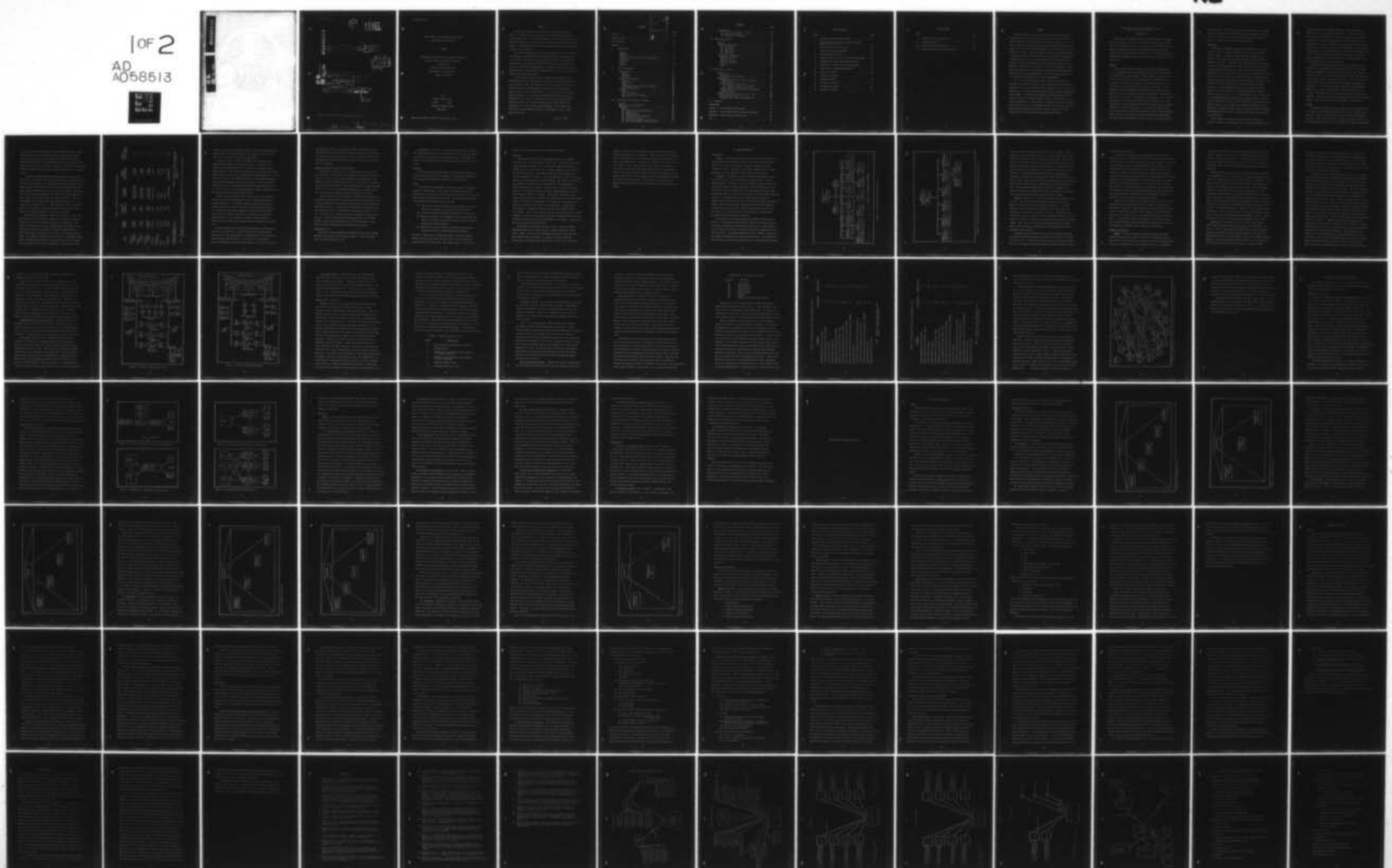
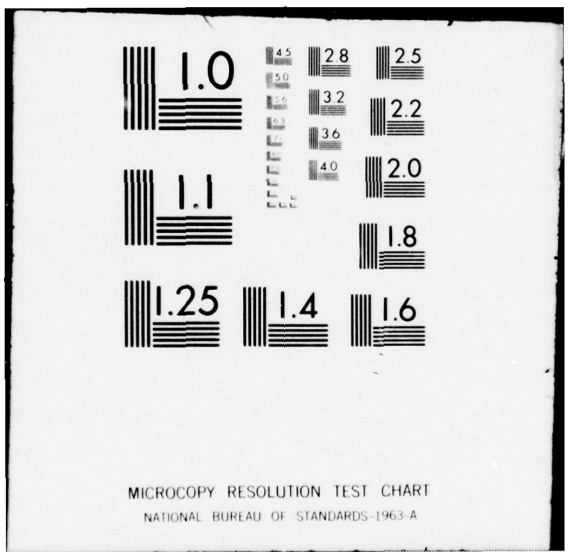
AD-A058 513 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OHIO SCH--ETC F/G 5/1
SYSTEM SURVEY WITH A VIEW TOWARD UTILIZING A BACK-END DATA BASE--ETC(U)
MAR 78 L E NAGEL

UNCLASSIFIED AFIT/GCS/EE/78-5 NL

1 OF 2
AD
A058513




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AFIT/GCS/EE/78-5

LEVEL II

ADA058513

DDC
SEP 12 1978
RECEIVED
F

AD No.
DDC FILE COPY

Mar 78

103p.

SYSTEM SURVEY WITH A VIEW TOWARD UTILIZING A BACK-END DATA BASE PROCESSOR.

Master's THESIS,

AFIT/GCS/EE/78-5

Lester [redacted]/Nagel

Emil

Approved for public release; distribution unlimited.

78 08 04 056

012 225

AFIT/GCS/EE/78-5

SYSTEM SURVEY WITH A VIEW TOWARD UTILIZING A BACK-END DATA BASE PROCESSOR

THESIS

Presented to the Faculty of the School of Engineering
of the Air Force Institute of Technology
Air University
in Partial Fulfillment of the
Requirements for the Degree of
Master of Science

by

Lester E. Nagel, B.S.
Lt Col USAF
Graduate Computer Science

March 1978

Approved for public release; distribution unlimited

Preface

This thesis was completed in response to a request to develop a model of a back-end data base processor for the Air Force Military Personnel Center (AFMPC). The current computer system at the AFMPC is heavily utilized, and this has caused an increase in the time between data base file updates. A back-end data base processor system configuration is one possible solution to these problems.

The size and complexity of the Air Force personnel system and the AFMPC data management system dictated that the complete project be divided into several phases. This thesis is the first step, or phase, and it provides the foundation, background, and direction for the future studies that are required to satisfy the initial request. Alternate solutions to the system problems should be investigated, and this thesis may be used as a foundation for those investigations as well.

I wish to thank my thesis advisor, Captain Peter E. Miller, for the encouragement, advice, and confidence he expressed, especially when progress was slow and difficult. The editoral comments of my thesis readers, Major Kenneth Melendez and Captain James B. Peterson, are also appreciated. Special thanks must go to Captain Leslie J. Waguespack for his outstanding support throughout the investigation and his editoral comments during the preparation of this thesis. Thanks are also due to Miss Cindy Held for typing this manuscript. Finally, I deeply appreciate the support and encouragement of my wife, Dianne, and my children, Carla and Brian; who tolerated my various moods and sacrificed tremendously so that I could complete this work.

Lester E. Nagel

Contents

Contents

List of Figures

List of Tables

Abstract

Members of the Air Force Military Personnel Center (AFMPC) want to investigate the feasibility of utilizing a back-end data base processor system configuration for the AFMPC personnel data management system. This thesis surveys the current system, the personnel management organization (AFMPC), the back-end data base processor concept, and the general requirements of the system. The basic problems of the current system are that it is (1) heavily utilized, and (2) the data base files cannot be updated on a timely basis because of the heavy workload. The back-end data base processor concept is relatively new and may provide a solution to these problems. Consequently, a discussion of the back-end concept, its advantages, and disadvantages is presented. In addition, the general requirements of the system are discussed and are divided into two categories; (1) functional requirements, and (2) system requirements.

The discussions of the current system, the personnel management organization, the back-end concept, and the general requirements provide a foundation for future studies that will be required to (1) solve the system problems, and (2) model a back-end data base processor system configuration for the AFMPC. In addition to the background and foundation for future studies, a focus and direction for those studies is also presented. The focus and direction for future studies is provided through (1) an analysis of the current system, (2) a plan-of-attack that can be used to solve the data management problems of the system, and (3) a brief look at the application of a back-end data base processor at the AFMPC.

SYSTEM SURVEY WITH A VIEW TOWARD UTILIZING A BACK-END DATA BASE PROCESSOR

I Introduction

This thesis was requested by members of the Directorate of Personnel Data Systems (DPMD) in the Air Force Military Personnel Center (AFMPC) located at Randolph AFB, Texas. They requested that a back-end data base processor configuration for the Air Force personnel data management system be investigated, modeled, and evaluated. This thesis provides the background and foundation for future studies that are required to fulfill that request.

General

The Air Force Military Personnel Center (AFMPC) at Randolph AFB, Texas, is responsible for the management of the personnel resources of the United States Air Force (USAF). A USAF regulation, AFR 8-12 dated 14 February 1975, identifies the USAF Personnel Plan (USAFPP) as the "fundamental and pervasive authority on overall personnel policy, prescribing the Air Force approach to 'total force' management." The AFMPC automated data processing (ADP) system(s) must support the USAF personnel management objectives outlined in the USAFPP. These objectives fall into the five broad, functional areas of personnel: (1) procurement, (2) education and training, (3) utilization, (4) sustentation, and (5) separation. Currently, AFMPC maintains records on more than 1.2 million people in the following categories: (1) active duty military (USAF), (2) Air Force Reserve, (3) Air National Guard, and (4) civilian employees of the Air Force. In addition, records are maintained on individuals who have served in the Air Force, but are currently retired or separated.

from active duty. Over 35 percent of the Air Force budget is expended on people related costs to keep the force in a high state of readiness (Ref 1:1). Therefore, it is essential that the Air Force manage its people as effectively and as efficiently as possible.

Background

The personnel management system has evolved from a manual record keeping function at squadron or group level to the highly automated system of today. The evolution began when the squadron and group functions were consolidated into Consolidated Base Personnel Offices (CBPOs) at base level. Automated record keeping systems were developed at base level to manage the large volume of data and reduce the number of personnel support technicians. Initially, there was little if any standardization in the use of automated personnel data management systems. Then several of the Major Commands (MAJCOMs) began to standardize the automated personnel data systems within their respective commands. These systems improved the effectiveness of intra-command personnel data management, but inter-command personnel data management activities remained poor due to the lack of standardization between commands. In 1962, the goals and concepts of a standardized USAF system were published in the Long Range Plan for the Personnel Management System. After this plan was implemented, personnel support technicians could transfer inter-command with very little training, many MAJCOM unique directives were eliminated, standardized reports could be transmitted between the MAJCOMs and Headquarters USAF, and data collected at one base could be utilized at any other base.

Major advances in computer and communications technology are gradually leading to the development of a centralized personnel data base located in the AFMPC at Randolph AFB, Texas. In April 1974, the Advanced Personnel Data System was implemented. When this system is fully exploited, the AFMPC will handle the data management function for the MAJCOMs. The MAJCOMs will interact with this centralized system through the use of leased telephone communication circuits and AUTODIN II communication circuits as soon as they are available. Some consideration is being given to incorporating the base level CBPO data management functions with the data management functions at the AFMPC in the future. Initial deployment and testing of base level equipment configurations is scheduled to begin within the next year.

Presently, the data management functions at the AFMPC are accomplished on two Burroughs B6700 computer systems (Ref 2). These systems operated independently and were not linked in any way until recently. A software package was written by the AFMPC in late 1977 that facilitates access by both systems to a common disk resource. The "A" system is the largest, and it handles the majority of the personnel data management transactions. The "B" system is utilized to support the Procurement Management Information System (PROMIS). PROMIS provides the USAF recruiters throughout the world with on-line access to a central quota data bank. This system is used to match an applicant's qualifications and interests with potential jobs that are available in the Air Force.

Problem

The current computer systems consistently have a heavy workload and are being utilized at near peak capacity at all times. This has led to some rigid controls and restrictions in data processing on the AFMPC computer systems. The full impact of changes in personnel resources may not be reflected for several days or possibly two or three weeks, because

because personnel data base files are only updated periodically. This situation does not allow the AFMPC to have a current data base on a timely, day-to-day basis nor does the heavy workload allow optimum response/turnaround time for normal personnel data processing activities. These two factors adversely affect the quality, accuracy, and/or timeliness of data and reports, which in turn adversely affects personnel management actions.

Presently, the AFMPC data base structure consists of several files. The number of files identified as data base files will vary depending upon the eyes of the beholder. At a minimum, the data base includes the eight Master Personnel Files (MPFs), and it may include 18 or more subsystems which contain selected portions of one or more of the MPFs. The subsystem files can be updated independently or concurrently with the appropriate MPFs. These files are only updated at selected intervals. Some files are updated as often as three times per week while others may only be updated once per month (Table I). Table I contains some file statistics and update transaction statistics which were extracted from an APDS orientation briefing presented to the author at the AFMPC.

The AFMPC data base system is large and very complex. This system must produce a data base that is accurate and up-to-date if personnel resources are going to be managed efficiently and effectively. The accuracy of the data base files is dependent upon the frequency of the updates and the amount of interaction between the different files. A transaction on one can affect either directly or indirectly many other files. For example, an enlisted airman who receives a commission through Officer Training School (OTS) must be removed from the "active airman" file and placed upon the "active officer" file. When he was assigned

Table I. AFMPC Data Base File Statistics (Ref 3)

FILES	NUMBER RECORDS	MAX. RECORD SIZE (CHARACTERS)	FREQUENCY OF UPDATE	AVERAGE TRANSACTION VOLUME/UPDATE	AVERAGE RUN TIME PER UPDATE (HOURS)
ACTIVE					
*officer	105,575	5,634	three per week	67,900	8
*airman	492,365	3,402	three per week	226,400	14
GUARD					
*officer	11,473	4,428	two per week	4,400	1
*airman	83,096	2,316	two per week	18,200	3
RESERVE					
*officer	177,945	4,974	two per week	21,400	3
*airman	280,979	2,460	two per week	27,600	4
*CIVILIAN	244,318	5,674	two per week	45,000	4
*PRIVACY TRANSACTION	162,181	9,762	weekly	14,000	2
**PCARS	161,211	2,274	weekly	94,700	5
**PAS	10,364	738	weekly	800	1
**MANPOWER	750,000	306	weekly/monthly	10,000/900,000	25/3

*Master Personnel Files
**Subsystem Personnel Files

SOURCE: Briefing at AFMPC, Randolph AFB, Texas. 8 Sep 77 - Lt Col Nardi (DPMDOD)

NOTE: The Manpower file is now managed by the General Update System, and the author has chosen to consider it a Master Personnel File (MPF).

to OTS, he was replaced by another individual who may have been recruited and/or required some formal training. This sequence of actions would affect at least two MPFs and three subsystem files.

During the author's visits to the AFMPC, the complexity of the interactions between files was discussed briefly. A summary of the comments on the interaction between files is that, "No single person understands all of the interactions between the files, nor does any single person know exactly what data is contained in the different files." No one seemed to know where this information could be located without talking to the different programmers who work with the files. There are literally thousands of pages of documentation on detailed system characteristics, but there is little, if any, documentation that explains the characteristics of the files or the interaction between files.

Since the data base updates take so much time, they are completed at intervals that are determined by the file's relative importance in resource management. The personnel support staff must have accurate, timely information to manage and monitor actions that affect the force; i.e. promotions, assignments, separations, training, and many others. The volume of data that is maintained in each data base file and the dynamic character of the data make it essential that new and more effective data management systems be developed and evaluated for possible use.

Several individuals in the Directorate of Personnel Data Management Division at the AFMPC have an intuitive feeling that a back-end data processor will allow timely updates to the data base files and improve the overall quality of the data base. A back-end data base processor would be responsible for all of the data base functions that are normally accomplished in the main computer (Ref 4:1197). Representatives from the Modeling Branch (DPMDDA) at the AFMPC requested that a back-end data base processor model be developed to analyze and evaluate different cost and configuration alternatives using a back-end data base processor for data base management.

Current Knowledge and Sources of Information

Back-end data base processors are relatively new to the world of data management. The majority of the information available in this area can only be found in recent journal articles or research papers. The information about the AFMPC data base system is not located in any single source that can be identified. The specific details are spread throughout three different areas: (1) government publications, (2) AFMPC programs, and (3) the minds of different individuals assigned to the AFMPC.

Journal articles and research papers were obtained from professional organizations, libraries, and the Defense Documentation Center (DDC). The government publications were obtained through normal Air Force publication distribution channels. Personal interviews with the individuals from the Data Management Division at the AFMPC were conducted on three different trips to Randolph AFB. These individuals were selected so that they could provide a complete picture of the data management system at the AFMPC. An AFMPC working group established in late 1977 also provided a large amount of useful information that is reflected in this paper.

Assumption (Ref 3)

The amount of data maintained in the AFMPC data base files will not decrease significantly in the forseeable future. It will either stay about the same or increase in size.

Justification. The size of the active force may fluctuate slightly, but those records involved will be transferred from one file to another or new records will be added to the existing files. In addition, the number of items maintained in each record has increased steadily over the years.

Standards

No standards have been identified at the present time, however, in any follow-up study they will be essential. This study will highlight a few standards that should be considered in any future study.

Scope

The magnitude of this problem is such that it cannot be completely covered in a single thesis. This thesis is designed to provide the foundation for the development and evaluation of a model of a back-end data base processor configuration for the AFMPC. The complete study requested can be divided into different steps, as follows:

(1) Describe the current system, the back-end concept, the general data base requirements, and outline a course of action.

(2) Identify and document the detailed requirements of the system.

(3) Develop a document, i.e. a handbook or user's guide, that more explicitly outlines the interface required between the APDS and a back-end data base processor.

(4) Complete an evaluation of cost alternatives and system performance based upon different hardware configurations.

This thesis changed from a requirements analysis study to a problem analysis study and will cover Step (1) and provide some thoughts for consideration in the other Steps. The complete study is a "blue sky" project and as such it does not have a projected deadline.

Approach

The author originally planned to complete Steps 1 and 2 and had planned to use "Structured Analysis" (SA) in Step 2 to define the functional requirements of the system. This is an analysis technique developed by SOFTECH, Inc (Ref 5 and 6) that uses a topdown approach to analyze problems and define requirements. Two different models are developed during the use of this analysis technique: (1) an activity model, and (2) a data model. Normally, the activity model is developed first. These models are designed by beginning at an abstract level consistent with the requirements and desired viewpoint of the problem. Then the abstract level is broken into three to six sub-blocks, which may in turn be subdivided further until the desired amount of detail is obtained. These models highlight the interaction between "activities" and "data" by looking at these items as "controls", "inputs", "outputs", or "mechanisms". The data model is used primarily to point out discrepancies and verify the activity model. As these models are developed, a "reader" or "readers" crosscheck the validity and logic of the models. This is done to insure that the models are accurate and understandable. Due to the time limitation for thesis completion, Step 2 was not finished and the SA models that were developed were incomplete. Consequently, they are not included with this thesis.

This thesis is divided into six main sections. Chapter I provides background information, a broad perspective, and the rationale for this study. Chapter II outlines the environment within which a back-end data base processor will be utilized. It contains discussions about the organization, the hardware, the software, and the data files. Chapter III contains a review of the back-end data base processor concept and some potential advantages and disadvantages. Chapter IV describes the general system requirements which are divided into functional requirements and basic system requirements. In Chapter V, the results of this investigation are presented. This includes (1) the effort involved, (2) a plan-of-attack that is established for future studies, and (3) a discussion of a back-end system for the AFMPC. Chapter VI contains a conclusion and some comments about any future studies plus a short discussion about the utility of SA during this investigation. First, however, it is important to understand the current system environment which is discussed in the next chapter.

II System Environment

Organization

General. Personnel resource management is affected by the policies and decisions of the President, Congress, Department of Defense, Headquarters Air Force, major command headquarters (MAJCOM), base, and subordinate levels. The AFMPC, as the agency responsible for personnel management, must be responsive to these policies and decisions.

Structure. The AFMPC is a Special Operating Agency (SOA) located at Randolph AFB, Texas, and is commanded by a general officer, currently Major General L. W. Svendsen, Jr., who is also the Assistant Deputy Chief of Staff/Personnel for Military Personnel. At the AFMPC there are four Directorates, four "Assistants for", and three specialist offices that are directly involved with the five functional areas of personnel management (Figure 1). In addition, there is an administrative directorate, a squadron administrative section, and the Personnel Data Systems Directorate (DPMD). There are approximately 2000 people assigned to the AFMPC and nearly 800 are assigned to DPMD. DPMD is divided into four divisions; two offices, and two liaison offices subordinate to the Requirements Management Division (DPMDQ) (See Figure 2).

The Directorate of Personnel Data Systems (DPMD), according to the USAFPP, is "responsible for providing ADP support to personnel functions in the most cost effective method possible" (Ref 7:3-1). DPMD consists of four Divisions; two "offices", and two liaison offices subordinate to one of the divisions. The Computer Operations Division (DPMDB) is responsible for managing and operating the central system facility. They operate the host systems and process the system activities in accordance with schedules

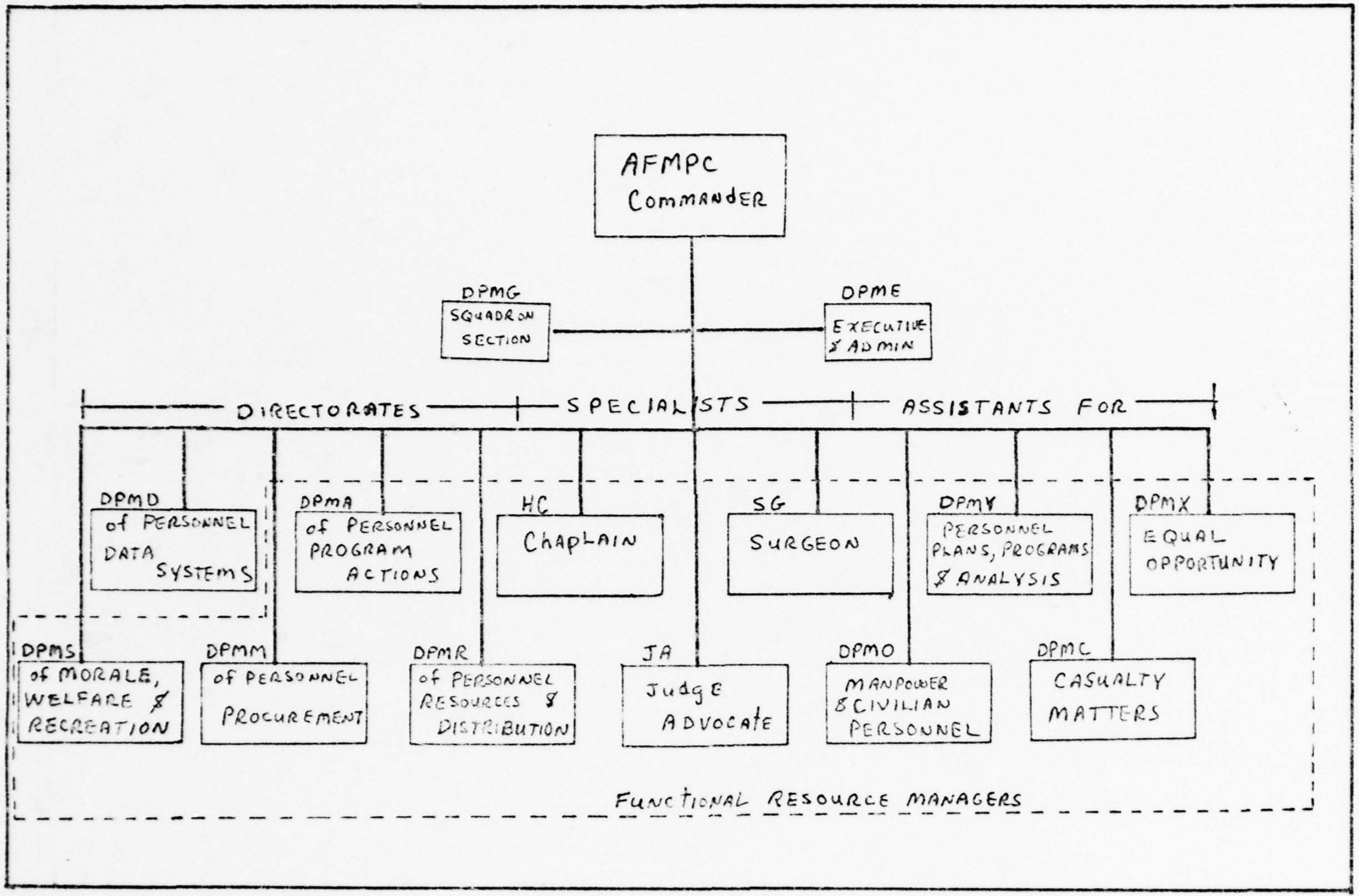


Figure 1. The AFMPC Organizational Structure.

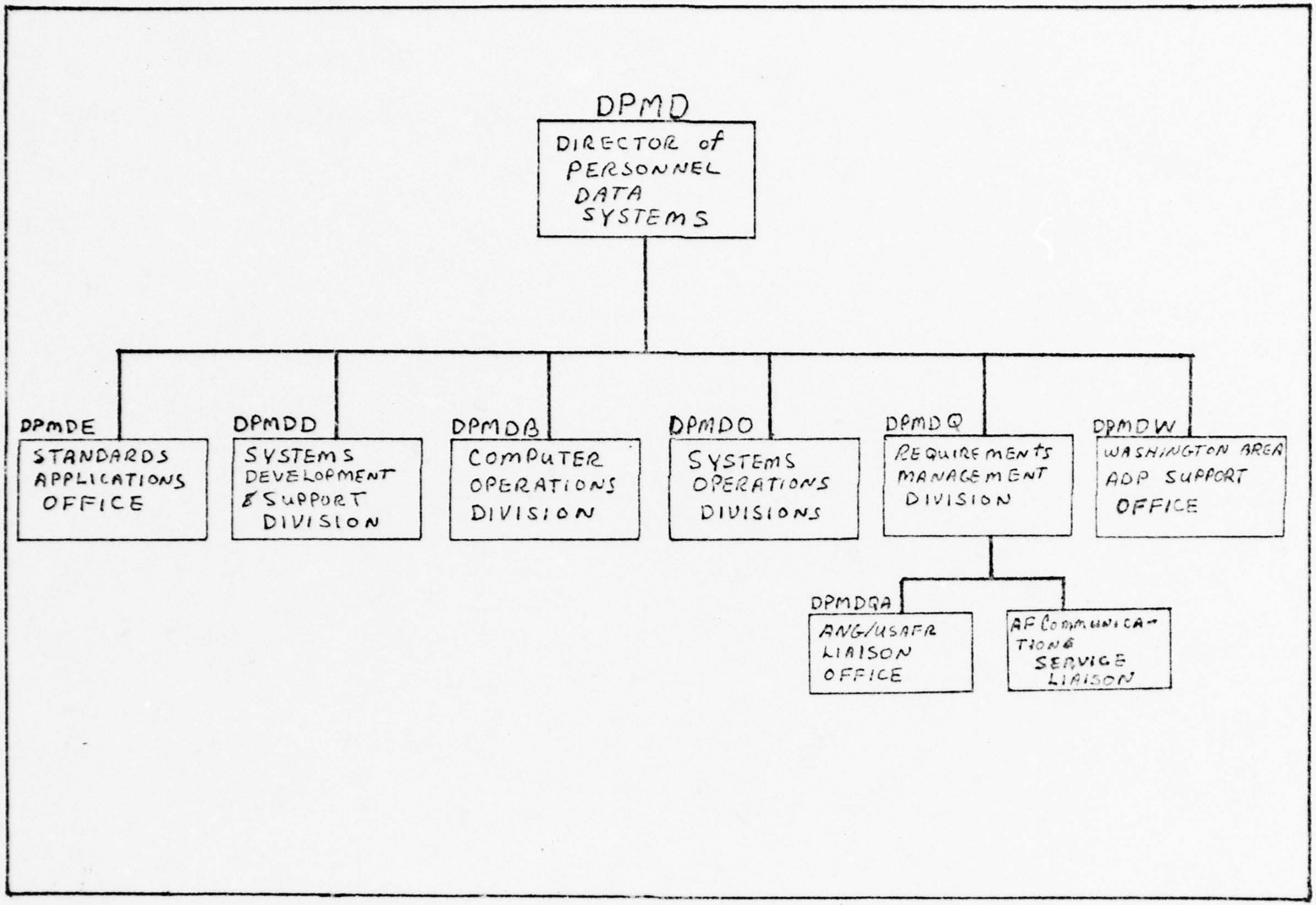


Figure 2. The AFMPC Directorate of Personnel Data Systems Organizational Structure.

that are prepared by the Systems Operations Division (DPMDO). DPMDO prepares the system schedules and acts as a liaison between the personnel technicians (personnel managers) and the computer system. They schedule computer activity based upon the needs of the personnel technicians. The Systems Development and Support Division (DPMDD) is responsible for software development and maintenance for the Advanced Personnel Data System (APDS II). The Requirements Management Division is responsible for developing and analyzing current and future personnel ADP requirements for the Air Force. The two liaison offices and the Washington Area ADP Support Office (DPMDW) coordinate their personnel management requirements with DPMD. The Standards Application Office (DPMDE) is responsible for publishing and monitoring AFMPC ADP standards, monitoring and evaluating system performance, and completing periodic systems analysis.

Policies. Change is a "way of life" in personnel management for the Air Force. National policy affects defense posture, which affects Federal Fiscal policy and budget management, which affects the force structure and military hardware. This fact causes changes that are reflected in the management of personnel resources. In addition, Air Force people and their characteristics are constantly changing because of promotions, training, assignments, separations, enlistments, and many other reasons. DPMD, with ADP management responsibility for the Air Force, must develop and maintain a computer and data management system that is responsive to these changes.

Personnel assigned to DPMD have a very strong "mission" motivation toward that goal with an attitude of "We will do it" and not an attitude of "Can we do it". This has required long work days during some periods, and it is also reflected in the development of the data management system and in hardware procurement.

In the author's opinion, the data management system has evolved through functional consolidation/centralization and has not been developed as a functionally integrated data management system. Because of the source and ever-changing nature of personnel management requirements, the APDS has evolved on an "as needed" basis in lieu of being developed from a functionally cohesive, top-down perspective. Any system developed in this manner is prone to have various kinds of inefficiencies, such as overlapping or ill-defined functions. If the current functional requirements of the system had been known prior to its orgin, the system could have been built with a top-down perspective. However, the system requirements are continually changing because personnel management policies change and new decisions are made. This makes the system extremely difficult to analyze in terms of a functional, top-down perspective.

This system works extremely well from a "mission" point of view, but the author has some reservation about the functional cohesiveness and effeciency of the system. System efficiency does not seem to be of great concern to many people, and this seems to promote the feeling that "If we can't do it with what we have, we will buy more, different, or larger units." In the author's opinion, the solution is to study and analyze the personnel management system and document its functional requirements even though this will take a large amount of time and effort.

Hardware Configuration

Network. Tha Advanced Personnel Data System (APDS) is a large hardware network with the central site located at Randolph AFB, Texas. The central site is linked to all military and civilian personnel centers at base level, MAJCOM level, and Headquarters Air Force. In addition, the central site is linked to the recruiting centers through the PROMIS network. Appendix I contains a set of communications network figures that were extracted from Reference 2. The central site is also linked to the Air Reserve Personnel Center (ARPC), the Air Force Accounting and Finance Center, the National Guard Bureau, and to the Civil Service Commission.

The communications network is serviced through dedicated telephone lines and AUTODIN circuits. By FY 1981, all dedicated circuits are to be released and communications support will be provided by AUTODIN II. There are two types of remotes connected to the network; (1) Query/Response terminals and (2) Remote Job Entry (RJE) terminals. The query/response terminals are polled for service and the RJE terminals must signal the central site for service. The APDS uses three different telecommunications techniques; (1) multiplexing, (2) multipointing, and (3) point-to-point. The link between Randolph AFB and Bolling AFB is the only encrypted link, and it is conditioned to handle material that is classified SECRET or lower. The APDS-MAJCOM project, completed in 1977, has added more than 100 additional terminals to the network. Annex B of DOD Directive 4630.1 contains more detailed information about APDS-MAJCOM. Currently, there are more than 500 terminals connected to the APDS communications network.

<u>Central Site</u>. The central site at the AFMPC has two Burroughs B-6700 computer systems which are the nucleus of the APDS system. In addition, there is a Honeywell 6040 (H-6040) that is used for microform processing, an AUTODIN terminal (owned and operated by the Air Force Communications Service), and miscellaneous other special purpose equipment. Appendix II lists the APDS hardware configuration as of 15 October 1977, and it includes the off-station remote devices. Burroughs B-3500

computers at base level and Honeywell 6000 computers at MAJCOM level are linked to the central site through telephone and AUTODIN circuits and support personnel management functions at their respective levels. The remaining hardware discussion will be restricted to the two B-6700 systems since they are the nucleus of the APDS, and they manage and process all of the personnel data at the AFMPC.

The B-6700 is a large, third-generation computer that is designed for a multiprogramming and multiprocessing environment (References 8 and 9 contain detailed information on the B-6700). The "A" and "B" B-6700 systems are both configured with three central processors (the maximum possible) and a 5 MHz system clock (the fastest). The B-6700 is designed to support high-order-languages (HOLs) efficiently, especially ALGOL. It is a stack oriented machine, and it assigns an area of memory to each program for use as a stack. While a program is executing, four registers in the processor serve as the top of the stack and are linked by hardware to the remainder of the stack in memory. Arithmetic and logical operations are performed with a Polish stack, which allows data values and storage pointers to be pushed onto the stack and then popped off as operands are needed or values are stored. There are two states of processor operation, "control" and "normal". "Control" is used for executing privileged instructions and is reserved for operating system. "Normal" is used for regular instruction execution. Interrupts may be generated internally by the processor or externally by some device. Prior to servicing an interrupt, all critical registers are saved on the stack and a link is established to insure that the processor returns to the proper location. Memory protection is provided in two ways; (1) by comparing memory addresses to program boundary registers, and (2) by using control bits to to protect code and words which define memory areas. Consequently, programs cannot modify their own code.

Memory. There are two different size core modules available for the B-6700, one with 16K words and the other with 65K words. Both sizes are utilized at the AFMPC. The "A" system contains 703K words, and the "B" system contains 524K words. The memory access times vary from 770 nanoseconds to 1600 nanoseconds. Each memory word consists of 48 information bits, a parity bit, and three control bits that identify the word as code, data, or descriptor. The processors in each system are connected to their respective memory modules by a memory bus. The memory bus contains 20 address bits, 6 control bits, and 52 information bits. The memory modules operate independently, and they check every address on the bus. Memory interleaving is possible on the B-6700 by using a pluggable jumper.

Input/Output Processors and Peripherals. Each system has two I/O processors which can be connected to as many as 20 peripheral units. The I/O processors are linked to the central processors by the scan control bus. A control bit is passed between the processors to restrict access to the bus. A processor may only use the bus when it has the control bit.

Data-switching channels link the peripheral devices to the main memory and are assigned to a peripheral control by the I/O processor when I/O is initiated. There are ten data-switching channels with each I/O processor on the "A" system. This system has two separate peripheral control busses, and this prevents the I/O processors from using devices that are not on the same bus as the I/O processor. "Exchanges" for tape drives and disk drives allow the peripheral control units to work with any device on the "exchange". One disk "exchange" is shared between the "A" and "B" systems, and this allows the two systems to access common packs.

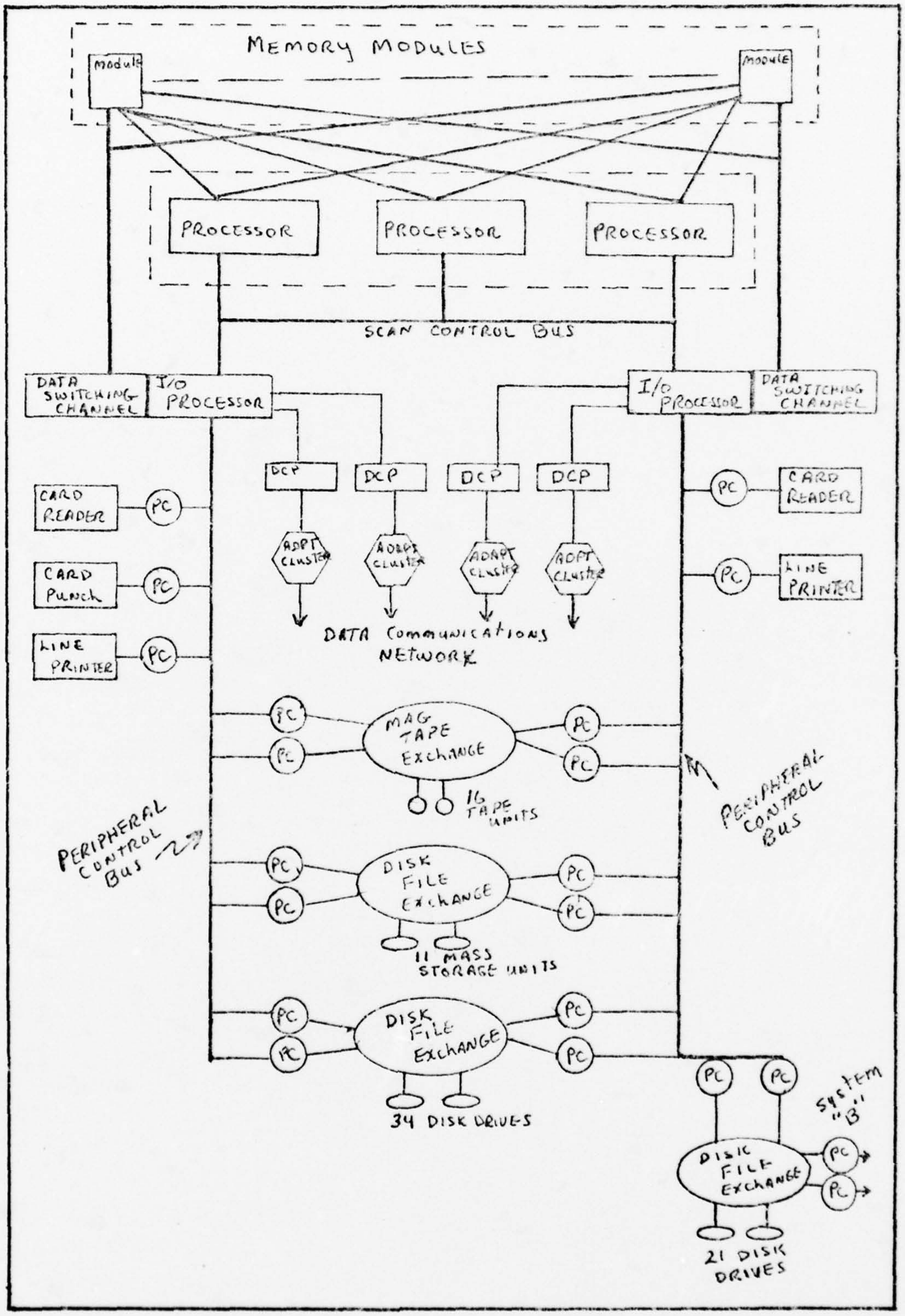


Figure 3. B-6700 "A" System Configuration

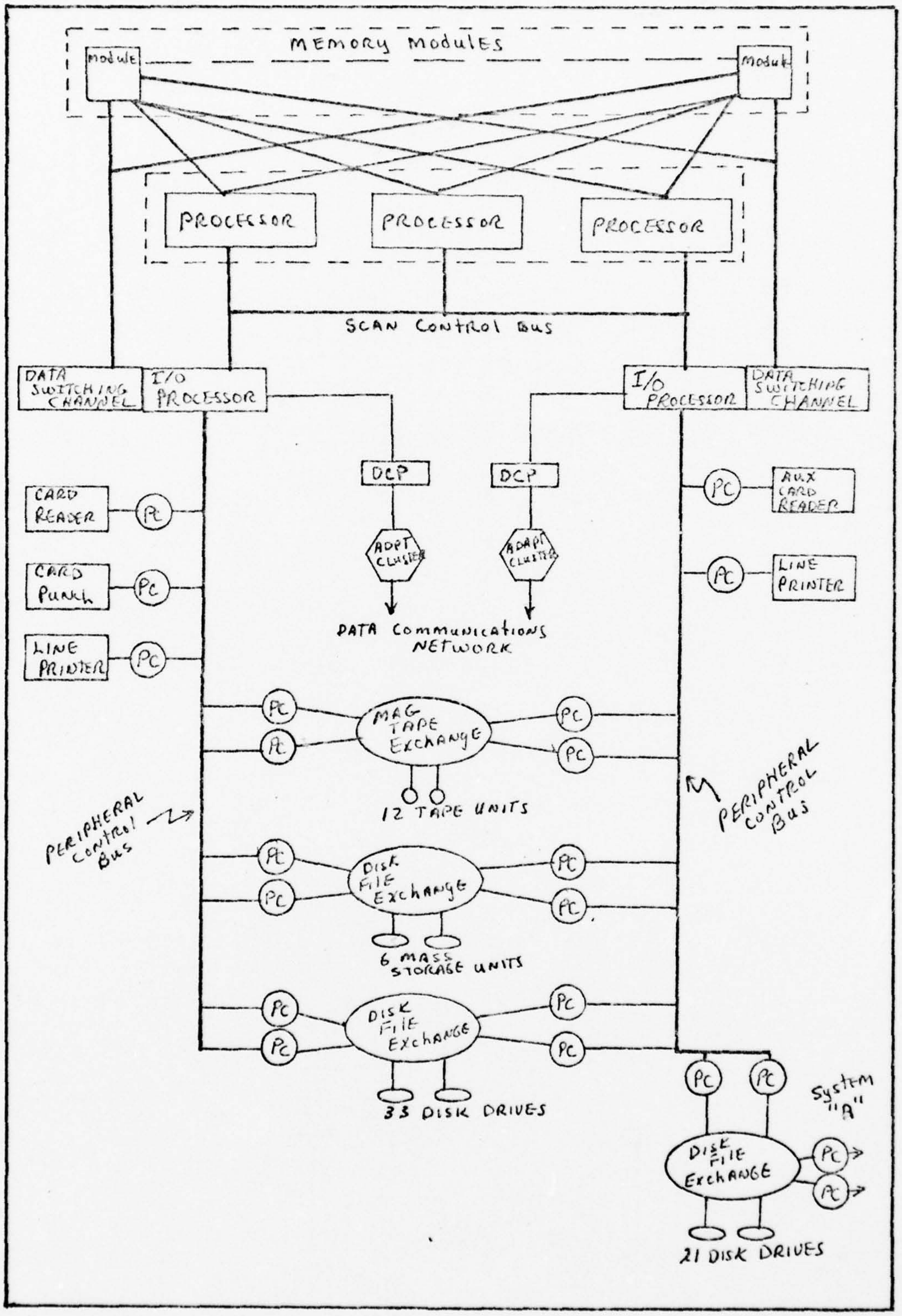


Figure 4. B-6700 "B" System Configuration

Data Communications. System "A" has four data communications processors (DCPs), and system "B" has two DCPs that interface with their respective I/O processors. Adapters provide the logic that is needed to interface a DCP with a data set or communications line. The basic system architectures for the "A" and "B" system are outlined in Figure 3 and 4. More detailed information can be found in Burroughs Technical Manuals and in documentation maintained by DPMDB at the AFMPC.

Software (Ref 8 through 14)

General. There are three categories of software on the B-6700; the Master Control Program (MCP) which is the operating system, compilers, and data communications software (Ref 8 and 9). The MCP is divided into three levels; a kernel for processing interrupts is the highest level, resource allocation is the next level, and the utility functions are at the lowest level. The kernel is capable of reconfiguring the system in 13 different ways in the event the system fails. If a suitable configuration is found, the system is reinitiated and restarted from a suitable checkpoint. Main memory is allocated by variable length segments, and the segments are removed on a least-recently-allocated algorithm. Segments may be shared by tasks to facilitate the use of compilers and some MCP routines. Resource allocation comprises the largest portion of the MCP's activities. The resources are assigned by tasks which can in turn be divided into sub-tasks to facilitate parallel processing. Main memory is also allocated in "working sets", which limits the number of segments a task can have in core. The "working set" size is determined at compilation time and is updated by the MCP to maximize system efficiency. Memory in the B-6700s at the AFMPC is divided into two separate areas to support on-line users and batch respectively. This was done to keep the on-line users (high-priority activity) from dominating the machine resources and completely disrupting the batch processing activity. Memory protection is provided by using (1) stack and stack limit registers to identify task boundaries, (2) data descriptors that identify the base address and the size of each data block, and (3) a flag bit on each memory word to identify it as code or data.

The MCP also manages the I/O devices. It maintains device status and assigns devices as needed to allow efficient machine and device utilization. Output can be "spooled" to disk and then transferred to an output device to improve the I/O efficiency of the machine. Batch jobs are separated into six different queues (stacks) at the AFMPC based upon job characteristics (See Table 2). These queues contain the following information about the job; priority, resource requirements, and location of code segments. The queues can be in three different states; priority, filler, or off, with queues 1 and 6 remaining in the priority state. The other queues are adjusted by the SUPERVISOR program. This program was written by personnel at the AFMPC, and it schedules the jobs in the queues.

Table II. B-6700 Input Queues (Ref 3)

Queue	Types of Jobs
1	Jobs entered from the operator's console
2	Production jobs
3	Recurring daily maintenance runs requiring an overnight turnaround
4	Recurring daily maintenance runs requiring a daytime turnaround
5	Program Development jobs
6	Promotion board support jobs

After the priority queues are empty, the SUPERVISOR schedules the filler queues. Batch processing is routinely scheduled at night to support the heavy on-line processing requirement during the daytime.

Data Management System II (DMS II) is a host language DMS interface developed by Burroughs that can be used by either batch or on-line programs. DMS II provides several methods for retrieving data; can be used to structure a data base; and also provides checkpoints for program restarts after hardware malfunctions.

Compilers/Languages. The following high-order languages can be used on the B-6700; ALGOL, APL, COBOL, FORTRAN I, and PL/1. Even though the B-6700 is an ALGOL oriented machine, COBOL is the most commonly used language at the AFMPC. There are a few programs, however, that use ALGOL when it is impractical or impossible to use COBOL to produce the desired software.

There is a, locally developed, DETAP (acronym-source unknown) preprocessor that is used to convert programs written in a special analyst language, Decision Logic Tables (DLTs), to COBOL source statements. The analyst software is comprised of many DLTs which contain logic routines that reflect actions and conditions contained in the applicable directives and regulations. Each routine is identified with and related to a specific transaction; however, the routines may be called by more than one transaction. The DLT software is used by the General Update System (GUS) to build and maintain the master personnel files (MPFs). Section 3 in Reference 10 documents the AFMPC rationale and general procedures for using DLTs.

Data Communications Software. Programs and routines in the MCP and the Data Communications Processor (DCP) share the communications control functions. Programs for the DCP are produced by processing local specification punched cards containing a terminal's characteristics through the Network Definition Language compiler. The compiler generates DCP programs for the user's specific terminal configuration. A message control system in the MCP allows messages to be passed between programs operating under the MCP and users operating on-line.

Data Files (Ref 14). There are many files, program series, utilized and maintained by the AFMPC. Appendix III contains a list of files and file codes extracted from Reference 11 plus a few additional files that have been added since document publication. These files can be divided into four different classes; (1) the General Update System (GUS) files (the MPFs), (2) other subsystem files, (3) extract files, and (4) special-purpose work or local-use files. The extract and special-purpose files are special-use files that are generally small and/or contain data that is transient in nature. These files are of little interest except for the fact that they do exist because they only contain and/or use functional data that is duplicated in the MPFs and subsystem files.

The MPFs are the files that form the core of the personnel system. They include the people files, a job/position authorization file, and a privacy transaction information file (Table 3). These files are updated and maintained by the General Update System (GUS). The GUS is transaction oriented and utilizes Transaction Identification Codes (TICs) to identify the procedures/transactions written in the DLT language. The first seven files are people files that contain personnel records and divide the records into groups that reflect an individual's duty status. The individual's Social Security number is the key used to access records on these files.

Table III. MPFs and Associated File Codes

File Code	MPF Title
AA	Active Airman
AG	Guard Airman
AR	Reserve Airman
BA	Active Officer
BG	Guard Officer
BR	Reserve Officer
CA	Civilian
MD	Manpower
PR	Privacy Act Tracking System (PATS)

The Manpower file is used to monitor and manage the Manpower authorizations (positions) in the Air Force. A duty designator (AFSC) is the key used to access records on the Manpower file. The Privacy Act Tracking System (PATS) file is used to record data pertaining to "Privacy Act" information that is released outside the personnel management system.

The other subsystem files are files that are used to support a specialized personnel management function or functions. The subsystems may update/process a single file or several files depending upon the function of the particular subsystem. Table 4 identifies some of the more prominent subsystems and their processing requirements. The files updated and maintained by these subsystems may contain information that is also contained on an MPF and/or other subsystem files plus any functionally unique information that is required. The MPFs and other subsystem files are updated/processed at varying intervals depending upon personnel management requirements. Some files are updated/processed several times per day and others may only be updated/processed monthly. Update transactions are collected in a transaction/update file that is processed against the applicable file at the desired time. Each subsystem has its own transaction/update file. These updates may in turn precipitate other

Table IV. Processing Time for Selected Subsystems (Ref 3)

Subsystem	Avg Mo Hours	Number Mo Runs
Retired Personnel Data System (RPDS)	5	4
General Officer Subsystem (GOS) or (GODS)	2	6
Active Officer Promotions	85	250
Reserve Officer Promotions	5	12
Weighted Airman Promotion System (WAPS)	104	89
Personnel Accounting Symbol System (PAS)	6	4
Airman Information Management System (AIMS)	160	95
Point Credit Accounting Reporting System (PCARS)	32	16
Career Airman Re-enlistment Reservation System (CAREERS)	17	32
TDY Contingency System	5	60
Procurement Management Information System (PROMIS)	155	143
Training Management Information System (TRAMIS)	166	96
Training Pipeline Management Information System (TRAPMIS)	84	60
MAJCOM IMR Feedback System	18	4
Officer JOB File System (JOB)	10	1

SOURCE: Briefing at AFMPC, Randolph AFB, Texas.
8 Sep 77 - Lt Col Nardi (DPMDOD)

Table IV. Processing Time for Selected Subsystems (Ref 3)

Subsystem	Avg Mo Hours	Number Mo Runs
Retired Personnel Data System (RPDS)	5	4
General Officer Subsystem (GOS) or (GODS)	2	6
Active Officer Promotions	85	250
Reserve Officer Promotions	5	12
Weighted Airman Promotion System (WAPS)	104	89
Personnel Accounting Symbol System (PAS)	6	4
Airman Information Management System (AIMS)	160	95
Point Credit Accounting Reporting System (PCARS)	32	16
Career Airman Re-enlistment Reservation System (CAREERS)	17	32
TDY Contingency System	5	60
Procurement Management Information System (PROMIS)	155	143
Training Management Information System (TRAMIS)	166	96
Training Pipeline Management Information System (TRAPMIS)	84	60
MAJCOM IMR Feedback System	18	4
Officer JOB File System (JOB)	10	1

SOURCE: Briefing at AFMPC, Randolph AFB, Texas.
8 Sep 77 - Lt Col Nardi (DPMDOD)

other transactions that must be processed on other subsystems/files. It can be several days or more before the effect of a transaction is completely reflected in all files.

The interactions and relationships between files are very complex and not well documented. Many are quite obvious, while others are not so readily apparent. The author was shown a diagram very similar to Figure 5, which represented the subsystem interfaces. At this point, the author asked "Which of those subsystems/files make up the AFMPC data base"? The answer varied depending upon who answered the question and their perspective at the time. On occasion it was intimated that the MPFs plus as many as 16 subsystem files might comprise the data base. It was difficult for the author to get a consistent picture of the data base, but the MPFs were included in all discussions about the data base system. So for the purpose of this paper, the data base is considered to be the MPFs identified in Table 3. As a minimum, the back-end data base processor concept must support these files since they form the nucleus of the personnel data system.

There are several different retrieval systems used against these AFMPC files. The more commonly used retrieval systems are ATLAS, SURF, WINQ, WSMM, and AIRS. ATLAS is a batch, multiple record, retrieval system that can be used on any file that is described by the standard APDS Data Descriptor Table (DDT). SURF is a single record retrieval system for use on-line. A single personnel record is retrieved by using a Social Security Number (SSAN) key and then the data is reformatted as desired by the user. WINQ is both an on-line and a batch retrieval system that is capable of multiple record retrieval from any GUS file or free-formated file. [illegible] is capable of producing a variety of reports in

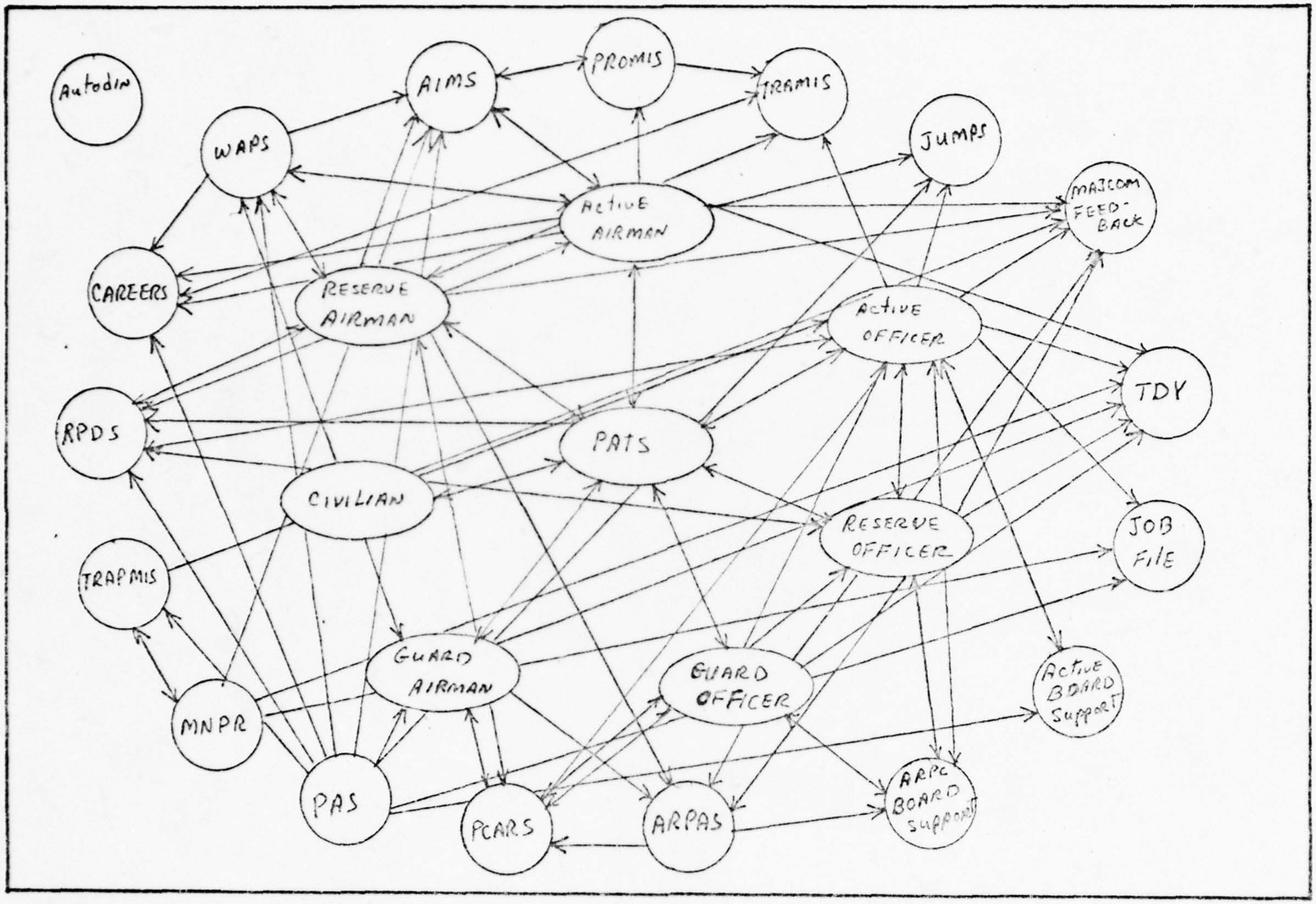


Figure 5. Subsystems/File Interfaces (Ref 3). Note: This is not an exact duplicate.

several different formats. WSMM is a specialized retrieval system that is used to provide weapons system managers with on-line access to weapon system data on the Active Officer file. AIRS is another specialized retrieval system that is used to obtain and summarize Active Airman manning statistics. More detailed information is available in Chapter 9 of Reference 12 and through the applicable programmers in DPMDD at the AFMPC.

This chapter has described the environment within which any new data management system will be developed. The next chapter contains a description of the back-end data base processor concept. It is a relatively new concept in data management with some distinct advantages and capabilities that look promising to the AFMPC.

III Back-End Data Base Processor Concept

This section of the report contains a discussion of the back-end data base processor concept which includes a discussion of some potential advantages and disadvantages of the concept.

General (Ref 15 and 16)

The world of information management is changing rapidly. In an effort to effectively manage limited resources, commercial and government organizations are frequently expanding their need for management information. This has caused an increase in the kinds, quantity, and/or complexity of the data that is maintained in their respective data base systems. As the user's information needs have increased, so has the proliferation of data base systems increased. Many different data base systems have been developed to meet the information requirements of the many different users. Appendix B in Reference 17 lists more than 90 different data base systems and to paraphrase the author "these systems are historically significant or potential sources for further study and experimentation." These systems were developed in relative isolation, and as a result, there is little standardization between them, especially in the following areas: hardware design, file structure, data base software, and terminology. Standards in these areas have been nearly non-existent. The CODASYL Data Base Task Group (DBTG) has developed a high level data base management language, which is designed to provide some uniformity and possibly be an industry standard for data base systems.

Many recent developments in several areas, especially computer hardware; i.e. microprocessors, minicomputers, and memory devices; have a great potential to improve data base management systems. Hardware technological advances and decreasing hardware costs are making it feasible to investigate several other concepts for data base management. In addition, the advances in hardware give the systems designers greater flexibility in system configuration and also make it practical to employ new concepts in areas like data base file structure design and data base file management software. One of the new concepts in system configuration involves the use of a back-end data base processor for data base management.

Back-End Data Base Processor

The back-end processor is similar to the front-end processor which serves as the interface between the host computer and the different input devices. The back-end processor is the interface between the host computer and its data base, and it accomplishes the specialized data base functions that are normally handled by the host computer. Figure 6 is a block diagram of a basic back-end data base processor system configuration. Figures 7, 8, and 9, depict more complex configurations of back-end data base processor systems. The back-end processor can be anything from a minicomputer to a large scale computer. It can be a conventional general-purpose computer or it can be a highly specialized computer, a data base computer (DBC), that is specifically designed to support the data base management functions. The functions that a back-end processor will perform depends to some degree on the configuration of the system that it supports. It could support a single host, a dual host, or other multiple host configurations. The back-end processor might be one of several back-ends that support a single data base system or multiple data base systems. It might be utilized as one of many data base processors that support a network of distribution data basis. The technological advances in the areas of

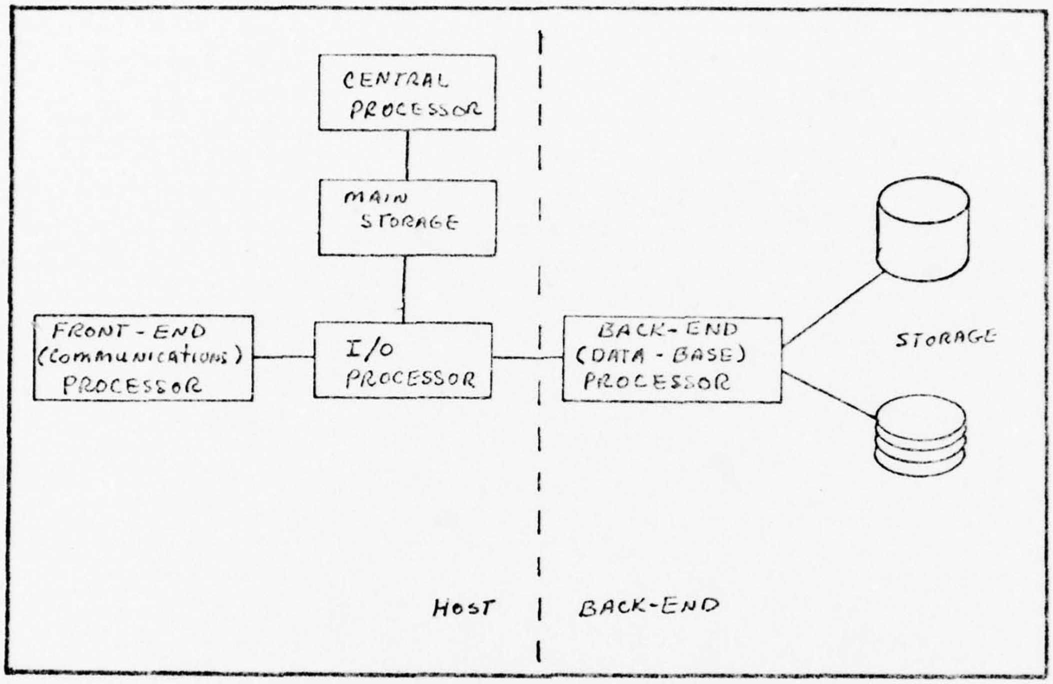


Figure 6. A basic back-end data base processor configuration

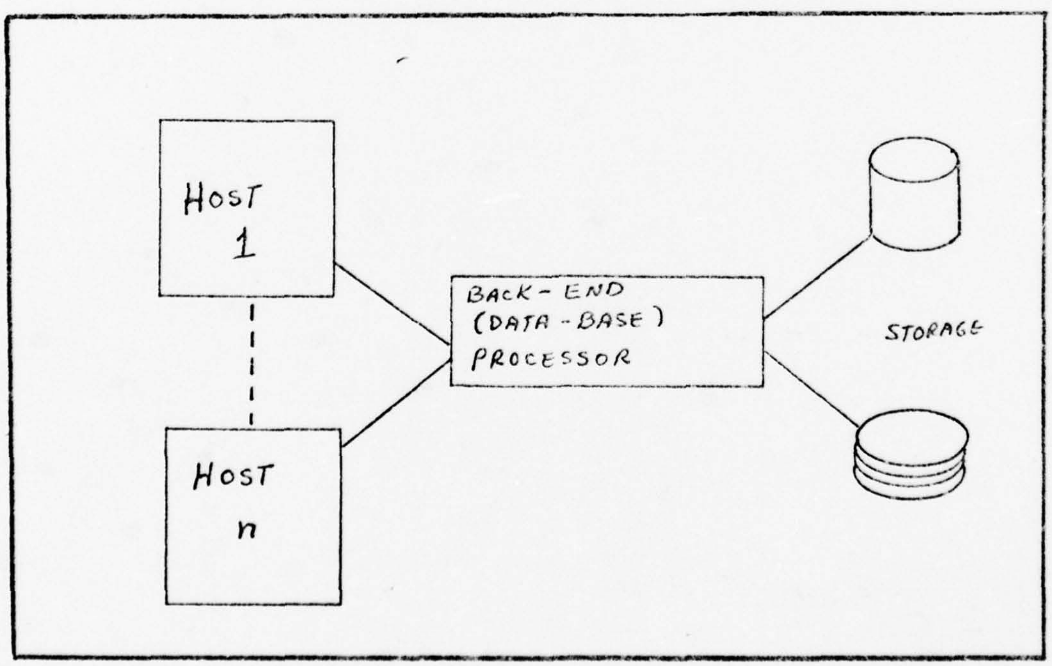


Figure 7. Multiple host, single back-end configuration

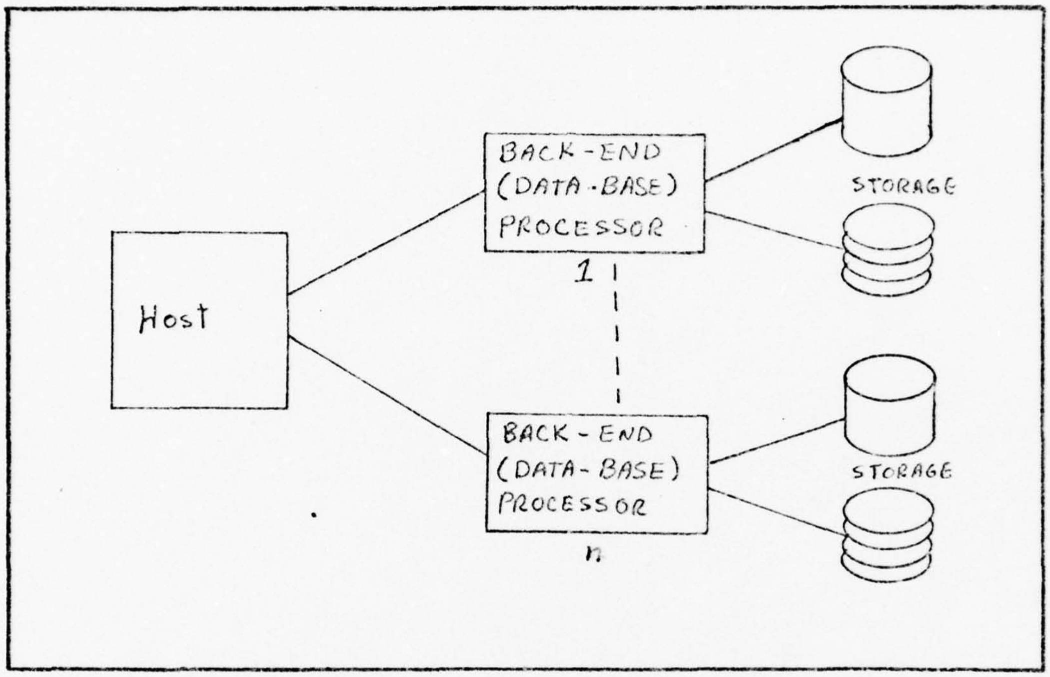


Figure 8. Single host, multiple back-end configuration.

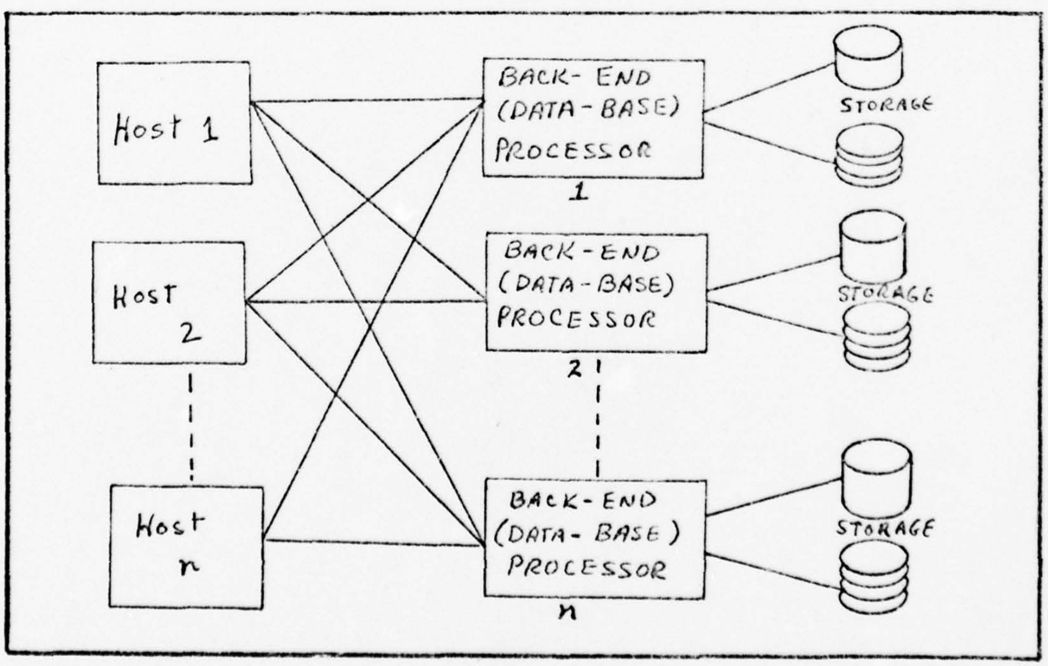


Figure 9. Host, back-end network configuration.

of hardware design, hardware manufacture, memory systems, data base systems, data structures and file organization, and communications systems; contribute to the practical feasibility of using a back-end processor at the AFMPC.

Advantages

General. There are several potential advantages that have been noted by different sources (Ref 15 and 16). These advantages are discussed below along with an occasional observation on the significant advantage to the Air Force personnel data management system.

(1) Economy Through Specialization (Ref 16:6-36). By selecting the proper hardware and software for the back-end processor, the system can be tailored to meet the data management requirements of the AFMPC. The specialized purpose of the back-end processor eliminates the requirement for a large general-purpose operating system and allows the operating system to be designed to support the data management function. This in turn simplifies the interface between the operating system and the data management system. This leads to economics in the areas of (1) smaller on-line core requirements, (2) simpler programs which would require less core and less processing time, (3) smaller development costs, and (4) shorter development cycles. A specialized data base computer (DBC) would not need all of the sophisticated capabilities of the traditional computer, i.e. floating point operations, high-speed multiply and divide, and circuits to handle a wide variety of peripherals. A specialized processor with an efficient encode-decode capability will allow the data to be compressed with encoding techniques which will reduce data base storage requirements. The implementation of a specialized data base computer (DBC) is discussed in References 15, and 18 through 24.

(2) Shared Data (Ref 16:6-36/575). There is a potential to share data between computer systems in lieu of creating and/or maintaining duplicate information in different systems. The maintenance of the same data in different files or different systems can cause inconsistencies in data if the updates to the files are not coordinated or synchronized in some way. Reference 15:1197 points out that the "Datacomputer" is functioning as a loosely coupled back-end processor through the Arpanet and it maintains information for several different computers. A distributed data base system could be developed by using several back-end processors at data base nodes and linking these nodes together.

(3) Low Storage Cost (Ref 15:1197 and 18:74). The storage cost per byte can be reduced by pooling the storage requirements for several computers and utilizing more economical high-volume storage devices. Because of the volume of data that is maintained by the AFMPC in their data base system, it may not be prudent to pool requirements except within the Air Force personnel system. At the present time, the AFMPC is utilizing several disk packs to hold their MPFs, and until storage devices have a greater capacity for storing and managing data there does not appear to be any need for the AFMPC to pool storage requirements with any other system(s).

(4) Compatibility and Uniformity (Ref 15:1197). There may be many different computers spread throughout a large corporation or government organization. These computers quite frequently are different systems (produced by different manufacturers) and the transfer of information between them is difficult because of the differences between the systems and their data bases. A back-end data base processor will alleviate this problem as long as the computers (hosts) communicate with either a common

back-end processor, or an identical processor, and/or use a common data base language in the interfaces between the hosts and the back-end processor(s).

(5) Data Base Protection (Ref 16:6-38-/577). Both the security and reliability of the data base can be improved by using a back-end processor. With a single, centralized link to the data base, the security management functions can be localized in the back-end processor. This single link should reduce the potential for malicious or accidental access to the data base and reduce the possibility of any unexpected sneak paths, and subsequent unauthorized access, to the data through another management system or some breach of the memory protection system. Reliability of the systems and data base could be improved by using the host and the back-end to cross-check each other for failures. This can be accomplished by monitoring messages for consistency and proper formatting. If a failure in the host occurs, a "rollback" could be accomplished through the use of an audit trail of data base changes maintained in the back-end processor. The back-end could be restored to a suitable inactive state with this information and then wait for the host to be restarted. The host can stop requesting service and save or hold the requested transactions until the back-end can accept them.

(6) Data Base Management for New Machines (Ref 16:6-38/577). After the back-end system is established for a given host, it should simplify the development of a new interface for a new/replacement host computer. A new and complete data management system would not have to be developed for the new host, but only the interface with the back-end would have to be developed. In addition, the data management function for a single host could be handled by a smaller computer, possible a minicomputer,

in a back-end configuration.

(7) Extended Usefulness of Current Systems (Ref 15:1197). If the data base management functions can be withdrawn from an overloaded system or systems and placed in a back-end data base processor, the workload of the host(s) could be reduced enough to extend the usefulness of the host(s) for several years. This would also allow data base processing and routine processing to proceed concurrently and would also reduce the amount of core required in the host to support data base management. A common back-end processor, utilized by two or more systems, can serve as a link between the hosts and their respective data bases. This may eliminate the need to carry duplicate copies of information in two different files and/or systems.

Disadvantages

(1) Cost of an Additional Machine (Ref 16:6-38/577, 6-39/578). A second machine will cost money and also require some effort to implement the interfaces. The cost of the second machine will have to be evaluated in light of the alternatives to determine if it is practical to obtain the additional computer. However, the use of a back-end may permit the use of a smaller, less expensive host or preclude the purchase of a larger more expensive host. Procurement is another potential problem area; since the two computers, the back-end and the host, would probably be purchased under separate contracts. The contracting problems would be increased because of the procurement and the increased requirements for items like operator training, maintenance procedures and support, interface designs, and systems programming support.

(2) Unbalanced Resources (Ref 16:6-39/578). The addition of the back-end could lead to an unbalance in system resource utilization. The

host may be busy while there is a large amount of idle time on the back-end or vice versa. Either of these situations may make the economics of utilizing a back-end processor questionable, if not unacceptable. It may be possible to increase the workload of the under utilized system by sharing it with another user. The unbalanced condition could be continuous, random, or even oscillate between the host and the back-end. The exact nature of the unbalance could easily impact the decision of how to solve the problem of unbalanced resource utilization.

(3) Response Time Overhead (Ref 16:6-39/578). In a back-end processor system configuration, the response time could be degraded since the access request must go from the host to the back-end, followed by the data retrieval/update, and then returned to the host. Two steps have been added in the access sequence which could quite reasonably downgrade response time. However, if the back-end is a data base computer (DBC) that is specifically designed to support data base management and the data base is structured for efficient access, including both update and retrieval, the response time could possibly be improved instead of degraded.

In this portion of the thesis, the back-end concept was reviewed and some of its advantages and disadvantages were discussed. In the following chapter, the personnel management functions (functional requirements) are described and followed by a discussion of the associated basic system requirements. The basic system requirements are discussed with a view toward the utilization of a back-end data base processor system at the AFMPC.

THIS PAGE INTENTIONALLY LEFT BLANK

IV General Requirements

General

Effective personnel management is the "mission" of the AFMPC. The data management system, first and foremost, must support this "mission". Requirements pescribed in this chapter are divided into two distinct categories; (1) functional, and (2) system.

In this chapter, personnel management is discussed from a top-down perspective. The viewpoint for this discussion is a high-level view that looks at the full spectrum of personnel management functions. This point-of-view was selected to develop a clear picture and understanding of the relationships between the different functions and their subfunctions. These relationships represent interfaces which cause many of the file interactions in the current system. The different personnel management functions and responsibilities are addressed in this chapter as "functional requirements", since the system exists to support these functions.

The personnel management functional requirements are the basis for the data base system and they determine what information is needed in the data base. They also dictate what, when, and how the data base information is used. Therefore, it is essential for a system designer to understand the functional requirements and their impact upon the system structure and design.

The physical structure and design of the system are determined by the basic system requirements. These requirements are general design considerations that are used to determine the capability and feasibility of any AFMPC data management system. They are derived from the defined functional requirements, the desired performance characteristics, and/or

formated file. . is capable of producing a variety of reports in

27

the known design limitations. The basic system requirements will be discussed after the functional requirements are described.

Functional Requirements

The following discussions are based upon the knowledge and understanding obtained from the personnel directives and the personal interviews at the AFMPC. These discussions are presented with a top-down perspective and constitute a starting point for future studies in this area. Personnel management is divided into five different functional areas which must be supported by the AFMPC data management system. Figures 10 through 15 graphically display Air Force personnel management from the highest perspective. Figure 10 is the very top view and includes the five basic management functions of personnel.

(1) Procurement. Procurement is the process of obtaining people to fill the manpower positions in the Air Force. Figure 11 shows a breakdown of the procurement function into sub-functions. First, the desired force manning is determined based upon the Air Force mission requirements and it is structured by such factors, as: educational level, skills, sex, race, age, grade, etc. The current force is controlled by comparing the projected force manning with the desired force manning to establish the required input quotas. The projected force manning is determined by adjusting current manning with force attrition statistics, which are determined by using historical data and projected separation-date information. Manpower models are used frequently to determine the impact of decisions and policy changes on manning and to predict future manpower requirements.

The manpower needs (quotas) of the Air Force are filled by obtaining people through several different methods; recruitment, agmentation,

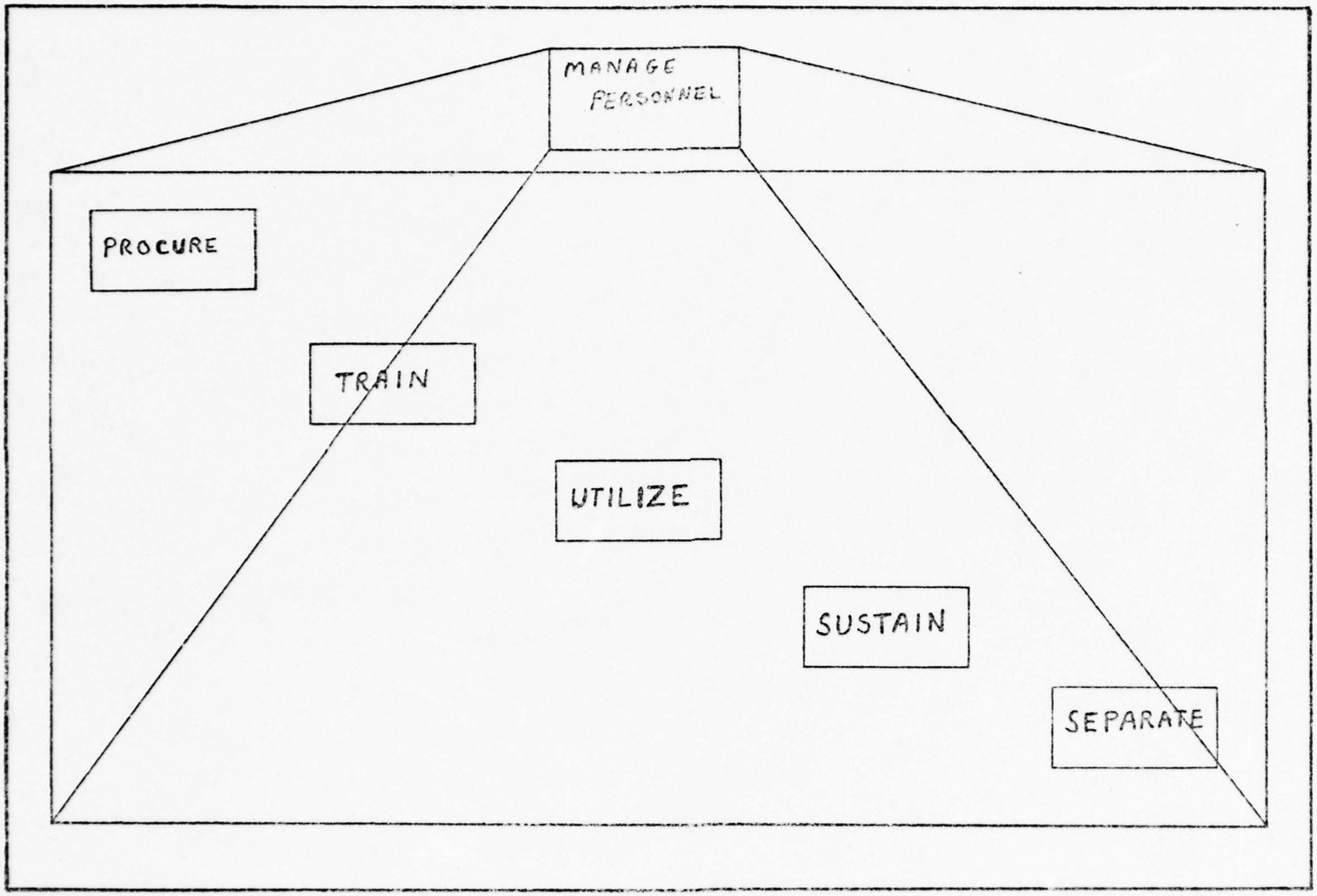


Figure 10. Personnel Functions.

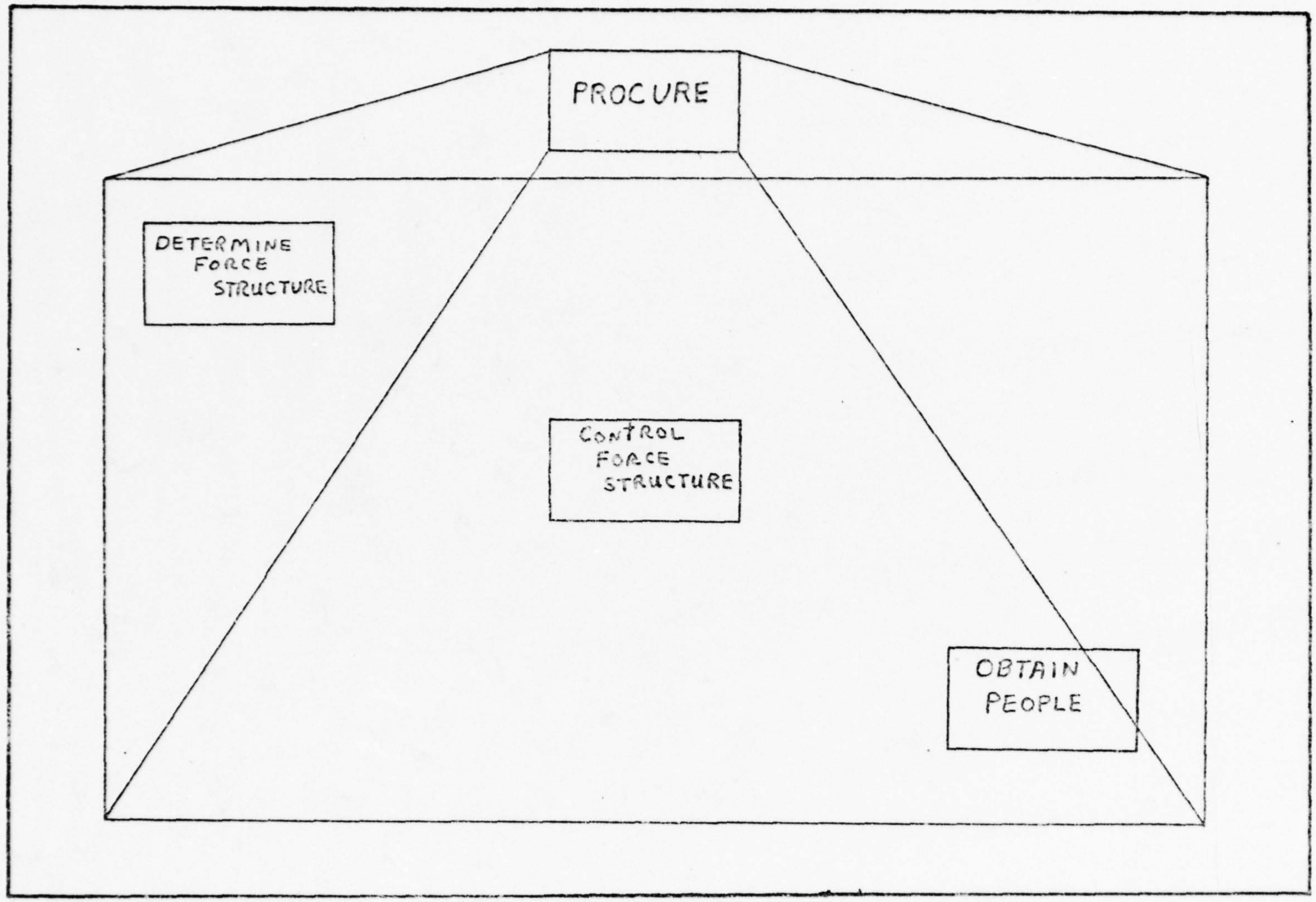


Figure 11. Personnel Procurement.

retention, re-enlistment, and appointment (direct commission). All of these functions are supported by the personnel information and the job requirements data maintained at the AFMPC.

(2) Training. There are three major categories of training, which are: (1) Professional Military Training (PME), (2) Technical Training, and (3) Academic Education. This function is sub-divided into four lesser functions (See Figure 12). People are screened to identify training eligibles and to meet the Air Force training requirements. These eligibles are then matched with class quotas and scheduled for training. The training status of the students is monitored to determine graduation dates and the availability of trained resources. To support these functions, it is necessary to maintain course-summary data and coordinate training quotas. Several different files are currently used to support all of these functions.

There is a large amount of data interaction between the training function and the other functions. For example, the class schedules have to be passed to the assignments and procurement functional managers so they can accomplish their jobs effectively. Class schedules and course completion dates are very important in scheduling assignments and enlistments. As people are procured, they usually need some form of training and many other people receive assignments that require some form of specialized training. Highly qualified individuals are selected for a professional military education (PME) or an advanced academic education, which can affect their assignments and utilization both before and after they complete the education.

(3) Utilization. The Air Force must utilize people to accomplish its mission and, consequently, "utilization" is the central function of personnel management. The other four functions support the Air Force

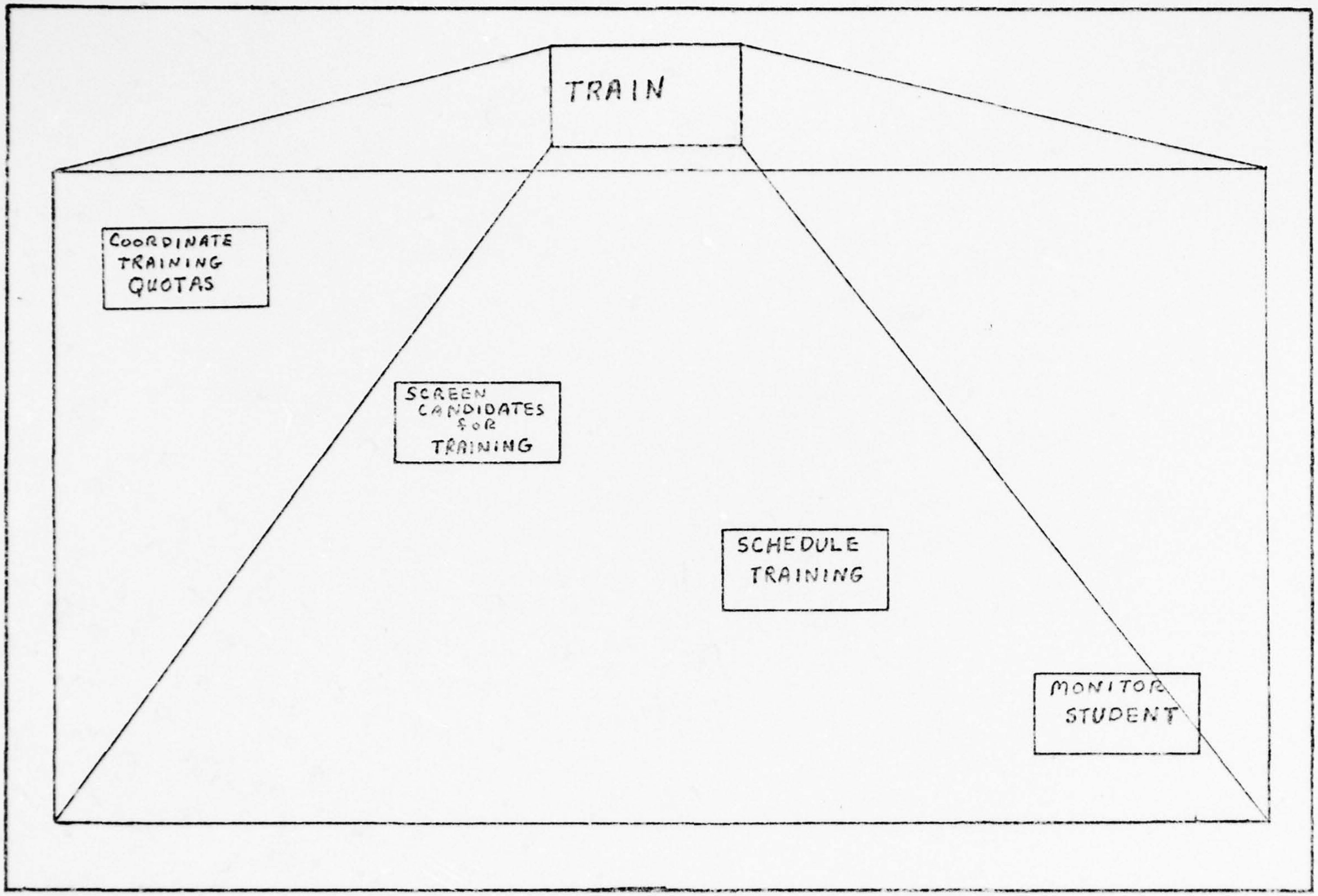


Figure 12. Personnel Training.

requirement to use people and are important because they affect how efficiently and effectively the personnel resources are used. Figure 13 displays a breakdown of the utilization function into four sub-functions.

People must be properly assigned based upon their skills and other job qualifications, if they are going to be utilized effectively. This requires that experience, training, and educational background be maintained in the personnel data base system. An individual's assignment depends upon his qualifications and the available job vacancies that are caused by a change in mission requirements, separations, or reassignments. This requires that a record of all of the jobs in the Air Force be maintained in the data base and that the characteristics of each job be specified, i.e. job qualifications required, status of the job (filled or unfilled), special training required, job title, AFSC, and location. To provide a balanced force structure the AFMPC maintains an active Career Development program which also affects personnel utilization and adds to the quantity of data that must be maintained by the AFMPC. This includes the following: career broadening information, career counseling data, and career management patterns. There are certain selected assignments that are maintained for graduates of professional military schools and Air Force sponsored graduate programs. There is an obvious data link between this function and the other personnel functions.

(4) Sustainment. The Air Force promotes "espirit de corps" and provides motivation to its employees when it satisfies the function of sustainment. Figure 14 contains a breakdown of this function. Items that fall into the area of sustainment include: personal recognition for achievements, compensation, and promotion. It also includes providing for the welfare and needs of its people, i.e. religious and medical support,

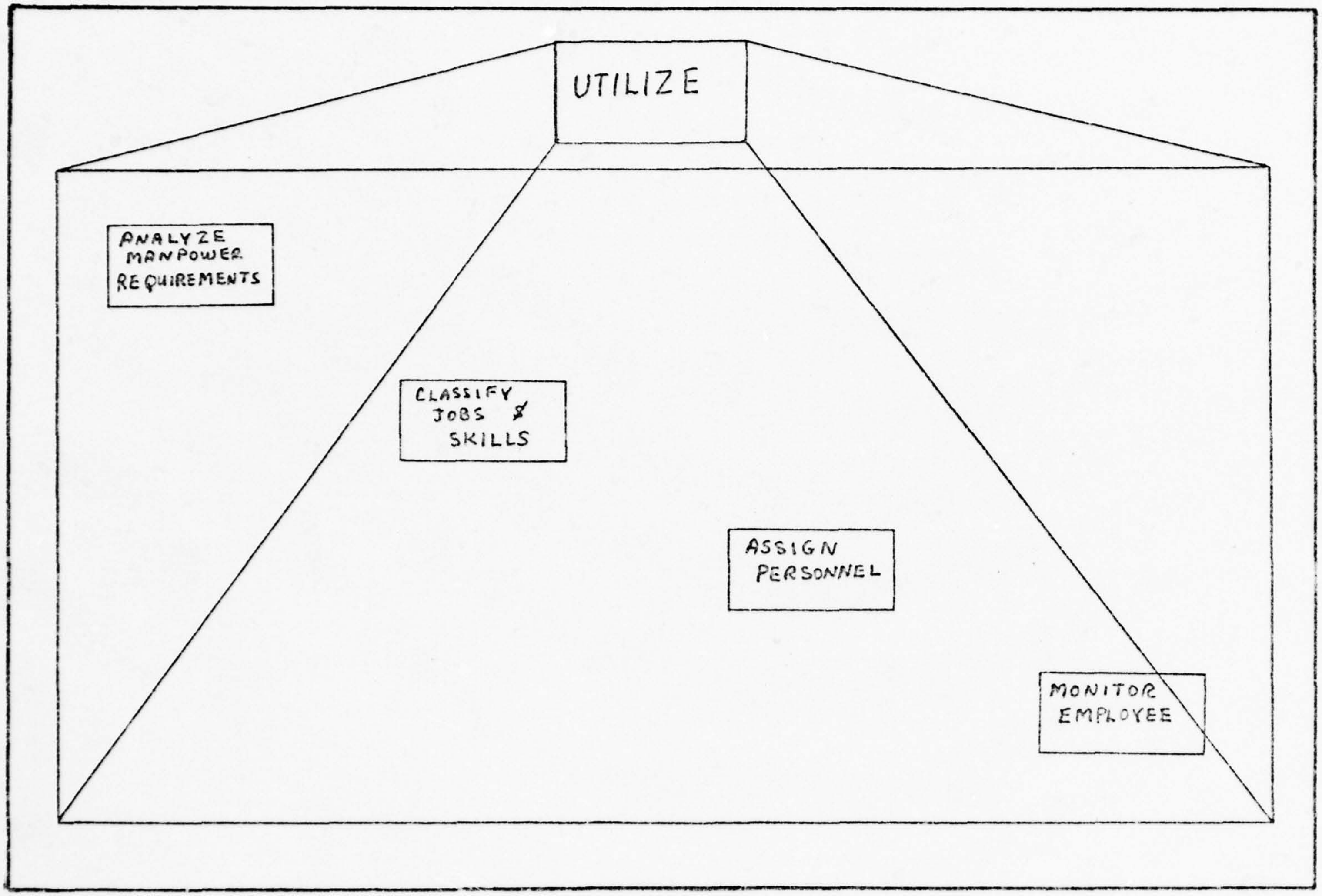


Figure 13. Personnel Utilization.

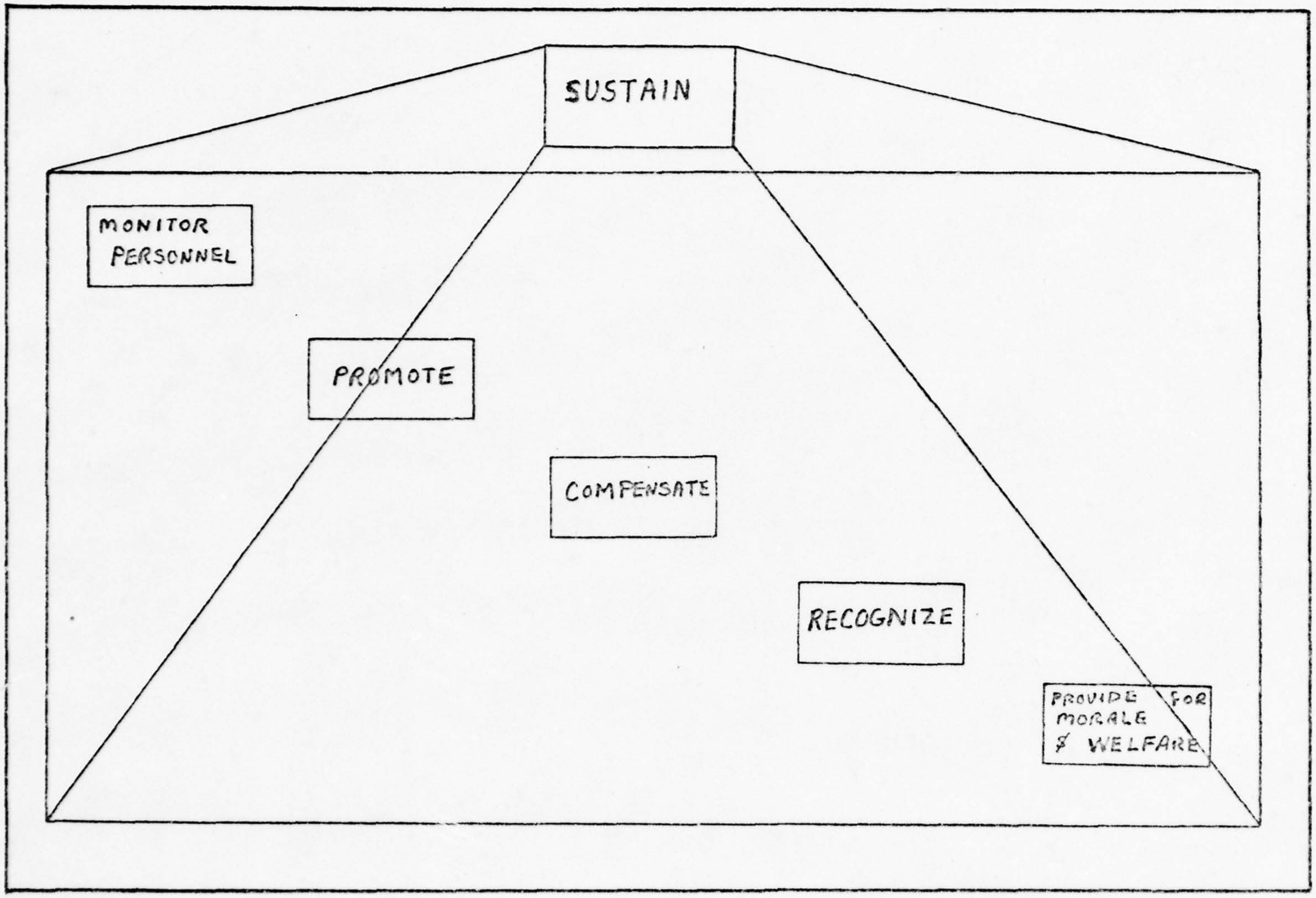


Figure 14. Personnel Sustainment.

legal assistance, and personal affairs counseling. A large variety and quantity of data must be maintained in the AFMPC to support this function. This includes information which describes the individuals performance, his personal characteristics, and his personal history.

The personnel in the Air Force must be monitored and evaluated to be sure that they are properly supported and rewarded for their service. People with superior performance records must be promoted and those with distinctive achievements must be recognized with awards, decorations, and other recognition devices. In addition, all people must be compensated for their Air Force service and this requires that selected accounting and finance data be maintained and forwarded to the Air Force Accounting and Finance Center at Denver, Colorado. The function of sustainment also includes monitoring and administering the "Equal Opportunity" programs plus monitoring the conduct and discipline of the Air Force employees.

From the preceding paragraphs, it is quite obvious that a large amount of the data maintained in the data base is used to support this function. There are approximately 15 different file systems that support this function and utilize information that is maintained on the MPFs. It is quite conceivable that at least one-fourth of the information of the MPFs is used to support the function of sustainment either directly or indirectly. Sustainment is a very important function that spans the personnel life cycle from procurement to separation.

(5) Separation. Separation is considered to be any form of termination of service either voluntary or involuntary, and includes the following: deaths, retirement, end-of-tour separations, and reduction-in-force (RIF) separations. This function is closely related to procurement since suitable replacements must be found to fill vacancies in the force. It also

affects the other functions because of the personnel changes that are required and the resulting personnel status changes that must be made.

Figure 15 shows a breakdown of this function. Air Force employees are terminated in several ways, some voluntary and others involuntary. Voluntary separation dates are maintained and updated to reflect the Air Force member's duty commitment based upon his service entry date and special training received through the Air Force. Involuntary separations require an evaluation and/or review to determine if the individual should be retained in the Air Force. This requires that a substantial amount of personal and performance history information be maintained in the personnel system to identify the people who will be separated.

The two remaining sub-functions in Figure 15 are concerned with (1) monitoring and tracking separated personnel, and (2) providing assistance and support to separated personnel during and after their separation. Embedded within this function is the responsibility for insuring that the rights, privileges, and benefits of retired/separated personnel are protected. In addition, there is a responsibility for assisting and supporting the next-of-kin for deaths, and for persons who have been captured or are missing-in-action. A separation history file is maintained to monitor the status and location of separated persons. This file also contains their military background and, if necessary, is used to select and recruit former Air Force members to augment the current force. In addition, casualty data is maintained in history files that are used to develop casualty statistics and to help next-of-kin obtain benefits they deserve. Separation is the last function of the five primary functions of personnel management.

This was a view of personnel management in the Air Force with a top-

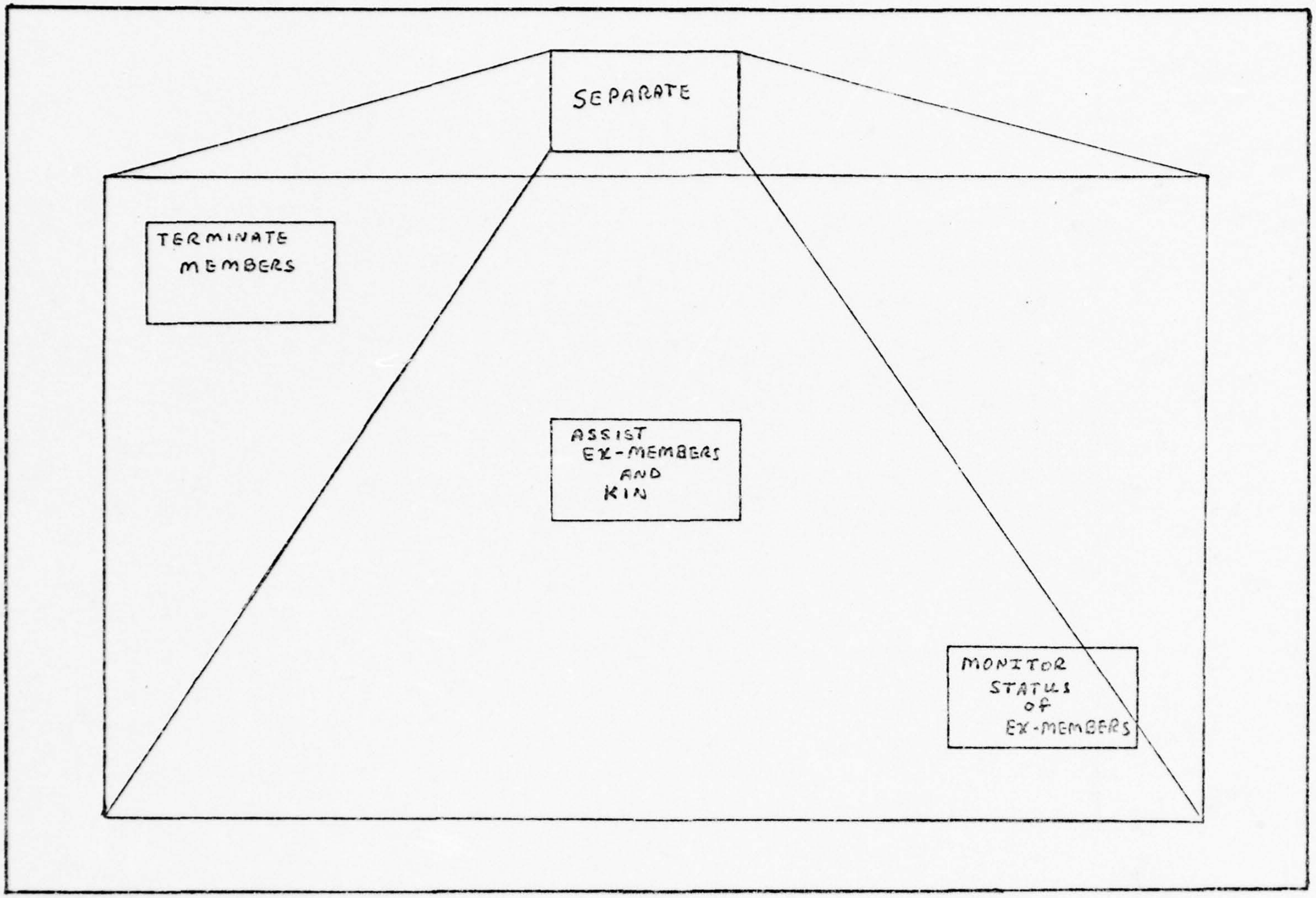


Figure 15. Personnel Separation.

down perspective. Because of the limited documentation available and the distance between the AFMPC and the author, this picture may be incomplete or may contain some misconceptions. This picture should be verified with the functional managers to establish its credibility and to determine its completeness. In any case, it is a veiw that can be updated and expanded as needed to meet the objectives of future studies. The best means of improving this picture would be (1) to let the functional users review and critique this description and (2) to study the different directives utilized by the functional users. In addition to the functional requirements described in the preceding paragraphs, the following basic system requirements are important design considerations for any AFMPC data management system.

Basic System Requirements

The following basic system requirements describe the desired characteristics and the design limitations for an AFMPC data management system. They are the basic criteria that are used to study system performance and to analyze the feasibility of utilizing a particular system. The first requirement to be discussed is that the system be adaptable to change.

Adaptable to Change. Any data management system at the AFMPC must be adaptable to changes. The very nature of personnel management and personnel policy in the Air Force make it essential that the data management system be sensitive and responsive to changes in the following:

1. National policy
2. Higher headquarters directives
3. Personnel management philosophy
4. Individual characteristics
5. Computer system characteristics

Currently, there are nearly three million transactions each month that are used to update the personnel data on the MPFs, and estimates from the system survey (Reference 14) indicate that there are more than 2500 software changes to the personnel data management system each year. Many of these changes are directly related to the items above, and in many instances, must be reflected quickly and with a minimum of effort. This is one of the primary reasons that the AFMPC uses the Decision Logic Tables (DLTs) in the General Update System (GUS). Adaptability to change has been and will continue to be a key requirement for any data management system at the AFMPC.

System Response. People who use the personnel data management system either directly or indirectly are users and they do have a response requirement that must be supported by the system. It has been impossible to identify or precisely determine the response requirements for all of the users. However, the Air Force recruiters expect a 15 second response on queries through the PROMIS system and the majority of the other remote users expect a similar response time on queries. Batch users are generally satisfied with turnarounds varying from one hour to one day. The system response times will have to be more clearly defined as the data base system development proceeds.

Quantity and Size. The back-end data base processor(s) must handle the data base management functions of the MPFs identified in a preceding section. There are more than 7 billion characters/bytes of information in the MPFs identified in Table III. If the AFMPC decides to include any other data in the data base to be handled by the back-end processor(s), the quantity of data managed could easily exceed 10 billion characters/bytes. Back-end configurations that utilize a data base computer (DBC) and are capable of managing quantities of data in the 1 to 10 billion byte range are discussed in References 18, 19, and 20.

Another area of importance is the record size which in most MPF files exceeds 1000 characters/bytes. The Civilian MPF contains records that are more than 9600 characters/bytes long. These large records could require that a large amount of data be transferred between the host and the back-end(s) for each transaction.

There is little doubt that the communication link(s) between the host and the back-end(s) will have to be capable of handling large volumes of data because of the large record sizes and the large number of transactions that are processed against the MPFs. However, the volume of data that is passed between the computers must be kept to a minimum consistent with data base and personnel management requirements. Efficient methods of data transfer must be investigated and utilized to reduce and/or minimize system response time if feasible.

Data Base Structure. The data base structure should be efficient for both update and retrieval to maximize the efficiency of the system. More than 70 per cent of the CPU time is devoted to supporting these two functions in the current system. The current data base strucure is basically a collection of independent files that contain a significant amount of duplicated information. In addition, the files have an "index random" structure, which means that the files are managed by using a sequential key to access records that are stored randomly. The key for personnel files is the SSAN of the individual and this is not the most practical key to use for personnel management. The SSAN is unique, and it is used by other agencies like the Internal Revenue Service, Social Security Administration, and the Air Force Accounting and Finance Center; however, it is not descriptive of the person or his skills.

There are meaningful keys that could be used or developed for use. For example, a descriptive key similar to a "fingerprint" would be more efficient and useful for file management. This "fingerprint" should be an identifier that describes the individual, his background, and his capabilities. Certain personal characteristics are basic and are fixed very early in a person's life and career. For example the following:

1. Date of birth
2. Place of birth
3. Name
4. Race
5. Date employed by or entered the Air Force
6. Date graduated from high school
7. Source of commission
8. Date of commission

Other items provide a historical picture of the person and become fixed once they occur, for example:

1. Academic, military, and technical training
2. Promotions
3. Assignments
4. Duties and skill levels

If a key were developed from items similar to those in the lists above, the key would change very little and would be descriptive of the individual. If the remaining personnel data were clustered around or linked to the key, the data base updates and retrievals would be more efficient and less time consuming.

New concepts, along with traditional data base structures should be evaluated to find the most effective and efficient way to structure the AFMPC data base. Some of the data base design concepts and data structures discussed in References 17, 25, and 26 might be very helpful in developing an efficient data base structure for the back-end system.

Security. The data base must be secure and protected from unauthorized access for both security and reliability considerations; consequently, the security and access restrictions must be clearly defined, understood, and incorporated in the design of the data management system. Currently, there is classified information stored in the Manpower MPF and the Personnel Accounting Symbol (PAS) file. In addition, selected data in many of the other personnel files is sensitive and must be protected due to Privacy Act restrictions and other considerations. For example, the General Officer System (GOS) file is maintained and updated at the AFMPC, but the information is only reviewed in Washington, DC. Transactions relating to the release of privacy information are recorded in the Privacy Act Tracking System (PATS) file, which is used to monitor the dissemination of privacy information outside of the personnel system. When a person separates from the Air Force, the data on the PATS file related to his privacy information is transferred to a PATS history file for reference if necessary.

Cost. The method used to overcome the AFMPC system workload and associated data management update and retrieval problems must be cost effective relative to suitable alternatives. There are several possible solutions which include (1) buying or leasing a larger machine, (2) restructuring the data base and using the existing hardware, and (3) utilizing a back-end data base processor system configuration with an efficient data base structure. The purchase of a larger machine or a back-end processor will require a special procurement effort and will incur some additional training, installation, and maintenance costs. Many other cost factors must also be considered before a final decision is made to utilize a back-end system configuration or to select some other alternative solution.

The functional requirements and the basic system requirements will determine whether a new or different system configuration is needed. First, however, a plan-of-attack is required to focus the large effort that is required to evaluate the feasibility of using a different system configuration. A plan that describes the steps required to complete a comprehensive evaluation of a back-end data base processor at the AFMPC is presented in the next chapter. This discussion is followed by an analysis of the feasibility of using a back-end system at the AFMPC considering the general requirements described in this chapter.

V Results of this Study

General

This chapter describes the effort involved in this thesis and provides a plan-of-attack that will end with the evaluation of a back-end data base processor system for the AFMPC. This plan-of-attack is designed to look at the system with a top-down perspective. This means that the system requirements will be completely redefined and documented based upon the current charter and personnel management responsibilities of the AFMPC. Following the description of the plan-of-attack, there is a discussion of the feasibility of using a back-end data base processor system at the AFMPC. The back-end concept is discussed considering the general system requirements and other information presented in the preceding chapters. The following paragraphs describe the effort involved in developing this thesis.

The Effort. The initial goal of this thesis was to develop the functional data requirements necessary to implement a back-end data base processor at the AFMPC by using "Structured Analysis" (SA). The available literature was studied to become familiar with both the Air Force personnel system and the back-end processor concept. This knowledge was augmented with information obtained on three different visits to the AFMPC at Randolph AFB, Texas. A total of 11 days was spent on-site gathering information about the system and its general requirements. This involved approximately 80 hours spent in interviews, briefings, and discussions plus 20 hours devoted to obtaining the reports and other documentation required to develop a comprehensive understanding of the current system. The discussions, interviews, and briefings involved over 30 different people; including systems planners, programmers, operations managers, requirements analysis, operations schedulers, and a few functional managers.

The goal of the study was revised because of the knowledge and understanding of the system that was obtained during these visits. It became evident that a solid background and perspective of the overall system and the problem should be developed and documented. This documentation will allow other people to complete follow-on studies with a minimum of effort. The perspective of this thesis was raised and the goal was revised because of the need to (1) document the system and its environment, (2) define the problem, and (3) establish a direction for future studies. The investigation was refocused and generally confined to analyzing and documenting the current system. As a result of the investigation, a course of action was developed that will satisfy the original request of the AFMPC. This course of action (plan-of-attack) is presented later in the chapter, and it will provide a focus and direction for future studies.

The preceding chapters are a result of the changed perspective and the goal of this thesis and represent a significant part of this investigation. A brief analysis of the current system is provided in the following paragraphs and is followed by the plan-of-attack. The plan-of-attack is based upon a top-down approach to problem solving and emphasizes requirements definition. The following system analysis highlights the system problems and points out several factors that contribute to these problems.

Analysis of Current System. This analysis is a summary of facts related to system problems and reflects information presented in preceding chapters. The AFMPC data management system is nearly saturated with the CPU utilization at or above 90 per cent continually. An extremely large portion of the CPU workload is concerned with either MPF data updates or MFP data retrievals. More than 50 per cent of the CPU time is devoted to

MPF data retrievals and approximately 20 per cent of the CPU time is devoted to updates. The time between updates on the different MPF files varies from two days to one week because of the heavy workload. The "ripple" effect caused by the file inter-relationships and the update schedule may cause several days or weeks to elapse before the final impact of a change is reflected in all files.

Several factors contribute to the CPU workload problem and the file update problem. First, the MPFs are either keyed upon Social Security Number (SSAN) or job number, and this makes the file structures efficient for updates but inefficient for retrieval. Second, there are more than 200 files in the total personnel system at the AFMPC, and many of these files contain data elements that are duplicated in one or more of the MPFs. This means that many redundant updates are required to update files that contain duplicated data. Third, there are more than 250 different interface links between the MPFs and the other files. This is indicative of (1) the amount of data that is duplicated in the different files, and (2) the complexity of the data relationships between the MPFs and the other files. These complex relationships are the primary reason it takes so long for a change to be fully reflected in all of the files. Finally, the current system does not reflect a top-down design and does not have an efficient structure for data management. A system that is designed top-down tends to be (1) easier to understand and maintain, (2) more efficiently structured to satisfy the system requirements, and (3) more easily redesigned and modified. The current data management system was developed by centralizing management functions and adding files and data requirements to the existing system. This development process has caused data to be duplicated throughout the file system and increased the complexity of data relationships between the files. This has adversely affected the system workload and data management at the AFMPC.

The following plan-of-attack provides a top-down approach to solve the problems and eliminate the deficiencies described in the preceding paragraph. The first two phases in the plan-of-attack outline the general steps required to support investigations into different possible solutions to the data base problem. Phases 3 and 4 are slanted toward the back-end data base processor concept and its implementation at the AFMPC. However, alternate solutions may be more promising as follow-on studies are developed and may be investigated using the information obtained in the first two phases.

Plan-of-Attack

There are many actions that must be completed to properly satisfy the request by the AFMPC to evaluate and model a back-end data base processor. These actions and activities are divided into four different phases, which are (1) Analyze the Problem and Define the General Requirements, (2) Define the Detailed Requirements of the System, (3) Develop a Back-end Configuration and Document the System Interface, and (4) Model and Evaluate the Back-end System.

Analyze the Problem and Define the General Requirements. This is an essential part of the overall study because it provides the focus and the foundation for the follow-on studies. This thesis serves that purpose for the back-end data base processor evaluation. It also establishes an environment where realistic alternatives can be evaluated with very little duplicated effort. The preceding sections of this thesis have established the background and focused the problem for future studies. The general requirements were discussed in Chapter IV and provide a starting point for the next phase of study.

Define Detailed Requirements. The detailed requirements of the system must be known and understood before a realistic model of a back-end processor system can be developed. This is a broad area and involves many different aspects of the system which must be described either by or for the AFMPC. These requirements must be explicitly and accurately documented in order to develop system configurations that will meet and satisfy the AFMPC data management requirements. The detailed requirements are divided into two categories; (1) detailed functional requirements, and (2) detailed system requirements.

These categories are similar to the requirements categories addressed in Chapter IV. However, during this phase of the overall study, the requirements must be defined in more depth. The detailed functional requirements are discussed first and are followed by a discussion of the detailed system requirements.

(1) Detailed Functional Requirements. In concert with previous discussions, the AFMPC personnel management functions and responsibilities are defined as the "functional requirements" of the system. The functional requirements in Chapter IV can be used as a starting point but they must be validated, expanded, and documented in much greater detail. In addition, the data interactions caused by personnel management actions, functions, and activities must be well-defined, understood and documented. The detailed functional requirements and the associated data interactions should be developed by looking at the functional, personnel management responsibilities of the AFMPC with a top-down perspective. A top-down perspective will help create an integrated, cohesive, and complete picture of the AFMPC data management system. It may be necessary to document the functional requirements from different points-of-view to completely reflect the system

requirements; i.e. (1) the user, (2) the manager, and (3) the designer.

The functional requirements of the current system are not well-defined or readily available. In addition, they have not been documented from a top-down perspective. This makes it difficult, if not impossible, to understand the inter-relationships and functional significance of the data in the AFMPC data base system. Currently, a large amount of data is maintained in the data management system for each person and/or job in the Air Force. For instance, the majority of the records in the MPFs are more than 1000 characters long. This data is usually maintained in the data base system to support specific personnel management functions. However, some individuals at the AFMPC question whether all of this data is actually needed or utilized. The files and data should be scrutinized and the data should be deleted from the system if it is no longer functionally significant or needed.

The functional requirements documentation should include the inter-relationships of the data in the files, the cluster (closeness) relationships of the data, and the relative importance of the data to the personnel management functions. Everest et al (Ref 25: 7-58) describes data characteristics and data relationships, and discusses how this information is used to specify requirements and structure a data management system. A detailed understanding of data requirements and data relationships is needed to develop an efficient data base structure and system for the back-end data base processor. The more efficient the data structure, the more efficient the system will be.

The functional requirements should be identified and then correlated with the known inter-relationships in the current system to insure that the true requirements are properly identified. Early in the requirements definition process, a "user's manual" should be developed that defines the user-machine interface. This "user's manual" is a valuable source of information for structured approaches to requirements definition. Formal structured methods should be used to develop and document these requirements so that a complete and accurate definition of requirements is produced. Structured Analysis (SA) and/or Computer Aided Design and Systems Analysis Tool (CADSAT), formerly Computer Aided Requirements Analysis (CARA), are tools that can be very useful during requirements studies (Ref 5, 6, and 27). The following sources should be helpful in gathering the information to define the functional requirements:

(1) "Reports" file (Ref 28)
(2) "Rich" file (Ref 27)
(3) "GUSDATA" cross reference retrieval (Ref 30)
(4) "Working Group Survey" forms (Ref 14)
(5) USAFPP (Ref 7)
(6) Air Force/AFMPC Manuals and Regulations (Ref 10 - 13)
(7) Functional users
(8) Personnel programmers

Most of the source information will have to come from Air Force publications, the functional users and managers, and the supporting programmers. After the detailed functional requirements have been identified and documented, the detailed system requirements can be fully developed and specified.

(2) Detailed System Requirements. The detailed system requirements must be clearly defined and documented, too. The system requirements, as discussed in Chapter IV, are derived from the functional requirements, desired performance characteristics, and/or the known design limitations. In addition, the specific evaluation and system design criteria to be used in developing and analyzing a back-end data base processor system must be

explicitly defined and stated by or for the AFMPC. The following list of items includes the most important system requirements and performance considerations that must be defined:

(1) Content of the data base files

(2) Response time requirements for

   (a) Functional users
   (b) Programmers
   (c) Batch users
   (d) Remote terminal users
   (e) Others

(3) Flexibility and adaptability to change

   (a) Criteria to describe types and number of changes
   (b) Speed of adaptability

(4) Special preferences or needs in system

(5) Cost considerations

(6) Requirements to expand capacity

(7) Physical facility - space, location, power, etc.

   (a) Capabilities
   (b) Restrictions

(8) Projected workload pertaining to jobs and transactions

   (a) Jobs - types, quantity, and sizes
   (b) Transactions - types, quantity, and relative frequency of use
   (c) Workload trends - highs, lows, and means
   (d) Future trends in workload

Items may be added to or deleted from this list to meet the objectives of future studies and satisfy the requirements of the AFMPC. The information in this list is needed to complete the last two phases of the overall study requested by the AFMPC. Any person who attempts to define the detailed system requirements should have some knowledge and understanding of (1) requirement definition tools and techniques, and (2) computer performance evaluation (CPE) principles and techniques.

Develop a Back-End Configuration and Document the Interface. This step in the study is required to fully understand the design alternatives and comprehend the interface requirements. Prior to accomplishing this step in the back-end model development process, a system designer must understand the system requirements identified in the preceding section, and specified by the AFMPC. After the back-end system configuration is developed, the interface requirements must be defined and documented. Embedded within the activities of this pahse is the requirement to define a data base structure. This is necessary because the data base structure could affect the interface requirements of the system. The following list identifies items that should be included in the interface documentation:

(1) Hardware

- (a) Type of hardware (microprocessors, minicomputers, or large data base computer)
- (b) Compatibility with current and future systems
- (c) Physical requirements (space, location, power, etc.)
- (d) Storage mediums and memory units

(2) Software

- (a) Conversion packages/languages for the host(s) and the back-end(s)
- (b) Communications protocols (encoding, encryption, decoding, decryption, transmission, reception, etc.)
- (c) Data base languages and software
- (d) Host languages and software

(3) Data requirements and data base design

- (a) Transfer rates (volume)
- (b) Transfer quantity per transaction (record size)
- (c) Data protection

(d) Storage devices for data base (types, capacity, and characteristics)

(e) File organization, data structures, and access techniques

This list may not be complete but it does provide an outline of items to consider during the documentation of the interface requirements for a back-end data processor system at the AFMPC. Items may be added to or deleted from this list, as necessary, to meet the objectives of future studies and satisfy the requirements of the AFMPC. During this phase, some design and configuration decisions will be required to restrict and bound the scope of the study or it will expand rapidly and could quickly become unmanageable. A person who continues the study in this particular area should have some knowledge of data base design and management, data structuring approaches, security methods, communications protocols, and data storage systems. There are many papers, journal articles, and/or texts available that discuss these subjects in detail (Ref 17, 21, 22, 25, and 26).

Model and Evaluate. This is the final step in analyzing the feasibility of utilizing a back-end data base processor at the AFMPC. After the system requirements have been identified and the basic system configuration with its associated interface requirements has been designed, the models can be developed to analyze and evaluate the system and its capabilities. The nature and types of models utilized will depend, in large measure, upon the results obtained in preceding phases. The models will be based upon the functional and performance requirements identified during the first phase and the system configuration(s) developed in the second phase. The key considerations will be the effect of the back-end on response time and the overall system workload. The analysis and the evaluation of the system models will be based upon criteria and standards established during the second phase.

A person who works on this phase should have a knowledge of computer performance evaluation (CPE) tools and techniques, the engineering aspects of probability and statistics, and computer simulation and modeling techniques. This discussion has been kept very general, since the modeling approach must be determined by the person(s) developing the model in consonance with the AFMPC requirements.

The preceding discussions in this chapter outline a course of action that will culminate in the development and evaluation of a model of a back-end data base system configuration for the AFMPC. In the following section, possible back-end system configurations are analyzed and the feasibility of utilizing a back-end system is discussed.

A Back-End Data Base Processor at the AFMPC

This section contains a discussion of different possible back-end system configurations and their application at the AFMPC. This is followed by discussion of the feasibility of utilizing a back-end system configuration based upon the general system requirements and the capabilities of back-end processors.

System Configuration. A single host - single back-end configuration is the simplest back-end system that can be designed, and it has the simplest interface. There is only one source for commands to the back-end, and since only a single host needs to be served, the status of the data base can be controlled relatively easily. Security measures are also simpler to implement because of the single interface. The size of the AFMPC data base, the two existing host computers at the AFMPC, and the mission of the AFMPC may make this particular configuration impractical.

A multiple host - single back-end will require that the data base status be maintained to provide some means of controlling the condition of the data in the data base. The read-write status of the data base files must be maintained or a request through one host could retrieve data that is in the process of being updated by the other host. Control of data updates and retrieval must be maintained and utilized to insure that the information obtained from this data is meaningful and consistent. The multiple host - single back-end is realistic configuration for the AFMPC since there are two host computers currently. This is contingent upon the fact that a single back-end could handle the data management functions required to support personnel activities.

The single host - multiple back-end configuration is possible but not likely since the AFMPC has the two host computers. The interface in this configuration is more complex than the first configuration discussed. since it also requires controls and monitors to keep track of file status. An advantage of this system is that several independent file systems could be processed concurrently. This type configuration might permit the use of several smaller processors which might be less expensive than a single larger system. It does provide some degree of redundancy and flexibility in system design and operation.

The multiple host - multiple back-end configuration has an extremely complex interface because of the number of different processors involved. This configuration also requires that some form of file status be maintained and utilized. The security problem is compounded, and the communications protocol is more critical due to the number of different units involved in the system. This configuration is basically a distributed processing/data base network and can possibly distribute and/or minimize the workload of the hosts and/or the back-end processors. Any system that is configured with a back-end processor has the basic elements required to either join or be developed into a distributed network regardless of the system's original back-end configuration. The complexity of the multiple host - multiple back-end configuration will probably preclude the use of it at the AFMPC, at least initially. However, the AFMPC with two hosts plus the base level systems could be developed into a network system if it proves to be desirable in the future.

The different possible back-end system configurations and their application at the AFMPC have been discussed briefly. The following discussion is devoted to analyzing the feasibility of utilizing a back-end system at the AFMPC.

Feasibility of a Back-end Configuration. The following analysis and comments are presented based upon a comparison of the general requirements discussed in Chapter IV and the capabilities of back-end data base processors. There are back-end designs that are capable of handling the large quantity of data required to support personnel management. The security requirements at the AFMPC are significant but a single back-end system configuration will allow the security functions to be concentrated at a single point. The large amount of CPU time that is devoted to updating and retrieving data from the MPFs would be transferred to the back-end. However, some processing overhead would be required to handle the transfers to and from the back-end, but the overall workload on the host system would be reduced significantly. In fact, it is conceivable that the workload on the host(s) would be reduced enough so that the entire host workload could be handled by one B-6700 host machine.

If a specialized data base computer (DBC) is utilized and an efficient data base structure is used, the response times would probably decrease or remain comparable to the response times of the current system. A back-end data base processor has improved response times by one or two orders of magnitude for complex data management tasks such as storing a record that is a member of a number of sorted sets (Ref 16:6 - 43/582). The communications interface and its effect on response time is difficult to determine since the delays caused by queuing in both the host and the back-end are unpredictable at this point. The time involved in data transfer and responses in Reference 16 was less than three seconds which could have been reduced to less than one second by increasing the capacity of the communications link to 50K BAUD. The back-end processor is quite appealing, since it provides a great deal of flexibility for the future and appears to meet the current system requirements. This is especially true if current and projected advances in hardware technology are considered.

Another possible alternative, not mentioned previously, is to structure the data base and utilize one of the B-6700s as a back-end processor and utilize the other as the host. This would not require a new computer and could reduce the costs involved in converting to a back-end system configuration. In addition, it is quite probable that a large computer will be required to handle the functions of the back-end processor unless a number of smaller computers are utilized. The B-6700 might be the answer and there could be an advantage to retaining both B-6700s; for instance, redundancy or software compatibility.

At this point in the overall investigation, a back-end system does appear to be a reasonable solution to the problems of CPU utilization and timely data base updates at the AFMPC, for the following reasons:

Back-end systems

(1) can handle the large volume of data maintained.

(2) are capable of meeting the known response requirements.

(3) allow security functions to be concentrated at a single point (the back-end processor).

(4) are building blocks for distributed networks, which improves the system design flexibility and adaptability.

(5) are improving rapidly with advances in computer technology, especially advances in hardware and data base design.

In this chapter, a course of action has been presented that will help the AFMPC develop an effective and efficient solution to their workload and data management problems. In addition, the potential application of a back-end data base management system was discussed, and it appears to be a realistic solution to the AFMPC problems. Some final comments on the results of this thesis are presented in the next chapter.

VI Conclusion

The initial request by the AFMPC for a model of a back-end data processor rapidly developed into a much larger problem. Because of the magnitude of the problem, the perspective of this thesis was raised and the primary effort was focused upon developing a solid foundation for future studies and outlining a course of action to satisfy the original request. This portion of the thesis contains some final comments about future studies in these areas and the utility of "Structured Analysis" (SA) in a study of this magnitude and complexity.

(1) The AFMPC should take action to identify and document their system requirements using a top-down approach. A "user's manual" must be developed that defines the user - machine interface and describes the functions users must perform on the system, since it is a valuable source of information for structured approaches to requirements definition. This information will be necessary for any system development and will enable the system to be maintained and operated efficiently. By using a top-down approach, the details of the requirements can be controlled at different levels consistent with the particular needs of the affected individual. In addition, the requirements definition will then reflect a fully integrated and cohesive picture of the system and allow the AFMPC to develop an efficient data base structure. Future studies in this area will need the firm commitment and strong support of the AFMPC and other affected agencies. These studies will take a significant amount of time and effort if they are completed in any great amount of detail.

(2) Back-end data base processor configurations should be investigated in more detail. The validity of this concept has been addressed in many

publications and is receiving increasing attention from industry and computer vendors (Ref 23:35). The potential advantages seem to outweigh the disadvantages, although the AFMPC has not quantified the required performance standards for such a system. However, alternative solutions to the problems of heavy machine utilization and timely data base file maintenance may become apparent as the overall study continues, and there may be more practical solutions than a back-end system.

(3) The original goal of this thesis was to "document the functional requirements of the system with SA models." However, the level and the perspective of this investigation were raised and the goal was revised because of the complexity, size, and scope of the AFMPC data management system. During this period of time, SA was utilized to develop a more complete understanding of the functional requirements of the AFMPC. The SA models developed by the author were not included in this thesis because they were incomplete and lacked consistency. It was difficult to create satisfactory SA models for the following reasons: (1) the distance between the AFMPC and the author, (2) the complexity and magnitude of the problem, (3) the lack of centralized documentation that outlines the functional relationships of the data files, (4) the need for several models with different viewpoints, (5) the lack of available readers with a knowledge of both the technique and the personnel environment, and (6) the time available for thesis completion. A discussion with SOFTECH experts indicated that in some instances on projects of this size, complexity, and character, it may be helpful to develop the data model first (Ref 31). This approach was not attempted because of the time limitation and other factors listed above. However, the time devoted to SA model development was worthwhile because it resulted in a more complete and accurate picture

of the personnel system. It focused attention upon some weaknesses in the author's perspective of the system which were eliminated through supplementary research and discussions with personnel at AFMPC.

The preceding comments summarize the results of this thesis. This study should be useful as a stepping stone and foundation for the follow-on studies that are required. It was designed to provide a comprehensive background and, also, to establish a direction and focus for future studies.

Bibliography

1. McCall, George A. A Functional Approach to Design of the USAF Personnel System. Research Report No. 131. Maxwell AFB, Alabama, Air War College, April 1977.

2. Hicks, Maj Donald B. Chief, HAF Support Section, Directorate of Personnel Data Systems, Headquarters Air Force Military Personnel Center "personal correspondence, attachment 2", Randolph AFB, Texas, undated (approximate date, 1 July 1977).

3. Waguespack, Capt Leslie J., Lt Col Frank Sutter, Lt Col Norman Haugen, Lt Col G. Nardi, Lt Col George McCall, Lt Col W. Siefert, and Maj James Nolen. Directorate of Personnel Data Systems, Headquarters Air Force Military Personnel Center, (personal briefings and interviews), Randolph AFB, Texas, 6 - 8 September 1977.

4. Madnick, Stuart E. "Trends in Computers and Computing: The Information Utility", Science, 19, 1197 (18 March 1977).

5. 9022-78R. An Introduction to SADT-Structured Analysis and Design Technique. Waltham, Massachusetts: SOFTECH, Inc., November 1976.

6. 9022-73.2. Structured Analysis Reader's Guide. Waltham, Massachusetts: SOFTECH, Inc., May 1975.

7. USAFPP Vol VIII. The USAF Personnel Plan: Automated Information & Data Support Systems, Washington: Department of the Air Force/ DPXXS, 1 May 1975.

8. Burroughs Corporation. Burroughs B-6700 Information Processing Systems Reference Manual. Detroit, Michigan: Burroughs Corporation, 1972.

9. Datapro Research Corporation. Datapro 70 EDP Buyers Guide (Vol 1). Delran, New Jersey: Datapro Research Corproation, 1977.

10. Directorate of Personnel Data Systems. APDS Operating Standards Handbook 171 - 100, Randolph AFB, Texas: Air Force Military Personnel Center, 1 January 1977.

11. Directorate of Personnel Data Systems. APDS Standards Handbook 171 - 100: Advanced Personnel Data System Development, Maintenance, Documentation, Standards, and Techniques, Randolph AFB, Texas: Air Force Military Center, 15 April 1974.

12. Directorate of Personnel Data Systems. PDS Documentation Handbook 171 - 30, Part 19, Section 7. Randolph AFB, Texas: Air Force Military Personnel Center, 24 March 1977.

13. AFM 30-3, Volume 1. Military Personnel Data System. Washington: Department of the Air Force, 22 November 1974.

14. Moore, D. R., Capt Leslie J. Waguespack, MSgt Richard Thayer, and SSgt Douglas Clapp. System Survey Wroking Group, Air Force Military Personnel Center, (unpublished System Survey forms, notes, and personal interviews). Randolph AFB, Texas, October - December 1977.

15. Madnick, Stuart T., "Trends in Computers and Computing: The Information Utility". Science, 195 (4283): 1191 - 1199 (18 March 1977).

16. Canaday, R. H., R. D. Harrison, E. L. Ivie, J. L. Ryder, and L. A. Wehr. "A Back-end Computer for Data Base Management," Distributed Processing: Macros, Minis, & Maxis: Tutorial for COMPCON Fall 77: 6 - 36, 6 - 37. New York NY: Institute of Electrical and Electronics Engineers. (Reprint from October 1974 issue of Communications of the ACM 17 (10): 575 - 582. Association for Computing Machinery, Inc.)

17. Wiederhold, Gio. Database Design. New York, NY: McGraw-Hill Book Company, 1977.

18. Hsiao, D. K. and S. E. Madnick, "Database Machine Architecture in the Context of Information Technology Evolution," Proceedings: Third International Conference on Very Large Data Bases: 63 - 84. (Tokyo 6 - 8 October 1977). New York NY: Institute of Electrical and Electronics Engineers. 1977.

19. Baum, R. I. and D. K. Hsiao, "Data Base Computers - A Step Toward Data Utilities," IEEE Transactions on Computers C - 25 (12): 1254 - 1259. New York, NY, December 1976.

20. Baum, R. I., D. K. Hsiao, and K. Kannan. The Architecture of a Database Computer, Part I. Concepts and Capabilities. OSU Technical Report OSU-CISRC-76-1. Columbus, Ohio: The Ohio State University. September 1976. (AD-A034154).

21. Hsiao, D. K. and K. Kannan. The Architecture of a Database Computer, Part II. The Design of Structure Memory and Its Related Processors. OSU Technical Report OSU-CISRC-76-2. Columbus, Ohio: The Ohio State University. October 1976. (AD-A035178).

22. Hsiao, D. K., D. Kerr, and F. Ng. DBC Software Requirements for Supporting Hierarchical Databases. OSU Technical Report OSU-CISRC-77-1. Columbus, Ohio: The Ohio State University. April 1977. (AD-A039038).

23. Maryanski, Fred J. "A Survey of Developments in Distributed Data Base Management Systems," Computer, Vol 11, (2): 28 - 38 (February 1978).

24. Marill, T. and D. Stern. "The Datacomputer-A Network Data Utility," Proceedings AFIPS Spring Joint Computer Conference, 44: 389 - 395 (1975).

25. Everest, G. C., D. Bray, and I. Valters. Developing a Data Perspective on the Specification of Information System Requirements. University of Minnesota Technical Report MISRC-TR-77-05. Minneapolis, Minnesota: University of Minnesota. May 1977. (AD-A042482).

26. Emory, J., S. Green, R. Grimes, O. Haslop, A. Shah, and H. Ullman. A Comprehensive Data Base Access Methodologies Design Guide. Falls Church, Virginia: Computer Sciences Corporation. 28 September 1976. (AD-A041459).

27. Eiden, H. J. Maj. and C. R. Moore. Introduction to Computer Aided Requirements Analysis. ESD-TR-75-88, Vol I - III; Reference Manuals for CARA (Computer Aided Requirements Analysis). Hanscom Air Force Base, Massachusetts: Information Systems Technology Applications Office, 1975.

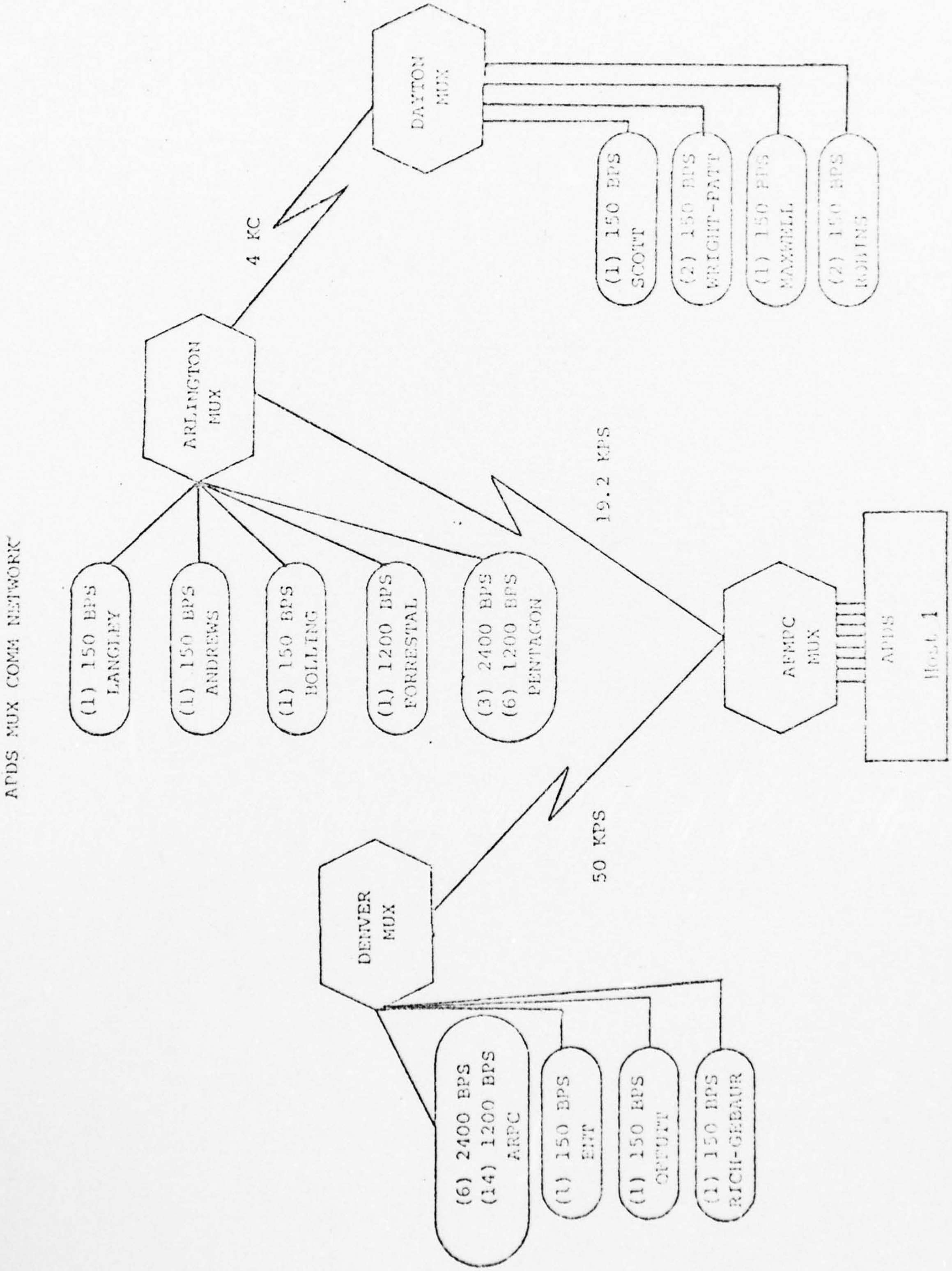
28. Furlow, S. and TSgt R. Siler. The "Reports" file (An unpublished list and brief description of the computerized personnel reports published by the AFMPC/DPMDOR Branch). Randolph Air Force Base, Texas. October 1977.

29. Furlow, S. and TSgt R. Siler. The "Rich" file (An unpublished list and brief description of the AFMPC computer files). Randolph Air Force Base, Texas. October 1977.

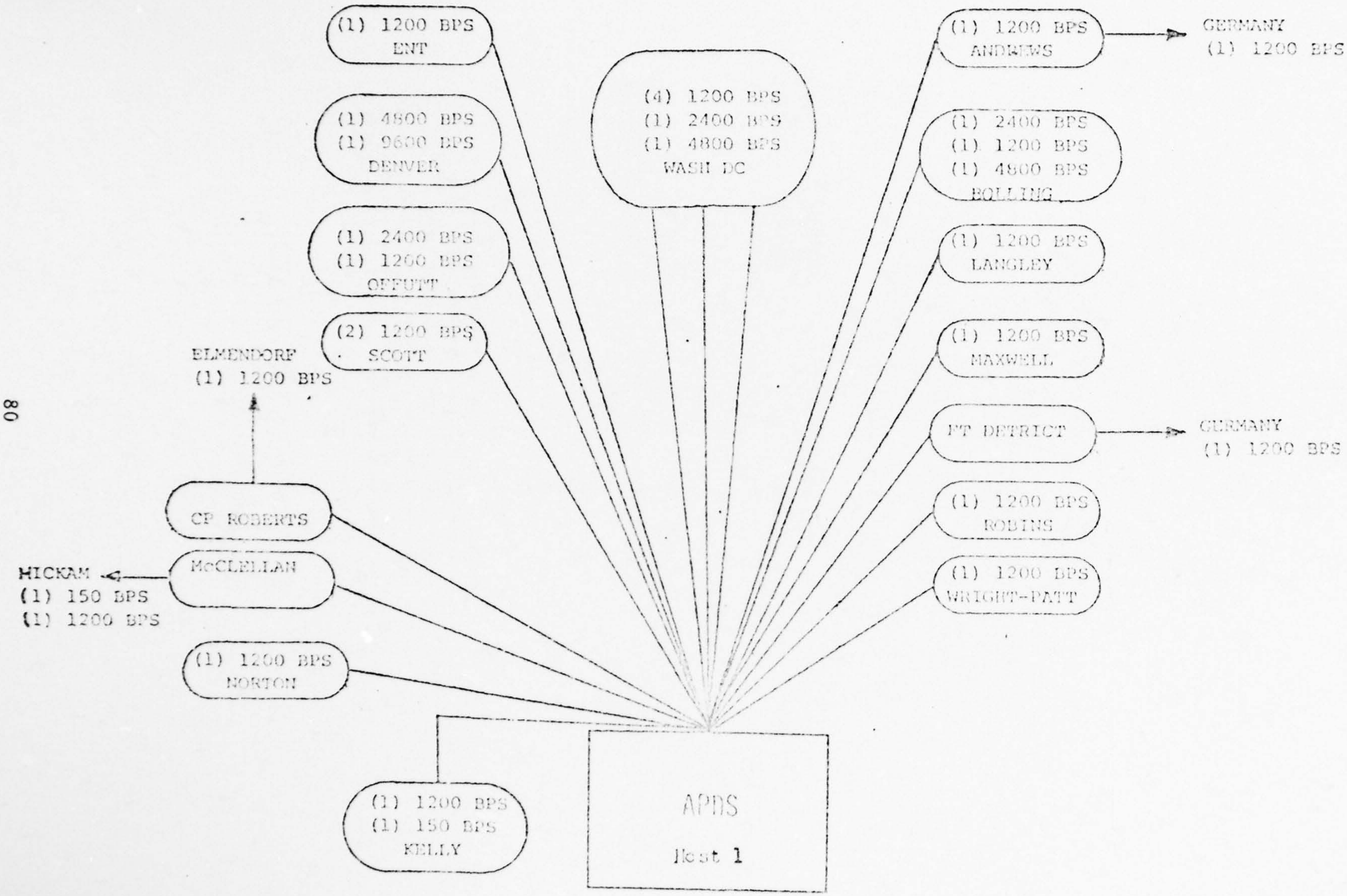
30. Huffman, J., MSgt Wizbicki, A1C Brothers. "Computerized Retrieval of Transaction Identification Codes Cross Referenced to Different Applications of the Transactions." AFMPC/DPMDDS, Randolph AFB, Texas. October 1977.

31. Munck, R. and H. Thomas. SOFTECH representatives (personal interviews and discussions in "Structured Analysis" course). Dayton, Ohio. December 1977.

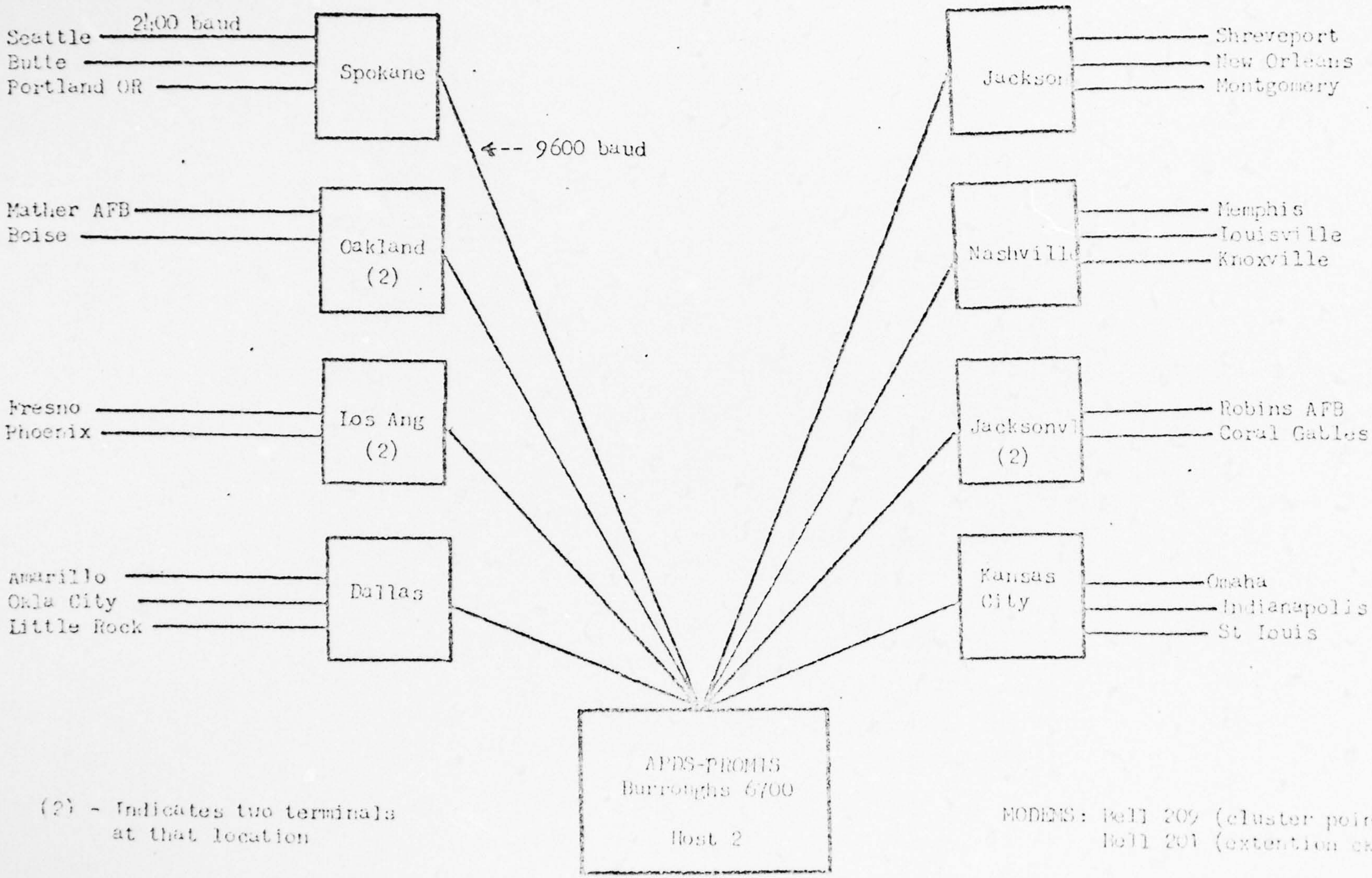
A APDS Communications Networks (Ref 2)



APDS PT-PT COMM NETWORK



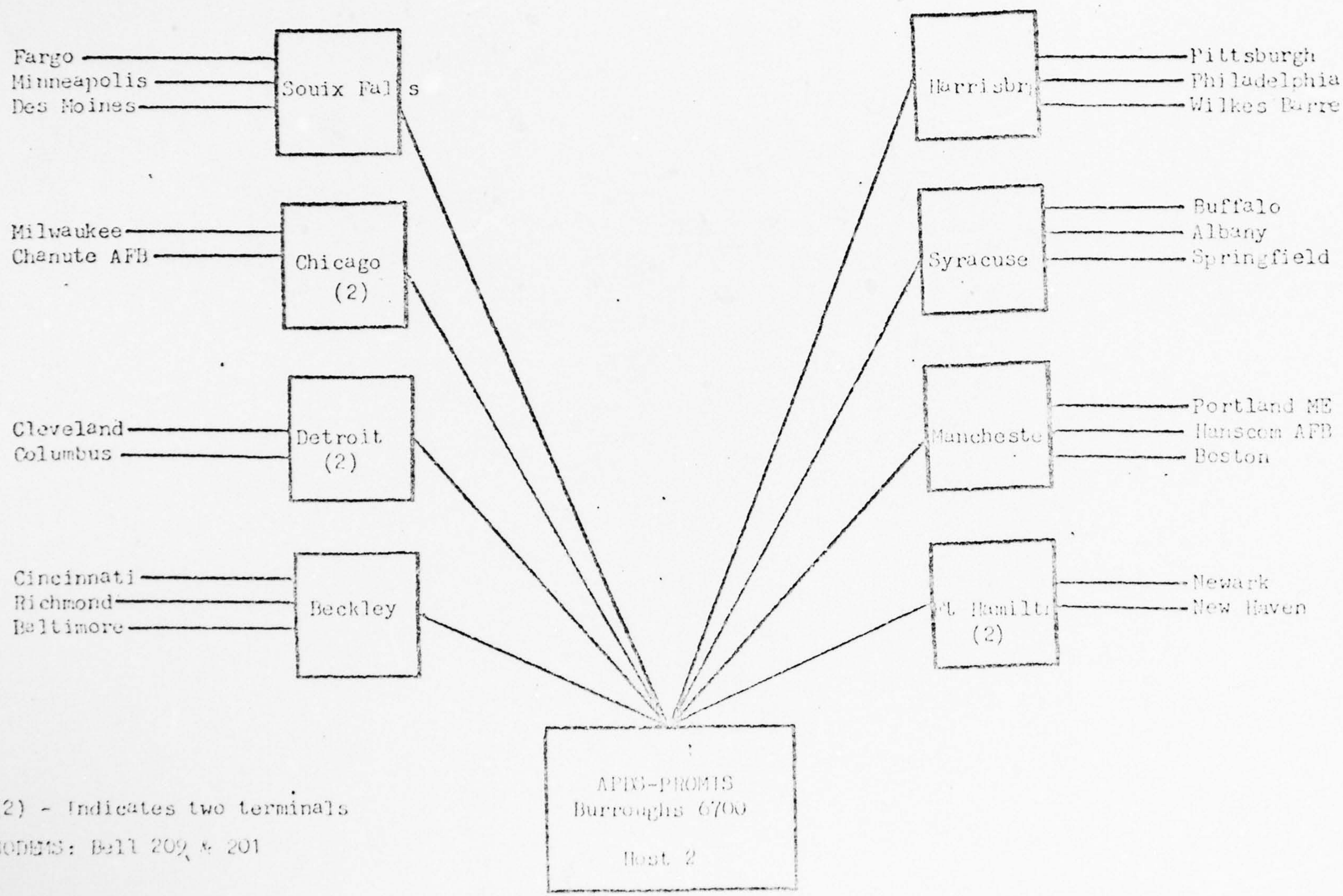
APDS-PROMIS



(2) - Indicates two terminals at that location

MODEMS: Bell 209 (cluster points)
Bell 201 (extention ckts)

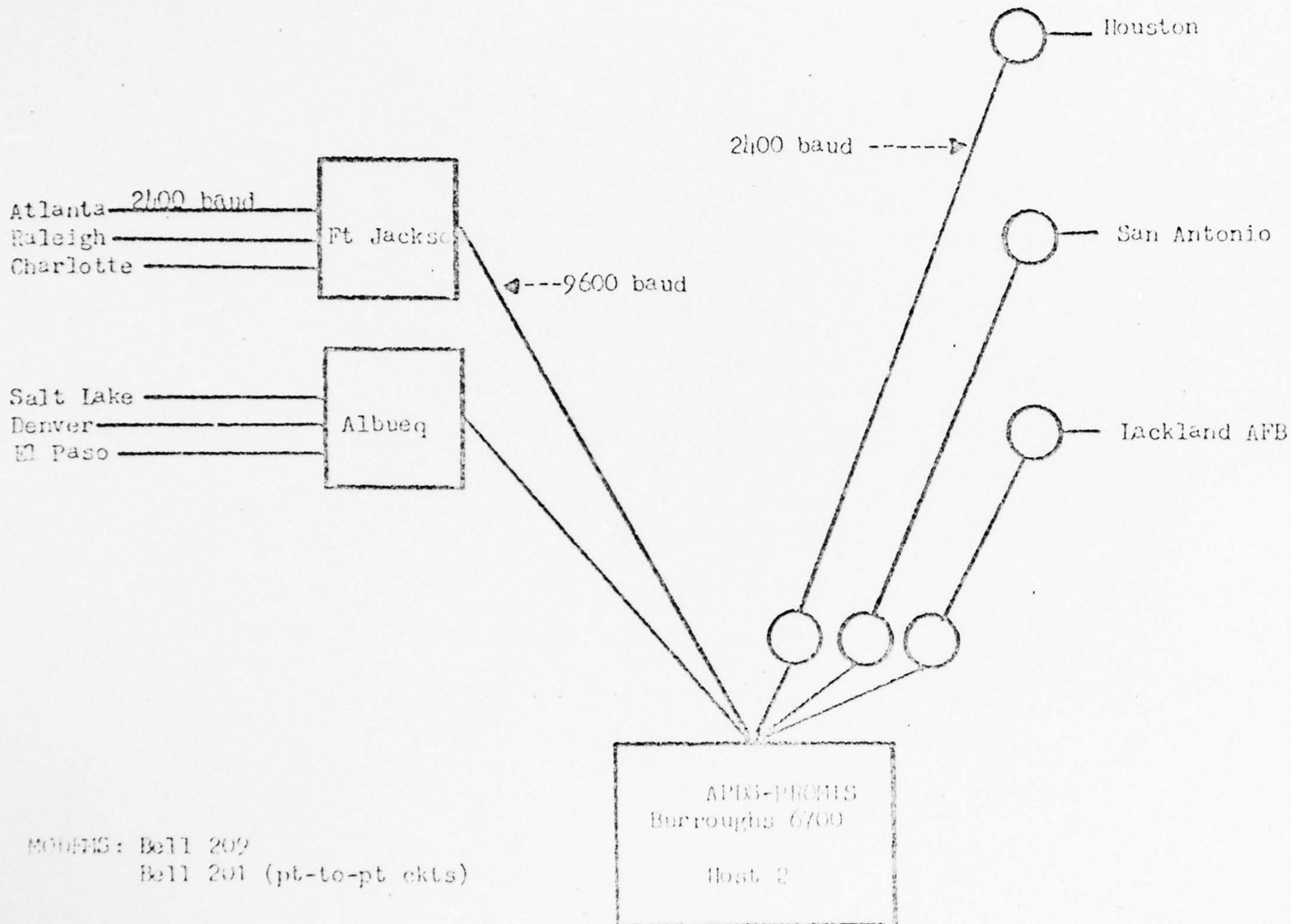
APDS-PROMIS (CONT)



(2) - Indicates two terminals

MODEMS: Bell 209 & 201

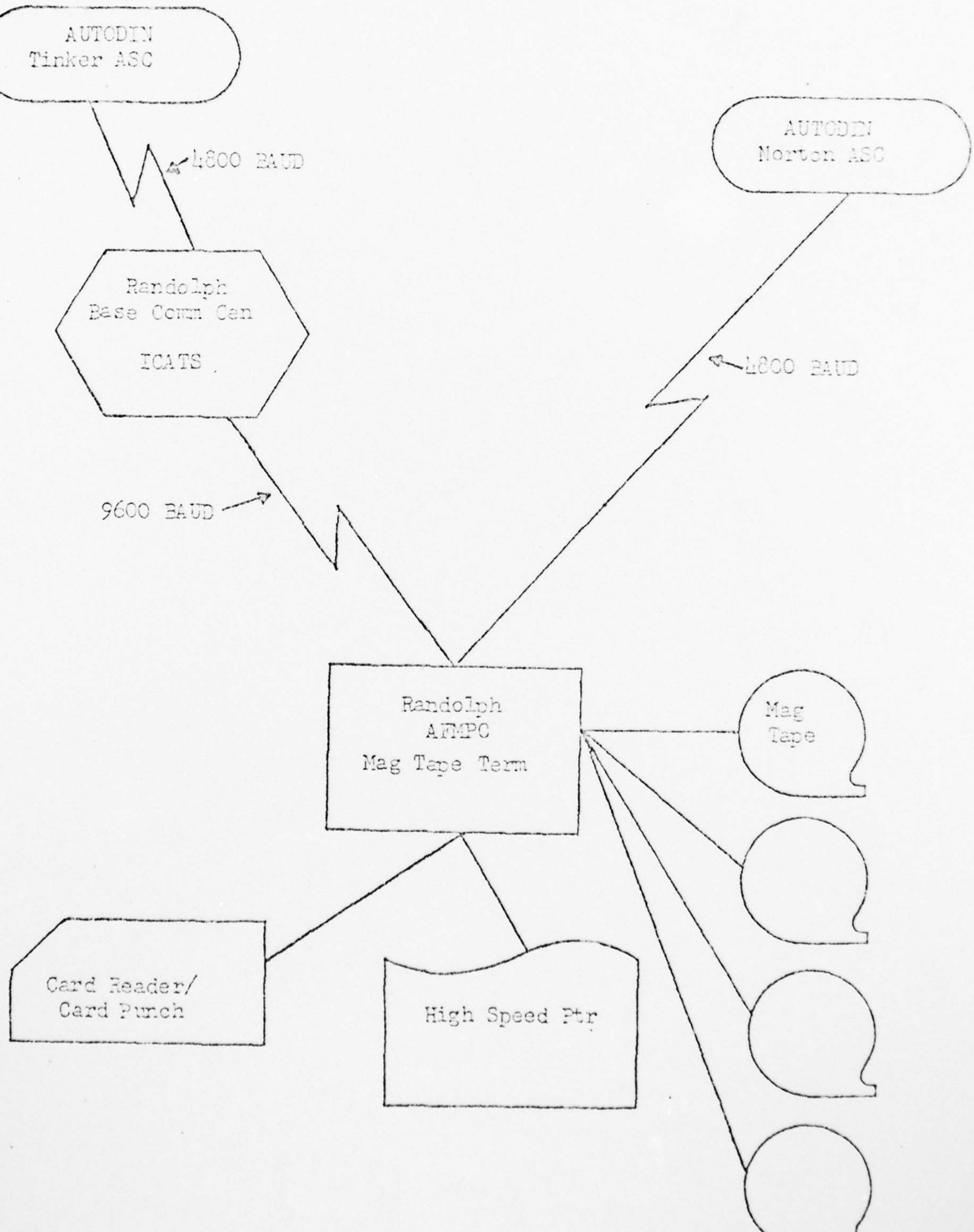
APIS-PROMIS (CONT)



MODEMS: Bell 209
Bell 201 (pt-to-pt ckts)

AUTODIN TERMINAL

Randolph AFB



B Current AFMPC Computer System Configuration (Ref 3)

- Two Burroughs B-6700s (referred to as "A" and "B")
  - -- Each has three central processors and two Input/Output processors, 5 MHz clock, multiprocessing and multiprogramming
  - -- Memory, overlayable/virtual, 770 ns to 1.6 us access
    - --- "A" has 703K words (4.2 million characters)
    - --- "B" has 524K words (3.1 million characters)
  - -- Fixed-head disk storage, auxiliary, 23 ms access
    - --- "A" has 220 million bytes
    - --- "B" has 120 million bytes
  - -- Dual disk pack drives, 30 ms access
    - --- "A" has 34 drives (7.2 billion bytes)
    - --- "B" has 33 drives (4.0 billion bytes)
    - --- 21 drives are shared by both/either (3.7 billion bytes)
  - -- Magnetic tape drives, 9 channel, 1600 bpi, 320K byte transfer
    - --- "A" has 16 drives
    - --- "B" has 12 drives
    - --- Also three 9 channel 800 bpi and two 7 channel 556 bpi drives
  - -- Line printers
    - --- "A" has one 1100 lpm IBM train and one 750 lpm Burroughs train
    - --- "B" has two 1100 lpm Burroughs trains
  - -- Card readers
    - --- "A" has two 800 cpm
    - --- "B" has one 300 cpm, and one 300 cpm auxiliary
  - -- Card punches
    - --- "A" and "B" have one 300 cpm each

-- Operator consoles

--- "A" and "B" have one console each with dual displays

--- "A" and "B" each have dual displays remoted to systems

-- Data communications

--- "A" has four data communications processors, each with 8k words local memory

---- Two have six adapter clusters each

---- Two have three adapter clusters each

--- "B" has two data communications processors, each with 8k words local memory and three adapter clusters

-- Remote devices

--- 341 CRT terminals (1200-2400 baud) with companion printers (plus 130 for MAJCOM, 46 for OCPO)

--- 90 keyboard and dial-up type terminals

--- Five RJE mini-computers

--- Five remote communications processors/printers (plus 14 for MAJCOM)

- One Honeywell H6040

-- One central processor and one Input/Output processor, multiprogramming

-- 131,072 words of memory

-- Eight disk pack drives, 548 million bytes

-- Six magnetic tape drives, 9 channel 800bpi

-- One 1150 lpm train printer

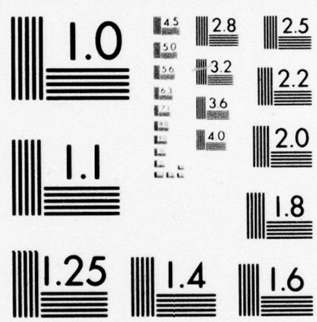
-- One 900 cpm card reader

AD-A058 513 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OHIO SCH--ETC F/G 5/1
SYSTEM SURVEY WITH A VIEW TOWARD UTILIZING A BACK-END DATA BASE--ETC(U)
MAR 78 L E NAGEL

UNCLASSIFIED AFIT/GCS/EE/78-5 NL

2 OF 2
AD
A058513

END
DATE
FILMED
11-78
DDC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

-- One master operator console

-- One data net 355 front-end communications processor with 16K

-- Ten CRT terminals (plus 30 for Microform enchancement)

- One Burroughs B1700 small computer (van-mounted for PERSCO)
- One each Burroughs B776 and B876 for MAJCOM prototype space development and testing
- One Burroughs B771 for program development and operations testing
- One Hewlett-Packard HP2116B for marked card scoring and tape conversion
- One Varian (Univac) 6201 for Microform fiche mounter control
- One 12,000 lpm Honeywell Page Printing System

C File and Program Series Codes (Ref 9)

Note: Questions on the use of these codes should be addressed to AFMPC/DPMDDS3.

Program Serie's Code

Code	Program Series
AA	Airman Active MPF
AB	Airman Active Asgmt Action File
AC	PROMIS
AD	MAJCOM Deployment File, Airman
AF	ARRAS (Reserve & Guard)
AG	Airman Guard MPF
AI	AIMS
AJ-AM	Program Conversion, Current System
AP	Career Job Reservation File
AQ	Reenlistment Quota Bank File
AR	Airman Reserve MPF
AT	ATLAS/SHOP CODE
AU	AFSC Conversion (Airman)
AW	WAPS
AX	ARMS Accounting
AZ	Airman Retired Master File (Reserves)
BA	Officer Active MPF
BB	Officer Active Asgmt Action File
BC	Officer Accession Analyzer
BD	MAJCOM Deployment File, Officer
BE	JOB FILE
BF	Board Support
BG	Officer Guard MPF
BH	AFIT Quota Bank File
BI	Officer Assignment Indicator
BJ	OSSM Officer siml sys model
BK	Officer Follow-on Asgmt File
BM	OER Format Conversion File
BN	Assignment Stability File
BO	Officer Authorization Entitlement
BP	Officer Manpower Data Compare
BQ	UFT Schedule Model File
BR	Officer Reserve MPF
BS	Officer Separated History File
BT	Retraining Analyzer
BU	AFSC Conversion (Officer)
BV	AFR/ANG Board Support
BW-BY	Program Conversion, Current System
BZ	Officer Retired Master File (Reserves)

Code	Program Series
CA	Civilian MPF
CH	Civilian Historical
DA	Death History File
DC	Casualty Hostile Action File
DD	Decorations Awards Stat File
DE	ARMS
DM	Contingency MANFOR File (HAF Level)
DQ	Contingency Requirements (HAF Level (Officer and Airman)
DR	Contingency Retrieval File (HAF Level (Officer and Airman)
DS	Contingency State File & Duty Status (HAF)
DT	TDY Deployment Auth/Asgd Stat File
DU	Contingency UTC File (HAF)
EA	Personnel Dist by Country or other Specified Area
EB	Personnel Dist by Operating Location in CONUS
EC	Officer & Airman Combined Reports, Program Conversion, Current System
EJ	E2Ø1 File Extract
FA-FQ	Reserved for Tech Training
FR	Mobilization Filler (Reserves)
FS-FZ	Reserved for Tech Training
GA	Guard Airmen Reports
GC	Guard Combined Reports (Officer & Airmen)
GI	EOM Processing
GN	GODS (Gen Off Date System)
GO	Guard Officer Reports
GR	PCARS (ANG & RESERVES)
HA	Pers Human Rel Perm Disq (Officer & Airmen)
ID	Drug Abuse
IM	Integrated Manning File
LA-LD	Reserved for HAF Retrieval
LF	Micro-Form File
LG-LH	Reserved for HAF Retrieval
LI	Micro-Form On-Line
LJ-LL	Reserved for HAF Retrieval
LM	Micro-Form Monitor
LN-LQ	Reserved for HAF Retrieval
LR	Micro-Form Application
LS	Micro-Form System Software
LT-LZ	Reserved for HAF Retrieval

Code	Program Series
MA	Course Summary File
MB	SAN Master File
MC	Training Requirements File
MD	TPR AFSC File
ME	Daily Load File
MF	Prog/Actual Monthly Summary File
MG	Actual Summary File
MH	Training Course Data File
MJ	Training Manager Profile File
MK	Factors File
ML	Projected Student File
MM	Requirements Trans Hold File
MT	Micro-Form APDS Interface
MY	Flying Man Years File
NA	Available/Non-Available File
NG	ANG TPMIS
OA	Officer Change File
OB	Flying Hour Analysis File
OC	Officer Stat File
OD-OZ	Reserved for DPMRO Uniques
PA-PG	Reserved for Tech Training
PH	Privacy Act Historical
PL	Reserved for Tech Training
PN-PO	Reserved for Tech Training
PP	PAS Master File (HAF Level)
PQ	Reserved for Tech Training
PR	Privacy Act Tracking System (PATS)
PS-PZ	Reserved for Tech Training
QA	Reserved for Tech Training
RA	Retired Airman Master File
RB	Retired Officer Master File
RC	Reserve Combined Reports (Officer & Airmen)
RD	RPDS Edits
RE	Reserve Enlisted Reports
RF	Reserve Table-Tape
RG	Reserve Grid-Zip
RH	TDRL File
RM	Reserve Manpower Reprots System
RO	Reserve Officer Reports
RQ	Air Force Active Off & Enlisted Reports
RR	Air Force Guard Reserve/Reports
RS	Retirement/Separation Stat File (Active)
RT	Retirement/Separation Stat File (USAFR)
RU	Retirement/Separation (ANG)
RV	Project CAPTURE Update

Code	Program Series
SA	AFP 900-2 Awds & Decs Pamphlet by Units
SB	Program Conversion HAF Levle MPR's
SD	DMS Utility
SM	Standard Microfiche Products (HAF Level)
SO	Station Organization Master
SP	Standard Products (HAF Level)
SU	Softward Utilities (HAF Level)
SW	Software System (HAF Level)
SX	DAMIS Transactions (From Base Level)
TA	TRAPMIS
TB-TD	School Quota Control System
TE-TZ	Reserved for Tech Training
UT	Reserved for Subsystem Code 16
WA-WZ	Reserved for Washington Area Support (DPMDW & DPMDD)

VITA

Lester Emil Nagel was born on 28 September 1935 near Defiance, Ohio. He graduated from North Richland-Adams High School near Jewell, Ohio in 1953 and attended The Defiance College, Defiance, Ohio from which he received a Bachelor of Science degree in 1957. Upon graduation, he was employed by the Board of Education at Chatfield, Ohio as a high school mathematics and science teacher. He enlisted in the Air Force and enrolled in the Officer Training School (OTS) program on 22 December 1959 and was commissioned on 22 March 1960. He completed navigation training and received his wings on 13 December 1960. In 1961, he completed navigation-bombardment training and was assigned to a B-52 crew in the Strategic Air Command (SAC). He spent 7 years in SAC performing crew duties as navigator, radar-navigator, flight instructor, and flight examiner in the 19th and 17th Bombardment Wings (SAC). He was assigned to the operations staff of the 17th Bombardment Wing (SAC) as a target study officer in 1968. In 1972, he was assigned to the 43rd Strategic Wing (SAC) on the island of Guam, where he was an aircrew target study officer for the B-52 Arc Light missions over Southeast Asia. He was assigned to the Strategic Air Command Headquarters staff and the Joint Strategic Target Planning Staff at Offutt AFB, Nebraska in 1974 until he entered the School of Engineering, Air Force Institute of Technology, in August 1976.

Permanent Address: Route 2, Brandt Road
Defiance, Ohio 43512

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: AFIT/GCS/EE/78-5	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): System Survey with a View Toward Utilizing a Back-End Data Base Processor	5. TYPE OF REPORT & PERIOD COVERED: MS Thesis
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Lester E. Nagel, Lt Col USAF	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Air Force Institute of Technology (AFIT/EN), Wright-Patterson AFB, OH 45433	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: Directorate of Personnel Data Systems/Air Force Military Personnel Center (DPMD/AFMPC), Randolph AFB, Texas 78148	12. REPORT DATE: March 1978
	13. NUMBER OF PAGES: 100
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLAS
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Approved for public release; IAW AFR 190-17

JERRAL F. GUESS, Captain, USAF
Director of Information

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

personnel management
back-end data base processor
Air Force personnel system
large data management system
computer system survey
problem analysis (computer)
Burroughs B-6700 computer system
requirements definition
Structured Analysis

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Members of the Air Force Military Personnel Center (AFMPC) want to investigate the feasibility of utilizing a back-end data base processor system configuration for the AFMPC personnel data management system. This thesis surveys the current system, the personnel management organization (AFMPC), the back-end data base processor concept, and the general requirements of the system. The basic problems of the current system are that it is (1) heavily utilized, and (2) the data base files cannot be updated on a timely basis because of the heavy workload. The back-end data base processor concept is relatively new

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. continued.

and may provide a solution to these problems. Consequently, a discussion of the back-end concept, its advantages, and disadvantages is presented. In addition, the general requirements of the system are discussed and are divided into two categories; (1) functional requirements, and (2) system requirements.

The discussions of the current system, the personnel management organization, the back-end concept, and the general requirements provide a foundation for future studies that will be required to (1) solve the system problems, and (2) model a back-end data base processor system configuration for the AFMPC. In addition to the background and foundation for future studies, a focus and direction for those studies is also presented. The focus and direction for future studies is provided through (1) an analysis of the current system, (2) a plan-of-attack that can be used to solve the data management problems of the system, and (3) a brief look at the application of a back-end data base processor at the AFMPC.