Office Automation: Revolution or Evolution?

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1.0 INTRODUCTION

One of the great shortcomings of the information systems industry has been our inability to manage expectations. This is not surprising when one considers the frequency with which we announce a new management concept or technological breakthrough which will inevitably "revolutionize" the means by which we manage our information resources. In the past ten years, we have thrust upon the world the "revolutions" of timesharing, database management, the minicomputer, the "total" MIS, distributed data processing, distributed databases, structured programming, microcomputers, and now upon us is the "revolution" of office automation. Each of these proclaimed revolutions has led the user community to a level of expectation which is to a large extent unattainable, at least in the timeframes predicted.

Recent literature has suggested that there will soon be a revolution in the office as computer technology is brought to bear to increase the productivity of our white collar labor force. The "widespread" use of word processing and the introduction of electronic mail systems are cited as evidence of the oncoming revolution of office automation. Although we are led to believe that office automation is a relatively new phenomenon, office automation is rather an old term given new meaning. In the late sixties, the term
Office automation referred to the application of computers to well structured, high volume office tasks such as payroll processing, accounts payable, purchasing, etc. In its present reincarnation, "office automation" refers to the application of computer technology, communications technology, systems science and behavioral science to the vast majority of less structured office functions which have not been amenable to traditional data processing technology. In both cases, however, the objective of office automation is to improve the productivity of our white collar labor force.

While there can be little doubt that technology has provided an opportunity to dramatically change the ways in which we perform administrative processing, the rate at which this technology will be integrated into most organizations will not be revolutionary at all. Rather, a scenario in which office environments evolve and adapt to this new technology is a much more reasonable one. The purpose of this paper is to address the evolution of office automation technology. Although this approach may seem less dramatic, we suggest that it is far more realizable and will provide managers a framework with which to realistically plan for the integration of new technology into the office. We will view this evolution in the framework of Nolan's stage hypothesis for the development of information systems.
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organizations [6], and use this framework to distinguish "office automation" from "office mechanization". This will be followed by a discussion of some recent research results which will impact and provide direction for this evolution.

Before delving into an examination of Nolan's stage hypothesis, it will be useful to motivate the discussion by considering why the office is now "ripe" for further automation.

2.0 WHY OFFICE AUTOMATION NOW??

Why are we interested in office automation? What benefits are to be gained by applying this computer technology to millions of office workers who make up our white collar labor force? Some statistics shed light on these questions.

Traditionally, the organization has made little investment in its office employees. Estimates for average capitalization per office worker vary from $2000 [4] to about $6000 [16]. By comparison, the average capitalization per factory worker is reported to be about $25,000 [4]. Organizations have made fundamentally different capital/labor decisions in these two environments. In the factory, opportunities for automation have led the organization to trade labor for capital investment; this
has resulted in impressive productivity increases. In the office, however, there has been little interest in automation opportunities.

Current cost trends now make automation in the office more attractive. Presently, labor costs in the office are increasing at 6% per year, while communications costs are declining at 11% per year, computer logic costs are dropping at 25% per year, and computer memory costs are plummeting at a rate of 40% per year [3]. When one considers that approximately 22% of the U.S. labor force is involved in "office work" or "administrative processing" and that the shift toward a more service based economy will likely increase this factor, the implications are very clear, indeed.

Until recently, offices have taken little advantage of technological opportunities to increase productivity. This has resulted in office costs increasing from 20% - 30% of total company costs to 40% - 50% of total costs [4]. Furthermore, accounting for these costs is very haphazard in most organizations, where a large portion of these costs are lumped into corporate overhead [16]. The decreasing cost of office automation technology, as well as the availability of that technology, coupled with the increased cost of office labor, provides an opportunity for innovative corporate managers to stabilize or reduce office costs.
Many organizations now realize that they must begin to move toward the automated office if they expect to stem the rising tide of office costs and still process the growing workloads being placed on them. A Stanford Research Institute study suggests that average investment per office employee will rise from $2000 to $10000 by 1985 [4]. If this is the case, the total market for office systems technology could reach $85 billion by the 1985-1990 timeframe.

On the negative side, the availability of sophisticated technology at relatively low prices has led some individuals to believe that technology alone will solve the problems of the office. This is a delusion. Technology alone provides opportunities. If the technology is to be of use to an organization, it must be incorporated into a systems solution to the problems of the office.

3.0 STAGES OF GROWTH

A stage hypothesis proposes that a specific evolutionary process can be conveniently segmented into a number of clearly identifiable phases for purposes of discussion and comparison. A good example is the division of the human growth process into stages of infancy, childhood, adolescence, adulthood and old age. Obviously,
any one of these stages could be further subdivided if needs so dictated. As such, a stage hypothesis is useful to the extent that it provides insights into the evolutionary process under study.

Nolan suggests that there exist four stages of growth for an organization as its use of information systems matures. He labels these stages initiation, expansion, formalization, and maturity. These stages lead to the familiar "S" growth curve. The office will soon become a major applications area for information systems organizations and we foresee the office undergoing similar stages of growth. We examine these stages in more detail so that managers can place present and future developments into a broader perspective. This will be followed by an examination of other relevant hypotheses.

3.1 Initiation

In the initiation stage, organizations will perceive (or have perceived) technological opportunities for cost-reduction or increased productivity and will begin to use mechanized office equipment. This will normally be limited to text processing equipment, just as the first computer installations were limited to bread and butter applications. Some users will take advantage of the machine
readable text and will interface to photocomposition systems, TWX/Telex and other output mediums for enhanced output capabilities. Many of today's larger organizations are already in or through the initiation stage, using standalone word processing equipment, shared logic systems, or text editing systems on large computers. Emphasis will be on the more efficient production of paper (as opposed to the longer range objective of reducing paperwork), and in most organizations the technology will be introduced and managed by the administrative services function. There will be a fairly clear delineation between word processing and data processing at this point. Unfortunately, most data processing managers will view this stage with little or no interest, viewing word processing as an activity outside the scope of their mission.

3.2 Expansion

The initiation stage will be followed by a stage of rapid expansion. Office automation will "catch on", just as data processing did during the second stage of EDP growth. There will be an explosion of interest and predictions of revolution; poorly planned and uncoordinated development efforts will be justified on low marginal cost, given the equipment in place from stage 1.
The emphasis in this stage will be on the development of tools by mechanizing devices in the office such as the in-basket, file cabinet, Roladex, calendar, telephone, etc. Most references to "office automation" or the "office of the future" really refer to this stage of development, and would be more accurately labelled "office mechanization". The objective here will be to replace paper flow with electronic information flows. We note that the technology, to a large extent, exists today to develop sophisticated document generators, computer based message systems, basic calendar management functions, and other related office tools. In this stage, the data processing sector of the organization may recognize the office as an applications area.

We will mechanize tasks that people perform (i.e., typing, filing) but not automate functions (e.g., order entry, credit approval). Here we are not faced with a technology problem as much as a systems problem and an organization problem. This stage will bring with it the introduction of large amounts of distributed hardware. For many of these applications to be successful, they must be used by a "critical mass" of users (electronic mail is a good example of this). As more and more people begin to use these systems, we will have to address the organizational problems which will undoubtedly arise. The challenges of the organizational problems will probably be larger than the
technical challenges in this stage. The proliferation of applications and hardware will be very similar to the proliferation of applications in the corporate computer facilities in the 1960's.

Since the emphasis in this stage is on the mechanization of tools in the office as opposed to office functions, per se, there will not be great concern for the integration of these tools into a cohesive whole. Rather, it will be a period of experimentation as tools are proposed, developed, refined, and some discarded.

3.3 Formalization

The period of rapid expansion will result in a proliferation of disjointed tools, very analogous to the proliferation of non-integrated data processing applications of the 1960's. As users become more comfortable with these tools, they will demand cohesiveness and further integration in their office environments. This will motivate a third stage of growth which will focus on what is being done in the office in addition to the tools used in the office to carry out office functions. The first change will be toward integrating applications and facilities into more cohesive systems. The second change will be a shift from mechanizing devices toward automating processes, and from mechanizing
tasks to automating functions. A substantial portion of the work carried on in most offices is the execution of routine or "almost routine" office procedures. It is these procedures which give utility to the various devices in the office and the automation of these routine and almost routine procedures will allow us to use the computer in the office as more than a "word cruncher". The processes that we are addressing here are those office procedures which are not amenable to conventional data processing technology due to a lack of structure.

This shift in emphasis from devices to process is a crucial one. Ackoff [1] provides a succinct definition of process as a "sequence of behavior that constitutes a system and has a goal producing function." It is the manager in an organization that has a notion of process. From a very simplistic viewpoint, the devices in the office are resources of the secretary, and the secretary is a resource of the manager. By mechanizing devices, we are addressing the resources of the secretary but, by and large, not those of the manager. However, when we attack office processes, we are automating office functions, not office tasks, and are addressing problems of the manager. We are not suggesting that secretaries will be replaced; we do suggest that some of the more structured, routine and mundane responsibilities of the secretary and manager will be
(almost) completely automated in this stage, thus making this group of workers available for more productive functions. Naturally, the difference between stage 2 and stage 3 is one of degree. In stage 2, we mechanize many of the secretary's tools but still rely on the secretary to know when these tools are to be used and how they are to be used to accomplish some job function. In stage 3, we take the organization's knowledge about the office processes and put that into the machine so that the computer system will know how the various tools should be used together (the sequence of behavior) to accomplish some particular job function (the goal producing function), and when to use the various tools. In this stage, we begin to use "automation" in the stricter sense of replacing people with machines, rather than simply supporting or augmenting them with more mechanized devices. This focus on office automation goes beyond many current perceptions of the field.

3.4 Maturity

The last stage in the growth process is a relatively self-explanatory one, and a period of stabilization as the organization adapts to change. We will see a continued integration of functions and facilities in office systems. Less structured office procedures will be automated as we learn more about this area. Obviously, some functions will
be "de-automated" as we learn from the mistakes. As major new technologies develop, this growth curve will be repeated, as organizations generate change, integrate the changes into their work environments (possibly by changing the work environment), and stabilize from the effects of these changes.

3.5 Other Stage Hypotheses

Strassmann [17], of Xerox, has also considered the implications of the stage hypothesis on office automation. He suggests that while traditional data processing may be in the fourth stage of Nolan's growth curve, "general administrative systems" are just beginning to emerge, largely because they have been ignored for the past ten to twenty years. Strassmann sees the four stages of growth in general administrative systems to be mechanization of tasks, machine-aided transactions, work redesign and work enlargement. The work reported in this paper concentrates on what Strassmann has labelled task mechanization and machine-aided transactions, and is complementary to Strassmann's model.

In the late sixties, a popular stage hypothesis [15] for office automation included the nonmechanized craft stage, an early mechanization stage characterized by the use
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of typewriters, adding machines and the like, the punched card data processing stage and the automation stage of electronic data processing. Clearly the stage hypothesis discussed in this paper, and that discussed by Strassmann, deals solely with what was previously considered the automation stage of electronic data processing and explodes that single stage into mechanization and automation components. These views are not necessarily inconsistent if one views the distinction between mechanization and automation as a technology frontier which is continually moving forward; what we view as automation today will probably be viewed as mechanization is some future period.

4.0 IMPLICATIONS OF THE STAGE HYPOTHESIS

Our view of the evolution of office automation clearly revolves around a distinction between mechanization of tasks in stage 2 and automation of functions in stage 3. We believe that there are several implications for those charged with managing this evolution, and we discuss some of those implications in this section. Before proceeding to that, however, it will be necessary to more clearly distinguish the terms mechanization and automation.
It is distressing that most of the current literature on office automation addresses the oncoming "revolution" in the office but makes no attempt to distinguish office automation from office mechanization, and in fact, often mistakes one for the other. Earlier literature on the subject of office automation studied the distinction between mechanization and automation. In addressing this distinction, Shepard [15] provides a good summarization of the literature. Two major points distinguishing mechanization from automation according to studies by Faunce, Bright and Diebold are:

1. As automaticity increases, the initiating control source moves from man to technology (i.e., automatic control);

2. As automaticity increases, integration of function increases.

As pointed out in the previous section, it is these characteristics which distinguish stage 2 from stage 3. The second point, that of integration of function, is fairly self-explanatory. The first point, that of control, is crucial to real automation. In the office domain, this means that we not only mechanize the task (e.g., from
typewriter to word processor), but that we also use the technology to know when a task should be executed (e.g., under what conditions the word processor should be instructed to produce a specific document). As Simon indicates [14], technology is knowledge: "knowledge of how to make things, but also knowledge of how to do things." The technology of automation implies a different kind of knowledge and a higher degree of knowledge, than the technology of mecanization. In the office domain, this incremental knowledge is, in fact, the knowledge of office procedures.

4.1.1 Automating Office Procedures -

In order to automate office procedures, we need a general mechanism for representing the knowledge about office procedures in the computer memory. In this way, the computer can automatically react to inputs to the office by activating the various mecanized tools with instructions supplied by the encoded procedures. This issue of office process representation is an instance of a more general process representation and knowledge representation problem which is of wide interest in the artificial intelligence and computer science research communities. What we are really addressing is the development of knowledge based systems.
In considering the representation and automation of office procedures, certain characteristics become apparent which can be exploited. Foremost is the extent to which office procedures are event driven. By that, we mean that many office procedures are defined in such a way that office personnel react to various stimuli from the environment. A reasonable paradigm for an office manager is to "keep the ball in someone else's court." When something happens which requires our attention, we react to it, and then send it on to the next station for further action.

As part of a research project to develop a suitable representation for office processes, the author worked with a large mortgage banking company and large insurance company in analyzing their office procedures. To a surprisingly large extent, their procedures were event driven and could be characterized by what we came to call a "local focus of attention." The procedure is composed of a number of related activities. An activity is an action or series of actions which occur in a single attention span, is frequently performed by a single individual, and is initiated by some external event (external to the person performing the activity) such as the arrival of a document or the arrival of some specific date. An activity terminates when no other actions can be taken with respect to the procedure. Normally, this means that the organization must await new
information from the environment or must wait for some fixed time period to elapse.

Another interesting aspect of office procedures is the observation that oftentimes difficulties in offices arise not so much from doing the wrong things as from not doing the right things when they should be done. The difficulty is not task performance as much as task recognition. This is an area in which the computer may be very helpful.

4.2 Organizational Implications

Much of the work cited earlier which distinguished mechanization from automation was actually motivated by questions of worker alienation in offices and factories. In general, the literature indicates that workers in automated environments are less alienated than workers in mechanized environments. This is generally due to job enlargement and less function specialization in automated environments [15]. Shepard shows that for both the office and the factory "the degree of differentiation in the division of labor at work is related to technology and that automated technology reduces the level of alienation among office employees as well as factory workers."
An obvious example is the factory production line. In a mechanized production line, each worker makes a small contribution to the final product as the assembly moves by each work station. The job is characterized by mechanical pacing of work, repetitiveness, minimum skill requirements, surface mental attention and minute subdivision of labor [18]. These workers are likely to have relatively high levels of alienation. In contrast, the worker in an automated continuous process plant is a monitor of an integrated production system, a maintainer of complex equipment and an exception handler. These jobs are associated with the whole of the process, as compared to the high subdivision of labor associated with mechanization, and job enlargement usually occurs.

We can expect the same results in the continuing evolution of office systems technology. During periods of device mechanization we can expect to encounter substantial employee resistance and alienation. Large word processing centers provide a good example of a highly mechanized, functionally specialized environment which met with substantial worker alienation. As we move from the mechanization of stage 2 to the automation of stage 3, we will relieve workers of the mundane and routine functions and turn these over to computer control; during this period we can expect less employee alienation and quicker
acceptance of the technology.

4.3 How Long An Evolution?

The rapid proliferation of tools in stage 2 is essentially unavoidable as organizations begin to assimilate new office technology. It is important to long run success, however, that organizations keep a steady eye toward the integration of these tools which become crucial to the third stage of development. The tools of the office are not an end in themselves; mechanizing the tools cannot be an end in itself.

How long will this growth cycle take and who will manage it? The emphasis in this paper has been on controlled and managed evolution; office environments are not going to change overnight. Stage 2 will be technology driven; since most of the technology is here and getting less expensive by the minute, we can expect products to start reaching the market fairly rapidly, and in fact this is already the case with word processing and electronic mail systems. However, mechanization of stage 2 implies organizational problems. In stage 2, technology will not be on the critical path, but rather the organization's ability to assimilate the technology.
Systems to address the third stage of growth are at least five to 10 years from being commercially available. Many problems related to understanding and representing office processes remain to be solved. We can expect to see specific ad hoc implementations in the short run, however. These implementations will be fairly close to traditional data processing implementations but will make use of office mechanization tools such as document generators and electronic mail systems. Managers should be careful not to confuse specific application dependent implementations with the more general issue of knowledge based representations. Generality of representation is needed in the long run, but it comes at a substantial cost. The critical path in this stage will probably be technology.

It will be interesting to see who manages this evolution in organizations. Office automation requires information processing in a much broader perspective than traditional data processing, general administrative services or telecommunications (see Strassmann [16]). The leadership for the office automation effort will come from one of these areas, but a successful effort will require the involvement of all groups. Each group will have to widen the scope of its mission to include the office of the future; the group which does so most quickly will emerge as the leader and catalyst.
5.0 OFFICE PROCEDURES AS SEMI-STRUCTURED PROCESSES

We expect the automation of office processes to present some unique problems relative to other computer automation efforts. Most of these difficulties center around the degree of structure in the applications area. The history of commercial data processing has been one of moving from highly structured application domains to less structured domains. For example, the early development of automated accounting systems followed by the relatively recent development of decision support systems is a progression from a highly structured domain to a much less structured domain. In this context, the automation of semi-structured office processes is a natural step in this progression.

An examination of Gorry and Scott Mortons's framework for MIS [7] provides useful insights here. In their work, they motivate the development of decision support systems (DSS) to support managers operating in unstructured problem domains. Essentially, a DSS provides an environment consisting of a set of tools such as models, data base systems, data analysis systems, data extraction programs, report generators, etc. and a means with which to interface these normally incompatible tools into a synergistic whole (refer, for example, to the GMIS system at the Sloan School [5] or the DAISY system at the Wharton School [2]). The individual manager provides the structure by using the tools
in some manner to carry out his/her objectives. Since the problem domain is inherently unstructured, we cannot put a notion of process into the computer; we rely on the manager using the system to provide the process. At the other extreme, we have highly structured operational control systems (e.g., payroll) where the underlying process is well understood and is implicitly encoded into the computer system. As Gorry and Scott Morton indicate, an understanding of the underlying structure or lack of structure in the problem domain is essential to determining how the computer can best be used in the problem domain.

Where do office procedures fit into the Gorry-Scott Morton framework? Some office procedures are highly structured and have been automated with traditional data processing techniques (these also tend to be high volume procedures such as order entry). On the other hand, there are clearly some totally unstructured office processes (it doesn't make much sense to talk about an unstructured procedure). For these processes, the integration of stage 2 tools into a cohesive DSS environment which augments the manager will be of great value, but attempts to automate the process will fail just as other attempts to impose too much structure on an inherently unstructured process have failed. An example of such an unstructured process might be the day to day informal communications of a manager.
There is a lot going on in an office that falls between these two cases. These are what Gorry and Scott Morton call semi-structured processes. We suggest that a large number of office procedures are instances of "semi-structured" processes. Although these processes will clearly benefit from the tools developed in stage 2, the real payoff in terms of productivity will come in stage 3 when we can capture the notion of process and exploit it with the computer.

6.0 AN EXAMPLE

At this point, a sample application and an examination of how it might evolve through this growth cycle will be beneficial. We introduce an example here which was used to study the representation and automation of office processes [19]. Consider the job function of serving as an editor for an academic journal. While this may not be a typical office procedure in most businesses, in general form it is very typical of office procedures which involve a number of individuals in different organizations, a large amount of written, standardized communication, a relatively long time horizon for completion of the process, and is somewhat structured. An informal description of the journal editing procedure would be the following:
When an individual or group of individuals write a paper and desire to publish the paper in an academic journal, the paper must be sent to one of the journal editors. It is typically received by the secretary or administrative assistant to the editor. Relevant data from the paper is entered into a log which is kept for the journal. This data includes the author and title of the paper, as well as the author to which correspondence should be directed. The paper is assigned a log number, and an acknowledgement letter is sent to the primary author.

The editor is informed that a paper has been submitted and is expected to designate referees—individuals knowledgeable in the subject matter of the paper who will read the paper and offer an opinion as to its suitability for publication. Normally, the editor designates two referees, but this is not absolutely necessary. The editor may designate as few as one or as many as three referees.

When the editor has designated referees, the secretary sends letters to these individuals asking their assistance in reviewing the paper. The letter is mailed to each prospective referee along with a copy of the submitted paper, information about the refereeing process, and a return postcard. The referee is asked to return the postcard and indicate his/her willingness to review the paper.

If the prospective referee returns the postcard and indicates an unwillingness to review the paper, the editor is notified and asked to select another prospective referee. If the prospective referee returns the postcard and indicates a willingness to review the paper, then s/he is expected to review the paper and submit a report within one month.

After all of the referee reports are in, the editor is so informed and is expected to make a decision about the publication of the paper. He can decide to accept the paper in its present form, to reject the paper, or to request that the author(s) revise the paper in accordance with the referees' comments.
When the editor makes his decision, a letter is sent to the primary author informing him/her of the decision. Additionally, copies of the referee reports, with referee names deleted, are sent to the primary author.

If the author submits a revision of the paper, the revised version of the paper is sent to the original referees and the whole process is repeated.

To gain an appreciation for the implications of the stage hypothesis, we now examine how this journal editing procedure might evolve in an office automation environment.

6.1 Stage 1

In the first stage, we would expect to see the editor's communications standardized and letters to be processed on an automatic typewriter of some sort. While this will relieve the secretary of the task of retyping the documents for every paper, we have not addressed any of the control problems in managing the paper flow. Manual logs will be maintained which will detail the communications for each paper submitted. In terms of the function of journal editing, we have really automated very little.
6.2 Stage 2

In stage 2, other tools will become available for mechanizing portions of the editing process. The various participants will rely on an electronic mail system for their normal communications and will use postal services to a far lesser extent. Automated filing systems will be used to store some of the correspondence and for other data storage purposes. At this point, though, we are still relying on individuals, namely the editor and the secretary, to recognize when tasks must be performed and at least to initiate these tasks. Just as importantly, we rely on the secretary to recognize when expected events have not occurred (e.g., a referee not submitting a report on time). We still expect the secretary to perform all of the tasks as in stage 1; the only difference is that we give him/her new tools to accomplish some of these tasks by mechanizing some of the devices that the secretary uses. We still rely on the secretary to receive inputs, interpret these inputs no matter how routine they are, and to see that the proper outputs are generated.

6.3 Stage 3

Most of the technology described above for stage 2 exists or will soon become commercially available. Such is
not the case for the automation implied in stage 3. An important distinction must be made here. The technology certainly exist to write a specific computer program to automate the journal editing function and to keep track of each paper submitted; such systems exist today and are used. What does not exists is a general computer system which has knowledge of general office procedures, of which journal editing is one particular but not unique instance.

The third stage of growth will concentrate on the procedure to be performed and not just on the tasks which must be accomplished in execution of the procedure. Here we will see attempts to actually automate portions of these processes. In this example, a computer system will automatically keep track of each paper submitted, generating the proper documents at the proper times, and reacting to inputs by producing the proper outputs. For example, when someone wishes to submit a paper for publication, s/he will "send" the paper to this system with a proper cover message. Upon accepting this message, the computer system (not the secretary) will consult a machine-readable library of procedures, find the journal editing procedure, and determine that an acknowledgement letter should be generated and that a message should be sent to the editor requesting the names of referees. The computer system will then initiate these actions by sending detailed commands to the
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various mechanized tools, such as the document generation subsystem or electronic message subsystem. The editor will receive an electronic mail message informing him that a paper has been received and requesting the names of referees.

The editor will probably file this message in his electronic "inbox" file and respond to the message at some later date by supplying the names of referees. This will cause the electronic mail system to send an electronic message back to the computer system. When the computer system processes this message it will again consult its machine-readable procedure library to determine what actions, if any, can be taken. The computer system will now determine that since it has the names of referees for the paper, it should send a message (probably through the computer network) to the selected referees by instructing the document generation subsystem to transmit a form letter filled in with some variable information. If the computer system does not receive a response from the referees within some specified period, it will automatically take action to correct the situation (this might involve sending out a reminder notice or informing the editor). The process would continue like this until a decision was made on the paper, with the computer system automatically "tracking" each paper, and managing the routine control functions.
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In effect, the computer system now assumes the role of the secretary. It detects inputs, consults procedures to determine what actions should be taken, and generates outputs. The outputs may be messages to other parties (the computer system is acting as an intelligent message switch) or instructions to other office systems to take certain actions such as filing information. The computer system can also react when expected events do not occur within specified time periods. As one can see, a large portion of the routine and almost routine work done by a secretary for the journal editing procedure can be automated once we change our focus from device mechanization to process automation.

7.0 TOWARD THE THIRD STAGE

In a recently completed research project at the Wharton School, we investigated the methodology and technology required for achieving stage 3 capability in office automation systems (see Morgan [8] and Ness [9] for a description of the Wharton Office Automation Project). During the previous two years other researchers, chiefly Professor David Ness, had developed a large testbed of tools, including document generators, electronic mail systems, and electronic filing systems [10,11,12]. Thus, there existed a robust stage 2 environment, and our
objective was to push that technology toward the third stage described in this paper.

The research project is discussed in the author's doctoral dissertation [19] and is briefly summarized here.

1. As we stated earlier, mechanization and automation are levels of technology, and technology is essentially knowledge of how to do things. Automation implies that a more sophisticated knowledge base be used, and this in turn requires a way of representing this knowledge in the computer system. To that end, we developed a modelling formalism called an augmented Petri net (APN) [20,21], based on formalisms previously developed in the computer science and artificial intelligence fields. With the APN, we can describe office procedures such as the journal editing procedure in a manner that can be interpreted by the computer system for control of the various mechanized devices. An office procedure specification language was also designed so that analysts could describe office procedures in a parsimonious fashion; the external specification can be automatically converted into the APN internal representation.
2. The other part of the research project was the development and implementation of a computer system named SCOOP (System for Computerization of Office Procedures). The objective of SCOOP is to provide the technology for achieving the third stage of automation. SCOOP is the interface between the user and the mechanized tools of the office, thus allowing the user to deal with the computer at the level of process instead of task.

SCOOP interprets the APN descriptions of office procedures stored in the procedure library to control the various office tools. It is presently being used by an editor of Communications of the Association for Computing Machinery (CACM) and Transactions on Database Systems (TODS) to help in the editorial function, and operates in the manner described in the previous section where we considered the evolution of the journal editing function through the four stages of automation (specifically, it operates as we described stage 3 capabilities in the previous section). SCOOP is capable of interpreting the APN descriptions of office procedures, sending and receiving messages from individuals, and sending instructions to other mechanized office tools.
While we have used the example of journal editing, there is nothing in the SCOOP system specific to journal editing; the specificity to this application comes from the description of journal editing supplied by the APN descriptions. SCOOP could be used for a wide range of office procedures, without having to write specific computer programs for each procedure. In this way, SCOOP can be used to automate many of the procedures performed by the secretary and to track the information flow in the organization. Naturally, SCOOP could also be interfaced to the organization's data processing systems so that SCOOP could interrogate and update the organization's databases normally maintained through traditional data processing systems. In this manner, office automation and data processing will blend together into a more general "information processing" system.

8.0 CONCLUSION

In this paper, we have provided a framework with which the manager can rationalize the evolution of office automation systems. We suggest that office automation will
evolve and mature from a focus on task mechanization to one on process automation. An understanding of the evolutionary growth process and its implications will assist managers in planning for the introduction and management of office systems technology.

A prototype system for automating office functions, operating from a knowledge base of office procedures, has been described. Our experience with that project reinforces our opinion that while the benefits of stage 2 mechanization are substantial, the truly "automated office" requires that we incorporate a notion of process into our systems thinking.

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REFERENCES


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