BC267	CHILD CARE CENTER	CAMP PEBBLETON CA MCB	6/6/86	11/20/87	11/20/87		\$1,467,000	\$1,501,867	\$0	P00009	ADMIN	\$4,100								
											P00010	EROM	\$10,760								
											P00011	DSGN	\$23,800								
											P00012	CREG	\$2,600								
											P00013	DSGN	\$45,000								
											P00015	CREG	\$15,900								
											P00001	DSGD	\$85,744					4887	832	10000	SF
											P00002	DSGC	\$14,776								
											P00004	DSGD	\$15,657								
											P00005	DSGC	\$3,673								
8	NBS2748BC019	CHILD CARE CENTER	LONG BEACH CA NS	9/26/86	10/20/87	10/19/87	82487	\$918,700	\$1,083,765	\$444	P00001	PLAB	\$54,605	166539	369	10000	SF				
											P00002	UNFC	\$17,065								
											P00003	PLAB	\$51,647								
											P00004	PLAB	\$30,032								
											P00005	PLAB	\$68,652								
											P00011	ADMIN	\$0					282814	608	14000	SF
											P00002	CRED	\$67,309								
											P00003	CRED	\$7,609								
											P00004	DSGD	\$3,865								
											P00005	DSGN	\$23,042								
9	NBS2748BC040	CHILD CARE CENTER	MONTEREY CAMPOS	1/16/91	6/8/92	6/8/92	13162	\$1,915,000	\$1,877,814	\$0	P00008	DSGD	\$3,990								
											P00009	CRED	\$23,000								
											P00010	UNFC	\$10,008								
											P00011	DSGN	\$9,398								
											P00012	UNFC	\$67,600								
											P00001	UNFC	\$3,642					61032	472	6625	SF
											P00002	CRB	\$991								
											P00003	CRA	\$55,035								
											P00004	ADMIN	\$0								
											P00005	CREC	\$484								
10	NBS2748BC424	CAS TROB RPK CHILD CARE CENT	TUSTIN CA MCAS	6/29/89	9/25/91			\$2,026,000	\$390,142	\$0	P00001	ADMIN	\$0	224388	816	16800	SF				
											P00002	CREA	\$7,865								
											P00009	ADMIN	\$0								
											P00013	UNFC	\$33,332								
											P00014	DSGC	\$21,864								
											P00015	DSGC	\$7,393								
											P00002	CREA	\$47,135								
											P00003	ADMIN	\$0								
											P00004	DSGC	\$1,205								
											P00005	DSGA	\$3,267								
P00006	UNFC	\$3,390																			
P00007	DSGC	\$7,897																			
P00009	CRED	\$3,000																			
P00010	DSGC	\$8,621																			
P00011	DSGC	\$9,665																			
P00012	CREA	\$7,286																			

Design/Bid/Build Dataset

CONTRACT NUMBER	OFFER CODE	WORK DESCRIPTION	ACTIVITY LOCATION	AWARD DATE	LEGAL CCD	ACTUAL MOD	ORIGINAL LEGAL CCD	CONTRACT AWARD AMOUNT	TOTAL CONTRACT COST	LIQUIDATED DAMAGES TO-DATE	MOD NUMBER	MOD REASON CODE	MOD AMOUNT	TOTAL MOD VOLUME	TIME TO COMPLETE	PROJECT AWARD SCOPE	SCOPE UNIT OF MEASURE
15	N887186C003	B		10/26/88	30180			\$1,197,700	\$25,000	\$0	A00057 UNFO *****		\$0				
			KINGS BAY GAINSB								A00059 DSGN *****		\$0				
											A00008 DSGN		\$859				
											A00007 DSGN		\$3,104				
											A00008 DSGN		\$24,461				
											P00002 UNFO (\$1,660)		\$1,660	31919	821	10000	SF
											P00003 UNFO		\$1,098				
											P00004 DSGN		\$2,400				
											P00005 DSGN		\$1,000				
											P00006 DSGN		\$367				
											P00007 DSGN		\$0				
											P00008 UNFO		\$7,286				
											P00009 DSGN		\$3,946				
											P00010 TIME		\$0				
											P00011 CREC		\$17,000				
											P00012 UNFO (\$1,000)		\$1,000				
											P00013 CREC		\$1,000				
											P00002 DSGN		\$2,298	61640	378	6696	SF
											P00003 DSGN		\$700				
											P00004 DSGN		\$3,600				
											P00005 CREC		\$14,770				
											P00006 DSGC		\$600				
											P00007 UNFC		\$669				
											P00009 DSGN		\$1,600				
											P00009 DSGN		\$1,000				
											P00010 CREC		\$1,600				
											P00011 DSGN		\$1,009				
											P00012 DSGN		\$2,298				
											P00013 DSGN		\$4,000				
											P00014 CRTI		\$0				
											P00016 DSGN		\$606				
											P00016 DSGN (\$662)		\$662				
											P00017 CREC		\$1,576				
											P00018 DSGN		\$592				
											P00019 DSGC		\$669				
											P00020 DSGC		\$462				
											P00021 DSGN		\$8,000				
											P00022 CREC		\$660				
											P00023 DSGN		\$2,170				
											P00024 DSGC		\$3,713				
											P00001 ADMIN		\$0	42991	608	3000	SF
17	N887186C5149	R	CHILD CARE CENTER	2/21/81	70182	157182		\$489,705	\$534,997	\$0	P00003 DSGC		\$316				
			SAN DIEGO CA MCRD								P00005 DSGC		\$2,440				
											P00006 DSGC		\$2,082				
											P00007 DSGC		\$2,336				
											P00008 DSGC		\$12,165				
											P00010 GRID		\$1,024				
											P00011 CRIB		\$2,664				
											P00012 DSGD		\$6,600				
											P00013 CREC		\$9,400				
											P00014 CRIB		\$4,265				
											P00001 CREC		\$50,000	165106	602	20400	SF
											P00002 DSGN		\$1,288				
											P00003 DSGC		\$3,080				
											P00004 CREC		\$17,363				
18	N887186C5149	R	CHILD CARE CENTER	10/25/80	31062	16062		\$1,920,000	\$2,073,106	\$0							
			SAN DIEGO CA MTC														

Design/Bid/Build Dataset

CONTRACT NUMBER	USER CODE	WORK DESCRIPTION	ACTIVITY LOCATION	AWARD DATE	LEGAL CCD	ACTUAL BOO	ORIGINAL LEGAL CCD	CONTRACT AWARD AMOUNT	TOTAL CONTRACT COST	LIQUIDATED DAMAGES TO-DATE	MOD NUMBER	MOD REASON CODE	MOD AMOUNT	TOTAL MOD VOLUME	TIME TO COMPLETE	PROJECT AWARD SCOPE	SCOPE UNIT OF MEASURE
19 N871186C1037	R	CHILD CARE CENTER	SAN DIEGO, CANSB	7/24/83	60084			\$2,281,747	\$3,389,317	\$0	P00005	DSGC	\$1,264				
											P00006	DSGC	\$0				
											P00007	DSGC	\$2,716				
											P00008	DSGC	\$3,626				
											P00009	CREC	\$185				
											P00010	CREC	\$0				
											P00011	DSGC	\$500				
											P00012	DSGN	\$2,578				
											P00013	DSGC	\$2,180				
											P00014	CREC	\$5,671				
											P00015	CREC	\$3,140				
											P00016	DSGC	\$3,186				
											P00017	CREC	\$9,600				
											P00018	CREC	\$5,047				
											P00019	DSGC	\$3,404				
											P00020	DSGC	\$,462				
											P00021	CREC	\$1,029				
											P00022	DSGC	\$2,266				
											P00023	DSGC	\$3,346				
											P00024	GMDD	\$14,136				
											P00025	DSGC	\$1,438				
											P00026	DSGC	\$9,790				
											P00027	CLMR	\$916				
											P00028	CLMR	\$9,000				
											P00029	DSGC	\$3,000				
											P00001	ADRN	\$0	366570	3-2	20870	SF
											P00002	DSGC	\$5,000				
											P00003	DEFG	\$4,321				
											P00004	UNFO	\$16,000				
											P00005	DSGD	\$3,391				
											P00006	DSGC	\$30,765				
											P00007	CRIT	\$9,000				
											P00008	DSGD	\$48,000				
											P00009	DSGN	\$4,844				
											P00010	DSGN	\$2,000				
											P00011	DSGN	\$3,500				
											P00012	DSGN	\$11,371				
											P00013	CREO	\$52,349				
											P00014	CREO	\$11,620				
											P00015	CREO	\$12,000				
											P00016	DSGC	\$29,500				
											P00017	DSGC	\$19,000				
											P00018	DSGN	\$20,624				
											P00019	DSGC	\$9,143				
											P00020	DSGN	\$25,600				
											P00021	DSGN	\$800				
											P00022	DSGN	\$10,000				
											P00023	CREO	\$3,600				
											P00024	DSGN	\$3,600				
											P00025	DSGC	\$19,500				
											P00026	DSGN	\$5,200				
											P00027	DSGN	\$19,252				
											P00028	DSGN	\$20,500				
											P00029	CLMA	\$3,000				
											P00030	UNFO	\$5,000				

Design/Bid/Build Dataset

CONTRACT NUMBER	USER CODE	WORK DESCRIPTION	ACTIVITY LOCATION	AWARD DATE	LEGAL CCD	ACTUAL BOD	ORIGINAL LEGAL CCD	CONTRACT AWARD AMOUNT	TOTAL CONTRACT COST	LIQUIDATED DAMAGES TO-DATE	MOD NUMBER	MOD REASON CODE	MOD AMOUNT	TOTAL MOD VOLUME	TIME TO COMPLETE	PROJECT AWARD SCOPE	SCOPE UNIT OF MEASURE
20 N87118100124	R	CHILD CARE CENTER	TWENTYNINE PALMS CALMAGCC	8/23/81	82293			\$1,947,775	\$1,832,050	\$0	P00001	UNFD	\$3,743	18,427.7	639	13,480	SF
											P00002	CRED	\$469				
											P00003	CRED	\$574				
											P00004	UNFD	\$4,600				
											P00005	UNFD	\$109				
											P00006	TIME	\$0				
											P00007	DSGC	\$4,200				
											P00008	UNFC	\$1,167				
											P00009	DSGC	\$7,252				
											P00010	DSGD	\$5,700				
											P00011	DSGC	\$1,059				
											P00012	DSGD	\$4,198				
											P00013	DSGC	\$18,700				
											P00014	CRIB	\$19,201				
											P00015	DSGC	\$1,029				
											P00016	CRED	\$91,866				
											P00017	DSGC	\$23,680				
											P00018	CREA	\$10,837				
											P00019	DSGD	\$22,810				

Bibliography

- Bradford, Hazel. (1991). "Design-build issue heats up. (Naval Facilities Engineering Command to do in-house consulting engineering)." *ENR*, 227(3), 7
- Branca, Anthony J. (1987). Cost effective design/build construction. Kingston, Ma: R. S. Means Co.
- Briggs, James M. and Wironen, Allen M. (1993). "Newport Design/Build: A Winner for the Government and the Contractor." *Navy Civil Engineer*, Winter/Spring, 1993, 21-24.
- Courtillet, Jacques R. (1992). "Have You Considered Design/Build?" *Navy Civil Engineer*, Winter/Spring, 1992, 18-22.
- Coxe, Weld. (1994). "Design-build: lessons from Japan." *Progressive Architecture*, 75(8), 72-73.
- Denning, James. (1992). "Design-build goes public." *Civil Engineering*, 62(7), 76 - 78.
- Dietsch, Deborah K. (1995). "Improving design/build: new guidelines promote fairness in the design/build process for public projects." *Architecture*, 84(1), 15.
- Edmunds, Jane. (1992). "Design-build gaining ground." *ENR*, 228(5), 12
- "For design-build" (1994) "For design-build, it's all in the perception." *Civil Engineering*, 64(6), 11-12.
- Grogan, Tim. (1991). "Design-constructors boost awards 5.6%." *ENR*, 226(21), 68-69.
- Grogan, Tim. (1995). "Inflation checked." *ENR*, 234(16), 79-85.
- Hannan, Roger (1989). "Banner year for new business. (The Top 400 Contractors)." *ENR*, 222, (21), 40-41.
- Hannan, Roger (1991). "Industry optimistic despite setbacks. (The Top 400 Contractors)." *ENR*, 226, (21), 34-48.

Herbsman, Zohar. (1992). "Multiparameter bidding system - innovation in contract administration." *Journal of Construction Engineering and Management*, 118(1), 142 - 150.

Hutchens, Peyton E. (1992). "Risk reduction through indemnification contract clauses." *ASCE Journal of Construction Management Engineering*, 8(3), 267-277.

Korman, Richard (1992) "Overseas jobs power a great leap upward. (Special Report: The Top 400 Contractors)." *ENR*, 228, (21), 94

Korman, Richard. (1993). "Specialties stabilize design-build contracts." *ENR*, 230(21), 71-72.

Krizan, William G. (1993). "Diversified firms are chomping at market. (construction-related design services)." *ENR*, 230(14), 34-37.

Lawson, Michael (1990). "Owners warming up to design-construct." *ENR*, 225, (21), 77

McKee, Bradford (1994). "Federal design/build: six projects reveal how the government has succeeded - and failed - by teaming architects and contractors." *Architecture*, 83(10), 109-116.

McKee, Bradford. (1994). "Design/build gains appeal." *Architecture*, 83(7), 107-111.

McManamy, Rob. (1994) "Design-builders take a breather. (The Top 400 Contractors)." *ENR*, 232(21), 77-79

McManamy, Rob. (1994). "Design-build goes back to the future." *ENR*, 232(23), 26-28.

Miller, Irwin and Freund, John E. (1977). Probability and Statistics for Engineers. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

NAVFACENGCOM, (1995). *Design/Build Specifications Workshop, Report., Draft Copy*, Naval Facilities Engineering Command, January 30-31.

NAVFACENGCOM, (1994). *Newport Design/Build (D/B), Description of Process*, Naval Facilities Engineering Command, November 25.

"Package deal" (1993). "Package deal. (The New Client: Design-Build)." *Architectural Record*, 181(11), 36-37.

Potter, Kevin J. (1994). "Design/Build Pre-qualification System." *Journal of Management in Engineering*, 10(2), 48-56.

"Procurement" (1994) "Procurement, A Design-Build Deal." *ENR*, 233(4), 5.

Schriener, Judy (1989) "Good times roll for design-construct (Special Report: The Top 400 Contractors)." *ENR*, 222, (21), 94

Schriener, Judy (1995). "Total quality management struggles into a low orbit." *ENR*, 234(19), 24-28.

Setzer, Steven W. (1991) "One-stop shopping has designers nervous. (contracts calling for both architectural design and construction)." *ENR*, 227(6), 9-10.

Setzer, Steven W. (1992). "Design-build job stokes tempers. (Corps of Engineers' design-build construction projects)." *ENR*, 229(13), 8-9.

Songer, Anthony D. (1992) Knowledge-based advisory system for public-sector design-build." *Journal of Computing in Civil Engineering*, 6(4), 456-471.

Songer, Anthony D. (1994). "Process model for public sector design-build planning." *Journal of Construction Engineering and Management*, 120(4), 857-874.

Spaulding, V. M. (1988). *A Study on Integrating the Newport Design/Build Strategy into the NAVFACENGCOCOM Facilities Design and Acquisition Process*, Naval Facilities Engineering Command, May.

Spaulding, V. M. (1995). Personal Interview. 17 May.

Tarricone, Paul. (1993) "Deliverance. (alternative bidding system in public projects)." *Civil Engineering*, 63(2), 36-37.

Tieder, John B. (1989). "The Special risks inherent in Design/Build and Fast Track Projects - The Contractor's Perspective." Watt, Tieder Killian & Hoffar, 1-54.

Tulacz, Gary J. (1994). "Special Report: The Top 400 Contractors." *ENR*, 232(21), 40-44.

Tulacz, Gary J. (1995) "Industry embraces design-build, (Special Report: The Top 400 Contractors.)" *ENR*, 234(20), 74

Vita

Michael B. Roth was born in Minneapolis, Minnesota on April 9, 1964, the son of Ruth Ann and Thomas William Roth. After completing his work at Bishop Kelly High School, Tulsa, Oklahoma, in 1982, he entered Texas A & M University in College Station, Texas on a Naval Reserve Officer Training Corps Scholarship. He received the Degree of Bachelor of Science in Civil Engineering from Texas A&M University and was commissioned as an Ensign in the United States Navy in December of 1986. He was promoted to Lieutenant on December 12, 1991. His tours of duty within the United States Navy Civil Engineer Corps have included assignments as an Assistant Resident Officer in Charge of Construction, Resident Officer in Charge of Construction, and as Company Commander and Staff Officer in the Naval Mobile Construction Force.

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