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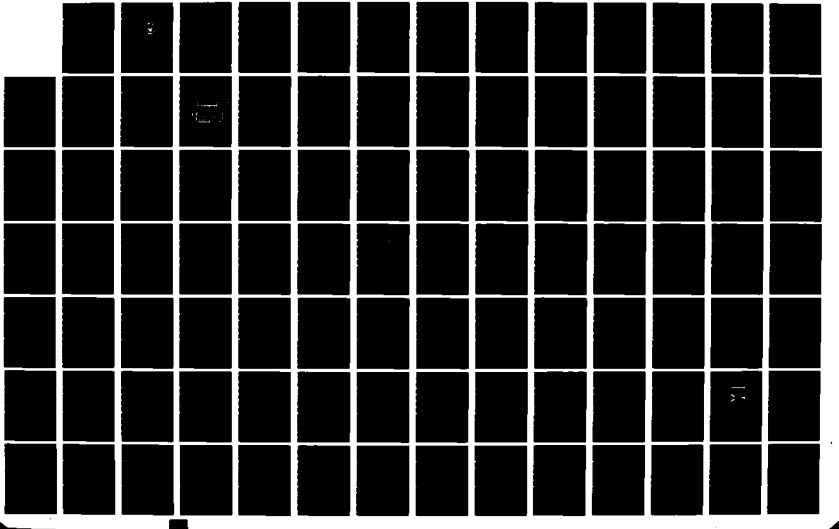

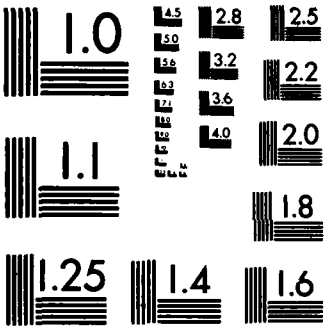

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NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

WORD PROCESSING AT THE NAVAL POSTGRADUATE SCHOOL

by

Richard E. Brooks
Gerard B. Baigis

December 1982

Thesis Advisor: N. Lyons

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In spite of current technological advances in office automation technology little productivity gains have been made in the office environment. Some possible reasons for this are; lack of supervision, little or improper training, disregard for the human factor in equipment and work design and lack of clear organizational goals with regard to productivity gains. The purpose of this study is to explore the productivity aspect of word processing. An examination of selected productivity studies is presented

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Word Processing at the Naval Postgraduate School

by

Richard E. Brooks
Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1974

and

Gerard B. Baigis
Captain, United States Marine Corps
B.S., University of Pittsburgh, 1977

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN INFORMATION SYSTEMS

from the

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December 1982

Authors: Richard E. Brooks

Gerard B. Baigis

Approved by: _____
Thesis Advisor

W. M. Woods
Second Reader

_____
Chairman, Department of Administrative Sciences

_____
Dean of Information and Policy Sciences

ABSTRACT

In spite of current technological advances in office automation technology little productivity gains have been made in the office environment. Some possible reasons for this are; lack of supervision, little or improper training, disregard for the human factor in equipment and work design and lack of clear organizational goals with regard to productivity gains. The purpose of this study is to explore the productivity aspect of word processing. An examination of selected productivity studies is presented with a look at the costs and benefits associated with the use of word processing equipment versus conventional electric typewriters. An examination of the science of ergonomics is presented as it deals with the physical and mental aspects of word processing equipment and its affects on the word processing equipment operator. The results of a survey of word processing equipment operators attitudes toward their job at the Naval Postgraduate School are presented along with conclusions and recommendations concerning the implementation of a humane and productive system.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

As the cost of managerial and secretarial time has continued to increase, the importance of office automation and increased productivity among the office staff has risen drastically. Unfortunately, as Whieldon [Ref. 1], points out, the productivity growth in the United States has continually failed to keep pace with that of other nations, like Japan which have shown higher gains for years. Factory productivity has realized some gains, thanks mainly to computerized systems, however, office productivity, comparison, has improved very little. The technology equipment for major improvements in office productivity is available, however the gains are not always being realized. Several reasons are cited for this shortcoming including lack of managerial support for new office systems, fear on the part of office workers of being replaced by machines, and the initial capital outlay for new systems.

This problem is not limited to the private sector and is found in organizations both large and small. The Naval Postgraduate School is no different. At the present time there are several different word processing systems available, and they all serve to increase productivity to some extent, however increased improvements are available. The situation is not all bad however. As organizations become more educated in the capabilities of word processing systems and the increased productivity they offer, more companies are purchasing systems. A Datapro Research Corporation report in 1977, [Ref. 2], estimated that the word processing market was over $500 million and increasing daily. The annual production rate was over 50,000 units, with an estimated 300,000 to 400,000 units installed. The Federal

government alone is estimated to spend about $100 million per year for the leasing and purchase of automated typing equipment.

It is not the purpose of this paper to recommend specific office systems, but instead to provide background into the word processing area, review current systems at the Naval Postgraduate School, and emphasize those attributes in a system which the operators find most beneficial in the performance of their work.

A. ADVANTAGES OF WORD PROCESSING

When a number of clerical workers at the Naval Postgraduate School were asked to describe their respective word processing systems, the majority responded, "I could not perform my job without it." Once operators are familiar with a system and adequately trained in its use, most would agree with the above statement. These personnel realize that they are no longer secretaries, but have become systems operators of computerized word processors. They are the critical interface between their office and a system which offers the organization increases in efficiency and productivity. In addition to these benefits, Datapro [Ref. 3], explains that WP systems offer: (1) improved secretarial support for all levels of management and/or word originators; (2) reduction in the amount of proof reading and retyping required in the preparation of numerous documents; (3) higher utilization of installed office machines; (4) higher quality typed output resulting from the utilization of advanced WP equipment; and (5) improved career opportunities for secretarial and clerical workers.

These are by no means all the benefits resulting from the correct implementation and use of WP systems. The entire list is quite extensive. As a direct result of these

benefits, however, it has generally been found that considerable savings are possible. The initial cost may be substantial, however, increased productivity and the movement of personnel into other positions, results in an overall savings to the organization.

B. HISTORY OF WORD PROCESSING

The earliest form of WP was first utilized with the discovery of the stylus and a tablet which allowed man to record information. WP progressed with the invention of the pen, the printing press and eventually the typewriter. The modern concept of word processing, however, was actually developed in the 1960's. As Whithead [Ref. 4], reveals, the actual term 'word processing' was originally used by IBM Deutschland to describe the corporation's new line of self-correcting typewriters. The German word, 'Textverarbeitung', was quickly translated by the English speaking branches of IBM into word processing. Once IBM moved into the development and production of typewriters and other office equipment, it was inevitable that their computer technology would appear in the equipment in the form of increased efficiency and productivity. In his article on the development of word processing systems Whitehead [Ref. 5], explains how the introduction of the IBM Selectric 'golf-ball' typewriter, in 1961, revolutionized the entire concept of typing. Gone was the old moving carriage, and in its place was a single print element which not only allowed operators the choice of several typefaces or founts, but also improved the print quality.

The next major breakthrough in word processing ocurred in 1964, with the introduction of a machine that captured keystrokes and recorded them on magnetic tape. Kleinschrod [Ref. 6], puts forward the claim that the Magnetic Tape

Selectric Typewriter, or MT/ST was the machine that gave birth to modern word processing as it is known today. Although the machine is now close to 20 years old, many are still in use. Five years after the introduction of the MT/ST, IBM introduced the Mag Card Selectric Typewriter, or MC/ST, which utilized a magnetic card as the storage medium. These systems are found throughout the military. Three are in use at the Naval Postgraduate School. According to a Datapro Research Corporation report on word processors [Ref. 7], the introduction of the MC/ST marked the beginning of competition in the word processing area and a new industry was born. As of 1981, over 50 firms were directly involved in the marketing of word processing equipment, and more are entering the marketplace every month.

C. WORD PROCESSING VS DATA PROCESSING

In order to fully understand the concept of word processing and office automation, one must realize that word processing and data processing are not one in the same. There are as many definitions for word processing as there are systems available on the market today, however, for the purpose of this study the definition as provided by Thomas [Ref. 8], will suffice. Word processing is "the efficient and effective production of written communications at the lowest possible cost through the combined use of systems management procedures, automated technology, and accomplished personnel" [Ref. 9]. In contrast, the definition of data processing or electronic data processing (EDP), as it is often called, is provided by Hussain [Ref. 10], as the execution of a systematic sequence of operations performed upon data.

1. WP and DP Differences

There are many differences between WP and DP, and Balderston [Ref. 11], provides several as outlined below:

WORD PROCESSING	DATA PROCESSING
1. Users have strong interaction	1. Limited interaction by users
2. Frequent iterations with user	2. Very few iterations
3. Key to good WP is the operator	3. Key to good DP is the program
4. Users close to operation	4. Users removed from operation
5. Manipulation of lines/text and words	5. Manipulation of data (number computation)

In word processing human factors have proven to be much more important than technological ones. The most productive system on the market is only as good as its operator. If a person lacks the motivation, knowledge, or experience required to operate the system, then the organization has purchased little more than a very expensive typewriter. In a study conducted by the Army's Adjutant General Center of [Ref. 12], word processing, a constant theme was that less than 15% of the success or failure of any new word processing system is directly attributable to the machines. Greater than 85% of the systems success depends on the quality of the operators and established procedures.

As outlined above, data processing is quite different. The data is entered into the system, and the program takes control until a report is generated.

Manipulation of the data is seldom required. A word processing operator spends the majority of his or her time accomplishing the editing function. The system involved is essentially an electronic way to manipulate the text easily and quickly. As shown in Figure 1-1 [Ref. 13], this manipulation must often be repeated several times until the desired output is obtained.

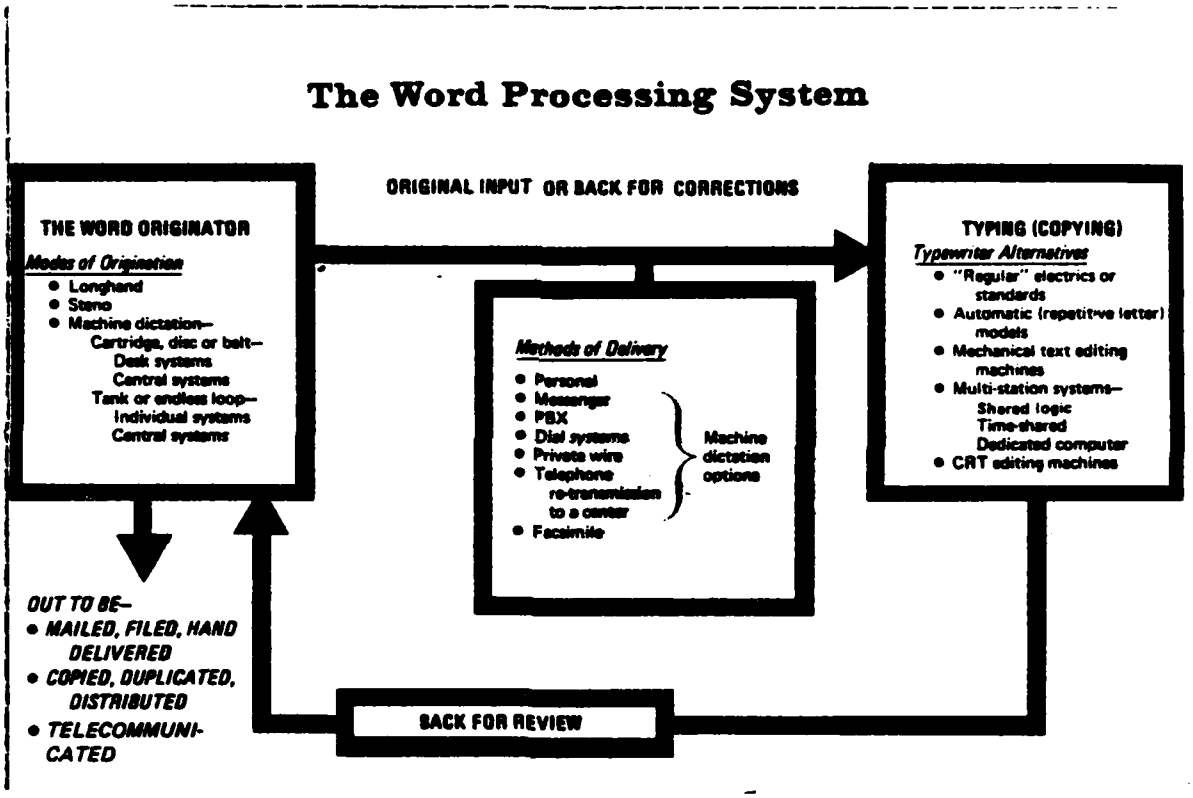


Figure 1.1 The Word Processing System.

D. CATEGORIES OF WORD PROCESSING EQUIPMENT

At present, there are more word processors on the market than a person would care to count, however all word processing equipment may be divided into four categories

[Ref. 14]. These categories are 1) standalone hardcopy equipment, 2) standalone display equipment, 3) shared logic equipment, and 4) time-shared services.

1. Standalone Hardcopy WP Equipment

This category would include the majority of the less sophisticated, less expensive systems, such as electronic typewriters, which do not include video displays. According to a 1981 Datapro report on word processing systems [Ref. 15], these systems fall in the $4000 to $10,000 price range. Electronic typewriters feature small buffer memories for minimal text storage and are intended for the traditional office environment. Also included in this area are larger standalone mechanical systems which consist of a keyboard that has internal memory and is coupled to an auxiliary memory media such as magnetic card, diskette, or floppy disk. In general, these systems are best suited for page oriented tasks such as letter and memo writing.

2. Standalone Display WP Equipment

As Kelly, [Ref. 15], and other authors point out, the jump to the largest class of word processing equipment is a large one. These systems generally consist of a visual display unit (VDU) which may display a single line or an entire page, keyboard, processing unit and some form of letter quality printer. Their internal or buffer memory systems provide these units with the capability of holding in excess of a display page of text. These systems are usually found in the $10,000 to $20,000 price range, and include systems such as the Lanier, model LTE-1, which is in use at the Naval Postgraduate School. The more sophisticated systems in this category are able to communicate, perform data processing, and a wide range of text correction and editing. In addition, optional peripherals, such as

Optical Character Readers (OCR) and higher speed printers, are available.

3. Shared Logic WP Systems

In a shared logic system, as Kelly [Ref. 17], explains several screens or workstations, each possibly housing memory, are interfaced to a processor of substantial capacity and power, in order to share facilities and resources. When this concept was first introduced, the major drawback was the possibility of system failure. If the entire system went down, all work stations and terminals would be unusable. This problem has been solved with the introduction of cluster configurations where a smaller number of terminals are connected together. In this manner, system failures are not so catastrophic. The shared logic approach to word processing has become increasingly popular in recent years. The state capital in Pierre, South Dakota, utilized a shared logic system, as shown in Figure 1-2 [Ref. 18], to connect seven buildings which were all highly paper intensive and information dependent on each other.

The end result of the new system was an increase in employee efficiency and productivity and a major improvement in communications between the various state agencies and the public. In the transportation department alone, throughput and productivity more than doubled over the gains realized under the old magnetic tape system.

Many organizations find themselves in situations similar to that which existed in the State of South Dakota. The size of the organization dictates the requirement for several buildings, and personnel in these buildings must communicate. In addition, large companies often own several different and incompatible WP systems. At one time, the cost and difficulties encountered prohibited the electronic interconnection of these systems. This is no longer the

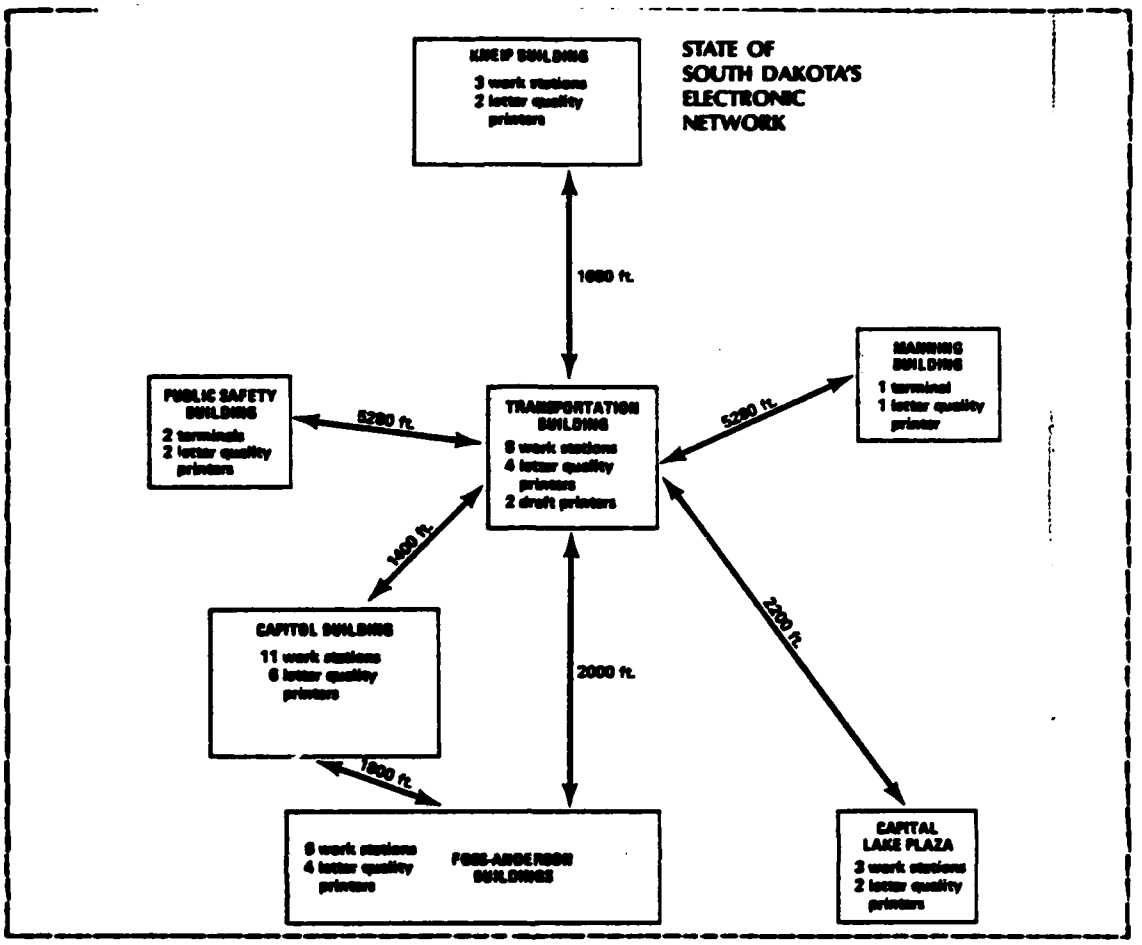


Figure 1.2 State of South Dakota's Electronic Network.

case. Advances in technology have made it practical to network these systems together, providing advantages such as those discussed by Liebowitz [Ref. 19],

(1) Single terminals are able to access multiple computers, which results in more computing power in the hands of the operator.

(2) Terminals that were originally designed to communicate with one type of computer, are now able to work with different manufacturer's computers.

(3) Multiple computers can be controlled from a centralized location.

(4) Back-up computers may be situated in various locations which decreases the chance of a disaster destroying redundant systems.

(5) Information from one word processor may be transferred at a high speed to another system with no manual intervention.

In summary, the local network provides the capability to build highly effective, productive word processing systems, utilizing equipment from different manufacturers.

4. Time Shared Word Processing Systems

Many companies that seldom require the services of a word processor, or are unable to afford their own system, find that time shared services provide a feasible solution to their WP requirements. The only investment required is the rental or purchase of an appropriate terminal. Once a communicating word processor is acquired, the user has access to the word processing power of a remote computer system via the telephone network. Sophisticated WP functions are provided by the time-shared service vendor at a modest cost. Other services that are often available to time-shared customers are the access to large commercial databases, off-line storage of infrequently used information, and an interface to mailgram or telegram services.

E. PURPOSE OF STUDY

It is not the purpose of this study to recommend any specific word processing systems for use at the Postgraduate School, or to provide a detailed cost-benefit analysis of current systems. What is presented is background information in the WP area and a discussion of the different categories of word processing equipment. The study also reviews the present status of word processing at NPS. In addition, the study will explore the productivity increases realized from WP systems, discuss the operator satisfaction level here at the Naval Postgraduate School, review the science of ergonomics as it relates to word processors, and

review characteristics of word processing systems that the operators at NPS find extremely useful. Finally, system implementation considerations will be presented. The methodology of the study will consist of two parts; 1) a survey of NPS operators, and 2) literature research.

1. Word Processing Survey

A major portion of the information in this study was derived from a word processing questionaire, included as Appendix A, which was distributed to approximately 50 government service employees (GS) at the Postgraduate School. The majority of respondents had direct access to one or more of the WP systems currently in use at the school. In addition, operators whose access was limited to electric typewriters, were polled in order to provide them the opportunity to present characteristics of WP systems which would increase their productivity. The survey itself, Appendix A, consists of three parts. The first portion explores operator background information such as education level and time of employment. The second part studies the present level of operator satisfaction, and the final area of the survey, asks the respondents to provide information concerning the nature of their work, their exposure to WP systems, and those system characteristics which they believe to be the most beneficial or detrimental to their work.

2. Literature Research

In addition to the survey, a detailed literature search was conducted in order to obtain background and historical information concerning word processing systems. Since a detailed productivity study of each individual operator at NPS is not included in this study, literature research provided valuable information in the area of measuring operator productivity and the increases available

through the utilization of WP systems. Material covered in this research included textbooks, periodicals, professional papers and reports, and both governmental and civilian studies into the WP area.

II. WORD PROCESSING AND PRODUCTIVITY

A. INTRODUCTION

When business historians look back at the 1970's one development will certainly be singled out as critical in changing the ways that offices are run, this development of course is word processing. Word processing will also be credited with having a profound impact on the ways that top managers will subsequently regard all office activities. Word processing has been, is, and preeminently will be a system for upgrading productivity, cutting office overhead, and improving managements ability to do its job much more effectively.

As we have already seen WP makes use of automated equipment for typing, text editing and dictation. Some of it is highly sophisticated and people need training in its use. It requires supervision, often in areas like the secretarial function where little or no professional supervision had existed before. It requires degrees of control and measurement to maximize its returns. In this chapter the productivity aspect of word processing equipment will be considered.

B. WORD PROCESSING PRODUCTIVITY MEASUREMENT

Productivity may be defined as the output of goods and services produced by a given input of human and other resources. It may be measured in terms of the ratio of output to input.

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

The productivity concept has been applied extensively in manufacturing industries, where the output and input factors are generally quantifiable. These factors are normally expressed in dollars and hours, or the equivalent. The output per man-hour statistic compiled by the Bureau of Labor Statistics is probably the best known example of a productivity index. This index is calculated by dividing constant dollar gross national product by labor hours employed in the private sector of the economy. Attempts have been made to apply the productivity concepts developed for manufacturing industries to the service sector of the economy. The service sector includes businesses and institutions concerned with government operations, health, finance, education and personal services. The results generally have not been adequate. A major difficulty is in quantifying the value of the output term -- the goods, services and products produced and word processing output has not been immune to this problem.

1. Approaches to Productivity Improvement

Hanes [Ref. 20], reports that there are five generally recognized approaches to productivity improvement. Of course, productivity programs typically include elements from more than one approach.

1. Substitution of equipment for human effort: This approach has been responsible for major increases in productivity levels during the last 30 years in all sectors of the economy. It has been successful because technological developments have resulted in equipment availability, capital has been available to acquire and install the equipment, and the work force has generally accepted the chaange.

2. Better utilization of human resources: This approach has received much attention throughout the years. It involves achieving a higher level of output with an existing

work force. Many techniques have been developed and applied in attempts to realize higher productivity through this approach. Examples include the threat approach (produce more or be terminated), pay and incentive systems, worker and supervisory training programs, and human resource management. A technique receiving current attention is worker participation, such as through quality circle programs. Theory Z has emerged as a management style empasizing participation as a vehicle to achieve better utilization of human resources.

3. Improved work methods and aids: Some managers and productivity specialists would argue that this approach has accounted for the second largest increase in productivity in the last 30 years, exceeded only by substitution of equipment for human effort. It involves application of such techniques as facility arrangement, task analysis and job design to provide an efficient flow of work and efficient worker job performance. The approach has been successful in improving productivity because human factors and engineering disciplines have developed the techniques, management has installed the techniques, and the work force has generally accepted the changes.

4. Improved design of systems to accomodate users: This approach involves designing equipment and its enviroment taking into account the physical and mental capabilities and limitations of the people involved with the system. For example, the design of a computer terminal for extended data entry should take into account the size of the expected users, the characteristics of the visual display to minimize eye fatigue, and the operating functions that should be automated or manual. The human factors discipline has developed knowledge and techniques upon which this approach is based. The approach has been applied during the last 30 years, but can be expected to become more important with

increased utilization of new technology in offices and factories of the future. Human factors as it relates to word processing will be further examined in a later chapter.

5. Removal of unproductive regulatory, labor and organizational practices: This approach is often controversial and difficult to implement. It involves removing or modifying practices that inhibit or detract from productivity and that are no longer needed. The practices may be based on government regulation, labor agreements, or organizational policies.

Approaches 1, Substitution of equipment of effort for human effort; 3, Improved work metods and aids; and 4, Improved design of systems to accomodate users; are the typical methods of improving office productivity and in particular, word processing productivity. A case can be made for method 2, better utilization of human resources, however this method of improving office productivity has most surely been tried before the advent of word processing systems.

Productivity has become headline news. Leaders from business and government have unanimously deplored the poor performance of the United States in productivity improvement in the last decade. However, reading between the lines, it is clear that many of these leaders are not exactly sure what they are deploring. Productivity is a widely misunderstood concept. It is related to virtually every business and economic principle in one way or another, but most of the standard solutions of these disciplines do not directly address productivity.

In the 25 years after World War II, productivity of the United States' private economy increased at an average rate of 3.2 percent per year. In the last ten years, that rate has been cut to about 1.3 percent per year. In 1978 productivity improved only 0.5 percent over 1977. In the first three quarters of 1979, productivity actually

declined. The performance varies from industry to industry. Some industries showed substantially higher improvements in productivity, and other industries showed declines throughout the period. Chemical and chemical-related industries have tended to perform quite a bit better than average, but that does not change the the general statement on the inadequate performance in the American economy as a whole. Though the United States is last in its rate of productivity growth among large industrialized nations, the United States is still first among these nations in level of productivity, but the other industrial countries are rapidly catching up. The American Productivity Center of Houston Texas projects that several leading industrial countries will pass the United States in level of productivity between 1985 and 1990 if we do not improve our performance over that presently projected.

Martin [Ref. 21], notes that more than half of the working force in advanced countries work in offices and that in the United States the capital expenditure per white collar worker is less than $3,000 while that of the farm worker is about $35,000 and that of the typical blue collar worker is about $25,000. It is now the time for increasing expenditures in office automation to realize the productivity gains made in other areas of the economy however with these attempts at increasing the productivity of the office come the difficulties of measuring these anticipated gains.

2. Measuring Word Processing Productivity

Poppel [Ref. 22], in a mock retrospective view of the 1980s, observes "... all organizations benefitted from improved productivity in offices. This came from widespread installation of multipurpose, interactive, EDP-assisted workstations that speed completion of clerical and administrative tasks." However, measuring productivity so that

improvements can be honestly documented is not a simple matter. Where jobs are changed by office automation, expected output will also change, and any improvement or drop in staff productivity may be impossible to quantify. Mason [Ref. 23], describes three separate levels of productivity measures relating to word processing, these are: the technological level, semantic level and pragmatic level.

At the technological level output is measured in terms of characters per second, words per minute, lines per minute, documents per day, and letters per day. A technical measure involves the number of units of information processed. At this level it is very easy to produce misleading statistics about productivity improvements. Installing a word processing center may increase typed output from every typist, apparently increasing their efficiency, but may not improve the productivity of any managers, who now must send all their typing to the central facility instead of handing it to their secretary in the office next-door.

In measuring productivity at the semantic level one is concerned not just with the number of characters or the number of symbols processed, but rather with the number of units of meaning processed. How many actual exchanges of ideas took place. This is a far more difficult thing to measure: but, it is clear that such measures as characters per second are not very effective at this level. For example, two different people may write what is essentially the same letter. One may be very verbose and wordy, and go on for several pages to express his idea. The other one may take only a paragraph to say the same thing. The secretary who types the first persons letter may have a much higher performance and productivity rating in terms of characters and words and letters per unit time; but the secretary who types the second persons letter will actually be much more

effective as a total system. Quantifying this type of productivity is extremely difficult.

Mason's final level of productivity measure, the pragmatic level or the level of influence and effectiveness is concerned with how much change took place in thetotal performance of the organization as a result of the activities performed by a function. This leads one to ask questions like, "Is this a more profitable organization or is it a more innovative organization as a result of the implementation of advanced office practices and concepts?" From a practical standpoint this involves monitoring the profitability of the entire organization and assessing what proportion of a profitability change can be attributed to office automation techniques in order to determine its effect.

Bair [Ref. 24], has proposed a model from which the effect of office automation and word processing in particular can be assessed, based on the observation of "organizational variables". By considering a variety of these variables the model can operate at four levels similar to Mason's:

-- Equipment performance - includes only the capabilities of the equipment
-- Throughput performance - depends also on operator performance
-- Organizatioanl performance - measures the acceptability of the end product
-- Institutional performance - the overall success of the company.

Bair's model not only assesses productivity improvements, but indicates the benefit areas and the areas which have not been helped by automation.

3. Productivity Studies

Few thorough, comprehensive and detailed word processing studies were found in the literature. Many of those that are available are of a promotional nature that are distributed by the equipment manufacturers. These either compare their system with their competitors or simply expound upon the productivity increases that managers want to hear about with little or no factual data to back up their claims. Baily [Ref. 25], notes that when word processing equipment was first introduced industrial engineers had not yet developed techniques for measuring productivity in offices, however WP salesmen were determined to show the office manager that word processing equipment would increase office productivity. In the early days they quoted time-and-motion studies that proved word processing equipment was many times more effective at increasing office productivity than conventional typewriters. These "studies" were usually based on an armchair analysis of how much keystroking could be accomplished per worker. This fact didn't deter the salesman from extrapolating to claims of more productive offices and many systems were bought and sold only on the belief and claims of the salesman that word processing would be a cost effective means of improving office productivity.

Cost - benefit studies have shown that word processing equipment is a viable alternative to manual typwriting systems [Ref. 26], and the opposite case has been shown also [Ref. 27]. A standard electric typewriter or correcting electric typewriter can be purchased for about $800, while more sophisticated equipment can range from about $5000 to over $15,000 or 10 to 20 times as expensive as convential and correcting electric typewriters. Standard and correcting typewriters are often purchased, however the

rapid changes occuring in automatic typewriter technology make rental a more viable alternative than purchase. Thus, the difference in the equipment cost of conventional and automatic typewriters is often much higher than 1:10 or 1:20 and more in the range of 1:20 and 1:30. Word processing equipment is often marketed on the basis that their increase in cost in comparison to conventional typewriters is offset by dramatically increased typing productivity. Many manufacturers and proponents of word processing attest to this increase in productivity while often ignoring a thorough cost-benefit study of the proposed system versus the expected productivity gains. Oman [Ref. 28], did such a study where he compared a sampling of 61 word processing systems and 85 conventional typewriters, he found that the productivity increase with the use of word processing equipment is small (10 to 15 percent) and is not sufficient to offset the higher costs of automated typing equipment. Few articles in the office literature critically examine the costs and benefits of automatic versus conventional electric typewriters, nor document typing productivity decreases or increases due to automatic typewriters. Simpson and Swett [Ref. 29], found typing productivity to be reduced or only slightly increased with the substitution of automatic for conventional electric typewriters. Simpson in a work sampling of 56 work stations, nine of which were mag card typewriters, concludes that typing production on the automatic equipment was less than non-automated equipment. Swett notes that automatic typewriters are sometimes slower than conventional electrics depending on how they are used, and that even when automatic typewriters are faster, the difference in typewriter productivity is not dramatic, except in the case of multiple copy material.

In Omans study of the 85 conventional electric typewriters, Table I, 46 were correcting electrics and 39 were standard electrics. Of the 61 automatic typewriters in the survey 36 used a magnetic or paper tape storage media without internal memory units or dual stations, and which provided little text editing capability. The remaining 25 automatic typewriters had a text editing ability and external memory. The automatic typewriters were not recently installed and had been in the offices for several years. Nor were most of the operators new or untrained.

In measuring the output of the typists at their workstations Omans study team collected copies of everything that was typed at each of the 146 stations over a 12 day period. Each typist noted the amount of time spent on each task and recorded this time on a job record sheet that was collected with the copies of the typed material. In view of the fact that one typist might time themself more accurately than another the study team assumed that errors in timing were randomly distributed among the conventional and automatic typewriters. They further assumed that typing skills were evenly distributed between the two groups, that is the operators of the automatic equipment were not poorer typists on the average than those who used the conventional equipment. To obtain a measure of productivity the team counted the number of lines typed and divided by the amount of time required to complete the job and arrived at the number of Lines Typed/Hour. Both a mean and a median were computed for both groups. The difference between the average (mean) Number of Lines Typed/Hour on the automatic typewriters and the conventional electrics was 19.5 lines per hour. The automatic typewriters as a group were about 13.4% faster than the conventional electrics using the means for comparison. Using the median as a point of comparison, the automatic typewriters were on the average 12.2% faster than the conventional electrics.

TABLE I

Comparison of Conventional and Automatic Equipment

	Lines Typed Per Hour Mean	Median
Conventional Electric Typewriters (N=85)	145.4	135.0
Automatic Typewriters (N=61)	164.9	151.4
Percent Increase in Productivity with Automatic Typewriters	+13.4%	+12.2%

Oman found that the Labor Cost Per Page was slightly lower for the automatic typewriters than for the conventional electrics, Table II. For the purpose of making a cost comparison the same labor rate was used for all typing

TABLE II

Labor Cost Per Page Comparison

	Labor Cost Per Page Mean	Median
Conventional Electric Typewriters	$.90	$.97
Automatic Typewriters	.79	.86
Percent Decrease in Labor Cost Per Page with Automatic Typewriters	-12.2%	-11.3%

stations, that is $5.23 per hour. The difference in Labor Cost Per Page reflects the difference in productivity of the

two sets of machines measured in Lines Typed Per Hour. Because the productivity of the automatic typewriters was somewhat higher than that of the conventional electrics, the Labor Cost Per Line Typed was less for the automatics. Proponents of word processing have continually boasted that the increased productivity and the resulting decrease in labor cost is of sufficient magnitude to offset the increased word processing equipment costs. The relationship between Labor Cost Per Page and the kind of typewriter was also examined by ranking all of the 146 typewriter stations (automatics and conventionals) from high to low by Labor Cost Per Page and computing a median. This count resulted in the following data: Percent of automatic typewriters above the median cost 46; below the median cost 54. Percent of conventional typewriters above the median cost 53; below the median cost 47.

Typing production per unit time is an important parameter in determining the total cost per typed page because labor cost is usually the largest item in the total cost of typing production. Oman reports for example, that the daily equipment cost of a conventional typewriter costing $700 and amortized over 12 years is less than $25 per day while the daily cost per day of sophisticated word processing equipment varies from $7 to $15 per day.

The Total Cost Per Page, Table III, is composed of labor cost per page and equipment cost per page. An illustration of the method of computing total cost per page is as follows: assuming one page is typed per day on a conventional electric typewriter and the page takes 15 minutes to type, and assuming the typists pay rate is $5.00 per hour. It is important to note that as the number of pages typed per day increases, the equipment cost per page decreases. The effect is particularly dramatic in the case of more sophisticated word processing equipment with their higher

equipment costs. Thus the arguement must be made that to increase the cost-effectiveness of word processing equipment it should be utilized to the maximum extent as possible and

TABLE III

Total Cost Per Typed Page (labor + equipment)

	Total Cost Per Page Mean	Median
Conventional Electric Typewriters	$1.00	$1.02
Automatic Typewriters	$2.49	$1.65
Percent Increase in Total Cost Per Page with Automatic Typewriters	+149%	+62.6%

for large applications. Oman concludes that the substitution of much more costly automatic typewriters for conventional typewriters is often justified on the assertion of dramatically increased typing productivity for automation however that on the average the cost of producing a typed page was much more on automatic than on manual typewriters.

The National Archives and Records Service (NARS) conducted a search for data regarding productivity and word processing equipment in 1980 this effort revealed that no valid productivity data existed. They then initiated the Keyboard Productivity Research Project to compare the performance of typists on conventional electric typewriters with the same performance on word processing equipment in the production of narrative textual material. The equipment used consisted of: conventional electric typewriters; self-correcting electric typewriters; memory typewriters; stand-alone video-display word processors; and shared-logic word processors. Each group of equipment was used by at

least 30 participants (all were volunteers) except the shared-logic word processors which are less widely accessible in Federal Agencies. The material that was typed consisted of pretyped copy and the same copy with handwritten changes (all in the same writing). The material consisted of five pages of double spaced narrative on general interest topics. NARS personnel timed each of the participants while typing their copy and proofread their finished product. A copy of the study is enclosed as Appendix B. The NARS research revealed that for original typing, self-correcting electric typewriters outproduced all other groups of equipment. For typing with changes or revisions, the most significant productivity increases occur when stand-alone, video-display word processors were used. Thier results also indicated that word processing equipment does not reduce error rates for first time (original) typing. Original material produced on WPE had as many or more errors than the same material produced on self-correcting electric typewriters. NARS primary conclusion was that as the percent of changed lines increases, WPE productivity decreases to (and beyond) a point where it is less costly to retype a page on a self-correcting electric typewriter than to revise it on WPE.

Word processing systems typically cost anywhere from a few thousand to $25,000. Obviously before management commits itself to this type of an expenditure it will require a comprehensive evaluation of the administrative organization and workload levels. An adequate return on investment can only be achieved through a substantial increase in high quality output or a decrease in the costs of the work involved. Amport [Ref. 30], notes that the use of these systems can bring about savings in two general areas. two general areas. The first is at the input end. Authors can increase their productivity since with faster

typewriten feedback they can see their material in format and can rethink their ideas while thoughts are fresh in mind. The second savings area is at the output end; less clerical staff will be needed to handle the workload. Amport states that it is possible to reduce staff levels up to 30% even at capacity output. The results of his work are shown

TABLE IV

Word Processing Productivity Relationships

	Electric typewriter (manually operated)	Automatic memory card/ cassette typewriter	Video display-printer
Primary work (up to 10% correction)	1.0	1.2	1.6
Revision work (up to 25% change)	1.0	1.5	3.0

in Table IV The ratios mean that an average typist typing original material (with up to 10% corrections) will produce about 1.6 time the amount of useful work with a video based word processing system than with an ordinary typewriter. With revision work, useful output will average at least three times as much (some of this includes the higher speed of the printer as compared to the manually operated typewriter). The ratios concerning revision work can be interpreted in the same manner also. Amport's results are consistent with those of the NARS study in that word processing equipment is much more productive where numerous revisions are made.

4. Summary

In practice word processing systems savings come from producing work that was not done in the first place, or is now done in another way, such as three rough drafts under the new system versus one under the old system. This increased work is typically called "phantom work" and consists of work that is not now done or which cannot be done because the system is incapable of doing it. Thus total document output will increase with the installation of word processing equipment. This phenomenon generaly makes its presence known after the installation of WPE and can quickly ruin the effectiveness of the system.

Many people blindly believe that anything new must be better and word processing equipment is no exception. They do not take the time to make a critical analysis of their needs and objectives and feel that word processing must be for them without fully realizing where these sophisticated typewriters will best fit into their organization. Word processing equipment is best suited for repetitive production of large quantities of material where the possibility of numerous revisions exists. These are the strong points of word processing equipment and those people who remember this in implementing a system will undoubtedly be successful in their experience with it.

III. HUMAN FACTORS CONSIDERATIONS OF WORD PROCESSING

A. BACKGROUND

In looking at the benefits of word processing we must also concern ourselves with the human element and the toll that the operators pay in using the equipment. What factors influence the word processing operator's satisfaction? The number of office workers is growing at a phenomenal rate, Maskovsky [Ref. 31], reports that in the 1980's over 70 percent of the working population will work in an office environment. Human as well as electronic administrative support is required to supply the needs of those at work in the office. Applying word processing technology to the office is an undertaking that will affect the whole fabric of the organization. It is therefore essential to formally integrate human factors into the development of office automation projects. While few people will argue with this idea, comprehensive human factors have rarely been employed in office automation projects. Maskovsky believes that there are reasons for this failure:

-- Management and systems builders do not understand the disciplines of human factors or behavioral sciences.

-- Management and systems builders think that they understand these disciplines, usually confusing them with much narrower human engineering concepts.

-- Appropriate human factors approaches demand a commitment of resources and time which management is reluctant to grant because they don't understand them.

Mitchel [Ref. 32], reports that monotony, overspecialization, and, as a result, dissatisfaction are often evident in companies which have implemented word processing systems. These companies suffer from high turnover rates within their word processing departments. Many word processing experts,

however, point to numuerous examples of people gaining career opportunities through the machine oriented world of word processing.

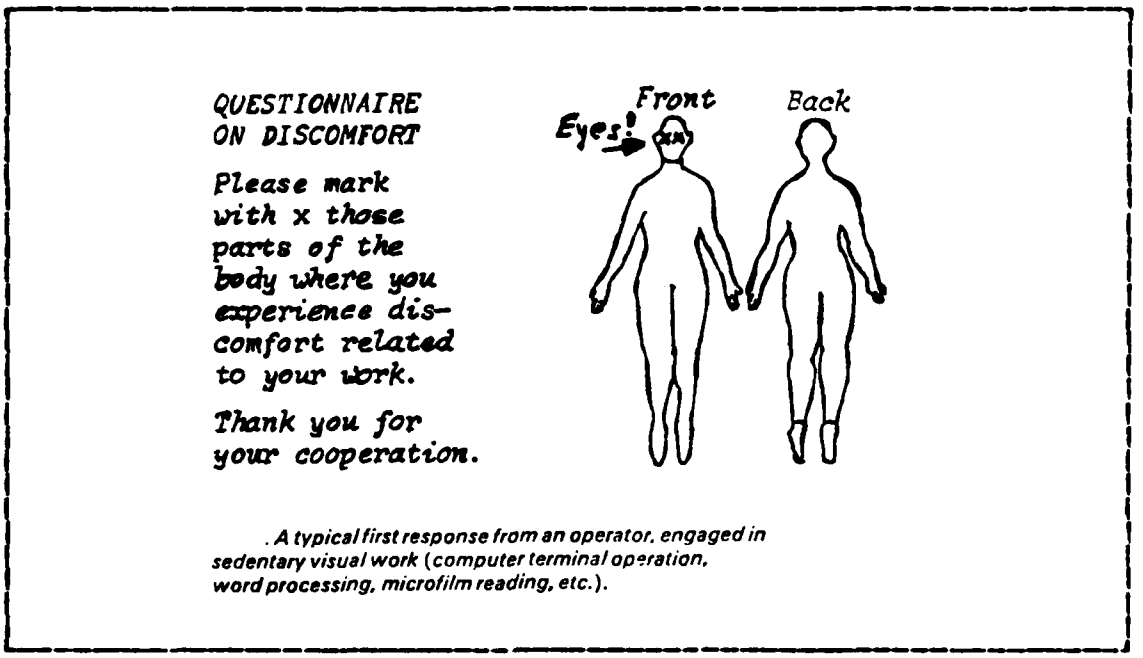
The importance of ergonomics or human factors cannot be overemphasized. It means increased productivity and satisfied employees. Plenty of evidence exists to show that userunfriendly designs preclude a widespread acceptance of word processing equipment. In the past, system designers could be less attentive to human factors considerations of hardware and software since most applications were used by technical and computer oriented users. However as automation is entering the office at an ever increasing rate we are seeing that word processing and data processing are being merged and we must be alert to the increasing complexity of the equipment and tasks that operators must perform. It does little good to have a system so complex that the average individual cannot operate it or even if he or she can they don't feel at ease with it. These problems are solved by the science of ergonomics, which is concerned with the design of physical equipment and facilities people use and the environments in which they work so they are more suitable for human use. This section will explore the ergonomics of word processing equipment from a broad managerial viewpoint rather than a technical viewpoint. In conducting this reasearch most companies that were contacted felt that this area of office automation was one that held the most promise in gaining a marketing edge and essentially all of their information was proprietary and could not be released for this reason.

1. Hardware and Environmental Cosiderations

Shaffer [Ref. 33], reports that the Video Display Terminal (VDT) will soon outpace the photocopy machine in the number used in the office and other places. He further

notes that by 1985 over 75 percent of all office jobs will involve computers in some way. Obviously the most visible sign of that use will be the VDT. There have been many cases, reports and studies that have examined the health aspects of the VDT. The issues raised include cataracts, deteriation of eyesight, backaches and even fainting spells. Present evidence strongly refutes the unconfirmed claims that VDTs can damage health by radiation or that eyesight can be affected. Safety and health experts do not hesitate in declaring that it is safe to work at a VDT. Yet one must realize that there can be problems of discomfort and fatigue which, although can be temporary, may reduce the effiency and well being of the operator. Working at a VDT equiped word processing machine may compete favorably with both traditional typewriting and television viewing but there are numerous examples where the reverse is true. It is the nature of the task that determines the degree of strain and fatigue. TV viewing, typewriting, proofreading and computerized word processing present different types of problems. Operating a keyboard and looking a screen impose a relatively fixed working posture and eye fixation. This creates strain and fatigue and more so if the work intensity is high.

Ostberg [Ref. 34], reports that the Swedish National Board of Occupational Safety and Health has looked at operator discomfort in work tasks which call for full time sedentary visual work (computer terminal operation, word processing, microfilm reading etc.). When operators were asked to mark the location of work-related discomfort on a human silhouette, an operator's typical first response would be as shown in Figure 3.1. Visual and postural discomfort might be expected among operators engaged in sedentary visual work, and accordingly the relative distribution of operator complaints shown in Table V comes as no surprise,



. A typical first response from an operator, engaged in sedentary visual work (computer terminal operation, word processing, microfilm reading, etc.).

Figure 3.1 Sedentary Work Operator Response.

these are also the results of the Swedish National Board of

TABLE V

Percentage of Operators Experiencing Bodily Discomfort

Eyes	75%
Back/Shoulders	55%
Head/Neck	35%
Arms/Wrist	25%
Legs	15%

Occupational Safety and Health study. Operators have also been concerned with other problems relating to the use of Cathode Ray Tubes (CRT). Some of these are X-ray emission,

electromagnetic emission, optical radiation and screen flicker. Up to ten years ago CRTs did emit X-rays. This is no longer the case. The high voltage supplies of today's CRTs operate at a level below 20,000 volts. X-ray emission will appear at about 30,000 volts. Ostberg notes that several investigations have concluded that this is a safe margin. Concerns over electromagnetic radiation are unfounded, although under special circumstances a microwave oven may emit electromagnetic radiation there is no possibility that a CRT could ever act this way. What is meant by optical radiation are the ultraviolet, infrared and visible ends of the spectrum. There is no ultraviolet and infrared radiation from a CRT screen. The screen light is produced by electrons hitting the phosphor-coated inside of the screen (similar to the light produced by a flourescent tube lamp), and the resulting light is absolutely harmless. However a characteristic of a CRT that almost all experience is screen flicker. Flourescent light flickers with a frequency that is given by the frequency of the a.c. power source. CRTs flicker with a frequency that is given by the design of the circuitry inside the video display unit (VDU). A flicker of 10 Hz is extremely annoying and may actually induce seizure in epileptics. A flicker of 100Hz is almost imperceptible. The aim in the design of a VDU is to make it appear flicker free at the lowest possible frequency. To keep the price down, virtually no comercial CRT display for word processing eqipment has a flicker frequency above 60Hz and this means that they all may appear flickering, especially in large displays filled up with text. It is harmless but some operators find it annoying. The quality of the characters displayed on the CRT is an important characteristic of a screen. Characters should be crisp, clear and above all stable. The operator should not notice any distortion, jittering, bouncing or flickering of characters.

They should be large enough to be easily read yet dot matrix characters should not be so large that the spaces between the dots interfere with readability. Also character brightness and contrast should be independently adjustable. Screens with reverse video are now available and have certain advantages because some glare problems are minimized. After a word processing system has been installed some operators may discover that they now need glasses or new glasses. This typically the result of altered visual tasks; luminance distribution, time of eye fixation, viewing angle, reading distance, reflections, glare, higher productivity, etc. Ostberg [Ref. 35], notes that about one out of four office workers typically have uncorrected or inadequately corrected visual defects. To this should be added that bifocal lenses suited for typewriting often are not suited for VDU work. And even after the operator has been given a new pair of glasses the visual strain and/or fatigue may persist. This of course will make the operator worried no matter what an eye specialist may say.

An area that is related to the design, installation and use of CRTs is the lighting in the room where the CRT is installed. While adequate levels of illumination must exist for the office worker to read printed or handwritten copy easily, the presence of glare sources (direct or reflected) within the workers field of view must also be minimized. If this is not done, the visual sensitivity mechanisms may be forced to readjust rapidly back and forth between the light level on the desk and the much higher levels of bright sunlight at a window 10 feet away, but in the direct field of view. Dainoff [Ref. 35], reports that there should be between 37 and 56 footcandles (400 to 600 lux) of light falling on the print surface, while, at the same time, light-intensity ratios in excess of 3:1 in the immediate visual field should be avoided. The illumination problem

can be much more complicated when a CRT is introduced. An upright glass serves as a kind of mirror that nicely reflects images of the surrounding work place, particularly glare sources such as windows and light fixtures located behind the operator. Thus, if one has a terminal located under a long row of flourescent light fixtures, the fixtures far in front of the operator will appear in the field of view as a direct glare source, while those behind appear on the screen as a reflected glare source. The latter will present the additional problem of washing out the light on dark characters on the screen, reducing contrast and making reading it more difficult.

As a result, the solution requires that lighting fixtures be located in such a way as to provide sufficient footcandles on the operator's copy while at the same time minimizing the glare/contrast reduction problems inherent in the presence of an upright glass screen.

Adequate solutions to this problem are not yet evident from the lighting industry. However, a number of things will improve the situation. One can simply rearrange the desks, move or tilt the terminal screens and if possible, relocate lighting fixtures to minimize the obvious reflections seen on the screen. In many cases it may be necessary to turn off certain overhead lights and to use individual desk lamps ("task lighting") to provide the necessary illumination. Some sort of window covering may be necessary and one must be alert to other potential sources of glare such as highly reflective table tops, wall fixtures, decorations and floors.

Furniture and office furnishings is another consideration that must not be overlooked if morale and productivity are to be maintained. Excessive strain on the musculoskeletal system will result from any activity in which a person is forced to maintain th same posture for

long periods of time. In an automated office, where a large percentage of a person's daily work activity will involve interaction with a single CRT terminal, musculoskeletal strain will be of particular concern, and can be exacerbated if that posture is awkward or unnatural, resulting in pains of the back, shoulders, arms and wrists.

Strain can be minimized if the workstation is designed to enable each operator to work with the home row of the keyboard at about elbow height, so that the forearm is approximately parallel to the floor and the angle of the wrist, with respect to the forearm, is within 5 to 10 degrees. At the same time the feet must be flat on the floor (or foot rest) with adequate thigh clearance and firm support for the lumbar (lower back) region of the spine. Figure 3.2 shows recommended workstation dimensions for a female VDU operator. Finally the line of sight from the operator to the screen should fall within 10 to 30 degrees from the horizontal, with the display screen located at adistance of 50 to 70 centimeters (from 20 to 28 inches).

Realistically these goals cannot be achieved with conventional office furniture, one piece terminals and ordinary chairs. People vary considerably along several important body dimensions; designing for the average means, at best, that a larger number of users will be only somewhat uncomfortable as opposed to very uncomfortable. It is also important to realize that user populations of word processing equipment may include males as well as females and a diversity of racial and ethnic groups. Thus, even the computed average body dimensions used for traditional office furniture design may be inappropriate because they are based on populations of North American women.

The key to effective ergonomic design is flexibility. A display terminal should have a detachable keyboard and a tiltable screen. A good chair is mandatory; it should

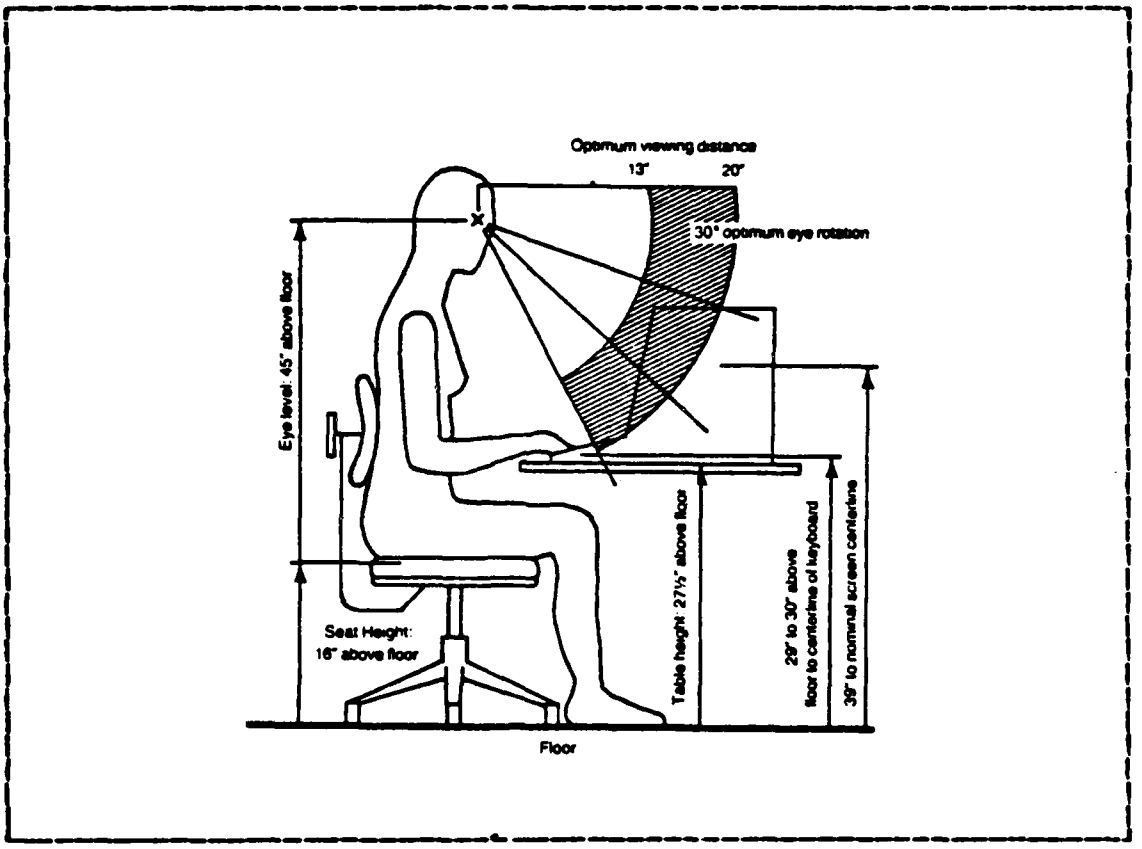


Figure 3.2 Typical VDU Workstation Position.

have an easily adjustable seat height and backrest, provide lumbar support and have a five point base. In addition, the use of a wrist rest immediately in front of the keyboard along with a good copy holder are inexpensive but essential elements in minimizing potentially stressful arm and wrist angles.

The heat and noise of the physical environment must also be considered. Electronic equipment generates a lot of heat and requires extensive air conditioning systems in large-scale CRT terminal installations. However, if heat removal is not accompanied by proper humidification, the resulting excessively dry air may result in aggrevating the symptoms of eyestrain, dry skin and other problems.

On the whole, when the soft click of terminal keyboards replaces the clattering of the typewriter, the office environment is, with one exception, a much quieter place. That one exception is, of course, the printer. Some early printer models exhibited noise levels in excess of 80 decibels - levels which are enough to be classified as occupational noise hazards. Considerations must be made for the printer when installing WPE and sound proofed work places almost always must be used.

2. Mental and Software Considerations

Koffler [Ref. 37], notes that while there has been significant progress in the area of physical ergonomics and word processing equipment there has been little in the way of progress towards solving the mental problems concerning ergonomics and WPE. He further feels that the majority of potential users lack the skills and training necessary to operate most systems available in todays market and that vendors expect their target users to have perfect memory capabilities, advanced Boolean logic training and highly developed deduction and induction techniques.

Although the keyboard is part of the physical machine we can think of the layout of the keys in terms of the mental aspect of machine design. Layout and labeling will be dependent upon the particular application for which the terminal or system is intended. For example a terminal designed for airlines reservations will be different from a WP terminal even if both have the same physical profile.

In general, certain areas of the keyboard should be reserved for certain function keys according to their relative frequency of use. The area to the right of the typing area has proven to be the best place for the most often used keys, followed by the area immediately to the left of the typing area. The layout of the traditional keyboard is

referred to as the "QWERTY" design so named for the top row of keys. Although there have been keyboard designs that have resulted in more productive output the "QWERTY" layout seems to be the standard as a matter of tradition. A common problem that many WPE manufactures are guilty of is placing the cursor control keys - the most frequently used key in word processing - immediately over the typing area, which is the least desireable in terms of operator accessibility and comfort.

Displays are another gray area between physical and mental ergonomics. In general office automation is forcing systems to deliver what can be described as "what you see is what you get" effect, whereby displays are expected to be replicas of what will appear on paper. Thus screens are being designed to accomodate such things as underlining, bolding, multiple pitches, variable spacing and multiple fonts. The more popular and successful screens are those that permit an entire page to be displayed rather than the more traditional partial page.

Koffler [Ref. 38], believes that one of the weakest components of word processing equipment is the software. Software is perhaps the most important component of a word processing system. It is not only what the system does but how it does it. We can refer to this area as "software ergonomics". This component of a word processing system may be the most irritating aspect of a job to an operator and can cause serious efficiency and productivity problems. Koffler states that two general rules should be applied to the design of word processing software. The first refers to the software being "functionally distributed". This deals with the allocation of different functions of a system in relation to menus, single-purpose and multi-purpose keys, mnemonics and commands. Inherent to this area is the actual physical design and layout of the menus and commands. His

second rule refers to the establishment of a common approach of doing things and is called "consistency". For example placing a promt on a screen always at the same location or giving the same logical meaning to such conventions as delete, insert and erase rest of line.

Word processing software should be implemented in a layered manner. This means that proficient users are given ways to bypass certain executional steps that novices or casual users need in order to use the system without continuously referring to manuals or support personnel.

This is related to the problem of documentation. Software vendors have been notoriously lax in their efforts to thoroughly and properly document their software. And the word processing field has been no exception. Software must be written for the WPE user not the supervisor or the computer center manager.

3. Summary

The importance of ergonomics in the office cannot be overstated. Without consideration given to the human element in the word processing function we cannot expect to achieve the increases in productivity, efficiency and improved communications that this technology can bring. Most of the human factors considerations that have been discussed here lie in the responsibility realm of the manuafacurer, however todays manager who is invloved with WPE must be constantly alert to the changing technology and the major effects this technology has on personnel.

B. WORD PROCESSING AT NPS

1. Background

The word processing question has been an area of concern for quite some time at the Naval Postgraduate School. Increasing student enrollment, billet reductions, personnel limitations and fiscal constraints have further aggrevated the administrative workload. A formal feasibility study has not currently been done to determine the most effective system to be employed here. However plans are currently in effect to have such a study completed by the Spring of 1983 to determine the hardware requirements and implementation strategy.

Implementation of word processing equipment may offset billet reductions directed by the schools major claimant, Chief of Naval Education and Training (CNET) and permit a possible reallignment of existing billets to provide a more efficient and effective workforce. These billet readjustments could also permit job reclassification and upward mobility similar to that experienced by civilian organizations upon the installation of word processing equipment.

The use of word processing at the Naval Postgraduate School is viewed to be a very important matter by the faculty, staff and administration. Preliminary thoughts are not aimed at a centralized WP center but rather at a decentralized system organized by departments and functions. However two major concerns became evident in this research. The first concern deals with the problem of decentralization, it is believed that the cost of the decentralization, which is necessitated by the diversified functions performed at NPS, could become prohibitive. Secondly, due to the unique mission of NPS, relative to the civilian sector security of sensitive and classified material could be an

important factor relating to the organization of WPE at the Naval Postgraduate School.

2. Current Word Processing Capabilities and Plans

There currently exists a variety of word processing equipment at the Naval Postgraduate School. These range from an IBM Mag Card II to the SCRIPT option (a document-composition program written by the Department of Computing Services at the University of Waterloo, Ontario Canada) on the schools mainframe. The SCRIPT option has not been considered as a part of the word processing solution mainly because there are only two printers at the school neither of which produce letter quality output, the inaccessibility of the terminals and the psychological factor that the computer is thought by most to be mainly for computational use. This fact has not inhibited students and faculty from extensively using the mainframe for document production though. There are currently no statistics available concerning the utilization of the IBM 3033 AP as a word processor and it is unlikely that it would ever be considered as the primary means of text reproduction since it was not purchased with that idea in mind.

Funds for the acquisition and implementation of the proposed system are currently programmed in the schools Fiscal Year '85 budget. As an interim measure 8 A B Dick Magna S L's were recently leased to augment those machines already in use. A complete listing of current WPE and their locations are contained in Table VI.

TABLE VI

Current Naval Postgraduate School WPE

WPE	DEPARTMENT	PROCUREMENT
A B Dick Magna SL	National Security Affiars	Lease
A B Dick Magna SL	Comptroller/Supply	Lease
A B Dick Magna SL	Correspondence and Records	Lease
A B Dick Magna SL	Administrative Science	Lease
A B Dick Magna SL	Operations Research	Lease
A B Dick Magna SL	Mechanical Engineering	Lease
A B Dick Magna SL	Oceanography	Lease
A B Dick Magna SL	Aeronautical Engineering	Lease
Lanier LTE-3D	National Security Affairs	Lease
Lanier LTE-3D	Electrical Engineering	Lease
Lanier LTE-3D	Administrative Science	Lease
Lanier LTE-3D	Physics and Chemistry	Lease
DEC WT/78	Continuing Education	Purchased
DEC WT/78	Electrical Engineering	Purchased
DEC WT/78	Meteorology	Purchased
IBM Mag Card II	Supply	Lease
IBM Mag Card II	Public Works	Lease
IBM Mag Card I	Legal Office	Lease

IV. WORD PROCESSING SURVEY RESULTS

A. SURVEY DESIGN

Whenever an organization is contemplating either purchasing a word processing system for the first time, or updating its present capabilities, there are many factors involved in making the decision. The initial capital outlay and lifetime expense of the system is one of the major factors to consider, however, before this area is researched an organization should attempt to assess its present strengths and weaknesses in the WP field. The word processing survey (Appendix A) distributed to the personnel at the postgraduate school was designed with the intent of investigating three major areas which many organizations often overlook. Questions were included to gather information in word processing personnel background, satisfaction level, and desirable system attributes.

Word processing personnel were defined as all clerical or secretarial government service (GS) employees who either worked with word processing systems at the time of the survey or were likely to come in contact with WP systems during their employment at NPS. The first group of questions were included to provide background information as to the operators educational level, time of employment, job activities, and other related fields. In addition, respondents were asked to include information on the nature of their work, what kinds of documents they worked with most often, any seasonal tasks, and those situations which tend to hinder their work. Before implementing a word processing system it is imperative that an organization be familiar with this information. It would be catastrophic for a

company to purchase an expensive new system only to discover that the workers lacked the educational level to operate the machine or much worse that a relatively inexpensive electric typewriter would provide all the support required. A second group of survey questions pertain to worker satisfaction. This study does not offer an in depth study of operator satisfaction and its relationship to performance or productivity measures. However, when developing or purchasing a new word processing system (or any system) it is imperative that one consider present worker satisfaction and the effects, both positive and negative, a new system will present. Present clerical worker satisfaction at NPS was measured utilizing the Hoppock Job Satisfaction Blank. [Ref. 39]. The final group of questions, queried the respondents as to the WP systems they are presently using, attributes they found to be either beneficial or detrimental to their WP tasks, and characteristics they would desire in a new word processor. This information would prove helpful in determining if the workers' word processing needs were actually being met with the WP systems presently located at NPS.

B. DISTRIBUTION METHODOLOGY

After development of the WP survey and advisor approval, the survey was distributed to each NPS department which had its own word processing equipment or access to a system located in another department. In addition, surveys were provided to departments where no WP systems were available. In each case, the survey was discussed with the departmental chairman, or in his absence, the curricular officer or other designated supervisor, to ensure departmental cooperation. Whenever possible, the surveys were then personally presented to the workers. In this manner, all personal

questions were answered and the importance of completely and accurately filling out the survey was stressed.

In distributing the surveys to the secretarial/clerical respondents, three attitudes were prevelant. The vast majority of workers who participated in the survey were very responsive. Most believed that their personal inputs were critical to the success of any new system. In the past, new systems were purchased with very little, if any, interaction with the personnel who would actually utilize the system on a daily basis. This results in equipment that is not completely understood and therefore often underutilized. The second attitute which presented itself approximately 15 per cent of the time, was most uncooperative. The individuals supported the use of WP systems, however they were unwilling to participate in the survey. The two major reasons provided were that the person was either much too busy or simply did not want to complete the survey. The third prevalent attitude which manifested itself approximately 5 per cent of the time was one of suspicion. Here again the individuals involved supported word processing, however they perceived the survey as a threat to their job security. It was strongly emphasized that the survey was completely anonymous and that the researchers were in no way affiliated with the civilian personnel office however, the respondents were still very reluctant to comply with the intent of the survey. As a result of the second two attitudes, 50 surveys which were distributed resulted in a data-producing sample of 31 surveys or 62 percent of personnel polled.

C. POPULATION AND SAMPLE

In his book, The Research Process in Education, David Fox [Ref. 40], describes five states often utilized in the sampling process. This study utilizes these states. These states are the universe, the population, the invited sample, the accepting sample, and the data producing sample. In this study the universe consists of all clerical and secretarial personnel at NPS. The majority of these personnel either use WP equipment or will be exposed to it sometime in their career. The population and the invited sample are both represented by the 50 personnel who were asked to participate in the survey. The accepting sample consists of the 36 clerical/secretarial workers who completed the survey. Finally, the data producing sample consists of the 31 respondents who correctly completed the survey. Table VII illustrates the sample selection.

D. BACKGROUND INFORMATION

After the surveys were collected from participating clerical/secretarial personnel, each form was checked for accuracy and completeness. Data from the 31 data-producing surveys was then tabulated and recorded. The first seven questions pertained to background information. All respondents were women, and all were employed in the GS-3 to GS-6 range. Table VIII shows the government service rating breakdown. The data from questions 2 and 6 was tabulated and a mean was calculated utilizing the following formula [Ref. 41],

$$\text{SAMPLE MEAN } (\bar{x}) = \frac{\sum x}{n}$$

where: x = value of the respondent

n = number of the sample

TABLE VII

Sample Selection

UNIVERSE	All Secretarial/Clerical Personnel at NPS
POPULATION	50 Randomly Selected Secretarial/Clerical Personnel at NPS
INVITED SAMPLE	50 Randomly Selected Secretarial/Clerical Personnel at NPS
ACCEPTING SAMPLE	36 Secretarial/Clerical NPS Personnel who returned the survey
DATA-PRODUCING SAMPLE	31 Secretarial/Clerical NPS Personnel who correctly completed the survey

TABLE VIII

Sample Breakdown by GS Rating

RATING	NUMBER	PERCENTAGE
GS-3	7	.23
GS-4	10	.32
GS-5	12	.39
GS-6	2	.06

This produced a mean of 64.8 words per minute typing and a mean age of 33.3 years. Questions number 3 through 5 and question 7 produced the following information which is also located in Appendix B in the form of histograms.

1. Educational Level

. The educational level of the respondents is as follows:

10 percent graduated from high school or have their G.E.D.
58 percent have some college or technical training beyond high school.
26 percent graduated from college.
3 percent have some graduate school.
3 percent have a graduate degree.

2. Years of Federal Service

The experience level as a federal civilian employee is as follows:

10 percent have worked less than one year.
48 percent have worked between one and five years.
29 percent have worked between five and ten years.
13 percent have worked between ten and twenty years.

3. Formal Secretarial Training

61 percent of the respondents have had no formal secretarial training. Of the 39 percent which have had some formal training, some have taken two years of secretarial courses while others have completed one semester of training.

4. Time in Present NPS Position

The time at the present NPS position is as follows:

16 percent have been at their present job less than three months.
31 percent have been at their present job between three and eleven months.
29 percent have been at their present job between 1 and 3 years.
23 percent have been at their present job more than 3 years.

5. Job Activity Breakdown

In addition to providing background information, respondents were asked to divide their work into the categories listed in question 8, and any other categories, by percentage. As shown in Table IX, the majority of the secretarial/clerical workers time is spent typing, performing general clerical work, and either placing or receiving calls. Activities specified in the "other" cate-

TABLE IX

Job Activity Breakdown

TASK	PERCENT OF TIME
Dictation	.003
General and Statistical Typing and Proofreading	.404
Filing	.056
Telephoning	.145
Mail	.034
"Go-Fering" Run errands, etc.	.033
General Clerical Work	.235
Personal Time	.022
Waiting for Work	.016
Other	.052
(Total)	1.000

gory included the supervising and counseling of other clerical personnel, training new hires, duplicating materials for staff and faculty personnel, answering questions from students, and running errands to other buildings.

Question 19 asked the workers to specify the type of documents they worked with most often and question 13 asked for information regarding any seasonal tasks. In response to question 19, the majority of the personnel surveyed work with manuscripts for faculty members, letters and memos for

their supervisors, and to some extent forms, brochures, and reports. Seasonal tasks, question 13, were centered around the academic quarter system at the school. These tasks included typing research proposals, exams, section lists and enrollment summaries, and graduation reports. Respondents from the supply and public works departments listed fiscal quarter related reports such as the operational target (OPTAR) spending report and contracts. Question 12 asked personnel to provide the current turnaround time for documents which required typing. The results were as follows:

14 percent of respondents reported a 1-2 hour turnaround.
64 percent reported a 1 day (8 working hours) turnaround.
14 percent reported a 2 day turnaround time.
8 percent reported a turnaround of greater than 2 days.

Turnaround times of greater than 2 days, are generally the result of lengthy manuscripts or technical reports. From talking with the respondents during survey distribution and from comments added to question 12, over 50 percent of the workers noted that their turnaround times were directly affected by the availability of their respective WP system. Turnaround times increased as the availability of the WP system decreased. The task could still be performed, however, use of a typewriter often resulted in increased turnaround times.

6. Work Hindrances

Question 9 asked personnel to list the major hindrances to the performance of their jobs. Respondents provided ten major categories of hindrances which are listed in Table X along with the percentage of respondents who

TABLE X

Situations Which Hinder Work Performance

SITUATION	PERCENTAGE OF RESPONDENTS
1) Telephone Interruptions	.61
2) WP Equipment Down or Unavailable	.23
3) Personnel Interruptions	.19
4) Inadequate WP Training	.17
5) Walking Documents through for final approval/signature	.16
6) Poor Quality Supplies/ Supplies unavailable	.10
7) Schedule of Boss	.06
8) Departmental Cooperation	.06
9) Making Copies	.03
10) General Office Confusion/Noise	.03

listed the item. As the table shows, the major interruption to the workers job is the telephone. Several respondents added the comment that when they were utilizing a word processor not located in the office, such as the Administrative Science Department's Lanier LTE-3D which is located in a separate room with no phone, other personnel would interrupt them by relaying phone messages. Phone interruptions continually added to the increase in document turnaround times. The second highest category is equipment down time or unavailability due to excessive use. Once a document is entered into the system and placed on main memory, such as the IBM 3033AP Script system, or on an

offline storage media such as a mag card or floppy disk, if the system goes down, there is no way to work on the document until the system is fixed. Personnel interruptions, the third highest category, also serve to distract the clerical personnel. Answering student or staff/faculty questions often takes time and this is time taken away from the preparation of a document. Inadequate training was included on several surveys. While the majority of respondents felt on the job training was useful, many noted that the constant interruptions precluded them from adequately learning the system. One individual attended a DEC WT/78 training course and believed that all personnel utilizing WP systems should receive similar training. Walking through documents for final approval and signature was also a major hindrance listed. Valuable time was lost from the job while tracking down supervisors for final review and approval.

From the job distractions noted above, it would seem that a word processing center (WPC) or centers may be in order at the postgraduate school. With the establishment of a word processing center, personnel requiring the typing or preparation of lengthy documents such as manuscripts, reports, or theses, would submit them to the center which would be relatively free from the daily interruptions listed above. This would not necessarily require the hiring of more personnel. The number of clerical workers in each office could be reduced, with those desiring a transfer, being placed in the word processing center. A logical career progression might be to start as an office worker and then progress to the WPC. The formation of a WPC would present problems however, in that it would deprive a worker of variety and would also restrict socialization on the job. Electronic mail could also prove to be beneficial at NPS. With its introduction, workers would no longer have to walk a document through for final approval. The document could

be relayed to each necessary department via interconnected terminals. Appropriate changes could be made if necessary, and the final copy returned to the secretary for printing and distribution.

E. WORKER SATISFACTION

According to Websters Dictionary, satisfaction is defined as, "the complete fulfillment of a need or want, or the attainment of a desired end" [Ref. 42]. There are many measures of job satisfaction available and, as Schletzer notes in her doctoral thesis they may be classified as either "direct or indirect, objective or subjective, structured or unstructured, questionnaire or interview" [Ref. 43]. Whichever measure is utilized, it must ask the respondent about the entire job or about different job aspects. Organizations must decide if they are interested in learning about the overall satisfaction level of workers, or specific items which the workers believe make positive or negative contributions to their own satisfaction level. The method included in the word processing survey distributed to workers at NPS is the Hoppock Job Satisfaction Blank. This questionnaire was designed by Robert Hoppock in 1935 [Ref. 44], to measure the overall job satisfaction level, and it has become one of the most widely used instruments in this area. When completing the survey, workers are asked to respond to four 7 choice items which ask how much the individual likes his or her position, how much of the time the person feels satisfied with the job, how the worker feels he compares with other people in liking their jobs and how he feels about changing his position. In the word processing survey (Appendix A), questions 13, 15, 16, and 17 represent the Hoppock Blank. When scoring the results, values of one to seven are assigned to the individual responses in each

question with the larger numbers representing satisfaction and the smaller numbers dissatisfaction. The corrected reliability reported for this scale was approximately .83. In addition to these four questions, question 14 was included to measure job turnover at NPS. Question 10 was included to provide the workers with some flexibility in their responses.

After scoring the 31 data-producing surveys, the Minitab Statistical Package [Ref. 45], on the IBM 3033AP was utilized to generate a mean and standard deviation for the responses. Minitab utilizes the the following formulas:

MEAN ($\bar{x}$): $$\bar{x} = \frac{\sum x}{n}$$

STANDARD DEVIATION (s): $$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$

Minitab produced the following information:

MEAN: 19.71

STANDARD DEVIATION: 4.27

In order to use this information, it is necessary to compare it with the results generated from other samples. In a 1976 paper entitled, "The Valility and Reliability of Hoppock's Job Satisfaction Measure", Charles McNicholas [Ref. 46], provides the results of three samples which utilized the Hoppock Job Satisfaction Blank. These three samples consisted of (1) 360 managers in a public utility company, (2) over 17,000 Department of Defense civil service employees, and (3) approximately 11,000 military personnel in all grades up to colonel. Another sample (4), was generated in a 1977 thesis entitled "A Behavioral Assessment of Word Processing Centers" by Donald Royner and Jon King [Ref. 47]. These four samples and the sample from the Naval Postgraduate School (5) are shown in Table XI.

TABLE XI

Five Samples Utilizing Hoppock Job Satisfaction Blank

SAMPLE	NUMBER	MEAN	STANDARD DEVIATION
1	360	21.25	2.73
2	17,110	19.31	4.07
3	10,996	17.69	4.98
4	62	18.39	4.07
5	31	19.71	4.27

From looking at the data, it would initially seem that clerical and secretarial personnel at NPS are more satisfied with their jobs than any other sample except the first. In order to evaluate the data correctly, however, it is necessary to perform a test of significance. The following example compares the WPC sample and the sample obtained at NPS. This comparison uses the t-test [Ref. 48]. This method will test the hypothesis that the NPS mean for satisfaction is significantly higher than the WPC mean. The following data is used:

$\bar{x} = 19.71$ $\quad s = 4.27$

$u_0 = 18.39$ $\quad n = 31$

where:

$\bar{x}$ = the mean of the sample
s = the standard deviation of the sample
n = the sample size
u_0 = mean of the comparison population (in this case assumed to be the WPC)

This data is used in the "t" formula which is:

$$t = \frac{\bar{x} - u_0}{s / \sqrt{n}}$$

This produces:

$$t = .417$$

A one-tail t test at a .05 level of significance will require a value of 1.65 to indicate significance. This value is found in the statistical tables found in the back of statistics texts. To complete this example the hypothesis that the NPS mean is equal to the WPC mean (known as the null hypothesis (H_o)) is compared against the hypothesis that the NPS mean is greater than the WPC mean (known as the alternate hypothesis (H_a)) as follows:

$$H_o : u = 18.39$$

$$H_a : u > 18.39$$

In this case, .417 is not > 1.65, therefore the alternate hypothesis cannot be accepted. The difference between the sample mean of 19.71 and the hypothetical mean, "u", could

be attributed to chance, therefore the hypothesis that the two are equal must either be accepted or judgement must be reserved. Similar comparisons could be made between the other samples and the satisfaction level of NPS personnel.

1. Satisfaction Improvement

Question 10 provided the respondents with the opportunity to list any changes in their environment which they felt would improve job satisfaction. Responses are shown in Table XII, with the correspondending percentage of personnel

TABLE XII

Changes to Improve Job Satisfaction

CHANGES	PERCENTAGE
Office Assistant	.27
Improved Training	.25
WP in a Secluded Area	.22
Improved WP Equipment	.22
Improved Duplicating Machine	.14
Better Office Supplies	.06
Better Pay	.03

who included the change. Most of the personnel who requested an aide to answer the phone and run errands also suggested that the word processing facilities be moved to a secluded area. In this manner, their work would not be continually interrupted. 25 percent of the respondents stated that improved training, especially in the WP area was definitely in order. Many individuals compained of the down time on WP equipment as well as the duplicating machines. Only one of the 31 respondents stated that increased pay would increase their job satisfaction level.

2. Personnel Turnover

Question 15 asked the workers to state their intentions regarding staying or leaving their present job. It produced the following results as listed below and shown in the form of a histogram (Appendix B).

16 percent definitely will leave (resignation).
6 percent definitely will leave (transfer).
16 percent are leaning toward resigning or transferring.
19 percent are leaning toward staying.
30 percent definitely will stay.

Many of the respondents felt it necessary to justify their reason for leaving due to resignation. The two major reasons given were that the spouse was a student at NPS and was completing school or that the individual was getting married.

F. WORD PROCESSING SYSTEM CHARACTERISTICS

In order to explore the system characteristics that operators desired in a word processing system, it was first necessary to ascertain which systems were in use at the postgraduate school. Question 20 provided the following information as shown in Table XIII. During survey distribution it was discovered that several office were scheduled for the installation of A. B. Dick word processing systems. These offices were shown in chapter 3. As Table XIII shows, all secretarial/clerical personnel have access to an electric typewriter. Of the 31 respondents, 24 utilized at least one word processing system in addition to the electric typewriter. Workers noted that their use of the available

TABLE XIII

WP Systems in Use at NPS

SYSTEM	# OF USERS	PERCENTAGE
Manual typewriter	0	0.00
Electric typewriter (only)	7	.23
Elec. Type. + WPE	24	.77
IBM Mag Card I	1	.03
IBM Mag Card II	3	.10
Lanier LTE-3D	9	.29
DEC WT/78	5	.16
AM Varityper	1	.03
Script (IBM 3033AP)	3	.10
Osbourne Minicomputer	1	.03

WP system ranged from as little as 10 percent of their time to as much as 90 percent.

Question 21 asked the 24 workers who utilized a WP system in addition to the typewriter to provide reasons why the work load was divided. Table XIII displays the information as the number and percentage of respondents who listed each reason. As the table shows, the major reason that operators prefer to use the typewriter over a word processor is a lack of system knowledge. Several surveys, had the added comment that more time and effort should be devoted to training the operators in the use of their respective systems. The second major reason listed, nature of work, was attributed to the use of government forms which are not stored in the WP system, and the necessity for the workers to produce memos and other relatively short material which are easier to type on the typewriter. 11 of the 24 users listed system response time and 10 users noted system availability as reasons for not using WP. During survey distribution, several workers commented on how difficult it was to utilize a particular system because it was always

being used by someone else. This not only precluded the operator from accomplishing work on the system, but also restricted training. 9 of the persons surveyed listed system set-up time and the quality of printed output as reasons to avoid the WP system. When discussing this with them, they stated that the time required to set-up the system is often better spent at their desk. For those systems such as Script which do not have letter quality printed output, operators believed that it was a waste of time to type a letter or report utilizing script, if the

TABLE XIV

Reasons for Division of Workload

REASON	# OF USERS	PERCENTAGE
1. Physical proximity	2	.08
2. Nature of Work	11	.42
3. Set-up time	9	.37
4. User Friendly	2	.08
5. System Knowledge	15	.63
6. System Availability	10	.42
7. Response Time	10	.42
8. Quality--printed output	9	.37
9. Other	2	.08

work had to be redone. Table XV breaks down the information provided in Table XIV by system.

Interpreting the data in Table XV reveals much of the same information found in Table XIV. Operators are not as knowledgeable about the systems as is required or desired. All 3 of the persons that use Script mentioned the nature of their work as a reason for the division of workload and 2 of the 3 listed the quality of the printed output. In the "other" category, one operator of the Lanier LTE-3D stated

TABLE XV

Division of Workload by System

SYSTEM	REASON (# OF USERS)								
	1	2	3	4	5	6	7	8	9
Manual Typewriter	---	---	---	---	---	---	---	---	---
Elec Typewriter	---	---	---	---	---	---	---	---	---
IBM Mag Card I	---	---	---	---	---	---	---	---	---
IBM Mag Card II	---	---	---	---	---	---	---	---	---
Lanier LTE-3D	1	5	5	2	7	6	5	4	1
DEC WT/78	---	3	3	---	3	1	3	1	1
AM Varityper	---	---	---	---	1	---	---	---	---
Script (IBM 3033AP)	1	3	1	---	3	3	2	3	---
Osbourne Mini.	---	---	---	---	1	---	---	1	---
TOTAL	2	11	9	2	15	10	10	9	2

that she was unable to use the system for more than 20 minutes without acquiring a headache, and a DEC WT/78 user stated that more forms should be stored in the system.

G. BENEFICIAL AND DETRIMENTAL FEATURES

Question 22 asked the user to list the features of their particular word processor which they found to be the most or least helpful in the performance of their jobs. These features are discussed by system.

1. IBM Mag Card I and II

Information provided on the IBM Mag Card units was somewhat limited due to the fact that only 4 workers utilize this equipment. All respondents felt that these systems were vast improvements over the electric typewriter and found the memory (magnetic card media) to be most helpful. The worst feature noted was the necessary to change the information on the magnetic media. The users were all aware of the other systems available and realized that many improvements to the Mag Card units are available.

2. Script (IBM 3033AP)

The major advantage to the script function was its availability. All three users noted that it was relatively easy to find an open terminal. This was the only benefit listed. The bad points included poor quality of printed output and slow system response time. Waiting at the printer during peak utilization periods was a critical waste of time. One operator felt that the system, although very helpful for in-house reports, was not all that user friendly in that the list of possible commands seemed to continue forever.

3. AM Varityper

Positive features of the Varityper included the ease of correction, the floppy disk memory media, and the increased speed. Features or characteristics which were least beneficial included system noise, the lack of text manipulation capability, and the ability to view only a single line.

4. Osbourne Minicomputer

No comments were provided for this system.

5. DEC WT/78

All 5 users of the DEC system commented on the correction feature and found it most beneficial. They also listed the text manipulation characteristics and the system responsiveness as major benefits. Finally, at least one of the operators listed the storage feature, embedded rulers, disk filing system, ability to draft a document into smooth copy, and ease in producing mailing lists as definite pluses. Under poor characteristics 3 of the 5 noted that the users manual was weak and that formal training should be obtained for all users. In addition, the lack of a sorting feature was noted. One user complained of operator fatigue when using the system for long periods.

6. Lanier LTE-3D

More information was obtained for this system than any other due to the fact that 9 of the 31 respondents, or 29 percent use the system. The beneficial features are as follows:

- Ease of correction
- Storage of documents
- Increased typing speed
- Text manipulation
- Insertion/Deletion of words, lines, paragraphs
- Joining pages
- Transportability of data
- Automatic carriage return
- Centering capability
- Repaging
- Printing

The least beneficial or useful features are as follows:

- Partial display of page
- CRT eyestrain
- Unreliability (system down time)
- Poor for technical (equation) typing
- Users manual
- Heat from machine
- Noise from printer
- Necessity to store each individual page
- Warm up time
- Poor print quality (letter spacing not consistent)
- Keyboard too low

H. THE IDEAL SYSTEM

Question 23 was included to obtain data on system characteristics that the operators had used or heard about at one time but were not presently avialable on systems here at the school. In concluding the survey, respondants provided information on a system which would meet all their needs. 17 of the respondants provided information for this question as shown in Table XVI.

As Table X shows there are many features that different operators find useful in a system, however the one feature which is most important on any system is a reliable users manual. This, coupled with a dedicated training program is a basic requirement for all systems. Combining the information from questions 22 and 23 results in a system with the following characteristics:

- Text manipulation
- Automatic spelling correction
- Users manual and training program
- Full page screen

TABLE XVI

Desired System Characteristics

CHARACTERISTIC	# OF USERS	PERCENTAGE
Working users manual	11	.65
Text manipulation	11	.65
Full page screen	10	.59
Spelling correction	9	.53
High quality printer	9	.53
Operator training	8	.47
Increased availiability	3	.18
Sorting Capability	2	.12
Color graphics	2	.12
Increased Reliability	2	.12
Equation Capability	2	.12
Quiet printer	1	.06
Libraries	1	.06
Preprinted forms	1	.06
Vertical lines	1	.06

- High quality/quiet printer
- Color graphics for chart production
- User designed console (human factor consideration)
- Capability to use preprinted forms
- Sorting capability
- Libraries
- Equation/Symbol capability
- Short warm-up period
- System compatible/transportable storage media
- Automatic carriage return
- Increased storage capacity
- Embedded rulers
- Vertical and horizontal line production

It should be noted that with each additional feature comes a corresponding increase in system price. It is highly unlikely that all the items listed above could be included in one system due to cost considerations , however, system

operators at NPS have found these features to be most beneficial to their work. The end result would be increased operator productivity and satisfaction.

V. SUMMARY AND CONCLUSIONS

The purpose of this chapter is to summarize areas presented and make recommendations for the implementation of a word processing system at the Naval Postgraduate School or any other information dependant organization.

A. WHY CHANGE TO WORD PROCESSING ?

As one surveys past developments in the history of word processing two major characteristics stand out. The first is that after each technological breakthrough and corresponding period of high costs for the new equipment, the price of implementing and utilizing the system falls quite rapidly. The other main impetus for growth in the WP market is the price of labor. While the costs of systems continues to decline, the cost of manpower has been rising steadily over the past two decades. As Whithead [Ref. 49], suggests the point has now been reached where it is no longer cost beneficial to continue adding additional workers in an attempt to solve an organizational productivity problem. It is now cheaper to introduce automated systems than to continue using traditional means. Successful implementation of word processing systems and the corresponding increases in productivity require the total committment of all organizational levels. It is no longer enough for an organization to find the cheapest machine on the market, place it in front of the secretary, and then expect major productivity improvements. The old approach to a systems study, as shown in Figure 5-1, [Ref. 50], where you study the secretary's job and then decide on what she needs must be improved upon. A system should fit the needs of the organization as well as

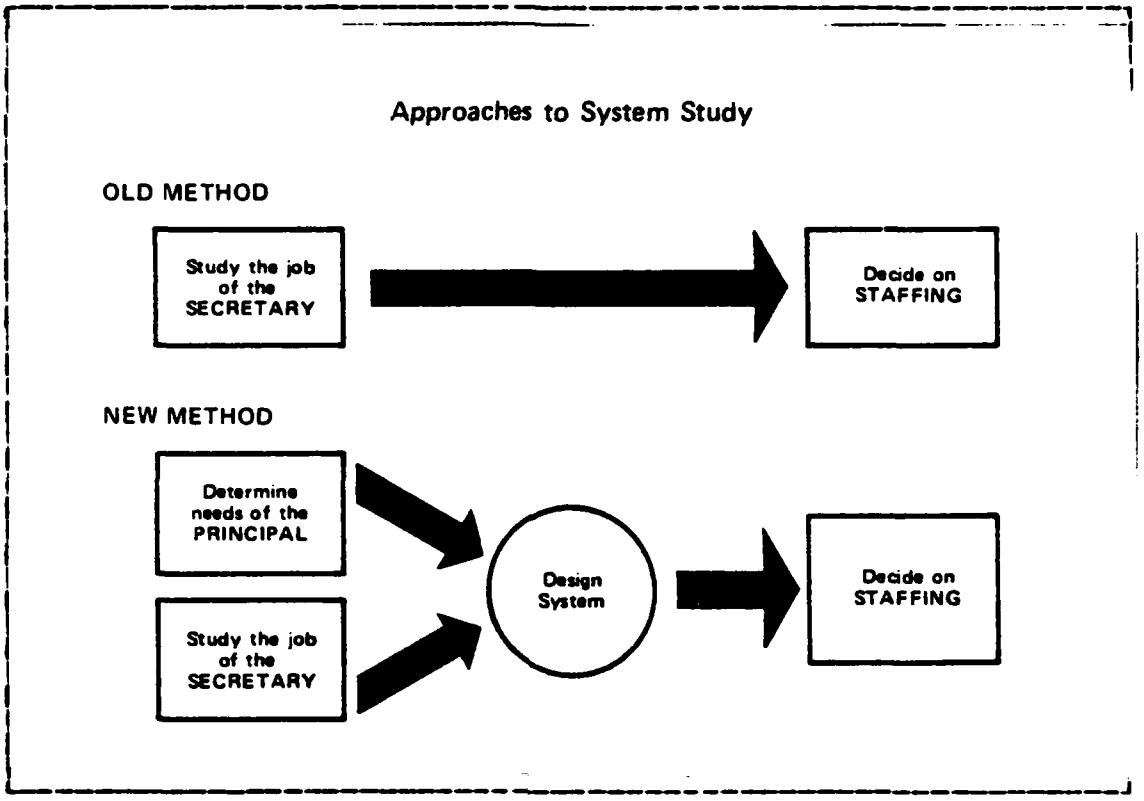


Figure 5.1 Approaches to Systems Study.

the needs of the secretary. Areas such as human factors considerations and the educational level of the operators must be considered. What is required is a well thought out, documented plan for the implementation of the system.

B. IMPLEMENTING A WORD PROCESSING SYSTEM

There are many different suggestions on how to successfuly implement and utilize a word processing system in an organization, and the number of steps in the process range from one or two to infinity. There is a common ground however. All seem to agree, that an organization must first understand where it is before it attempts to decide upon where it wants to go.

1. Appraise Your Present Situation

The first question that must be answered when considering a new word processing system or updating present capabilities is; "What is the present organizational situation regarding word processing?" The situation must be examined both internally and externally in order to fully understand all factors involved. Current systems in use, flows of information, operator requirements, and system utilization are only a few of the factors which must be considered. Much of this information may be gathered by using a survey, as was done at NPS. This survey revealed that (1) the majority of WP operators were well educated, (2) improved users manuals and more training were desired, and (3) productive WP time was lost due to constant interruptions. This represents only a sample of the valuable information available. Secretaries and other possible users of a word processing system are more than anxious to provide information on exactly what they do and on what characteristics a system should have to improve their work. All one has to do is ask. At the same time it is important to ascertain upper management's position on any change to the present system. If top-level management does not wish to trade in electric typewriters for word processors this presents a major obstacle. It is not impossible to overcome, however, it is much easier to deal with when a system is under consideration than after the funds have already been allocated.

2. Define and Set Organizational Goals

Once the present status of the organization is ascertained, realistic goals may be established. The organization is answering the question; "Where do I want to go?" When considering word processing a conscientious manager

will establish long-range, intermediate, and short-range goals. The short range goal may be to thoroughly educate one member of the organization in the area of available WP systems, while a long range goal may be to establish an organizational wide distributed word processing system. Other goals, as discussed by Primrose [Ref. 51], include:

(1) Increasing Productivity -- For example, increase volume output by 10 percent within 6 months and 20 percent after 1 year;

(2) Quality Control -- To ensure quality of output is not sacrificed for increased volume. For example, decrease typographical errors of system operators while increasing speed;

(3) Establish Training Programs -- Ensure all users are thoroughly indoctrinated and educated in the correct use of the system. Acquire manufacturer users manuals or if inadequate develop own;

(4) Establish Job Descriptions -- Provide for career paths in the word processing field. Explain to all personnel that the incoming system represents a new and challenging career path. Dispell all notions that the workers are being replaced by machines.

At this stage, a feasibility study may prove most beneficial. There may exist several goals, many of which are not compatible. A feasibility study will prove helpful in determining which goals are most realistic. Other goals are not necessarily eliminated. They may instead be shifted from a short or intermediate type goal to a long range one.

3. Plan of Action

Now that the organization is totally familiar with its present situation and has established some direction and goals for the end result, it must decide on a plan of action to get there. This is the area where many organizations fail. From exhausting literature research and reviewing the results of many implementation procedures, there is often one factor missing from a carefully designed plan of action. Many organizations fail to place adequate emphasis on the development of an organizational interface with the system designers. Instead, they often place their trust in consultants or manufacturers' representatives to decide upon, design, and install word processing systems that are perfect for their particular situation. Many small organizations, with very limited resources, have no other choice. This plan of action is not always a poor one, as who else would know more about a system's characteristics and capabilities than the company that designed it or a consultant who has years of experience working with it. Most large organizations have a choice.

It would be foolish to believe that one person from the organization could learn everything there is to know about word processing systems in a relatively short period. It is equally as foolish to believe that the same individual could not learn enough about WP to work with the manufacturers or consultants. This person or persons must act as the interface between the organization and the companies interested in selling and installing a system. Previous chapters have stressed the importance of productivity factors, ergonomics, and meeting the requirements of the organization. Someone must be educated in these areas in order to ensure the system purchased is one that meets all the established requirements. The same person or persons

must also be familiar with systems that are presently in the marketplace. It would not be cost beneficial to purchase an additional 500K of memory that will never be used, or to install a system or systems that are not compatible with systems under future consideration.

The bottom line is involving members of the organization in the overall plan. Personnel who are involved in the process should know exactly what is required of them. The assignments should be divided among all participants to ensure everyone is working towards the same goals. Everyone should do his or her part. The use of consultants or manufacturers' representatives is not bad in itself. They often provide a significant intelligence base. What is poor, is when these individuals are not provided with adequate guidance or direction. Someone must keep the best interests of the organization in mind. That someone should be a member of the organization.

4. Selection of the System

Once organizational needs are determined, goals set, and a plan of action decided upon, it is time to analyze the systems that will meet the requirements and make a final selection. Many systems have similar functions, and this makes the final decision quite difficult. At the same time there are always cost constraints to consider. A particular system may have that one desireable extra function, but is it worth the extra expense. At this point it is imperative to consider areas such as organizational growth, system compatibility, and productivity. If the organization is growing at a fairly stable pace, it may be wise to purchase a system that will expand to meet this growth. How much is increased productivity worth? Are managers making decisions that require instantaneous information, or is a on or two hour delay acceptable? These questions are very difficult

to answer, but they shoul at least be considered. Cost considerations and personal preferences will usually preclude any one system from meeting all the needs, but an organization should meet as many as possible in the most effective manner.

5. System Installation

While the selection process is taking place, the question of system installation should alsc be answered. For a small system, such as an IBM Magcard II, the installation itself is relatively simple. Installing a distributed system which may connect several buildings or states would be more difficult. Both have one thing in common: personnel must be trained to use them. Whether the manufacturer provides the training or the organization establishes its own program is a critical decision. The survey at NPS showed the importance of training personnel in the use of a system. On the job training may work in some situations, however constant interruptions often preclude the operator from learning the system. It is important to establish time schedules for both the installation process and operator training.

Secretarial and clerical personnel must be indoctrinated in the use and benefits of the new system. As the NPS survey revealed, people are often skeptical about changes. Their sense of job security is threatened. This attitude is counterproductive to say the least and should be eliminated as early as possible.

6. Measure System Performance

Does the system meet the organizational expections? Only a well defined and properly managed monitor system will answer this question. Once again the actual users in addition to all those who benefit from the system can provide

the necessary information. As the organization changes, the word processing system should expand or contract to meet these changes. Adjustments are always necessary. By reviewing the organizational requirements and system performance, the organization will not be faced with the sudden realization that it has outgrown its word processing system.

C. CONCLUSION

Determining the informational needs of any organization and deciding upon a word processing system to meet these needs is a time consuming process. It requires the assistance of the organization involved. There is no such thing as a quick fix or overnight solution for word processing problems.

This thesis has attempted to reveal some of the areas that must be considered when contemplating a new or improved system. The areas discussed here are as applicable to the Naval Postgraduate School as they are to any large scale corporation. The information is there which allows the organization to determine its own needs, set its own goals, and work with any outside help in determining the best system for its specific needs. There is no single best plan of action for successfully choosing and implementing a word processing. There are no guareentees. The first major step required, however, is establishing a firm committment on the part of the entire organization.

APPENDIX A
WORD PROCESSING SURVEY

WORD PROCESSING SURVEY

---

1. This survey is being conducted to collect information to be used in research aimed at studying the current and future word processing requirements at the Naval Postgraduate School.

2. Word Processing may be defined as any automated system designed to cut cost and time of familiar office routines such as dictating, typing/proofing/retyping, and distributing business documents.

3. The survey data will be converted to information for use in research management and will be included in a written master's thesis. Distribution of the results of the research and the thesis will be unlimited.

4. Participation in this survey is entirely voluntary. Responses to the survey are confidential. Please take your time and answer all questions completely. Your participation will be greatly appreciated.

Dept._____ GS/Military Rate_____

1. Are you
   a. Female
   b. Male

2. How many words per minute can you type? _____

3. What is your educational level? (Indicate highest completed)
   a. Some elementary school, not a graduate
   b. Completed elementary school
   c. Some high school
   d. Graduated from high school or have G.E.D. completion certificate
   e. Some college or technical training beyond high school
   f. Graduated from college (B.A., B.S. or other Bachelors degree)
   g. Some graduate school
   h. Graduate degree (Masters, Ph.D.)

4. How many years have you been a federal civilian employee?
   a. Less than 1
   b. 1 - 5
   c. 5 - 10
   d. 10 - 20
   e. Over 20

5. Have you received any formal secretarial training?
   a. Yes
   b. No
   If yes, how much?_____
   _____
   _____

6. What was you age on your last birthday?_____

7. How long have you been in your present job at NPS?
   a. Less than 3 months
   b. 3 - 11 months
   c. 1 - 3 years
   d. More than 3 years

8. Please indicate the percent of your time during a normal workday that you spend at each activity:

TASK	PERCENT OF TIME
Dictation	_____
General and statistical typing and proofreading	_____
Filing	_____
Telephoning	_____
Mail	_____
"Go-Fering" (go for coffee etc.)	_____
General clerical work	_____
Personal Time	_____
Waiting for work	_____
Other (please specify)	
	_____
TOTAL	100%

9. What situations tend to hinder your work?

1. _____
2. _____
3. _____
4. _____
5. _____

10. What changes could be made to give you more satisfaction?

1._____
2._____
3._____
4._____
5._____

11. What is the current turnaround for documents you are required to type? (1-2 hours, same day, 2 days, etc)

_____

12. Please list seasonal tasks and time required for completion.

1._____
2._____
3._____
4._____
5._____

13. Which one of the following shows how much of the time you feel satisfied with your job?

a. Never	b. Seldom	c. Occasionally
d. About half the time	e. A good deal of the time	f. Most of the time.
g. All the time		

14. What are your intentions regarding staying or leaving your present job situatuion?

a. I definitely will leave -- I have submitted or will submit a letter of resignation.

b. I definitely will leave -- I have submitted or will submit a request for lateral transfer.

c. I am leaning toward resigning or requesting a transfer.

d. I am undecided at this time whether to stay or leave.

e. I am leaning toward staying in my present job.

f. I definitely intend to stay in my present job situation.

15. Which of the following best tells how you feel about changing your job?

a. I would quit this job at once if I could.

b. I would take almost any other job in which I could earn as much as I am earning now.

c. I would like to change both my job and my occupation.

d. I would like to exchange my present job for another.

e. I am not eager to change my present job, but I would do so if I could get another job.

f. I cannot think of any job for which I would exchange.

g. I would not exchange my job for any other.

16. Which one of the following shows how you compare with other people?

a. No one dislikes his job more than I dislike mine.

b. I dislike my job much more than most people dislike theirs.

c. I dislike my job more than most people dislike theirs.

d. I like my job about as well as as most people like theirs.

e. I like my job better than most people like theirs.

f. I like my job much better than most people like theirs.

g. No one likes his job better than I like mine.

17. Choose the one of the following statements which best tells how well you like your job.

a. I hate it
b. I dislike it
c. I don't like it.
d. I am indifferent to it.
e. I like it
f. I am enthusiastic about it
g. I love it

18. What type of documents do you type most?

example: Memos, Letters, Reports

1. _____
2. _____
3. _____
4. _____
5. _____

19. Which of the following typing and/or word processing systems are utilized in your daily work? (If you utilize more than one, please specify the percent of time used on each)

1. Manual Typewriter
2. Electric Typewriter
3. IBM MAG CARD I
4. IBM MAG CARD II
5. Lanier LTE-3D
6. DEC WT/78
7. AM Varityper
8. IBM Displaywriter
9. SCRIPT FUNCTION (IBM 3033AP)
10. Other

20. If you use more than one system (ie. electric typewriter and Lanier LTE-3D) please specify the top 5 reasons from the following list as to why.

1. Physical proximity (too far to walk)
2. Nature of work (memos vs. text)
3. Set-Up time of WP system
4. User Friendliness of system
5. Knowledge of system
6. System availability (system busy)
7. Response Time
8. Quality of printed output
9. Other

21. Of the Word Processing Systems available to you, please list the features you find most beneficial/useful.

example: Ease of correction

1._____ 5._____
2._____ 6._____
3._____ 7._____
4._____ 8._____

Please list the features you dislike or find least beneficial/useful.

1._____ 5._____
2._____ 6._____
3._____ 7._____
4._____ 8._____

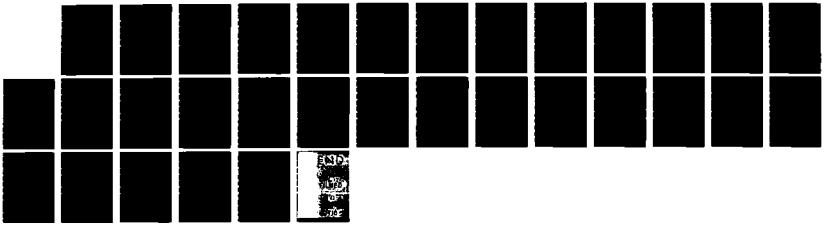
22. From your experience with word processing systems, please list in order of importance, the features you feel are necessary to make the system as responsive to your needs and/or user friendly as possible.

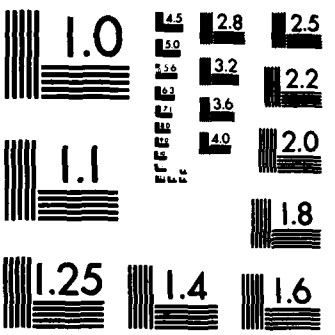
examples: Video display of full page
Spelling correction
Users manual
Text manipulation (moving paragraphs/lines)
Quality printing

1._____ 5._____
2._____ 6._____
3._____ 7._____
4._____ 8._____

PLEASE FEEL FREE TO PROVIDE ANY ADDITIONAL COMMENTS CONCERNING WORD PROCESSING SYSTEMS/CAPABILITIES AT NPS. THANK YOU FOR YOUR ASSISTANCE.

AD-A127 217 WORD PROCESSING AT THE NAVAL POSTGRADUATE SCHOOL(U) 2/2
NAVAL POSTGRADUATE SCHOOL MONTEREY CA
R E BROOKS ET AL. DEC 82
UNCLASSIFIED F/G 5/9 NL





APPENDIX B

NATIONAL ARCHIVES AND RECORDS SERVICE (NARS) STUDY

How Textual Changes Affect WPE Productivity

A Keyboard Productivity Research Project

PRELIMINARY DISTRIBUTION COPY

December 1980

General Services Administration National Archives and Records Service Office of Records and Information Management

INTRODUCTION

In order for managers to decide whether word processing equipment (WPE) is cost effective, standards and guidelines for typing productivity must be available.

To provide standards and guidelines for typing productivity to Federal agencies, NARS conducted a search for usable data regarding typing productivity on WPE. This effort revealed that no validated productivity data existed. Therefore, NARS initiated the Keyboard Productivity Research Project to compare the performance of typists on electric typewriters (ETW's) with the same performance on word processing equipment in the production of narrative textual material, which resulted in validated data that could be used to establish standards. This pamphlet describes the methodology used in the project and reports the results of the project.

PURPOSE: The project compared the performance of typists on ETW's with that on WPE. The results were analyzed to establish a basis for developing productivity standards for assessing the cost-effectiveness of several categories of WPE.

EQUIPMENT USED: Two groups of ETW's—standard ETW's (S/ETW) and self-correcting ETW's (SC/ETW)—and three groups of WPE—stand-alone, repetitive typewriters (WPE Category I); stand-alone, video-display word processors (WPE Category II); and shared-logic word processors (WPE Category III)—were used.

METHODOLOGY: Statistical methods used for this project were developed with the assistance of the Office of Personnel Management and the National Bureau of Standards and were designed to produce a 95-percent confidence level for each group of equipment. Each group of equipment was used by at least 30 participants (all participants were volunteers) except WPE Category III, which is less widely accessible in Federal Agencies. The number of participants for all groups except WPE Category III resulted in the 95-percent confidence level. The number of participants (15) using WPE Category III resulted in a 90-percent confidence level. The specific models of equipment and the number of participants in each group of equipment are shown in figure 1.

TEST DESIGN: The material to be typed consisted of five sets of pretyped copy. Each set consisted of two parts: (1) pretyped copy and (2) the same copy with handwritten changes (all in the same handwriting). The pretyped copy consisted of five pages of double-spaced narrative (25 lines per page and 65 characters per line) on general interest topics.

FIGURE 1.—GROUPS OF EQUIPMENT USED.

1. Standard Electric Typewriters (S/ETW's)

   Adler 21D
   IBM Executive
   IBM Selectric

   Number of Participants: 30

2. Self-Correcting Electric Typewriters (SC/ETW's)

Adler SC	Olivetti Lexikon 92C
IBM Selectric II	Olivetti Lexikon 93C
Olivetti Editor 4C	Royal 5000 CD

   Number of Participants: 30

3. Stand-Alone, Repetitive Typewriters (WPE Cat. I)

AB Dick Magna I	IBM MTST 775
CPT 4200	Redactron
IBM Mag Card I	Savin 900
IBM Mag Card II	Xerox 800
IBM Memory Typewriter	

   Number of Participants: 32

4. Stand-Alone, Video-Display Word Processors (WPE Cat. II)

AB Dick Magna II	Lexitron 900
Amtext 425	Lexitron 942
CPT 8000	Lexitron VT942
IBM 6-430	Lexitron VT9000
IBM System 6	Lexitron VT1303
Lanier 103	Linolex 4012
Lanier LTE 1	Micom 2000
Lanier LTE 2	NBI System 1
Lanier "No Problem"	Vydec 1200
Lexitron 92	Vydec 1400

   Number of Participants: 42

5. Shared-Logic Word Processors (WPE Cat. III)

Daconics	Wang System 20
IBM 2741 (communications terminal only)	Wang System 30
Lanier Wordplex	Wordstream MAI
Unix	

   Number of Participants: 15

To measure the effect of textual changes on retyping or playback, the handwritten changes in part 2 of each set were controlled variables. Figure 2 shows how the amount of change was varied in the pages of each set.

FIGURE 2.—NUMBER OF PAGES ON WHICH GIVEN NUMBERS OF CHANGES WERE MADE.

Number of Lines Changed (Per Page)	Sets				
	A	B	C	D	E
4 ("Light" 16%)	1	1	5	0	0
8 ("Medium" 32%)	1	1	0	5	0
14 ("Heavy" 56%)	3	3	0	0	5

The dispersal of changes was varied in each set. On some pages, the changes were dispersed throughout the page; on other pages, they were concentrated in consecutive lines.

CONSIDERATIONS IN ADMINISTERING TYPING SETS: To isolate the capabilities of each group of equipment used, it was necessary to control variables in the form and nature of input, the typing environment, operator skill levels, and geographic location.

- Form of Input—Pretyped copy was used for ease of reading and for familiar and constant input. Longhand and dictation input were not used because they introduce uncontrollable variables, such as clarity of handwriting and skill in dictation techniques. The abilities of each participant to interpret handwriting and dictation in a consistent manner would have been impossible to control.
- Nature of Input—Narrative was used because it is the most common type of material produced in Federal offices. The narrative material employed the full keyboard range, including numbers, symbols, and underlining.
- Typing Environment—Participants typed at their own work stations, using equipment that they were accustomed to. Arrangements were made to avoid such interruptions as phone calls and copying duties during the administering of the typing sets.
- Operator Skill Levels—The Office of Personnel Management stated that, on the average, operators attain their level of proficiency within 6 months of operating a particular or comparable piece of equipment. Figure 3 shows the number of participants for different lengths of experience.
- Geographic Location—All the typists were from the Washington, D.C., metropolitan area and were employed by the Federal agencies listed in figure 4.

FIGURE 3.—OPERATOR EXPERIENCE.*

	Less Than 6 Months	6 - 11 Months	12 Months or More	Total
Number . . .	23	32	94	149
Percent . . .	15	22	63	100

*Experience means the amount of time the participant had been using the equipment on which the material was typed, not the participant's total typing experience.

FIGURE 4.—DISTRIBUTION OF TYPISTS BY AGENCY OF EMPLOYMENT IN THE WASHINGTON, DC, METROPOLITAN AREA.

Agency	Number	Percent
Agriculture	12	8.1
Air Force	19	12.8
Army	17	11.4
Commerce	33	22.1
Federal Bureau of Investigation . . .	9	6.0
General Services Administration . . .	24	16.1
Health, Education, and Welfare . . .	11	7.4
Veterans Administration	24	16.1
Total	149	100.0

PRELIMINARY TESTING: Preliminary administration of the typing sets was conducted at the U.S. Office of Education to: (1) determine the adequacy of the material in the typing sets, (2) verify the clarity of the procedural instructions, and (3) substantiate the method of recording typing time. The results were analyzed and necessary adjustments were made to the typing material and administration procedures.

ACTUAL TESTING: NARS management analysts were trained to administer the typing sets. Participants were assigned code numbers to ensure anonymity. Each participant typed all five sets of material. One set was typed on each of 5 consecutive days. (Work schedules or leave plans precluded this for some operators.) The order in which the sets were typed was varied, as was the time of day for typing each set, but at least one set was typed in the morning and at least one other in the afternoon. NARS observers recorded, to the second, the time taken to complete each page of typing, including time for corrections and for making equipment settings, but not for unavoidable interruptions.

- Part 1 (from pretyped copy). All participants typed the five pages of copy, and in the process WPE operators recorded the material in their machines' memory. All participants followed their usual typing practices, such as those for correcting errors (using correcting tape, strikeover, white out, etc.). If, because of errors, a participant chose to start over on a page, the throwaway page was marked and attached to the back of the completed typing. Time "lost" by such restarts was included in the total typing time. Time lost by machine problems, routine maintenance (e.g., changing ribbons), or unavoidable interruptions was not recorded.

- Part 2 (from pretyped copy with handwritten changes). The second part of each set was typed immediately after the first part. Participants on ETW's retyped the entire five pages; those on WPE retrieved the recorded pages and manually typed only the changes. All participants were instructed not to correct any errors they may have made in part 1 of the test unless the corrections were necessary to incorporate the handwritten changes.

ANALYSIS OF TEST RESULTS: Each participant's work was proofread twice and the number of errors and number of lines with errors (error lines) were totaled. Each incorrectly typed or missing word or punctuation mark counted as an error (no more than one error per word). Strikeovers were not counted as errors because some participants normally used strikeovers to correct errors. The following data for each participant were entered on a computer: operator identification number, experience level, machine model identification, error-line counts, and typing times. Then the following calculations were made for each participant:

- Total Net Lines. The total number of usable lines was computed by the formula TNL = TLT - EL, where:

  TNL = Total Net Lines
  TLT = Total Lines Typed
  EL = Error Lines

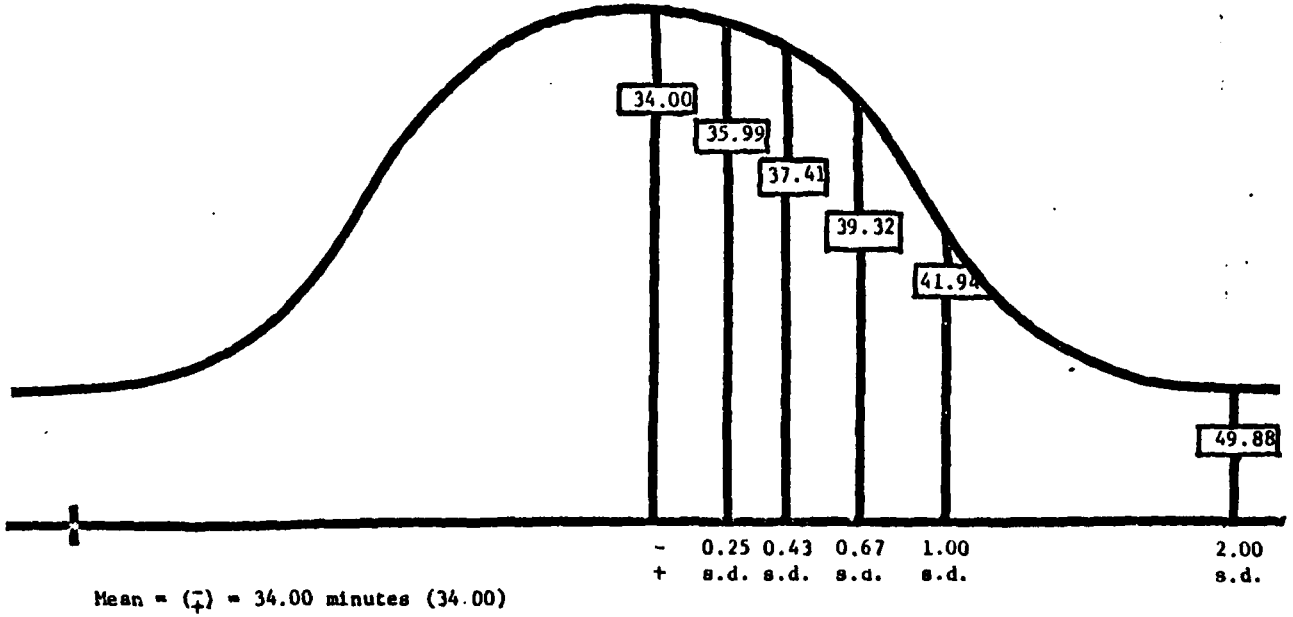
- The Productivity Rate (in lines per hour). The productivity rate was computed by the formula $PR = \frac{TNL}{TM} \times 60$, where:

  PR = Productivity Rate (in lines per hour)
  TNL = Total Net Lines
  TM = Total Minutes (to complete typing)

  For example, the mean and standard deviation for TM for participants using S/ETW's is shown in figure 5.

FINDINGS: Figure 6 shows the productivity rate for each group of equipment based on the data for original typing and for the specific change rates of 16, 32, and 56 percents. Figure 7 shows a projection of the data in figure 6.

FIGURE 5.—DISTRIBUTION OF TIME (MINUTES) REQUIRED BY PARTICIPANTS TO COMPLETE ORIGINAL TYPING USING STANDARD ELECTRIC TYPEWRITERS (S/ETW's).



Mean = ($\bar{x}$) = 34.00 minutes (34.00)
Standard Deviation (s.d.) = 7.94 minutes

FIGURE 6.—PRODUCTIVITY RATES MEASURED IN NET LINES PER HOUR.

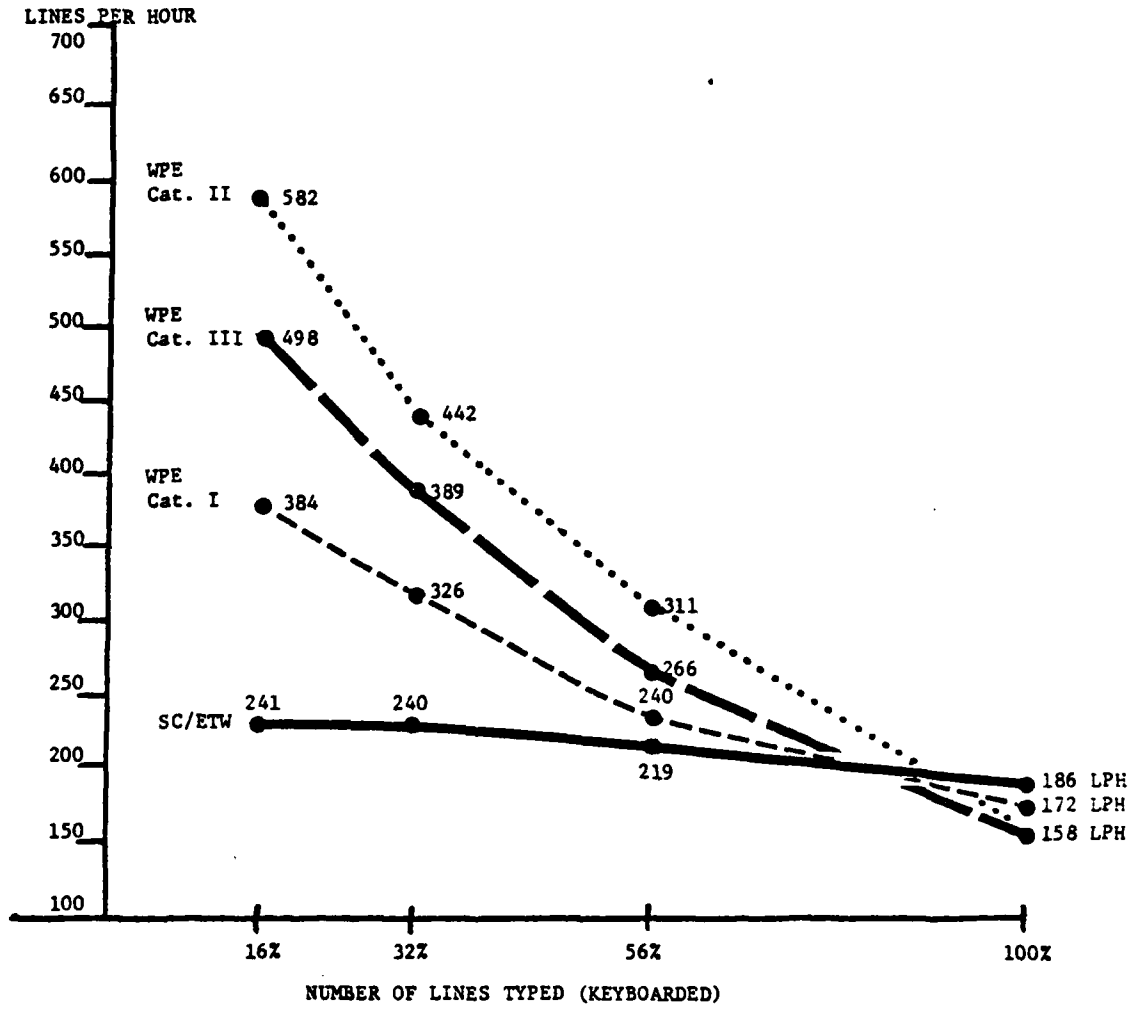
A. Original Typing

Percent of Lines Typed	Typewriters		WPE		
	S/ETW	SC/ETW	Cat I	Cat II	Cat III
100	170	186	172	158	158

B. Revised Material

Percent of Lines Typed	Typewriters		WPE		
	S/ETW	SC/ETW	Cat I	Cat II	Cat III
16	229	241	384	582	498
32	219	240	326	442	389
56	211	219	240	311	266

FIGURE 7.—PRODUCTIVITY RATES OF WPE COMPARED WITH SC/ETW's.



Because each typing set contained concentrated changes on some pages and dispersed changes on other pages, productivity rates for both concentrated and dispersed changes were derived from the data. Typing concentrated changes on WPE involves fewer correction stops than typing dispersed changes. The result is higher productivity rates for typing concentrated changes. Approximately two-thirds of the pages contained dispersed changes and one-third of the pages contained concentrated changes. Figure 8 shows productivity rates for typing dispersed and concentrated changes on the three WPE categories of equipment.

FIGURE 8.—PRODUCTIVITY RATE MEASURED IN LINES PER HOUR FOR DISPERSED AND CONCENTRATED CHANGES.

Change Rate	WPE Cat I	Cat II	Cat III
16 percent			
For dispersed changes	363	538	476
For concentrated changes	451	737	561
32 percent			
For dispersed changes	317	438	376
For concentrated changes	374	454	427
56 percent			
For dispersed changes	238	306	263
For concentrated changes	275	361	297

The results revealed that, for original typing, SC/ETW's outproduce all other groups of equipment. For typing with changes or revisions, the most significant productivity increases occur when WPE Category II is used. For example, the use of WPE Category II resulted in a productivity level that was 254 percent of that achieved on S/ETW's when there was a 16 percent change rate, and 241 percent of that achieved on SC/ETW's. At the 32 percent change rate, use of WPE Category II resulted in a productivity level that was 202 percent of that achieved on S/ETW's and 184 percent of that achieved on SC/ETW's.

Large WPE productivity increases occurred only in cases where revision typing included a high percentage of unchanged lines. As the percentage of unchanged lines decreased, so did productivity.

The results also revealed that WPE does not reduce error rates for first-time (original) typing. Original material produced on WPE had as many or more errors than the same material produced on SC/ETW's (see fig. 9).

FIGURE 9.—AVERAGE ERRORS FOR 100 LINES OF ORIGINAL TYPING

S/ETW's	21
SC/ETW's	16
WPE Category I	18
WPE Category II	16
WPE Category III	17

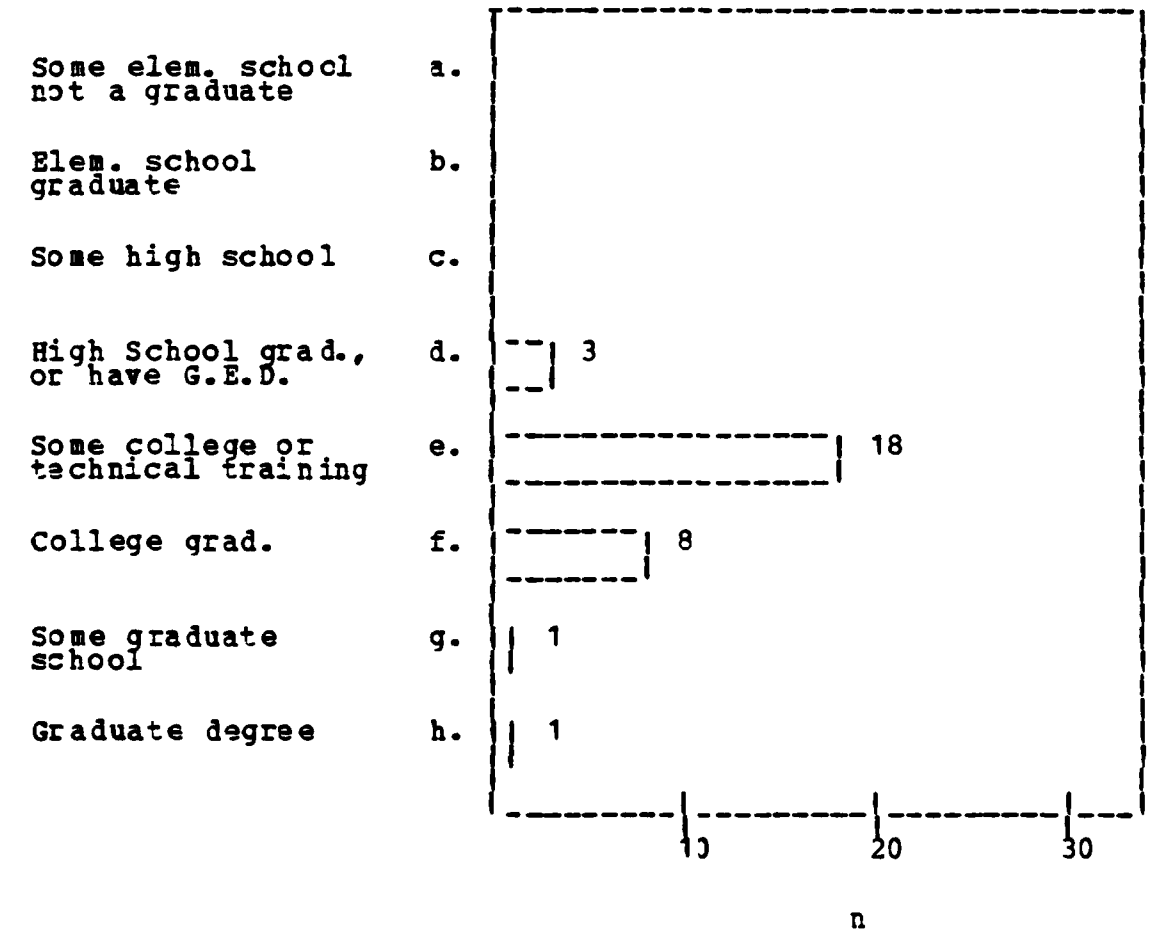
PRIMARY CONCLUSION:

As the percent of changed lines increases, WPE productivity decreases to (and beyond) a point where it is less costly to retype a page on an SC/ETW than to revise it on WPE.

APPENDIX C
HISTOGRAMS

Question 3:

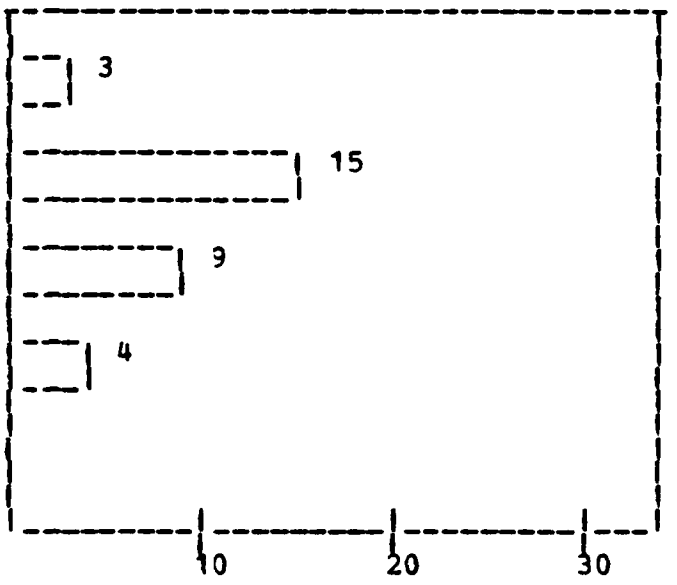
What is your educational level? (indicate highest completed)



Question 4:

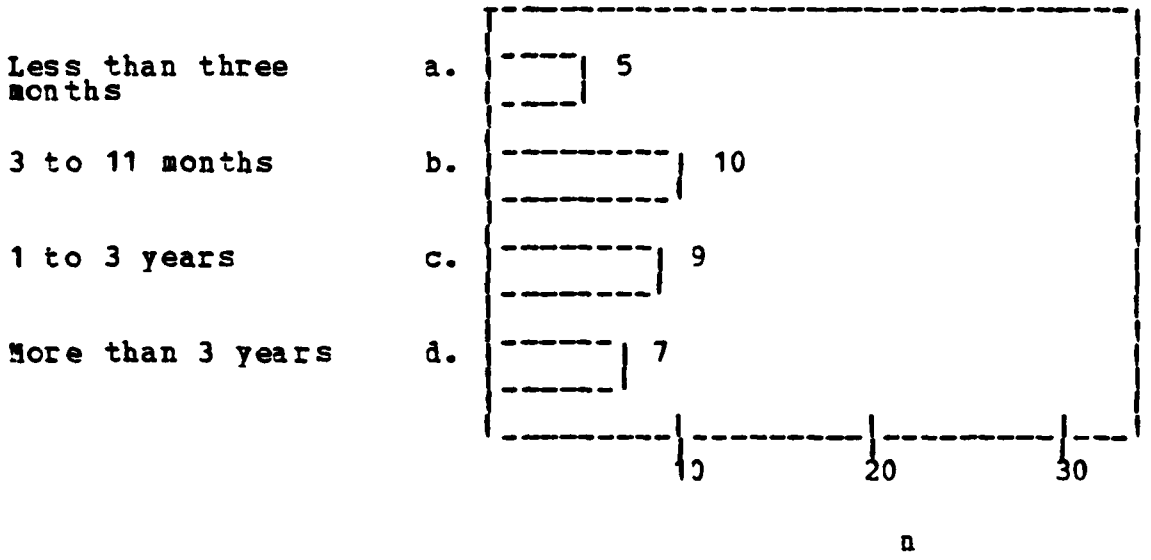
How many years have you been a federal civilian employee?

Less than 1	a.	3
1 to 5	b.	15
5 to 10	c.	9
10 to 20	d.	4
Over 20	e.	



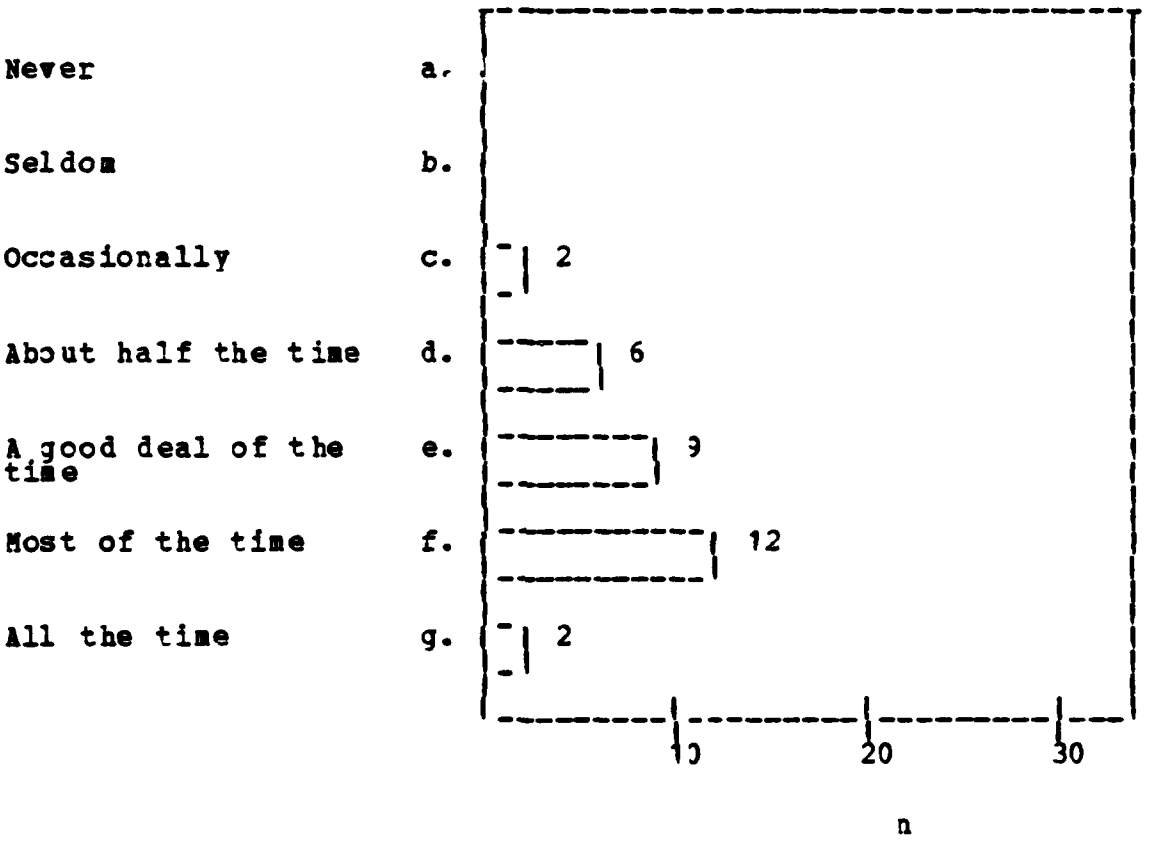
Question 7:

How long have you been in your present job at NPS?



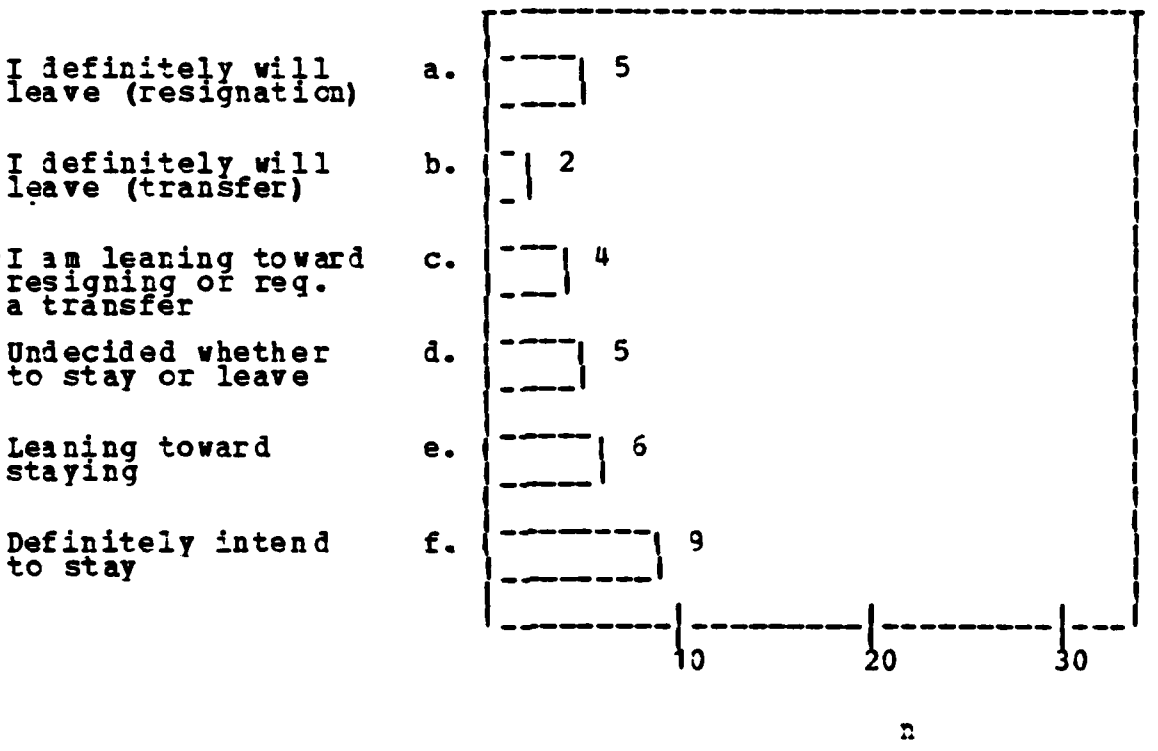
Question 14:

Which one of the following shows how much of the time you feel satisfied with your job?



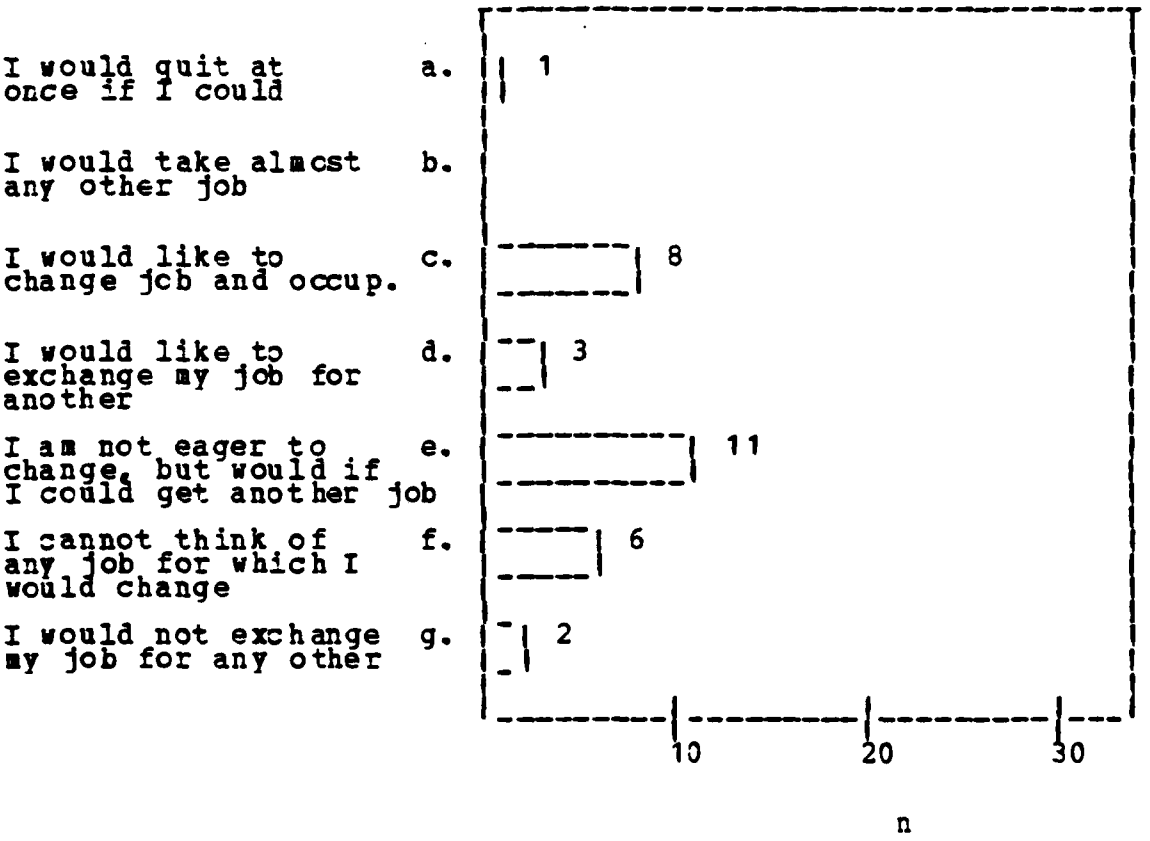
Question 15:

What are your intentions regarding staying or leaving your present job situation?



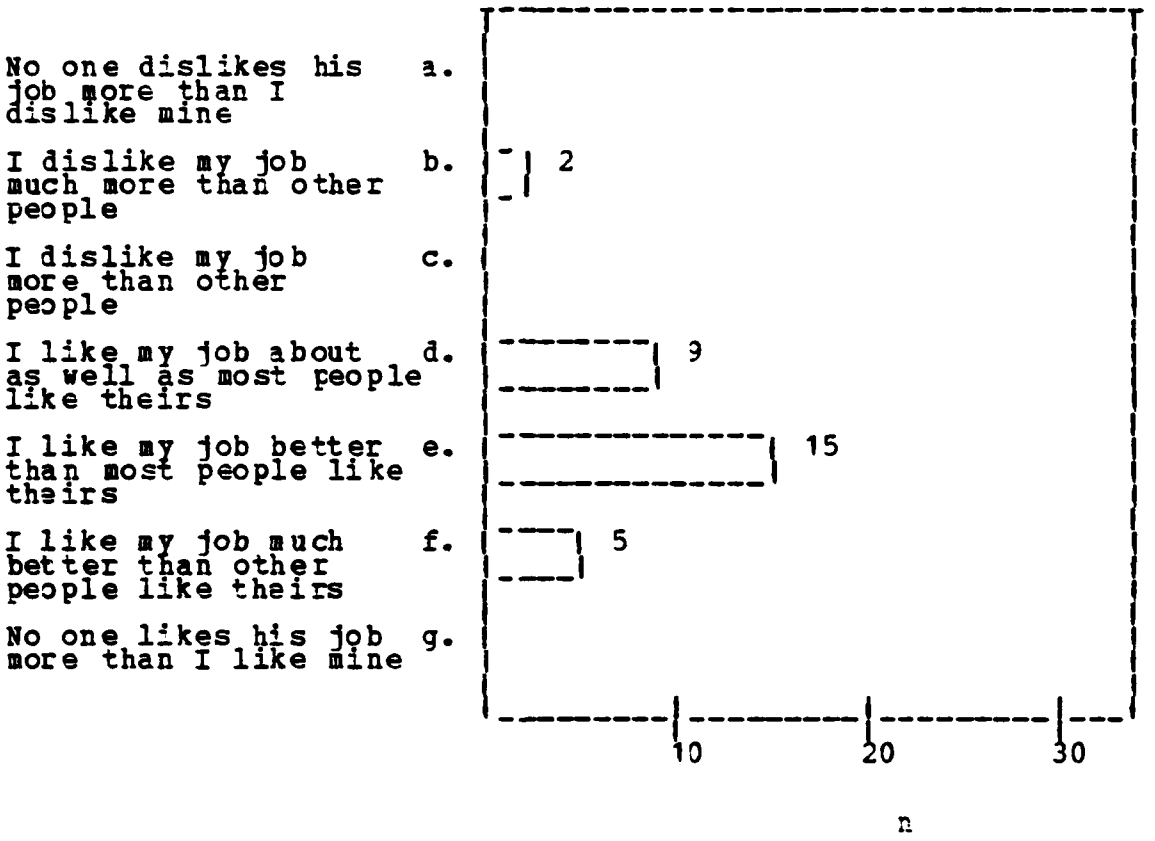
Question 16:

Which of the following best tells how you feel about changing your job?



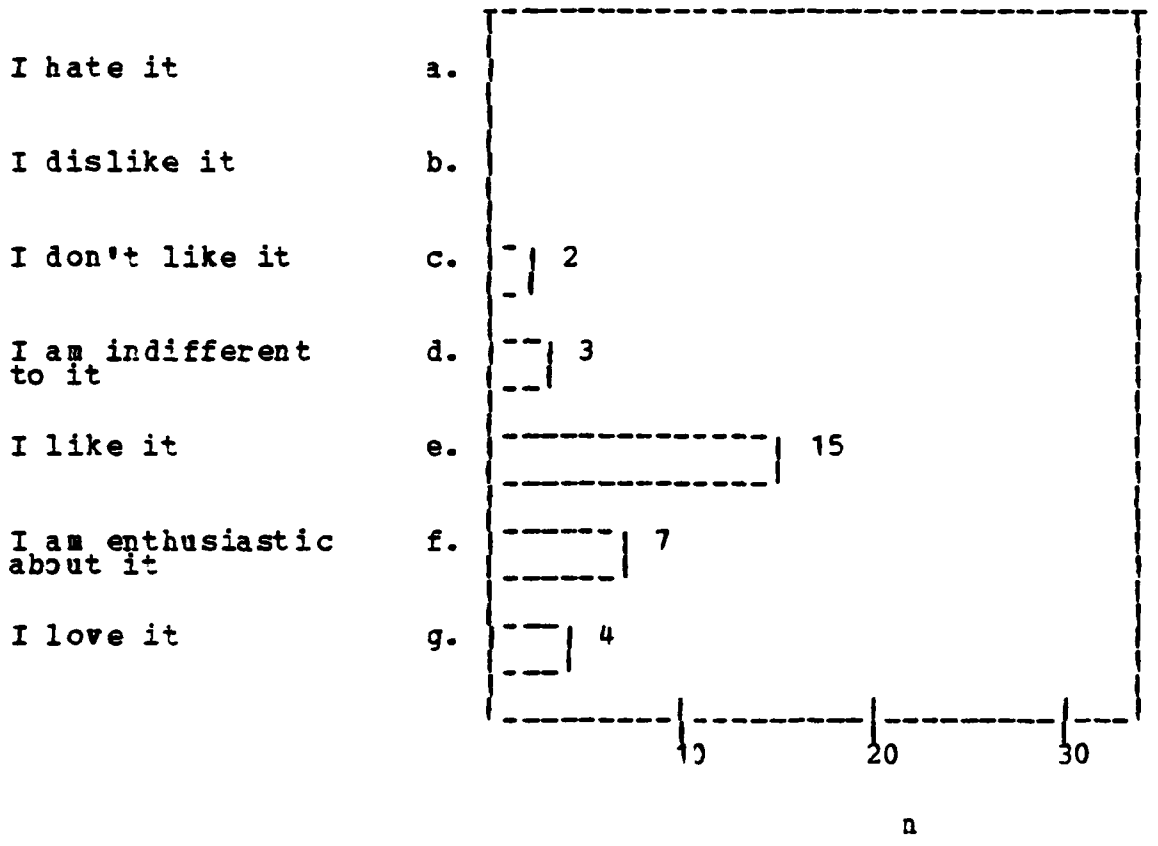
Question 17:

Which one of the following shows how you compare with other people?



Question 18:

Choose the one of the following statements which best tells how well you like your job?



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