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Data administration and its role at Naval Supply Systems Headquarters.

Knight, Robert Lewis.

NAVAL POSTGRADUATE SCHOOL
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THESIS

DATA ADMINISTRATION AND ITS ROLE
AT NAVAL SUPPLY SYSTEMS HEADQUARTERS

by

Robert Lewis Knight

September 1985

Thesis Advisor: Daniel R. Dolk

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ABSTRACT (Continued)

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Data Administration and Its Role at Naval Supply Systems Headquarters

by

Robert Lewis Knight
Lieutenant, Supply Corps, United States Navy
B.A., University of Texas, 1977

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ABSTRACT

As many organizations transit through Nolan's phases of ADP evolution, the process of designing systems to satisfy their data needs has become extremely complex. Application-oriented design techniques have given way to data-oriented concepts such as Information Engineering. One of the primary tools of Information Engineering is the group of management functions known as Data Administration. Naval Supply Systems Command (NAVSUP) has established a data administration branch in an attempt to integrate three logistic information systems: SUADPS REAL-TIME, UADPS-SP and UICP.

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I. INTRODUCTION

Through the years, the design, implementation, and maintenance of computer information systems has become one of the most important elements of an effective organization. An army is commonly referred to as "marching on its stomach". An organization marches not only on the content of its information, but also on how it accesses that information up and down its organizational structure.

Many organizations are evolving towards Richard Nolan's concept of "mature" data processing users [Ref. 1]. Computers are no longer used just to assist the operational managers in the day to day transactional processing as they were five to seven years ago. Managers at all levels of the organization need information to make countless decisions. Today's computer technology provides the capability to retrieve needed information from throughout the organization. However, the weak link is the compatibility of data and data structures to allow access to the information of the organization.

Much attention has been given to the development and improvements in computer hardware. These improvements have been easy to observe. Early computers that contained small amounts of memory were physically huge and required large investments of capital. Management concern was with keeping the computer busy by processing millions of transactions that were relatively easy to program. Today, processors which possess almost a million bytes of computer memory are commonplace on workers' desks throughout the organization. Computers have become smaller, cheaper, faster, more reliable, and easier to maintain than earlier models. Now management concern is with coordinating all the computer systems in an organization in order to support and control an effective overall information system.

The Naval Supply Systems Command (NAVSUP) is similar to any large organization with computer information systems. In the mid 1960's, NAVSUP developed three major financial and inventory control systems to provide support for its tri level organization. They are the Shipboard Uniform Automated Data Processing System (SUADPS), the Uniform Automated Data Processing System for Stock Points (UADPS-SP), and the Uniform Inventory Control Point sytem (UICP). These systems were designed using second generation hardware and software techniques with major emphasis on individual file processing.

Today, all three of these major systems are being redesigned to utilize the state of the art hardware technology. NAVSUP has the unique opportunity to design these systems to provide integration throughout the organization and to take an important step towards realizing a true corporate information system allowing top management access to the information that they need.

This thesis will discuss the problems of coordinating the design of the three systems experienced by NAVSUP with an emphasis on the role of data administration in the overall concept of information systems. Much attention will be given to the concepts of software design including the basics of Information Engineering which is being used by the Fleet Material Support Office (FMSO), the central design activity for UADPS-SP and UICP. After the discussion of the three replacement systems, the need for a strong data administration activity at NAVSUP Headquarters to allow for vertical integration will be emphasized.

II. BACKGROUND

A. NAVSUP ORGANIZATION

NAVSUP supports logistic operations through a tri-level organizational structure as shown in Figure 1. The bottom layer is the ship or squadron supply department which maintains an inventory of up to 100,000 line items for issue. If a needed part is not available, a referral is sent to the next level, the nearest stock point (Naval Supply Center or Depot). A stock point carries an inventory of between 90,000 and 1,500,000 items and satisfies approximately 75% of the referral requests it receives. The unfilled referrals are sent to either the Aviation Supply Office (ASO) or the Ship Parts Control Center (SPCC), the third level in the logistic chain. ASO and SPCC do not stock any parts for issue. They function as inventory control points (ICPs) and monitor the worldwide inventory of supply parts, the status of depot level repairables, and the contracts for new procurements. The two ICP's handle over 2,000,000 demands every month. The ICP will direct the issue of a needed part from any supply source throughout the world.

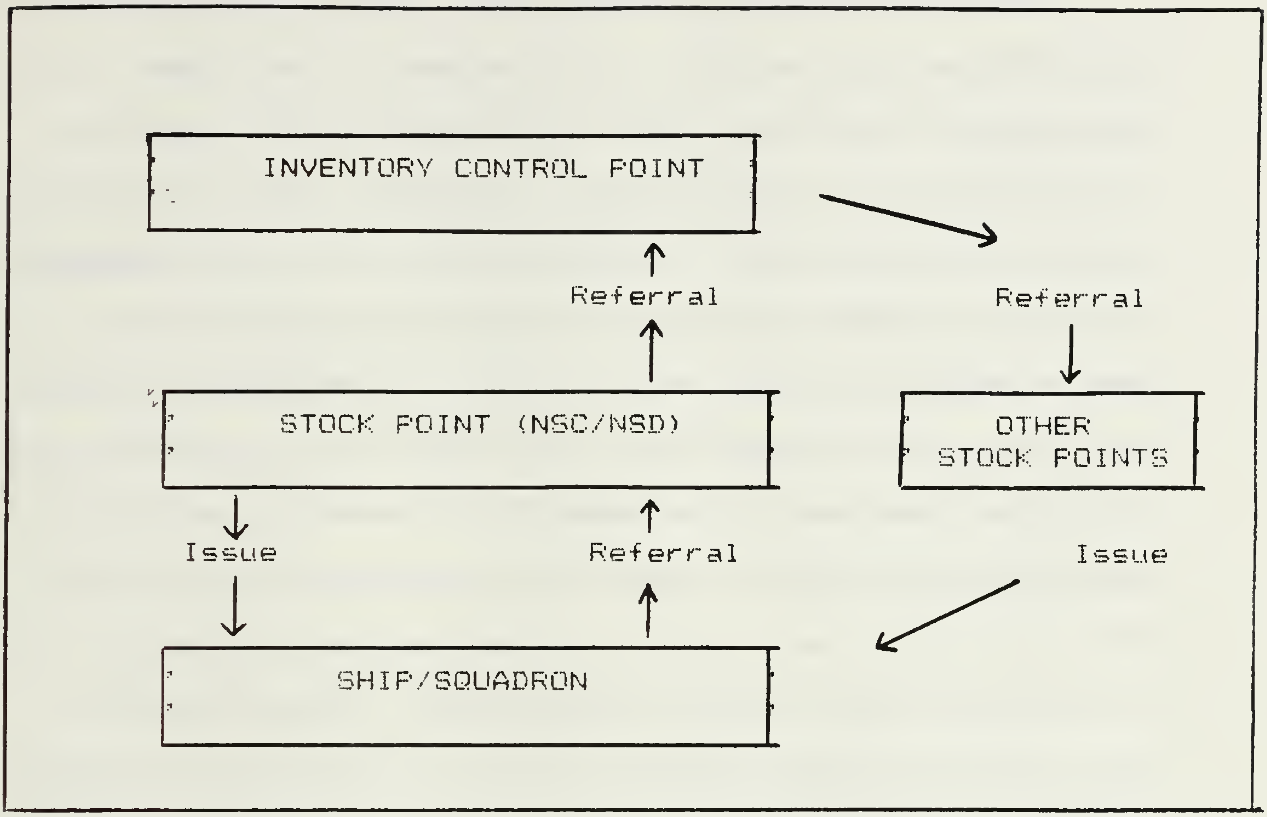

Figure 1 --Logistic Support Organization

Each level in the supply chain utilizes a different sophisticated automated inventory control system. These computer systems were effective in the past in assisting the NAVSUP activities in performing their missions. However, for the last ten years, the pace of operations and the sheer size of the computing load have created a desperate need for modern information systems at all levels. Additionally, NAVSUP headquarters now needs access to information at all three levels much faster than what is currently available.

The Navy's information needs have changed dramatically since the earlier systems were developed. They were designed as report generators executing in batch mode to provide page upon page of output needed by inventory control clerks. This satisfied the operational level of management information needs. Upper and middle management do not receive sufficient information from these systems to answer the "what should we be doing?" and "what is our status right now?" type questions. For NAVSUP, the need for integrated information systems was made obvious during 1979 and 1980 when naval units were required to operate in the Indian Ocean for extended periods outside their normal logistics chain. Top management had difficulty in getting up to date information from the ships, stock points, and ICPs to make the many decisions to adequately support all units. The lack of integration among the three major information systems has become a chief concern of the Inventory and Information Systems Directorate (SUP-04) at NAVSUP Headquarters.

B. INFORMATION SYSTEMS

An information system, in general, consists of hardware, software, data, personnel, and procedures. Each element must interact correctly in order to have an efficient and effective system. With the remarkable advances in the amount of computer memory available, the pivotal element has shifted from the computer processor itself to the data contained within a system. Data is now viewed as a valuable resource to be shared throughout the system. The user must become more responsible for the integrity of the data than was required by the older systems. This concept requires a coordinated effort by the designers, managers, and users to ensure new information systems will satisfy the requirements of individual activities and allow access to and from other information systems. This need for integration has led to the development of a new methodolgy for systems design known as information engineering.

Until recently, NAVSUP activities at each level were allowed to develop information systems to satisfy their own requirements with little concern for interfacing with other systems. This "isolated" design methodology evolved primarily because each activity's data processing requirements centered around specific functional programs such as payroll, personnel accounting, or inventory management. Such programs were developed using second generation computers and were designed for independent file processing. During this period, the Navy implemented three large automated logistics systems to handle uniform data processing requirements: UICP (with UNIVAC hardware) for the two inventory control points, UADPS-SP (with Burroughs equipment and file structures) for stock points, and SUADPS (with UNIVAC hardware) for large fleet units. The lack of compatibility among these systems forced NAVSUP to support many redundant applications and data files. Because of the size of these computer systems, the immense investment in maintaining and expanding them through the years, and a long period of ADP funding shortfalls, the Navy was prohibited from replacing its outdated equipment and processes even though newer hardware and more efficient applications existed.

C. NAVSUP MODERNIZATION PROGRAMS

1. Overview

NAVSUP is now involved with modernizing its three major information systems to catch up with the technological advances of the past twenty years and allow managers at every level to have access to the information they need. The programs are : UICP RESYSTEMIZATION, UADPS Stock Point ADP Replacement (SPAR), and SUADPS Real-Time. The first two systems are being designed by FMSO in Mechanicsburg, Pennsylvania using many of the techniques of information engineering. SUADPS Real-Time is under the cognizance of Navy Management Systems Support Office (NAVMASSO), Norfolk, Virginia. It is a much smaller system and has kept many of the traditional file design techniques. Figure 2 summarizes the key elements of the three projects.

2. SUADPS Real-Time

SUADPS Real-Time is a user oriented on-line interactive supply and financial system which utilizes the SNAP I computer hardware to support designated shipboard, Marine Air Group (MAG) Supply Departments, and certain Shore Intermediate Maintenance Activities (SIMA) mission support functions. It makes maximum use of the interactive capabilities of the hardware in data input, data update, and data base query operations. It replaces the original version of SUADPS which was a card oriented batch system designed for the UNIVAC 1500 system.

The primary reason for the development of SUADPS Real-Time is to take advantage of the upgrade in computer processing capability made possible by the Shipboard Non Tactical ADP Program for large ships (SNAP I). SNAP I removed the second generation U1500 systems from the field activities and replaced them with a fourth generation mini computer, the Honeywell DPS-6. The DPS-6 increases the memory capabilty from 16,000 to 2,000,000 bytes and provides for on-line storage of at least 12,000,000 bytes. With this quantum leap in computer capacity, the capability for creating a more effective system became a reality. SUADPS Real-Time is one of several on-line systems being implemented on the SNAP I systems. According to its charter [Ref. 2], it is designed to :

a. Reduce the time and effort required to process supply transactions and to access supply information.

b. Improve supply response times for organizational and intermediate level material requirements.

c. Improve utilization of fleet operations and maintenance funds.

d. Improve accuracy, consistency, and timeliness of supply, financial, and logistics data.

e. Provide a direct interface with maintenance systems.

An important element missing from this design criteria is the need to interface with UADPS-SP or UICP. NAVMASSO chose to continue many of the file design techniques of the old SUADPS system to allow easier transition to the new system and interface with the ship's 3M maintenance reporting system. This has resulted in data redundancy and lack of file integration. Many processes are duplicated for one transaction. Using a data base management system (DBMS) would have reduced the redundacy and possibly allowed better interaction with external systems. Keeping the imbedded file structures has also made the future development of a NAVSUP corporate data base much more difficult. Other factors such as getting a system out to the fleet as soon as possible to use the new hardware took precedence.

NAVMASSO's implementation plan involves phasing in versions of the new SUADPS RT as they are developed and backfitting previously installed systems. Unfortunately, users are discovering many bugs in the system. This decreases their faith in the system and increases their reluctance to change from many outdated processing methods such as using punched card input. Currently, USS Dixon (AS-37) homported in San Diego has the latest version of SUADPS Real-Time on the west coast. Due to the phase-in approach, stock control personnel are forced to perform dual processing until final system development is completed in approximately two years. The dual processing involves entering data into the "real time" files for query processing and requisitioning material, then downloading that data for processing to the "official" data files for processing by the old SUADPS system running in emulation mode. While the old system is running, the ship loses its "real time" capabilities. Additionally, requisitions which must be passed off-ship are being prepared and submitted in three different methods which vary from ship to ship depending on their experience. Requisition processing is accomplished by (1) direct input into a Burroughs terminal and utilizing a fleet on-line program, (2) submitting a SUADPS tape to the stock point for UADPS processing, or (3) writing out a requisition document and having the stock point prepare the automated requisition card.

SUADPS Real-Time has created a new element in the shipboard supply department operations by giving remote access to its supply files. Under the old SUADPS processing, one or two storekeepers and the stock control officer were SUADPS trained. They were responsible for ensuring that supply documents were correctly prepared for submission to the data processing division. After the inventory programs were executed, they then had to work error listings of improper transactions. It was not uncommon for a single transaction to require two weeks of processing before being completed if it was originally submitted incorrectly. In the meantime, the rest of the supply department was working with printouts of the inventory files that were up to two weeks old. With SUADPS Real-Time, all storekeepers will be involved with the inventory data. Remote terminals at stock control and most of the storerooms will allow direct on-line processing of receipts, issues, and requisitions. This will require SUADPS training for all supply personnel to ensure data integrity.

The new system allows output of requisition files to either floppy disk, magnetic tape, or punched cards. Currently, the stock points are only capable of using tape or punched cards. Because of initial problems with the UADPS-SP system reading the Honeywell tapes, the majority of ships with SUADPS Real-Time are reluctant to change to the new technology and are continuing to use the punched card output that they used for twenty years. This severely slows processing time. This will continue to be a problem until the "second generation mentality" is removed through training and hopefully with the implementation of the SPAR equipment at the stock points which is being designed to allow direct transfer of requisitions by floppy disks.

3. Stock Point ADP Replacement Project

The Stock Point ADP Replacement Project (SPAR) received its charter from NAVSUP in March 1983. It has two main objectives: (1) replace the computer systems at 25 major data processing facilities that provide services to 72 activities which utilize the Uniform Automated Data Processing System for Stock Points (UADPS-SP); (2) the modernization of UADPS-SP to improve the level of supply support provided to the operating forces of the Navy. Deployment of new hardware and software will extend into the 1990's with a contract life of 24 years to allow for technological improvements and capacity expansion as required. [Ref. 3]

Stock point computer systems have been operating at full capacity for years. Because of the sheer size of SPAR and the lead time for system acquisition and development, the Navy implemented the Navy Stock Point Logistic Integrated Communication Environment (SPLICE) as an interim program. The primary objectives of SPLICE are to relieve the saturation of computer systems currently at the stock points and to provide for the telecommunication needs of the modernized UADPS. SPLICE was envisioned as a quick stop-gap measure to allow for a controlled redesign effort in SPAR. However, problems with the establishment of network protocol for the Department of Defense Network (DDN) has delayed the actual implementation of SPLICE. Meanwhile, the design phase of SPAR has pushed forward.

The SPAR project involves replacing 60 medium scale computers and converting or redesigning 7800 programs that contain 11.5 million lines of source code. It does not include the redesign or conversion of the hundreds of local programs that exist throughout the system. The completed system is being designed to efficiently interface with both the UICP and SUADPS Real Time systems. Since it is such a huge project, a "risk aversion" attitude has partitioned it into three main phases: (1) hardware acquisition with equipment selection now scheduled for March 1987, (2) conversion of the current UADPS system to execute on the new hardware, and (3) modernization of UADPS. Each phase has a separate manager at NAVSUP headquarters.

The transistion plan for the replacement project discussed four different alternatives for replacing the current software including standard conversion, generic COBOL, shell or bridges, and redesign. An initial decision to implement SPAR with converted software vice a modernized system was made because many of the design techniques that the modernization team will use are a radical departure from traditional methods. The cost of having the system fail during implementation at any stock point is deemed too high to risk. Also, the feeling is that conversion will be the quickest method to get the new hardware to the activities. A final decision will be made in late 1985 after the redesign team at FMSO prepares its initial package. [Ref 4]

The SPAR redesign team at FMSO began its project by preparing a functional description of all the tasks performed by the current version of UADPS-SP. Utilizing a fourth generation software design tool, DATA DESIGNER, they compiled the logical relationship of all the functions and the data files with which they interact. This identified data classes with one to one, one to many, and many to many relationships. The team took this output to the users and asked "Is this really the way you do your processing?" At the same time, they queried the users on what they thought the new system should do. This bottom-up design method contradicts one of the key elements of Information Engineering (IE). In IE, top management decides what the new system should do and lets the design work top-down in the conceptual stage. However, IE also assumes that corporate headquarters has a firm description of its information needs included in its strategic plan. The pressures of time forced FMSO to query the users first, make managerial recommendations, and forward its intentions to NAVSUP Headquarters.

From the preliminary results, the FMSO team has decided to proceed with a phased implementation of the redesigned software and backfit organizations with the new software as it is developed instead of attempting to prototype all of the changes on one system. This is similiar to the SUADPS REAL-TIME implementation plan. The major difference is that under SPAR there will be no duplicate processing under emulation mode. Currently, the redesign team is continuing its development work while serving as a beta test site for a new fourth generation software design program.

4. UICP RESYSTEMIZATION

FMSO has also been tasked with designing the modernized software for the inventory control point (ICP) level. UICP RESYSTEMIZATION or RESOLICITATION is the ICP version of SPAR. Uniform Inventory Control Point (UICP) is a collection of programs very similar to the UADPS-SP system. The current system involves IBM hardware at two sites, SPCC in Mechanicsburg, Pennsylvania and ASO in Philadelphia, Pennsylvania. RESYSTEMIZATION efforts began in 1978 with an expected completion date of March 1989. The project has already selected and installed IBM 3080/3090 hardware.

The software redesign effort began before the development of the design techniques of Information

Engineering. However, the redesign team has been in close communication with the SPAR team and would like to integrate many of the concepts of IE into their project. This may prove to be very difficult due to the mechanics involved. Currently, the project is also geared towards a phased implementation with the financial accounting subsystem being the first scheduled to come on line. The system is built around the IBM IDMS data base system which could be a problem for integration of UADPS-SP AND UICP data. The interface between SPAR and UICP is deemed critical to the future development of a corporate data base capability.

LEVEL	SHIP/SQUADRON	STOCK POINT	ICP
IS	SUADPS	UADPS-SP	UICP
HARDWARE	HONEYWELL DPS6	UNKNOWN	IBM 3080/3090
REDESIGN PROJECT	SUADPS-RT	SPAR	RESYSTEMIZATION
CENTRAL DESIGN AGENCY	NAVMASSO	FMSO	FMSO
CHARTER DATE	1982	1983	1978
ESTIMATED COMPLETION DATE	1987	1990	1989

Figure 2 - NAVSUP IS Redesign Projects

III. SOFTWARE DEVELOPMENT/INFORMATION ENGINEERING

A. BACKGROUND

To the layman, the quantum leap in computer technology during the past five to seven years has been, at best, mind boggling. Much attention has been given to the development and improvements in hardware which have been easy to observe. Early computers that contained small amounts of memory were physically huge and required a large investment of capital. Today, processors which work with almost a million bytes of memory are commonplace on workers' desks in almost every office building. Even as they have become smaller, computers are cheaper, faster, more reliable, and easier to maintain than earlier models.

Unseen to most people, a remarkable change in the manner in which computers are programmed has been taking place. During the early days of computer programming, the development of software was severely limited by the capabilities of the computer. As the computer became less restrictive, the programs became more complex because man demanded more from this electronic resource. However, until recently, the manner in which people approached the programming problem remained the same. Most software was developed top-down and was application or function oriented. But as demand for solutions to more general problems increased, the methodology of programming has slowly evolved into an "information engineering" project. To appreciate the power and complexity of information engineering, a brief description of the earlier methods is needed.

B. ERAS OF SOFTWARE DEVELOPMENT

The evolution of computer systems and software development has been characterized by three eras [Ref. 5]. In the first era, programming was initially accomplished by hardwiring the computer. Each different application being executed on the computer required a complete rewiring of the computer. The programmers were, in fact, electrical engineers. Once the second generation computers were developed, non-engineers became involved. The use of compilers and higher level programming languages gave programmers much more flexibility. But for a period of twenty-five years, all programs were developed to solve a specific problem. Much redundancy in the programming effort existed. Also, there were many ways to approach the same problem. Programmers used different techniques and algorithms and most programs had very limited distribution.

The second era reflected a significant leap in the capabilities and functions of computer systems. Systems were now being used by more than one person or organization so programs had to be more flexible. Product software evolved which required months or years of designing, coding, testing, and evaluating before being used. Libraries of common programs became necessary. However most software development still was application oriented, and the applications were becoming more and more complex. The cost of software development and maintenance began to skyrocket, and soon exceeded hardware costs. During this "growth" stage of data processing development, a better method of programming had to be found to control the escalating costs. Data processing experts such as C.F. Gibson and Richard Nolan voiced their concern over the uncontrollable growth in data processing requirements and tried to provide industry with guidelines towards a "mature" DP environment [Ref. 6]. Many of their concerns became real as computer processing moved into the third era.

The third era of software development began with the arrival of microprocessors and distributed computing systems and continues today. The need for software greatly exceeds the personnel and technical resources available. The fact that many functions are now hardwired into the processors helps, but the computing world can no longer afford the luxury of putting months or years into developing a program that does not satisfy current requirements. Many businesses are discovering how important the computer can be to both their day-to-day operations and to their long range planning efforts. However, many users are frustrated with the traditional programming requirements and limitations.

Charles Rubin states "Ideally, what's needed is software with a flexible command processor that would let the user define . . . the way the user likes to communicate . . . The solution is beyond our current means, although there are some integrated packages on the horizon that promise 'modeless' operation . . . . [Ref. 7] This "need" requires a new method of programming. A major step in satisfying that requirement is the emergence of software engineering.

C. SOFTWARE ENGINEERING

Previous programming techniques centered on a flowchart approach that was concerned with procedural or "how to" questions. Software engineering is geared towards a "what to do" question and is functionally oriented. To ensure efficiency and effectiveness of the software product, a great deal of planning is required. Hence, the engineering attitude is employed. It is a methodology that uses techniques that are application independent. It is modeled on the time-proven techniques, methods, and controls associated with hardware development and is centered on three key objectives: (1) a well defined methodology that addresses a software life cycle of planning, development, and maintenance, (2) an established set of software components that documents each step in the life cycle and shows traceability from step to step, and (3) a set of predictable milestones that can be reviewed at regular intervals throughout the software life cycle. [Ref. 8]

The three phases of a software life cycle are the key elements of software engineering. The planning phase includes software planning, software requirements analysis and definition, and a review of the software requirements specification. From the specifications generated during the planning phase, deliverables are created during the development phase. This phase includes two software design steps, coding, unit testing, integration testing, and validation testing. The final phase is the maintenance phase which involves maintaining code or modifying the software to ensure its reliability, effectiveness, and relevance. Today, 40% to 70% of a company's programming effort is involved with software maintenance. [Ref 9] The large amount of maintenance during the life cycle of the software is often overlooked during the planning phase and resources are not available when needed.

Software engineering is definitely improving the effectiveness and reliability of many programming projects. But it is still a traditional programming methodology in the sense that large teams of programmers are required as well as considerable time. This does not solve the problem of today's users who require the capability to instantaneously answer scores of questions regarding a wide range of data. They cannot afford to wait for a programming team to provide them with a software tool. Information engineering represents a radical change in program design that will in effect take the responsibility for the majority of programming away from the application programmer and place it in the hands of the user.

D. INFORMATION ENGINEERING

Information Engineering (IE) is a discipline that is broader than software engineering and encompasses all the interrelated disciplines necessary to manage an effective data center. It ties the design of the data center squarely into the corporate planning processes of each organization. A mature organization lives and dies on its data. Contrary to software engineering which focuses on the logic used in computerized processes, information engineering is primarily concerned with how data is created, updated, and used. Earlier programming methodologies were designed around static procedures. IE maintains a basic premise that the type of data used in an enterprise do not change significantly while procedures using the data will.

1. Building Blocks

There are nine basic building blocks defined for information engineering as outlined in Figure 3. Each block is dependent on the firm development of its predecessors. They are:

a. Strategic requirements analysis
b. Information analysis
c. Data modeling
d. Procedure formation
e. Data use analysis
f. Distribution analysis
g. Physical data base design
h. Program specification synthesis
i. Application generation without programmers

The strategic requirements analysis block is the most important and the most overlooked portion of IE. In this block, the overall objectives of the enterprise and the information needed to accomplish those objectives are determined. Many organizations have learned the hard way about the wastefulness of application software created to generate paperwork and give the managers little, if any, benefit. Once organizational objectives have been determined, the second block performs a top-down analysis of the types of data that must be kept and how they relate to one another. This is a critical process because the cornerstone of information engineering is that data structures will remain stable. During the third step, data modeling, a detailed logical data base design is created. The key is that the data is structured independent of how it will be used. The fourth block, procedure formation, concerns the events that change or use the data base. These procedures can and should be designed and programmed by the users. To enable non-programming personnel to accomplish this, information engineering is strongly dependent upon fourth generation programming languages which are basically non-procedural and allow coding in Englishlike statements. Additionally, there is the capability for automatic code generation using the procedure charts created during this block.

The fifth and sixth blocks, data use analysis and distribution analysis, prepare the data organization for the physical data base design step of block seven. In earlier methodologies, the physical structure of the data was dictated by the application being programmed. Block eight, program specification synthesis, integrates the different procedures, documents any data changes, and creates functionally cohesive program code. Finally, block nine represents the capability of application development without programmers in the sense of dedicated programmers working as a team. In this block non-procedural languages allow the user to answer queries on the data base, model "what if" questions, streamline reports, and generally get to the data they need. Non-procedural languages differ from procedural languages in the sense that a procedural language specifies how something is accomplished. A non-procedural language specifies what is accomplished but not how in detail. Application development without programmers is probably the most important and exciting element of IE. The vast backlog in application development in most organizations has severely restricted the flow of information.

By using all of the above blocks, corporations can develop flexible systems which meet overall organizational information needs much more rapidly than by using traditional design methods and at an overall lower cost. [Ref. 10]

2. Life Cycle Stages

Software engineering assumes a life cycle of three distinct phases: planning, development, and maintenance. Information engineering decomposes the life cycle into eight stages: (1) Business strategy planning, (2) Information strategy planning, (3) Business area analysis, (4) Business system design, (5) Technical design, (6) Construction, (7) Transition, and (8) Production. Each of these stages has a building block that addresses its main functions. A key element is the existence of a data dictionary or encyclopedia that is referenced during each one of the life cycle stages. Without a good data dictionary, information engineering would be impossible.

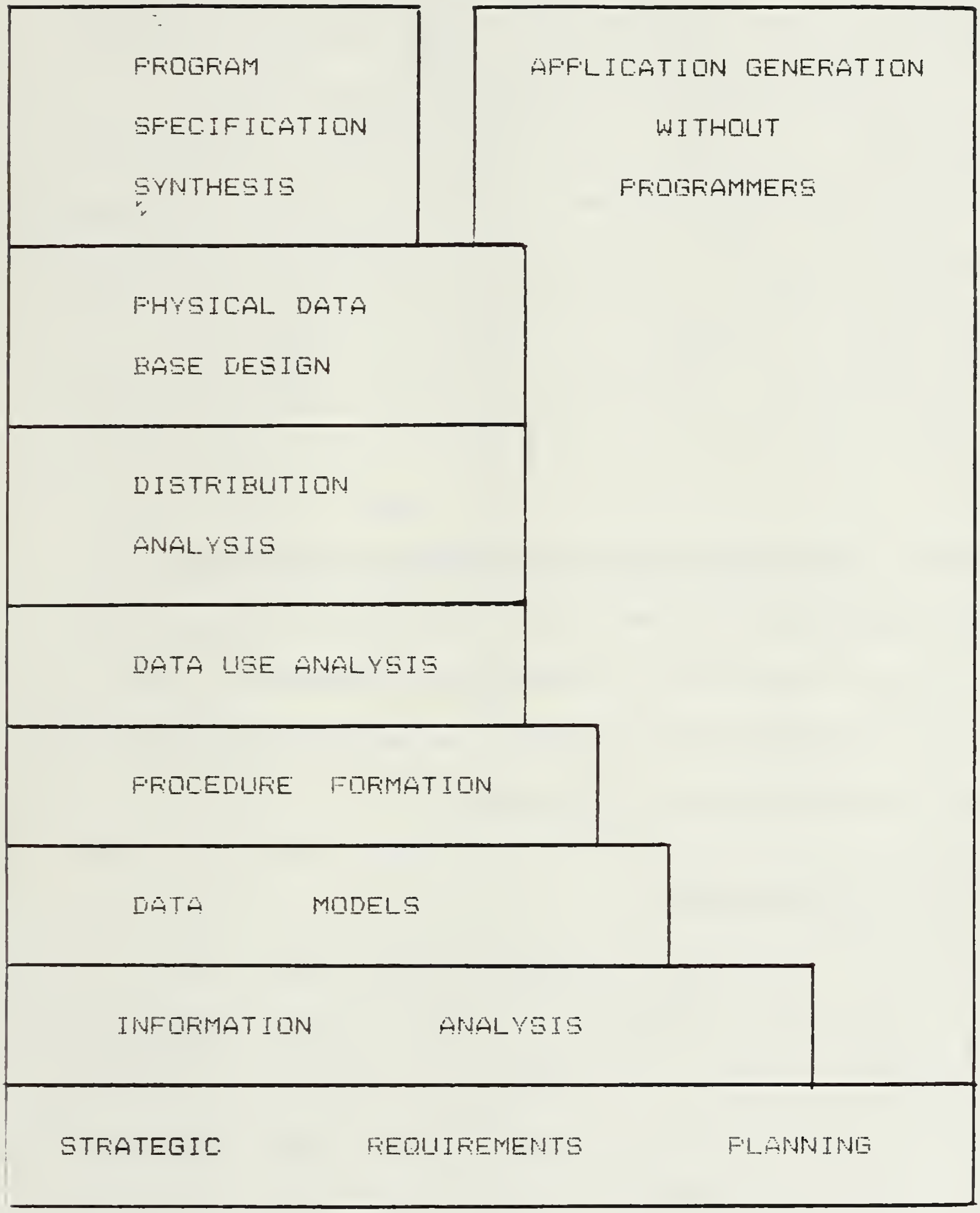

Figure 3 - Steps in Information Engineering [Ref. 10]

3. Data Dictionary

There are basically four classes of data environments. Early programming methods involved only the first class: files. The second class, application data bases, include data bases designed for separate applications. The third and fourth classes, subject data bases and information systems, require an enormous amount of sharing of data attributes and if uncontrolled can become unmanageable. The purpose of a data dictionary is to control that data. James Martin defines a data dictionary as " a tool which lists all fields that are used, their definitions, how and where they are used, and who is responsible for them. All fields in all locations are in the data dictionary." [Ref. 11] The data administrator needs the data dictionary to enforce agreement on the definition of each field in order to ensure compatibility of the data throughout the corporation.

4. User Involvement

Another major difference between traditional software development techniques and information engineering is the degree of user involvement. In the past, the user filled out a form stating his application requirement and sometime--on the average of three or four years later--a piece of output might show up. But in information engineering, the user is directly involved in each of the stages. For instance, in strategic requirements planning, senior management must be involved to ensure the correct objectives and direction of the organization for the future are properly communicated. In information analysis, the user is primarily responsible for the completeness and accuracy of the organizational data base. Finally, in application development without programmers, the user creates and utilizes the applications he needs to get results. This method of user involvement leads to a more flexible environment in which changes can be made easily and quickly.

5. Six Stages of Growth in Data Processing

A final differentiation between the data-oriented analysis of information engineering and the procedure-oriented analysis of software engineering can be shown by discussing the effects of the six stages of growth in data processing identified by Richard Nolan and shown in Figure 4 [Ref. 12]. During the first two stages, initiation and contagion, the data processing department is concerned with automating functional cost reduction applications of specific areas such as accounting or inventory control. If all goes well, additional requirements are considered. During the third stage, control, the DP department finds itself unable to keep pace with requirements. Often this is caused by the lack of an overall plan throughout the corporation for utilizing data processing. During the control phase, management upgrades documentation and requires formalized justification for future applications. Integration is the fourth phase and is marked by a fundamental change in the way applications are developed. Data is consolidated. In the fifth stage, data administration, the organization has a well-developed data base. In the final stage, maturity, the data processing function "mirrors" the way the organization operates and all is right in the world.

Organizations in stage 1 or 2 can successfully utilize procedure-oriented analysis and design techniques. A more mature organization must use the data-oriented techniques because procedure-oriented techniques make it virtually impossible to identify data redundancy which exists throughout the organization.

INITIATION	CONTAGION	CONTROL	INTEGRATION	DATA ADMIN	MATURITY

Figure 4 - Stages of growth in data processing [Ref. 12]

6. Summary

The traditional methods of software development are still important to smaller applications and to organizations just beginning to utilize data processing. Information engineering was not created to replace those methods. The primary goal of information engineering is to give larger organizations the capability to design data processing systems that support the organization's objectives and capitalize on the value of the data resource. Corporations such as Exxon and government agencies such as the Naval Supply Systems Command have endorsed the concept of information engineering and are currently involved in projects based on its methodologies. The "mature" organization of the future is closer to becoming a reality.

IV. DATA ADMINISTRATION AND VERTICAL INTEGRATION

A. OVERVIEW

The design of modern information systems is far more complex than any project most organizations have previously attempted. As an organization moves through Nolan's stages of ADP evolution, it is more difficult to change its ADP structure to fit its information needs. No simple tools exist to assist corporate managers in planning the transition to the next phase. Techniques such as life cycle planning, stages of growth, Business Systems Planning and critical success factors all lack some integral elements and are not totally effective in today's highly technical, complex information world [Ref. 13]. Information Engineering is the latest attempt at successful planning of information needs.

An organization cannot rely solely on the concepts of Information Engineering in creating information systems. IE should be viewed as the nucleus of a variety of data processing tools or techniques that when thoughtfully integrated furnish the organization with an effective system that handles information needs now and will allow sufficient expansion to meet all future requirements. The following are some of the many components of a complete information system as shown in Figure 5:

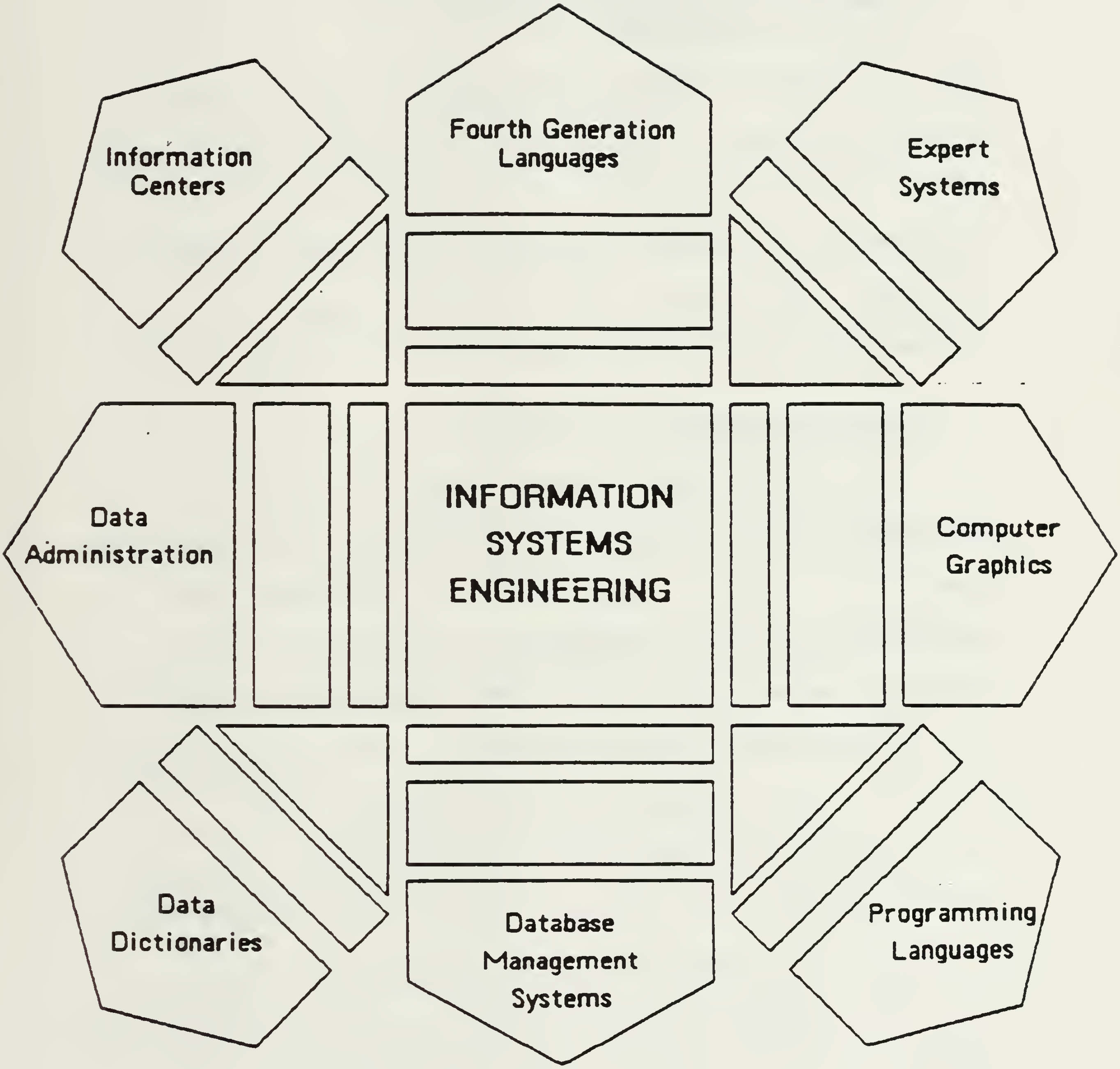

Figure 5 - Components of Information Engineering

1. Information Centers
2. Fourth Generation Languages
3. Expert Systems
4. Computer Graphics
5. Programming Languages
6. Database Management Systems
7. Data Dictionaries
8. Data Administration

Most of these components are software tools that aid the system developers or allow easier retrieval of data by the users. The last component, Data Administration, is a collection of management functions that when properly performed significantly ease the effort required in an Information Engineering project.

B. DATA ADMINISTRATION FUNCTIONS

Data Administration is best described as the responsibility for planning, coordinating, and managing an organization's data. Basic functions to support that responsibility have evolved from administrative and technical issues involved with data base administration. The concept of Data Administration is less than ten years old and is far from being a defined entity. Most definitions of Data Administration embrace at least five areas: strategic data planning, data modeling, data conventions and standards, data interchange and tools management. An overall goal should be the establishment of policies and guidelines for the management of data as a valuable corporate resource. The following list of duties of a data administrator is representative of those found on position descriptions for a variety of companies.

> Manages the development of standards, methods, and guidelines for data planning, analysis, data modeling, documentation, and logical database design.
>
> Manages the coordination between users, project management, analysts, and management.
>
> Manages the logical database designs and the use of logical design software.
>
> Manages the establishment of the Data Dictionary and develops standards for its use.
>
> Plans and manages the education of the staff on data planning, analysis, modeling, documentation, and logical design.
>
> Manages the staff in providing data modeling support to all project team system development efforts.
>
> Provides logical database designs and performance specifications to database administration and verifies any required database design changes for the project and user management.
>
> Provides an awareness of contemporary methods of data modeling and evaluates their application in the current organizational setting.
>
> Manages the security and privacy of the data in all logical design.
>
> Manages the maintenance of the strategic plan.
>
> Provides the resolution of all data definition and usage issues.

Originally, data administration was thought of as a purely technical function having primary responsibility over the effectiveness and efficiency of data bases and database management systems (DBMS) [Ref. 14]. However, corporations soon found that merely appointing someone to be in charge of data bases left a void in the overall management of data. The data administrator definitely needs to possess two types of talent: administrative and technical.

Administrative skill is required to handle management and policy affairs, to interact with various groups of concerned and affected people, and to define what should be in the organization's data bases. The technical skills are required to determine implementation issues relevant to the specific data bases and to define how the organization data bases will be structured and accessed.

The functions of data administration (DA) are often combined with those of database administration (DBA) in organizations where the same person performs both sets of functions. Many organizations consider the DA to be simply the chief DBA. For those organizations moving towards the maturity phase, combining Data Administration and database administration functions is not realistic. Those organizations require the DA to have extensive knowledge of the organization and its overall composition. For instance, in Information Engineering, the Data Administrator would be fully involved in the first three steps: strategic requirements planning, information analysis, and data modeling. There are few data base administrators that possess the necessary skills to properly execute those functions as well as have the time to adequately control the data bases.

The combination of these skills or rather the lack of combination often determines the placement of the data administration function within the organization's structure. When a data administration shop is just beginning it is often placed lower in the organizational heirarchy because upper management is unsure of the technical aspects of its data bases. However, to ensure better data consistency throughout the organization, it is better to separate the functions of the data administrator from the database administrator and place the DA function high enough in the organizational chain to be effective in policy matters that affect information systems.

C. DATA ADMINISTRATION VS. DATABASE ADMINISTRATION

Figure 6 shows a comparison of data administration and database administration concerns [Ref. 15]. The basic difference involves interfacing with a particular data base vice structuring data independent of a data base. Data administration must be concerned with the long term design needs and utilizes the data dictionary as a primary tool. The data administrator has the overall responsibility for the organization's data resources, and is responsible for non technical activities such as planning and defining the conceptual framework for the overall database environment.

not just that specifically limited to DBMS usage. Database administration is concerned with the efficiency of the actual database structure and DBMS. The DBA is the organization's leading technical expert on database related activities and is reponsible for the day-to-day operation of all database related activities. He is involved with the daily decisions and activities which have immediate impact upon the organization's operational data bases. The DBA is not overly concerned with data modularity, extendability, or utility. Data modularity is the ability of a data structure to accommodate more easily changes to the information requirements of the organization. Data extendability is the ability of the data structure to accommodate additions or deletions to instances of data without affecting the design of the structure or the programs that use the data. Data utility is the ability of a data structure to satisfy the information needs of a variety of end users.

DATA ADMINISTRATION VS. DATA BASE ADMINISTRATION

	DATA ADMIN	DATA BASE
PRIMARY RESPONSIBILITY	ADMINISTRATIVE	TECHNICAL
SCOPE	ALL DATA BASES	DATA BASE SPECIFIC
DATA DESIGN	LOGICAL	PHYSICAL
TIME FRAME	LONG-TERM DATA PLANNING	SHORT-TERM DEVELOPMENT AND USE
PRIMARY ORIENTATION	METADATA DATA DICTIONARY DATA ANALYSIS DBMS-INDEPENDENT	DATA DATA BASE DATA DESIGN DBMS-SPECIFIC
DESIRES TO:		
MINIMIZE	FUTURE DATA STRUCTURES MAINTENANCE COSTS	ACCESS TIME
	FUTURE PROGRAM MAINTENANCE COSTS	CPU CYCLES
	DATA REDUNDANCY	DATA BASE REORGANIZATIONS
	DATA COUPLING	TRANSMISSION COSTS
MAXIMIZE	DATA MODULARITY DATA EXTENDABILITY DATA UTILITY DATA SHARING PROCESS/DATA INDEPENDENCE	STRENGTH OF DBMS DISK UTILIZATION DATA SECURITY

Figure 6 - Data Administration vs. Database Administration [Ref. 15]

D. DATA ADMINISTRATION AT NAVSUP

In November 1984, NAVSUP reorganized the Inventory and Information Systems Directorate (SUP-04) in a move to help gain control over current and future systems development. A major point prompting the reorganization was the fact that NAVSUP was supporting development of separate information systems without any integration between those systems. As part of the reorganization of SUP-04, a data administration branch was created (SUP-0414) as part of the Information Systems Management and ADP Security Division. Its primary objective is to develop a corporate data plan and logical data model for NAVSUP that will maximize sharing, minimize redundacy and coordinate all data flow within the Naval Supply System and its interfaces with external systems.

The majority of the Data Administration Branch's effort to date has been with defining goals and implementing the DA function at NAVSUP. The branch has created the following objectives and a timetable for the next two years:

Mar 86 IMPLEMENT THE DATA ADMINISTRATION FUNCTION

Staffing POM and Recruitment
NAVSUP Corporate Requirements
Mission Statement
Policy and Procedures Statement

June 86 DEFINE AN OVERALL INFORMATION SYSTEM ARCHITECTURE TO SUPPORT NAVSUP BUSINESS FUNCTIONS

- Define Current Initiatives
- Create NAVSUP Steering Committee
- Develop NAVSUP Business Model
- Develop Information Architecture

Dec 86 DEVELOP DATA ARCHITECTURE TO SUPPORT THE NAVSUP INFORMATION SYSTEMS ARCHITECTURE

- Design NAVSUP Logical Data Model
- Develop Corporate Data Dictionary

Jun 87 DEVELOP A NAVSUP TECHNICAL PLAN ENCOMPASSING TELECOMMUNICATIONS, OFFICE AUTOMATION, AND OTHER EXISTING NAVSUP INITIATIVES

- Document Systems Hardware and Software
- Develop Systems Concept Paper
- Perform Input Analysis
- Develop Technical Plan

The above objectives support goals of (1) developing the overall objectives of the data administration function and secure their endorsement by top management; (2) determining NAVSUP's DA scope, in terms of both subject matter, and organizational components and programs; (3) assigning overall authority and responsibility; and (4) promulgating overall organizational policy. According to its mission statement, the data administration branch is dedicated to providing a systematic plan for developing standards and policies which ensure ultimate vertical and horizontal integration of data among the various NAVSUP and external information systems.

Although the branch has been poorly staffed since its inception, a considerable amount of headway has been made towards achieving its first year goals. An initial decision has been made for SUP-0414 to be the proponent for all NAVSUP information resources and to develop the DA plan while FMSO is being tasked to accomplish the DA tasks. The following is a list of SUP-0414 and FMSO functions as currently defined:

SUP-0414 FUNCTIONS

1. Develop and maintain a NAVSUP Corporate Data Plan and Logical Data Model to reflect the data structures required to support the information requirements of the Naval Supply System.

2. Initiate and develop, in coordination with the Planning and Policy Branch, NAVSUP standards and procedures related to data resource management, including, but not limited to, Data Dictionary Specification Standards and Data Element Naming Conventions.

3. Serve as NAVSUP arbiter to review and resolve data resource issues within ADP program development.

4. Review Data Communication Requests to insure compliance with Data Administration Standards and Procedures.

5. Develop and implement Data Element Naming Standards and Policies for all NAVSUP ADP systems.

6. Develop policy and procedures for data transfer across all NAVSUP networks, including data download to microcomputers.

7. Manage development, implementation, and maintenance of the Corporate Data Dictionary.

8. Act as NAVSUP liason with all external data systems within Navy, DOD, and civilian agencies and data standardization efforts.

9. Review System Life Cycle Maintenance Documentation for adherence to Data Administration Policies and Procedures.

10. Develop policy and standards for logical data base design for all NAVSUP system development projects. Conduct post implementation reviews to insure compliance to standards.

11. Develop NAVSUP policy and standards for initiatives that access any data base, both Corporate and private.

FMSO Functions

1. Perform system planning.

2. Provide access procedures and monitoring for all databases.

3. Perform data and impact analysis.

4. Assist NAVSUP DA Branch in determining Headquarter's Corporate data requirements.

5. Provide input to policy.

6. Implement corporate data model.

7. Determine and maintain a record of relationships among databases.

8. Develop corporate data dictionary.

9. Monitor quality and integrity of data.

10. Function as technical DA expert.

11. Establish documentation standards for database systems.

12. Conduct formal DA training.

13. Evaluate various automated tools for DA development.

14. Serve as principle consultant on database design projects and audit trails.

From the above lists, it can readily be seen that SUP-0414 has a good idea of what it wants to accomplish but must rely heavily on FMSO to do so. What remains to be seen is how much top management support SUP-0414 will be given. The next step for NAVSUP's Data Administration Branch is to develop the NAVSUP DA Directive to outline all responsibilities and establish its corporate policy.

E. DATA ADMINISTRATION AND VERTICAL INTEGRATION

One of the goals formulated by NAVSUP in its strategic plan is to "Develop databases which support the single update of related data and provide the required views of that data to all levels of the work force" [Ref 16]. To achieve that goal requires the integration of NAVSUP's information systems both vertically and horizontally. In relation to the three information systems discussed, SUADPS REAL-TIME, UADPS-SP and UICP, vertical integration involves transferring information from one system to another, ie., from ship to stock point. Horizontal integration involves passing information from organization to organization on the same level, ie., from stock point to stock point.

Integration of information systems requires compatible hardware and software and well-developed data bases. NAVSUP has addressed the problem of hardware and software compatibility and included those requirements in the specifications for the SPAR system acquisition. Indeed, the technology to allow communication between the three systems exists today. Additionally, at the completion of the SPLICE project, the capability for UADPS-SP systems to communicate through the DDN will be achieved. However, compatible systems cannot overcome weaknesses in data organization. How valuable is having integrated information systems if the needed data does not exist, or no one knows whether the data is available or not, or if conflicting data exists, or if effective controls over the use of the data are lacking? The above weaknesses exist in most organizations' information systems and are the primary focus of data administration.

NAVSUP headquarters has a definite problem with integrating its three information systems because its overall ADP environment has never existed in stages 4 and 5 of Nolan's cycle: Integration and Data Administration. These two stages are characterized by the integration of applications vice information systems and by the development and management of data bases. All of NAVSUP's previous systems utilized file structures based on applications. SUADPS REAL-TIME has retained its redundant file structures. UICP RESYSTEMIZATION is being designed around its current applications. The redesign of UADPS-SP is NAVSUP's first attempt at using modern database structures and database management systems as well as restructuring applications. NAVSUP is therefore having to move through two phases to catch up to today's technology. This is primarily due to the requirement for NAVSUP to keep its original systems throughout the period that comparable organizations were implementing data base systems. Another negative factor is the decentralized environment in which the NAVSUP systems have evolved. For two decades, the coordination of the three systems at the ship, stock point, and ICP level was a low priority at headquarters.

In an effort to support the goal of integrated information systems, NAVSUP's strategic plan requires the establishment of a formal SPAR/ICP RESOLICTATION/SUADPS application working group to identify and justify integration opportunities. Although it initially restricts the concept of integration to the three current systems and their current applications, it is a beginning. For this integration team to be effective, it should be relatively independent of the management hierarchy in order to avoid the power struggles of each of the current systems and to escape the risk aversion attitude of corporate headquarters. The accessibility of data creates a multitude of questions regarding NAVSUP's traditional support structure. The business of providing supply support to the operating units of the Navy remains the same. However, NAVSUP should take advantage of technological advances, look at the current automated applications and functions, and ask whether it can be done better with new technology. For instance, if a ship has access to the worldwide inventory of parts, does it need to submit a referrral to the closest stock point if it is not carried there? Why not refer the requisition to the stock point or activity that has the part available and avoid the additional referral to the ICP? In a segregated information organization, the answer would be because that function does not exist at the shipboard level. It is the ICP's responsibility. Finding the optimum solution to questions created by the new availability of data will be difficult at best. It requires a total rethinking of the processes.

Many of the questions that the integration team will address should have been answered prior to the beginning of the UICP RESYSTEMIZATION project or at least the Information Engineering portion of the SPAR project. An example is the interfaces needed between the three current systems. That guidance should have originated from headquarters as part of a top-down planning technique of the strategic requirements phase. The redesign team at FMSO used a bottom-up approach to define the probable interfaces. No decision has been made about whether all the interfaces are correct and complete. In the meantime, FMSO is beginning to feel the pressure of command dictated completion dates.

The objectives of Data Administration support the goal of integrated information systems. Data is the most important component of information systems. The key is knowing what data exists and where it is located. The functions of the DA include developing and maintaining a data dictionary which can answer queries regarding information resources. For instance, if NAVSUP needed to know the data entities and applications containing standard MILSTRIP requisition information such as QUANTITY-ON-ORDER, the Data Administrator should be able to respond with information detailing the fact that QUANTITY-ON-ORDER is represented by six different variable names in 23 different programs and be able to list them. Data dictionary information is extremely valuable in systems integration. Therefore, the integration team should study the overall Data Administration organization at NAVSUP to help understand the complexities of structuring data to facilitate system interfaces. NAVSUP may have begun its Data Administration program too late to play out its complete role in the information engineering project for SPAR. However, NAVSUP is not just in the business of supply support; it is also involved in retail operations, petroleum, household goods shipments and many other information-dependent functions. The establishment of effective integrated systems in one area may pave the way for additional improvements in other information systems.

F. PROBLEMS WITH DATA ADMINISTRATION AT NAVSUP

The establishment of the data administration function at NAVSUP is now at a crossroads. The definition of goals and objectives for DA are relatively complete. Implementation of those objectives and achieving the goals will not be as easy. Top management at headquarters must dedicate support and make a decision regarding the scope of the DA function to give the Data Administration Branch the power it needs to fulfill its responsibilities. SUP-0414 has encountered many of the same problems in establishing the data administration function as its counterparts in other large corporations. Among those are lack of expertise and resistance to change. Other problems such as the budget constraints for the DA evolution are unique to a military or government environment. The following is a list of factors that are currently hindering the proper development and effectiveness of the data administration function at NAVSUP:

1. Incomplete staffing of DA Branch: The current plan allocates three positions in SUP-0414. Only one position remained filled for the past 10 months and it is now vacant. Recruitment does not seem to be a top priority.

2. Limited ADP background of staff: The one staff member previously employed devoted the majority of her time getting up to speed on ADP terminology and database techniques. This has resulted in a lack of credibility with the principal players at FMSO and the information systems sponsors at NAVSUP.

3. The DA Branch's location in NAVSUP'S organizational structure is too low to solicit

cooperation from information systems sponsors: SUP-0414 is competing against the firmly entrenched support structures of the three current information systems. DA objectives which require a rethinking of application functions are unachievable in the current structure without power struggles.

4. Attempting to establish a DA environment in a decentralized ADP environment: NAVSUP headquarters has no control over the data or the applications development of its information systems. Data is processed around the world while the design and development of the three information systems is accomplished by two separate activities. Implementing data standards will be more difficult than if NAVSUP functioned under a centralized ADP concept.

5. Attempting to implement DA functions in time to determine data needs for SUADPS REAL-TIME/ SPAR/ UICP interface: If data administration is to effectively support the information engineering concept, data needs and interfaces must be determined prior to system design. SUP-0414 is way behind the power curve regarding the current development of information systems. The needs of the three projects may be dictating the DA efforts instead of the true needs of the corporation.

6. Corporate inexperience with database management: Data administration functions evolved from database administration. It is difficult to determine long range and overall data needs without experience with designing and operating specific databases.

7. Data Administration conflicts with the traditional organizational philosophy of NAVSUP: Headquarters is uncomfortable with the concept of DA because it is historically a reactive or risk aversion centered organization. The lack of ADP oriented personnel at headquarters restricts the knowledge of information engineering and the value of well-integrated data.

8. Current time schedule for achieving DA functions waits too long before tangible benefits are achieved: An organization such as NAVSUP needs to see tangible benefits in order to justify the expense of the DA function. In the government,

this is especially a problem due to the budget process and current deficit spending concerns.

The above problems are by no means fatal to the data administration function. However, collectively they critically restrict the evolution of the DA function at NAVSUP. If NAVSUP is serious about providing integrated data throughout its organization, then it must dedicate top management resources to solve these problems. SUP-0414 has identified the needed tasks. However, no real authority exists to ensure they are performed.

V. CONCLUSIONS

The world of information systems design has undergone a remarkable change since NAVSUP first implemented SUADPS, UADPS-SP and UICP. Unlike many corporations which have implemented database systems, NAVSUP is not afforded the opportunity to make an easy transition from the application centered projects to the concept of information engineering and integrated systems. Data Administration is one management function that can allow NAVSUP to eventually catch up with its information needs if it is given enough support.

The UADPS-SP redesign effort will be the key to NAVSUP having integrated information systems. SUADPS REAL-TIME and UICP have already been committed to application-dependent file structures. UADPS-SP will be the prime interface vehicle for the integration of data. The FMSO UADPS-SP Redesign Team has taken the lead in performing the strategic requirements function of information engineering. It must be completed prior to the design of the logical database structure. NAVSUP should respond as soon as possible to their queries regarding the desired functional activities of UADPS-SP.

Aside from providing token input regarding naming standards, the NAVSUP Data Administration Branch has been ineffective in assisting the information engineering project. Its obvious weakness has been in staffing. Now that the goals and objectives for data administration have been delineated, NAVSUP should decide what it is going to do with its organization. DA cannot evolve effectively as it is currently located and manned. If a true IE effort is envisioned, it should be moved up the NAVSUP organization to either the SUP-00X or SUP-04 level to give it the full "top-down" support it requires. Otherwise it should be moved to FMSO where the knowledge of database management and design resides and where it can realize its objectives relating to integrated data design. Then, after tangible benefits become evident, consideration can be given to expanding the scope of DA and migrating it to headquarters for higher level administrative purposes.

The UADPS-SP redesign project is not a true, top-down information engineering project. Nevertheless, many of the issues the FMSO team is addressing are top management issues. This results in the equivalent of a "middle out" approach to IE which makes the development of a corporate data dictionary exceedingly difficult. The NAVAL SECURITY GROUP for example required six months just to standardize 400 names for a corporate dictionary. UADPS-SP is much more involved. With the current time restrictions placed on the redesign effort, serious consideration should be given to developing a dictionary which is much smaller in scope and which facilitates the transition to a data-oriented

UADPS-SP. If this is successful, then a concept known as selective retrofitting can be used to incorporate new applications as they arise and evolve towards a comprehensive, integrated corporate dictionary.

Today, there is a critical need to integrate information systems within NAVSUP. Information needs throughout the organization have increased tremendously. The capability to have an integrated system exists, if NAVSUP can gain control of the data. SUADPS Real-Time, SPAR, and UICP RESYSTEMIZATION began at different times and are in different stages of development. For NAVSUP to properly integrate those systems to allow worldwide access to data at all three levels of the logistic chain, it will have to free data design from applications. An effective data administration organization is needed to ensure the data requirements of the overall corporation are satisfied.

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