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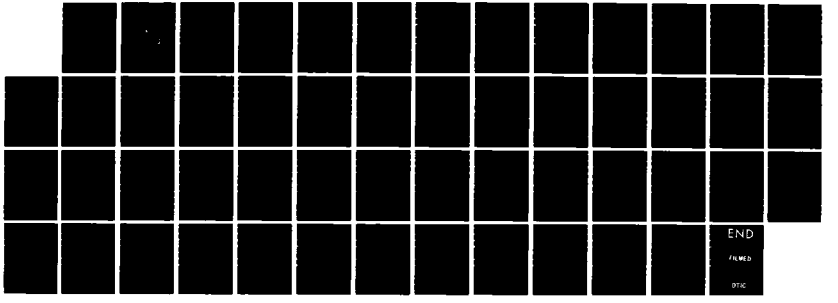

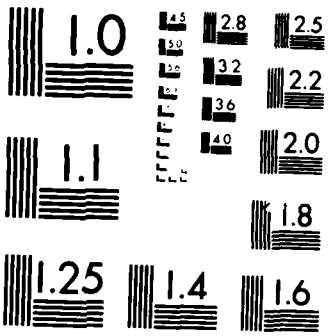

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

MANAGEMENT CONSIDERATIONS
FOR AN INFORMATION CENTER

by

John D. Auvil

September 1984

Thesis Advisor: Norman R. Lyons

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An actual government installation is used as an example of using a modern Systems Analysis approach in the installation of an Information Center.

Industry trends are discussed and the debate of centralization versus decentralization presented.

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Management Considerations for an Information Center

by

John D. Auvil
Naval Air Test Center, Patuxent River, MD
BSEE, West Virginia Institute of Technology, 1971

Submitted in partial fulfillment of the
requirements for the degree of

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Author: _____
John D. Auvil

Approved by: _____
Norman R. Lyons, Thesis Advisor

_____
Daniel R. Dolk, Second Reader

_____
Willis R. Greer, Chairman, Department
of Administrative Sciences

_____
Kneale T. Marshall, Dean of Information
and Policy Sciences

ABSTRACT

Recent studies have shown that the data processing industry has a very severe problem to solve. In the next few years there is going to be an extensive increase in millions of instructions per second (MIPS) available due to increases in hardware technology. It is imperative that the software development industry find ways to utilize this capability. Increased programmer productivity is the key.

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I. INTRODUCTION

A. CONTEXT OF THE STUDY AND BACKGROUND

This thesis deals with the subject of an Information Center as seen from a managers point of view. It is an innovative departure from the existing, well established concept introduced by IBM several years ago. Instead of being primarily a service group involved in providing information and sources of information, this newer concept provides a rather all-inclusive approach in trying to cope with the overwhelming problems of increasing software development efficiency and programmer productivity. In many aspects, the Information Center concept presented integrates the major data processing areas such as the Management Information System, the Database Administration, and Software Development activities of an organization.

This new concept of an Information Center also covers such areas as hardware and software acquisition, physical and software security, and instruction and training on modern Software Engineering principles and practices. The prime impetus for this study is the almost evolutionary proliferation of data processing capability, (both hardware and software) at all levels of many organizations. Although this paper describes a particular organization, it can easily

be extrapolated to other organizations, especially within the Federal Government's scientific laboratory community.

An Information Center (I/C) is normally part of a larger organization called a Management Information System (MIS). In the 1970's, much attention was focused upon MIS development. These systems were designed to provide managers with information needed for effective planning, control, and decision making. In the 1980's this emphasis will continue in order to improve the productivity of managers at all levels.

A precise definition of an I/C is difficult because the concept is changing continuously. The tremendous increase in management information requirements have stepped up the demands of laboratory and administrative personnel for expanded, more efficient, and better integrated information services. The result has been a trend to consolidate the technical expertise in all aspects of computer hardware and software engineering within a single facility.

Much of the literature today talks of a specialized Information System. It is called an Information Analysis Center (IAC) and does essentially the same function as an I/C. One such definition is:

An information center is a person or group of persons who has accepted the responsibility to gather together everything known that is relevant to a particular well-defined field, to organize the information in some systematic fashion so that

they and others will know what information exists, to analyze...the new knowledge and to maintain these activities as a long term commitment for a substantial portion of their professional career [Ref. 1].

The need for an I/C environment becomes very clear when you look at some of the factors that contribute to the frustration of both users and managers in the data processing field.

This paper will focus on a narrow portion of the problem, specifically, the efficient utilization of data processing, ie. the use of microprocessors, minicomputers, and intelligent data terminals distributed throughout many organizations.

B. FORMAT OF THE THESIS

This paper is divided into three major areas. The first area presents an overview and general discussion of areas of management concern involving the incorporation of an I/C.

The second major area describes the system analysis methodology that will be used at a specific government installation as it prepares to establish an I/C function into its organization.

The third area covers industry wide opinions on the MIS/IC concept and describes present attitudes and general trends the industry is taking in this very important area.

II. AREAS OF MANAGEMENT CONCERN

A. USER REQUIREMENTS

As users become more knowledgeable about data processing operations, in part because more and more of them use micros, MIS departments are under greater pressure than ever before to perform and support an ever wider range of DP functions.

Most users are very happy compared to past years, and the reason is their much greater involvement in actual DP operations. One of the best ways to involve users is having them contribute in the process of improving the performance of key systems, of setting priority assignments for new developmental efforts, and of helping to plan for the future by defining new concerns. [Ref. 2]

Management is especially concerned with service level reporting, especially on insuring that the DP center responds quickly to user requests.

Part of keeping users happy involves the rapid dissemination of the data they request. The information center concept has been developed to meet this goal. With an information center, MIS gets a highly visible program for users and management for a modest investment of effort. The big plus is that the concept promotes a dialogue between MIS and users. [Ref. 3]

There is definitely a trend in modern organizations which shows a much closer association between the data gathering functions and the data analysis and users of the information. This can clearly be shown in the software programming/ analysis skills being taught as part of the technical curriculum at most colleges and universities, and the work that project engineers are actually doing as part of their everyday jobs.

The users of today have become much more knowledgeable and familiar with computers and computer software. They are in a much better position to decide how their data is to be analyzed.

Even with this sophistication, the average user cannot possibly keep up with the rapidly changing world of computers and software engineering. This is where the I/C concept is extremely beneficial in that a core of expertise can be maintained, not to do, but to guide the users in the right direction taking into account the principles of modern software engineering.

From a social point of view, computers and software are making an even deeper impact on our personal lives. This personal involvement also carries over into the working environment. The impact on human welfare presents several tremendous challenges for management and data processing communities. As an indication of this growth, the following

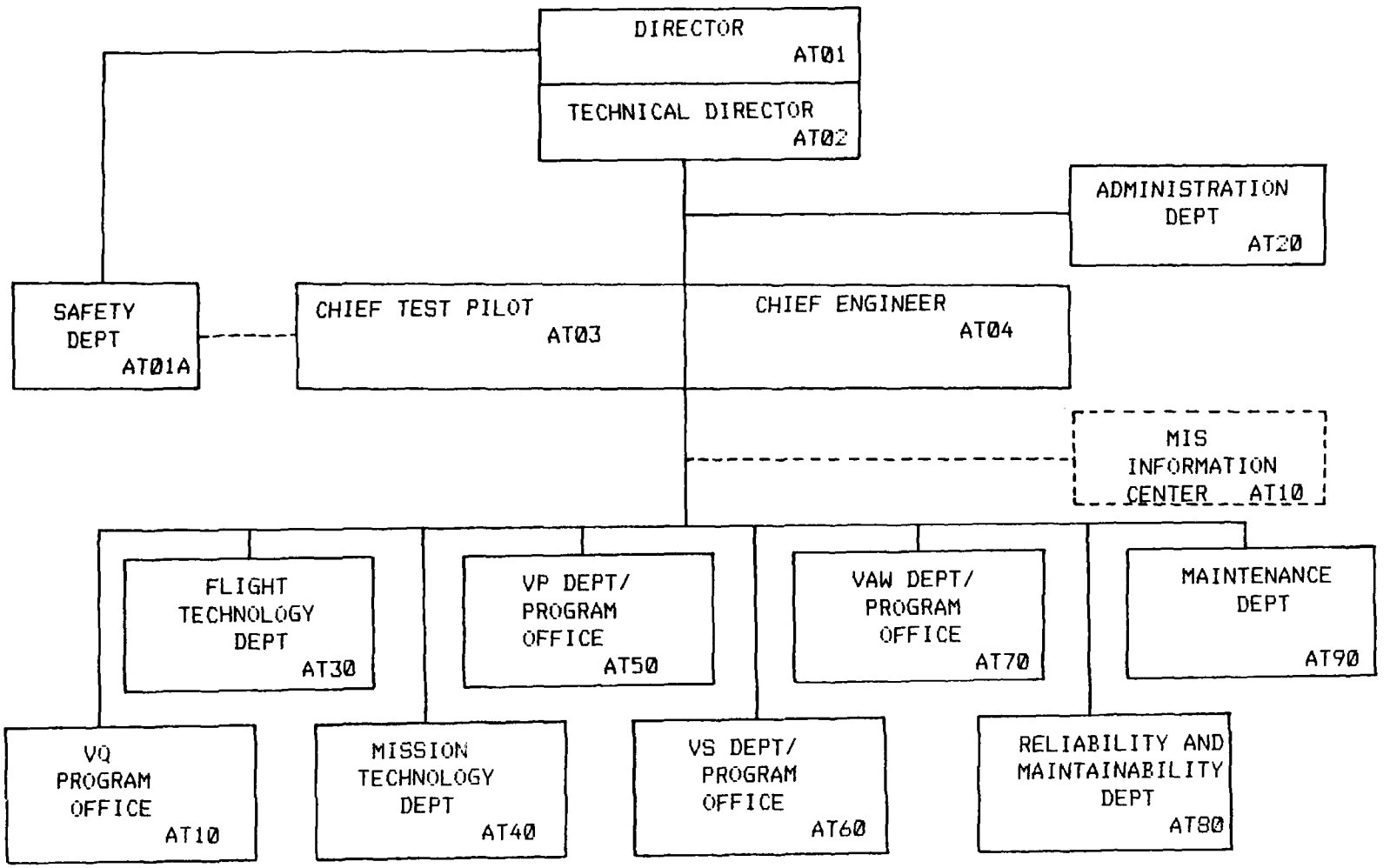

Figure 3. Updated Organizational Chart of ASATD

change. These people, both in-house government and contractors, will be concerned about the analysis group's activities. This is one of the major reasons why it is imperative that the identity, responsibility, and authority of the analysis group be well established and documented. This must originate from top management and be approved at the branch level throughout the directorate.

A project file will be established which will contain these major elements: [Ref. 8]

a. Information requests and other directives and memoranda received by the group.

b. Plans and schedules.

c. Collected documentation and existing studies already performed.

d. Memoranda and reports produced by the group.

One of the major observances of the group during this initial investigation is the possibility of a required organizational change. An example of such a recommended change is shown on the updated organizational chart (Figure 3.).

Interviews will be conducted and meetings will be scheduled, both formal and informal, to document all of the DP needs of the directorate.

In addition to interviews, a data element analysis will be performed. This will detail the real requirements of the users and will assist the analysis group in understanding

The MIS data processing requirements of ASATD can be broken down into three major areas:

a. Integration with base wide MIS systems used primarily for NAVAIRTESTCEN Project Management and Financial accounting.

b. Project management information that is used by ASATD project engineers to track all pertinent data associated with ASATD projects.

c. Local Administrative data processing requirements which include personnel records, travel, staffing, and branch administrative support functions.

This paper will address and be primarily concerned with management's concerns and interaction as it pertains to the establishment of a local MIS and IC. The value of this paper is not in the specifics but in the broad overview that must be maintained in order to accomplish a manageable DP system that will support the entire directorate.

2. Initial Investigation

One of the first steps in starting a system analysis is getting top management approval and support. Although there is a consensus of opinion among the branches that a new, modern information system is required, the formal structure and organization that will be needed to perform the analysis and to implement the chosen system has not been established. When starting the initial investigation, the analysis group must contact as many individuals in the user community as possible that may be affected by a system

The system analysis of ASATD will be constrained to using the existing hardware as much as possible with emphasis being placed on compatibility with the mainframes and existing base wide MIS.

B. STUDY PHASE

The study phase is the first of the four life-cycle phases. It is the phase in which problems are identified and the most feasible solution recommended. An initial investigation is performed, followed by a feasibility analysis. At the end of the study phase a report is made describing the results of the study and recommendations presented. [Ref. 7]

1. Problems are Identified

An important part of the study phase is in identifying the major problems that face the organization in the area of data processing. The overriding question and management's greatest concern is how best to utilize the decentralized data processing, ie. the use of minicomputers, microcomputers, and data terminals, to satisfy the growing demands and needs of users.

There is also a need to integrate management information into a common local data base and be able to network this data with centralized data at the Test Center level. Since an actual organization is being used to describe the system analysis, specific problems can be addressed.

The Test Center has incorporated a semi-automated project tracking system in that a data base is resident in the Computer Systems Directorate (CSD) mainframe systems and weekly reports distributed throughout the directorates.

Existing facilities include the base wide Computer Systems Directorate central computer facility that serves the entire base. It has as major components a large configuration IBM 360/195 coupled with an Amdahl 470 time sharing system. The laboratory systems include a large configuration Gould S.E.L. 32/7780, several smaller 32/27 systems, and a Wang VS90 system.

The terminal/PC equipment that will be distributed throughout the directorate is the Lee Data Corporation's "ALL IN ONE" PC. This is a versatile terminal which allows ASYNC operation for communication with any of the local computer systems and also the ability to operate BISYNC to be compatible with the IBM and Amdahl mainframes at CSD.

The Lee Data can also be used as a stand-alone micro-computer which emulates an IBM PC in both architecture and functions. The Lee Data terminals will be networked throughout the directorate and will be used to access the centralized 32/7780 via the TOTAL® DBMS.

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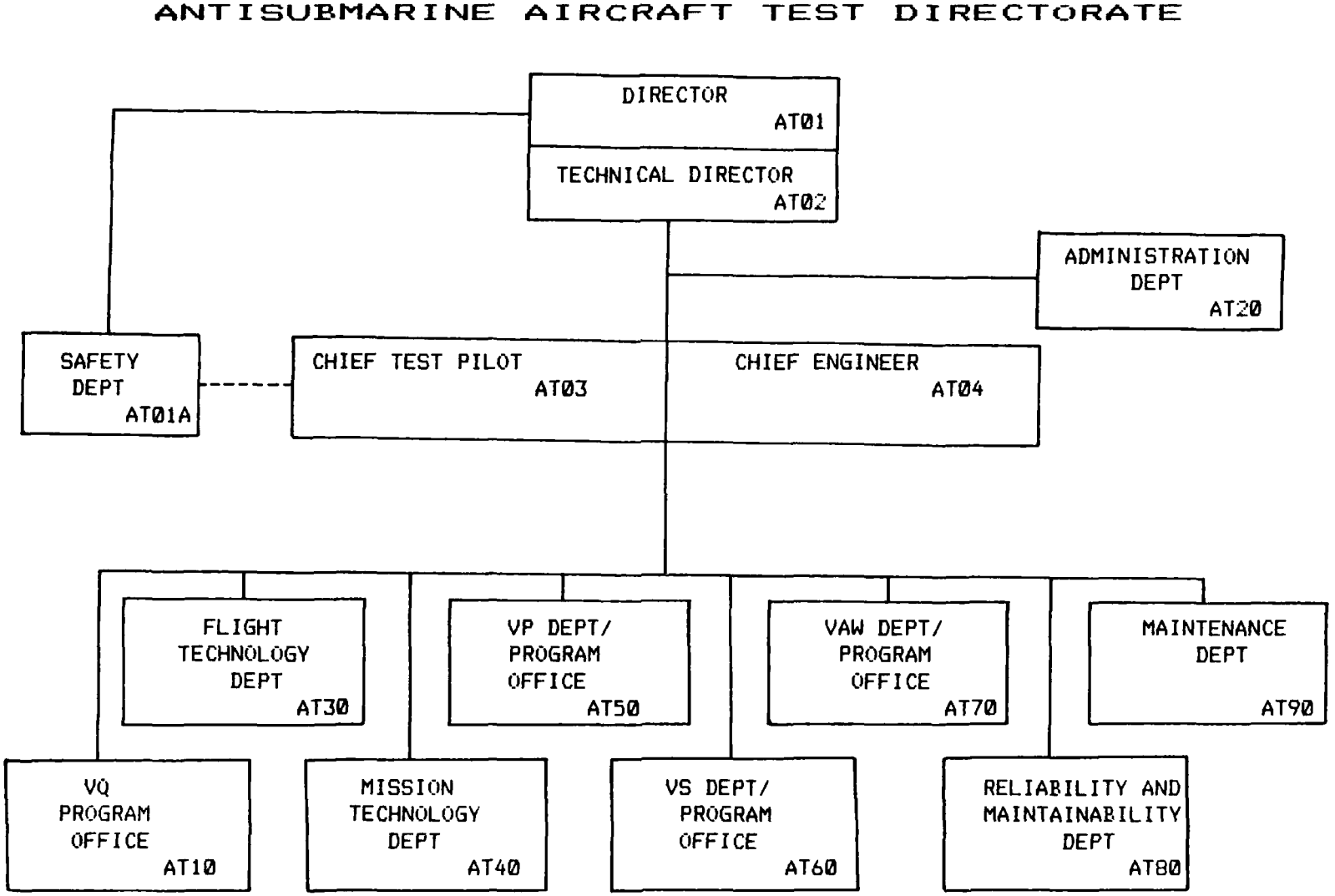

Figure 2. Present Organizational Chart of ASATD

III. SYSTEM ANALYSIS

A. BACKGROUND

In order to fully describe the MIS/IC concept, an actual government installation will be used as an example. This section of the paper will examine the four phases of the life-cycle methodology used in a modern systems analysis approach to the development of a MIS/IC organization.

The installation to be studied is the Antisubmarine Aircraft Test Directorate, Naval Air Test Center, Patuxent River, Maryland. The Naval Air Test Center (NAVAIRTESTCEN) is a major field activity for the Naval Air Systems Command, Washington, D.C.

The Antisubmarine Aircraft Test Directorate (ASATD) is one of six major directorates within NAVAIRTESTCEN. The primary task of ASATD is to perform Test and Evaluation (T&E) on the Navy's newest and latest designed airborne weapon systems. Of particular interest are those projects which involve the T&E of Antisubmarine Warfare (ASW) aircraft or weapon systems. Figure 2. shows the present organizational chart of ASATD.

In recent years there has been a tremendous growth in data processing directly related to project testing. The project engineers find themselves devoting more and more time trying to keep up with project tracking.

The I/C is an organization that is responsible to users and is required to perform such tasks as: [Ref. 6]

1. Analyzing user support needs
2. Assisting with the development of management reports and data
3. Guiding the users to the appropriate source for the solution to their problem, including non I/C approaches as the situation indicates
4. Training and guiding the users as they develop the solution to their problems
5. Helping users evaluate benefits
6. Identifying and introducing new users to the I/C
7. Identifying and introducing new ADP resources into the organization

The I/C must be designed to fully support the most up-to-date methods of modern systems analysis and software engineering. The personnel of the I/C must encourage good programming practice such as structured programming, extensive use of high level languages, modern DBMS use, and appropriate documentation standards. A modern and effective technical library is also a required function of an I/C staff. Early attention to software maintainability and the subject of software re-usability is also very important.

in ADP Security is increasingly important to all organizations.

The government has set up a detailed hierarchy of functions responsible for ADP Security. These functions include the ADP Security Officer (ASO), Computer Systems Security Officer (CSSO), and Terminal Security Officer (TSO) personnel designated by each command. The I/C is the logical functional area that would normally host these special ADP Security positions.

F. I/C CONCEPT

The concept or role of the I/C is mainly as a core of expertise, knowledgeable in ADP from many aspects: hardware, software, data bases, data base management systems, and security.

Problems involved in the I/C concept are: unfamiliar organizational structure, lack of definitive personnel classification, lack of management's knowledge and understanding of the complexity of hardware, software, and software engineering considerations.

The I/C is a concept that is designed to bridge the gap between the economics of a centralized information center and a diversified set of users who have numerous problems, questions, and requirements for the utilization of modern ADP equipment.

An example of a typical I/C facility would be comprised of a large mainframe and/or several minicomputers, specialized graphic displays, plotters, and intelligent data terminals, which can be configured as 'stand-alone' systems if required. All of these systems could be networked into a common large configuration mini through a communication switching system, and could thus utilize a very important advantage of a networked system, a data base management system (DBMS).

E. DATA SECURITY

Certainly one of the more important functions of an I/C is to track and maintain close control of data from the data security aspect. This is especially true when operating from a DBMS and national security classified information could be present as part of the data base.

Normally the I/C would also be involved in maintaining management information such as administrative data, as well as the technical data used in the everyday product of the organization. Much of this information is privacy data and must be controlled and protected from disclosure to unauthorized uses.

ADP Security is a very severe problem facing both the private sector and government. Certainly maintaining an I/C and maintaining a bank of corporate knowledge and expertise

service classifications have not kept up with the computer hardware/software revolution, especially in the software engineering area. There is no formal classification in this area, and it is becoming increasingly evident that a highly trained, highly motivated professional must be maintained in this position in order to reap the true benefits of what a modern MIS/IC can provide. At the present time, this function is being performed by engineers and system analysts as a collateral duty, and hence diluting the full capability that is required.

D. EQUIPMENT AND FACILITIES

Under the general description of an I/C, a computer or several computers, possibly networked together, provide the baseline of the equipment. The facility also normally requires an environmentally controlled laboratory. The I/C may or may not be co-located at a centralized computer facility and could be one of the nodes on a decentralized and networked system.

Actually, one of the most important functions of the I/C is not in its physical DP capabilities, but in the expertise and bank of information available to users on all aspects of data processing, equipment acquisition, and efficient use of computer resources. This is especially true in this age of individual ownership of microcomputers being used in practically all areas of the organization.

likely to have centralized computing. Arguments favoring decentralization tend to focus on improved computing service for users.

The I/C concept uses the best of both worlds in that overall corporate policy is maintained and the advantages of decentralized computing still maintained.

Also important in this respect is the core of expertise that is maintained in the I/C which would otherwise be diluted if each sub organization was to maintain their own DP staff.

The relationship between the use of an I/C as part of an MIS and the efficient operation of an organization is still not really known. Like an economic analysis, one can document the cost functions such as waste and abuse of duplicate systems, but to accurately quantify the benefits and advantages is far more subjective in nature.

C. ORGANIZATION AND STAFFING

The I/C, being solely a support organization, should be a staff function and functionally located within the organization so as to allow as free access as possible to all sub-organizations.

Staffing an I/C organization is actually a much more difficult problem than one would realize. There is great demand for good DP professionals throughout industry. This is especially evident in the public sector. The government civil

B. OVERALL MISSION OBJECTIVES

As in most organizations, the higher up in the management chain, the broader the view of the overall mission of the activity. Each Department, Branch, or sub organization, that requires data processing, sees thei own requirements from an independent view.

If the utilization of ADP is to be more efficient, a centralized view and perception of the overall objective must be kept in focus. This can be best accomplished within the I/C concept where top management can direct overall policy and direction, and still maintain the advantages of local data processing.

It must be emphasized that the I/C is set up as an information center, a repository of experience, knowledge, and current state-of-the-art concepts that are available but not mandated on the users.

Should computing be centralized or decentralized? This question, covered in-depth in an article by John Leslie King [Ref. 5] is discussed more thoroughly in section IV. Unfortunately, there is no easy answer. The real issue is control and who will control the DP resources, including DP policy. The issues involved in centralization/ decentralization decisions are deeply tied to the particular organization and how that organization functions. Organizations with centralized control and/or location of most activities are

graph (Figure 1.), [Ref. 4] shows the reliance of computers and software on today's workforce.

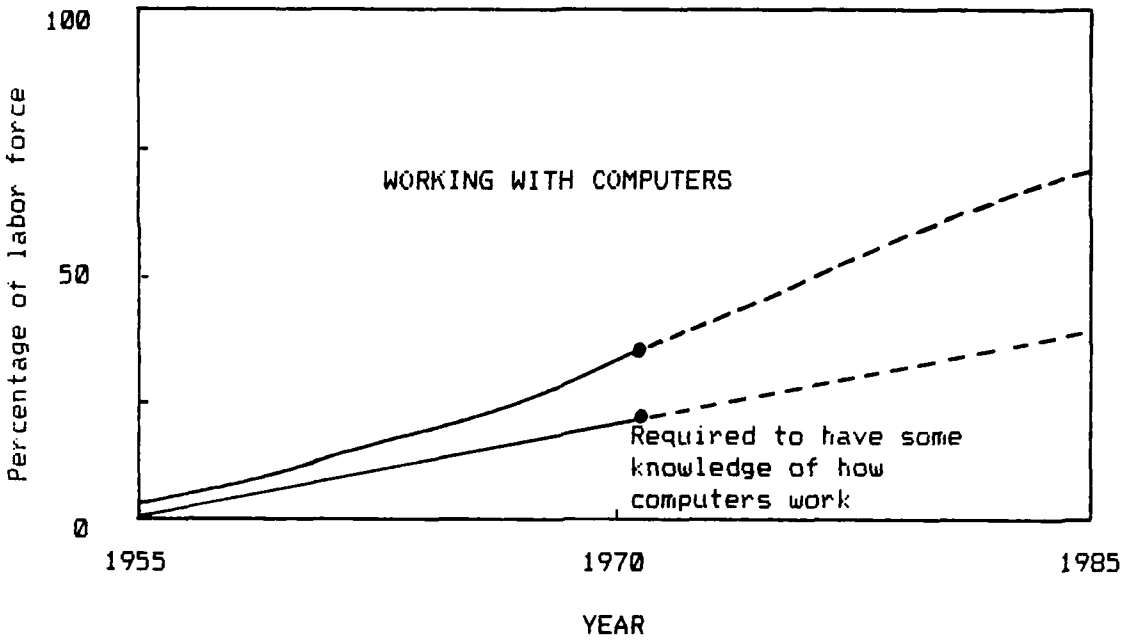

Figure 1. Growth of Reliance on Computers and Software

With this heavy reliance on local data processing, the user is faced with problems such as:

1. What hardware/software is required
2. Is the capability already in existence and available
3. What interfaces are needed
4. What about data security

These and many more questions are raised continuously throughout the organization and thus gives a valid reason for an I/C being needed and developed.

the true flow of information. This is the most important of the detail work that must be performed early in the investigation period. An input-output analysis will also be used to document the required reports, documents, interactive data screen displays, and other information system requirements.

It is during this initial investigation that major system philosophies are examined. The major questions of data sharing, multiple user updates, frequency of data processing, and data security must be addressed. Part of this investigation includes doing a Recurring Data Analysis. The significance of recurring data analysis is that unnecessary input and output data duplication can be detected. This leads to a consolidation of data and in some cases, elimination altogether. Redundant files can be located, which leads to more efficient use of file media and hopefully suggests the use of shared data bases. [Ref. 9]

From this initial investigation, several important elements can be identified. First, a determination of the major philosophy of the MIS can be shown, ie. a file orientated system, a centralized data base system, a decentralized system, or a combination of each. Second, the definition of expected or required system performance can be documented. The third element is the documented commitments required by management to develop the new MIS system. This

should also address all the resources required including manpower, financial or budgeted resources, and organizational changes, job titles, and 'charter' for the MIS/IC personnel.

3. Feasibility Analysis

From the initial investigations, interviews with users, and general system performance requirements, a system can be chosen that will best meet the requirements at a reasonable cost. The most essential tasks performed by a feasibility analysis are: [Ref. 10]

a. The identification and description of candidate configurations.

b. The evaluation of these candidate systems.

c. The selection of the best of the candidate systems.

It is during this feasibility analysis that major system tradeoffs are investigated. Because of the previously defined hardware and software constraints. The major system elements are well defined and known. The major areas to be investigated are the configuration, location, and functions to be performed by the new MIS/IC.The important considerations are:

a. Performance

1. Networking capability

2. Control

3. Flexibility

4. Growth potential

5. Response time

6. Storage requirements

7. Usability

b. Costs

1. System development

2. System maintenance

3. System operation

During the feasibility analysis, consideration must be given not only to ASATD performance criteria, but just as important, the ability to network to outside MIS systems such as other departments within NAVAIRTESTCEN.

The question of centralization versus decentralization continues to be debated. Since the early days of data processing, batch systems have given way to modern distributed data processing. This trend continues with the modern powerful minicomputers that can be distributed and networked into effective configurations. Now with the almost evolutionary proliferation of microcomputers, extreme decentralization exists with considerable loss of networking, and difficult if not impossible utilization of common data bases.

Of utmost importance to top management is the present day and future problem of efficient utilization of computer resources. At the present growth rate, the hardware capability will so far exceed the utilization capability of

DP personnel that major emphasis must now be placed on those software engineering principles that address efficient programming.

4. Study Phase Report

The Study phase report is a carefully prepared document. It is a management-oriented report that must be free of computer jargon so that it can be understood by senior managers wno may not have a computer-oriented background. [Ref. 11]

The results of the feasibility study will be presented and specific performance specifications outlined. Not only is the system described in its recommended configuration, but a detailed milestone schedule is presented covering all phases of the development.

Included in this report is the major underlying constraints and premises that precipitated the recommended configuration.

C. DESIGN PHASE

The design phase is the life-cycle phase in which the detailed design of the system selected in the study phase is developed. The performance specifications are expanded and the details of the design are baselined to include not only all the hardware and software required to develop the system, but also the DP personnel who will develop the system and maintain it once it goes operational. [Ref. 12]

It is during this phase that the need and requirement for an Information Center is documented. Also, the details of staffing and final organizational changes are outlined.

The design phase addresses the selection of those functions that are to be performed and also the personnel responsible to perform those functions. All conflicts regarding the organization, staffing, responsibilities, funding, and operation must be solved by top management before proceeding further.

The overriding factors that dictated the recommended configuration must be made known and agreed upon by key management within ASATD.

Important areas that must be addressed are the identification of controls (especially on input, and/or modification or updating the common data bases), and the question of security and authorization in working with the specific data bases. The general question of ADP Security must be addressed with both physical and software security taken into account.

1. Detailed Design Schedule

The details of the MIS/IC system can now be finalized with the main underlying principles of software engineering being maintained. Those principles are:

a. Utilize 4th generation software where possible and a modern DBMS with query language capability.

b. Encourage good programming practices such as structured programming.

c. Maximize use of high level programming language such as structured FORTRAN-77 and PASCAL for ADP and ADA, for embedded computer software development.

d. Early attention to software maintainability.

2. Data Base Design

As the number of data bases increase, the solution to the problems of maintaining and controlling this data is with the effective use of a data base management system. Data base management systems have three major functions:

a. To maintain the data base independently from the application programs that use the data.

b. To provide a measure of data security so that unauthorized users will not have access to the data.

c. To be able to share data and to have common data bases so as to reduce redundancy and waste of valuable DP resources.

The DBMS description of the data elements and the relationships between the data elements in the data base is called the schema.

Four major components are common to most data base management systems. The first two are a data description component and a data manipulation component. A third component is a query language. This is a simplified programming language that allows users to specify the data wanted and the format that will meet user information needs. The query language is easy to use and typically requires only

a few key words to create a user output. It is especially valuable in on-line systems where a user can specify the data through the terminal and see the resulting output almost immediately. The last component is a DBMS utility. It is a series of programs used to create, back up, and restore the data base.

Of extreme importance to any successful DBMS is the Data Base Administrator (DBA). The DBA is the authority that regulates the DBMS by controlling the data base schema and subschemas and insures the integrity and security of the data for all the users. [Ref. 13]

3. Design Phase Report

The design phase report is one of the most important items to be addressed by the analysis group. The design specification is the technical core of the design phase report. It is this document that must have both top management support and support from the various branches throughout ASATD.

The design specification has two major sections. The first section is on external design requirement that relates to the interaction between the central computer complex and outside and/or distributed systems. The second section deals with the internal design requirements. This is primarily the data base design, network software, and software security.

The following is a list of important external design considerations that will be addressed in the design report: [Ref. 14]

a. System hardware configuration

b. Terminal/PC distribution

c. System interface requirements

d. Interface to communications system

e. Maintenance costs and contracts

f. Ownership and control of equipment

g. Location of distributed processing equipment

h. Networking scheme

i. ADP System Security

The internal design requirements cover such topics as:

a. The data base management system

b. Data dictionary and schemas

c. Control and maintenance of data base

d. Passwords and data security

e. Programming standards

f. Documentation standards

g. Software distribution

h. Programming support

i. In-house software development

Included in the design phase report is the detailed milestone chart of the design phase, as well as major

milestones covering all phases. An important item to be included in this report is DP staffing and overall personnel training that must be addressed if the information system is to be effective.

D. DEVELOPMENT PHASE

The development phase is the third of the four life-cycle phases. In the development phase the computer based MIS/IC system is developed to conform to the design specifications and the agreed to configuration approved in the design report. [Ref. 15]

Since most of the hardware is presently installed, the primary emphasis is placed on the actual data base development. Included in this activity is the testing that must be done to validate the data base and verify the functionality of the data base concept with the branches of the directorate.

1. Coding and Installation of the DBMS

The DBMS software that will be used in the development of the MIS/IC is TOTAL. TOTAL is a modern relational data base system that is well known and very capable of supporting the directorate for the next several years.

One of the major advantages of TOTAL is the ease of building and setting up a data base file, data dictionary,

and appropriate data screen displays to be used in the input/output of the data values.

Along with the basic DBMS software, the package includes a Screen Formatter program to allow input/output of data simply and easily, and a complete query language program to generate lists, sorts, and various retrievals of data from the data base.

The TOTAL DBMS software is extremely flexible and allows application programs to interact in the data bases for such things as initial loading of the data base from a FORTRAN file and also to re-format the output from the retrieval file to any user's request.

2. Implementation Planning

The process of bringing a developed system into operational use is far more complex than anticipated. It requires planning and attention to schedules, operational requirements, training, and especially good communication between the MIS/IC developers and all potential users of the system.

The best way to accomplish a good implementation is to produce an implementation plan and to assign responsibility for specific parts of the plan to specific individuals or teams.

3. Equipment Acquisition

Earlier in the life cycle, fundamental equipment decisions were made. Alternative configurations were evaluated and final overall system configuration was decided upon.

The principal equipment-related activities that must be implemented are (1) site preparation, (2) equipment installation, and (3) hardware and software check-out.

4. Development Phase Report

At the conclusion of the development phase the analysis group prepares a report and reviews it with the key management personnel and the principal users of the MIS/IC. [Ref. 16]

At this time all major changes to the system will be discussed and specific training will be scheduled.

At the end of this development phase all appropriate documentation will be available, including but not limited to:

a. A TOTAL DBMS user's reference manual

b. Screen Formatter reference manual

c. T-ASK query language reference manual

d. Latest version of FORTRAN-77 structured FORTRAN manual

e. Complete set of MPX-32 operating system manuals

f. Documented procedures for requesting a data base

g. Approved programming standards

h. Approved documentation standards

In the development report will be plans and cost schedules covering detailed milestones of development phase, major milestones of all phases, and the changeover plan. Total system costs can now be finalized and a detailed cost pay-back system designed.

E. OPERATIONAL PHASE

The operational phase follows the development phase and contains four major stages. Initially the new MIS/IC system will be introduced and explained with a series of briefings. This is actually part of the system changeover. Next, the system enters the operation and routine maintenance stage. Close attention must be paid to assist users in utilizing the new system and take full advantage of what a data base system has to offer.

This is where the concept of the Information Center will really make a large contribution. I/C personnel must be available to answer questions, assist users in solving their own problems, set up new data bases, and assure that the new system runs smoothly during this critical time.

The I/C group must be able to respond to many change requests. A very easy to use but formalized procedure must be available at this time for users to request changes to the system. A review process must be established and faithfully

followed to evaluate each change and make an appropriate response back to the user.

Very early attention must be paid to security during this operational phase. The new MIS is expected to provide not only adequate input, processing, and output controls, but also protection against unauthorized disclosure of data, especially classified or privacy data. This protection should be a shared responsibility. This is another area where the I/C concept is extremely valuable by setting guidelines and enforcing compliance of established security procedures.

Formalized procedures for system backup must be in place and strictly adhered to. Nothing will jeopardize the successful transition faster than dissatisfied users who have 'lost' their data due to factors beyond their control.

IV. INDUSTRY TRENDS

A. CENTRALIZATION vs DECENTRALIZATION

The following discussion, taken primarily from the King article [Ref. 5], emphasizes the fact that managers have been debating this question for many years. It is especially relevant now, given the advent of small and inexpensive microcomputers that have proliferated throughout most organizations in the past ten years. The major question has been to determine what the appropriate arrangement and balance of user needs and the desire and need of management to control both cost and uses.

The very rapid pace of change in technology and microcomputer proliferation helps sustain the centralization/decentralization debate. This is an important factor, but the real debate is rooted in the basic questions of organizational structure and functions required.

When the term centralization is used in the data processing sense, most managers think of physical location or physical centralization of hardware. Actually centralization versus decentralization concerns the locus of decision-making activity in the organization. Centralization implies the concentration of decision-making power in a single person or

small group; decentralization implies that decisions are made at various levels in the organization hierarchy.

There are many pros and cons of the two alternatives. Centralization of control gives top management more control over decisions, whereas decentralization allows lower level managers discretion in choosing among options.

Centralization can capitalize on economics of scale and preserves both organizational integrity and also decreases the duplication of functions, thereby decreasing overhead and waste.

Decentralization of functions is advantageous when the functions being performed require close cooperation with other units and tasks require greater worker interaction and less guidance.

One of the most common arguments favoring decentralization is to focus not on economies, but on improved computing service for users.

The argument of centralization versus decentralization is often discussed in terms of efficiency versus effectiveness. The proponents of centralization argue that centralized computing, oriented toward top-down control insures efficiency and cost effective computing to users. The proponents of decentralization argue that the greater productivity shown in decentralized systems using a bottom-up

programming philosophy provides greater effectiveness, and therefore improved service to users.

Now the question of cost has further aggravated the argument because of the very low cost of microcomputers causing a trend in decentralization. The question is if this new technology has made decentralization affordable, why not decentralize? Answers range from statements that computer hardware is only a fraction of the cost of data processing and that decentralization often means fragmentation of organizational activities that might otherwise be more coordinated.

The experience in many organizations over the past several years suggests that decentralization entails organizational changes that are likely to prove costly for two primary reasons.

The first factor is the expansion of computing activity as users gain control of computer resources. Of course, instead of decentralization through the use of minicomputers and microcomputers signaling the demise of the mainframe era, it could signal the beginning of an era in which both the centralized and decentralized computing activities of the organization grow dramatically.

The second major factor suggesting that decentralization of computing will increase computing costs arises from the disruptions in organizational operations that often accompany

decentralization. Too often decentralization occurs by default as beleaguered data processing departments simply give users permission to obtain their own systems. This approach is often more costly in the long run as changes must be made to re-integrate computing operations with top management desires and to restore coordination and planning into computer usage and activity.

In the argument for decentralization, additional consideration must be applied when the systems are networked vice stand alone. If they are able to tap into network-wide data bases, considerable additional computer power can be realized.

The fact is that networking is an immature technology and many problems still plague the industry. The primary technical problems arise from the lack of standards for communications, file structures, databases, and operating systems.

The fundamental question of whether to centralize or decentralize computing is who will have control over procurement, use, and management of the DP resources.

As discussed, each alternative had advantages and drawbacks. Extreme centralization keeps computing activity and growth under control of the center. It can provide economies of scale, especially considering data processing personnel, and tends to track more closely with modern

methods and more importantly, modern software engineering practices. On the other hand, extreme centralization can result in too large a bureaucracy that fails to fully meet the needs of users.

Extreme decentralization provides greater flexibility in exploiting new hardware technology and can build up considerable computer talent in the organization. The drawbacks of extreme decentralization are that overall organizational costs of computing are likely to rise. Perhaps most important for top management, extreme decentralization can make it very difficult to keep computing activities in line with organizational goals.

This is where the concept of an information center is very useful. If organized properly, the I/C will provide the best of the two worlds. Management can still maintain considerable control, but the I/C group can facilitate and assist users in procuring, using, and networking the appropriate distributed processing equipment, making maximum use of modern software engineering practice and utilizing modern data base management systems for a truly integrated organizational-wide data processing system.

B. THE INFORMATION CENTER

As microcomputers and user-friendly software tools for non DP personnel proliferate, more institutions are discovering that they need to support end-user computing.

Some label their new strategy an "Information Center"; others attempt to incorporate it into their traditional applications development process. Of the two approaches, the Information Center concept is proving to be the more successful long-term strategy. [Ref. 17]

In a well-organized center with a good DBMS, some 70% of the requests from end users can be satisfied using on-line report generators and query language processing.

Another important idea is to select general-purpose, easy-to-use software. Start with tools that have the greatest versatility and add specialized packages as the user requirement develops. Many Information Centers are built around three generic types of software.

1. A fourth-generation language
2. Excellent support of a high level structured programming language
3. A DBMS with query language capability

A fourth generation language is basically a language that is designed to improve software productivity, such as program generators, which are systems for constructing programs out of pre-existing pieces.

Various types of program generators exist, such as program libraries, applications generators, and Very High Level Languages (VHLL's).

Application generators typically consist of a program library which operates in a prestructured context, based on

knowledge of a particular application area. The structure imposed by the particular knowledge domain allows users to generate application programs simply by specifying options, sequences, and parameters in a special application-oriented language.

Automatic programming is also considered a part of the fourth generation language capability. When a user specifies his desired information processing activity to an automatic programming system, the system automatically generates a program which implements the specification.

The key idea behind the Information Center is end-user self-sufficiency. In many organizations, the backlog of applications has reached staggering proportions. It is not uncommon to hear of backlogs spanning three years and longer. The Information Center provides an effective method for cutting through the backlog.

As a separate department within management information systems, the Information Center is chartered with the responsibility of providing end-users with a means for generating their own reports and developing their own applications with user-friendly software tools.

There have been numerous questions raised on the purchase and use of personal computers in many organizations. It is generally agreed that this is not necessarily bad, but it is unfortunate if the impetus to go that way is a consequence of

the failure to plan and implement an effective Information Center.

In defining the role of the Information Center in the acquisition of microcomputers [Ref. 18], it must be emphasized that the I/C should perform more as a consultant and less as a dictator. If the organization wants to share information and to interconnect systems, then the role of the I/C to provide guidelines and oversee procurements should be followed.

The role of an effective I/C in the organizational acquisition of microcomputers should not be an adversarial one. But it clearly is a job that requires the data processing professional to wear the hat of consultant, manager, educator, even advocate. I/C managers, armed with a corporate acquisition policy are apparently in a prime spot to extend their influence in their organizations.

V. CONCLUSIONS

This paper has described some of the options management has in facing the staggering problems and benefits that are accompanying the information explosion. Along with the extreme decentralization accompanying the influx of microcomputers, there is just as great a force pressing on management to come up with a way to significantly increase the software programming capability of their users.

This problem has been stated by a number of prominent DP system professionals who all are saying, basically, that there is going to be an extensive increase in millions of instructions per second (MIPS) in the next few years, and it is evident that the software development industry today cannot utilize this capability. If this increase in computer power was programmed with today's programmer productivity, it would require more than 30 million programmers in the United States alone. This then is perhaps the most fundamental problem that the computer industry must solve in the next ten years.

Basically, there are two ways of solving this problem. Advances in new techniques with more universal compliance in known modern software engineering principles and the incorporation of new management concepts which will further efficient utilization of existing programming capabilities.

The Information Center concept addresses the latter, but also makes great use of modern software engineering principles as a major part of its structure.

As Barry Boehm points out..."significant software productivity improvements are not achievable without the full commitment of higher management" [Ref. 4].

In pursuing improvements in software productivity, care must be taken not to confuse means with ends. Improved software productivity is not an end in itself; it is a means of helping people better expand their own capabilities to deal with data, information, and decisions.

This is exactly what an Information Center is designed to accomplish.

It is increasingly evident that an organization's information system is becoming an important part of the total organizational resources that make up the organization.

A new generation of hardware and software tools exist today and are being developed for the future. Designed specifically for the non-MIS person, these tools incorporate human factors to a much greater extent than ever before.

An information center may very well be the key to forging a successful relationship with users during the 1980's. The concept has experienced good acceptance and success in many varied activities and in many organizations.

The key to successfully establishing a center lies in a carefully, well planned study, followed by well-defined objectives and realistic goals. Under this approach, the risks to management and the organization are minimized, and the chances for success are greatest.

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