DOCUMENT RESUME

03390 - [A2723935]

Planning for Source Data Automation in Government Industrial Activities: Coordination Needed. LCD-77-441; B-175132. September 23, 1977. 27 pp. + 2 appendices (3 pp.).

Report to Executive Director, National Center for Productivity and the Quality of Working Life; Secretary, Department of Defense; by Fred J. Shafer, Director, Logistics and Communications Div.

Issue Area: Automatic Data Processing: Social Impacts of Computer-Based Systems (109).
Contact: Logistics and Communications Div.
Budget Function: Miscellaneous: Automatic Data Processing (1001).
Organization Concerned: General Services Administration.
Congressional Relevance: House Committee on Armed Services; Senate Committee on Armed Services.
Authority: P.L. 89-306. P.L. 94-136, sec. 204.

Source data automation techniques collect data in computer readable form at the point and time of an activity. The data are automatically transmitted to a central computer or intermediate storage device where it is recorded and analyzed. Properly applied in the industrial environment, source data automation can increase productivity through improved data timing and accuracy, improved production control, and reduced inventories. However, a source data automation installation can be expensive and its benefits, some of which are difficult to identify or measure, must be carefully weighed against the cost. The Department of Defense, with its complex of manufacturing and repair facilities and its large purchases from the private sector, would be a prime benefactor of properly applied source data automation. Findings/Conclusions: Some Government industrial-type activities have employed source data automation systems to their advantage. Barriers to diffusion of this technology include a lack of criteria for assessing source data automation's potential, complexities involved in equipment procurement, and poor use of pilot study results. Source data automation systems and pilot projects are not tracked or sponsored beyond the command level within the Department of Defense, and feedback on the desirability of source data automation is lacking. Application of source data automation in Government industrial activities is growing, and a central source for information on installed systems would be beneficial. Recommendations: The Director of the National Center for Productivity and Quality of Working Life should coordinate the Government's industrial source data automation efforts and designate focal points to encourage development of criteria for identifying potential applications, diffuse technology, study problems affecting systems development and use, define aspects needing standards, and coordinate with industry on source data automation technology, uses, and research. The Secretary of Defense should designate a group modeled after its Manufacturing Technology Advisory Group to coordinate the services' use of source data automation. (Author/SW)

UNITED STATES
GENERAL ACCOUNTING OFFICE

Planning For Source Data Automation In Government Industrial Activities-- Coordination Needed

National Center for Productivity and Quality of Working Life
Department of Defense

Properly applied in the industrial environment, source data automation can benefit productivity by improving data timing and accuracy, and through control of production processes. Some Government and private industrial activities have successful systems; however, there are barriers to widespread use and thus unexplored opportunities. Coordination of Government efforts by the National Center for Productivity and Quality of Working Life would help the orderly diffusion of the technology.

LCD-77-441

SEPTEMBER 23, 1977

UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

LOGISTICS AND COMMUNICATIONS DIVISION

B-175132

To the Executive Director of the
National Center for Productivity and
Quality of Working Life and
the Secretary of Defense

We have studied the growing use of source data automation in the Government's industrial environment. This report points out problems incurred by activities in exploring this technology and discusses opportunities to improve the diffusion process.

This report contains recommendations to you on page 24. As you know, section 236 of the Legislative Reorganization Act of 1970 requires the head of a Federal agency to submit a written statement on actions taken on our recommendations to the House Committee on Government Operations and the Senate Committee on Governmental Affairs not later than 60 days after the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

We are sending copies of this report to the Director, Office of Management and Budget, and to the Chairmen, House and Senate Committees on Appropriations and Armed Services, the House Committee on Government Operations, and the Senate Committee on Governmental Affairs.

for Fred J. Shafer
Director

GENERAL ACCOUNTING OFFICE REPORT TO THE EXECUTIVE DIRECTOR, NATIONAL CENTER FOR PRODUCTIVITY AND QUALITY OF WORKING LIFE, AND TO THE SECRETARY OF DEFENSE

PLANNING FOR SOURCE DATA AUTOMATION IN GOVERNMENT INDUSTRIAL ACTIVITIES-- COORDINATION NEEDED
National Center For Productivity and Quality of Working Life
Department of Defense

D I G E S T

Properly applied in the industrial environment, source data automation can increase productivity through improved data timing and accuracy, improved production control, and reduced inventories. However, a source data automation installation can be expensive and its benefits, some of which are difficult to identify or measure, must be carefully weighed against the cost.

Source data automation techniques collect data in computer readable form at the point and time an activity occurs. The technology for collecting data includes optical character readers and printers, magnetic strip encoders and readers, embossed badge systems, and voice input. The data is automatically transmitted to a central computer or intermediate storage device where it is recorded and analyzed.

Source data automation can apply to many aspects of industry: material tracking, work force management, tool issue and receipt, inventory control, machine use, inspection results, work order tracking, authorized personnel access, purchasing, and sensitive item control. Applications are highly diversified and are found in Government and private industrial facilities, as well as in such service sector activities as hospitals, schools, and retail stores.

The concept of source data automation for item identification and tracking is the same whether the items are repair parts, books, people, or services. For example:

--A naval ordnance station installed multimedia terminals and card/badge readers

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for time and attendance, labor distribution, production planning and control, and direct material control and estimates it saved over $300,000 in 1976. (See p. 15.)

--A hospital installed a color bar code system to record transactions faster and more accurately and has increased efficiency and reduced stock levels. (See p. 6.)

The Department of Defense, with its complex of manufacturing and repair facilities and its large purchases of manufactured products from the private sector, would be a prime benefactor of properly applied source data automation.

In the opinion of GAO,

--the technology is not systematically diffused,

--source data automation systems and pilot projects are not tracked or sponsored beyond the command level within the Department of Defense, and

--feedback on the desirability of source data automation is lacking.

While some Government activities are using source data automation, there are unexplored opportunities. Some activities have had difficulty keeping up with technology and identifying good applications. Other barriers include a lack of criteria for assessing source data automation's potential, complexities involved in equipment procurement, and poor use of pilot study results. (See p. 16.)

Application of these techniques in Government industrial activities is growing. A central source for information on installed systems would enhance the expansion of source data automation and help avoid uneconomical applications. More cooperation between Government and industry would also help to make the technology better known and develop standards. (See pp. 12 and 13.)

GAO recommends that the National Center for Productivity and Quality of Working Life serve as a focal point to encourage the development of criteria to assist in identifying the potential for applications, the diffusion of technology, the studying of problems affecting development and use, the definition of aspects needing standards, and the coordination with industry.

GAO also recommends that the Secretary of Defense designate a group, modeled after its Manufacturing Technology Advisory Group, to coordinate the services' use of source data automation and to work with the National Center for Productivity and Quality of Working Life.

These issues were discussed with officials of the National Center for Productivity and Quality of Working Life and the Department of Defense. They were in general agreement that there is a need for a focal point to diffuse source data automation. The National Center officials told GAO that this report would be useful to them in determining their priorities in the area of industrial productivity. Defense officials said that in designating a group to coordinate the services' use of industrial source data automation, they would consider other aspects of the concept to assure the proper interface with nonindustrial activities. (See p. 25.)

Contents

ABBREVIATIONS

ADP	automatic data processing
DOD	Department of Defense
GAO	General Accounting Office
GSA	General Services Administration
SDA	source data automation

CHAPTER 1

INTRODUCTION

"Source data automation" (SDA) is a term used to describe various means of collecting data about an event in computer readable form at the point and time of the event's occurrence. SDA techniques are among several advanced data entry methods that are currently being used in Government and private industrial facilities, as well as in such service sector activities as hospitals, schools, and retail stores. Recent rapid advances in computer technology, such as emergence of powerful minicomputers, have permitted more imaginative uses, and with these uses has come a need for more efficient data entry techniques. In a related study we are addressing various advanced data entry techniques and the need for agencies' data processing installations to consider these more effective techniques.

Although the SDA concept applies to both the service and industrial sectors, this report addresses the use of SDA in the industrial environment because of the significant investment and cost of operating industrial facilities and the increasing need for better and more accurate data to manage the facilities. However, since the tracking of items in the service sector and in industrial activities is similar, we refer to several successful service sector applications in this report.

Coupled with other advances in technology, such as using computers to control manufacturing processes and to automate material handling, SDA techniques can benefit the entire industrial management environment.

HOW SDA WORKS

Where there is a need to track large numbers of objects, persons, or processes, there is a potential for SDA. As an example, employees can insert identification badges into terminals and the computer can instantly tell management the manpower size and profile for the workday. Also, from job order entries, the system can monitor every job through production, answer inquiries, and immediately inform management of material shortages and inoperative machines. At the end of the day, or during the work shift, the system can compute the payroll, job status, job cost, department performance, and other analyses. The employee badge also can automatically control access to secure areas and monitor employee movements.

(2) bar code readers which associate a configuration of bars with a character, and (3) mark sense readers which detect a mark or absence of a mark in specific locations. Scanning with optical character readers is an efficient method for directly reading typed, printed, or written numbers. Bar code readers cost less than character readers but have the disadvantage of requiring a device to prepare the bar code. Mark sense readers are usually low cost and highly reliable but are inflexible due to the need for preprinted forms and exacting data placement and design.

Magnetic readers

Characters to be read have magnetic properties which are sensed. Advantages of this class are more immunity to dirt and ease of document changes. A disadvantage is the requirement for a special set of high-quality printed characters. Most current applications are for transportation tickets, clothing identification, and bank checks.

Voice input

This technique is the most revolutionary, in that a computer recognizes human voice patterns. Spoken words automatically enter data and can trigger control mechanisms of production equipment. It is slower than some of the other techniques but can be performed simultaneously with other work.

Direct hand data entry

A special pen converts handwriting into machine language at the time the data is written. The technology is based on recognition of up/down/left/right patterns, but it is relatively new and few varieties are offered.

Mixed media

Several data entry technologies can be integrated into one device, or several devices can be connected to a minicomputer to collect and consolidate data. Either combination is called mixed media input.

SOME SDA APPLICATIONS

Within the industrial environment, people and materials are brought together to produce or repair products, many of which are used by Government agencies. In the public sector, the Army, Navy, and Air Force operate facilities to repair airplanes, ships, and guns or to manufacture repair parts, weapons, and ammunition. DOD also maintains large inventories of supply items. Common to all types of industries and the related supply functions is the need to schedule, control, and account for the movement of people and materials through the various processes. However, tracking systems in manufacturing and repair facilities can be more complex than those in supply operations because, in the former, the resources being tracked, (people, raw materials, energy, tools, and data) are of a dynamic nature and are being combined and converted to finished products.

SDA can be applied to many aspects of industrial operations, including material tracking, work force management, tool issue and receipt, inventory control, machine use, inspection results, work order tracking, authorized personnel access, purchasing, and sensitive item control. Some of these applications are in use in private industry and at Government installations.

Through plant visits, phone contacts, and literature, we identified a number of private companies and Government activities using SDA. Included were:

1. An automobile manufacturer that was able to increase spare parts inventory turnover from 17 to 22 times a year, which reduced the required inventory level and, with union cooperation, permitted the reassignment of 40 employees. This enabled the company to pay for a $1 million SDA system in less than a year. The system consists of 180 terminals on the receiving docks, in warehouses, and in receiving offices. The receiving clerk keys in data on the incoming orders and obtains purchase order information, such as quantities, and stock level requirements for verification. Warehouse assignments are also given. Those activities were previously time-consuming manual operations.

2. An aerospace manufacturer that increased the average metal cutting utilization of 16 numerically controlled machine tools, valued at over $3 million, from 15 percent to 50 percent over a 4-year period (1972-76). The machine operator pushes 1 of 12 status keys on input terminals located at each machine. This action feeds status data to a computer and also activates a master display panel which gives management a constant picture of the status of the entire system. The investment in SDA equipment and software at this plant was less than $75,000. (See p. 18.)

3. A naval ordnance station that estimated a savings of over $300,000 in 1976 because of an SDA system consisting of a minicomputer and 40 terminals. The data obtained, which is entered by shop employees, replaces information previously gathered through manual preparation of job cards and other

production reports. The data collected concerns time and attendance, labor distribution, production planning and control, and direct material control. (See p. 15.)

4. A manufacturer of electromechanical devices that estimated a savings of $750,000 annually after changing its financial accounting oriented manual filing system to a 200-terminal shop activity oriented system. Shop employees enter data into shop floor terminals that contain a limited number of keys, a card reader, and a badge reader. This captures information permitting the real time tracking of such things as customer order status, in-process inventory flow, status of work on parts in process, and materials control.

5. A manufacturer of computer terminals that estimated net dollar savings of $309,000 for 1976, 1977, and 1978 following the installation of a shop floor in-process SDA production control system that collects data on the varying requirements and specifications of each customer's orders. The in-process status of a job order is keyed in at each work station, giving management real time data on the work-in-process inventory. Shop employees are also able to call up specification sheets for each order, a task that previously required time-consuming manual matching of records.

Not all SDA installations can demonstrate cost effectiveness as clearly as do these examples. The justification is often difficult and the bases nebulous, since there are many intangible, although real, benefits. For example, it is difficult, if not impossible, to affix a direct dollar value to improved customer relations when repair parts can be delivered within 2 days rather than taking a week. Yet an organization servicing oil rig operators claims to have secured and held customers due to the prompt service they are able to offer using their SDA system.

Another example of intangible savings from SDA involves a hospital that uses hand-held wands to read color bar codes on patient charts and bar codes that represent each hospital service rendered and to transmit this information directly to a computer. The system provides faster and more accurate information collection, which, in turn, results in more efficient work schedules, reduced paper work, reduced admission time, and improved billing procedures. The hospital staff feels sure that the system is worthwhile; however, it is difficult to quantify all of the dollar savings.

The fact that the amount of savings is difficult to assign to SDA justifications is a key reason for caution. If a justification is weighted too liberally on the benefit side, there can be a real economic loss; if too conservatively, then true and substantial benefits may be bypassed. SDA systems must be analyzed carefully. They can be expensive and complex, and they require substantial software support. In some cases, the volume of work, number of people required, or dollar value of resources involved in the potential application may not justify the expenditure.

GROWTH OF SDA

"Data Entry Today"[1] estimated 1975 sales for all computer data entry devices (including non-source keying devices) to be over $2 billion and projected over $2.8 billion in 1978. In 1975, there were 275 manufacturers with over 600 data entry products. The article reported that the trend is to use devices which capture data at the source but such devices are still not widespread.

Sales of devices designed for the industrial environment are projected to increase from $55 million (2.63 percent of the total data entry market) in 1975 to $150 million (5.36 percent of the total data entry market) in 1978 and are expected to exceed $300 million in the early 1980s.

As has happened with hospital data collection, equipment manufacturers are becoming more user oriented. More effort is being spent to develop devices which the clerk, nurse, salesman, and factory worker can use with no prior data processing experience.

"Data Entry Today" also reports that data entry technology to date far exceeds its use; only recently has its use been accelerating.

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[1]Management Information Corporation, Cherry Hill, New Jersey, vol. 2, p. 9-1, 9-2, 9-10, 9-12.

CHAPTER 2

MAJOR ISSUES

SDA'S RELATIONSHIP TO AUTOMATED MANUFACTURING

In a previous report,[1] we described the use of the computer and computer systems in manufacturing, particularly as applied to small-lot or batch-type production. Computer-integrated manufacturing, as described in that report, brings together the numerous requirements for production under the central control and guidance of the computer. Instructions to the shop, such as schedules, estimated costs, manpower requirements, inspection procedures, and materials requirements, may be automatically computed and transmitted directly by the computer. Even the electronic commands for automatically operating the machines may be calculated and transmitted directly by the computer.

In this production scheme, one function of SDA is to obtain the necessary results of the computer directions and to promptly report them to management so that the necessary changes and modifications may be made. This may be compared to a feedback system that monitors the movements and operations of a numerically controlled machine. In addition to process controls, SDA can generate timely data on such production factors as material used, scrap generated, and staff-hours expended. With this information, machine utilization may be monitored; workloads may be adjusted; inventories may be rapidly adjusted to account for actual production; actual schedules may be compared with forecasts; and costs may be readily compared against the estimates.

SDA is one of the building blocks in the concept of computer-integrated manufacturing and, eventually, the automated factory.

SDA'S IMPORTANCE TO GOVERNMENT ACTIVITIES

The Federal Government is the largest single purchaser of manufactured products. Each year DOD alone spends over $20 billion on supplies and equipment produced by private manufacturing firms and distributes these items throughout its supply system. DOD also spends $2 billion yearly in the private sector for maintenance, repair, and modification of its equipment, and over $6 billion for research and development of new equipment items. In addition, it operates over 100 major manufacturing and repair facilities and about 50

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[1]"Manufacturing Technology--A Changing Challenge to Improved Productivity," (LCD-75-436, June 3, 1975).

major supply activities. Many of these activities could benefit by the application of SDA.

In recent years, improved productivity has been sought in every segment of our economy. The establishment of the National Center for Productivity and Quality of Working Life, in November 1975, is evidence of this concern. In the simplest terms, productivity relates to the amount of output in relation to input, usually expressed in terms of labor; however, other input, such as materials and energy, also apply. Industrial productivity in the United States has become an area of real concern.

In the 1976 study noted earlier, we pointed out the need to make manufacturing productivity, through technology, a national priority. It has been generally agreed that human behavior approaches can provide a small, one-time increase in productivity, but any long-term sustained growth would have to come from technology.

RESTRAINTS TO SDA GROWTH

SDA systems can be costly; therefore, managers need to know cost/benefit relationships if they are to make the proper decision. Unlike a more straightforward type of justification, such as comparing the staff savings from using a computer-operated machine rather than a similar conventional type, SDA justifications are often intangible and are difficult to quantify in traditional savings. For example, it would be difficult to quantify improved customer relations due to speedier deliveries resulting from better spare parts control.

SDA systems, like most industrial computer systems, are relatively new, and there is not a wealth of information available to draw from. Because of the wide variety of systems and applications, it is difficult to predict benefits precisely.

Many times, need for specific data that could not be obtained under conventional practices makes SDA mandatory, and traditional dollar return on investment is not the primary motivator. In some instances, only after a system has been installed are cost savings recognized and appreciated.

This is not to imply that tangible savings cannot be estimated. One large manufacturer, for example, estimated that machine tool utilization would increase by about 50 percent as a result of its SDA system, and the savings that would be realized from this benefit alone were expected to pay for the system. The fact that the installed system improved the machine tool utilization by approximately 200 percent, in addition to providing other benefits, was a pleasant surprise.

Another restraint is that, to our knowledge, there is no one source for information on SDA equipment, nor is there a trade organization for SDA.

Even information received directly from suppliers is fragmented in that manufacturers of computers and production, communication, and office equipment all offer many product lines that can be used for SDA applications. There is no single automation industry. Components of a single SDA system can fall under the definition of automatic data processing (ADP) or production equipment, and in some cases the same item can be classified either way, depending on the application.

Procurement by Federal agencies

Although different procedures could apply to ADP procurement compared to industrial procurement, the underlying management planning requirements are the same. Each industrial process should be planned and management should approve the formal plan. Automated systems should be acquired in consonance with that plan. SDA can be considered a subsystem from the viewpoint of automation planning.

Within the Government, there are differing levels of approval and controls in the procurement process which depend upon the definition of the procurement channel. The criteria, however, should be prudent management practices--practices that will best achieve the planning goals, regardless of the levels of approval involved in a procurement process.

To provide for economical procurement of ADP equipment, and contemplating free and open competition, Public Law 89-306 was enacted authorizing the General Services Administration (GSA) to coordinate the Government's acquisition of this equipment. GSA negotiates schedule contracts with manufacturers for the purchase, lease, and maintenance of ADP equipment, and publishes yearly catalogs showing the types, models, prices, and terms of equipment offered. The Federal Property Management Regulations authorize agencies to place orders for lease or purchase of equipment from the schedule contracts, within the constraints of maximum orders limitations.

If a proposed procurement exceeds this limitation, a delegation of procurement authority from GSA is required.

The maximum order limitation for initial acquisition of central processing units is 1, and for peripheral units of the same type and model, the limit is 10 unless the purchase price of 2 or more exceeds $400,000. These limits can vary among contracts.

In addition, GSA authorizes agencies to enter into separate contracts with schedule contractors if they obtain terms or conditions better than those in the schedule contracts. Agencies are authorized to procure equipment not available under a schedule contract only if its cost does not exceed $50,000. When the cost of such equipment exceeds $50,000, a delegation of procurement authority from GSA is needed before acquisition. When GSA receives a request for a delegation of authority, it can elect to (1) grant authority to the requesting agency, (2) participate with the agency in the procurement, or (3) procure the equipment for the agency. It is required that, prior to any procurement, existing excess equipment be screened for available items that could fill the needs.

Agencies issue their own implementing regulations on ADP equipment procurement. Within DOD full authority has been delegated to the military services. As discussed in a previous report,[1] the military services regulations include additional reviews and approvals. For example, Navy regulations require its various components to seek approval from the Chief of Naval Operations for procuring from schedule contracts ADP equipment exceeding $25,000 annual lease or $100,000 purchase cost or for any nonschedule purchase of a central processing unit, even though it is within the GSA blanket authority.

Procurement of other types of equipment by Government agencies does not fall under the control of a single Government-wide manager. There is a screening process required, similar to the ADP-equipment-screening process, to identify available Government-owned equipment which could satisfy the need. Actual procurement, however, is more decentralized. The services, within the guidelines set forth by DOD, have authority to establish their own regulations for procuring such industrial equipment as material handling or manufacturing equipment. In general, the services must submit to DOD for final approval those industrial projects exceeding $5 million and any project over $1 million that was not included in a budget or apportionment submission to DOD.

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[1]"Uses of Minicomputers in the Federal Government: Trends, Benefits, and Problems" (FGMSD-75-53, Apr. 22, 1976).

STANDARDIZATION

Public Law 89-306 gives to the National Bureau of Standards the responsibilitiy to make recommendations for establishing uniform ADP standards. If SDA systems are to be used efficiently, it may be desirable to develop such standards for hardware, software, and item identifiers. For example, it may be beneficial to develop standards for item identifiers when items are widely used. Some items have potential for tracking by SDA and are used by several activities, both industrial and nonindustrial. Standards could reduce the number of times item identifiers have to be developed and applied and thus could reduce system costs. For example, a scanable bar code identifying the characteristics of specific major reparable parts could help track a part through industrial repair facilities, monitor its distribution in the subsequent supply channels, and record use data during its functional life. These standard codes could benefit all users of an item, not just Government facilities. In addition, involving manufacturers of the items and the equipment might encourage manufacturers to apply the code at the time of manufacture.

Standards for item identifiers should be coordinated between Government and industry. The commercial distribution industry selected a standard bar code symbol for shipping containers in December 1975 and issued a manual for the symbol in June 1976. The distribution code is compatible with the universal product code used by the grocery industry and with the European article numbering symbol used by countries in Europe. The distribution codes uniquely identify thousands of different suppliers and millions of different items that are warehoused, sold, delivered, and billed through commercial distribution channels.

DOD has organized a Joint Steering Group for Logistics Applications of Automated Marking and Reading Symbols to recommend a standard Defense-wide symbology for automated marking and reading of data on supply items. Current milestones call for recommending a standard by 1978. DOD's symbol and code should be compatible with that accepted by the distribution industry. DOD's study seems to be a feasible mechanism for bringing the services together before large investments in dissimilar systems make standardization impractical.

There is widespread belief, however, that standards might stifle initiative and inhibit technological progress. We have previously studied the effects of ADP standards and found that this generally is not the case. Although standards could have inhibiting effects if they are developed prematurely or are not maintained, the timely development of standards would afford a more economical use of resources while allowing for initiative and technological progress. In a current study, however, we have found that the development of ADP standards has not been timely. This slow development cycle, coupled with a long Federal procurement cycle, makes some standards costly to implement because, by the time they are published, agencies have a heavy investment in the nonstandard approach.

In our 1976 study on manufacturing technology, we noted a concept of standards emerging which could stimulate diffusion of technology. The concept calls for a framework within which companies can pursue the development of individual components that will fit into systems with other manufacturers' components. Standards usually denote an agreement on a product or practice after they have been developed and marketed, whereas the new concept would require a standard framework within which products can be developed. This approach can be an incentive to further development if the standards are set by a truly representative group of supplier and user industries with participation from Government to protect the public interest.

According to the National Bureau of Standards, this is a powerful concept that could allow creating a system from modular components purchased from competitive manufacturers, without special engineering or software development. Computer-Aided Manufacturing--International and Brigham Young University sponsored a meeting at Brigham Young in February 1975 of standards organizations working on aspects of computer-aided manufacturing. This group concluded that interface standards or guidelines were desirable as a stimulus to the further development and diffusion of this technology. However, it was recognized that there were obstacles and that the practicality of such standards was not yet clear.

REVIEW OBJECTIVES

From all indications, SDA can be an important step in advanced industrial technology. The Federal Government would benefit from the orderly growth of its use. During this review we identified some restraints to this growth which must be dealt with before SDA can obtain maximum benefits--such as the difficulty an activity has in recognizing and justifying potential applications, in obtaining the most suitable equipment, and in assuring the maximum use of previously acquired knowledge of SDA technology. These concerns are discussed in chapter 3.

CHAPTER 3

PROGRESS AND PROBLEMS OF GOVERNMENT INDUSTRIAL ACTIVITIES IN IMPLEMENTING SDA

An increasing number of Government industrial activities are using SDA technology to improve their operations, and many activities are beginning to study the technology and examine its applicability. DOD has been one of the primary Government users. (See app. I.) Advancements in SDA technology are rapidly emerging, creating new potential and unexplored opportunities. As with the expansion of any new technology, there are some problems. Some activities have had difficulty in keeping up with the technology and in identifying good areas of application. Other problems we noted concern lack of criteria for assessing SDA's potential, complexities involved in equipment procurement, and poor use of pilot study results.

We believe that the orderly diffusion of SDA would be enhanced by establishing overview responsibilities, which could provide direction to the development and application of systems.

CURRENT APPLICATIONS

Some Government industrial activities have successfully applied SDA techniques and are realizing benefits. For example:

--Lawrence Livermore Laboratory's mechanical shop needed a more accurate, timely system to obtain operating reports on parts movement, labor cost, and machine use. SDA equipment was selected to record shop transactions as they occurred. The input includes an employee identification badge and two pre-punched cards (one to identify the part and one to identify the machine) and a keyboard for variable data. The badge and cards are inserted into readers by the machine operator when a part is loaded into the machine and again when it is removed. Information is transmitted to the computer to update the shop's master files and generate reports which are available to shop managers and supervisors each morning. This system allows for simple, quick capture of data without taking valuable time from shop workers. Capturing information quickly allows management to better match personnel and equipment to work priorities. Also, data accuracy has increased.

--The Louisville Naval Ordnance Station installed an SDA system in September 1972, that consisted of a minicomputer and 40 terminals (some multimedia and some badge/card readers). By means of badge or card insertion or key depression, employees on the shop floor enter data into the terminals which describes actions as they take place. Data is collected concerning employee activities, job status, and materials in use. This information is used by management for labor distribution, production planning and control, and direct material control. Louisville estimates it saved over $300,000 in 1976 from increased efficiency, elimination of work scheduling meetings and manual preparation of reports, and reductions in personnel.

Other examples of existing and proposed systems are noted in appendix I.

UNEXPLORED OPPORTUNITIES

It is important to point out that, even though there have been some notable successes with SDA, many opportunities have not been explored. Identification of SDA opportunities requires a sound knowledge of the operations at the industrial activity, as well as knowledge of available equipment which might improve the operation and increase productivity. This places the burden for exploring SDA use with each individual industrial activity. It would be helpful to these activities if SDA experiences could be shared.

We observed, however, that diffusion of the knowledge gained from SDA experiences has been limited. Some activities have not used SDA although other activities with similar operations have benefited from this technology. For example:

--The Naval Air Rework Facilities have had employee badge and punched card readers in their shops for over 14 years. They are being replaced by an updated SDA system which will provide more timely, as well as additional, information. The Naval Air Systems Command's 1975 study estimated that the SDA system would cost $4.1 million and that a manual (keypunch) system, even if it could be timely, would have cost over $7 million. In contrast, Naval shipyards, with similar operations in industrial shops, still have manual systems. Although SDA was studied by the Philadelphia Naval Shipyard 10 years ago and found to be practical and cost effective, it was not implemented. Naval Sea Systems Command officials said SDA had not been implemented in shipyards because computer memory capabilities needed to be increased and, after that was accomplished, correcting problems with the system took priority over additional system capability.

Many other Government activities have manual data entry systems with long waiting times between an event's occurrence and management's notification of the event. For example:

--Warner Robins Air Logistics Center personnel estimated their average inventory to be $1.8 billion and their daily receipts to be $1.5 million. When an item is received, the shipping documents must be processed and keypunched so the computer can issue the item or assign it to storage. Material sits on the receiving dock an average of 2 days before personnel are notified what to do with it. Using SDA to record material receipts faster could help reduce inventory pipeline time and thereby reduce stock levels.

--Norfolk Navy Shipyard operates about 37 tool rooms with about 20,000 different tools valued at approximately $15 million. About $112,000 was spent from August 1974 to August 1975 to replace lost tools. Using a manual system makes it difficult to determine who has which tools or whether another tool room has the tool a worker requests. Officials recognize a need for an SDA system and are studying alternatives.

Numerous potential SDA applications exist within the Government's industrial complex; greater investigative efforts on the part of Government industrial activities and improved diffusion of experiences on the part of activities using SDA are required.

BARRIERS TO DIFFUSION

In analyzing the concern for unexplored opportunities, we looked at some of the primary factors affecting diffusion. We noted that a lack of a centralized source of knowledge, unclear criteria for assessing SDA's potential, problems with equipment procurement, and poor use of pilot study results all act as barriers to diffusion.

Need for central source of information

Source data automation is accomplished through such a range of diverse technologies and applications that it is almost impossible to define a "source data automation industry" to which the prospective user can turn. For example, manufacturers of highly diversified lines of computers, computer peripherals, and communication equipment all contribute to SDA systems. The Federal Council for Science and

Technology reported that the lack of a structured automation industry hampers the coupling of suppliers to customers and puts the burden of managing automation on users rather than suppliers.[1] Similar circumstances surround SDA--a segment of the automation industry.

Today's SDA users are confronted with a proliferation of input devices, system options, and software. Some private research companies, such as Management Information Corporation and Datapro Research Corporation, prepare reports on various classes of equipment. The General Services Administration, which has responsibility for automatic data processing equipment, tracks central processing units and broad categories of data entry equipment being used by the Federal Government but does not track computer-controlled industrial equipment or the associated advanced data entry devices. Nor is information maintained on the types of applications in the industrial environment.

The primary barriers to diffusion of SDA cited by industrial activities illustrate this fragmentation. Potential users usually lacked knowledge of equipment and software requirements or believed no equipment was suitable for their environment. Some activities recognized problems with manual systems but did not know enough about SDA to know if it was feasible.

Personnel we contacted at various activities informed us they generally keep abreast of technology by reading trade journals and by attending equipment shows; but with few exceptions they said a data bank on available equipment and equipment in use by type of application would help them understand and evaluate the potential for SDA in their activities. Without this type of information, it is difficult to appreciate the benefits which could be gained from SDA. These concerns are not unique. Our 1976 report on manufacturing technology contained the results of a survey of the attitudes and perceptions of U.S. manufacturers toward technology. We reported at that time that the primary barriers to diffusion were the cost of the systems, and lack of understanding of computer capabilities in manufacturing environments.

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[1]"Automation Opportunities in the Service Sector," report of the Federal Council for Science and Technology, Committee on Automation Opportunities in the Service Areas, May 1975.

Need for criteria

Because SDA technology can be costly and the state of the art has not advanced to the point where clear economic criteria can always be established, the expected benefits, although somewhat intangible, should be clearly stated so they can be considered in relationship to system cost. A clear statement of the benefits expected is important also because it should be the basis for evaluating the success of the system. This is especially true since it is not unusual that the need for SDA is related to such benefits as the need for tighter control, security, or more timely, accurate data--not always quantifiable--rather than strictly economic benefits. For example, one large aerospace manufacturer noted that the chief reason for installing an SDA system was to be able to pinpoint problems in a timely manner and assign responsibility for correcting these problems. Prior to the SDA system, it was difficult to determine the extent or seriousness of a problem because manual collection of the necessary data was a costly time-consuming process. The SDA system now quantifies the amount of time required for such inefficiencies as waiting for material, waiting for a maintenance man, absence of an operator, or lack of tooling and gives management access to this information on a real time basis. The company has been able to set priorities and concentrate on the most serious problems. The results have been significant. As an example, parts loading and machine setup are reported to have been reduced from 20 percent of the overall time to 10 percent by installing improved overload handling devices and improved fixturing. The absence of an operator has been reduced from 25 percent to 5 percent, resulting in increased use of the equipment from 15 percent to 50 percent over 4 years and, consequently, tangible savings. However, not all areas for improvement, and the extent to which they could be improved, were discernable prior to the installation and thus the justification could not be based solely on a predictable cost-effective basis.

Because of the changing nature of SDA and the wide range of applications, there are no cost models or other criteria available for activities to uniformly assess potential and assure that all costs and benefits are considered when investigating SDA and preparing a justification. We believe that, at a minimum, the following points covering costs and potential savings should be considered in any industrial SDA evaluation.

Costs

--Data entry devices are located at the source and may be operated through such methods as optical or magnetic readers and voice control.

--Connecting lines between the input devices and the computer could be expensive, especially if coaxial cables are required.

-Computer requirements could be met either by a mini-computer which costs as little as $15,000 or through a shared arrangement using part of the capabilities of a larger more expensive computer.

--Software programs that are especially prepared for the particular application and enable the system to interpret, assimilate, and develop the required reporting data are a necessary part of the system and frequently are a major portion of the total system cost.

Potential areas of savings

--Reduced storage inventory would reduce the overall inventory cost. Due to more accurate and timely accounting, it may be possible to maintain lower levels of inventory awaiting processing.

--Reduced in-process inventory is possible. An up-to-the-minute accounting is maintained for work in process and affords closer control, so that the amount of inventory that is normally kept as a buffer between operations may be reduced.

--Ordering of supplies and materials can be an almost automatic process with the purchase orders being prepared by the computer based on preestablished minimum stock levels.

--Accountability for tools and operating hardware can be greatly improved.

--Determination of cause and extent of operating problems can be simplified. With an SDA system it is possible, for example, to determine precisely the downtime on specific equipment and to take measures to improve uptime.

--More readily available cost data could result in improved estimates of both materials and manpower.

--Better use of supervisory personnel could reduce the number required. The time a foreman spends on the shop floor taking expediting actions can be reduced since he would be provided with timely status reports.

--Management can respond and correct adverse situations more quickly and thus can reduce the cost effect of the problem.

--Quality control is enhanced. Permanent records can be prepared almost simultaneously with the inspection procedure, thereby reducing data transcribing which is a common source of error.

In addition, the National Bureau of Standards is planning to publish the results of a project, "Guidance on Evaluation of Data Acquisition Technology." While it does not specifically address the industrial environment, it may be useful to industrial activities.

Procurement problems

Another concern facing an activity in obtaining an SDA system is found in the procurement process. As discussed in chapter 2, SDA equipment can sometimes be classified either as ADP or industrial equipment, and procedures for procuring ADP equipment are more stringent than for the other types. In some instances, agencies obtained a more expensive alternative system because avoiding data processing procurement channels was simpler and faster.

Similar problems on procuring data processing equipment were also discussed in our April 1976 report to the Congress. (See footnote, p. 11.) Just as in our current observations, this report noted that agencies said data processing procurement regulations were too complicated and caused agencies to incur excessive administrative costs and delays.

Procurement through several channels also makes it more difficult for an activity considering SDA to obtain information on existing systems and the types of equipment most suited to various applications. Selection of data entry devices is a particularly important process in the industrial environment because of the need for input stations designed for ease of use to minimize errors of operators not trained in ADP techniques. Many times equipment typically for the office environment, such as remote terminals with a keyboard, would be a poor choice in a shop. Too often the process of examining available equipment is cut short because equipment choices are limited to that easiest to get. For example,

--Mare Island Naval Shipyard is installing 27 key-to-disc terminals costing $97,000 annually to provide information on status of ship repairs. Officials said they did not evaluate other types of SDA equipment, which might have been better, but chose equipment that could be obtained under local authority in order to reduce the lengthy procurement process associated with data processing equipment.

Poor coordination and followup

The large number of ongoing SDA studies (see app. I) indicates there could be benefits in having an entity overseeing the direction of these efforts. Some duplication in study effort is unavoidable and even desirable but, without an overview, it can become counterproductive. For example:

--Naval Air Systems Command authorized $44,000 for the Pensacola Naval Air Rework Facility to develop an automated tool control system. Naval Sea Systems Command tasked the Norfolk shipyard to study tool control using an embossed badge and optical character reader system. Meanwhile, Charleston Naval Shipyard tried two systems, one optical character reader and one keyboard; and the Norfolk Naval Air Rework Facility is considering a study of the use of a light pencil. Additionally, an option for automated tool control using keyboards is included for all Naval Air Rework Facilities in their standard system. Each activity has similar tool control problems which indicates that some of the overlap in studies may have been unnecessary.

Several commands have internal mechanisms, such as the Naval Air Systems Command's Workload Control Teams, for sharing ideas and problems. These can be valuable vehicles for identifying good applications and monitoring study efforts. Most of the activities we visited were aware of studies or installed systems within their commands. Also, most services have a headquarters group that monitors industrial activities of similar types, such as (1) the Naval Air Systems Command's Depot Management Division for all naval air rework facilities and (2) the Air Force Logistics Command for all air logistics centers. However, of the activities included in our review, few were knowledgeable of SDA studies outside their commands even though the potential sharing could go beyond command levels. A higher level mechanism could be used by DOD to foster interchange of SDA information among services; however, to date, no DOD group has emphasized industrial uses of SDA.

When agencies do procure SDA equipment for tests and ongoing operations, they should follow up periodically to determine whether the equipment's use is effective and efficient. Sometimes studies are initiated by headquarters groups but progress is not monitored.

--At the Defense Logistics Agency depots in Mechanicsburg, Pennsylvania, and Memphis, Tennessee, voice-activated SDA equipment valued at $77,000 was purchased for automatic sorting. According to Defense officials, technical problems and rejection by employees caused depot commanders to discontinue its use. Headquarters officials did not become aware of this until a year later when Mechanicsburg requested to excess the equipment. These officials said staff shortages and a desire to allow depot commanders freedom of operation limited the amount of followup and involvement in the test.

Knowing the results of SDA in use can help determine future equipment selections and provide valuable information which can affect the success of other operations.

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Properly applied in the industrial environment, SDA offers many benefits, including increased utilization of facilities and manpower, improved data timing and accuracy, improved production control, and inventory reduction--all leading to increased productivity. However, because experience is lacking, potential applications have to be carefully analyzed to insure that maximum benefits will be achieved.

Some Government industrial-type activities have employed SDA systems to their advantage; but there are barriers to diffusion of this technology and, thus, unexplored opportunities. Some activities have had difficulty keeping up with the technology and in identifying good applications. Among others, problems occurred with (1) the criteria for assessing SDA's potential, (2) equipment procurement, and (3) the followup of pilot studies. More coordination is needed to allow agencies to draw on the experience of others and to work together to solve common problems.

The Federal Government should plan for an increase in industrial SDA activity. Assignment of overview responsibilities for monitoring SDA development and use and for maintaining a central source of information on installed systems would enhance its orderly expansion within industrial-type activities. Greater cooperation between industry and Government would also be beneficial in diffusing technology and developing standards.

We believe the Department of Defense is in a key position to help this expansion because it has a large industrial and supply complex and would be a primary beneficiary of improved use of SDA techniques.

The National Center for Productivity and Quality of Working Life, by authority of section 204 of Public Law 94-136, should encourage the diffusion of SDA by coordinating the Government's efforts to use SDA in its industrial activities. The Center should encourage active participation by DOD, GSA, the National Bureau of Standards, and other Federal agencies having responsibility for, or interest in, the future of SDA in industrial activities. The Center should also work with industry to further the development and diffusion of appropriate applications. The Center's responsibilities should include designating a focal point to

- --serve as a source of information on SDA systems being used or studied in the industrial environment,
- --serve as a mechanism to systematically diffuse technology, including training and indoctrination where appropriate,
- --study whether criteria could be developed to assist activities in identifying appropriate SDA opportunities and avoiding unwise investments,
- --monitor systems to assure that benefits are being achieved and to provide more knowledge to ongoing and future endeavors,
- --study the extent to which procurement problems adversely affect SDA systems and make recommendations to GSA and/or the services to assure that procurement practices are not a disincentive to obtaining the most productive equipment,
- --explore problems common to industrial and nonindustrial uses of SDA,
- --define aspects of systems needing standards and encourage the National Bureau of Standards to develop such standards, considering those existing for private industry, and
- --serve as a communication link between the Government and industry, especially when defining areas where research is needed and identifying aspects of systems needing standards.

RECOMMENDATIONS

We recommend that the Director of the National Center for Productivity and Quality of Working Life coordinate the Government's industrial SDA efforts and designate focal points to encourage development of criteria for identifying potential applications, diffuse technology, study problems affecting SDA systems development and use, define aspects needing standards, and coordinate with industry on SDA technology, uses, and research.

We also recommend that the Secretary of Defense designate a group modeled after its Manufacturing Technology Advisory Group to coordinate the services' use of SDA. Such a group could materially assist the National Center for Productivity and Quality of Working Life to diffuse the technology, assuring more efficient use of resources.

AGENCY COMMENTS

We discussed this report and our recommendations with officials of the National Center for Productivity and Quality of Working Life and the Department of Defense. They agreed, in general, that there is a need for a focal point to facilitate SDA diffusion.

The National Center officials agreed that diffusion of technology through encouraging active participation of executive agencies was a proper role for the Center and that our recommendation would be useful to them in determining priorities in the area of industrial productivity.

DOD officials indicated they were interested in assuring that the services coordinate their industrial SDA activities and would consider the appropriateness of designating a focal point to provide an overview on all SDA aspects, assuring the proper coordination with nonindustrial SDA activities.

CHAPTER 5

SCOPE OF SURVEY

At the military services' headquarters in Washington, D.C., we reviewed policies, procedures, and reports pertaining to the present and planned use of SDA equipment. We visited or contacted the following DOD activities and interviewed officials concerning the progress and problems encountered with the design, acquisition, and management of SDA systems.

U.S. Air Force:

Ogden Air Logistics Center, Ogden, Utah
Sacramento Air Logistics Center, Sacramento, California
Warner Robins Air Logistics Center, Atlanta, Georgia

U.S. Army:

Anniston Army Depot, Anniston, Alabama
Corpus Christi Army Depot, Corpus Christi, Texas
Letterkenny Army Depot, Letterkenny, Pennsylvania
New Cumberland Army Depot, New Cumberland, Pennsylvania
Sacramento Army Depot, Sacramento, California
Tobyhanna Army Depot, Tobyhanna, Pennsylvania

U.S. Navy:

Central Naval Ordnance Management Information Systems Office, Indian Head, Maryland
Charleston Naval Shipyard, Charleston, South Carolina
Computer Applications Support and Development Office, Kittery, Maine
Little Creek Amphibious Base Commissary, Norfolk, Virginia
Management Systems Development Office, San Diego, California
Mare Island Naval Shipyard, San Francisco, California
Naval Air Rework Facility, Alameda, California
Naval Air Rework Facility, Norfolk, Virginia
Naval Air Rework Facility, Pensacola, Florida
Naval Resale Service Office, Brooklyn, New York
Naval Supply Center, Norfolk, Virginia
Naval Supply Center, Oakland, California
Naval Weapons Station, Yorktown, Virginia
Norfolk Naval Shipyard, Portsmouth, Virginia
Norfolk Naval Station Commissary, Norfolk, Virginia

Defense Supply Agency:

Defense General Supply Center, Richmond, Virginia

Other Federal activities contacted during our survey included the National Center for Productivity and Quality of Working Life, the Library of Congress, the National Bureau of Standards, the United States Postal Service, and the General Services Administration.

We also visited libraries, hospitals, private and city government warehousing operations, and private manufacturing concerns which had installed SDA systems. In addition, we visited several manufacturers of SDA equipment, a private research company, and studied literature on SDA technology and applications.

EXAMPLES OF SDA APPLICATIONS

BEING USED OR STUDIED BY DOD (note a)

Input device	Activity	Application	Equipment cost	Status
Multi-input terminals	Ogden Air Logistics Center	Job costing, production engineering, budgeting, workloading, scheduling, material control, labor distribution	$12,809,000 for all AF	System approval delayed
Multi-input terminals	All Naval Air Rework Facilities and the Naval Avionics Rework Facility	Time and attendance, labor distribution, material usage, quality assurance, job status	$2,606,000	System approved, not installed
Multi-input terminals	Crane Naval Ammunition Depot	Time and attendance labor data collection	Information not obtained	Prototype study
Multi-input terminals	Yorktown Naval Weapons Station	Ammunition distribution and control, shop stores control	$207,000	Prototype study
Multi-input terminals	Louisville Naval Ordnance Station	Time and attendance, labor distribution, direct material control	$96,000 annual lease	Prototype study
Bar code reader	New Cumberland Army Depot	Automatic package marking	$68,000	Proposed
Bar code reader	Sacramento Air Logistics Center	Material and parts tracking	Information not obtained	System approved, not installed
Bar code reader	Warner Robins Air Logistics Center	Sorting tote trays	$1,430,000	Existing system

a/Some systems listed do not meet the definition of SDA given on page 2. With some devices, data is entered at the source but is keyed instead of read automatically. Other systems use SDA techniques to sort material but do not accumulate data.

APPENDIX I

Input device	Activity	Application	Equipment cost	Status
Multi-input terminals	Norfolk Naval Air Rework Facility	Tool control	Information not obtained	Local study
Multi-input terminals	Dover Air Force Base	Material tracking	Information not obtained	Prototype study
Key entry with cathode ray tube	Corpus Christi Army Depot	Job costing	Information not obtained	Prototype study
Key entry with cathode ray tube	Charleston Naval Shipyard	Tool control	$65,000 annual lease	Existing system
Key entry with cathode ray tube	Charleston Naval Shipyard	Material control	Information not obtained	Prototype study
Key entry with cathode ray tube	Norfolk Naval Shipyard	Material control	$20,000 annual lease	Existing system
Key entry with cathode ray tube	Sacramento Army Depot	Tool control	Information not obtained	Existing system
Key entry with cathode ray tube	Mare Island Naval Shipyard	Job order status	$97,000	Prototype study
Optical character reader	Oklahoma City Air Logistics Center	Material handling	$937,000	System approved, not installed
Optical character reader	Anniston Army Depot	Inventory tracking	$87,000	System approved, not installed
Input devices to be studied	Pensacola Naval Air Rework Facility	Tool control	$44,000 authorized to study	Prototype study
Input devices to be studied	Portsmouth Naval Shipyard	Work tracking	Information not obtained	Prototype study
Input devices to be studied	Sacramento Air Logistics Center	Material handling	$2,047,000	System approved, not installed

APPENDIX II

PRINCIPAL OFFICIALS

RESPONSIBLE FOR ADMINISTERING

ACTIVITIES DISCUSSED IN THIS REPORT

	Tenure of office	
	From	To
NATIONAL CENTER FOR PRODUCTIVITY AND QUALITY OF WORKING LIFE		
CHAIRMAN:		
Vacant	Jan. 1977	Present
Nelson A. Rockefeller	Nov. 1975	Jan. 1977
EXECUTIVE DIRECTOR:		
George H. Kuper	Nov. 1975	Present
DEPARTMENT OF DEFENSE		
SECRETARY OF DEFENSE:		
Dr. Harold Brown	Jan. 1977	Present
Donald H. Rumsfeld	Nov. 1975	Jan. 1977
James R. Schlesinger	July 1973	Nov. 1975
William P. Clements, Jr. (acting)	Apr. 1973	July 1973
Elliott L. Richardson	Jan. 1973	Apr. 1973
DEPUTY SECRETARY OF DEFENSE:		
Charles W. Duncan, Jr.	Jan. 1977	Present
William P. Clements, Jr.	Feb. 1973	Jan. 1977
ASSISTANT SECRETARY OF DEFENSE (MANPOWER, RESERVE AFFAIRS AND LOGISTICS):		
Dr. John P. White	May 1977	Present
Carl W. Clewlow (acting)	Apr. 1977	May 1977
ASSISTANT SECRETARY OF DEFENSE (INSTALLATIONS AND LOGISTICS):		
Dale R. Babione (acting)	Jan. 1977	Apr. 1977
Frank A. Shrontz	Feb. 1976	Jan. 1977
John J. Bennett (acting)	Apr. 1975	Feb. 1976
Arthur I. Mendolia	Apr. 1973	Mar. 1975
Hugh McCullough (acting)	Jan. 1973	Apr. 1973

(947221)