AN APPROACH TO OFFICE AUTOMATION

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FORWORD

This Working Paper was prepared by A. Ischenko and M. Tumeo during their participation in the IIASA 1983 Young Scientists' Summer Program and serves as an introduction to the problem of office automation. While various IIASA Research Reports and Working Papers have already been written on this topic, only a few selected problems have been analyzed. For example, in his research report B. Melichar reports on nonprocedural communication between users and application software (RR-81-22), while in several Working Papers R. Lee deals with organization (for example: WP-82-75/76/77), etc.

It is a common aspect of IIASA's activities that several constraints prevent treating any subject as a whole. One can only build a complete picture of a problem by working on individual details over time.

This Working Paper aims to scan most of the known problems associated with implementing an office automation system and in turn render a more integrative service for potential research on this subject.

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ABSTRACT

PURPOSE

In recent years, the increasing scale of production and degree of specialization within firms has led to a significant growth in the amount of information needed for their successful management. As a result, the use of computer systems (office automation) has become increasingly common. However, no manuals or set automation procedures exist to help organizations design and implement an efficient and effective office automation system.

The goals of this paper are to outline some important factors which should be considered when developing a common approach to office automation; to detail some of the problems and pitfalls which may be encountered; and to present one possible framework for the optimal method of designing and implementing an office automation system.

DEFINITIONS

It is important to note that throughout this paper, the term "office" does not only refer to a single location, but to an organization as a whole, be it a single office or several offices organized into a firm, company, or corporation.

CONSIDERATIONS IN THE DECISION TO AUTOMATE

Four major areas are discussed in the decision to automate. These are the matching of computer functions and office functions, the impacts of office automation on office productivity, the effects of office automation on office structure, and economic considerations. A decision on office automation should be made only after an organization has explored each of these questions, as well as other impacts of automation which are unique to that organization.

AN APPROACH TO AUTOMATION

The aproach to office automation presented in this paper is based on past experiences of office automation projects, as well as consideration of the human aspects involved in implemening such systems.

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PART 1 THE QUESTION OF AUTOMATION

CHAPTER 1 BASIC CONCEPTS

1.1 What is a Modern Office?

Before plunging into a discussion of the problems involved in office automation, it is necessary to briefly elaborate on the concept of "office". Several views exist on the actual definition of "an office". It may be considered as: a set of activities each having a certain priority and supported by a filing system; a group of communicating people involved in different kinds of activities and referring to supporting filing systems; a set of communication means with corresponding information exchanges and utilities; or a data base with users processing data, etc. (3). However, all these definitions share a common factor: an office is an institution where information is being processed in different ways. Information is gathered, stored, retrieved, updated, distributed, used and so on. This fact is extremely vital to the idea of office automation.

1.2 What is Office Productivity?

The productivity of an enterprise is generally measured by the ratio of the value of the output to the cost of the input resources required to produce the output, or with some equivalent measure of value in versus value out. However, the calculation of office productivity is not this straightforward. As discussed above, the output product of an office is information, which cannot be measured in traditional terms. Information is usually evaluated not only in terms of quantity, but also with respect to its quality. As a result, the evaluation of office productivity

evaluation of office productivity cannot be performed simply in terms of dollars in and information out. Such subjective factors as precision, accuracy, availability and adequate distribution of the information must also be considered.

1.3 What is Office Automation?

One of the most important principles of office automation is division of manual and intellectual work in management, whenever possible. Today office automation not only means a process of mechanizing office tasks (i.e. typing letters), but also of utilizing computer technology to automate office procedures (i.e. managing labor resourses).

As a result of a wide range of new equipment and technologies, it is now possibile for data, letters, audio/visual information and mechanical functions to be encoded and transmitted in digital form. In connection with the problem of office automation, these technologies are often grouped together and called "information technology" and offices using this technology and equipment are called "electronic" or "integrated" offices. From a technical standpoint, an electronic office can process and transmit information using electronic devices. Often, word and data processing have been combined and most office devices linked to create an integrated office system. Consequently, reprographics, word and data processing and telecommunications, which have traditionally been considered as radically different fields, are now merely becoming just different aspects of a single information technology.

CHAPTER 2 CONSIDERATIONS IN THE DECISION TO AUTOMATE

2.1 Matching Computer and Office Functions

Computers

In general, computers are devices which are able to handle and process vast amounts of information in very little time. Computers carry out three main functions when working with information: processing data in both digital and alpha-numeric form; information storage and retrevial; and mathematical and logical operations. Utilization of these functions requires a certain set of hardware and software.

Hardware is defined as the physical components of a computer system. Some major hardware items and their functions are listed below:

- The central processing unit (CPU) carries out the main processing functions and is supported by an internal memory that holds current working programs and operating data.
- External storage provides the capability to permanently store data and programs and to feed them to the internal memory as required.
- Input-output (I/O) devices such as screens, keyboards and printers provide the user/computer interface. These devices allow the input of data and information and display the output in various forms.
- Transfer facilities (modems, net processors, etc.) allow the interchange of information between users or between computer systems or devices.

Computer software is a series of commands or instructions for machine operation and is commonly divided into two classifications: system software (also called the operating system) and application software.

System software determines computer operation mode and is usually of little concern to the end user, although in principle it determines the kind of application software to be used. Some operating systems are more widely used than others and therefore have a much wider selection of application software packages available. This fact is important when initially choosing system software, as the selection of an operating system which does not have adequate, compatible application software could result in costly system and application software changes in the future.

Application software is designed to perform specific tasks. It is written in the computer languages available with the operating system. Preprogrammed application software packages are now available for general business functions such as word processing, accounting, stock control and payroll. These packages are adequate for approximately 95% of the business functions performed in the office (8). In special cases, however, preprogrammed application software may not be satisfactory. It may then be necessary to either tailor existing application software packages to meet specific needs or to write dedicated software from scratch. However, dedicated software created for a specific task usually cannot be run on a wide range of computers, and in the event of changes in office procedures, tasks or the computer system configuration, such software may require expensive re-adaptation. Furthermore, writing dedicated software is about ten times more expensive than buying commercial software packages and as a result, is usually not a viable option for small businesses.

Office

Even in widely differing organizations (which usually aim at different objectives), it is possible to find common office functions which result in some similar divisions within the office. Some of these common functions are: registration and control of incoming mail; creation, proofing, storage and retrieval of documents; report and memo production and circulation; communication activities and meeting participation; and business calculations and planning. Common office divisions created to carry out these functions include: personnel (labor management); marketing (sales and supply); purchasing; planning; accounting; research and development management; and publications and communications (information and communication-related services).

Ultimately, the essence of office automation is to match the afore mentioned three main computer functions to office functions. For example, processing data in digital and alpha-numeric form is used for word processing which, in turn, may be directly involved in the creation and proofing of documents. The computer storage function may be successfully used in different filing systems and/or management of document flow. Mathematical and logical computer abilities may be used for business planning, modeling and decision making. Various computer function applications will be reviewed in more detail in 4.1.

These examples of the application of computer functions to various office functions may be extended to many other office functions as well. Different office functions which can be aided by a particular computer function may be discovered by

considering the office tasks involved (e.g. various office storage functions can be detected by analyzing the lifecycle of a document (10)). A similar process may be applied to all other functions in the office. It is necessary to mention here that in order to effectively and efficiently use the computer in the office, it is not enough to study isolated services. Entire work functions, involving combinations of services, should be identified. This approach promotes integration of services, and is an important step to a fully automated, integrated office.

2.2 Impacts of Office Automation on Office Productivity

Before considering the impact of office automation on office productivity, it is necessary to clearly distinguish between office effectiveness and office efficiency. Effectiveness is the ability of an office to reach a certain set of objectives and is not greatly affected by automation. Automation impacts office efficiency, which is the ability of the office to produce the same or a higher quality information, with better distribution, given the same or decreasing input resources. If the office is not organized properly, or if it is performing activities which are not in accordance to its set of objectives, automation cannot help and in fact, may actually aggrevate the problem. The assumption is that before automation is considered, the office is already functioning more or less effectively.

In order to estimate the effects of office automation on office efficiency, and thereby the effect on office productivity, it is useful to analyse the office using the "technological approach" (7). The tecnological approach involves viewing the

office as a set of activities and functions as well as the methods for their realization.

Following the technological approach, the office may be viewed as an institution where information is being processed in different ways (see 1.1). The system can be further divided into two levels. The lower level of the system processes information in various ways and prepares it for top-level managers (decision makers). In this case, the result of management work (a particular decision) may be considered as new, high quality information. Computers can assist managers in both information processing and decision making. Improved office productivity therefore, may be realized through reduced document proofing time, improved document turnaround time, reduced physical mail handling, synchronized worldwide communications, reduced physical access time, and so on.

An illustration of the application of the technical approach to office automation and the resulting estimates of the effects on productivity are found in the case study of automation in Texas Instruments Inc. (4). In this study, the work force was divided into three components.

Managers and Administrators	- 26%
Professional and Technical	- 40%
Secretarial/Clerical	- 36%

Within each component, activities were divided into separate categories (i.e. verbal communication, written communication, decision making or technical activities). The effect of office automation on each component of the work force was then

estimated. The following is a short summary of the findings of the study.

Managers and Administrators:

About 85% of this group's time is spent on written or verbal communication. Other activities include technical development (5%) and decision making (10%). The overall productivity improvement upon full implementation of word processing system, electronic mailing and filing was expected to be 13%.

Professional and Technical:

About 40% of this group's time is spent on communication and 60% on technical functions. A potential impact due to automation was expected in document creation, physical mail handling, information access, and improved accountability. The most significant improvement was expected in communication activities (20%) with an overall productivity improvement of about 8%.

Secretarial/Clerical:

The activities of this group are very diverse, including dictation, filing, typing, handling of mail and telephone calls and so on. Communication functions consume 65% of their time. The most significant impact of office automation was expected in the area of document creation and revision, physical mail handling, copying, sending and receiving messages, and information storage and retrieval time. Potential productivity improvement in the area of communication was estimated at about 30%, with an overall productivity improvement of 20%.

At the time of the study (1981), the capital investment required for the implementation of the system was approximately $9,400,000. However, Texas Instruments Incorporated represents an administrative organization of about ten-thousand people, with a work-force cost of about 265 million dollars per year. Consequently, the above analysis predicted a savings in the order

of 31 million dollars per year, and recovery of the initial investment (approximately $9400 per person) in about three years.

2.3 Economic Considerations

After considering the use of the computer in the office and its subsequent impacts on office productivity, it is necessary to consider the economic impacts of automation. It must be remembered that the "value" of automation is difficult to measure in terms of currency since the ultimate effect, an improvement in the quality, flow and distribution of information, is not readily evaluated in terms of cost. Consequently, no set method of estimating the economic impacts of automation have been developed. It may be useful however, to mention those factors which should be taken into consideration.

Expenditures

Expenditures can be divided into two main categories: initial costs and recurring costs. Initial costs include capital equipment costs, installation costs, and initial training costs. Some initial costs will also be incurred in purchasing the system software and application software packages. Recurring costs include operation and maintenance costs, continuing training costs and possible software devlopment costs.

An important aspect of the evaluation of the economic impacts of automation deals with the software question. As mentioned above, some software costs will come as an initial expenditure (purchase of operational software or software packages). Additional, recurring costs may also be incurred due to the employment of programmers to write dedicated software as

needed. The relative benefit of these two methods of handling software must be determined for each specific case.

Other options which are possible when considering automation include renting or leasing the computer hardware and/or software, as opposed to direct purchase. Once again, this option must be evaluted in each individual situation.

Benefits

As mentioned above, the benefits of automation cannot simply be stated as expenditures. The effects of automation on productivity have been discussed above. It can be further noted that office automation shifts office costs from personnel to equipment - adding "capital " equipment to increase what each employee can do and reducing labor costs.

For example, at the City Bank in New York during the 1960's, hardware and software represented only some 10% of processing costs, while labor costs accounted for 70% of the total. Now however, the ratio is reversed: operation and labor costs constitute only 30%, while hardware and software costs make up the remaining 70% (4).

2.4 Impacts of Automation on Office Structure

Office structure may be considered as a set of divisions in which activities with common features are grouped in order to perform particular functions. This grouping of different activities determines the way in which information is processed within the office and how the divisions are prioritized and linked to achieve a set of common goals.

The office automation process has a significant impact on office structure because automation is not just the simple modification of existing office procedures, but the implementation of new ones. This in turn affects the way in which activities are grouped. Even before a computer is brought into the office, the automation process results in changes. Before computerization, a manager has to clearly identify the processes occuring in the office and to determine which of them can be aided by automation. Regardless of the final decision on automation, the examination process is a positive one and results in a better understanding of the organizational structure.

PART 2 AN APPROACH TO OFFICE AUTOMATION

In Part 1 various considerations in the decision to automate were mentioned. Based on the estimates of the impact of automation on productivity and office structure, economic considerations, and consideration of those unique factors important to any given organization, the decision to automate or not can be made.

One question that arises at this point in the process is the advantage of an "integrated" system. Before approaching the question, it is necessary to define what is meant by system integration.

An integrated office automation system is one that is designed considering not only the relationships between the various physical elements of the system, but also the relationships between users, facilities, services, equipment, procedures and technologies (10). The advantage of an integrated automation system is that it increases the efficiency of the entire automation process. Integration also avoids the use of several special purpose machines to support highly repetitive tasks in different areas of the office.

Failure to develop an integrated system may prove to be costly in the future. A large collection of highly specialized equipment dedicated to specific tasks will result in extra expense for management and training. Furthermore, duplication of components for redundant tasks will result in the purchase of unnecessary and expensive equipment.

As a rule, the following steps have to be taken in the development of an integrated office automation system:

- Analyze the existing office structure and resulting information flow (3.1);
- Build an office information model on the basis of the analysis and optimize the information flow processes (3.2);
- Assess the impacts of the organizational structure changes which result from optimization of the information model (3.3);
- Develop a new office structure based on the above assessment. The structure indicated by the optimized information model may be modified based on the specific situation being considered (3.3);
- Design and implement an integrated office automation system based on the selected office structure, considering technical aspects, human factors and organizational difficulties and restrictions (Chapter 4).

CHAPTER 3 OFFICE STRUCTURE ANALYSIS, INFORMATION FLOW MODEL DEVELOPMENT AND OPTIMIZATION

3.1 Analysis of Office Structure

Velev and Razvigorova (7) point out that existing office structures are usually based on one of three viewpoints: functional, sociological, and goal oriented. However, each of these approaches treat the organizational structure as if it were seperate from the tasks performed in the office. The authors go on to suggest an approach to organizational structuring called the "technological approach", which includes the particular goals and decisions within the office and their relationship to the divisions within the office.

While the technological approach is an improvement, it still does not allow the analysis of office structure with respect to automation. We suggest that a more adequate approach would be an analysis of the existing system based on a combination of these approaches.

Initially, the office structure should be analyzed in light of organizational goals and subgoals and the ability of the divisions to effectively achieve these goals and subgoals. Next, the technological approach should be applied to facilitate consideration of the different office procedures and activities present and the resulting information flow.

3.2 Development and Optimization of an Information Flow Model

After the combination of approaches have been applied, a model of the information flow processes should be developed. An information flow model traces all the information flow paths

within a given office structure. In this way it will be possible to see the various channels that information follows within the office and to better understand the relationship of the office structure and information flow.

Optimization of the model requires the elimination of redundancies in information flow paths. Attention is also given to "dead end" and unneccessary information flow paths to see why they exist and to determine if they can be eliminated. The optimization of the information flow model will result in a new office structure. However, before this office structure is implemented through automation, it is necessary to assess the impacts of office structure changes. The result of this assessment may be a modification of the office structure suggested by the optimization of the model.

3.3 Assessment of Office Automation Impacts and Office Structure Development

Once an information model has been constructed, it is possible to assess the impacts of office automation on the information flow and the resulting effects on office structure. There are two distinct approaches to office automation in relation to its effect on office structure (10). The first is to design the office automation system so that it fits as well as possible into the existing office structure. The second approach is to totally redesign the organizational structure in conjunction with the automation process.

Design of an office automation system based on the existing office structure involves identifying the existing underlying constant office processes which are aimed at achieving generally

unchanging objectives (10). Organizations are usually divided into groups by tasks. For example, possible groupings for an economic enterprise might include labor resources and personnel management, general ledger and accounting, supply regulation and control, sale registration and control, and financial control and planning. After identification of the existing organizational groups, they are analyzed and "automated" without considering the automation process in the other groupings. The analysis and automation process usually include the following aspects (10):

- Detailed specification of different user needs based on job functions;
- Identification of common computer services that satisfy user needs and discussion of additional services required for those needs not satisfied by standard services;
- Cost/benefit analysis of options for implementing a system to meet needs;
- Consultation with the computer manufacturing industry;
- Participation of future users in system design and selection of training programs.

One advantage of this method is that it allows the retention of the existing office structure. This may be useful in situations where the organizational structure is not easily changed (i.e. large multi-national corporations), or where the decision to automate is made on a level where the opportunity to change the organizational structure is not available (i.e. a department head in a large company). Furthermore, the economic impacts of each automated task can be easily assessed and, whenever the need arises to modify a specific task, software can be easily modernized

without deleterious effects on the entire system. One disadvantage, however, is that different automated tasks are not integrated and as a result, may require the collection of similar data, making the system redundant. Such redundancy increases the possiblity that information may be altered, either accidentally or intentionally, before it reaches top decision makers. It must be noted however, that such redundancy also provides a method for checking the integrity of information.

The option also exists to totally redesign the office structure when implementing an office automation system. This requires an analysis of all the various information flows present in the organization's information processing system. After the information processing system is described it is divided into information subsystems with the highest possible level of independence. The main advantage of this process is that it optimizes the information processing system by eliminating redundancies and unnecessary information flow paths (see above). This, in turn, determines the organizational structure. This structure will usually differ greatly from a traditional office structure because of the integration of office functions.

Individually, however, neither of the approaches is sufficient to build an optimal structure for an automated office. What is suggested here is to apply a combination of the two aproaches. The extent to which the existing office structure is changed can then be determined taking into account the constraints of each unique organization considering automation. It is extremely important to include the future users of the

system, the office personnel, in this restructuring process. Failure to do this, as will be discussed below, may result in serious problems with system implementation and consequently in ineffective use of the system.

CHAPTER 4 DESIGN AND IMPLEMENTATION OF AN INTEGRATED OFFICE AUTOMATION SYSTEM

There are two main aspects to the design and implementation of an integrated office automation system: technical and human. Within each, there are several important factors which must be considered to ensure successful design, implementation and use of the system. The following sections attempt to outline some of the more important factors common to all organizations. It must be remembered that organizations will also have to consider other factors which are unique to that organization.

4.1 Technical Aspects of Office Automation

Choice of System Configuration and Selection of System Functions

System configuration is the actual location pattern of the hardware componets of the system. As with most aspects of office automation discussed so far, there is no standard configuration for an effective office automation system. Each office considered will be unique in the way it matches people and equipment and will require individual analysis. A large part of the hardware requirements will be determined by the system design (i.e. computer RAM capacity, tape drives, storage capacity, etc.) However, questions such as the number and placement of terminals, selection of keyboards, and use of individual disc drives must be based on the physical design of the office, the size of the system, desired accessability, and selected system functions.

Once the appropriate pairings of computer functions and office functions have been made (see section 2.1) it is necessary

to have a certain set of software (and hardware) to allow use of the computer in the desired way. Hence, system fuction selection will determine both the operational and application software used in the system, and as mentioned above, will have an impact on the selection of hardware.

Pairings of office functions and computer functions usually fall into five main areas:

- Word Processing
- Business Information Management
- Business Calculations
- Business Modeling and Forecasting
- Telecommunications

The choice of one or more of these functions and the selection of the specific capabilities of the hardware and software are the main tasks in designing an office automation system.

Word Processing

Word processing is a basic facet of office automation. The idea behind word processing is the ability to type text and save it in the external memory of the computer (most often a magnetic disc) instead of having it typed on paper. Text can then be easily retrieved, edited or changed. Text correction, which is extremely time consuming when done on paper, may be easily accomplished through the use of the VDU and keyboard. Furthermore, printing can be executed without error and at speeds significantly higher than any professional typist.

When selecting a word processing system, the editing rate of

the system is usually not considered extremely important since actual typing accounts for only approximately 1.2% of white collar worker costs (12). One of the more important aspects is the ability of word processors to store, edit and merge files, allowing letters and other forms to be re-used after simple alterations. Sophisticated systems can also be used for advanced information retrieval and sorting, thereby linking two office technologies, word processing and data processing.

As of 1982, there were approximately 75 different word processing systems on the market (13). These systems can be divided into two categories: dedicated word processors which can only do word processing; and general computer based systems in which word processing is only one of several capabilities. However, the differences between these two catagories are beginning to become less significant.

Business Information Management

Data base management systems are the most effective way of creating office file support systems and managing office information. Data base management systems are programs which have the capability to create a certain pool of records which are logically linked (18). Important features of data base management systems include the ability to create data files with a specified structure, the possiblity of accessing, extracting and updating information for generation of reports and/or tables, and the development of relationships between various items contained in the data base.

This last feature, the use of relationships between elements in a data set, is one of the most important features of data base management systems. Using such relationships, large amounts of data can be updated automatically by simply updating a few key data items.

Data base management systems usually require a significant amount of random access memory (RAM) and fast processing time within the core. However, there are some data base managment program packages available for micro-computers which offer many of the features of larger systems. Consequently, data base management systems are now available to medium and small businesses.

Data base management systems operate in one of two file processing modes. Traditional data base management systems (i.e CPM micro-computer system dBASE II) handle sets of related data. Subsets of information within a file (a record), contain information about its relationship to other records within the file. Furthermore, each item contained in a record has some information about its relationship to other items in the record. In contrast, file management programs (i.e. CPM micro-computer system DATASTAR) do not indicate relationships between records within a file. Items within a record however, may be related. In these systems information is elicited by various sorting methods. Data base management systems are more general than file management systems, but file management systems are very useful for search and retrieval within a large set of unrelated data.

When selecting a data base management system several factors

must be considered. First, system documentation should be reviewed. Even the best data base management system is useless without good documentation. Second, data base structures vary greatly from system to system. There are definite limits as to record length, number of items in each record, length and type of item within a record, etc. In addition, not all systems have the ability to interface with other computer systems. This may limit the possiblity of accessing the data base created by the system with other software. Third, available input/output (I/O) functions should be investigated. I/O functions can reduce the probability of errors in data input. Programs are available which check input data for appropriate length and type (letters or numbers) and report errors in entry. Other data characteristics such as numeric range or spelling can also be checked. I/O functions also allow the printing of data in desired formats with such features as titles, subtitles, etc. Fourth, data editing functions are vital for system versatility. Good systems allow the updating of several files simultaneously, and allow the use of mathematical relationships to automatically update other related data within the set. It is also possible to have programs which mathematically alter input as specified before entry into the data base. Finally, the ability for users to create application programs for work with specific types of data (Code generators) should be considered. The best way to compare various data base management systems is to create a file of a certain size and test each different system with that file.

In early 1983, the number of available micro-computer data base management systems was approximatley 100, ranging in price

from $100 to $5000. Maximum record number ranged from 100 to 64K and more, the maximum number of items in each record ranged from 12 to 64K, the number of symbols in each data field varied from 30 to 64K, and the maximum number of pointers within a file ranged from 1 to 255 (19). This highlights the fact that there is a wide enough variety of data base management systems available to satisfy the needs of most organizations.

Business Calculations

As with data base management systems, there is currently a large variety of software packages available for business calculations. As a result, the probability that a company will have to alter existing software for a specific application in this area is remote. Instead, business procedures should be identified and analyzed, and appropriate software packages selected. The selection of software should include analysis of: the existing accounting and bookkeeping system; the qualifications of the staff; whether the package will be run in conjunction with other office programs or on its own; and whether new computer equipment will be purchased or an existing system used. Furthermore, the selection of software should again be closely linked with the examination of program documentation. Some system documentation includes application examples. Others may include an explanation of some principles of accounting and demonstrate their relationship to the functioning of the program. Documentation should also include a description of how the program is structured, an explanation of program functions, a listing of required input and resulting output files, an

explanation of possible errors, and instructions on elimination of errors.

Most available software packages provide programs for three basic office accounting areas: general ledger income/expenditure operations; salary computation; and bookeeping and planning. In many cases these programs are compatible, allowing the use of the same data base so that only one data base must be maintained and updated. It is also important to note whether the programs allow calculations to be performed in accordance with the consumers needs, or are oriented for a specific, standard calculation (i.e. tax calculations). Software packages which allow the user to specify the method of computation are very versatile and allow bookkeeping to be performed in any desired format. Business planning and forcasting (see below) capabilities are often included in these packages. Those packages which are oriented for standard calculations are easy to use but are limited in their application by their inflexibility.

Business Modeling and Forecasting

Business modeling and forecasting is rapidly becoming one of the major applications of computers in the office. Modeling involves the development of various "what if" scenarios to allow decision makers to explore the possible effects of various management actions. It must be remembered that these models are not able to predict the future, but allow a decision maker to explore the effects of various actions given an implicit set of assumptions about the behavior of a system in the future.

Business forcasting programs are often just electronic

tables where the user defines the headings of the rows and columns, and the inter-relationships between variables. It is then possible to change one member of the matrix and see the effects on all other members of the matrix. These programs can be used in several areas of business planning to explore the affects of different exogenous forces such as interest rates, market, inflation and labor costs.

Telecommunications

Communication activities occupy approximately 30% to 70% of a manager's time (14). With modern technology however, many communication activities may be greatly aided by electronic devices (15). Electronic mail systems and teleconferencing systems are two major examples of computer-aided communication.

The term electronic mail covers a wide range of electronic text communication facilities from immediate transmission of simple data to electronic mail boxes - a facility to store material until the receiving point asks for it. Electronic mail systems allow the transmission of information from one place or person to another using electronic means for capture, transmission and delivery. The information may be in text and/or graphic form. An electronic mail system may be successfully used within the office to coordinate information, distribute projects, monitor project progress, elicit specific information, and aid in coordinating intellectual, informational and production activities.

Usually, electronic mail systems work in a store-and-forward

mode with one of two principal configurations (16). The first configuration is called a "centralized configuration " and is based on a time sharing computer system to which users are connected by terminals. This allows electronic messages to be written, sent and received directly at the terminal. In this configuration each user has a personal file to which all incoming mail and copies of outgoing mail are written and stored. An example of such a system is the TELECTR system used at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria (17). The second configuration, called a "decentralized configuration", is based on working stations connected to small computers dedicated to storage and distribution of messages. Each computer is linked into a distributed communication network. An example of such a decentralized system is the ARPANET mail system named MSG.

Such features as integration of graphic abilities into electronic mail systems, word processing and voice mailing are now becoming commercially available. Efforts have also begun to adopt a standard message format that will promote further use of electronic mail systems.

Teleconferencing is another alternative in text-based communications and together with electronic mail serves specific communication needs within the office environment. All conferencing systems use a central computer to coordinate, distribute and retrieve text messages. Messages are stored in files corresponding to particular conferences and distributed to a list of participants (16).

4.2 Human Considerations

Although consideration of the technological aspects of office automation is important in the implementation of an office automation system, the most critical and delicate side of design and implementation is related to the human factors involved (10). Three main areas of concern are: the personnel/computer interface; social impacts; and health considerations.

Personnel/Computer Interface

The design of the personnel/computer interface must be an integral part of the total system design to help ensure successful implementation and easy, effective use of the system. Design of the interface should start with the establishment of current needs and the forecasting of future inter-office demands. The system can then be constructed to meet both current and anticipated demands. Future users should take an active part in this process.

The operational system within the computer should be as "user-friendly" as possible and avoid the use of terse and/or confusing messages. This will greatly reduce frustration when using the computer to perform office tasks. To make system use more effective, all system functions should be explained to users in manuals using non-technical terms, since most managerial and clerical staff are not familiar with technical computer language. A well designed, on-line "help function" would also facilitate full system utilization. Whenever possible, all communication interfaces (terminals) within the system should be standardized to

avoid confusion and frustration when personnel use more than one terminal.

Information presentation is another essential aspect of the user/computer interface. Information should be presented in the clearest manner possible. Clear presentation of information is often aided by the use of graphics. Neurophysiological studies have shown (6) that a single picture can often convey more information to a person than 1000 pages of written material. This is due to the ability of the human brain to recognize spacial patterns and relationships in a parallel mode. Interpretation of alpha-numeric information (written language and mathematical expressions) is performed in the brain in a sequential mode. Consequently, graphical presentation allows the user to quickly ingest and analyze large blocks of information. This human ability makes graphics an important part of the user/computer interface, allowing more effective data analysis. For top managers, graphical presentation is significant because different trends and cyclic factors can be more easily grasped in picture form, while understanding such information presented in numerical form is often difficult and time consuming. Graphical presentation also allows easy recognition of correlations between sets of figures, and can be further enhanced by the use of perspective and/or color.

Social Aspects

Unfortunately, the social impacts of office automation are poorly understood and often completely ignored when a system is selected and implemented. The lack of knowledge about the social

impacts of automation is even more serious in light of the ever increasing use of computers in the office. Implementation of office automation systems presents several serious social problems.

Many times, employees will feel "threatened" bythe implementation of a computer system, and in some cases, these feelings are well founded. As discussed above, automation is designed to increase efficiency by reducing the labor required for a specific task. In some instances this may result in staff reductions. Furthermore, top managers are often quite willing to invest in new equipment since the cost of computers and other electronic equipment can be largely recovered through depreciation while clerical workers are often demanding better pay, benefits, promotions and attention to health and saftey.

Another important social impact of the introduction of computers into the office is the resulting changes in the office structure and consequent elimination of some tasks and modification of others. Usually, employees must be retrained to perform office tasks using computers. Consequently, some management support has to be provided to encourage acceptance of the system chosen and to reduce the "fear" associated with the use of computer systems. If a computer system is "imposed" on an employee, the result will often be reluctance or complete refusal to use the system. Imposition of a system may also lead to destructive acts by frightened employees. Including the future users in the system design and selection process could reduce or eliminate some of these problems. It is also important to discuss

possible health effects openly with employees. Proper consideration of the user/computer interface, as discussed above, is another possible way to mitigate this impact.

Other social impacts associated with computer system implementation could be reduced if the problems were considered before implementation is begun. For example, the versatility of the computer terminal can provide variability and allow the user to deal with a wide range of office tasks. In this way, automation could make office jobs more interesting and attractive. However, in some cases, when the computer terminal is reserved for only one task, a user may become bored and frustrated and feel that they are simply an extension of the machine. Therefore, careful attention must be paid to the tasks to which each terminal will be dedicated, before implementation of the automation system begins.

It should be noted that only a few of the possible social impacts have been discussed here. To date there has been little, if any, in-depth, systematic investigation into this subject. Additional research is badly needed to further deliniate the impacts of automation on society.

Health Considerations

Several potential health problems should be taken into consideration when implementing an office automation system. The most important health problem is the possible development of stress conditions which may produce such symptoms as irritability, headaches, depression, nervousness, insomnia, and/or loss of appetite. This condition may be a result of the significant amounts of time devoted to work at the computer and

reduced personal contact. Furthermore, such factors as slow computer response time, boredom, weariness, poor environmental conditions, worry about responsibility and the general information load from the computer may aggrevate the situation.

There is also concern about the effects of X-rays which comes from the high-voltage electron beam in the cathode ray tube (CRT) of a videoterminal. Although the level of radiation is very low in comparison to set allowable radiation exposure limits for radiation, there is as yet no agreement on the potential effects of long-term, low-level radiation. Another area of concern which is not well understood is the effects of low-level radiation on pregnant women. Research is still required to better understand the possible health effects of automation and computer use.

Important health risks associated with screenbased systems are visual fatigue and eyestrain. Eyestrain and fatigue may be caused by glare, reflections and/or lack of contrast on the screen. Symptoms include soreness of eyes, a throbbing behind the eyeballs, and difficulty in focusing. These symptoms may also be accompanied by nausea and headaches.

Some evidence exists to show that visual display units (VDU) can accelerate certain occular disorders such as cataracts and that screens flickering at a certain rate may induce epileptic seizures. The latter can usually be avoided by adjustment of the VDU controls.

Well designed seats and desks with terminals are essential to avoid posture problems and protect personnel from sore muscles in the neck and shoulders, backaches and headaches.

In general, ergonomic and health considerations should be an

important and integral part of the system construction and not viewed as an expensive luxury which cannot be afforded. Furthermore, ergonomics can be highly cost effective through reduced error rates, increased productivity and improved staff morale and motivation.

CONCLUDING REMARKS

Office automation is an important area of today's management that is being significantly changed under the impacts of modern electronic technology with substantial technical, organizational, and social consequences. To devise an approach for such a phenomemon, one has to face several problems starting with semantics, which is far from unanimously accepted in this field. The problems then proceed across many disciplines, which can be called "managerial science" and one has to take these disciplines into account before any well based policy advice can be given.

This Working Paper has, of course, more modest aims, namely to describe the issues which should be taken into consideration when dealing with the problems of office automation. In this respect, it could prove to be a good introduction for a more detailed analysis of selected topics should this be undertaken at IIASA.

REFERENCES

1. Tomanek, G. 1980. "Implementing Electronic Mail in Telephone Systems: More Than Just Talk." Presented at the Computer Networking Symposium, December.

2. Bair, James H. 1979."Communication in the office of the future: where the real pay-off may be." Business Communications Review.

3. Ellis, Clarence, A., and Garry J. Nutt. 1980. "Office information systems and computer science." Computer Surveys, Vol.12, No.1, March.

4. Craig, L. 1981. "Office automation at Texas Instruments Incorporated." In Telecommunications and Productivity, M.Moss (ed), Addison-Wesley Publishing Company, London.

5. Matteis, Richard J. 1979. "The new office focuses on customer service", Harvard Business Review, March-April.

6. Hamilton, A.P. 1982. "Computer graphics - what it can do for you."In Planning for Information Handling. A. Simpson (ed.), Gower Publishing Co. Ltd.

7. Velev S., and E. Razvigorova. 1983. "An approach to organizational structuring in innovation" (to be published in Proceedings of the Task Force Meeting on Organizational Structures in Innovation Management, held in Prague, 30 May to 4 June, 1983.

8. Derriev, J., P. Oppenheim. 1982. A Handbook of New Office Technology. Kogan Page, London.

9. Jarrett D. 1982. The Electronic Office. A Management Guide to the Office of the Future. Gower Publishing Company Ltd.

10. Stokes, A., ed. 1982. Integrated office Systems. State of the Art Report. Pergamon Infotech Ltd.

11. Enticknap, N. 1979. The Philips Guide to Business Computers and the Electronic Office. Input Two-Nine Ltd, London.

12. Tapscott, D. 1979. Towards a methodology for office information communication systems research. In Integrated Office Systems. N. Naffah (ed.), North-Holland Publishing Co.

13. Kenealy, P. 1982. WP Software Advances Rapidly. Mini-Micro Systems, May.

14. Mintzberg, H. 1973. The Nature of Managerial Work. Harper & Row Inc., New York.

15. Pye, R., B. Champness, and N. Collins. 1978. The description and classification of meetings. Paper P/73160/PY, Communications Studies Group, London.

16. Lipinski, H. 1982. Electronic mail and its evolution in integrated office systems. In Integrated Office Systems. A. Stokes (ed.), Pergamon Infotech Ltd, London.

17. Lathrop, C., and M. Pearson. 1981. TELECTR Users' Manual. Laxenburg, Austria: International Institute for Applied Systems Analysis. WP-81-147.

18. Ischenko A. 1983. Office Automation (In Russian). To be published.

19. Heintz, Carl 1983. " Guide to Database System Software" Interface Age, February.