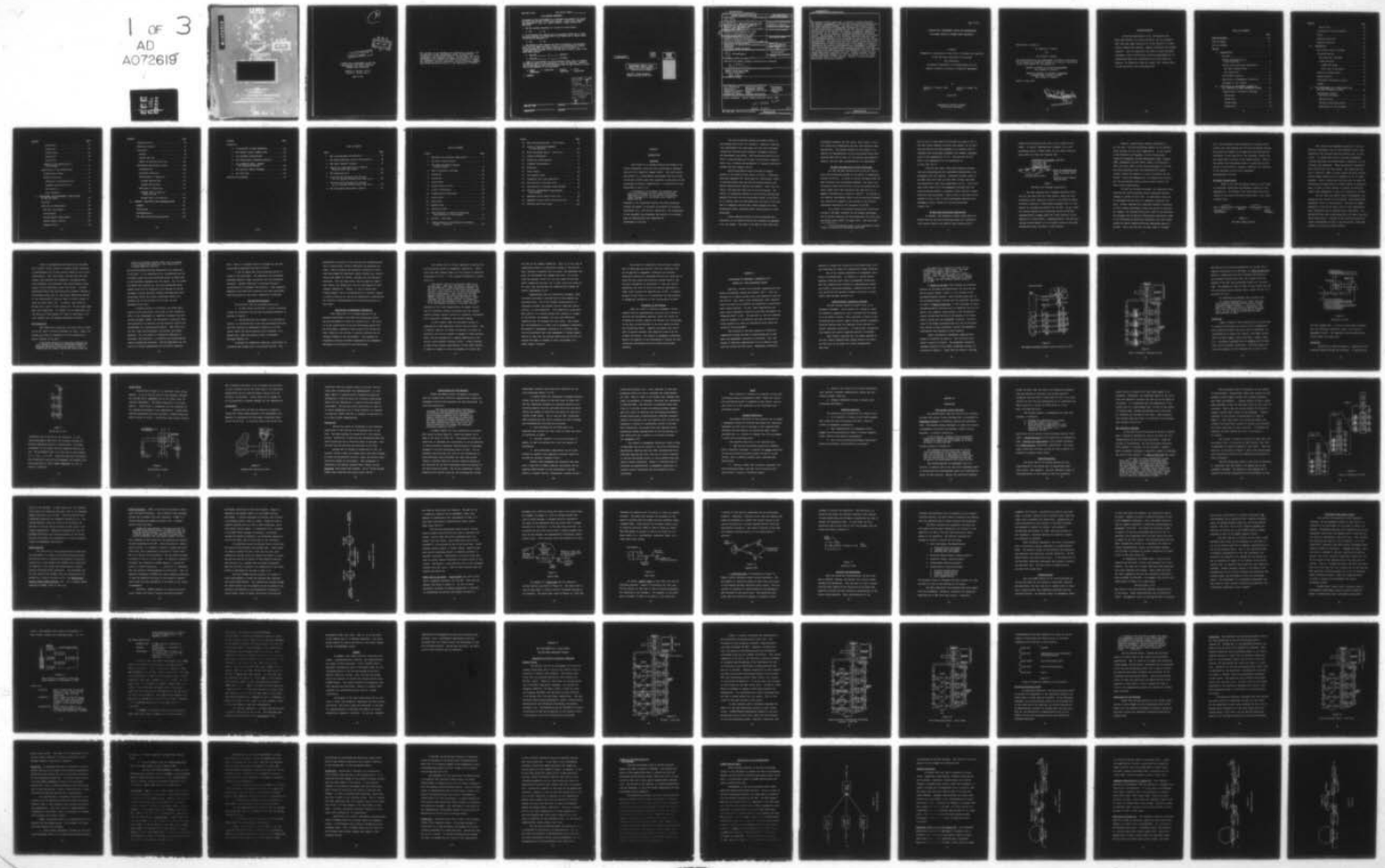
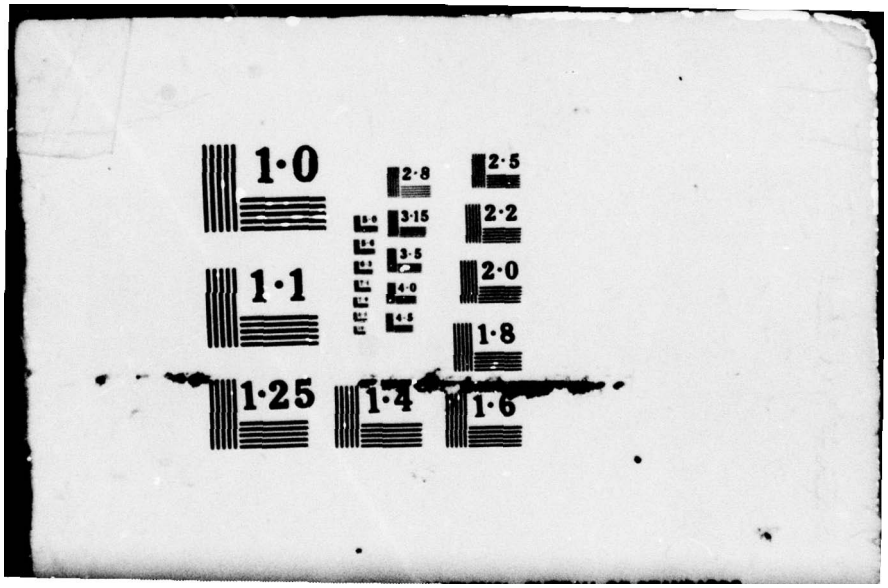
AD-A072 619 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL--ETC F/G 5/1
A DESIGN FOR A MANAGEMENT SYSTEM FOR HEADQUARTERS AIR FORCE LOG--ETC(U)
JUN 79 K W GLASSER, A B THOMAS

UNCLASSIFIED AFIT-LSSR-10-79A NL

1 OF 3
AD
A072619




1·0
1·1
1·25
2·8
3·15
3·5
4·0
2·5
2·2
2·0
1·8
1·4
1·6

LEVEL II

AD A072619

DDC
RECEIVED
AUG 13 1979
C

This document has been approved for public release and sale; its distribution is unlimited.

DDC FILE COPY

UNITED STATES AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY
Wright-Patterson Air Force Base, Ohio

79 08 10 073

DDC
RECEIVED
AUG 13 1979
C

This document has been approved for public release and sale; its distribution is unlimited.

A DESIGN FOR A MANAGEMENT SYSTEM FOR HEADQUARTERS AIR FORCE LOGISTICS COMMAND WORD PROCESSING

Kenneth W. Glasser, GS-12
Alfred B. Thomas, GS-12

LSSR 10-79A

The contents of the document are technically accurate, and no sensitive items, detrimental ideas, or deleterious information are contained therein. Furthermore, the views expressed in the document are those of the author(s) and do not necessarily reflect the views of the School of Systems and Logistics, the Air University, the Air Training Command, the United States Air Force, or the Department of Defense.

USAF SCN 75-20B AFIT Control Number _____

AFIT RESEARCH ASSESSMENT

The purpose of this questionnaire is to determine the potential for current and future applications of AFIT thesis research. Please return completed questionnaires to: AFIT/ LSH (Thesis Feedback), Wright-Patterson AFB, Ohio 45433.

1. Did this research contribute to a current Air Force project?

   a. Yes b. No

2. Do you believe this research topic is significant enough that it would have been researched (or contracted) by your organization or another agency if AFIT had not researched it?

   a. Yes b. No

3. The benefits of AFIT research can often be expressed by the equivalent value that your agency received by virtue of AFIT performing the research. Can you estimate what this research would have cost if it had been accomplished under contract or if it had been done in-house in terms of man-power and/or dollars?

   a. Man-years _____ $ _____ (Contract).

   b. Man-years _____ $ _____ (In-house).

4. Often it is not possible to attach equivalent dollar values to research, although the results of the research may, in fact, be important. Whether or not you were able to establish an equivalent value for this research (3 above), what is your estimate of its significance?

   a. Highly Significant b. Significant c. Slightly Significant d. Of No Significance

5. Comments:

Accession For	
NTIS GRA&I	☑
DDC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or special
A	

Name and Grade _____ Position _____

Organization _____ Location _____

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 73236 WASHINGTON D.C.

POSTAGE WILL BE PAID BY ADDRESSEE

AFIT/LSH (Thesis Feedback)
Wright-Patterson AFB OH 45433

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER LSSR 10-79A	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A DESIGN FOR A MANAGEMENT SYSTEM FOR HEADQUARTERS AIR FORCE LOGISTICS COMMAND WORD PROCESSING		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Kenneth W. Glasser, GS-12, USAF Alfred B. Thomas, GS-12, USAF		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Graduate Education Division School of Systems and Logistics Air Force Institute of Technology, WPAFB OH		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Department of Research and Administrative Management AFIT/LSGR, WPAFB OH 45433		12. REPORT DATE June 1979 13. NUMBER OF PAGES 180
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) AFIT-LSSR-10-79A		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

198 p.

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

JOSEPH P. HIPPS, Major, USAF
Director of Information

18. SUPPLEMENTARY NOTES

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

Word Processing	Operations Support	Performance Evaluation
Cybernetics	Management Methods	Organization Design
Management Concepts	Operations Evaluation	
Support Services	Models	
Management Analysis	Computer Simulation	

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

Thesis Chairman: Daniel Edmund Reynolds, GS-12, USAF

ON Other Side

012 250

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

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

The purpose of this thesis was to conduct a systems analysis and design a management system of word processing at Headquarters Air Force Logistics Command. The goals of this research were: (1) apply principles of management cybernetics in the analysis of the current word processing system, (2) identify organization deficiencies in the system, (3) develop recommended changes in the system, and (4) develop a proposed performance measurement system. The findings of this research indicated that the current word processing system is not returning the full benefits that are obtainable and that word processing is misused in the current manifestation. Revision work load has climbed dramatically since implementation of word processing due to the usage of automatic typewriters for routine correspondence and management's obsession with letter-perfect correspondence. The researchers concluded that most of the expensive automatic typewriters could be replaced by standard electric typewriters, and automatics used only for typing absolutely requiring revision. Another finding, using a Q-GERT simulation program, was that the minimal size of a word processing center is five typists. Finally, a new performance measurement system was proposed.

LSSR 10-79A

A DESIGN FOR A MANAGEMENT SYSTEM FOR HEADQUARTERS AIR FORCE LOGISTICS COMMAND WORD PROCESSING

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

By

Kenneth W. Glasser, BSIE
GS-12

Alfred B. Thomas, BA
GS-12

June 1979

Approved for public release;
distribution unlimited

This thesis, written by

Mr. Kenneth W. Glasser

and

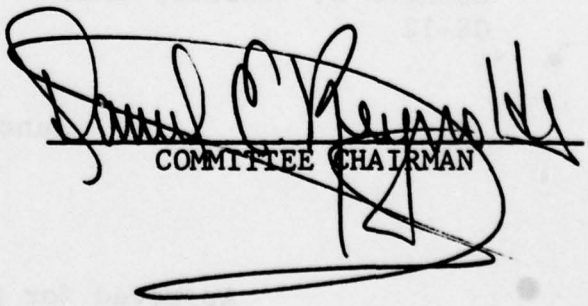
Mr. Alfred B. Thomas

has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degrees of

MASTER OF SCIENCE IN LOGISTICS MANAGEMENT
(Mr. Kenneth W. Glasser)

MASTER OF SCIENCE IN LOGISTICS MANAGEMENT
(INTERNATIONAL LOGISTICS MAJOR)
(Mr. Alfred B. Thomas)

DATE: 13 June 1979



COMMITTEE CHAIRMAN

ACKNOWLEDGEMENTS

We extend appreciation to Mr. Dan Reynolds and Major Mike Pearson, our thesis advisors, for the considerable time they spent educating us in the mysteries of cybernetics, quantitative methods, computer simulation and systems analysis. Also, we appreciate the labor of word processors everywhere, whose contributions toward accomplishment of organizational goals are considerable, but often taken for granted. We especially thank our typist, Mrs. Dorothy Mote, for her meticulous and outstanding work.

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	iii
LIST OF TABLES	ix
LIST OF FIGURES	x
CHAPTER	
I. INTRODUCTION	1
Overview	1
HQ AFLC Implementation of Word Processing	3
HQ AFLC Word Processing Organization	4
The Basic Typing System	7
The Typing Pool	9
The HQ AFLC Situation	11
Application of Management Cybernetics	12
Statement of the Problem	15
II. APPLICATION OF MANAGEMENT CYBERNETICS TO A DESIGN OF A WORD PROCESSING SYSTEM	16
Stafford Beer's Cybernetic Paradigm	17
System One	21
System Two	22
System Three	24
System Four	25

CHAPTER Page

System Five. 26

Justification for the Research 27

Scope. 30

Research Objectives. 30

Research Questions 31

III. METHODOLOGY. 32

The Systems Science Paradigm 32

Conceptualization. 33

The Cybernetic Paradigm. 34

Q-GERT Networks. 37

Q-GERT Philosophy. 38

Nodes Used in the Model. 41

Analysis and Measurement 45

Computerization. 47

Performance Measurement System 50

Summary. 54

IV. THE DEVELOPMENT OF A VIABLE MODEL FOR THE WORD PROCESSING SYSTEM 56

Application of Beer's Cybernetic Paradigm. 56

Research Focus 56

The Word Processing System 61

Application of the Paradigm. 62

CHAPTER Page

System One. 63

System Two. 65

System Three. 66

System Four 68

System Five 69

Summary of the Application of the Paradigm. 71

Application of the Q-GERT Model 72

Q-GERT Network Model. 72

Network Activities. 74

Mechanical Transcription--MT. 74

Longhand Transcription--LT. 76

Revisions--R. 76

Final Typing--F 79

V. MEASUREMENT AND EXPERIMENTAL IMPLICATIONS OF THE WPC MODEL. 83

Overview. 83

Analysis and Measurement. 83

WPC Work Load Demand. 84

Proofreading. 86

Machine Repair Requirements 87

Machine Repair Service. 87

Typing Service. 87

CHAPTER Page

Computerization. 90

Simulation Results 91

Evaluation 96

General. 96

Optimal WPC Size 98

Impact of Revision Work Load 102

Performance Measurement System 108

Considerations 109

Performance Measures 112

Effectiveness of Operation 112

Average Backlog Time 112

Average Quality Rate 113

Efficiency of Operations 115

Average Lines of Type per Typist per Day 115

Average Machine Utilization. 118

VI. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS . . . 121

Summary. 121

Conclusions. 125

Recommendations. 127

The Ideal Word Processing System 130

CHAPTER Page

APPENDICES

A. A DISCUSSION OF WORD PROCESSING. 133

B. WPC MONTHLY REPORT SUMMARY DATA. 154

C. WPC DOCUMENT DISTRIBUTIONS 157

D. WPC SYSTEM MODEL SIMULATION RESULTS. 162

E. WPC AGGREGATE MODEL, PROGRAM AND SIMULATION RESULTS 164

F. WPC ANALYSIS REPORT (EXCERPT). 167

G. WPC COST DATA. 170

SELECTED BIBLIOGRAPHY 174

LIST OF TABLES

Table		Page
1	WPC Lines/Document Distribution	90
2	WPC Minutes/Document Service Distribution	90
3	WPC Model Computer Program.	92
4	Effects on Total Work Load of Reduced Revision Work Load Levels	104
5	WPC Operating Costs	105
6	Potential WPC Operating Cost Savings at a 25 Percent Revision Work Load Level. . . .	106
7	Potential WPC Operating Cost Savings at a 10 Percent Revision Work Load Level. . . .	107
8	WPC Performance Measurement Example	117

LIST OF FIGURES

Figure		Page
1	DCS/Plans and Programs Organization.	5
2	The Basic Typing System.	7
3	The Human Neurophysiological Control System	19
4	Beer's Cybernetic Paradigm	20
5	System One	22
6	System Two	23
7	System Three	24
8	Systems Four and Five.	25
9	Levels of Recursion.	36
10	Q-GERT Network Philosophy.	40
11	Source Node.	42
12	Queue Node	43
13	Regular Node	44
14	Statistics Node.	45
15	Three Measures of Capacity Generating Three Measures of Achievement.	51
16	HQ AFLC: Level One.	57
17	Administration and Information Processing System: Level Two	59

Figure		Page
18	Word Processing System: Level Three.	60
19	Levels of Recursion Examined in this Research.	61
20	Word Processing Center: Level Four	64
21	General WPC Network	73
22	Mechanical Transcription.	75
23	Longhand Transcription.	77
24	Revisions	78
25	Final Typing.	80
26	The Complete Model.	81
27	Originator Work Load Generation	85
28	Distribution of Document Size	88
29	Distribution of Document Size--ASC/WPC.	89
30	WPC Work Load/Manpower Requirements Relationship.	95
31	Aggregate Server Model--First Run	99
32	Aggregate Server Model--Actual Data Run	101
33	Revision Work Load Levels	103

CHAPTER I

INTRODUCTION

Overview

This thesis is a systems analysis and design of an overall management system for word processing at Headquarters Air Force Logistics Command (AFLC). The word processing concept is a technological development that has arisen in the past fifteen years and represents a revolution in the processing of written communications. A definition of word processing is that it is:

> A combination of equipment and personnel working in an environment of job specialization and supervisory controls for the purpose of producing typed documents in a routinized, cost effective manner [22:32].

Although to the uninformed observer the word processing concept may appear to be merely an extension of previous technology (e.g., the electric typewriter), the combination of new equipment and techniques has resulted in an abrupt jump in administrative and communication technology (1:5;31:56).

The word processing concept has spread rapidly in the ensuing years since its inception. Numerous technological improvements have been made, and the word processing concept has received wide acceptance throughout industry and governments world-wide. Word processing basically fulfills a long-standing need of many socio-economic organizations (e.g., business and government) to process information quicker and more cheaply (18:12).

Word processing has been acclaimed as being a portent of the office of the future (7,16,29). There have been many arguments for converting the "traditional" office to word processing from the word processing industry and office administration analysts and experts. Until very recently, only good has been said of word processing. But, lately, a considerable amount of criticism and cynicism has emerged from users of word processing systems (15,19,20,21). It is obvious that word processing has lost much of the aura that it originally had and that office managers are less enthusiastic about converting their typing systems to word processing.

A more complete history of word processing and a discussion of its relative merits are contained in Appendix A to this thesis. The point to be made is that while word

processing certainly has real merit, and is here to stay, the concept and technologies may have been abused in many applications. The primary purpose of this thesis is to explore the implementation of word processing within Headquarters AFLC and to point out the positive and negative aspects, and also make recommendations for improvement.

HQ AFLC Implementation of Word Processing

In 1965, HQ USAF installed one of the Air Force's first word processing systems in the Office of Legislative Liaison (25:54-55). In spite of initial successes with the then available word processing equipment, the large scale conversion within the Air Force to word processing did not really begin until IBM introduced their Mag Card II, or Magnetic Card/Selectric Typewriter (MC/ST). In addition to the numerous improvements made in word processing equipment, the conversion to magnetic card storage of data greatly simplified operation by the processor (25:81-82).

As a result of successful application of word processing at HQ USAF, elsewhere in the federal government, and in private industry, HQ AFLC established its first word processing center (WPC)* in August 1975. This first WPC

*A word processing center is an organization established to perform word processing functions.

was set up on a test basis and included ten typists (34:1). The test center operated for about four months and the decision was made by the AFLC Commander on 2 December 1975 to implement word processing throughout the command, beginning first in the headquarters (11:4). The plan was for the WPCs in the headquarters to be operational by 30 June 1976 (34:v).

From the very start, there were numerous problems with word processing and the anticipated administrative improvements were not realized. Personnel turnover rates in the WPCs were twice that of other base clerical personnel and productivity rates were unimpressive (17:4). Over three years later there still are management problems with the word processing centers, according to AFLC officials responsible for word processing. Their belief is that part of the problem is due to lack of valid performance measures and a management control system for the word processing centers (12).

HQ AFLC Word Processing Organization

At present, each deputate or major staff office of HQ AFLC has its own word processing center and administrative cluster (some of the smaller staff offices share a

common word processing center due to low volumes of work loads). A typical organizational alignment for a word processing center is shown below, for the Deputy Chief of Staff (DCS) for Plans and Programs (XR):

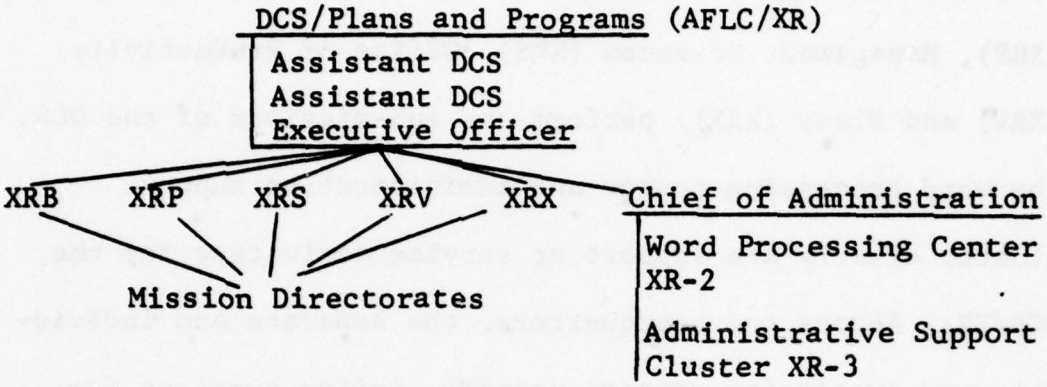


Figure 1

DCS/Plans and Programs Organization

The same organizational alignment generally holds true for the other DCS and staff offices, where the word processing center supervisor reports to the Chief of Administration (typically a Chief Master Sergeant) who, in turn, reports to the Executive Officer for the DCS. In all, there are sixteen separate word processing centers at HQ AFLC, organizationally aligned under the "front offices" of the deputates or staff offices. Organizationally, the word processing centers appear to be on similar status as the other subdivisions under the DCSs or staff offices.

However, organizational equality definitely is not the case. The word processing centers do not perform a direct mission for the total organization. In the example of the DCS/Plans and Programs, the five Directorates (Logistics Management Systems Requirements (XRB), Programs (XRP), Management Sciences (XRS), Office of Productivity (XRV) and Plans (XRX)) perform the sub-missions of the DCS. The word processing center and administrative support cluster clearly are support or service activities for the DCS/XR. Across the headquarters, the separate and individual word processing centers provide similar services for their parent organizations.

As they are currently arranged, the researchers have observed that word processing centers experience frequent changes in volumes of work load. An individual center may be backlogged one day and up to immediate turnaround the next. Certain organizations experience definite variations in their typing requirements during the course of each year. For example, the Programs Directorate (XPP) of the DCS/Plans and Programs and the Materiel Requirements Directorate (LOR) of the DCS/Logistics Operations experience work load surges during the annual Program Objectives Memorandum inputs to HQ USAF. While the work over the year tends to "average

out," the deviations toward underwork and overwork cause classic work load problems for the word processing centers. The centers are manned for average work load and when the variations in work load occur, the individual centers are not always able to adjust to the change readily. That is, the system (word processing center) is perturbed and the ability of the system to return to stability is a function of the variation in work load (subsequent perturbations) (5:8-16).

The Basic Typing System

Input to the word processing centers is the output of individual technicians and managers (authors) in the organization. The simplest "word processing" flow would consist of one author providing typing input to one typist as shown below:

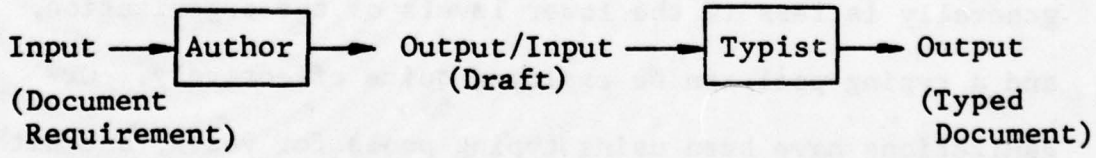


Figure 2

The Basic Typing System

This one-on-one arrangement typically is very inefficient (although it may be very effective) and is best typified by the corporate executive and his personal secretary. In certain cases this is the best arrangement (trading efficiency for effectiveness), especially for the situation just mentioned. There the executive secretary's tasks include far more than typing. The typing that she does is generally light in nature (memos and short letters; seldom lengthy reports) and the emphasis is put on timely response. There it makes good business sense to trade off efficiencies of operation for a higher degree of effectiveness; it would be false economy to require the executive (upper level management) to rely on a typing pool (19:100).

But for lower and middle levels of management, the typing pool has proved to be economical, while maintaining acceptable levels of effectiveness. The sense of urgency generally is less in the lower levels of the organization, and a typing pool can be employed quite effectively. Organizations have been using typing pools for years, and with fairly good results. Instead of the one-on-one author-to-typist relationship, we have a many-on-several, where many authors are served by several typists.

Prior to implementing word processing in HQ AFLC, the "typical" office (branch or division level) consisted of approximately six or more authors served by one or more clerk-typists. The clerk-typists did far more than just typing; they answered the telephones, distributed mail, filed documents, and performed other miscellaneous duties typical of the traditional office (22:34-39). The AFLC experience before word processing also probably conforms to the national norm; that is, only about twenty-five percent of the clerk-typist's time was spent on actual typing, or about two hours daily (36). In effect, each office at HQ AFLC had a form of "mini-typing pool" for the middle managers and technicians. It probably was an improvement over the one-on-one relationship (in terms of efficiency), but still nowhere near the maximum efficiency available.

The Typing Pool

The large-scale typing pool has been used by corporations for years to achieve economies of scale. Today, the typing pool often is considered to be an anachronism, a quaint reminder of the past.

> Long before modern word processing equipment was used, typing pools became an established method for handling large-scale production typing in offices. Typing pools are simply centralized office areas set

> aside for production typing, where work is assigned to the typing staff under the close supervision of a typing supervisor [22:39].

The word processing advocate depreciates the typing pool of the past. It is considered to be old-fashioned and undesirable, while the word processing center is modern and a very desirable atmosphere for the typist. But, as Larkin and Burkes have pointed out, the word processing center differs from the old typing pool only because of the new equipment, and any personnel savings resulting from word processing (versus the former traditional office) are probably due to the pooling of work load, not the equipment (8:5;21:81).

A similar process of evolution, now being experienced in word processing, can be seen in data automation. Prior to the development of commercial automated data processing equipment (ADPE), the tabulation of numerical data and preparation of financial and non-financial reports was accomplished in a decentralized fashion. Each office had its own clerks and accounting, calculating, and adding machines. But, the advent of (expensive) ADPE made it necessary, and practical, to centralize the accounting and reports preparation functions. The ADP department was created as a service organization for the entire corporate

body. Users or customers often are charged for the data processing accomplished for them (2:22-23).

It can be argued that word processing should be viewed in the same light. The expensive word processing equipment demands a high utilization rate for economical operation. Maximal efficiency is attained through a centralization of equipment and operators. Some companies apparently have made this connection and have centralized word processing for the entire corporation (31:80-100).

The HQ AFLC Situation

The questions that the preceding raises are:

1. To what should the HQ AFLC's clerical personnel savings be attributed, the new word processing equipment or pooling of typists?

2. Has HQ AFLC gone far enough in its pooling of typists, or centralization of the word processing function? The first question is addressed in Chapter VI of this thesis, while the second question can be examined, in a general way, under the purview of Beer's Cybernetic Paradigm (Chapter IV).

As McCabe and Popham have admitted, productivity is increased when typing work is centralized (22:39). The

generalized conclusion is that the more the typing function can be consolidated, the more efficient the operation becomes. This is because the stochastic variations in work load that plague the individual typists become less troublesome as the number of typists, working from the same pool, increases. This has been proven time and again by experience (hence, the typing pool) and was investigated by this research (Chapter V). Finally, it can be argued that "typing support" can be conceptualized as a distinct support or service function for the entire headquarters organization. Our tentative conceptualization of word processing was on this basis.

Application of Management Cybernetics

This thesis also is a systems analysis of the internal functioning of the AFLC word processing system, and the environment in which the system exists. The focus is on the interactions of the word processing system with the environment, especially those aspects that ensure systemic viability (the ability to survive arbitrary and unforeseen changes in the environment). The research incorporates currently available organization and management knowledge in the analysis of word processing.

The primary body of science employed to analyze the word processing system is management cybernetics. Cybernetics has been defined simply as "the science of effective organization [5:13]." A more complete definition of cybernetics is:

> The central thesis of cybernetics might be expressed thus: that there are natural laws governing the behavior of large interactive systems - in the flesh, in the metal, in the social and economic fabrics. These laws have to do with self-regulation and self-organization. They constitute the "management principle" by which systems grow and are stable, learn and adjust, adapt and evolve. These seemingly diverse systems are one, in cybernetic eyes, because they manifest viable behavior - which is to say behavior conducive to survival [28:53].

Cybernetics thus views organizations as organic systems that are extremely complex and dynamic and that require control through a proper structure of planning, information flows (especially feedback), and decision making.

On the surface, many socio-economic systems or organizations today apparently survive and are viable. But, in reality, many are in states of potential or actual instability, are slow to respond to changes in their environments, and are ineffective as regards application of resources versus benefits derived (5:5-6). A major problem of many socio-economic organizations is that their ability to adapt to changes in their environments is slower than

the rate of the changes themselves. That is, by the time an organization reacts to a particular change in the environment, develops a proposed plan of action, and implements the plan, the environment has changed once more. The action taken was perhaps correct for the state when the environmental change was detected, but it most likely was wrong for the state that existed when the organizational change was finally implemented (5:12).

Organizations that are effectively designed, using cybernetic principles, overcome much of the response lag described above. One of the primary characteristics of cybernetic systems, and perhaps the most important characteristic, is self-regulation. Self-regulation (using feedback control) in a system ensures fast response to changes in the system's environment, and this self-regulatory capability must be designed into the system. This design for self-regulation is a major aim of management cybernetics. The purpose of management cybernetics is to produce theories and principles that allow management to design organizations so that they can perform effectively and be able to respond and adapt to changes in their environment in a timely manner (3:38-39).

The science of cybernetics thus provides a general body of knowledge and specific tools and techniques that can be applied to management situations and problems. Cybernetics derives its knowledge from nature, where may be found the most stable and effective systems known to man. The major assumption of cybernetics is that the control mechanisms that work in nature are equally applicable to human social systems and organizations (3:99). A primary purpose of this thesis is to demonstrate the applicability of management cybernetics to word processing at HQ AFLC.

Statement of the Problem

There is a need to develop a management system, complete with an organizational structure and a system of policies and performance measures, which will result in satisfactory systemic behavior for HQ AFLC word processing, in the face of perturbations in the environment in which word processing exists. Adaptive strategies that can be used to provide internal self-regulation need to be developed and tested. The science of management cybernetics needs to be applied to word processing to develop the most effectively performing word processing system design possible.

CHAPTER II

APPLICATION OF MANAGEMENT CYBERNETICS TO A DESIGN OF A WORD PROCESSING SYSTEM

Typically, current socio-economic organizations have become increasingly complex and dynamic (38:1). They are conceded to be viable systems since they apparently function and survive. But, under closer examination, many organizations are found to be unstable and ineffective in performing their stated missions. In fact, some organizations may never really experience stability since they continually are "fighting fires" (5:12). The question is, how can organizations be designed to be effective and have the ability to return quickly to a state of equilibrium after being perturbed by the environment?

The solution to the above question of effective organization design has been a long-standing aim of managers and management scientists (4,22,28,38). But, the design of effective organizations is by no means an easy task and success has been mixed. Management cybernetics

promises to change this situation by providing formal tools and techniques for effective organization design (28:60-63).

One of the leading researchers in management cybernetics is Stafford Beer. In addition to having written numerous books and other works on management cybernetics, Beer has conducted much research on organizational design and control, including designing a communication and control system for the national economic system for a nation (Chile under Salvador Allende) (5).

Stafford Beer's Cybernetic Paradigm

The most salient feature of Beer's work is his Cybernetic Paradigm. In his search for a design or model for effective organization, Beer concluded that the answer is to be found in nature. This conclusion is based on the observation that natural organic systems exhibit tremendous stability because they are organized along universal or natural cybernetic principles. In other words, cybernetics help explain how natural organisms function (3:199-200).

Beer further concluded that the human organism is the most viable organizational design found in our world and can serve as the model for social organizations. Beer says:

> The object is to construct a model of the organization of any viable system. The firm is something organic, which intends to survive - and that is why I call it a viable system. There are many examples of such systems in nature. . . . But, the human body is perhaps the richest and most flexible viable system of all [3:99].

In Brain of the Firm, Beer presents an extensive analysis of the human neurophysiology; the brain and the entire nervous system. Figure 3 is an outline of the neurophysiological network. Beer describes each part of the neurophysiological network and the individual functions in detail in Brain of the Firm. A full knowledge of these neurophysiological functions was not mandatory for this research, but a general understanding of the neurophysiological system does facilitate the mapping of the human control system onto the management situation. The functions of the human neurophysiology will not be discussed here (except to make analogies); instead the management counterparts were examined in this research.

Beer's Paradigm for management organizational design is presented in Figure 4. The similarity with Figure 3 should be evident. The management Cybernetic Paradigm consists of five highly integrated systems, as indicated in Figure 4. Space does not permit a thorough

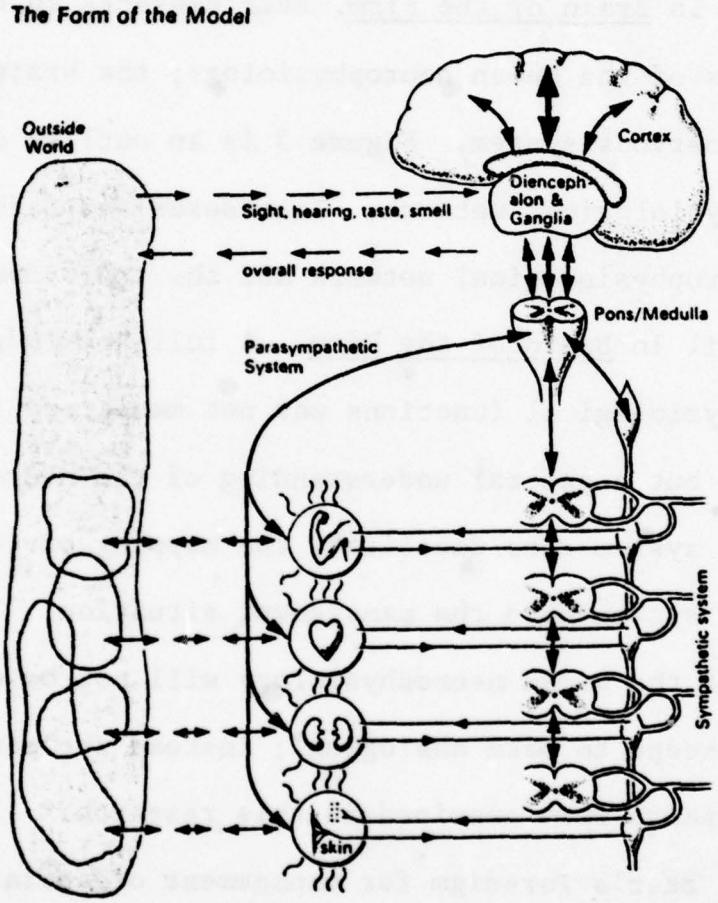


Figure 3

The Human Neurophysiological Control System (3:170)

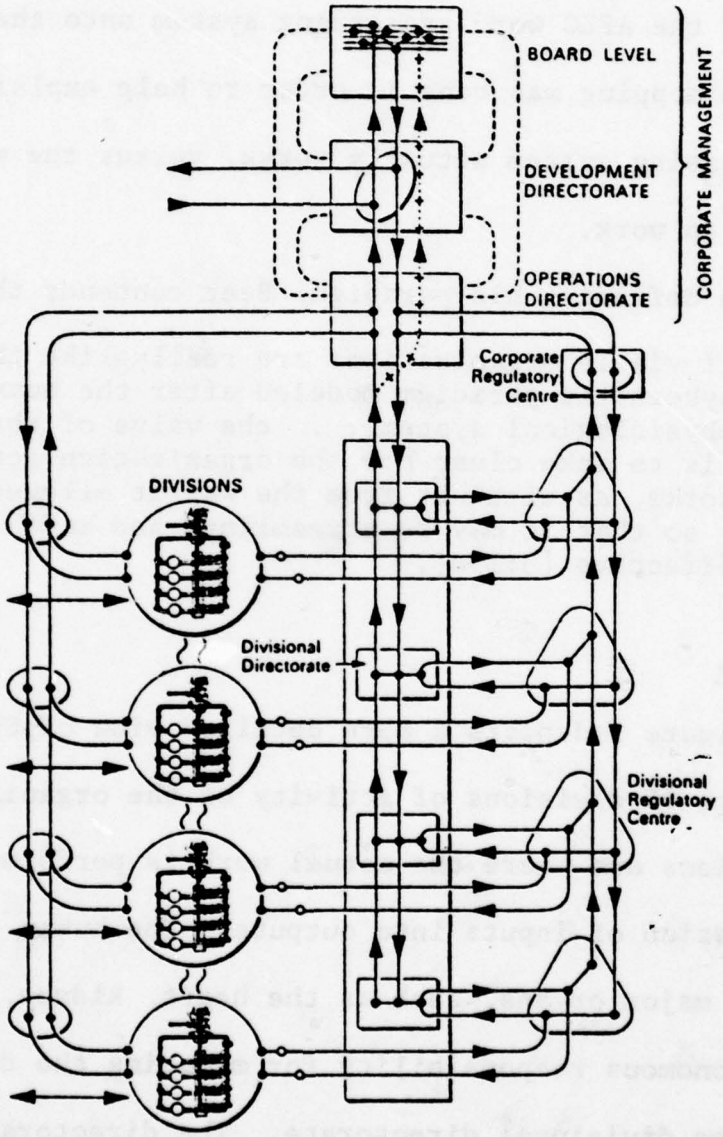


Figure 4

Beer's Cybernetic Paradigm (3:199)

description of the entire paradigm and its systems (for a complete discussion of the paradigm, see Brain of the Firm). However, a generalized and much condensed description of the paradigm is given below since the research involved mapping of the AFLC word processing system onto the paradigm. The mapping was done in order to help explain how the word processing system actually works, versus the way it is perceived to work.

In defending his paradigm, Beer contends that:

> All viable organizations are really like this [the cybernetic paradigm modeled after the human neurophysiological system]. . .the value of the model is to make clear how the organization actually works, as distinct from the way it allegedly works, so that it may be streamlined and made more effective [3:198].

System One

Figure 5 depicts a more detailed view of System One. It consists of divisions of activity of the organization. The divisions are where the actual work is performed; the transformation of inputs into outputs. The human counterparts are major organs, such as the heart, kidney, lungs, etc. Autonomous responsibility for managing the divisions lies in the divisional directorate. The directorate controls the operation of the divisions and is part of the

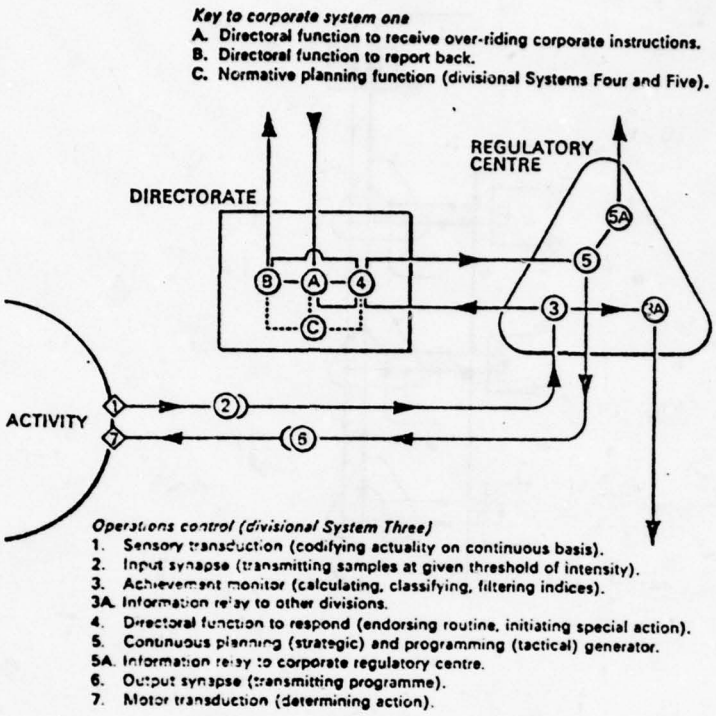


Figure 5

System One (3:216)

vertical command axis. It uses the third part of System One, the divisional regulatory centre, as a tool for management control. The regulatory centre monitors and filters input and output data.

System Two

System Two is shown in Figure 6. System Two is an interface between Systems One and Three. It monitors and

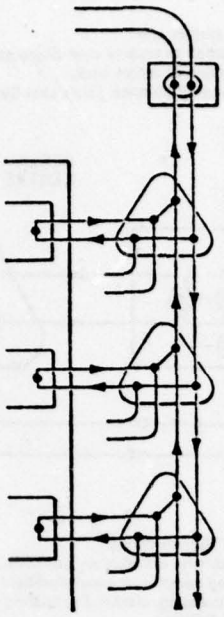


Figure 6

System Two (3:221)

coordinates the activities of the divisions. It also relays performance data about the divisions through the Corporate Regulatory Centre to System Three. The human counterpart is the spinal cord and connected nervous system. The performance data is in the form of ratio indices (0 - 1, e.g., .2,.5,.99). System Two functions continually and automatically and uses the management by exception concept extensively to alert higher management of "out of control" situations.

System Three

System Three (Figure 7) is the middle level of management. It is at the top level of the autonomic (Systems One through Three) management and at the lowest level of corporate management. The human counterpart is the pons/medulla. System Three is responsible for the stability of the internal environment of the organization. System Three receives information from the divisions, through System Two (which filters it first). System Three then further filters

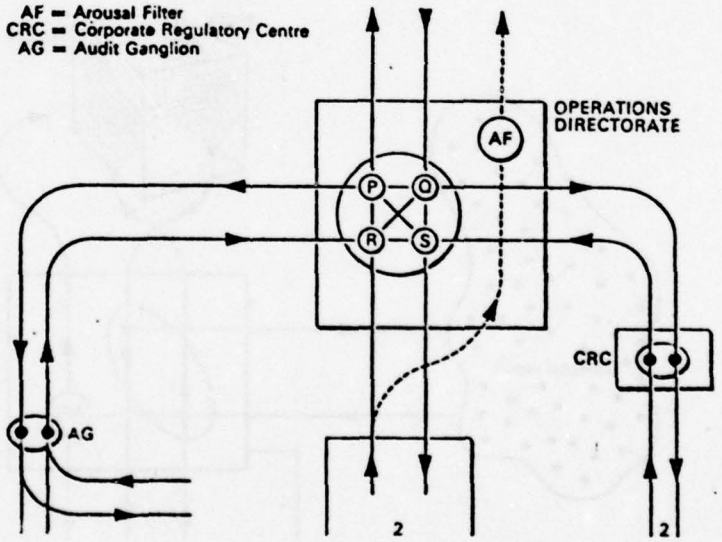


Figure 7

System Three (3:226)

the information and sends it up to Systems Four and Five. It also transmits policy from above down to the divisions. System Three can also exercise direct control over the division, if necessary. System Three can be thought of as the operations or general manager for the organization.

System Four

Systems Four and Five are depicted in Figure 8. System Four (whose human analogy is the diencephalon and ganglia) is considered the Development (planning) Directorate of the firm. It receives orders from System Five,

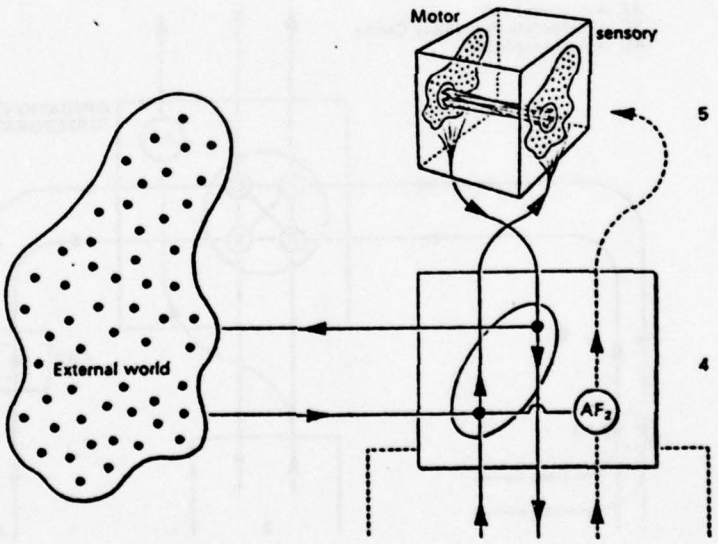


Figure 8

Systems Four and Five (3:231)

translates them into specific plans for action, and provides them to System Three for implementation. It also makes inputs to corporate policy formulation using the information it receives about the divisions (from System Three) and the information it receives from the external environment. The key point about System Four is that it is really considered to be a "line" function, in contrast to being the "staff" function it normally is perceived to be in most current organizations.

System Five

System Five should be recognized as the Corporate Board Level of the firm and is the guiding force of the firm. The human analogy for System Five is the cerebral cortex. System Five is involved with determining where the firm is going and not so much with where it has been. System Five sets the policies and direction of the firm.

Another way of looking at System Five is that our cerebral cortex is what sets humans apart from lower animals. We alone can purposefully decide to upset the natural equilibrium and change our environment. This phenomenon is addressed by the General Systems Theory concept called teleology, which means goal seeking. Of all living systems, humans alone establish and achieve goals (38:44).

Justification for the Research

McCabe and Popham clearly recognized the general need for research into effective organizational design and management policies and procedures for word processing. As they have pointed out:

> . . .the word processing field represents a challenge to business administrators and managers to prove that the sophisticated technology of word processing equipment can be matched by an equally sophisticated technology of democratic policies and work procedures governing its use. The right combination cannot help but result in satisfied employees who enjoy their work, and whose productivity will produce an efficient, profitable operation [22:74].

A primary impetus for this research was a previous AFIT thesis by Major Donald R. Joyner and Captain Jon N. King of the class of 1977A (17). The purpose of their research was to determine the relationship of job satisfaction to other observable behavioral characteristics of personnel assigned to the word processing centers in AFLC. The researchers concluded that the level of job satisfaction of word processing center personnel was lower than normal (based on national norms for clerical workers) because of the type work in the word processing centers and because of the AFLC promotion system. One of the researchers' recommendations for further study was the investigation of work

measurement standards and productivity measures for the word processing centers (17:53).

A related effort was undertaken by Captains Patrick O'Neill and David Walker of the AFIT class of 1978B (23). The two researchers attempted to determine whether a productivity measure could be developed that would accurately reflect the degree of difficulty and amount of time for a variety of WPC inputs. Due to time and data limitations their research was only partly complete but their findings and recommendations included the following:

1. Work standards for the WPCs need to be developed that account for total lines of output and level of difficulty of input.

2. Periodic feedback to the word processor is needed, so that the employee has a personal measure of performance.

3. Work performance computations can be accomplished by computer (the capability currently exists) to provide the necessary feedback (23:8).

Finally, AFLC management has indicated that they want to know how to define, measure, and project the in-progress effectiveness of word processing to include effects of machine failure, absenteeism, customer service

volume and variation, etc. Also, they want to know what parameters should be used to determine the establishment of a WPC. That is, what is the minimum size, maximum size, effect of proximity to customers, and basis for combination of adjacent WPCs. The objective of answering these questions is to provide a basis for making necessary changes that will result in improved word processing performance. HQ AFLC Directorate of Administration (AFLC/DA) personnel recently re-confirmed that the research topic is valid and represents a subject of considerable concern to HQ AFLC. Many difficulties (low productivity and employee morale) encountered during implementation of word processing, almost three years ago, continue to be chronic problems for management (12).

The science of management cybernetics offers a body of knowledge that can be applied to the above deficiencies. Specifically, Stafford Beer and other cyberneticians have developed theories and tools that can be directly applied to the word processing system, to solve problem areas and improve overall operations. There is a definite need to establish the applicability of management cybernetics to systemic control situations such as presented by word processing.

Scope

This research is limited to an analysis of the word processing system at Headquarters AFLC. While the overall word processing system is examined in this thesis, the primary focus is on the operations of the individual word processing centers.

Research Objectives

The primary objective of this research was to design a management system and internal measurement and regulatory mechanism for AFLC word processing so that organizational planning, decision making, and operations might respond satisfactorily to a variety of demands from the environment in which word processing exists.

The specific objectives of the research were:

1. Map the word processing system onto Stafford Beer's Cybernetic Paradigm, to explain the actual operations of the word processing system (versus the way it is perceived), and to identify possible gross organizational deficiencies.

2. Develop a model that accurately represents the word processing system, and that can be controlled and tested under a variety of different inputs.

3. Based on the results of the model experimentation, develop a proposed organizational design that will produce systemic viability.

4. Design a management system to measure word processing performance.

Research Questions

The questions to be answered by the research were:

1. Is it possible to design a more viable management system for word processing at HQ AFLC, using the science of management cybernetics?

2. What organizational and management policy changes in word processing are needed to ensure organizational viability and enhanced performance?

3. Can a word processing performance measurement system be developed, using cybernetic principles?

CHAPTER III

METHODOLOGY

The Systems Science Paradigm

The methodological approach used for this research followed the systems science paradigm that is presented in Management Systems by Schoderbek, Kefalas and Schoderbek (28). The systems science paradigm is a model for analysis of management situations and problems, using a systems approach. A system is defined as:

> A set of objects, together with relationships between the objects and between their attributes, connected or related in such a manner as to form an entity or whole [28:352].

Systems analysis is defined as:

> The organized step-by-step study of the detailed procedures for the collection, manipulation, and evaluation of data about an organization for the purpose of determining not only what must be done but also to ascertain the best way to improve the functioning of the system [28:352].

The systems approach to management thus is a holistic or Gestalt view of the real world phenomena whereby interrelated and interdependent parts are considered together as they interact. Whereas the analytical approach

breaks the whole down into parts for subsequent decomposition and analysis in isolation, the systems approach recognizes that the whole is more than the sum of its parts (38:56) and that the most appropriate way to understand the whole system is to study the system with all of its parts included (28:5-16).

The systems approach to management has three main concepts, or features:

1. Viewing the organization as a system.
2. Building a model of the system.
3. Using information technology as a tool both for model building and for experimentation with the model, i.e., simulation [28:239].

Application of the systems science paradigm requires three steps: conceptualization of the system into an appropriate model, analysis and measurement of the critical variables, and computerization (simulation) (28:247-262). The three steps, which were the basic outline for this research, are presented in greater detail below.

Conceptualization

The first step in our system analysis was conceptualization of the system into an appropriate model, first mental, then tangible. The most important aspect of conceptualization of the system is that the researcher

should start at a higher level than might appear to be necessary. Frequently, the researcher begins at too low a level and important variables are left out of the model of the system. It is important that the examination of the system start at a high enough level, so that as the system is narrowed down, through increasingly finer resolution, all variables are included in the model. Beer addresses this process under the "cones of resolution" and recursiveness concepts (6:111-115).

The Cybernetic Paradigm

In the case of word processing at HQ AFLC, Stafford Beer's cybernetic paradigm was used as the model for conceptualization of the word processing model. Using the concept of recursiveness, the word processing system was first defined, or bounded, for the research. Stafford Beer's cybernetic paradigm is especially helpful in defining the level of the research. In Brain of the Firm Beer notes:

> . . .the whole is always encapsulated in each part, and. . .this is a lesson of biology where we find the genetic blueprint of the whole organism in every cell. This means that the whole of the chart [Figure 4] is reproduced within each circle representing a division, and of course this means in turn that. . .the whole chart would be reproduced in each division of each division - which is to say in each little circle within every big circle. And so on indefinitely [3:200].

The preceding is Beer's description of the concept of recursiveness. Recursiveness means that systems are subsystems of other higher systems; also systems themselves have their own subsystems. Another feature of Beer's cybernetic paradign is that the same model works for any level of recursion. That is why the circles labeled "Divisions" in Figure 4 contain small figures of the paradigm. Another portrayal of the concept of recursiveness is shown in Figure 9. Here three levels of a system are shown; conceivably the hierarchical nesting of systems and subsystems can extend infinitely in both directions. In defining the research, one must specify the level of recursion to be studied.

The concept of "cones of resolution" means that once the desired level of recursion has been reached, that level is magnified and details examined in fine detail. This concept also is portrayed in Figure 9, where three hierarchical and interlocking levels are each magnified and presented in finer resolution.

The word processing system is the level of recursion, or resolution, that was chosen to be mapped onto by the cybernetic paradigm. The purpose of this mapping was to identify the various subsystems in word processing, as they

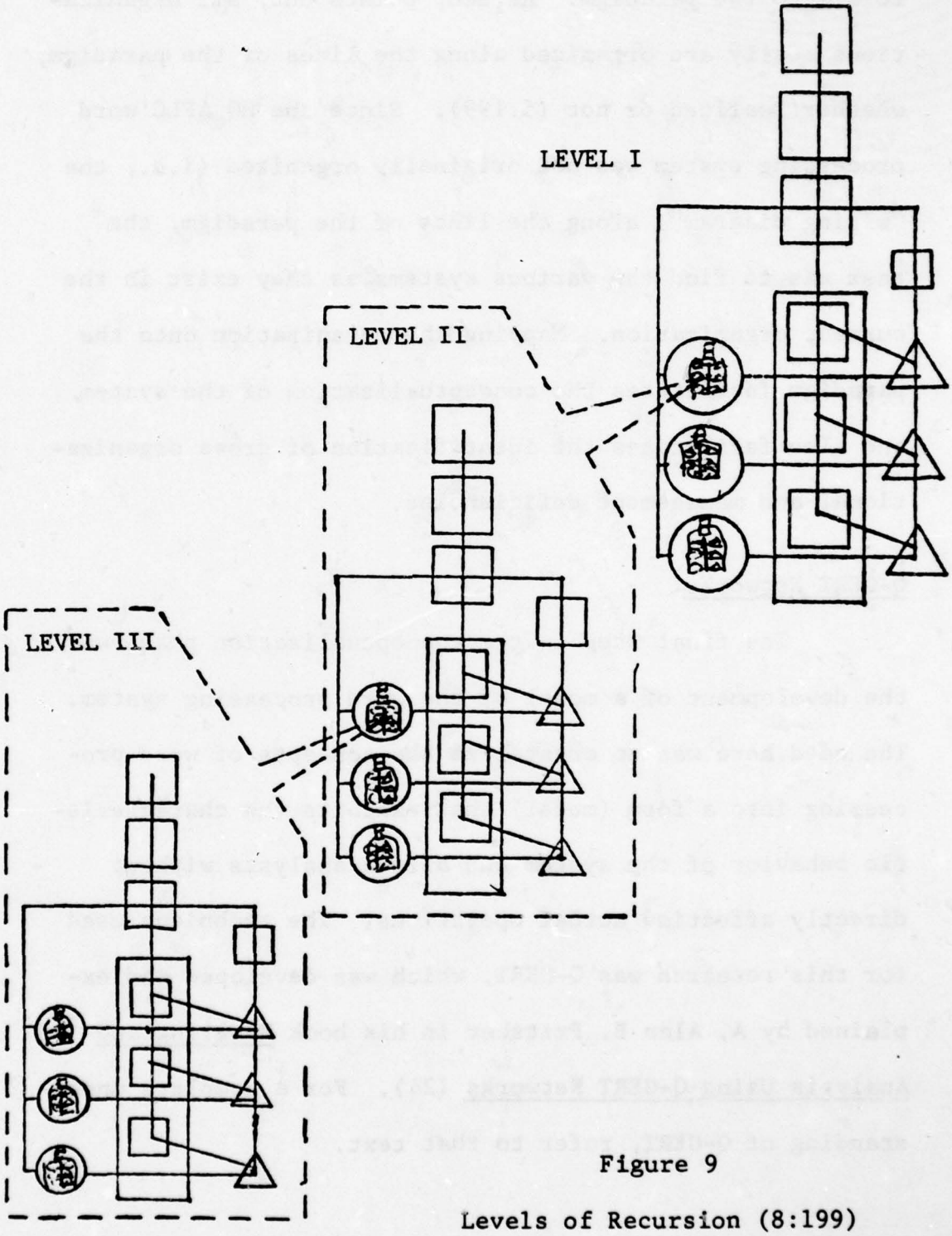


Figure 9

Levels of Recursion (8:199)

relate to the paradigm. As Beer points out, all organizations really are organized along the lines of the paradigm, whether realized or not (5:199). Since the HQ AFLC word processing system was not originally organized (i.e., the "wiring diagram") along the lines of the paradigm, the task was to find the various systems as they exist in the current organization. Mapping the organization onto the paradigm facilitates the conceptualization of the system and also facilitates the identification of gross organizational and management deficiencies.

Q-GERT Networks

The final step in the conceptualization phase was the development of a model of the word processing system. The need here was to crystalize the concepts of word processing into a form (model) that exhibits the characteristic behavior of the system and allows analysis without directly affecting actual operations. The technique used for this research was Q-GERT, which was developed and explained by A. Alan B. Pritsker in his book Modeling and Analysis Using Q-GERT Networks (24). For a complete understanding of Q-GERT, refer to that text.

Q-GERT Philosophy. GERT is an acronym for Graphical Evaluation and Review Technique. The Q indicates that queueing systems can be modeled with this technique. Q-GERT is a network modeling and computer analysis tool. Pritsker states in his book that:

> Q-GERT has been designed, developed and used for studying the procedural aspects of manufacturing, defense and service systems. It satisfies the need for a network approach to the modeling of systems that involve procedural, risk and random elements [24:vii].

This technique is well suited for the modeling and analysis of word processing at HQ AFLC. Word processing is indeed a service system. It contains a network of queues and activities which can be graphically portrayed in network form. And it is exactly the "procedural, risk and random elements" we wanted to look at in this study. In addition, Pritsker's statement that "basically, Q-GERT supports a systems approach to problem resolution. . . .[24:viii]" is consistent with our holistic systems approach in this study. Also, an important advantage of Q-GERT over other modeling techniques is that the graphical portrayal of the system in network form allows for easy explanation of the model to all levels of management.

Basically, Q-GERT consists of a network of activities, queues, and servers using an activity-on-branch

philosophy consisting of nodes and branches. Figure 10 represents the general aspects of the Q-GERT modeling philosophy. A branch represents an activity that involves a processing (server) time or a delay. Nodes are used to separate branches and are used to model milestones, decision points, and/or queues. A transaction (i.e., document to be typed) flows through the networks, is directed through the network according to the branching characteristics of the nodes, and is acted upon by the activities.

A transaction enters the network from a source node and travels along branches and through nodes. Each branch (as shown in Figure 10) has a start and end node, with transactions moving across the branch and delayed in reaching the end node by the amount of time needed to perform the activity (e.g., typing) that the branch represents. When the end node is reached, the disposition of the transaction is determined by the type of node it is.

The total Q-GERT network consists of a number of these relationships of nodes and branches that represent the system being modeled. The transactions flowing through the system network can be assigned certain attributes (e.g., priority) and statistics are automatically collected on travel times, status of queues and servers (utilization),

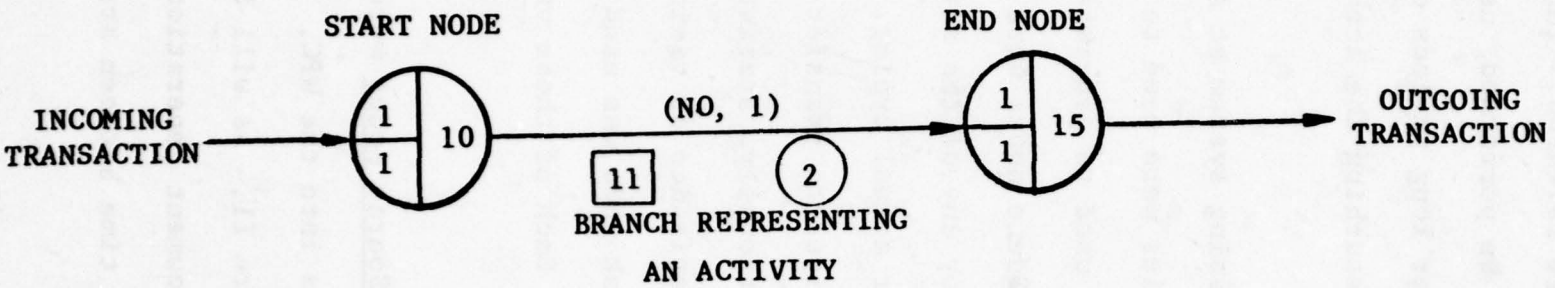


Figure 10

Q-GERT Network Philosophy

and times at which nodes are released. Through the use of computers, analysis can be performed, using large numbers of transactions over long periods of time, in a very short time without disturbing the actual system under study (24:3-4).

For the word processing system at AFLC, various kinds of nodes and activities were used to represent the system. Source nodes were used to generate documents (input) into the system. Queue nodes were used to hold documents to be processed by any of the activities: proof-reading, machine repair, or actual typing. Regular nodes were used as branching devices to transfer documents to specific activities. Additionally, statistics nodes were used to collect desired statistics at various points in the system. And finally, a sink node was used to exit documents (output) from the system. Each of these various nodes are briefly discussed next.

Nodes used in the model. Source nodes were used in this model to generate documents into the WPC. They take the general form shown in Figure 11. As will be later developed, the means of document generation is obtained by determining the average time between arrivals of

documents into a WPC and using this data in the source node. For example, in Figure 11, with an average interarrival time of thirty minutes, a document would be released at the start of the simulation from the source node 5 through activity 2 to the server. At the same time, activity 1 is activated and tells the source node to release another document (on the average, and exponentially distributed) thirty minutes later. This continues until the simulation is over.

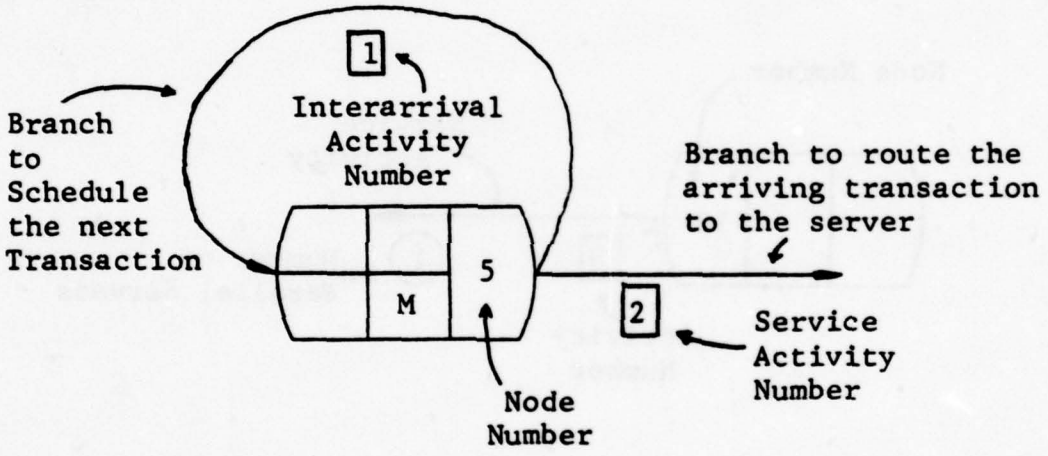


Figure 11

Source Node

An example of a queue node and its respective service activity are shown in Figure 12. The queue node is used in this model to collect and hold documents waiting to be processed. The queue node, shown in Figure 12, holds the

documents in suspense until the server is ready for another document. The queue node releases the documents in the model by priority with the higher priority documents being released first. Other options for document release could be first-in first-out (FIFO) or last-in first-out (LIFO). The FIFO method of release is used in our model for all queue nodes (i.e., proofreading, typewriter repair, etc.) other than actual typing.

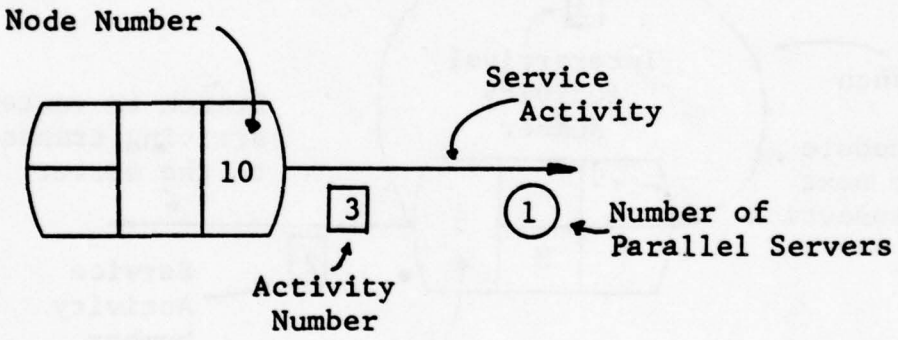


Figure 12

Queue Node

As stated, regular nodes in this model are used for branching purposes. Figure 13 illustrates one such node. The key feature of this node is that it permits probabilistic branching of the documents. For example, in the model when a document is ready to be typed, it was found that

3 percent of the time the typewriter was not functioning properly. Therefore, 3 percent of the time the regular node sends the document up a branch that delays arrival at the service activity for a certain downtime period, which was historically arrived at. The other 97 percent of the time the document proceeds directly to the typing service activity.

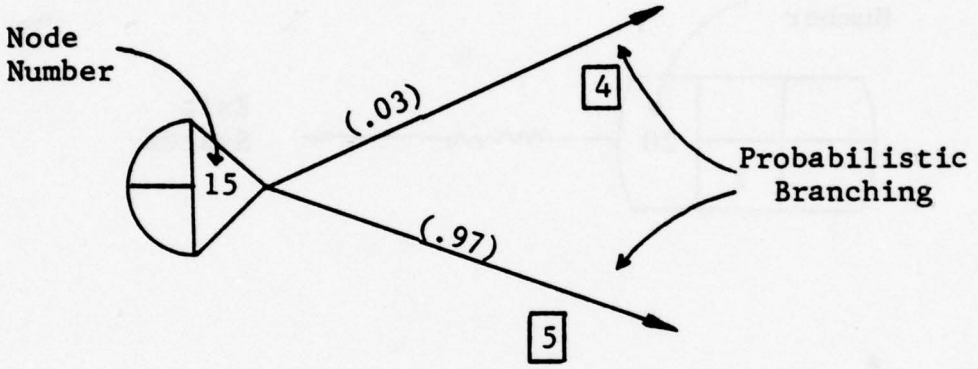


Figure 13

Regular Node

A statistics node is illustrated in Figure 14. Simply stated, statistics nodes collect statistics. The key aspects of statistics nodes are where they are placed in the network and what statistics they collect. The collection of statistics is made possible by the marking of each document at the source node. The statistics node draws upon the attributes assigned (or marked) on each

document to collect its statistics. The statistics collected in the model are interval statistics (the interval of time between when the document is marked and the time it reaches the statistics node). In this model the last statistics node is also used to exit the document from the system (as shown in Figure 14).

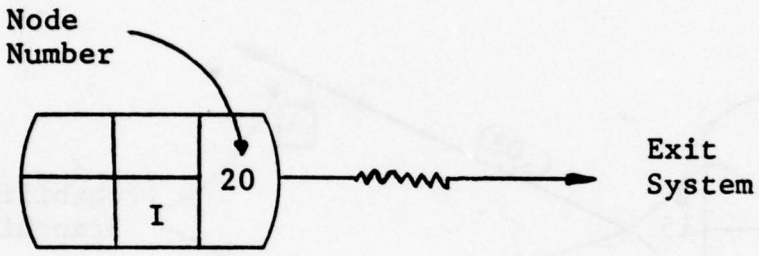


Figure 14

Statistics Node

Analysis and Measurement

Once the system was conceptualized, the next step was to identify, analyze, and measure the critical system variables and parameters. This was done in order to establish the exact nature of the activities of the model and, hopefully, provide the most realistic representation of the actual system possible. While identification of the

variables and parameters was an outgrowth of the conceptualization process, the major aspect of analysis and measurement was quantification of those variables and parameters.

The basic variables and parameters collected for this model were the ones considered to be critical to the operation of a WPC or the ones that would have a major impact on its operation. The specific variables and parameters looked at include the following:

1. Work Load Demand (documents/minute)
    a. Dictation Work Load Demand
    b. Longhand Work Load Demand
    c. Revision Work Load Demand
2. Dictation Machine Repair (minutes/repair)
3. Typewriter Repair (minutes/repair)
4. Proofreading (minutes/document)
5. Typing Service (minutes/document)
    a. Dictation Typing Service
    b. Longhand Typing Service
    c. Revision Typing Service
    d. Final Typing Service

We considered these to encompass the basic aspects of a WPC and were all used in the modeling of the system.

The basic functional relationships were then identified and documented. Generally, documents for typing are generated into a WPC from three sources: dictation,

longhand, and revision. Dictations are made by the originator, or author, directly into a dictation tank, which the typist taps to generate her typing work. Longhand and revision documents are sent directly to the WPC, proofread, and assigned to typists for typing. Once typing is accomplished the document is final typed and returned to the originator. Dictation machine and typewriter repairs are performed as required.

These variables, parameters, and their relationships were, as previously stated, expressed as a Q-GERT Network Model. The specific values of the variables and parameters were measured using data from the WPCs themselves. The WPC Monthly Report was used as the source. It contained most of the pertinent operations performance data needed to develop the necessary data. The Directorate of Administration provided other needed data.

Computerization

Once the Q-GERT network of the word processing system was developed and the parameters identified, measured and quantified, the next step was to combine these to formulate a computer model that adequately describes the word processing system. An important aspect of management models

is that they should be adequate, not necessarily totally accurate. Complete accuracy is seldom attainable in real world management situations. Also, the models should be kept as simple as possible to facilitate understanding by management (13:57-59). The reason for building a model, or models, of the word processing system was so the researchers could experiment with the model easily and with no impact on the real system. The experimentation with the model (simulation) enabled us to determine the effect of various organizational, policy, and procedural changes, with the goal of finding the optimal combination for application to the real system (24).

To computerize the Q-GERT model, a data card was required for each node, activity and parameter set in the network. The total set of these cards plus some specification cards comprises the program. These cards and rules for their composition and use are contained in Pritsker's book on Q-GERT (24:376-400). For example, the card for the branch shown in Figure 10 is shown below.

ACT,10,15,NO,1,11,2*

Each field of the card describes specific characteristics of the branch. These characteristics are as follows (in order): the ACTivity starts on node 10 and ends on node 15.

The activity time duration is normally distributed (NO) with parameter set 1 (specified with a separate parameter card), is labeled activity number 11, and has 2 parallel servers. The total set of cards (complete program) was then put on file and run on the Q-GERT Analysis Program available at AFIT on the CREATE computer system.

The next step was to actually run the model, using available real values for the parameters in the model to see if the initial model was an adequate representation of the word processing center. Once it was refined and made an adequate representation of the real phenomenon, the variables and parameters were changed and the program re-run to determine the impact of the changes on the system. Various "what if" questions were asked and their impact determined. Another important feature of the model is the determination of the critical variables and parameters that directly affect the performance of the word processing center. The development of a performance measurement system, based on these critical variables and parameters, was of paramount importance to this research

Performance Measurement System

The validity and usefulness of the Cybernetic Paradigm, and any management system for that matter, is measured by the performance of the system to which it is applied. Performance measures are an essential part of any management system since the manager needs to know how well the system is performing at any given time. Also, performance measures are used for control purposes. It is the researchers' experience that many current performance measurement systems are inadequate. A manager may make a decision that is intended to improve a particular production process, and he may succeed in improving "production," but in the process he may squander some of his long term resources. That is, a manager may make a decision that benefits him in the short run, but cripples him in the long run. This particular situation appears to be all too prevalent today in American industry, where not enough attention is given to research and development and capital investment (3:210).

Stafford Beer contends that a different type of "performance" measurement system is needed (3:206-212). Figure 15 demonstrates Beer's performance measurement

system. Beer defines three levels of achievement and three indices (ratios) for measuring output. The three

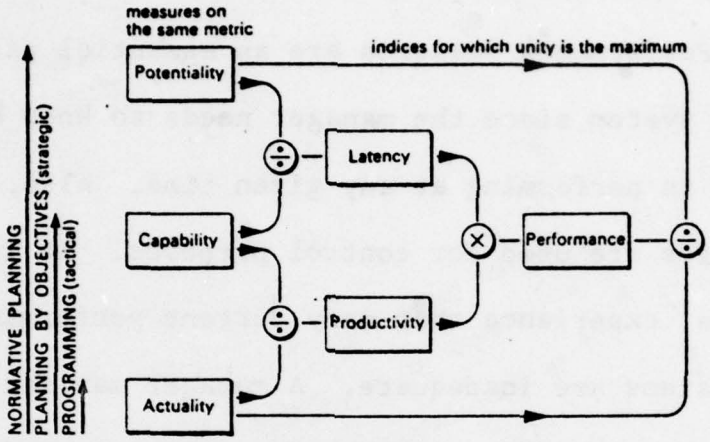


Figure 15

Three Measures of Capacity Generating
Three Measures of Achievement (3:209)

levels are:

actuality:	This is simply what we are managing to do now, with existing resources, under existing constraints.
capability:	This is what we could be doing (still right now) with existing resources, under existing constraints, if we really worked at it.
potentiality:	This is what we ought to be doing by developing our resources and removing constraints, although

> still operating within the bounds of what is already known to be feasible [3:207].

The three indices are:

> **productivity:** is the ratio of actuality and capability;
> **latency:** is the ratio of capability and potentiality;
> **performance:** is both the ratio of actuality and potentiality, and also the product of latency and productivity [3:208].

As can be seen, under Beer's performance measurement system, "performance" is measured in terms of actuality versus potentiality. This is considerably different from most performance measurement systems in use today, where the term "performance" is what Beer calls productivity. Beer's performance measurement system takes in to account the long term as well as the short term effects of management decisions. This performance measurement system discourages decisions that improve short term performance at the expense of long term potentiality. These performance measures can be applied at the division level of the Cybernetic Paradigm, or in management situations, to particular units of production.

An example to illustrate the use of this performance measurement system in context of word processing is

given below. In regard to typing performance, "potentiality" is defined as the optimal number of lines of type produced per day using the best equipment currently on the market, or capable of being produced, and with the world's best typist. The potential of this unconstrained combination could be perhaps 3000 lines per day. Since capability is what we currently are able to do, this would mean using our current equipment and our best typist. This combination could result in, say, 2000 lines per day. Finally, the actual production of typist A might be (for example) 1200 lines per day. These three figures can now be used to compute the three indices. In this case, productivity for this typist is 1200 ÷ 2000, or 0.6; latency would be 2000 ÷ 3000, or 0.67; and performance would be 1200 ÷ 3000, or 0.4. Again, the important point about performance is that it is the ratio of what is actually being done with what could be done if there were no constraints. This unconstrained level, although not easily attainable, is within the realm of human reach. In fact, managers should be striving always to meet their potentiality.

The numbers computed for the three indicies are not of primary importance in themselves. The thing that management is interested in is the <u>improvement</u> of the

performance index, over time. That is, it is the trend in the numbers that is of primary importance. The three indices should be used as the basis of the control mechanism for the management system.

Summary

In summary, this thesis involves three major processes: conceptualization, analysis, and computerization of a model of word processing. First, Stafford Beer's Cybernetic Paradigm was used as the general model for the conceptualization of the word processing system into a specific model for testing. Next, the word processing center was analyzed to identify the system network using Q-GERT Network. The system variables and parameters were then measured and quantified. Finally, a computer model (program) was constructed and was used for testing (simulation).

The purpose of the three step process was to construct a model that adequately represents the word processing system. Once such a model was developed, it was used for experimentation to determine the effects of various hypothetical changes to the model. In this way, improved

organization and management policies and procedures were explored. Also, a performance measurement system was developed that will measure better the performance of the word processing system. Having done the above, the objectives of this research were accomplished.

CHAPTER IV

THE DEVELOPMENT OF A VIABLE MODEL FOR THE WORD PROCESSING SYSTEM

Application of Beer's Cybernetic Paradigm

Research Focus

The initial step in the development of a word processing system model was to focus on the desired level of recursion to study in this research. The initial level (level one) of recursion explored in this research was HQ AFLC, itself. Figure 16 illustrates our conceptualization of HQ AFLC using Beer's Paradigm. We consider the Commander (AFLC/CC), the Deputy Chief of Staff for Plans and Programs (AFLC/XR), and the Chief of Staff (AFLC/CS) to be Systems Five, Four and Three, respectively. The main divisions would include Maintenance, Supply, Transportation, Administration and Information Processing, Procurement, Personnel, etc. The Administration and Information Processing Division is the one we explored in this research since it includes as one of its divisions word processing.

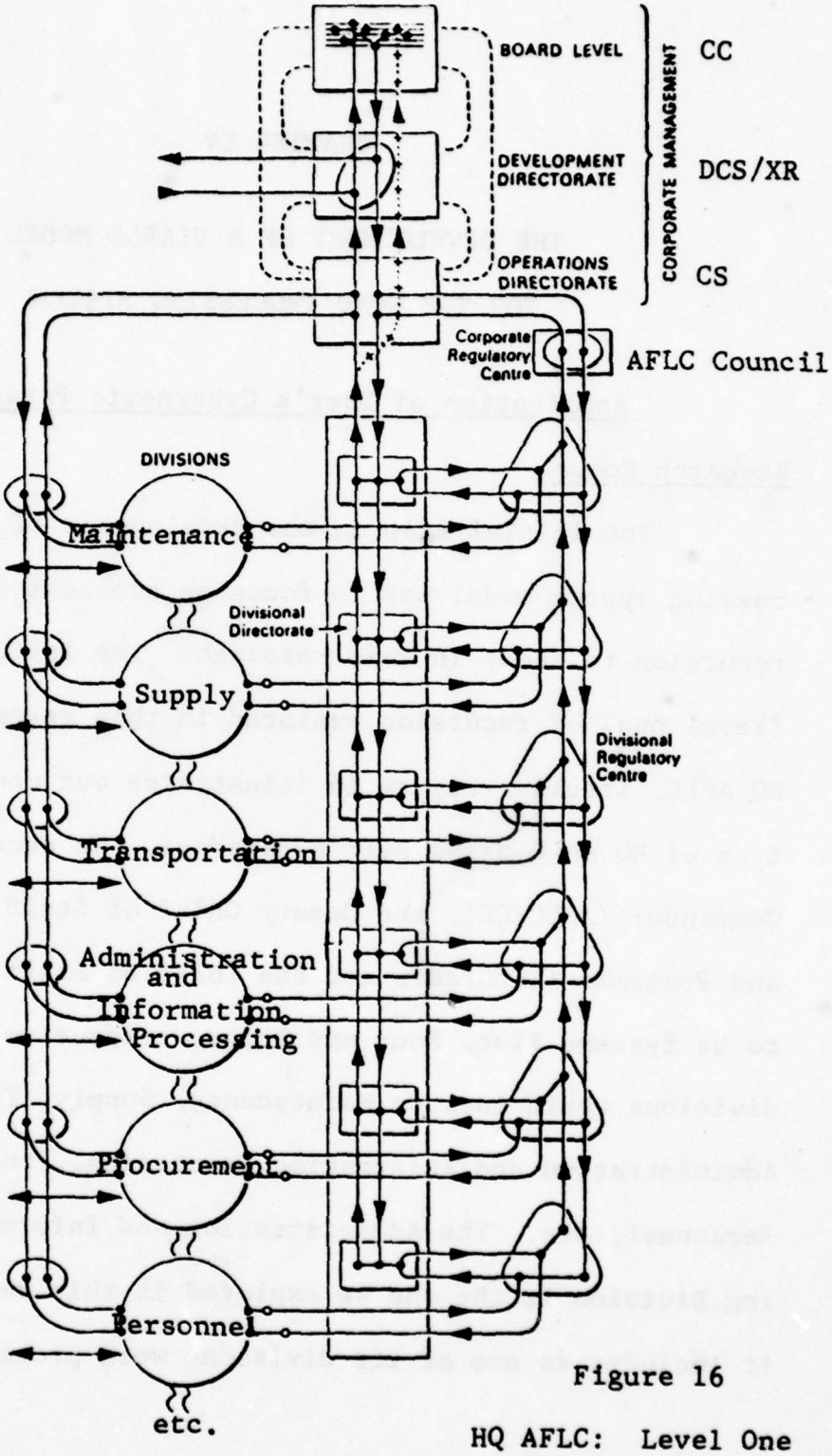


Figure 16

HQ AFLC: Level One

Figure 17 further illustrates the Administration and Information Processing system (level two). The divisions of this system are currently organizationally scattered throughout HQ AFLC. Therefore, Systems Five, Four, and Three of this Administration and Information Processing system are not readily discernible. This system comprises, as we see it, the functions currently performed in automated data processing of the DCS/Comptroller (AC), all functions of the Directorate of Administration (DA), and all of the WPCs. Detailed exploration in this research was made into the word processing division of this system. This word processing division (level three), as a system, is illustrated in Figure 18. As can be seen, the divisions of level three are the WPCs (level four). Currently, these WPCs are assigned to separate staff offices within the headquarters. Our interpretation of Beer's Paradigm would put each of these centers into one system. This is discussed in the next section of this thesis.

In this research, Beer's Cybernetic Paradigm was applied to the word processing system as a whole (level three). Q-GERT Network Modeling was applied to the word processing centers (level four), which are the divisions of the word processing system. Analysis, evaluation, and

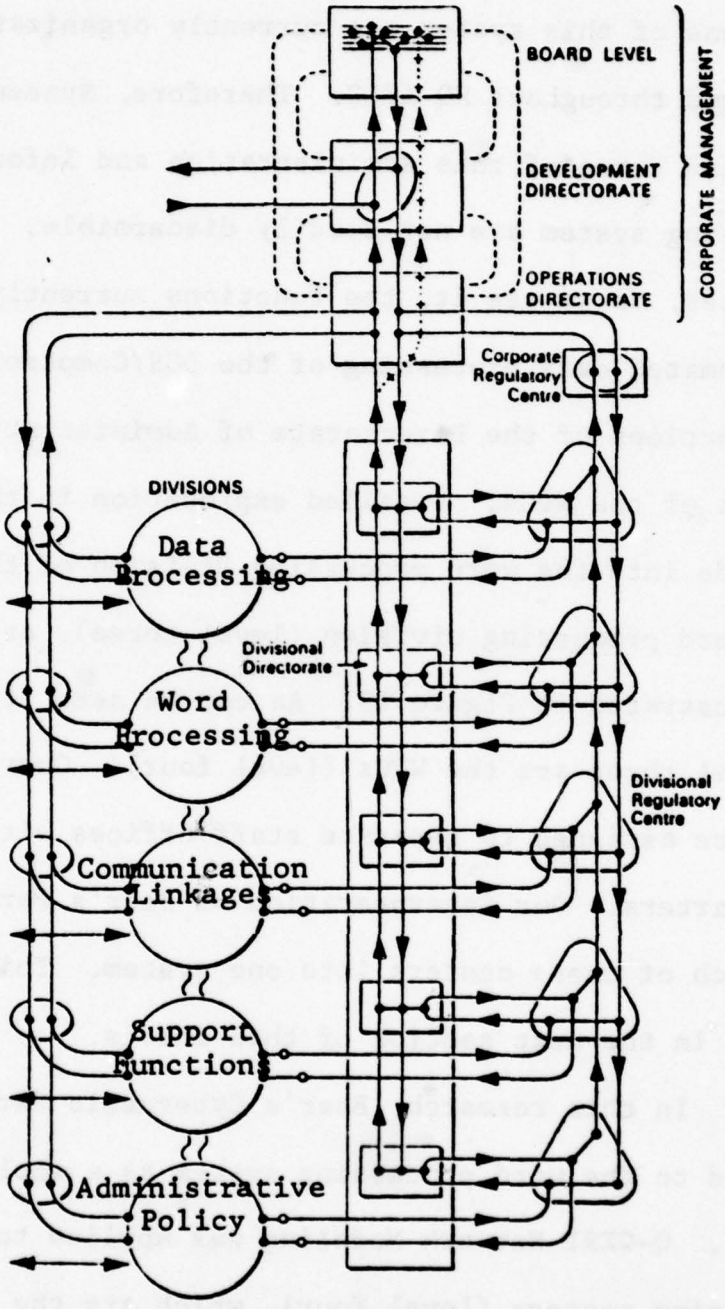


Figure 17

Administration & Information Processing System: Level Two

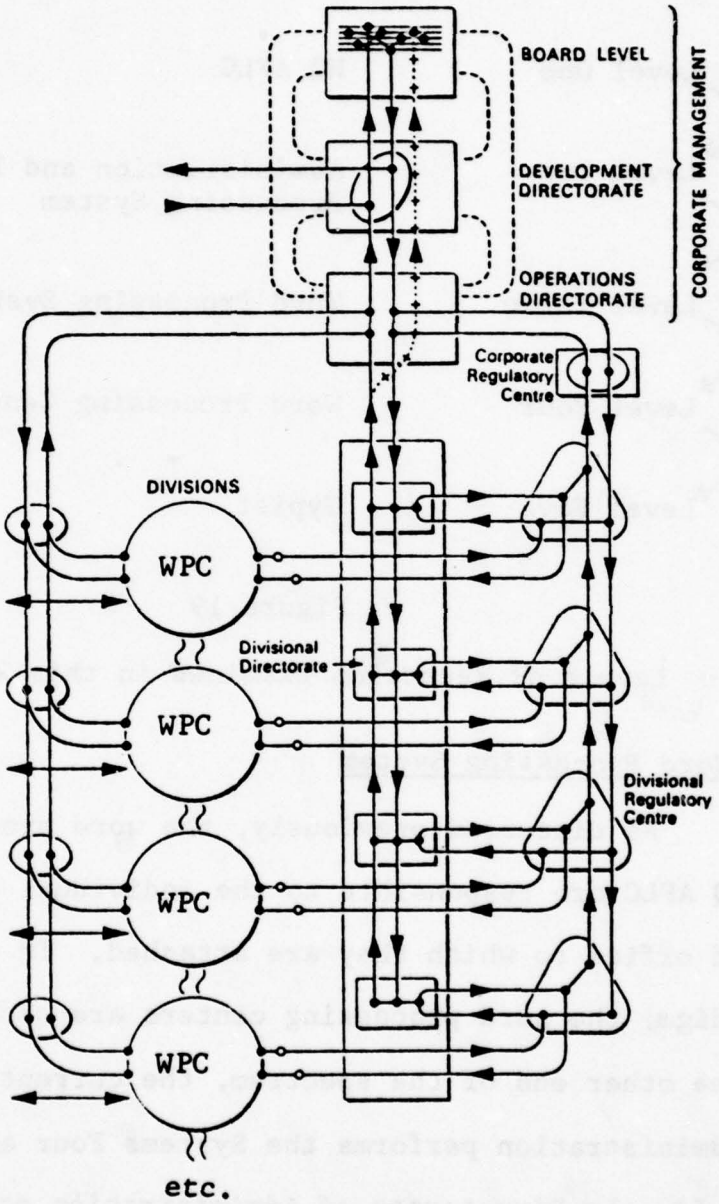


Figure 18

Word Processing System: Level Three

recommendations were made respective to those two levels. Figure 19 illustrates the various levels of recursion examined in the totality of this research.

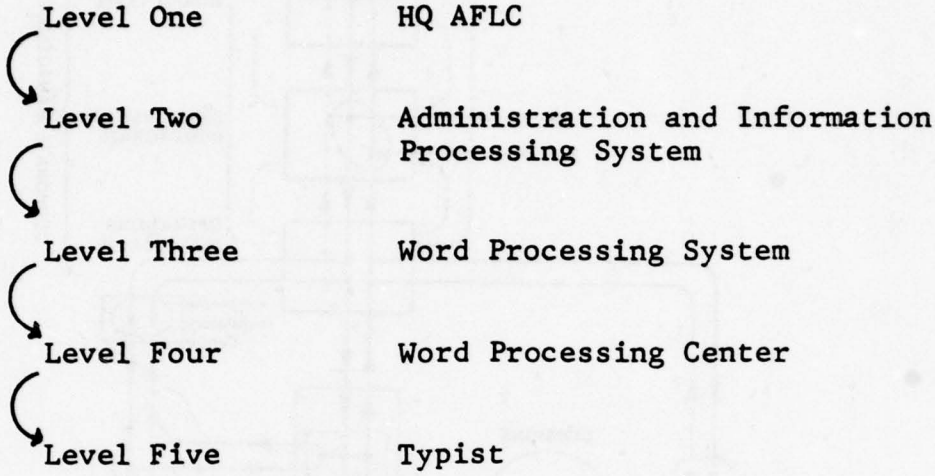


Figure 19

Levels of Recursion Examined in this Research

The Word Processing System

As discussed previously, the word processing centers at HQ AFLC are responsible to the individual deputates and staff office to which they are attached. In the Cybernetic Paradigm, the word processing centers are each Systems One. At the other end of the spectrum, the current Directorate of Administration performs the Systems Four and Five roles. That is, the Directorate of Administration acts as the "brain" of the word processing system, and performs the following functions:

> In harmony with functional managers and executive management, performs a continuing evaluation of administrative systems, manual or automated, applicable to the mission of administration and executive management. Develops detailed plans to define new or refine current systems to increase mission efficiency and/or reduce operational costs. . . . [33:2-8.1]

Now the problem arises. Systems Two and Three cannot be clearly found in the current word processing organization. That is, there is no single word processing system manager (System Three), responsible for the operation of all the word processing centers, nor is there a System Two function that would coordinate the activities of the individual word processing centers. Each word processing center is under the supervision and administration of the deputate or staff office to which assigned and there is little or no communication between the centers nor coordination of effort.

Application of the Paradigm

Rather than focusing directly on the current organization, we have mapped the word processing system (level three) onto the Cybernetic Paradigm to produce a system design that utilizes the cybernetic principles developed by Stafford Beer.

System One. The individual word processing centers clearly are each Systems One of the word processing system (Figure 18). Systems One, or the operating divisions, are where the actual work of the organism is performed. Each separate System One (word processing center) is in itself a complete system at a lower level of recursion (Figure 20). That is, the individual typists (level five) or word processors, are each Systems One within the center, or level four. System Two of the word processing center (level four) is manifested by the supervisor's switching work load from one typist to another, and by the performance measurement of each typist. The supervisor also performs the Systems Three, Four, and Five roles. In short, each of the systems manifested in the Cybernetic Paradigm can be found in the word processing center, or System One of the word processing system.

Following the Cybernetic Paradigm, each word processing center would be a System One division of level three, and the supervisor of each center performs the dual role of Systems Three through Five of the lower system (word processing center, level four), and the Division Regulatory Center of the individual System One of the word processing

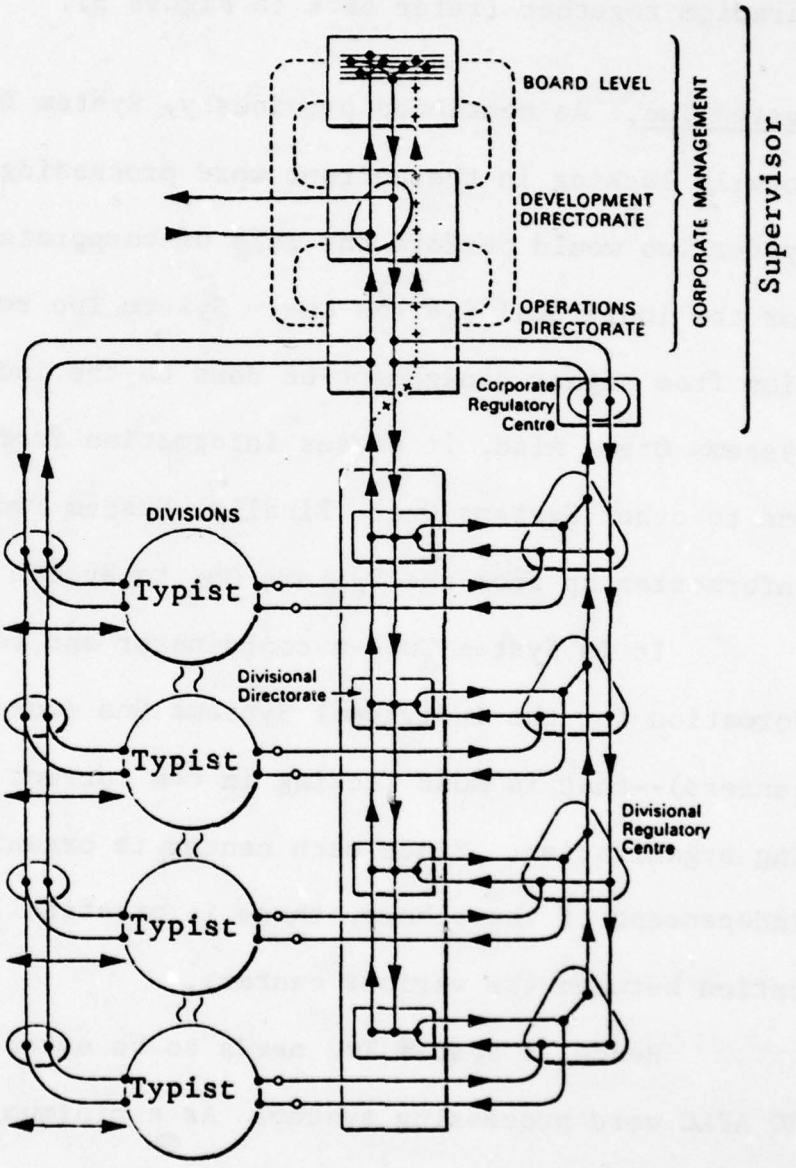


Figure 20

Word Processing Center: Level Four

system (level three). This dual role is what helps tie the various niveaux (echelons or levels of recursion) of the Paradigm together (refer back to Figure 9).

System Two. As mentioned previously, System Two is almost totally lacking in the current word processing organization. System Two would perform the role of corporate coordinator for the individual Systems One. System Two relays information from higher management on down to the individual Systems One. Also, it passes information from each System One to other Systems One. Finally, System Two acts to pass information up from the Systems One to System Three.

It is System Two--a coordinator and relayer of information for the individual Systems One (word processing centers)--that is most lacking in the current word processing organization. Since each center is organizationally independent of the others, there is practically no communication between the various centers.

Hence, a System Two needs to be established for the HQ AFLC word processing system. As a minimum, the System Two would perform the following:

1. Relay overall performance information from each word processing center to all other word processing centers

as well as to higher management (Systems Three through Five).

2. Transmit instructions from higher management down to the individual divisions (Systems One).

3. Provide a switching mechanism to move work load from one word processing center to another, as an individual center reaches work load saturation. This function would preclude various centers from becoming "critical" (over work loaded), while other centers are under worked.

System Three. Again, in the current organization, there is no clearly discernible System Three. System Three performs the general role as system manager. However, this title is somewhat misleading, under the conventional definition, since in normal circumstances System Three does not have to "manage." A paramount point of the Cybernetic Paradigm is that, under normal and routine circumstances, Systems One, Two, and Three function autonomically, or with a large degree of autonomy. As long as things are going well, System Three seldom has to take an overt or extraordinary management action. The various Systems One, acting in unison, should not over-reach their bounds. If they do, Systems Two and Three will automatically bring the aberrant Systems One into control using routine corporate policy.

Nevertheless, in certain circumstances, a strong supervisory role is needed to bring the operational divisions, or Systems One, into order. That is, the autonomic control system often must be by-passed, or orders come down from higher management to take exceptional (out of the ordinary) action. System Three is intended to exercise direct control in such situations, overriding the otherwise autonomy of the organization.

A clearly delineated System Three needs to be established at HQ AFLC. The System Three would be an operations directorate, or general manager for the word processing system. The operations directorate would be responsible for:

1. Transmitting corporate policy and special instructions to the divisions (word processing centers).

2. Receiving information directly from the individual Systems One, and also information about the Systems One through System Two.

3. Exercising direct control over the Systems One during periods of extraordinary requirements.

Again, the key aspect of System Three, under the Cybernetic Paradigm, is that it employs the management by exception principle extensively. As long as the Systems One are in control and System Two is taking care of random

fluctuations in the Systems One operations, System Three need not get directly involved in the routine operations of the Systems One, or word processing centers.

System Four. System Four's function is to provide the total system's eyes and ears to the outside world. It is concerned with the changes in the system's external environment and their impact on the system. It must analyze changes in the external environment and then develop proposed courses of action for the system to cope with the changes. In order to perform these functions, System Four must have a model of the corporate system. That is, System Four must understand what the corporate system is all about and be able to relate changes in the environment to that model. In short, System Four performs corporate or strategic level planning for the organization.

System Four also receives information through System Three of changes that are occurring within the corporate system. It incorporates this internal information in its strategic plans. Thus, strategic plans are the result of both internal and external changes that impact on the corporate system.

At HQ AFLC the System Four function is being performed by personnel in the Directorate of Administration. Their role is to analyze changes in the headquarter's word processing requirements and also changes in the external word processing world (12).

The mechanism for the Directorate of Administration to accomplish this function already exists, but their effectiveness is impaired by the lack of direct continuity with the separate word processing centers. Since the Directorate of Administration does not have direct control over the word processing centers (it acts as a headquarters "staff office" for word processing), it cannot perform the line function that System Four should perform, according to the Cybernetic Paradigm. This deficiency is the result of the organizational malalignment between the Directorate of Administration and the word processing centers.

System Five. The System Five role is that of the cerebral cortex of the corporate system. The primary purpose of System Five is to make decisions; the primary role of any corporate president is to make decisions. System Five does not act in a vacuum. It receives information up through the chain of command from all levels of the organization.

It also receives information about the external environment from System Four. On the basis of all information available, System Five makes decisions that change the entire posture of the corporate system. In general, it can be said that System Five makes mostly "tough decisions." The more routine "decisions" made by lower levels of the corporation generally are not really decisions--they are application of policies that already exist for the corporation. System Five operates in the realm of the unknown and uncertain. Finally, it can be said that System Five's role is to be the "unsettler" or agitator of the organization. Whereas lower animals that lack the System Five of Homo sapiens can only react passively to their environments, humans can change things, consciously. The role of System Five in the social organization or human organism is to move the organism away from current stability to a new state of stability at some different level. In the interim, organizational stress usually must occur.

For the word processing system, the System Five role is performed by the Director of Administration. For the most part, the Director of Administration calls the shots for word processing in the HQ, and was responsible for the implementation of word processing in the first place.

Summary of the Application of the Paradigm

The word processing system at HQ AFLC has been mapped onto Beer's Cybernetic Paradigm. The primary purposes of this mapping have been to explain how the word processing system actually works, versus the way it is perceived to work, and to spot gross organizational deficiencies. The outcome of the mapping, or system conceptualization and modeling, is that the current organization of word processing could be improved.

The Cybernetic Paradigm shows that Systems Two and Three are lacking in the current organization of the word processing system. As a result, there is little communication and support between the separate centers and there is no centralized management function to oversee the centers. If one center goes out of control (either becomes backlogged or experiences slack periods) there is no way to transfer work loads among the centers. Also, the lack of a strong System Three results in a communication gap between Systems Four and Five and the other lower systems. Beer would probably say that the brain of the firm is severed from the rest of the organism. As a result, Systems Four and Five cannot perform totally adequately.

Application of the Q-GERT Model

Q-GERT Network Model

After conceptualization of the word processing system, it was necessary to analyze the exact relationships between the activities of the word processing center (level four). As previously stated, a Q-GERT Network Model was used to perform this task.

Development of the word processing center (WPC) model was derived from several sources. First, as users of the word processing services, the researchers are familiar with the general operation of the WPC. The WPC Standard Operating Procedures (HOI 11-1, Appendix 2) (32) were used as a baseline description of how a WPC is supposed to work. Additional information was also gained from interviews with Directorate of Administration (DA) personnel and with WPC personnel. As described in Chapter IV, Q-GERT Network Modeling was used here to model the word processing center. A general look at a word processing center is provided in Figure 21. Basically, the WPC operation is fairly simple. Documents are generated from three sources: dictation, longhand, and revisions. They are first typed in draft and then output in final form. Provisions are included for

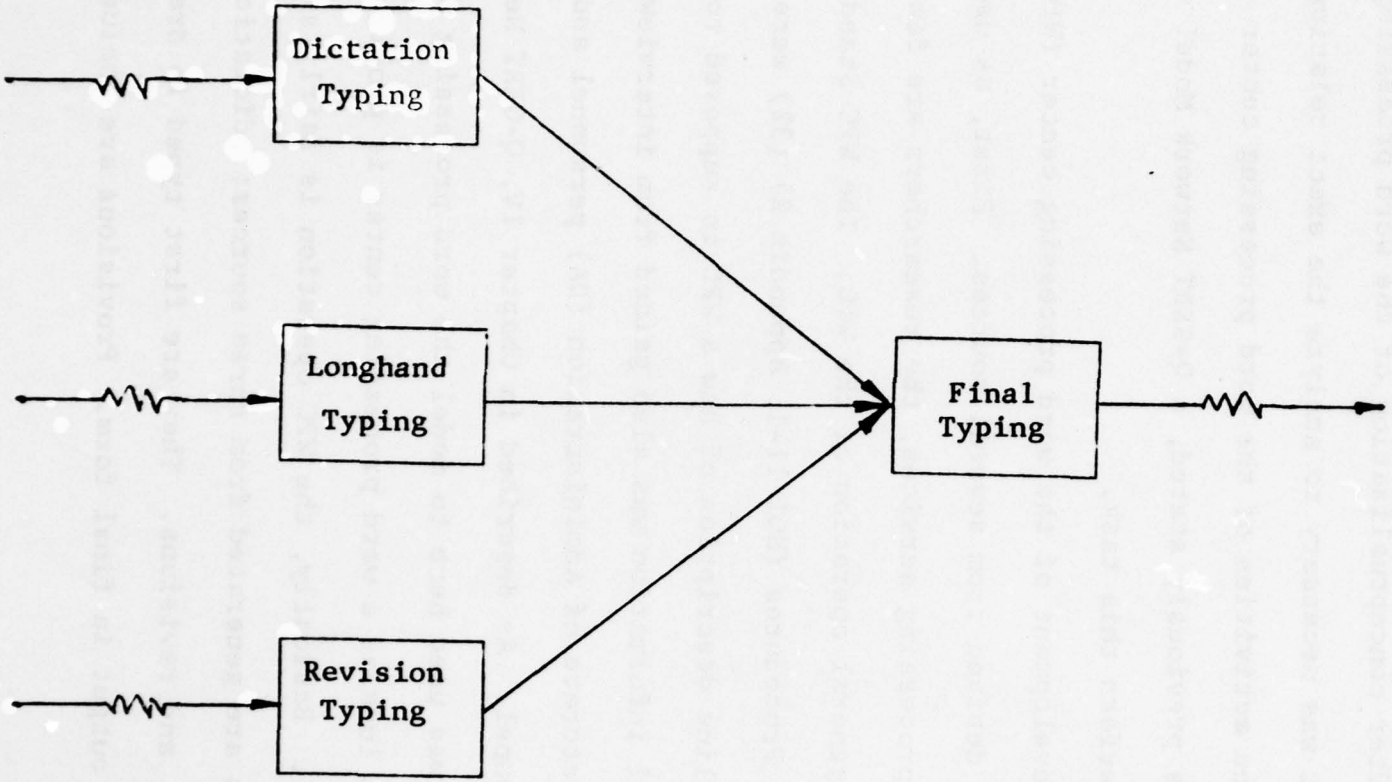


Figure 21

General WPC Network

proofreading and machine downtime. The detailed structural aspects of each segment are discussed next.

Network Activities

As stated, WPC work load is generated in three forms: mechanical transcription, longhand transcription, and revisions. Mechanical transcriptions are received through a telephone-tape setup in which the originator, or author, dictates his correspondence into a dictation tank. The typist then taps this tank in order to produce the typed document. Longhand transcriptions are simply handwritten hard copy drafts of the correspondence the originator wants typed. Revisions are changes to documents that were originally typed by the WPC. All three sources are transformed into final documents and returned to the originator. This is done through the final typing process. Following is a discussion of each of these four basic activities.

Mechanical transcription--MT (Figure 22). The originator generates correspondence (NODE 10) by telephone into a dictation tank. This dictation tank is used as a queue (N12) before draft typing (ACTIVITY 18) is performed. Should the tape equipment be down, a queue (N12) is formed

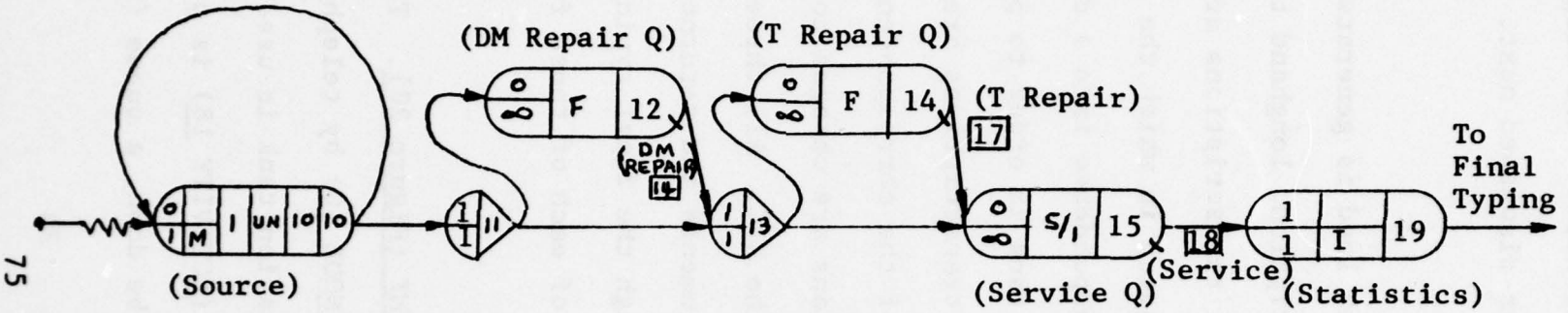


Figure 22

Mechanical Transcription

and dictation machine repair is performed (A14). Should the typewriter(s) be down, a queue (N14) and typewriter repair activity (A17) are formed prior to draft typing. The draft typing is performed (A18), statistics are collected (N19), and the document is sent to final type.

Longhand transcription--LT (Figure 23). The originator generates correspondence (N20) by turning in a longhand hard copy of his correspondence. It is put into a proofreading queue (N22), proofread (A22), and submitted to a service queue (N25) before draft typing (A26). Should the typewriter(s) be down, a queue (N24) and typewriter repair activity (A25) are formed before draft typing. The draft typing is performed (A26), statistics are collected (N29), and the document is sent to final type.

Revisions--R (Figure 24). The originator generates revisions (N30) by turning in previously typewritten hard copies with changes to be made to his correspondence. It is put into a proofreading queue (N32), is proofread (A32), and submitted to a service queue (N35) before retype (A36). Should the typewriter(s) be down, a queue (N34) and typewriter repair activity (A35) are formed before draft typing. The draft

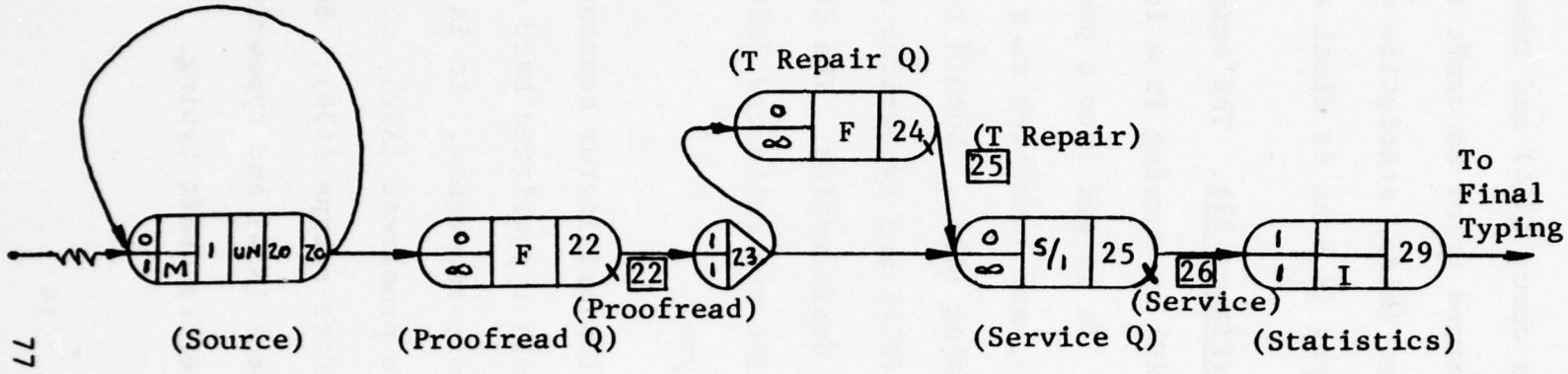


Figure 23

Longhand Transcription

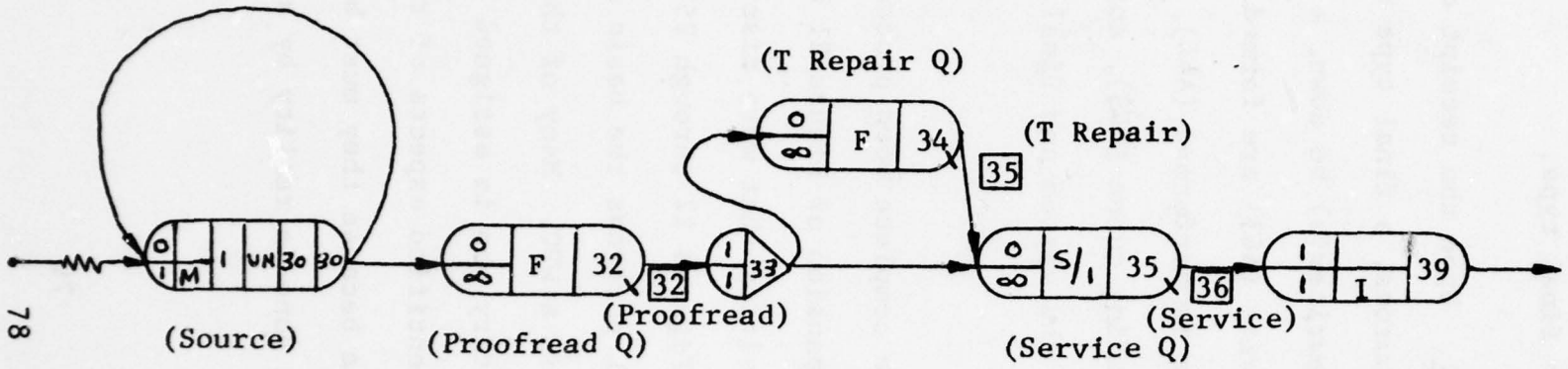


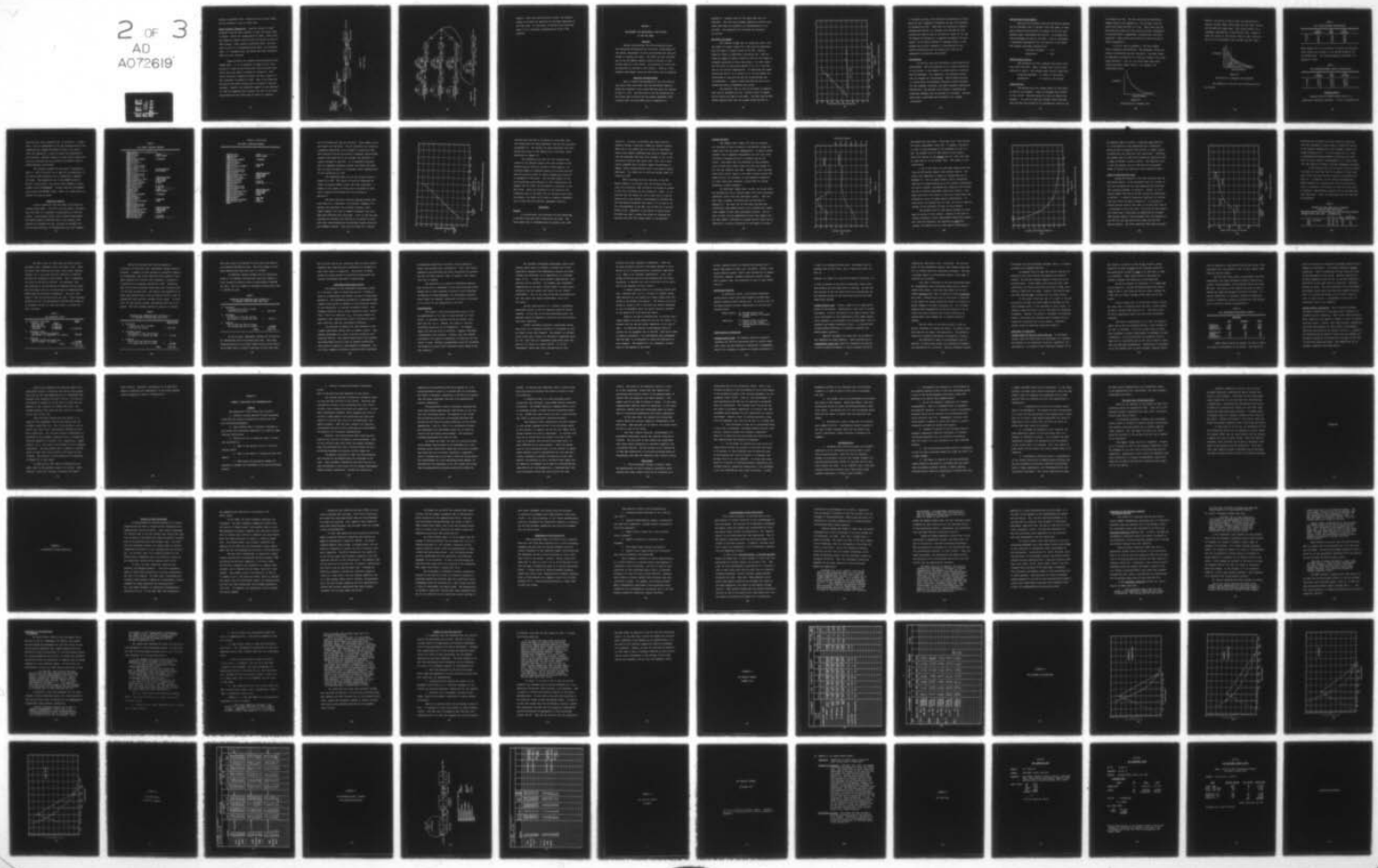
Figure 24

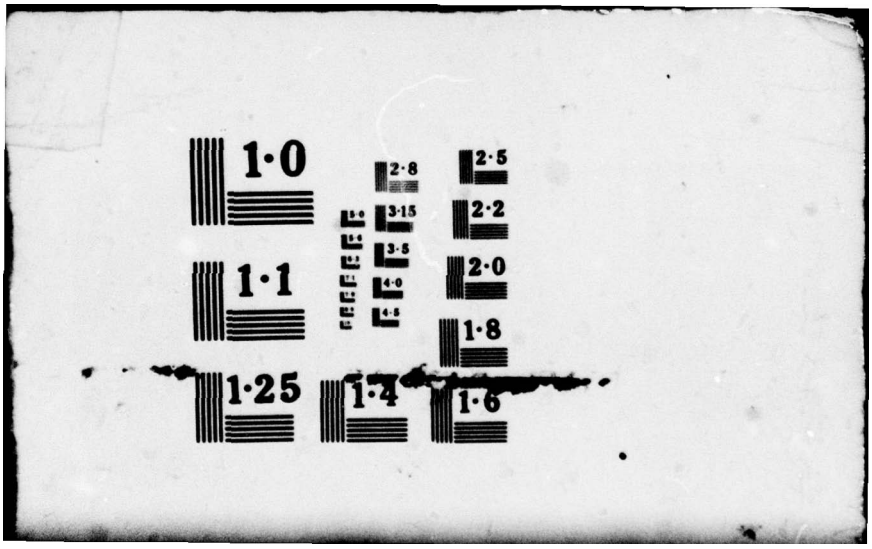
Revisions

AD-A072 619 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL--ETC F/G 5/1
A DESIGN FOR A MANAGEMENT SYSTEM FOR HEADQUARTERS AIR FORCE LOG--ETC(U)
JUN 79 K W GLASSER, A B THOMAS

UNCLASSIFIED AFIT-LSSR-10-79A NL

2 OF 3
AD
A072619




1·0
1·1
1·25
2·8
3·15
3·5
4·0
1·4
2·5
2·2
2·0
1·8
1·6

typing is performed (A36), statistics are collected (N39), and the document is sent to final type.

Final typing--F (Figure 25). Upon the receipt of draft documents from the three sources, a final type queue (N42) is formed. Should the typewriter(s) be down, a queue (N41) and typewriter repair activity (A43) are formed in front of final typing. Final typing is performed (A44), the documents are put in a proofreading queue (N43), and proofread (A45). The documents exit the system and final statistics (N50) are then collected.

Figure 26 shows the complete word processing center Q-GERT model. It is an expansion of Figure 21 and incorporates the nodes and activities that were discussed separately above and shown in Figures 22 through 25. This entire structural framework portrays the basic aspects of how a document is handled in a WPC. Many of the functions are done by the same secretary who is assigned a specific document. However, the identified aspects of the operation of a WPC are separated here because they must be for modeling purposes and are often done in reality by separate

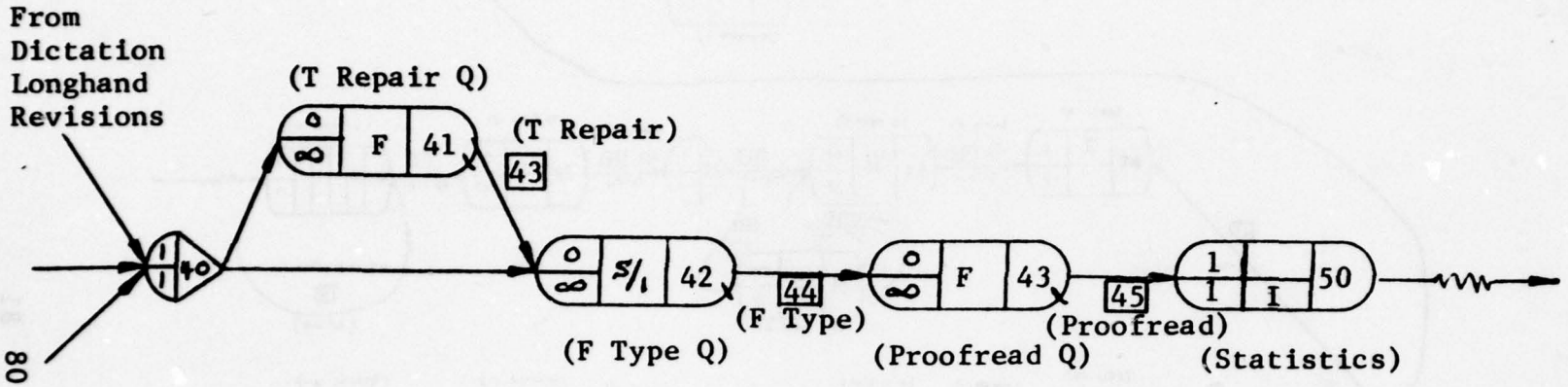


Figure 25

Final Typing

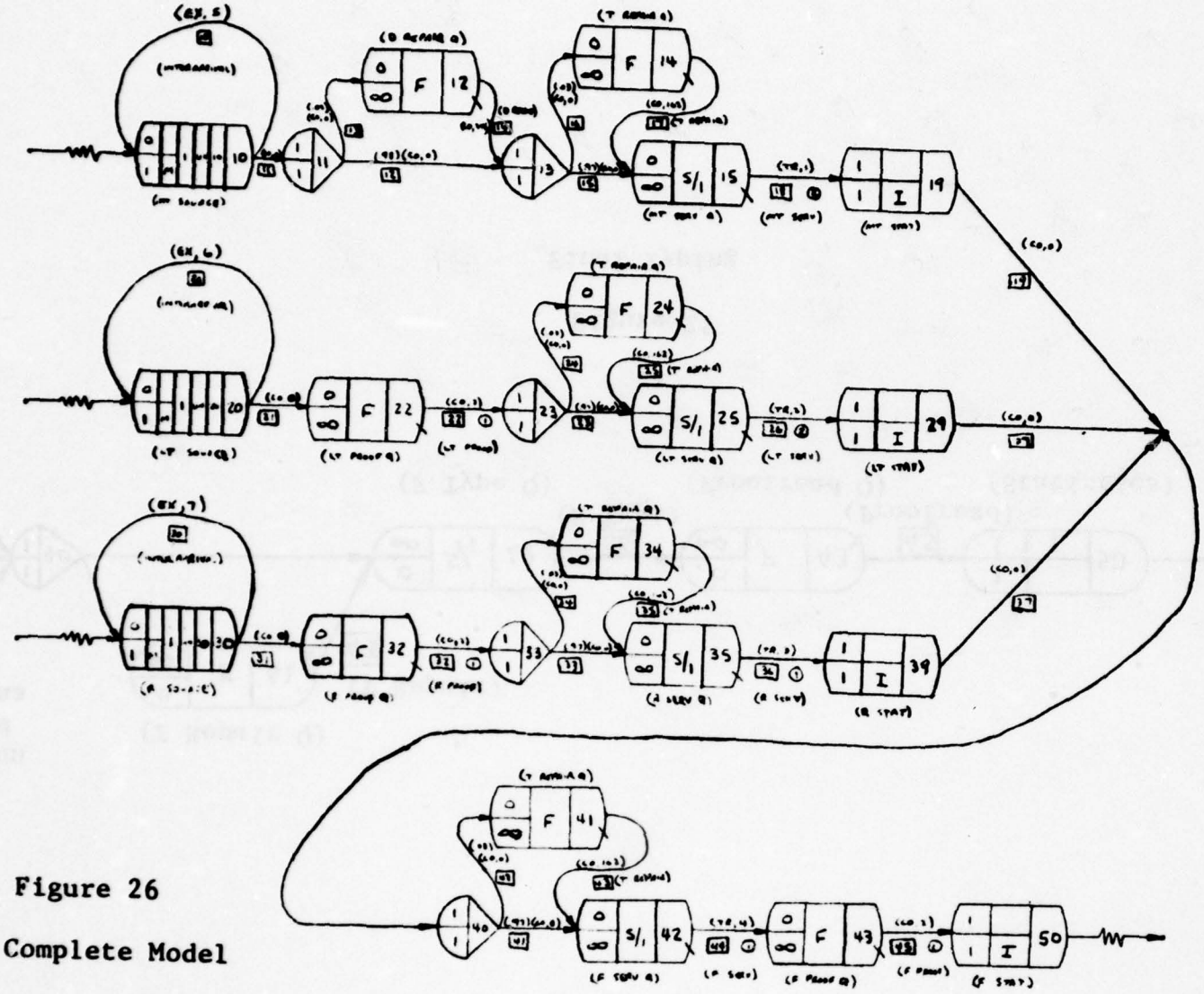


Figure 26

The Complete Model

typists. Since the functions must be done, the manpower needed to do them will generally be the same regardless of who does them. In conclusion, we believe this structural model to be a reasonable representation of how a WPC operates.

CHAPTER V

MEASUREMENT AND EXPERIMENTAL IMPLICATIONS OF THE WPC MODEL

Overview

Having conceptualized the word processing system and identified and analyzed the structural relationships of the system, measurement of those relationships was then performed to complete the model. The model was then validated and run on the CREATE computer system of HQ AFLC to test various aspects of the system. An evaluation of those runs was made and is included in this chapter. Finally, a performance measurement system for word processing is presented.

Analysis and Measurement

Data to develop the parameters of the word processing center model were taken from the WPC Monthly Reports, which are submitted to DA by each WPC each month as required by HOI 11-1 (32). The data used to set the parameters for this model were collected for six months (September 1978-February 1979) for seven WPCs and are summarized in

Appendix B. Complete data for the other WPCs were not available. The data (and averages computed) collected from these seven WPCs are assumed to be representative of all the WPCs. The parameters for the model are discussed as follows.

WPC Work Load Demand

The original thought was, by using this model, that the number of typists needed for a WPC could be determined from the number of people served by the WPC. However, Figure 27 shows no significant correlation (ρ = .378) between the number of people served by a WPC and the number of documents generated by those same people. The main reason for this lack of correlation appears to be due to the mission of the various organizations. An operating-type organization may have a lot of people in it, but the people are doing hands-on type work and may not be generating much correspondence. A smaller staff-type function may be producing much more correspondence per person.

The indicator that is used in the model to generate work load is documents per day. Various levels of demand can be used as an input to the model. The data from the WPC Monthly Reports show that the average demand per WPC is

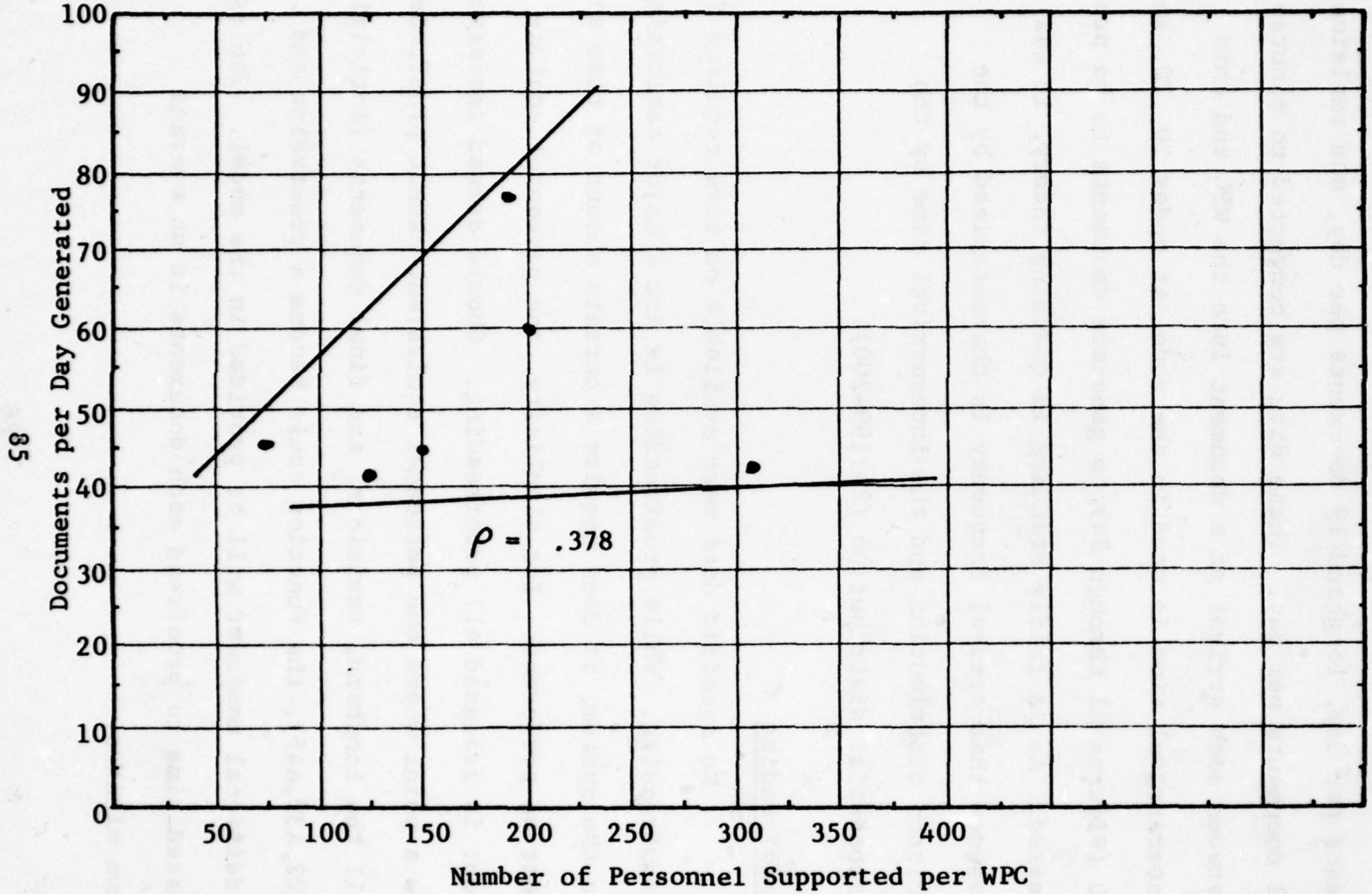


Figure 27

Originator Work Load Generation

51 documents per day, with dictation accounting for 10 documents per day, longhand 19 documents per day, and revisions 22 documents per day. These data are converted to minutes between each arrival of a document into the WPC and this interarrival time is used in the model at nodes 10, 20, and 30 (Figures 22 through 24) to generate documents to be processed. As is fairly standard in queueing theory, it was assumed that arrival frequency is characterized by the Poisson distribution and the interarrival time by the exponential distribution (24:199-200).

Proofreading

No specific data were available on time required for proofreading. While proofreading is not a major constraint on the system, it does require a certain amount of time and must be performed. For simplicity, one personnel equivalent is assigned all proofreading. Should demand increase to a point where one personnel equivalent cannot proofread all the longhand, revisions, and final documents (Activities A22,A32,A45), the function could become a constraint and additional manpower will be provided in the model. The estimated time to proofread each documents is an average two minutes.

Machine Repair Requirements

Data were not available from the WPC Monthly Reports for the September 1978 to February 1979 time frame, so data were collected from the first six months of 1977 for both machine repair requirements and service. An average downtime percentage was used in the model. This is considered a reasonable approximation for the purposes of this model. The average percentages downtime were:

Dictation Equipment - 2.1%

Typewriters - 3.2%

Machine Repair Service

This parameter was also computed from latest available (1977) WPC data. Again, averages were used for each instance of repair. The average repair service times were:

Dictation Equipment - 4.1 hours or 246 minutes

Typewriters - 2.7 hours or 162 minutes

Typing Service

The desired value for typing service in this model is minutes per document. Lines per document were divided by the standard lines per minute to arrive at minutes per document. The data on lines per document were actual WPC data and they were arrived at by dividing the lines per day

by documents per day. The data were from the WPC Monthly Summary Reports (see Appendix B). The standard lines per minute were taken from HOI 11-1 (32). These data from the WPCs gave data points for each service activity (mechanical transcription-A18, longhand-A26, revisions-A36, and final type-A44). These points were plotted for each activity as shown in Appendix C.

As can be seen in Appendix C, the data roughly follow triangular distributions. The phenomenon behind the several distributions was next evaluated. One might expect an exponential distribution of lines per document (the underlying indicator). That is, one would expect many short letters and fewer longer letters. For example, the relationship below:

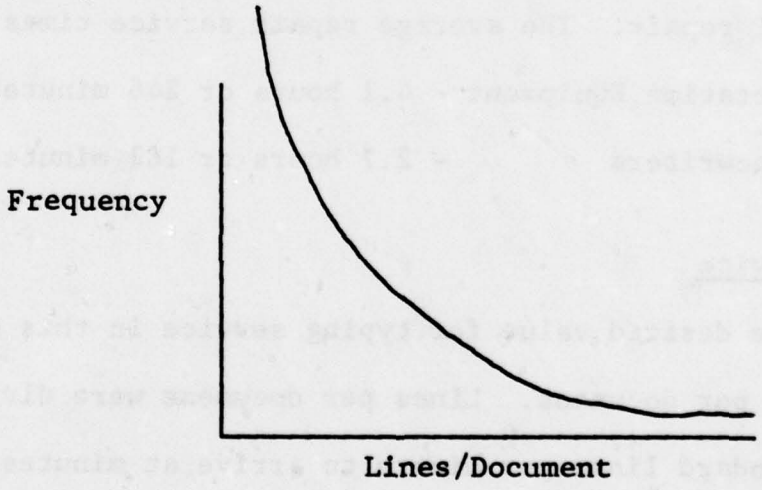


Figure 28

Distribution of Document Size

However, the policy at AFLC is that the administrative support clusters (ASCs) should type the very short letters and the WPCs the longer ones. This policy results in a triangular distribution of the WPC work load. Figure 29 shows the result of this policy (there is some overlap in the size of the documents that the WPCs and ASCs type).

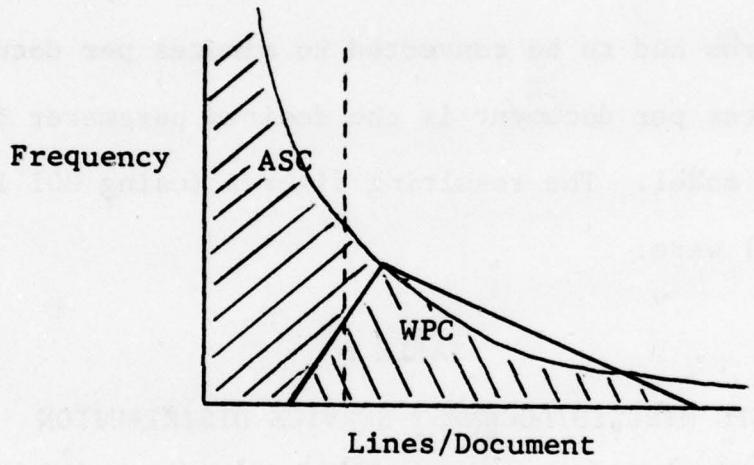


Figure 29

Distribution of Document Size--ASC/WPC

The parametric values for the distributions are as follows:

TABLE 1

WPC LINES/DOCUMENT DISTRIBUTION

	(a) MINIMUM	(m) MODE	(b) MAXIMUM
MT	35	50	100
LT	50	90	210
R	80	110	180
F	65	90	160

These figures had to be converted to minutes per document, since minutes per document is the desired parameter for the Q-GERT model. The resulting figures (using HOI 11-1 Appendix 2) were:

TABLE 2

WPC MINUTES/DOCUMENT SERVICE DISTRIBUTION

	(a) MINIMUM	(m) MODE	(b) MAXIMUM
MT	12.5	25.0	50.0
LT	30.1	54.2	126.5
R	16.0	22.0	36.0
F	6.5	9.0	16.0

Computerization

Computerizing the Q-GERT Network Model is a formalized, sequential procedure. A card is generated for

each activity, node, parameter set, or attribute. In addition, a card is established to set the specifications of the simulation run (length and number of runs, etc.) and to start the simulation. A card to finish the simulation is also provided. Specific formats for each field of each card had to be followed and are provided in Pritsker's book on Q-GERT Networks (24:376-400).

The computer program for this model is provided in Table 3. Each simulation run is made for the equivalent of one month of WPC operation and is automatically repeated ten times. The program was run on the CREATE system at HQ AFLC in batch node. The system level command to access Q-GERT is AFIT.LIB/RUNGERTS. Persons familiar with CREATE-type systems and FORTRAN, BASIC, COBOL, etc. should have no problem in using the model.

Simulation Results

Various simulation runs were made of the word processing center model. The first runs were made to validate that the model is a reasonable representation of the real system. As previously stated, data collected from recent WPC Monthly Reports indicated that on the average a WPC produces 51 documents per day, of which 10 documents per day are from dictation, 19 documents per day from longhand,

TABLE 3

WPC MODEL COMPUTER PROGRAM

```
1000GEN,GLASSER,WP,6,13,1979,4,0,,9600.0,10,(14)1*
1010SOU,10,0,1,D,M*                          MT SOURCE----------
1020VAS,10,1,UN,10*                          PRIORITY ATTRIBUTE
1030PAR,10,,1,6*
1040ACT,10,10,EX,5,16/MTARRIVE*              MT INTERARRIVAL
1045PAR,5,96.0,0.0*
1050ACT,10,11,CO,0.0,11*
1060REG,11,1,1,P*
1070ACT,11,13,CO,0.0,12,,0.98*
1080ACT,11,12,CO,0.0,13,,0.02*
1090QUE,12/D-REP-Q*                          DICTATION REPAIR QUEUE
1100ACT,12,13,CO,246.0,14/D-REP,5*           DICTATION REPAIR
1110REG,13,1,1,P*
1120ACT,13,15,CO,0.0,15,,0.97*
1130ACT,13,14,CO,0.0,16,,0.03*
1140QUE,14/T-REP-Q*                          TYPEWRITER REPAIR QUEUE
1150ACT,14,15,CO,162.0,17/T-REP,5*           TYPEWRITER REPAIR
1160QUE,15/MTSERV-Q,(6)S/1*                  MT SERVICE QUEUE
1170ACT,15,19,TR,1,18/MT-SERV,1*             MT SERVICE
1180PAR,1,25.0,17.5,50.0*
1190STA,19/MT-STAT,1,1,D,1*                  MT STATISTICS
1200ACT,19,40,CO,0.0,19*                     TO FINAL TYPE----------
1210SOU,20,0,1,D,M*                          LT SOURCE----------
1220VAS,20,1,UN,20*                          PRIORITY ATTRIBUTE
1230PAR,20,,1,6*
1240ACT,20,20,EX,6,20/LTARRIVE*              LT INTERARRIVAL
1245PAR,6,50.0,0.0*
1250ACT,20,22,CO,0.0,21*
1260QUE,22/LT-PRF-Q*                         LT PROOF QUEUE
1270ACT,22,23,CO,2.0,22/LT-PROOF,1*          LT PROOF
1280REG,23,1,1,P*
1290ACT,23,25,CO,0.0,23,,0.97*
1300ACT,23,24,CO,0.0,24,,0.03*
1310QUE,24/T-REP-Q*                          TYPEWRITER REPAIR QUEUE
1320ACT,24,25,CO,162.0,25/T-REP,5*           TYPEWRITER REPAIR
1330QUE,25/LTSERV-Q,(6)S/1*                  LT SERVICE QUEUE
1340ACT,25,29,TR,2,29/LT-SERV,2*             LT SERVICE
1350PAR,2,54.2,30.1,126.5*
1360STA,29/LT-STAT,1,1,D,1*                  LT STATISTICS
1370ACT,29,40,CO,0.0,27*                     TO FINAL TYPE----------
```

TABLE 3 (continued)

WPC MODEL COMPUTER PROGRAM

```
1380SOU,30,0,1,D,M$                    R SOURCE----------
1390VAS,30,1,UN,30$                    PRIORITY ATTRIBUTE
1400PAR,30,,1,6$
1410ACT,30,30,EI,7,30/RARRIVE$         R INTERARRIVAL
1415PAR,7,45.7,0.0$
1420ACT,30,32,CO,0.0,31$
1430QUE,32/R-PRF-Q$                    R PROOF QUEUE
1440ACT,32,33,CO,2.0,32/R-PROOF,1$     R PROOF
1450REG,33,1,1,P$
1460ACT,33,35,CO,0.0,33,,0.97$
1470ACT,33,34,CO,0.0,34,,0.03$
1480QUE,34/T-REP-Q$                    TYPEWRITER REPAIR QUEUE
1490ACT,34,35,CO,162.0,35/T-REP,5$     TYPEWRITER REPAIR
1500QUE,35/R-SERV-Q,(6)S/1$            R SERVICE QUEUE
1510ACT,35,39,TR,3,36/R-SERV,1$        R SERVICE
1520PAR,3,22.1,16.0,36.0$
1530STA,39/R-STAT,1,1,D,I$             R STATISTICS
1540ACT,39,40,CO,0.0,37$               TO FINAL TYPE----------
1550REG,40,1,1,P$
1560ACT,40,42,CO,0.0,41,,0.97$
1570ACT,40,41,CO,0.0,42,,0.03$
1580QUE,41/T-REP-Q$                    TYPEWRITER REPAIR QUEUE
1590ACT,41,42,CO,162.0,43/T-REP,5$     TYPEWRITER REPAIR
1600QUE,42/F-SERV-Q,(6)S/1$            F SERVICE QUEUE
1610ACT,42,43,TR,4,44/F-SERV,1$        F SERVICE
1620PAR,4,9.0,6.5,16.0$
1630QUE,43/F-PRF-Q$                    F PROOF QUEUE
1640ACT,43,50,CO,2.0,45/F-PROOF,1$     F PROOF
1650STA,50/F-STAT,1,1,D,I$             F STATISTICS
1660FIN$
```

and 22 documents per day are revisions. These demand levels were input into the model. The 10 simulation runs indicated a manpower requirement of an average 6.0 typists per WPC. Data received from the Directorate of Manpower (HQ AFLC/DPQ) indicate that there are on the average (for HQ AFLC) 6.2 typists assigned to each WPC. It is therefore concluded that for aggregate planning purposes (for which this model will be used) the model is a reasonably valid representation of real operations of a WPC.

The simulation model was run for various levels of demand for a WPC. The results of each run indicated the number of typists needed to meet that work load level. A summary of the results of these runs is provided in chart form in Figure 30 and backup data are provided in Appendix D.

The first runs were conducted keeping current work load mixes (i.e., dictation, 19.8 percent; longhand, 37.8 percent; and revisions, 42.4 percent) constant, while simply changing the level of demand; subsequent runs were made with different work load mixes. A set of runs was made reducing the revision work load mix to 25 percent of total work load, while keeping the relationship between dictation and longhand constant. Runs were also made for a reduced

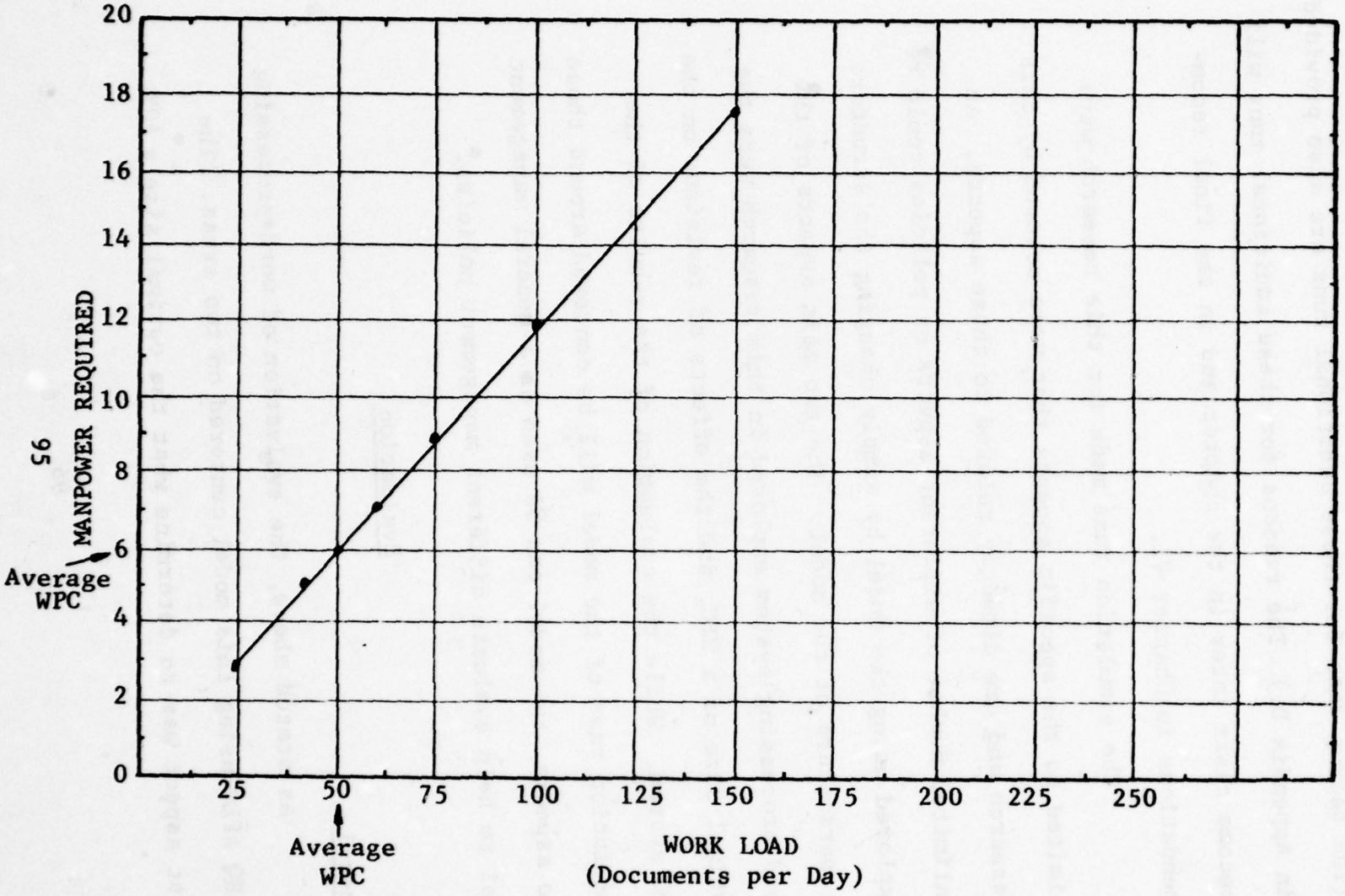


Figure 30

WPC Work Load/Manpower Requirements Relationship

revision work load mix of 10 percent of total work load. (The backup data for these additional runs are also provided in Appendix D.) The reasons for these additional runs will become clear later in the chapter and in the final recommendations in Chapter VI.

The simulation runs made for this research were limited to the specific aspects that were covered by this research and are directly related to those aspects. An unlimited number of different aspects or policies could be explored using the model by simply changing the structure or parameters of the model. The two main aspects of the word processing system explored in this research were the optimal size of a WPC, and the effects of revisions on the WPC system. While the evaluation of the results of the simulation runs of the model will be centered around those two aspects, the model can be used as a general management tool to help evaluate different management policies.

Evaluation

General

As stated above, the evaluation of word processing at HQ AFLC using this model centered on two areas. The first aspect was to determine what the optimal size a WPC

should be. A priori, we believed that there would be definite savings in putting a number of typists together. While one or two typists may not be able to efficiently keep up with demand (sometimes they would be swamped with work and sometimes they would have nothing to do), it was intuitively believed that three, four, five, six or more typists together would certainly dampen fluctuations in demand, reduce average backlog levels, and improve overall efficiency. The object was to find the optimal number of clerks in a WPC.

While reviewing the work load data in the WPC Monthly Reports, we believed that the revision work load level was excessively high (currently an average 42 percent of the total documents per day produced by a WPC). It is believed that the reason for such a high level is the obsession with letter perfect correspondence at HQ AFLC and the wide-spread perception that since it is so easy to revise correspondence in the WPC, send it back if it has any errors at all, regardless of the extent of those errors. The model was used to assess the effect of reducing this revision work load (the second aspect to be explored).

Optimal WPC Size

The summary chart (Figure 30) does not indicate any economies of scale in going to successively larger and larger work load and typist aggregations. It shows a fairly constant rate of manpower requirements per work load level (currently averaging around 8.3 documents per day per clerk). This means that the economies of scale probably occur outside (most likely lower) the work load ranges input into the computer runs made. Hopefully, since the work load levels used as inputs to the model include current WPC demand levels, the economies of scale manifest themselves at lower levels and, therefore, current WPCs are taking advantage of those economies.

An additional simple input, server, and output model was designed and run to simulate small scale word processing operations (level five--the individual typist). (The network chart, program, and backup data are provided in Appendix E.) The first run of this model was made with artificially high demand levels to help pinpoint any significant changes in work load performance patterns. The results of this run are summarized in chart form (Figure 31). The data showed a reduction in average backlog levels and an improvement in server utilization as the number of servers

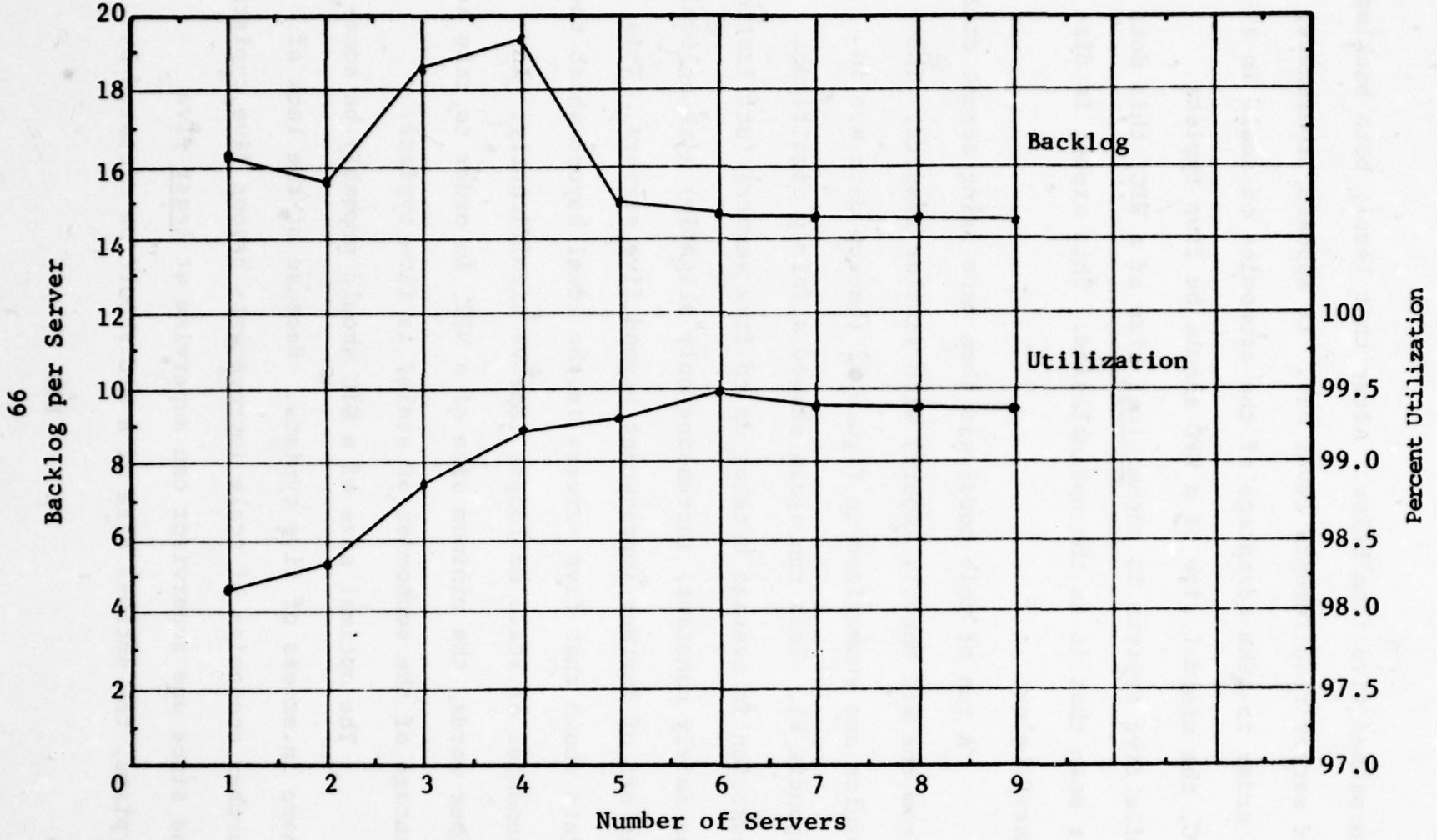


Figure 31

Aggregate Server Model--First Run

approached five from below. After that level, both backlog and server requirements level off. It appears, therefore, in order to take advantage of the economies of scale in a WPC, the minimal size of a WPC should be five typists. While five typists is the minimal size of a WPC, this does not mean that it is the optimal size. This aspect is discussed below.

A run of this model was then made using actual data (from the WPC Monthly Report) with similar results. The results are summarized in Figure 32 (backup data are in Appendix E). This run again showed a fairly significant reduction in average backlog up to five servers (utilization was fairly constant, increasing only slightly) with a leveling off of further improvement beyond five servers. This again shows that five servers is the level beyond which the economies of scale no longer improve significantly. In other words, the minimum size of a WPC, in order to take advantage of the economies of scale, is five typists.

The optimal size of a WPC should probably be somewhere in excess of five typists. Because of the lack of further economies of scale improvements beyond five typists and since one supervisor can supervise at least five typists, the optimal size of a WPC should be dictated by

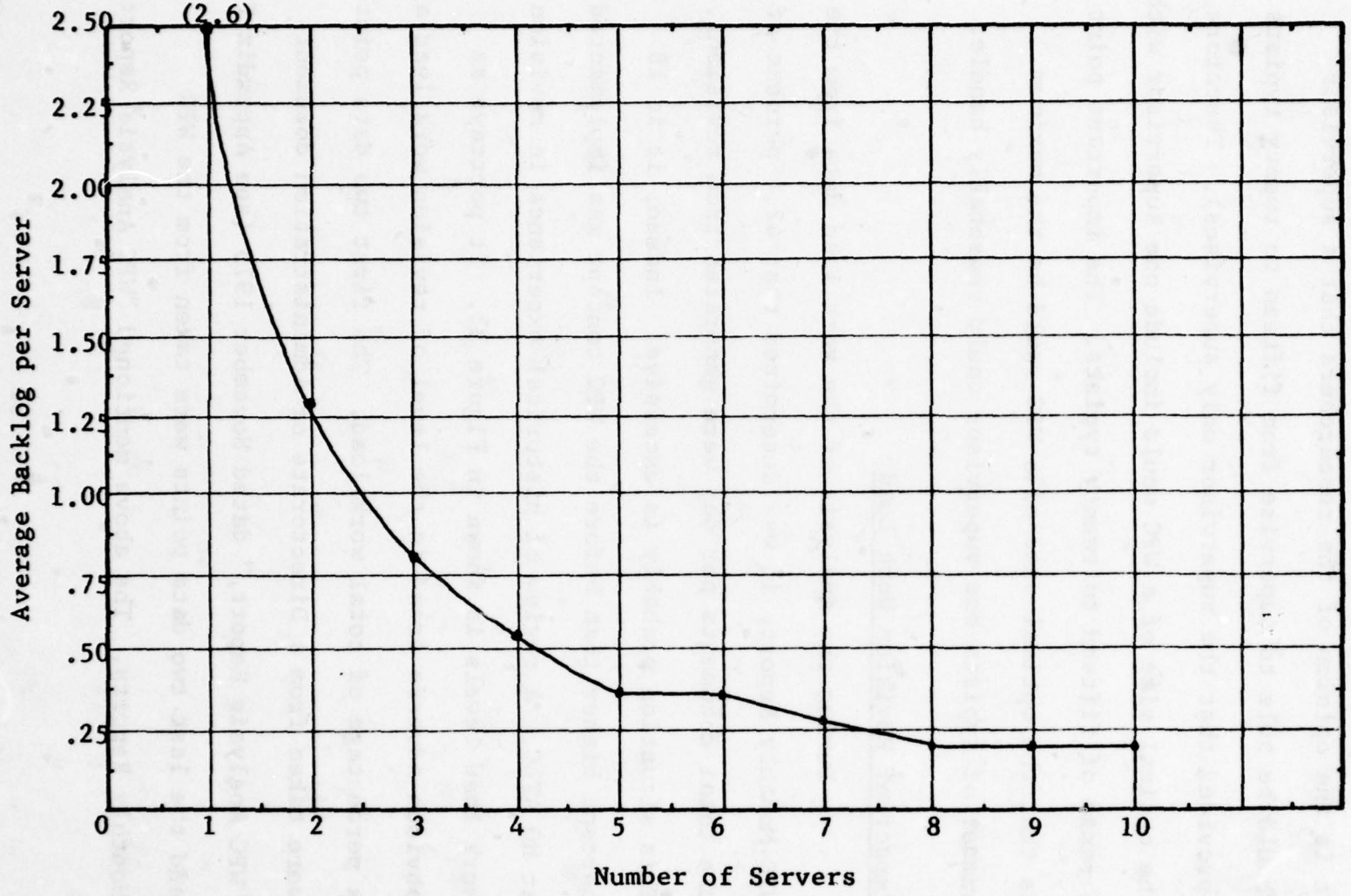


Figure 32

Aggregate Server Model--Actual Data Run

the maximum number of typists a supervisor can supervise. It is the opinion of the researchers that a supervisor should be able to supervise from fifteen to twenty typists (provided that the supervisor only supervises). Therefore, the optimal size of a WPC would include one supervisor with a range of fifteen to twenty typists. The important point is that the optimal size of a WPC would be the maximum number of typists one supervisor could reasonably handle.

Impact of Revision Work Load

During the analysis of the work load data from the WPC Monthly Report, it was determined that 42.4 percent of the total documents per day were generated from revisions. This situation probably is excessive. Indeed, it is 18 percent higher than before the WPC concept was implemented at HQ AFLC. A review of historical experience in revision work load levels is shown in Figure 33. It portrays an obvious adverse trend in the level of revision work load as a percentage of total work load. The first two data points were taken from a Directorate of Administration document "WPC Analysis Report," dated November 1975 (see Appendix F) and the last two data points were taken from the WPC Monthly Reports. The above mentioned "WPC Analysis Report"

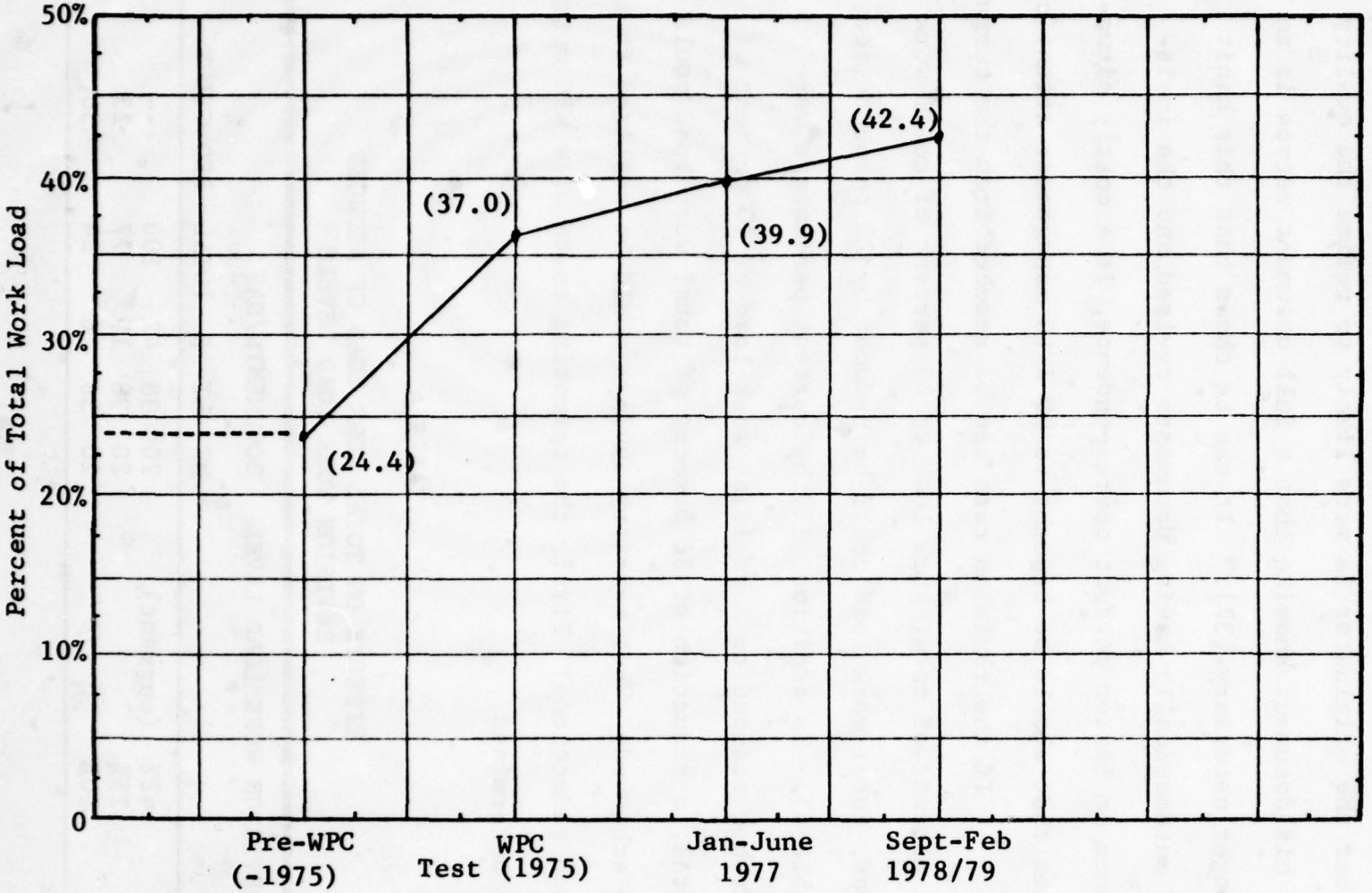


Figure 33

Revision Work Load Levels

attributed the increase to the new dictation system and "that the originator is more likely to refine the quality of his document knowing that a full document retype is no longer necessary [37]." It can be shown that thi habit of automatically having documents revised, and the insistence on letter perfect correspondence, is a costly situation that should be brought to HQ AFLC management attention.

If the revision rate can be reduced from the current 42 percent of total work load to 25 percent of total work load, total work load could be reduced by 23 percent (see Table 4). In addition, if the current percentage were further reduced to a revision work load of 10 percent of total, a reduction of 36 percent of total work load could be achieved. What monetary savings could be realized from such reductions? First, the operating costs of a WPC must be determined.

TABLE 4

EFFECTS ON TOTAL WORK LOAD OF REDUCED REVISION WORK LOAD LEVELS

REVISION WORK LOAD LEVEL	DOCUMENTS/DAY				
	MT	LT	R	TOTAL	% REDUCTION
42% (current)	20	38	42	100	---
25%	20	38	19	77	23
10%	20	38	6	64	36

The basic costs of a WPC come from three sources: personnel costs, equipment costs, and supply costs. There are other costs involved (utilities, floor space, administration, etc.), but these are more difficult to identify and were not addressed in this thesis. Table 5 summarizes the costs of the WPCs at HQ AFLC. The personnel costs were provided by the Directorate of Manpower and the equipment and supply costs by the Directorate of Administration. Backup data are provided in Appendix G. The total cost comes to over two million dollars per year. Total documents produced per year are approximately 200,000 (WPC average of 51 documents per day x 21 days per month x 12 months per year x 16 WPCs).

TABLE 5

WPC OPERATING COSTS

			TOTAL
A.	Personnel (Assigned)		
	Payroll cost	Total	
	plus 28% for	$1,242,067	
	Retirement and	347,779	
	Insurance	$1,589,846	$1,589,846
B.	Equipment Lease		
	Average of $351 per machine per month x 114 machines x 12 months		480,008
C.	Supplies		
	Average of $275 per month per WPC x 16 WPCs x 12 months		52,800
		TOTAL	$2,122,654 per year

Should the revision work load be reduced to 25 percent of total work load, substantial savings could be realized. A summary of these savings is provided in Table 6. If accomplished, this would reduce the total number of documents produced by 23 percent and, therefore, a savings of 23 percent of the supplies required by a WPC. Simulation runs of the word processing center model were conducted with a 25 percent revision rate. The results (see Appendix D) of these runs indicate that, with the reduced revision rate, an average WPC could realize a savings of one typist. In addition, for each typist savings, one machine would not be required. The total savings realized by going to a revision

TABLE 6

POTENTIAL WPC OPERATING COST SAVINGS AT A 25 PERCENT REVISION WORK LOAD LEVEL

		Yearly Cost
A. Personnel 1 person per WPC x 16 WPCs x $13,816 per person	=	$221,050
B. Equipment Lease 16 machines x $351 per machine per month x 12 months per year	=	67,392
C. Supplies 23% of $275 per WPC per month x 12 months per year x 16 WPC	=	12,144
TOTAL		$300,586

work load level of 25 percent of total work load would be an estimated $300,000 per year. The total number of documents produced per year would fall to 150,000.

In addition, further savings could be realized by going to a 10 percent revision work load level (Table 7). Total savings by doing so would be approximately $480,000 per year. The total number of documents produced would fall to 130,000 per year.

TABLE 7

POTENTIAL WPC OPERATING COST SAVINGS AT A 10 PERCENT REVISION WORK LOAD LEVEL

A. Personnel 1.6 persons per WPC x 16 WPCs x $13,816 per person	=	$353,670
B. Equipment 24 machines x 351 per machine per month x 12 months per year	=	109,512
C. Supplies 36% of $275 per WPC per month x 12 months per year x 16 WPCs	=	19,008
	TOTAL	$482,190

As can be seen, substantial savings can be realized by reducing the level of revision work load. The recommendation would be to at least reduce revision work load to the pre-WPC level of around 25 percent of total work load.

This could be done by not relying as much on letter perfect documents and conducting more coordination of documents in draft form (prior to signature). This policy is needed during the current period of constrained buying power and resource allocations that AFLC is experiencing.

Performance Measurement System

The purpose of any performance measurement system is to provide a means of indicating how well a system is doing in accomplishing some mission relative to established parameters. The information provided by a performance measurement system serves as feedback to the system and results in self-regulation, or internal autonomous control. Performance indicators can be either subjective (e.g., "good," "bad," "fair") or objective (e.g., 50 percent effective). Generally, most organizations strive to develop and implement objective, numerical performance indicators.

As discussed in Chapter III, Beer advocates a performance measurement system that is somewhat unusual. Beer defines performance as a ratio of actual production over potential ability. The unusual feature about this performance measurement system is that it unmasks potentiality, which often is ignored or shortchanged by management. All too often, managers artifically constrain their operations

by measuring productivity (actuality versus capability) rather than consider their potentiality. Thus, they delude themselves into believing that their operations are performing well and under control, when, in reality, their operations are in trouble.

The objective is to develop a performance measurement system that is meaningful to the word processing system manager and to other personnel involved in word processing. In addition to being meaningful, the performance measures should easily be computed, understood, and used by personnel at all levels in the organization (2:137-154).

Considerations

The output of the word processing system is very straightforward; it is lines of typed material per time period, or equivalent measures (words per minute, documents per day, etc.). However, the inputs to the word processing system are not so homogeneous. For example, inputs can take the form of dictation, longhand, shorthand (infrequently) and revisions. Further, work load differs according to its degree of complexity or difficulty for the typist to type. Ordinary correspondence would be considered the easiest to process while tabulated reports might be the most difficult.

The "perfect" performance measurement system would directly match inputs to outputs to produce one or more quantitative measures that meaningfully express the effectiveness and efficiency of an organization or individual human (2:151). In many socio-economic organizations, such measures are not possible. For example, many government organizations do not make a profit (which is a good output indicator) and the outputs that result are not readily quantifiable. But, in the case of the word processing system, the outputs are easily quantifiable, and so are the inputs.

Another characteristic of a "perfect" performance measurement system is that the measures should be easily computed. In the case of the word processing system, the measures should be computed or derived by the word processing center supervisor.

O'Neill and Walker advocated a measurement system that would use a "difficulty factor" to be applied to various types of work load (inputs). For example, an ordinary letter would have a factor of 1.00 while a regulation would be 3.75. Each line of a regulation typed would count the same as 3.75 lines in a letter (23:12). It is the researchers' belief that such a system would be very

difficult and time consuming to administer. There are too many variables involved to determine whether or not a factor of 3.75 is appropriate for a particular regulation (i.e., "What is an 'average' regulation?"). Also, computing the factors would be time consuming for the center supervisor, or whoever else does it, and would not be justified by any benefits of such a system.

A similar problem exists for counting revision work load. Revision work load is a mixture of original typing (that performed by the typist) and repeat typing (that performed by the machine from memory). The machine can do its typing at speeds of 150 to 450 words per minute (depending on type of equipment) while the typist typically performs in the range of 40 to 80 words per minute.

Based on the above considerations, we believe that a single measure of output should be used for the typist; i.e., average lines per day per typist regardless of the type of input. An additional measure of performance should be tracked for the equipment used in the WPC. This would simply be machine utilization. In a man-machine type arrangement like the WPCs, it is necessary to track the efficiency of both elements. One element will not, therefore, be optimized at the expense of the other.

Further, measures should be computed and averaged over a fairly long period of time; e.g., one month. Finally, each typist should be given a fairly even distribution of inputs; dictation, longhand, original typing and revision typing. Over a month's time, the variations in type of input should even out.

Performance Measures

As previously stated, a performance measurement system should reflect both effectiveness and efficiency. Separate measures should express each. We believe that the following measures are most significant for the word processing system:

Effectiveness:	(1) Average backlog time (2) Average quality of finished product
Efficiency:	(1) Average lines of type per typist per day (input) (2) Average machine utilization (output)

Effectiveness of Operation

Average backlog time. An adequate backlog in typing is desirable for the word processing center to ensure steady work, while too much backlog is undesirable to management. There is no consensus of opinion in current literature as

to what is an adequate backlog rate. We propose that an adequate rate is four hours, plus or minus four hours (9). That is,

Backlog = μ (mean) of 4 and σ (one standard deviation) of 2

so that 95 percent of the time an individual center would have between zero and eight hours of backlog. Two and one-half percent of the time there would be no backlog and two and one-half percent of the time there would be more than eight hours backlog.

Average quality rate. Ideally, quality in an organization should be 100 percent. Realistically, this level is seldom attainable. In fact, insistence on too high a quality level can be detrimental to the organization since higher quality levels generally are attainable only through higher costs of operation and higher frustration levels. A trade-off must be made between efficiency of operation (quantity) and effectiveness (quality).

"Quality" documents are those that are accepted by the originator as being adequate. Those returned due to typographical error only should be considered non-quality. A ratio of quality documents to total documents should be

computed per time period (e.g., one month). For the purposes of this performance measure, each separate page that must be revised should be considered a document. That way, a ten page report is of 90 percent quality if one page is returned for correction.

Work that is returned to the word processing center for typographical error correction should not be counted toward total output. Such work load should not be considered revision work load (it should be called correction work load). Revision work load is that which is returned to the center for retype because the author or reviewer requests changes to be made in wording, etc. If a document contains both typographical errors and sections to be revised, the lines corrected due to error should not be counted while lines changed due to revision should be counted.

The net effect of the above actions is that as quality increases, so should the output. As quality drops, more time will be spent correcting errors. The objective should be to improve both quality and quantity of output.

The question is, What is an acceptable level of quality? In the current system, all non-quality documents are reprocessed for correction. Quality ultimately becomes

100 percent for each individual document, when it is finally accepted by the signing official.

An argument could be made that quality need not be measured at all since quality and quantity are directly related. We need only measure quantity (lines per day of accepted type). A good typist could work very fast, make some errors, but since corrections are quick to make, still achieve a high level of output. However, the quality measure could indicate why a certain level of output exists.

If the output (lines per day) of a typist is low and the quality is high, the typist might be spending too much time avoiding errors, to the detriment of total output. If output is high and quality is low, that might be considered acceptable. However, the author's, reviewers' and delivery person's time should be considered when documents are returned for correction due to poor quality. Therefore, quality should be monitored along with quantity.

Efficiency of Operation

Average lines of type per typist per day. As previously stated, there are three levels of achievement of a performance measure to be considered; actuality, capability, and potentiality. As defined by Beer (reference Chapter III of

this thesis), actuality is what we are currently doing, capability is what we could do with existing conditions, and potentiality is what we ought to do with what is known to be feasible. These levels should be developed and tracked to measure the efficiency of WPC operations.

As far as actuality is concerned, it is simply what we are doing now. Current WPC Monthly Report data show a range of 766 to 1559 lines per day per typist (average for a WPC) with an overall average of 914 lines per day per typist.

Given a typing rate of 40 words per minute, 8 words per line, and 6.7 production hours per day, a typist should be able to produce 2000 lines per day. This level would be for an experienced typist with work load continuously available.

The level of potentiality is, at best, an educated guess, and as will be discussed shortly, a best estimate is all that is necessary. Given the current state of equipment technology (constant improvements in equipment are made continually), it is believed that the potential level of input will be constrained only by the rate at which a secretary can keystroke documentation. Potentiality is therefore set at the maximum level an above average, competent typist

could be expected to type, around 60 words per minute. This translates into a potentiality level of approximately 3000 lines per day per typist.

Now that the three levels of achievement have been established, the three performance indices; productivity, latency, and performance, can be explored using the actual WPC data. The values of the indices are given in Table 8 showing the range and average of the data collected. In review, productivity is actuality divided by capability; latency is capability divided by potentiality; and performance is actuality divided by potentiality.

TABLE 8

WPC PERFORMANCE MEASUREMENT EXAMPLE

	WPC Data		
	Low	Average	High
ACTUALITY	766	914	1559
CAPABILITY	2000	2000	2000
POTENTIALITY	3000	3000	3000
PRODUCTIVITY	.38	.46	.78
LATENCY	.67	.67	.67
PERFORMANCE	.25	.31	.52

These indices should be tracked over time to evaluate trends in performance of the system. They should be

used in the System Two (Cybernetic Paradigm) monitoring and feedback of performance. The numbers themselves are not significant. What is significant are any trends over time in the performance of the system. Specific expected performance parameters should be set up, and when breached, an exploration of the cause should be conducted. Otherwise, business as usual. The only maintenance of the performance measurement system (other than assuring credible actuality data) is to ensure the indices are all under a value of 1.00. If they are not, a reassessment of the levels of achievement needs to be conducted.

Average machine utilization. Word processing equipment (automatic typewriters) is extremely costly compared to a standard electric typewriter. Some of the stand-alone automatic typewriters are capable of output in excess of 400-500 words per minute. However, these same automatic typewriters are being used primarily as input devices (keystroking) which are constrained by the typists' abilities. Instead of the 400-500 words per minute of which they are capable, the automatic typewriters are being used to produce at the rate of from 20-40 words per minute. The capabilities of the automatic typewriter are being wasted.

Based on an average of 450 words per minute for a daisy-wheel printer, 8 words per line and 10 hours production time per day (the headquarters is on "flexitime" and business hours typically run from 7:30 a.m. to 5:30 p.m.), the printer is capable of 33,750 lines of output per day. Needless to say, actuality is nowhere near this. The average actuality (914 lines per day) results in a productivity rate of only .027.

While the above measure may seem absurd, it is important that management realize how underutilized the automatic typewriters are. Part of the problem is due to policy--the type of work load generated through the automatic typewriters. Far too much routine correspondence is processed on the automatic typewriters and not enough work load more amenable to revision (e.g., regulations, lengthy reports, etc.). But, most of the problem is due to machine constraints. The same printer that is capable of 400-500 words of output must also be used by the typist for keystroking. The solution to this problem will be addressed in Chapter VI of this thesis.

A final note is that there is theoretically no upper limit on the potential output of a printer. Manufacturers surely will continue to develop even faster

output devices. Therefore, potentiality is an impossible figure to establish and "performance" of the output machine should be ignored in favor of "productivity."

CHAPTER VI

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The objectives of this thesis were fourfold:

1. Perform a systems analysis of word processing at HQ AFLC and conduct an exhaustive research into the word processing phenomenon.

2. Apply Stafford Beer's Cybernetic Paradigm to the current word processing organization to identify organizational deficiencies.

3. Develop and test a simulation model to answer such questions as:

   a. What is the optimal size for a word processing center?

   b. What is the impact of varying the work load inputs?

   c. What policy and procedural changes are necessary to enhance the performance of the word processing system?

4. Develop a proposed performance measurement system.

Each of the above has been addressed in this thesis.

Our systems analysis included more conceptual analysis than has been included in this thesis. There has been considerable written on word processing and, until fairly recently, most literature has been very supportive. As with many technological advances, office managers have been unwilling to speak against word processing since they were afraid of criticism that they were "old-fashioned," and against progress. What has been lacking is an objective, cost-benefit analysis of word processing and establishment of parameters for economical implementation.

Recently, some analysts have been conducting such analyses and cynicism is growing on word processing. Much of the criticism comes from within the Federal Government, since the government has been a lucrative market for word processing equipment and systems, and has bought much.

The general conclusion is that word processing has been oversold by the manufacturers and overbought by the users. While automatic typewriters have merit and will be used increasingly in the future, not all typing requirements demand automatic typewriters. HQ AFLC has acquired an

expensive word processing system which appears not to be returning benefits equal to or greater than the investment. The output of automatic typewriters at HQ AFLC is no greater than the output obtainable from much less sophisticated electric typewriters.

The application of Beer's Cybernetic Paradigm indicated some glaring organizational deficiencies in the current word processing system. The mapping of the current word processing system onto the Paradigm indicated that Systems Two and Three are greatly deficient in the current organization. That is, there is no coordination between the independent word processing centers nor is there an overall word processing system manager. The Cybernetic Paradigm demonstrates the need for both.

As things are today, the lack of a word processing system manager (System Three in the Paradigm) and a coordinating system (System Two) means that if one word processing center goes out of control (overwork or underwork), there is nothing that can be done to help the ailing center. The establishment of a word processing system manager responsible for the operations of all the centers and a work load coordinating and switching system would remedy the

problem. As backlog (and underwork) reach a certain point, work load would be switched from center to center to even out production.

A simulation model of a word processing center (System One) was developed, using Q-GERT networks developed by Pritsker. The Q-GERT simulation language models classical queueing systems, of which the word processing system is one. Q-GERT thus lends itself very well to word processing, which is characterized by queueing processes.

The simulation model demonstrated two basic results: (1) the optimal minimum size for a word processing center is five servers, or typists, and (2) the cost impact of reducing revision work load is significant. If revision work load can be reduced from the current 42 percent of the total to 25 percent (the pre-word processing level), at least $300,000 can be saved annually. While the minimal size of a word processing center is five servers, no appreciable benefits could be substantiated for more than five servers, assuming no periodic fluctuations in work load. However, fluctuations do occur, and while their impact was not measured, an argument can be made for establishing one super-WPC for all the headquarters, or implementing a work load coordination system that would achieve the same

results. The latter is the preferred course of action. It is the researchers' belief that each separate word processing center should consist of the maximum number of typists that one supervisor can handle feasibly. This number could be as high as fifteen to twenty. In any event, organizational identity should be maintained, to the extent practical, whereby each word processing center is identified to a particular headquarters AFLC staff organization.

On the other hand, the separate word processing centers should not function completely independently from each other. When one goes out of control, the others should be able to come to the rescue.

The final research objective, establishment of a performance measurement system, was achieved using Beer's criteria. The key point is that indices are established that relate actual production to available capability and to potential ability. The net outcome of our research was to show that productivity in the word processing system is considerably less than the capability that currently exists.

Conclusions

1. "Word processing" borders on being a fraud. The manufacturers of costly automatic typewriters early realized that their product would not be economical as a

stand-alone unit in the traditional office. Most of the savings attributed to word processing are truly attributable to the pooling of typists, work load and equipment, not the equipment itself (21:81). Even so, the establishment of word processing in HQ AFLC has not resulted in noteworthy gains in productivity. The average lines of type per day per typist on automatic typewriters is no better than that attainable using standard electric typewriters in a pooled environment. However, there is nothing necessarily wrong with the equipment, only with the way that it is being used.

2. Word processing systems can be established using a wide range of equipment, including standard electric typewriters, dictation systems and automatic typewriters. There is no reason why word processing must mean only the most sophisticated (and expensive) equipment.

3. If the amount of revision work load can be reduced from 42 percent (at present) of the total work load to 25 percent, at least $300,000 could be saved per year. If the revision rate could be reduced to 10 percent, the savings would be at least $480,000. If leases were terminated on 75 percent of existing automatic typewriters, and standard electric typewriters substituted, a cost avoidance of at least $360,000 per year could be realized. If AFLC

management persists in its obsession with letter-perfect documents, at least be aware of the costs of attaining that end.

4. The minimal size for an autonomous word processing center is five typists. Below that number, work load fluctuations become too great and backlog/underwork conditions result. The optimal size of a word processing center should be the number of typists that one supervisor can manage.

5. Dictation as a form of input may be no better than longhand (35:2-3). Consideration should be given to the type of input (document type) and the author's and typist's preferences, before dictation is mandated over longhand.

Recommendations

1. Recognize that dictation systems and automatic typewriters do not necessarily go hand-in-hand in every word processing system. While the two are typically thought of as mutually inclusive and minimal elements of a word processing system, neither is essential and one can exist without the other. In its simplest form, a word processing system can be merely one or more typist using standard typewriters to produce typed documents.

2. De-emphasize the necessity to use dictation as the preferred method of input to the word processing system. A study by the HQ AFLC Manpower Directorate showed that dictation is no better than longhand drafts.

3. Do not use automatic typewriters for ordinary correspondence. This is a tremendous waste of equipment and financial resources. A corollary is that letter-perfect documents should not be insisted on and existing HQ AFLC policy expresses this (27). Management's obsession with letter-perfect documents is costly and results in greater frustration on behalf of authors and typists.

4. Probably 75 percent of the existing leases of automatic typewriters should be terminated, if standard correcting typewriters are used instead of automatics. This will result in a cost avoidance of at least $360,000 annually.

5. The word processing system should be reorganized so that all word processing centers are under the control of a single manager.

6. The number of typists in the word processing centers should be increased to the number that one supervisor can handle (probably fifteen to twenty typists). Existing centers should be consolidated to achieve this end.

A single super-WPC should not be established. To the extent possible, the same typist should consistently serve the same authors since the language and terminology used in headquarters AFLC are technical and vary from organization to organization.

7. A communication and work load transfer system needs to be implemented. The purpose of such a system would be to alert the word processing system manager when a center goes out of control (when backlog approaches zero hours or eight hours) and to switch work load from one center to another when such action is necessary.

8. Although not addressed in this research, the human behavioral aspects of word processing need to be examined in subsequent research. Job enrichment has been implemented throughout the headquarters and the benefits of that action need to be assessed. Also, the subject of grade levels for the typists and career ladders needs to be addressed.

9. Consideration should be given to consolidation of the current Directorate of Administration (AFLC/DA) and the data automation directorates (AFLC/ACD and AFLC/ACO) under a common organization, the "DCS/Administration and Information Processing." The current organizations share

the same mission (administrative and information support to the headquarters) and, increasingly, the same equipment, technologies and skills.

The Ideal Word Processing System

Based on our research, we can propose an ideal word processing system for headquarters AFLC. Since most of the existing automatic typewriters are under lease, conversion could be made fairly easily.

As discussed previously, separate word processing centers should be retained to maintain minimal distribution time between author and typists and to promote organizational identity. But, the number of typists per center should be increased to the optimal size that can be handled by one supervisor.

The biggest change would be in equipment. Possibly up to 75 percent or more of the automatic typewriters could be exchanged for far less costly self-correcting electric typewriters. Headquarter's policy should be emphasized that minor corrections to ordinary correspondence, reports and memos will be made by pen and ink or white-out and strike-over by the typists.

Automatic typewriters would be used for those documents absolutely requiring the memory storage capability of the automatic. The author and word processing center supervisor jointly would make this determination. A shared-logic, centralized word processing system should ultimately be acquired with cathode ray tube (CRT) input devices and high speed output printers. A minimal number of printers should be acquired, probably no more than one per center. Machine utilization on the printer should approach the maximal capability (400 to 500 words per minute).

At some point in the future, the performance of the word processing centers will be enhanced by optical character readers (OCRs) that can read standard type (at present, a special font must be used) (21:82). When such OCRs are available, major revisions can be made on documents originated on the standard electric typewriters. Until that time, some complete retypes of documents may be necessary, but that occurrence should be held to the absolute minimum.

APPENDICES

APPENDIX A

A DISCUSSION OF WORD PROCESSING

History of Word Processing

A long standing and pressing problem of all social organizations has been to process written information and communications better and faster. Some notable technological advances made in the more distant past include the creation of paper by the Chinese and Johann Gutenberg's development of the printing press with moveable type. But until the late nineteenth century, the primary means of written communication available to most organizations was the quill pen. In the early days of the industrialization of the United States, penmanship was a very important concern of our educational system and the business world (22:6).

In 1873, the first commercial typewriter was invented, the Remington Number 1. This first mechanical means of fairly rapid preparation of written communication was slow to be accepted. For many years, businessmen and customers alike resented typewritten correspondence (versus longhand) as being impersonal and insulting (22:6). But, the simple economics of typewritten communications eventually won out. By the year 1900, the acceptance of

the typewriter had resulted in a revolution in the office (22:6).

In the 1930s, the first automatic typewriter was introduced. The early automatic typewriters worked along the lines of a "player piano," with punched paper on rolls. This mechanical automatic typewriter was used quite successfully to produce form letters by companies that had requirements for large quantities of similar or identical paperwork. The "player piano" type automatic typewriter was improved in the 1950s with the development of more compact paper tape and electromechanical processors (10:S13-040-101).

The next major breakthrough in typewritten communications occurred when International Business Machines (IBM) introduced the Selectric typewriter in the early 1960s. The Selectric originally was designed as a computer output terminal, and it featured the now famous "golf ball" type element. The primary virtue of the Selectric is that it is capable of up to 180 words per minute, which is considerably faster than even the fastest typist, and machine errors are much less than conventional lever-linkage typewriters (22:11-12). In addition, the typing font could be readily and easily changed.

During the late 1950s and the early 1960s, an electronic revolution was occurring. Solid state transistors and diodes were replacing vacuum tubes and electromechanical relays and switches. Also, magnetic tape, drums and cards were replacing paper tape and paper cards for storage of data (10:S13-040-101).

In 1964, IBM coupled the new electronics with their highly successful Selectric typewriter and produced the Magnetic Tape/Selectric Typewriter (MT/ST). The MT/ST combined magnetic tape storage, a microprocessor, and the Selectric typewriter to produce the first electronic automatic typewriter. The MT/ST retained all the capability of the earlier paper tape automatic typewriter, plus the important addition of edit capabilities. The magnetic tape can be erased and re-recorded and, in general, handled much more easily than the punched paper tape. Although the MT/ST was originally intended for repetitive typing of letters on a mass scale, the text editing capability lent it to more mundane office work of ordinary correspondence. Also, the data storage capability was well appreciated by offices that produce standardized and rather lengthy documents such as legal papers (22:12-13).

The demand for the MT/ST far exceeded IBM's expectations, and the company recognized that it had started a major revolution in the communications world. The term word processing (Textverarbeitung) was coined in 1965 by IBM's German sales office, and it has been accepted worldwide as a useful term to describe the overall typing communication system that IBM created (22:13).

In a much broader sense, it can be argued that the concept of "word processing" did not begin with, nor is it entirely dependent on, the automatic typewriter and the central dictation system, which are characteristic of most current word processing systems. Word processing systems could be established with any typewriter, and dictation equipment is not essential. In fact, word processing systems have been around since the invention of the typewriter. They simply were known as typing pools (8:5).

The development of expensive automatic typewriters resulted in the need for a more cost effective approach to producing typewritten documents than the traditional office arrangement where the secretary was a "girl Friday" and did a little of everything, including typing. The manufacturers of automatic typewriters realized that their equipment would not be cost effective in the traditional office; pooling of

work loads, equipment, and typists would be necessary to realize any economies from using automatic typewriters (21:81). So, word processing, in its current manifestation, arose as a systematic and "innovative" approach to incorporate the new automatic typewriters and dictation equipment into the office place.

Advantages of Word Processing

Word processing today is a billion dollar industry, There are over fifty major manufacturers of word processing equipment and more than one hundred different word processors (hardware) on the commercial market (10:S13-040-102). The phenomenal success of word processing in such a short time is due to one reason: economy. Recent studies have shown that it costs at least $3.25 to $5.25 and more to produce one page of typewritten paper in a non-word processing office. A recent survey by Stanford Research Institute showed that office costs (administrative overhead) represent forty to fifty percent of a company's total cost of doing business (22:7). Word processing promises to reduce some of that cost burden.

Some specific claims of word processing are:

1. Increased typing efficiency of up to 500 per cent (18:1).

2. Improved administrative support to executives and other word originators, through quicker turnaround of error-free paperwork.

3. Higher quality output due to more advanced output equipment.

4. Higher utilization of installed office equipment.

5. Much higher human resource utilization.

6. Greater career opportunities for secretarial and clerical personnel (10:S13-040-108).

Due to numerous variables in office administration, it is often difficult to quantify exactly the benefits of conversion to word processing. One rule of thumb is that conversion to word processing should result in personnel savings of at least one-third (10:S13-040-109). Numerous case studies of private industry have indicated even more substantial savings. For example, the Illinois National Bank of Springfield established a word processing center staffed by five correspondence secretaries that do the work formerly handled by twenty-two typists (22:82-83).

Disadvantages of Word Processing

Until fairly recently, it has been hard to find much mention in current literature of any disadvantages of word processing. The economic and technological advantages are highly touted and perhaps well substantiated by facts and figures whose validity go unquestioned. But, negative aspects to word processing have been experienced. Many of the negative experiences with word processing appear to be related to personnel problems. In general, personnel problemts usually are symptomatic of more fundamental organization and management problems.

In their book, Word Processing: A Systems Approach McCabe and Popham went to great lengths to insist that word processing will benefit greatly the secretary (22). They point out that approximately three-fourths of a secretary's time is spent doing lower skilled tasks such as reception, telephone answering, clerical posting, running errands, filing and the like. They note, "when ambitious secretaries with special abilities are assigned work tasks below their capability, the result is secretarial boredom [22:41]." They further contend that the private secretary's function is one of low productivity, high salary cost, and low levels of motivation and morale due to uneven work

distribution and inadequate use of skills. Apparently, word processing is intended to free the secretary from the drudgery of "non-professional" office tasks and allow concentration on the more technical work of taking dictation and producing final typed documents.

However, McCabe and Pophal do admit that the actual implementation of word processing is less than optimal for the individual, at times. They cite C. Wright Mills, a noted sociologist, who points out that in the early stages of new technology, jobs are challenging to the worker and result in new skills. But as the technology advances, functions and work units are further subdivided, skills become increasingly narrow, and the individual becomes an automaton (22:69-70). This very phenomenon already has happened for key punch operators in data processing. McCabe and Popham note:

> Although still in its infancy, the evolving field of word processing seems to be following data processing down the same archaic path, applying organizational concepts of a bygone era to today's office environment. It is evident that word processing's popularity with top management is based on cost savings and increased productivity. . . . Some companies are applying outmoded work procedures to the new technologies, so that word processing centers are simply regarded as the same old typing pools equipped with expensive

> new machinery. Correspondence secretaries are seen as doing the drudge work of the secretary's job, the implication being that not much intelligence is needed to type [22:70].

McCabe and Popham further point out that "problems typical of industrial mass production are also becoming typical of word processing centers - absenteeism, job dissatisfaction, and high turnover of personnel [22:70]."

McCabe and Popham apparently believe that if word processing is implemented properly, the typist will not want to function in a non-word processing environment. The word processor is presented as more professional than the old-fashioned secretary, or "girl Friday." Under the right environment, the professional and highly skilled word processor will self-actualize and be much more productive than the anachronistic secretary.

> Now while still in its infancy, the word processing field represents a challenge to business administrators and managers to prove that the sophisticated technology of word processing equipment can be matched by an equally sophisticated technology of democratic policies and work procedures governing its use. The right combination cannot help but result in satisfied employees who enjoy their work, and whose productivity will produce an efficient, profitable operation. Many professionals in the word processing field are aware of the challenge and are attempting to emphasize the notion that people are the heart of any word processing operation [22:74].

Apparently, if word processing does not work right, it is the fault of the manager for not implementing more modern work procedures. But, the word processing manager is in the same boat as countless other managers of essentially monotonous, repetitive jobs, and many of them have not been overly successful, either. The problems experienced in the word processing center apparently are the same ones that were experienced in the old typing pool.

In a more economic vein, some analysts of the word processing phenomenon have cited rather serious shortcomings in the conversion of conventional office environments to word processing. In particular, Mr. Forest Williams, Assistant Archivist of the National Archives and Records Service (General Services Administration), along with analysts working in his office, and Mr. David Larkin, Chief of the Procurement Policy Division of the Department of Commerce, have initiated cost-benefit studies of word processing within their agencies. Both have gone on record as advising federal agencies to go slow on word processing and carefully assess their needs before acquiring costly automatic typewriters and implementing word processing systems.

Experience of the National Archives and Records Service

The results of a National Archives and Records Service (NARS) comprehensive study have yet to be officially published (they are expected late in the Spring of 1979), but preliminary results were disclosed in an article in Government Executive magazine (30). In short, the NARS has recommended a moratorium within the Federal Government on the acquisition of word processing equipment until thorough cost-benefit analyses have been conducted.

Recent studies conducted by NARS show that no appreciable savings can be attributed to word processing when it is used for one-time typing and that the real benefits of word processing are realized only when repetitive typing is called for. Furthermore, other studies recently performed within the Federal Government (notably by the U.S. General Accounting Office) have shown that promised savings that were cited as justification for implementing word processing simply have not been realized (14).

In the Government Executive article, Mr. Jack D. Kravitz of NARS noted that:

> ". . . word processing really adds only two things to the typewriter--a memory and the ability to manipulate. The pooling idea has been around

for years and in itself is nothing more than what always happens with specialization [30:24]."

Mr. Glen F. Flannagan of NARS added that:

> . . . 'revision' has too many definitions. "If revision is re-keyboarding [correcting previous errors] then the typewriter is the cost effective instrument. If revision means repetitive typing or playback, the word processing saves you money." What happens is that most federal users of word processing reverse the definitions with costly results [30:24].

A very frequently cited argument for word processing is that the automatic typewriters enable quick revision of documents for reasons of grammar, syntax, logic or message to be conveyed. In a typical federal government office, the originator (author) of a piece of correspondence must run the gauntlet of several layers of reviewers to obtain approval or signature by the required level of the office. Since changes are possible at any level of review, the document must be sent back for retype or correction after each change. If the document is to be ultimately signed by a fairly high ranking individual, there typically is an obsession with letter-perfect products.

Mr. Kravitz addressed the above concerns by noting:

> One of the classic delaying functions in any agency's paper communication is the review process. A letter may have to circulate through any number of people, each of whom feels obliged to make changes,

> before being sent to its intended recipient. Besides being a standard form of risk sharing, this type of delay is a pure management decision. If the communication should move faster, then cut down the number of reviewers involved. Word Processing cannot do a thing for you here.
>
> Another common justification for word processing reduces itself to the idea of error-free product. "Word Processing is an expensive way to reach this. In fact, we have found in study after study that word processing does not increase competence. In many cases, because it is so easy to correct errors, word processing equipment actually degrades the operator's initial error-free skills [30:24]."

NARS officials also noted that the British Government is looking into word processing and is in close contact with NARS. The British Government apparently wants to profit by our own government's experience with word processing and not make the same mistakes we have.

> "You have to admire the Brits in a way," says one NARS official. "Some of their correspondence to us has strikeovers and typos but since the meaning was clear, they sent the letters anyway without bothering to run them back through for cosmetic purposes [30:28]."

The NARS officials recognize that their efforts do not make the word processing industry or the word processing zealots and consultants happy. Even so, at least one word processing industry expert concedes that ". . . the best word processor is a heads-up secretary with an electric typewriter [30:28]."

Experience at the Department of Commerce

Mr. David Larkin, Chief of the Procurement Policy Division of the U.S. Department of Commerce, has studied the word processing phenomenon for over four years and has voiced concern repeatedly that federal agencies were not objective in their justification for word processing systems. In a study prepared by him in 1975, he argued that automatic typewriters within the Department of Commerce were not being employed in a cost effective manner. He noted that cost effectiveness results only when certain conditions are met:

> . . . (a) machines, work load and personnel are clustered into text editing [word processing] centers. (b) The preponderance of material to be typed is suitable for automatics; i.e., reports, studies, manuscripts, multiple address letters, regulations and other material subject to extensive editorial revisions. . . . (d) [sic] the work load is such that a queue of two to four hours of typing exists for each machine and each machine is in actual use 6 or more hours per day [9].

In addition to the above arguments for the establishment of word processing centers, Mr. Larkin specified that one particular type of typing work load should not be accomplished using automatic typewriters:

> Automatic typewriters should not be used to prepare correspondence. This is not a cost effective application in most instances because a correcting Selectric can do an acceptable job for a fraction of the cost of automatic. This

> also applies to most Congressional correspondent of 3 pages or less. The rank or status of either the signer or the recipient of correspondence are not factors which in themselves justify automatic typewriters [9].

Mr. Larkin also addressed the issue of using dictation equipment in a word processing system. He noted that all five of the following conditions must be met if dictation equipment is to be used successfully:

> 1. All authors using the system must make a commitment to learn to compose orally rather than with pen and ink or dictation to a secretary.
> 2. All authors must be successful in learning and applying this new skill.
> 3. All secretaries using the system must make a commitment to learn to transcribe machine-fed oral dictation rather than typing from handwritten manuscript or from shorthand notes.
> 4. All secretaries must be successful in learning and applying this new skill.
> 5. The nature of the written material must be such that it lends itself to composition by dictation such as letters, memoranda, transmittals, notes for the record, etc. and this material must be a significant time consuming activity for the authors and secretaries involved [9].

But, Mr. Larkin noted, most dictating equipment fails to save time and money due to one or more of the following reasons:

1. Authors do not commit themselves fully to learning to compose orally.

2. Not all authors can successfully master the skills of composing orally. They find it awkward to talk to a machine.

3. Most typists prefer to type from handwritten manuscripts. They view machine transcription as the least preferred method, after longhand and their own stenographic notes.

4. Many secretaries fail to master dictation transcription. In longhand, the onus is on the author to employ correct grammar, spelling, punctuation, and paragraphing while in dictation the onus is on the typist. Also, machine dictation necessarily results in more revision typing since there is less feedback from the typist to the author.

5. Few organizations have two or more authors who deal in high volume, short length correspondence, which is ideally suited for dictation (9).

Finally, Mr. Larkin has made the following general assessment of word processing.

> . . . Many users substitute automatic typewriters for standard typewriters without changing workflow, organization or workload. Secretarial personnel prevail upon management not to establish

word processing centers which they look on as dusted-off typing pools.

There is no question that, for the average typist or secretary, working in a cluster is less desirable than working in a traditional boss-secretary setup. The traditional pattern of organizing secretarial and clerical work is tolerable, if not cost effective, when equipment is simple and inexpensive. The versatility of the "Girl Friday" is most important. As equipment becomes more efficient and expensive, it is necessary to redesign the secretarial job to achieve the economies that can be obtained from the equipment. This requires specialization, and specialized typing means clustering the workload, machines and personnel.

Thus there is a trade-off situation. If the traditional boss-secretary organization is valued more highly than optimum cost effectiveness, it is extremely difficult for the organization to achieve cost-effective use of automatic typewriters. If, on the other hand, an organization wants to make effective use of expensive automated office equipment, it must restructure its clerical functions into specialized job functions to assure cost effectiveness. To maintain traditional job structure and introduce automatic typewriters is to drive up the cost of doing business without corresponding gains in productivity [19:100].

Mr. Larkin has also noted that personnel savings that have been attributed to the new word processing equipment probably are more correctly due to the pooling of work loads, typists and equipment (leading to greater utilization) and not the inherent qualities of the equipment itself (21:81).

Summary of the Pros and Cons

It is apparent from the preceding that word processing has its good points and its bad. The key to the controversy seems to be appropriate and effective implementation of word processing in the office environment. Although most organizations will claim savings and improved productivity as a result of word processing, the cost-benefit analyses may have been inadequate. The moral appears to be that word processing can be beneficial and cost effective but only if it is properly applied, in consideration of:

1. Work load processed by the word processing; which types are appropriate for word processing versus those work loads that are inappropriate.

2. Training for both authors and typists on the equipment used by each (i.e., dictation equipment for the authors and dictation/automatic typewriters for the typists).

3. Efficient use of equipment, pooling of work loads, typists and automatic typewriters to ensure optimal utilization.

There is no question that word processing is here to stay. It represents a valid step forward in office administration. The high costs of paperwork have been well substantiated and it is time that managers pay closer attention

to business costs that are the closest to them. As Rosen and Fielder point out:

> It is ironic that many firms devote much effort and money to initiate time and motion studies for manufacturing procedures but neglect their front office where ancient procedures and obsolete equipment exist. These offices continue to retain manual typewriters and use old-fashioned transcription methods. Perhaps administrative management is so close to the problems that it does not see them. Administrators do not realize that efficiency measures used on the production line could, perhaps with some modification, be used in the office. Instead, they take the easy way out when the office becomes bogged down with increased paperwork. They hire additional secretaries, which in turn swells the payroll and solves the problem temporarily. And so the office becomes the "loss department" on the financial statement when the same procedures are followed day after day and week after week [26:24].

Of course, it is just as bad to rush out and buy expensive and unneeded word processing equipment as it is to perpetuate obsolescent office procedures and equipment. What is needed is careful and objective analysis of the office administration. We also need to pay much more attention to the effective design of word processing systems. We need to do more than assume that word processing is merely a modernized typing pool and that the old typing pool organization and work procedures are appropriate to word processing centers (22:70). They did not work well for the typing pool

and they cannot be expected to work for the word processing center. At the same time, we must not assume that the automatic typewriter is the panacea to our administrative ills and that all our electric typewriters should be exchanged for automatics. Finally, we must not overlook the possibility that much or most of savings attributed to word processing are truly attributable to the pooling of work loads, typists and equipment, and not just the equipment itself.

APPENDIX B

WPC MONTHLY REPORT

SUMMARY DATA

SUMMARY — WPC MONTHLY REPORT

PERIOD — SEPT 78 – FEB 79 (6 MONTHS)

DATA ITEM	AC-3	LO-1	LO-2	MA/DA	MI/LO	PP-1	XR-3		COMMAND AVE	% OF TOTAL	DOC/ DAY	LINES/ DOC
WORKLOAD DATA												
A) OUTPUT LINES	128968	128960	92170	118916	57547	77099	127812		104496			
DOC	840	1202	885	1278	829	935	1520		1070	100.0	51	97.7
B) DICTATION LINES	24 N3	7142	3754	12275	3915	27448	9649		12618			
DOC	228	128	76	301	108	416	226		212	19.8	10	59.5
C) REVISIONS LINES	63984	51643	39693	60053	22595	42342	~~+2068~~		46717			
DOC	384	416	336	517	251	486	785		454	42.4	22	91.9
D) LONGHAND LINES	41847	70145	48733	46588	31037	7309	47872		41933			
DOC	227	659	473	460	470	43	503		405	37.8	19	103.5
LINES/DAY/SECRETARY	1155	1374	812	1254	930	975	936		914			
OVERTIME	1.1	18.6	83.6	14.8	0	0	3.8		17.4			
SUPPORTED PERSONNEL	310	200	150	168	124	95	185					

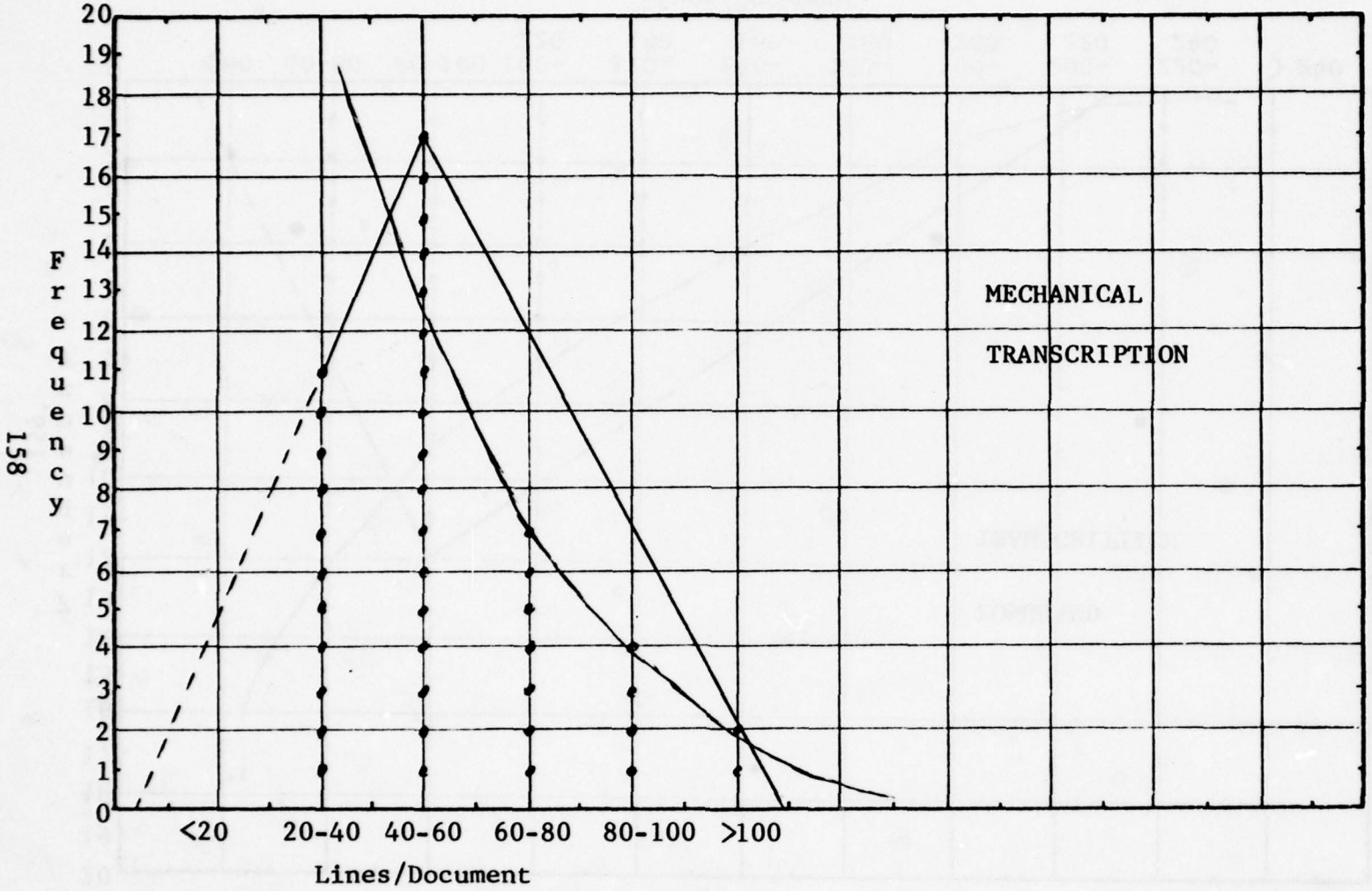
SUMMARY — WPC MONTHLY REPORT 1977

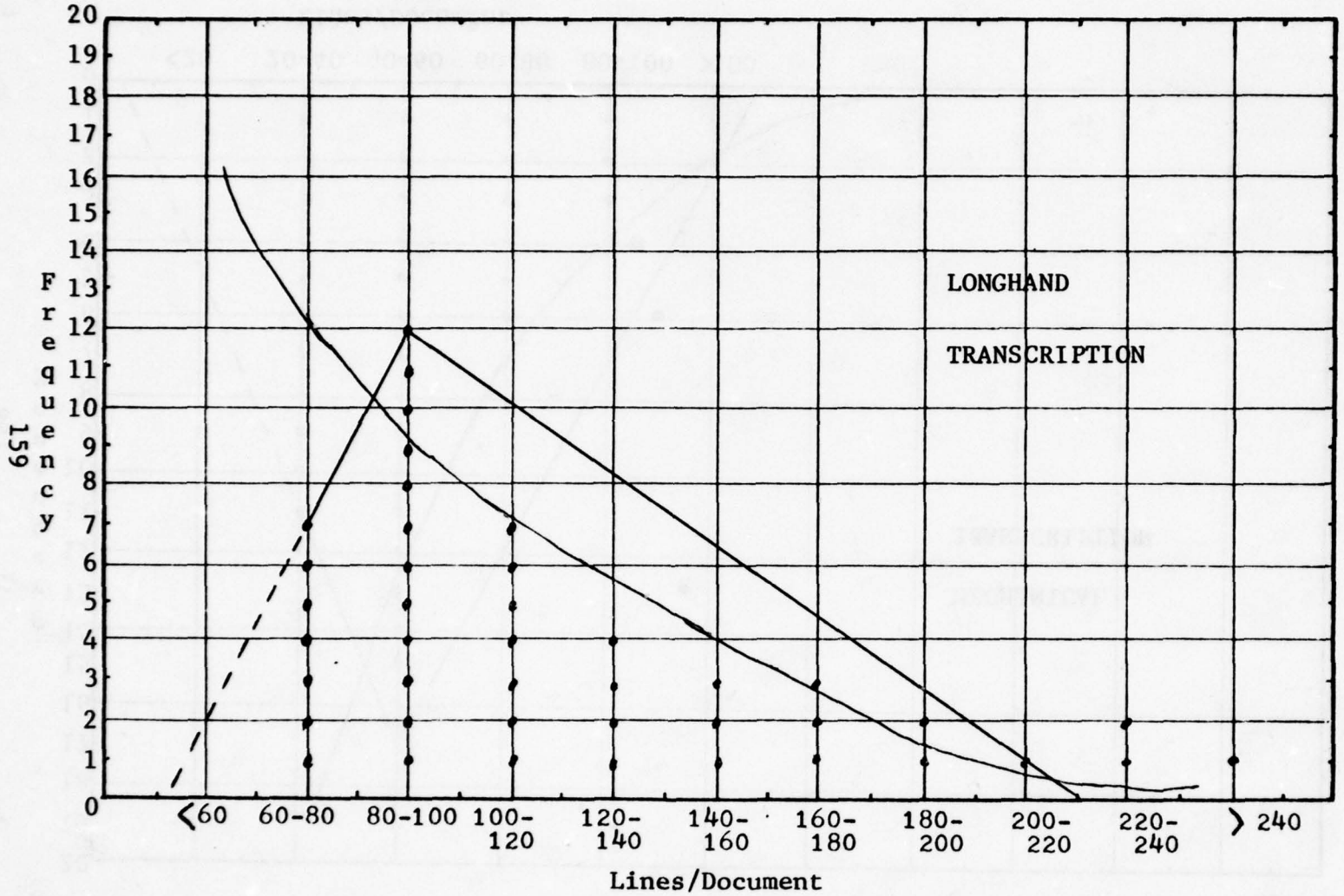
WPC

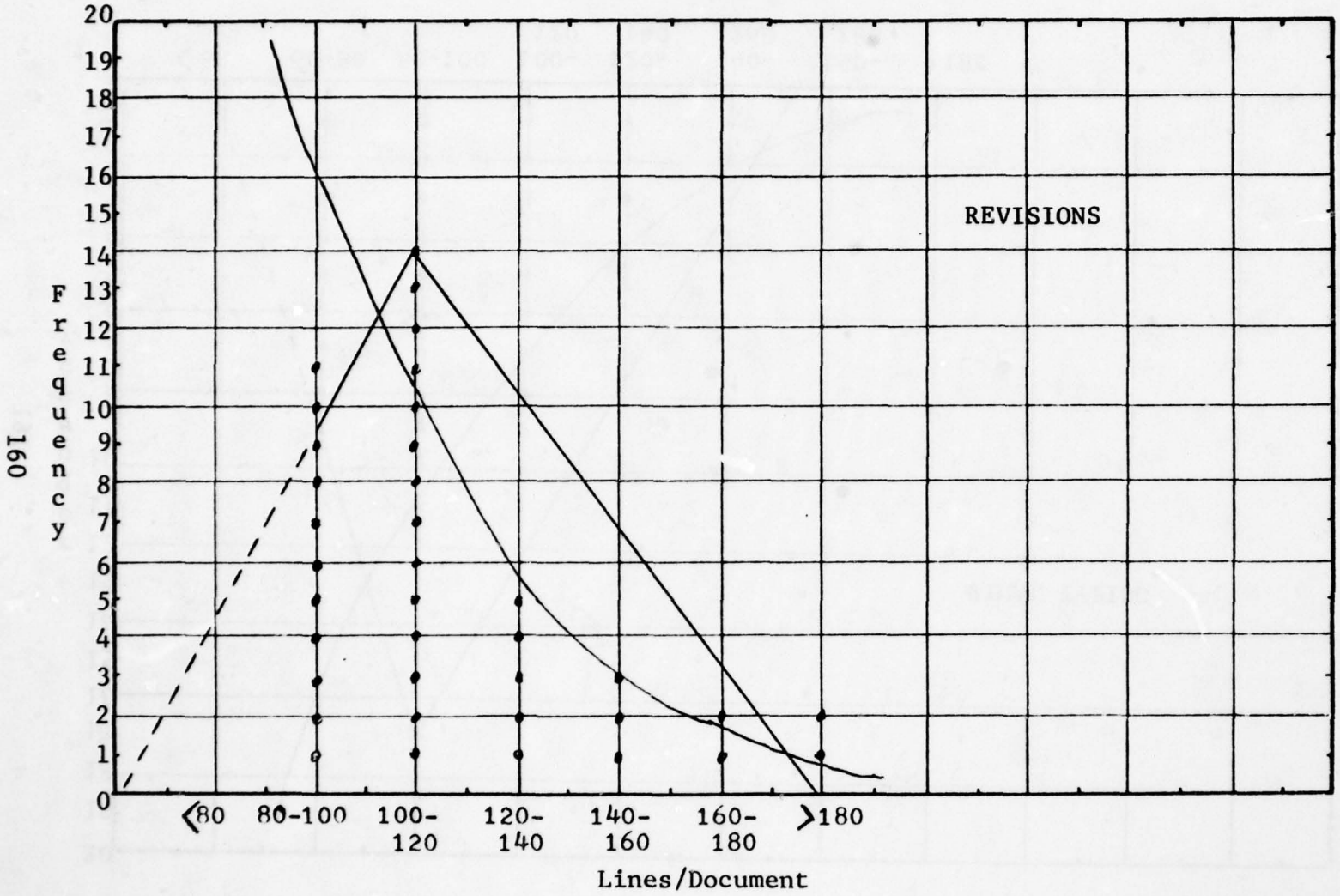
DOWNTIME DATA	JAN	FEB	MAR	APR	MAY	JUN	JUL					
AC-2 % - TYPING	6	3	14	6	5	2	4					
- DICTATION	29	3	5	5	2	3	5					
AVE HRS - TYPING	1.2	2.1	4.4	3.1	2.1	1.5	2.5					
DICTATION	4.2	2.6	5.8	4.5	2.2	3.4	5.1					
MA/DA % - TYPING	.01	3.7	3.0	1	0	1.2	NO					
- DICTATION	0	.04	1.2	0	1	1.0	NO					
AVE HRS - TYPING	1.5	2.4	4.9	9.4	3.1	2.8	NO					
DICTATION	0	3.0	3.8	0	7.3	3.5	NO					
MI/LO % - TYPING	NO	.06	3	.8	2	.6	.1					
- DICTATION	NO	.01	0	0	0	0	0					
AVE HRS - TYPING	NO	2.0	2.9	3.1	2.0	1.5	1.2					
- DICTATION	NO	2.0	0	0	0	0	0					
XR-2 % - TYPING	2.3	3.4	3.5	6.2	7.3	2.3	1.6					
- DICTATION	2.4	2.0	.8	11	.4	.9	0					
AVE HRS - TYPING	2.2	2.4	4.2	6.3	4.1	1.7	1.4					
- DICTATION	6.1	2.8	9.8	3.5	2.1	1.8	0					
								SEPT				
PP-1 % - TYPING	12.5	2.7	10	5	3	9	3	1				
- DICTATION	7.6	.9	1	.7	.01	0	0	1				
AVE HRS - TYPING	1.8	1.5	2.1	2.5	1.3	2.0	1.5	1.2				
- DICTATION	5.0	3.8	5.0	3.2	4.0	0	0	3.0				

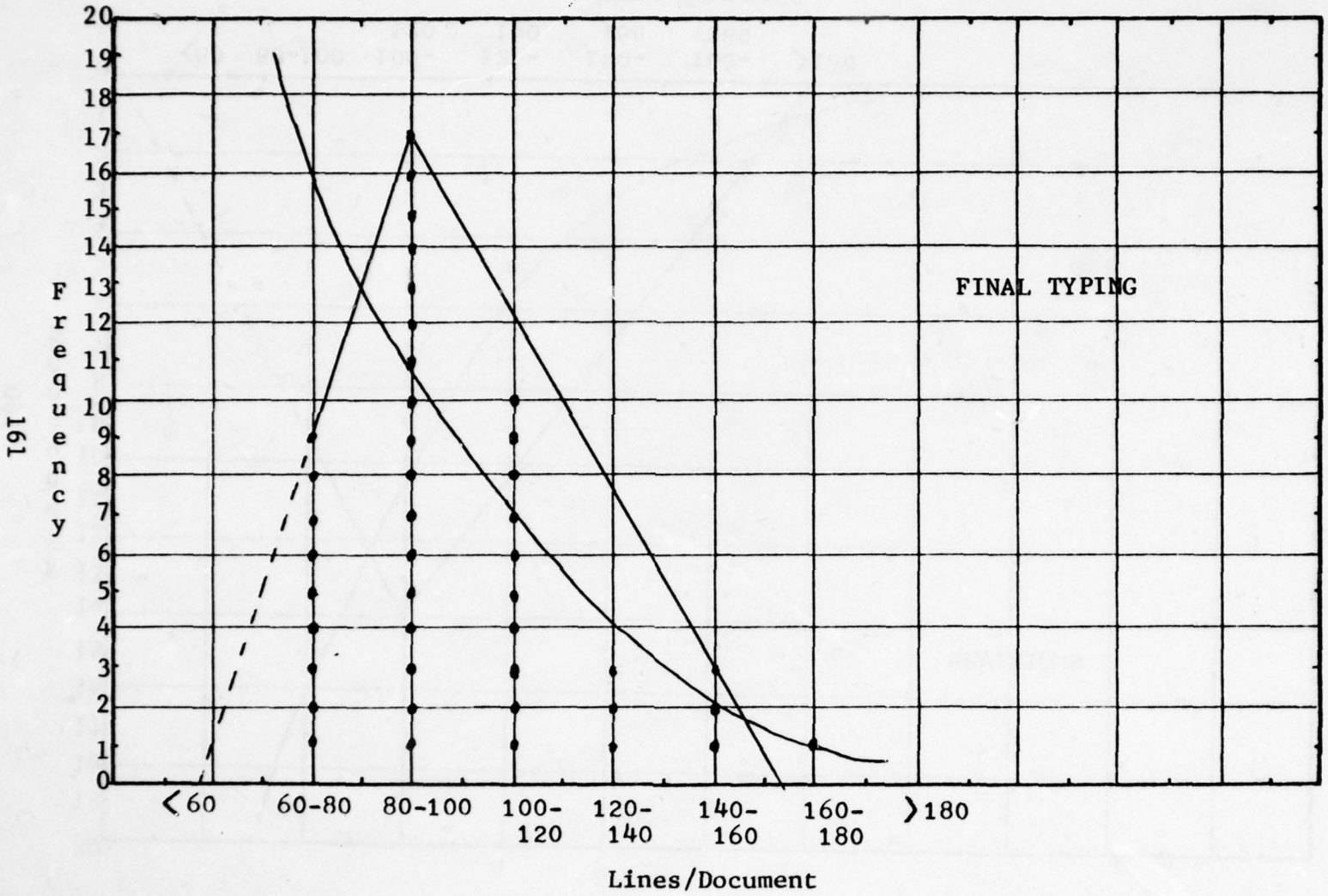
APPENDIX C

WPC DOCUMENT DISTRIBUTIONS


20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Frequency
MECHANICAL
TRANSCRIPTION
<20
20-40
40-60
60-80
80-100
>100
Lines/Document


20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Frequency
LONGHAND
TRANSCRIPTION
<60
60-80
80-100
100-120
120-140
140-160
160-180
180-200
200-220
220-240
> 240
Lines/Document


REVISIONS
Frequency
160
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
<80
80-100
100-120
120-140
140-160
160-180
>180
Lines/Document


FINAL TYPING
Frequency
161
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
<60
60-80
80-100
100-120
120-140
140-160
160-180
>180
Lines/Document

APPENDIX D

WPC SYSTEM MODEL

SIMULATION RESULTS

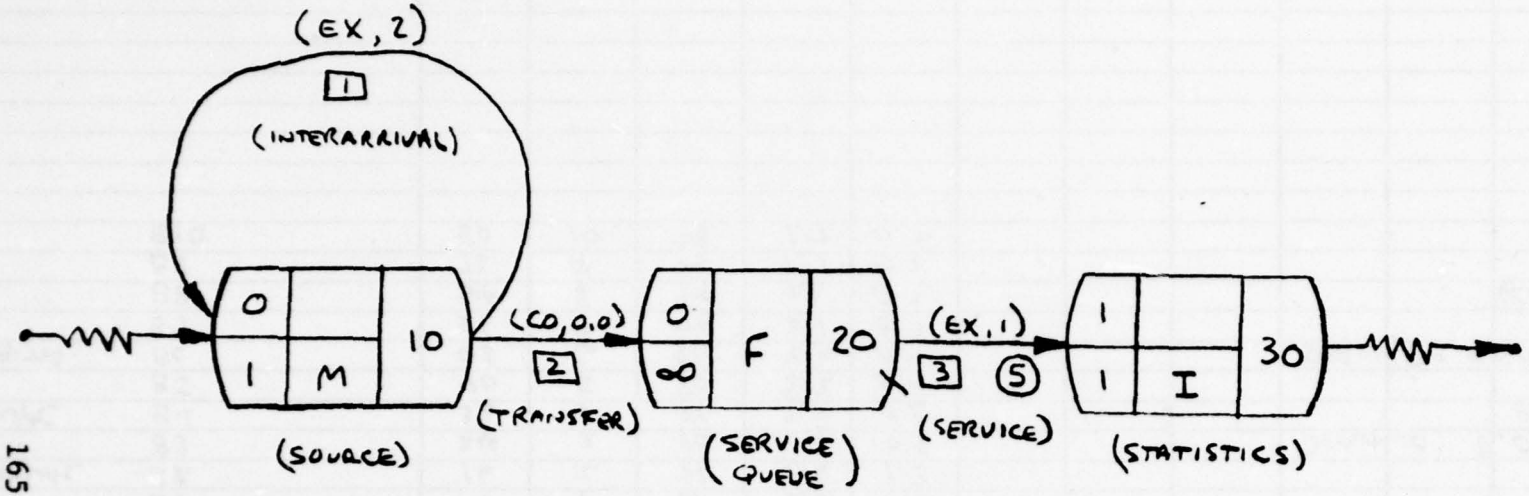
COMPUTER SIMULATION

RESULTS

	RUN		DEMAND (DOC/DAY) MT	LT	R	TOT		MANPOWER REQUIREMENTS (PE'S) MT	LT	R	F	P	TOT	
	WP 1		5.0	9.5	10.5	25.0		0.3	1.4	0.5	0.5	0.2	2.9	
	WP 2		8.0	15.2	16.8	40.0		0.5	2.2	0.9	0.9	0.3	4.8	
	WP 3	*AVE WPC*	10.0	19.0	21.0	50.0	←	0.6	2.8	1.1	1.1	0.4	6.0	←
42%	WP 4		12.0	22.8	25.2	60.0		0.8	3.3	1.3	1.3	0.5	7.2	
	WP 5		15.0	28.5	31.5	75.0		1.0	4.1	1.6	1.6	0.5	8.8	
REVISION	WP 6		20.0	38.0	42.0	100.0		1.3	5.5	2.2	2.2	0.6	11.8	
	WP 7		30.0	57.0	63.0	150.0		1.9	8.4	3.2	2.3	1.1	17.9	
RATE	WP 8		50.0	95.0	105.0	250.0		3.2	13.7	5.4	5.4	1.8	29.5	
	WP 9		100.0	190.0	210.0	500.0		6.4	27.9	10.7	10.9	3.8	59.7	
	WP 11		5.0	9.5	4.8	19.3		0.3	1.4	0.2	0.4	0.1	2.4	
	WP 12		8.0	15.2	7.7	30.9		0.5	2.2	0.4	0.7	0.2	4.0	
	WP 13	*AVE WPC*	10.0	19.0	9.7	38.7	←	0.6	2.8	0.5	0.8	0.3	5.0	←
25%	WP 14		12.0	22.8	11.6	46.4		0.8	3.3	0.6	1.0	0.3	6.0	
	WP 15		15.0	28.5	14.5	58.0		1.0	4.2	0.7	1.3	0.4	7.6	
REVISION	WP 16		20.0	38.0	19.3	77.3		1.3	5.6	1.0	1.7	0.6	10.2	
	WP 17		30.0	57.0	29.0	116.0		1.9	8.3	1.5	2.5	0.8	15.0	
RATE	WP 18		50.0	95.0	48.3	193.3		3.2	13.8	2.5	4.2	1.4	25.0	
	WP 19		100.0	190.0	96.7	386.7		6.4	27.9	4.9	8.4	2.8	50.4	
	WP 21		5.0	9.5	1.6	16.1		0.3	1.4	0.1	0.4	0.1	2.3	
	WP 22		8.0	15.2	2.6	25.8		0.5	2.2	0.1	0.6	0.2	3.6	
	WP 23	*AVE WPC*	10.0	19.0	3.2	32.2	←	0.6	2.7	0.2	0.7	0.2	4.4	←
10%	WP 24		12.0	22.8	3.9	38.7		0.8	3.3	0.2	0.8	0.3	5.4	
	WP 25		15.0	28.5	4.8	48.3		1.0	4.2	0.2	1.1	0.3	6.8	
REVISION	WP 26		20.0	38.0	6.4	64.4		1.2	5.6	0.3	1.4	0.5	9.1	
	WP 27		30.0	57.0	9.7	96.7		1.9	8.4	0.5	2.1	0.7	13.6	
RATE	WP 28		50.0	95.0	16.1	161.1		3.2	13.8	0.8	3.5	1.2	22.5	
	WP 29		100.0	190.0	32.2	322.2		6.4	27.9	1.7	7.0	2.3	45.3	

APPENDIX E

WPC AGGREGATE MODEL, PROGRAM AND SIMULATION RESULTS




```
1000GEN,GLASSER,OLDWAY1,6,13,1979,1,0,,9600.0,10*
1010SOU,10,0,1,D,M*                          SOURCE
1020ACT,10,10,EX,2,1/ARRIVAL*                INTERARRIVAL
1025PAR,2,60.0,0.0*
1030ACT,10,20,CO,0.0,2/TRANSFER*
1040QUE,20/SERV-Q*                           SERVICE QUEUE
1050ACT,20,30,EX,1,3/SERVICE,1*              SERVICE
1060PAR,1,48.0,0.0*
1070STA,30/STATS,1,1,D,I*                    STATISTICS
1080FIN*
```

COMPUTER SIMULATION
* RESULTS *

	RUN	DEMAND (doc/day)	SERV	UTIL	AVE BACK-LOG	AVE BACK-LOG PER SERV							
	A1	6.9	1	98.2	16.3	16.3							
	A2	13.8	2	98.3	31.8	15.9							
HIGH	A3	20.7	3	98.9	56.2	18.7				DEMAND: 6.9 DOC/DAY PER SERVER			
	A4	27.6	4	99.3	76.8	19.2							
BACKLOG	A5	34.5	5	99.3	78.0	15.6							
	A6	41.4	6	99.5	88.8	14.8				SERVICE: 434 LINES/DAY			
DATA	A7	48.3	7	99.4	103.8	14.8							
	A8	55.2	8	99.3	118.4	14.8						(PRE WPC LEVEL)	
	A9	62.1	9	99.3	134.0	14.9							
	B1	8	1	78	2.6	2.6							
ACTUAL	B2	16	2	79	2.6	1.3							
	B3	24	3	80	2.3	0.8				DEMAND: 8.0 DOC/DAY PER SERVER			
WPC	B4	32	4	81	2.3	0.6							
	B5	40	5	80	2.2	0.4							
DATA	B6	48	6	80	2.6	0.4				SERVICE: 900 LINES/DAY			
	B7	56	7	79	2.1	0.3							
	B8	64	8	79	1.6	0.2						(CURRENT LEVEL)	
	B9	72	9	79	1.7	0.2							
	B10	80	10	79	1.7	0.2							

APPENDIX F

WPC ANALYSIS REPORT

(EXCERPT)

WPC ANALYSIS REPORT

November 1975

First of a Series of periodic reports. Includes pre-survey (Implementation) and first 10 weeks of operation.

(d) RETYPE VS. ALL OTHER TYPING INPUTS -

Indicator: Comparison of retype inputs versus all other typing inputs (lines/week).

Purpose of Indicator: Evaluate, over time, and compare to the pre-implementation survey the retype rate. The retype rate, as such, should not significantly increase in the long run over the retype rate experienced before word processing. However, as more personnel begin to use the dictation system, potential generation of retypes can occur from word slurring, bad word enunciation, misidentification of paragraphs, formats, noninclusion of punctuation marks (hyphens, commas), and non-spelling of difficult words. Additionally, the spelling and proper document preparation burden, especially with dictation, is placed on the correspondence secretaries who may not be familiar with the type of work and are confronted with all the originator's input differences. A long range factor affecting the retype rate that can be attributed to word processing and can be expected is that the originator may be more likely to refine the quality of his document knowing that a full document retype is no longer necessary.

Conclusions to Date: The retype rate has increased from the pre-survey level of 24.4 percent to 37 percent. Referring to indicator (c), the dictation rate is increasing and most likely has contributed, as discussed above, to the retype rate.

APPENDIX G

WPC COST DATA

HQ AFLC

WPC SUPPLIES COST

PERIOD: Oct 78-Feb 79

SOURCE: AFLC/DAUS (Supply Section)

ELEMENTS: Bond Paper, Manifold Carbon, Ribbons, Continuous Paper, Print Wheels and Elements, Magnetic Tape and Disk Cards, Letterhead Paper, Misc. Paper.

TOTAL COSTS:

XR	$1157
MI	1092
MA(2)	1743
DP	1584
AVERAGE	$1394

or

$275 per month per center

HQ AFLC

WPC PERSONNEL COSTS

AS OF: 19 Apr 79

PREPARED: 20 Apr 79

SOURCE: Randall/DPCR, Desire List (PA)

ASSIGNED DATA

Type	No.	Cost	Avg.
SUPERVISORS	13	$183,878	$14,144
CLERKS	81	874,311	10,794
	94	$1,058,189	$11,257

AVG WPC - 1 SUPERVISOR

6.2 CLERKS

AVG CLERK COSTS

Cost	$10,794
+28%*	3,022
	$13,816

*Twenty-eight percent is the commonly accepted add-on percentage for retirement and insurance costs and is the percentage used by the U.S. Office of Management and Budget (OMB).

HQ AFLC

WPC EQUIPMENT RENTAL COSTS

Rental costs for word processing equipment
(automatic typewriters)

SOURCE: Jack Platten - AFLC/DA

Type	Monthly Rental	No. in HQ	Total Cost
Xerox 800	$300	28	$ 8,400
Xerox 850 page	580	6	3,480
Xerox 850 line	388	12	4,656
Redactron R-1	228	40	9,120
Redactron R-2	600	16	9,600
Redactron Q	396	12	4,752
		114	$40,008

TOTAL--$480,096 per year

Average Cost is $351 per Month

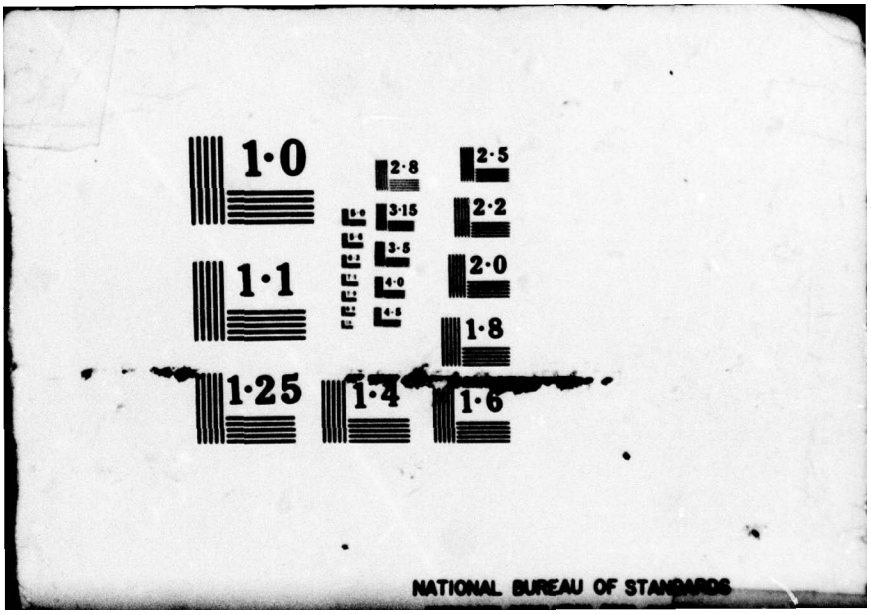
SELECTED BIBLIOGRAPHY

AD-A072 619 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL--ETC F/G 5/1
A DESIGN FOR A MANAGEMENT SYSTEM FOR HEADQUARTERS AIR FORCE LOG--ETC(U)
JUN 79 K W GLASSER, A B THOMAS

UNCLASSIFIED AFIT-LSSR-10-79A NL

3 OF 3
AD
A072619

END
DATE
FILMED
9 79
DDC


1·0
1·1
1·25
2·8
3·15
3·5
4·0
4·5
1·4
2·5
2·2
2·0
1·8
1·6
NATIONAL BUREAU OF STANDARDS

A. REFERENCES CITED

1. Anderson, Thomas J., and William R. Trotter. Word Processing. New York: Amacom, 1974.

2. Anthony, Robert N., and Regina Herzlinger. Management Control in Nonprofit Organizations. Homewood IL: Richard D. Irwin, 1975.

3. Beer, Stafford. Brain of the Firm. London: John Wiley & Sons, Ltd., 1974.

4. _____. Decision & Control. London: John Wiley & Sons, Ltd., 1966.

5. _____. Designing Freedom. London: John Wiley & Sons, Ltd., 1974.

6. _____. Management Science: The Business Use of Operations Research. New York: Doubleday and Company, 1968.

7. Brennan, John J. "Word Processing is the Beginning of the Future," The Office, February 1975, pp. 63-65.

8. Burkes, Dwayne. "Background Paper on Word Processing at HQ AFLC." Unpublished research paper, unnumbered Air Command and Staff College, Maxwell AFB AL, 1978.

9. Chamberlin, Guy W., Jr. Acting Assistant Secretary for Administration, U.S. Department of Commerce. Memo, subject: Automatic Typewriters, to Secretarial Officers and Heads of Operating Units, May 29, 1975.

10. Datapro Reports on Office Systems. Delvan, N.J.: Datapro Research Corporation, 1978.

11. Dickey, P. S. Chairman, Ad Hoc Committee for Contracting. Memo, subject: Contracting for Selected AFLC Support Activities, to HQ AFLC/CSF, 9 December 1975.

12. Eads, Dean and R. J. Trisel. Directorate of Administration, HQ AFLC/DAX, Wright-Patterson AFB OH. Personal interviews conducted intermittently from 16 October 1978 to 26 April 1979.

13. Forrester, Jay W. Industrial Dynamics. Cambridge MA: M.I.T. Press, 1961.

14. "GAO Finds Disarray on Word Processing," Federal Times, 30 April 1979, p. 16.

15. Hansen, William B. Vice-President, Office Systems Division, Bruce Payne Consultants, Inc. Letter, subject: Word Processing, to Mr. David Larkin, U.S. Department of Commerce, March 5, 1979.

16. Holt, Richard G. "Word Processing and Administrative Support are the Basis of Future Offices," The Office, June 1977, pp. 66-69.

17. Joyner, Major Donald R., USAF, and Captain Jon N. King, USAF. "A Behavioral Assessment of Word Processing Centers." Unpublished master's thesis, LSSR 18-77A, AFIT/SL, Wright-Patterson AFB OH, January 1977. AD A044195.

18. Kleinschrod, Walter A. Word Processing. New York: Amacom, 1974.

19. Larkin, David. Deputy Director for Program Development, U.S. Department of Commerce. "Making Word Processing Equipment Cost-Effective," The Office, January 1976, pp. 100-103.

20. _____. "Management Differs in Government Business," The Office, January 1978, pp. 85-86.

21. _____. "The Government Takes a New Look at Word Processing," The Office, January 1979, pp. 81-82.

22. McCabe, Helen Marie, and Estelle L. Popham. Word Processing: A Systems Approach to the Office. New York: Harcourt, Brace & Jovanovich, 1977.

23. O'Neill, Captain Patrick H., USAF, and Captain David B. Walker, USAF. "Productivity Measures for AFLC Word Processing Centers." Unpublished term paper, AFIT/LSG, Wright-Patterson AFB OH, May 1978.

24. Pritsker, A. Alan B. Modeling and Analysis Using Q-GERT Networks. New York: John Wiley & Sons, Inc., 1977.

25. Rayment, Lieutenant Colonel Donald W., USAF. "Word Processing: One Answer to Administrative Short Falls in the Air Force." Unpublished research report No. 6037, Air War College, Maxwell AFB AL, 1976.

26. Rosen, Arnold and Rosemary Fielder. Word Processing. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1977.

27. Schneider, Major General Carl G., USAF, Chief of Staff, HQ AFLC, Wright-Patterson AFB OH. Letter, subject: Conservation of Manpower and Paperwork, to all HQ AFLC DCSs, 16 March 1978.

28. Schoderbek, Peter P., Asterios G. Kefalas, and Charles G. Schoderbek. Management Systems: Conceptual Considerations. Dallas: Business Publications, Inc., 1975.

29. Stedman, Erv. "Word Processing Leads Way to Future Office," The Office, January 1979, pp. 83-84.

30. "The Word on Word Processing: Step Back and Reassess," Government Executive, January 1979, pp. 22-28.

31. Upton, Anthony. "Word Processing: The Problem is Career Ladders," Government Executive, April 1977, pp. 56-57.

32. U.S. Air Force Logistics Command. Administrative Center Policy and Procedures. HQ Operating Instruction (HOI) 11-1. Wright-Patterson AFB OH, 26 May 1976.

33. _____. Headquarters AFLC Organization and Functions Chartbook. AFLCM 23-1. Wright-Patterson AFB OH, 1 October 1974.

34. _____. Word Processing Implementation. AFLC Programming Plan No. 75-35. Wright-Patterson AFB OH, 1976.

35. _____. Directorate of Manpower. "AFLC Performance Standard Word Processing." Unpublished report, unnumbered, Wright-Patterson AFB OH, 1978.

36. _____. Office of Staff Management and Directorate of Administration. "HQ AFLC Word Processing Evaluation." Unpublished report, unnumbered, Wright-Patterson AFB OH, 1975.

37. _____. "WPC Analysis Report." Unpublished report, unnumbered, Wright-Patterson AFB OH, 1975.

38. Van Gigch, John P. Applied General Systems Theory. New York: Harper & Row, Publishers, 1978.

B. RELATED SOURCES

Bergeron, L. L. "Word Processing Survey," Journal of System Management, March 1975, pp. 20-24.

Christensen, Dr. G. Jay. "Has Word Processing Been Oversold?," The Office, September 1976, pp. 26-39.

Clark, Charles T. and Lawrence L. Schkade. Statistical Methods for Business Decisions. Cincinnati: South-Western Publishing Company, 1969.

Coyle, R. G. Management Systems Dynamics. London: John Wiley & Sons, ltd., 1975.

"Data Processing Productivity: LA County's Simple Measure," Government Executive, March 1978, pp. 48-50.

Hansen, Rasanna. "WP: How It's Changed Us and Where Do We Go From Here," Administrative Management, June 1977, pp. 33-35.

Helvey, T. C. The Age of Information: An Interdisciplinary Survey of Cybernetics. Englewood Cliffs, N.J.: Educational Technology Publications, 1971.

Johnson, Thomas P. "Are We Doing the Right Things, Right?," The Office, January 1979, pp. 97-98.

Judge, John F. "The Administrative Center: Air Force Makes It Work!," Government Executive, September 1976, pp. 39-44.

Klosinski, Donald J. "Efficiency Improves at Army Logistics Evaluation Agency," Government Executive, February 1977, pp. 27-30.

Malone, Frank. Assistant to the Director of Administration, U.S. Nuclear Regulatory Commission. "Word Processing: The Baby Grows Up," Government Executive, May 1978, pp. 48-50.

_____. "Word Processing: The Total Package . . . More To It Than You Think Possible," Government Executive, August 1977, pp. 36-50.

Nance, Harold W. and Robert E. Nolan. Office Work Measurement. New York: McGraw-Hill Book Co., 1971.

"Office System at Hill AFB Documents Real Savings and Efficiencies," Government Executive, March 1979, pp. 48-52.

"Paperless Office Slated for Air Force Unit," Government Executive, August 1978, p. 42.

Rix, Colonel J. H., USAF. Director of Administration, HQ AFLC/DAX, Wright-Patterson AFB OH. Personal interview, 3 November 1978.

Schumacher, E. F. A Guide for the Perplexed. New York: Harper & Row, 1977.

Stone, Milton M. and Dale Tarnowieski. Management Systems in the 1970s: Selling and Servicing a Tougher Customer. New York: American Management Association, Inc., 1972.

Taylor, Captain John B., USAF. "And Now, Dial a Letter," Airman Magazine, March 1975, pp. 14-18.

Thomas, Ruth. "The Federal Government's Word Processing Program," The Office, February 1975, pp. 52-53.

Truax, Paul G. and Jean Strong. "Think Before You Leap Into Word Processing," The Office, November 1976, pp. 73-75, 132.

Turban, Efraim and N. Paul Loomba. Readings in Management Science. Dallas: Business Publications, Inc., 1976.

_____, and Jack R. Meredith. Fundamentals of Management Science. Dallas: Business Publications, Inc., 1977.

U.S. Air Force Logistics Command. Directorate of Administration. "Word Processing in AFLC." Presentation to AFLC Commanders, Wright-Patterson AFB OH, 26 January 1977.

U.S. Army Troop Support Command. "Word Processing Feasibility Survey." Unpublished report, unnumbered, St. Louis, 1975.

U.S. Department of Commerce, Office of Administrative Services and Procurement. "Report of the Task Force on Automatic Typewriters." Unpublished report, unnumbered, Washington, April 1975.

U.S. General Services Administration. Use of Word Processing Equipment. GSA Bulletin FPMR B-86. January 17, 1979.

Williams, Vernon G. "Word Processing: The Contracting-Out Question." Unpublished research report, number 2685-78, Air Command and Staff College, Maxwell AFB AL, 1978.

"Word Processing: How to Save $700 Million a Year," Government Executive, December 1976, pp. 52-54.