REPORT TO THE CONGRESS

BY THE COMPTROLLER GENERAL
OF THE UNITED STATES

Uses Of Minicomputers In The Federal Government: Trends, Benefits, And Problems

Minicomputers, now used in Government primarily for scientific data processing and control of machinery, are expected to be increasingly adopted for more general data processing to improve productivity.

Although Government experience with minicomputers themselves is generally satisfactory, some agencies believe complicated acquisition regulations are causing problems.

General Services Administration agrees that simplified acquisition procedures are appropriate.

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This report describes why we believe minicomputer use can enhance an agency's productivity. It also describes the problems in and the limitations on using minicomputers.

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director, Office of Management and Budget; the Administrator of General Services; and the heads of Federal departments and agencies.

ACTING Comptroller General
of the United States

Contents

ABBREVIATIONS

ADP	automatic data processing
ERDA	Energy Research and Development Administration
FIPS	Federal Information Processing Standards
GAO	General Accounting Office
GSA	General Services Administration
NASA	National Aeronautics and Space Administration
NBS	National Bureau of Standards
OMB	Office of Management and Budget

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

USES OF MINICOMPUTERS IN THE FEDERAL GOVERNMENT: TRENDS, BENEFITS, AND PROBLEMS

D I G E S T

A minicomputer is considered, for purposes of this report, a all-scale computer for which the manufacturer may furnish only limited products and services. This practice contrasts with the full-service marketing practices of manufacturers of large computer equipment.

TRENDS

Minicomputer acquisition in the Federal Government is increasing faster than any other type of computers. (See p. 6.)

In the Federal Government, minicomputers are used primarily for scientific data processing and control of machinery, but Federal managers expect that they will be more widely used in the future for data entry and editing, communications, and general data processing. (See p. 8.)

BENEFITS

GAO describes several cases of minicomputers enhancing productivity. The cases demonstrate the potential use of minicomputers for:

--Initially automating a process previously done manually. (See p. 10.)

--Augmenting work previously done on large central computers. (See p. 11.)

--Replacing existing equipment or services. (See p. 13.)

PROBLEMS

GAO found that there were problems in and limitations on using minicomputers and that software costs of minicomputer systems generally were higher than hardware costs. In considering minicomputers, Federal managers should assess the impact of the total cost

on agency operations along with assessing the impact of the hardware acquisition costs. (See p. 15.)

GAO found also that many agencies were using computer programs in a language that could be used on only one manufacturer's hardware. GAO encourages users to program minicomputers in a high-level language, a language that can be used on a variety of computers. (See p. 16.)

The National Bureau of Standards is developing standards for FORTRAN and BASIC, two common scientific computing high-level languages, and is modifying the standards on COBOL, a common business-oriented high-level language, so that they can be used in minicomputer applications. (See p. 19.)

Some agencies reported that procurement regulations governing the minicomputer acquisition were too complicated and caused agencies to incur excessive administrative costs and time delays; in some instances agency officials indicated they obtained a more expensive alternative system instead of a minicomputer because the procurement process was simpler and faster. (See p. 20.)

Vendors opposed the General Services Administration's use of indefinite quantity requirements contracts on the basis that minicomputer technology was changing rapidly and that the agencies might be forced to accept a system that was not most desirable to their needs. (See pp. 21 and 22.) But General Services said that the possibility of purchasing obsolete equipment was minimal because these contracts were for only a 2-year period and were subject to review at midpoint.

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GAO recommends that General Services simplify procurement requirements agencies must follow in buying small quantities of low-cost minicomputers. (See p. 24.)

General Services agreed that it needed to simplify procurement requirements in these circumstances, and it is considering some steps to accomplish these purposes. (See p. 24.)

CHAPTER 1

INTRODUCTION

The Federal Government is the largest single user of automatic data processing (ADP) in the world. As of June 30, 1975, the General Services Administration (GSA) reported that the Government owned or leased 8,600 computers. About half of them cost $50,000 or less. Many of the computers in in this price range are known as minicomputers.

WHAT IS A MINICOMPUTER?

Although the term "minicomputer" has been extensively used by the data processing community, it defies a precise definition. For purposes of this report, minicomputer characteristics are described below.

Technical

--A simple computer system having a central processing unit which costs $50,000 or less.

--Technical features of the computer--such as memory, word size, and instruction sets--are either smaller or simpler than in large computers.

--Processing time generally is longer than for large computers, particularly for long, complex tasks.

--Special air-conditioning, wiring, and built-up floors generally are not required.

Marketing support

--Manufacturers' library of system software 1/ is generally limited.

--Minimum price of the system excludes products and services that frequently are required by other equipment manufacturers to be purchased by users when acquiring that manufacturer's equipment.

1/Represents computer programs, procedures, and related documentation of a computer system.

It is in the two marketing characteristics that minicomputer manufacturers differ from major manufacturers that offer a wide spectrum of computers, from large to small. Major manufacturers offer to help users develop their systems; the minicomputer manufacturers frequently expect customers to develop their own systems.

To show some of their distinguishing features, pictures of a large-scale data processing system, a medium-scale data processing system, and a minicomputer data processing system are shown on pages 3 to 5.

MINICOMPUTER USE TRENDS

The first commercially available minicomputer was introduced in 1963. It is difficult to estimate how many minicomputers are installed because of the differences of opinion of a definition of a minicomputer. One prominent data research organization estimated that over 135,000 minicomputers would be installed in the United States by the end of 1975. Another prominent data research organization estimated that over 750 000 minicomputers would be installed worldwide by the end of 1980.

Concerning the minicomputer market, industry representatives have made the following comments.

--Minicomputers started a revolution in data processing. Their compact size and low cost permitted the development of dedicated systems to meet specialized needs in communications, control, data acquisition, and business data processing.

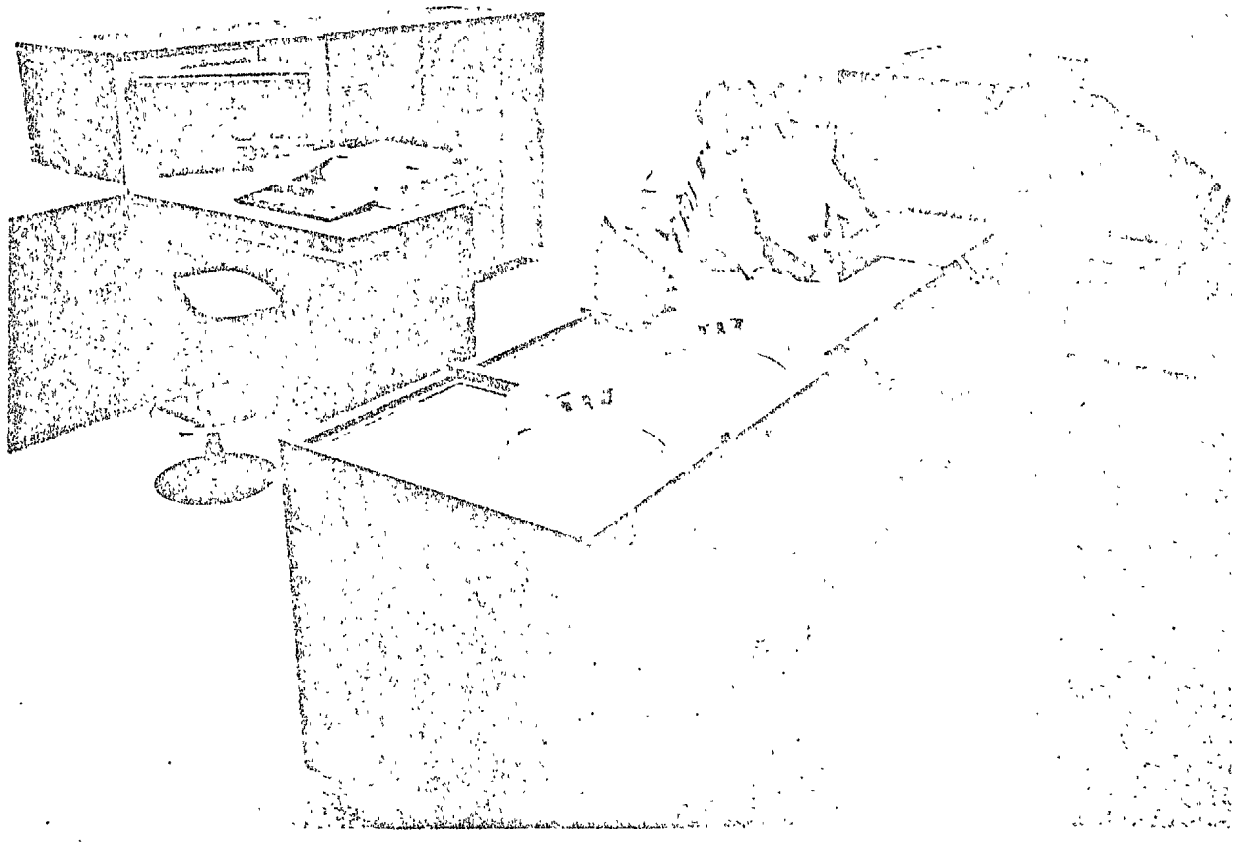
--Today a $2,000 minicomputer is more powerful, more reliable, and easier to use than the $100,000 machines of a decade ago.

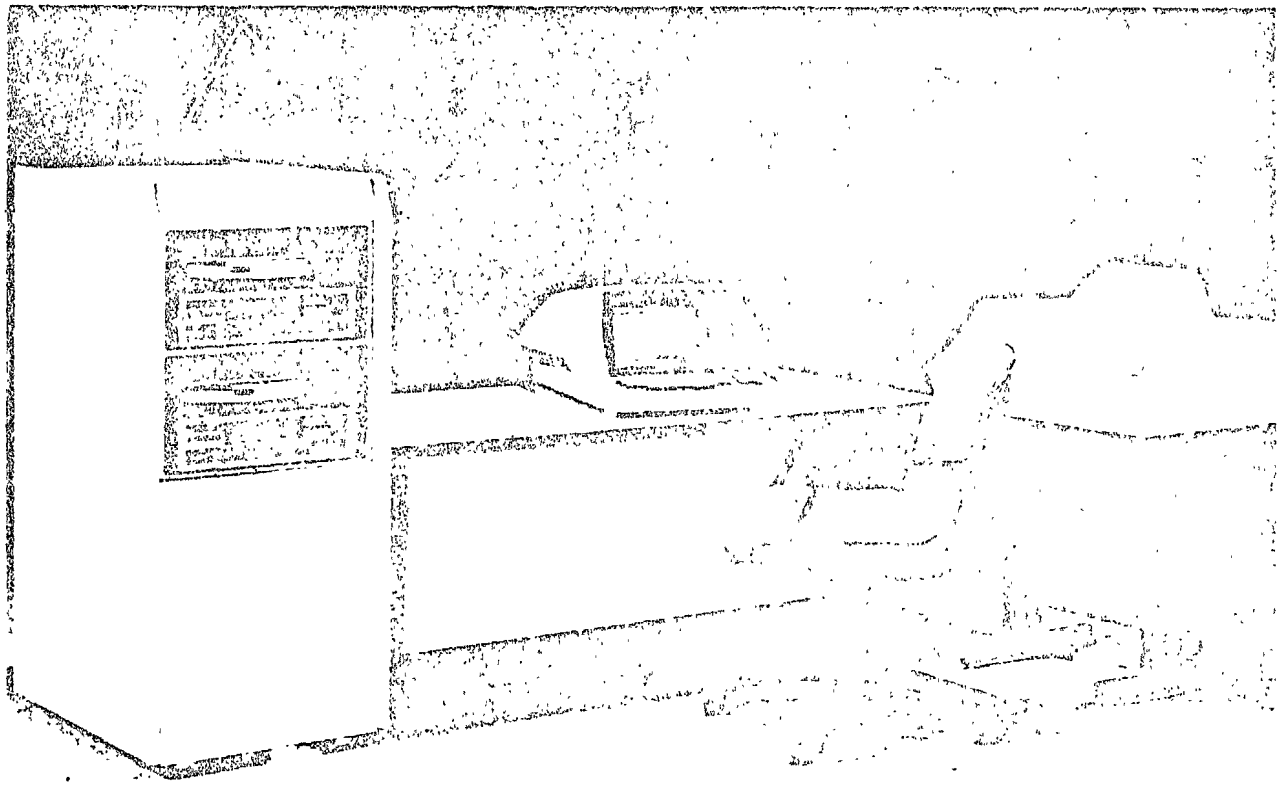
--Minicomputers are permeating every aspect of our society from control of traffic signals on city streets to checking the validity of credit cards and authorizing their use for purchases. As the prices of minicomputers continue to decline, the number of applications for which it becomes economical to computerize increases dramatically.

--The industrial user's need for better productivity and tighter control, coupled with the declining costs of minicomputers and microcomputers, will double the industrial automation market by 1979.

--Since the advent of the first readily available minicomputer, there has been a growing recognition of the

LARGE-SCALE DATA PROCESSING SYSTEM





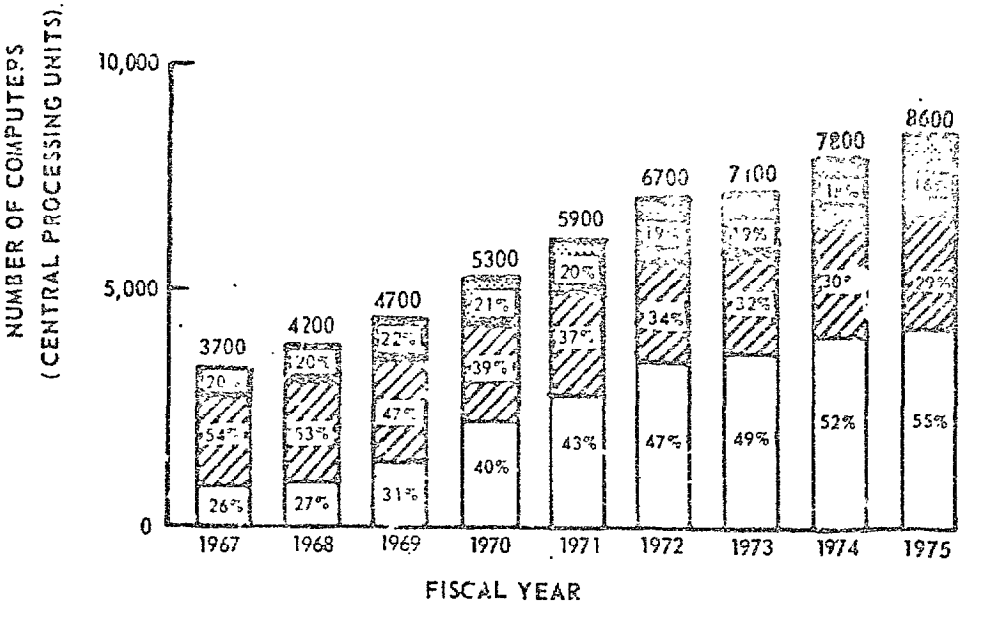
MINICOMPUTER DATA PROCESSING SYSTEM

cost effectiveness of minicomputer systems for communications applications.

Number of minicomputers in Government is growing

GSA reported that the number of computers in the Government increased from 3,700 in June 1967 to 8,600 in June 1975. As shown on the graph below, considerable growth has occurred in the lower priced computers, whereas use of the middle-priced computers has decreased and use of the more expensive computers has remained fairly constant.

NUMBER OF COMPUTERS IN THE FEDERAL GOVERNMENT
BY COMPUTER COST AND BY FISCAL YEAR



COMPUTER COST

UNDER $50,000
BETWEEN $50,000 AND $200,000
OVER $200,000

MINICOMPUTER APPLICATIONS

Initially, minicomputers were used as components of larger computer equipment configurations, as stand-alone equipment for scientific data processing, and as linking gear for data communications. Minicomputers fit these purposes well because they have been designed principally to handle the same tasks on a repeat basis. In such cases, the manufacturer's assembly programing language generally was used. Some minicomputer systems also contained a FORTRAN compiler which permitted the user to program in FORTRAN, a programing language used principally for scientific work.

Many minicomputer manufacturers initially did not market complete computer systems. They sold these minicomputers to other manufacturers and to organizations that incorporated them into their own products and systems. Minicomputers in the Government were first used in agencies that had employees with the capability to develop their applications and systems. For example, the Atomic Energy Commission (now Energy Research and Development Administration (ERDA)) and the National Aeronautics and Space Administration (NASA) used minicomputers in their scientific investigations in the field of atomic energy and space.

Federal users, in response to a questionnaire, said they used minicomputers primarily for scientific experiments data reduction and processing. Other uses mentioned included process control, communications, and input and/or output purposes. Appendix IV lists a variety of data processing applications using minicomputers.

Federal users expect that minicomputers will be used for an ever-widening spectrum of applications as manufacturers improve and increase the products and services they offer and as users become more knowledgeable. According to responses to our questionnaire, a wide use of minicomputers is forecasted for entering and editing data into larger computers and for general data processing.

Federal computer management

The Brooks Act (Public Law 89-306) vests certain overall ADP management responsibilities in the Office of Management and Budget (OMB) (then Bureau of the Budget), the General Services Administration (GSA), and the Department of Commerce. The act directed GSA to coordinate and provide for the economic and efficient acquisition of the Government's ADP equipment

subject to fiscal and policy control established by OMB. Each agency has certain responsibilities for its own ADP operations.

SCOPE OF REVIEW

We reviewed the legislative history of Public Law 89-306, OMB circulars and guidelines, GSA regulations and procedures, Commerce's National Bureau of Standards (NBS) directives and publications, and selected agency procedures pertaining to the acquisition and use of minicomputer technology. We interviewed officials of GSA and NBS and officials in civil agencies and in the Department of Defense who procured and used ADP equipment and we talked with representatives of the computer industry.

We studied minicomputer uses and visited private and Federal organizations to learn the benefits and problems they associated with using them. We used a questionnaire to obtain additional information. (See app. V for the questionnaire and results.)

Information on savings, benefits, and problems described in this report was provided to us by the organizations involved; we did not verify the amounts.

CHAPTER 2

OPPORTUNITY TO ENHANCE PRODUCTIVITY BY USING MINICOMPUTERS

Automation is one means of increasing productivity within the Government. Minicomputers can provide Federal managers with an economical opportunity for enhancing productivity. They may provide:

--An initial use of automation which was heretofore cost prohibitive.

--A more economical method of data processing and data communications.

--More rapid and meaningful information to managers to assist them in their decisionmaking process.

As stated in chapter 1, agencies have used minicomputers successfully for process control, scientific data processing, and data communications and they plan to expand minicomputer use, particularly in such areas as data entry and general data processing.

HOW DOES USING MINICOMPUTERS ENHANCE PRODUCTIVITY?

Computer use has been dictated principally by technological and economic factors. Early business computers were used for clerical and recordkeeping processes. As computer technology advanced, the variety of applications expanded. Additional computer uses were possible with the development of integrated circuit technology, multiprograming operating systems, and remote access capabilities. Many of these technological advances were economically feasible, however, only if the computer systems were large with attendant economies of scale. Many data processing applications were still not economically feasible in such large systems.

After large-scale integrated circuitry was developed, minicomputers and small computers using such circuitry could perform data processing functions heretofore done only by larger computers. This advance in technology therefore permitted users to transfer some computer applications from the larger gear to smaller equipment and to perform work at considerably less cost because some of the overhead costs of the larger computers' complex operating systems was eliminated. In addition to obtaining lower costs, minicomputer users obtained the following benefits.

--Increased capability.

--Increased system reliability.

--Growth potential.

--More timely and accurate data.

CLASSIFICATION OF PRODUCTIVITY ENHANCEMENTS

Minicomputers can be a major factor in increasing productivity. They can be cost effectively used to:

1. Automate manual or mechanized processes, which results in more work accomplished in relation to resources consumed.

2. Augment work previously done on large central computers and thereby release the large computer's time for use when its greater processing capability is needed.

3. Replace existing equipment or services with resulting increased benefits.

One of the questions we asked in our questionnaire was the purpose for which users acquired a minicomputer. Following is a summary of the responses and a discussion of the purposes given.

	Principal purpose
Initial computer automation	108
Augmentation of equipment	19
Replacement of equipment or service	7
Other	17
Total	151

Initial automation

The low cost of minicomputers has allowed initial automation of manual and mechanized processes, whereas previously it was cost prohibitive or impracticable to use large computers. These minicomputers have been incorporated in other pieces of equipment and used for process control; they have been used as input-output devices for larger computers; and they have been used as stand-alone computers. Examples showing how productivity has been enhanced follow.

--Data entry is being done in many instances by use of keypunches. This operation is time consuming and is subject to many errors. Minicomputers, either incorporated in an automated data entry device (such as the key-to-disc system) or operating as a stand-alone device, have been increasingly used by Federal agencies to increase the efficiency of this operation. According to agency officials, minicomputer use has reduced both the number of staff-years needed for data entry and the frequency of errors in the process. Data entry errors have been troublesome, historically, but minicomputer-based entry systems have reduced this problem.

--An ERDA laboratory automated the data collection of its mechanical shop by installing a minicomputer. The system was justified on the basis that it would (1) increase the efficiency of the data collection process, (2) provide management with timely and accurate information to improve inventory control of the parts stocked in the shops, and (3) provide information which could be used to improve the use of machine tools and throughput of jobs.

--An Air Force study entitled "Support of Air Force Automatic Data Processing Requirements Through the 1980's" reported that there were over 70,000 people in the Air Force engaged primarily in manually converting data to one form or another, computing and comparing data, or sorting data. Minicomputers are being considered for installation as part of the Air Force's systems for fiscal years 1980-82. This change will automate many data functions and reduce related costs by an estimated $98 million annually.

Augmentation of large computers

The technical features of large computers and their supporting operating systems--which perform such functions as concurrent programing and processing (referred to as multiprograming and multiprocessing), interrupting jobs in process for jobs with higher priorities, and manipulating large amounts of data--are acquired at a price. Often these functions are not needed, and minicomputers can be used instead of large computers. Using minicomputers to augment large computers can lower data processing and/or communications costs and can free large computers to perform functions where their sophisticated logic, large memory capability, and complex operating systems are required.

Examples of minicomputers augmenting large computers follow.

--The Advanced Research Projects Agency of the Department of Defense uses minicomputers for terminal connections to its nationwide computer network. The minicomputers support the use of wide-band communications links operated among network points of data concentration.

--Minicomputers are used at the ERDA Lawrence Livermore Laboratory computer network as remote job entry terminals. Studies have shown cost effectiveness due to (1) time saved by users traveling between remote office areas and the computer center and (2) reduced turnaround time for the processing itself.

--Minicomputers are used in large retail store chains to collect and process data from point-of-sale terminals within the store and to summarize the data as input to large computers.

A brief description of a case illustrating the benefits achieved by a minicomputer augmenting a large computer follows.

NASA designed a communications link that allowed a large computer to operate more efficiently. The large computer was used to process data received from six sending and/or receiving stations located in space throughout the world. The main purpose of the communications link was to merge six data signals so that data could be transmitted to a large computer over one line at a faster rate.

NASA decided to use a minicomputer as the linking device because it was more versatile and less costly than other alternatives. The $17,500 cost of the minicomputer compared very favorably with the estimated $60,000 cost to build a special-purpose device. Further, unlike the special-purpose device, the minicomputer could be reused on another job once the project was completed. Using the minicomputer freed space in the large computer's main memory and increased its available computing time from 5 to 10 percent.

The National Weather Service, Department of Commerce, plans to make extensive use of minicomputers in its Automation of Field Operations and Services Program which is scheduled to become fully operational in 1979. One of the key elements of this system is the automating of the 52 weather service forecast offices so that they can communicate readily with other links of the national distribution circuit.

Each forecast office, using a minicomputer-based system, will function as:

--An area data collection point, where all data acquired and preprocessed within that designated forecast area is collected; stored; and, if required, entered onto the national distribution circuit.

--An area data distribution and dissemination point from which all data arriving through the national distribution circuit or other local and/or area communications facilities can be relayed to other National Weather Service stations or users within the forecast area.

--A national distribution circuit store-and-forward communications point.

--An area data bank with high-speed local access and with medium- and low-speed, areawide request and/or reply capability.

The technique of decentralizing considerable computer capability to each forecast office is referred to as distributed processing. In our opinion, this technique presents considerable opportunities to enhance productivity since it cuts communication costs, which may be as high as data processing costs.

Another possible benefit from using minicomputers for work previously done on larger computers is to defer the replacement of the existing large system. For example, one agency plans to use minicomputers to augment its large computers to handle communication control. Agency officials estimate total savings of about $13 million, by deferring for 5 to 10 years the replacement of the large computers.

Replacement of computers with minicomputers

Because of the improvements in computer technology and lower minicomputer prices, minicomputers may represent cost-effective replacement alternatives to continued operation of older computer systems.

A company that was leasing a computer system decided to purchase a minicomputer system instead. The cost of a minicomputer was $50,000 less than the purchase price of the computer being leased, and the minicomputer system offered more expansion capability. Most of the computer programs had been written in a language that could also be adapted on a variety of equipment. This simplified the programer's problems in converting most of the existing programs for use on the minicomputer system.

Replacement of computer time-sharing service

A credit union could not get all the services it desired from a computer time-sharing company, and time-sharing costs were escalating. The time-sharing service provided record-keeping for customers' accounts.

The credit union officials decided to install their own system, instead of using the time-sharing service. A minicomputer was installed at the main office (which is tied into terminals located at two branch offices) for processing customer accounts, as well as for providing management-type reports.

Credit union officials estimated that they saved about $19,000 annually, and they were able to expand both volume and services to customers. Costs were reduced because unused computer capacity was sold to another credit union.

MULTIFACETED RAILWAY USE OF MINICOMPUTERS

The following case shows how one company's productivity was enhanced a number of ways by using minicomputers.

A railroad company needed a new freight car yard to handle increasing traffic and to relieve overloads in nearby yards. The effective operation of the old yard was dependent on employee judgment and on weather conditions. Management automated several of the manual processes (e.g., scheduling, distribution, management information, and process control) as much as possible to save time and reduce cost. A minicomputer system was chosen to do this because it appeared to be more reliable, less expensive, and provided a faster response time than other alternatives.

A system of five interconnected minicomputers is used at the new yard: two generate reports for management information purposes and three support the scheduling, distribution, and control functions--handling incoming trains having freight cars bound for a variety of destinations and reassigning them to a number of outbound trains. The minicomputer system is also connected to a large computer facility elsewhere which supplies such information as car destination, contents, and weight.

Company officials estimated the cost of automating the yard would be recovered within 5 years. Savings include $100,000 from a reduction in personnel costs and from a considerable decrease in freight damage.

CHAPTER 3

PROBLEMS RELATING TO THE USE AND ACQUISITION OF MINICOMPUTERS

Chapter 2 describes a number of cases in which minicomputers have been successfully used to do work more efficiently. Minicomputers are not appropriate, however, for some automation projects.

Federal managers should be aware of the computers' limitations as well as their capabilities in order to determine when it would be beneficial to acquire them.

Since an ADP system's software costs generally are higher than hardware costs, Federal managers should assess the impact of the total cost on agency operations along with assessing the impact of the hardware costs. NBS has provided some guidance to Federal agencies in this area, and is working on some tasks that should provide additional guidance.

Agency officials reported a number of problems that occurred in using and acquiring minicomputers.

USE PROBLEMS

Some hardware and software problems we identified which can hinder the effective use of the minicomputers follow.

Programing

Three levels of programing languages used in computer instructions follow.

--Machine language instruction is directly understood by the specific computer. (This instruction level is used infrequently.)

--Assembly language instruction is easier to use and the computer translates it directly into machine language.

--High-level-language instruction is even easier to use and is designed to be used on a variety of computers and then translated into machine language.

Although programing in assembly language may be the most efficient language to use in certain circumstances, this language has limitations.

Assembly language is unique to the equipment involved and generally can be used on only one manufacturer's hardware.

Therefore the user tends to be dependent on one manufacturer's equipment, even though it may no longer be the most desirable choice. A user wanting to use another manufacturer's equipment must rewrite the existing assembly language programs; this process is time consuming and is very costly. However, responses to our questionnaire indicated that many users programed only in assembly language.

Many minicomputers can now be programed in high-level languages, such as FORTRAN, COBOL, and BASIC. FORTRAN and BASIC are used principally for scientific work, whereas COBOL is used principally for business-related applications.

Use of these languages is helpful in transferring applications programs to other manufacturers' equipment and thus minimizes conversion problems and makes easier the sharing of software with other users. Since high-level languages are becoming more available for minicomputers, their use should be encouraged.

Limited manufacturers' support and service

Some minicomputer manufacturers provided only limited support to end-product users in designing and installing data processing systems. Many manufacturers' primary marketing strategy was simply to sell equipment. But other manufacturers not only sold or leased the equipment but also offered a wide assortment of software packages and provided considerable support or service to put the system into operation.

In 1974 a data research organization reported that about 70 percent of all minicomputers sold would be to organizations that add value to the equipment--by either developing complete systems or incorporating minicomputers within other products--and resold them as different end products. The remaining 30 percent would be sold directly to users of the end products. Some manufacturers' representatives said they did not want the responsibility of designing or installing systems for their customers.

In the Federal community, users have mostly been engaged in research and development work and normally have the technical capabilities to develop, install, and maintain the various segments of a computer system. Responses to our questionnaire showed that, out of 151 minicomputers, most of them were used for scientific, engineering, and other technical types of applications and that programs generally were developed by the users.

Organization officials using minicomputers told us they had problems in the support or service areas of (1)

manufacturers' software and technical support and (2) hiring, training, and retaining of personnel.

Many commercial firms acquiring minicomputer systems have overcome this support problem by contracting with independent companies to develop a fully operational system, commonly referred to as turnkey system, which is then turned over to the firm.

Some Federal agencies are starting to obtain from other sources the service and support not normally available from some minicomputer manufacturers. NBS uses a group of computer specialists to provide support to the professional staff in one of its institutes which uses minicomputers extensively, whereas the Environmental Protection Agency has an interagency agreement with an ERDA laboratory to provide technical assistance to develop software and interface devices for an automated laboratory management system.

We believe that the justification for acquiring a minicomputer should include an evaluation of whether technical support is available from the vendor and, if not, whether it is available in-house.

Equipment limitations

Generally a minicomputer can do the same type of work as a larger computer, but it cannot do so much at once or as fast. There are some jobs it cannot do at all; for example, certain large jobs cannot be broken into segments small enough to fit in the minicomputer's memory.

A minicomputer has the same basic components as larger computers. The internal parts of a minicomputer, however, are fewer in number and size and do not contain many of the expensive features offered by a larger computer. The following table illustrates some of the differences between features of a minicomputer and a larger computer (generally, the larger the number the more work a computer can do within a given time.)

Features	Typical minicomputer	Typical computer
Word size (bits)	16	32
Registers (general purpose)	8	16
Memory (thousands of bytes)	32	128 to 4,000

Our questionnaire results showed that 12 percent of the Government users responding encountered problems with word

size and 40 percent encountered problems with storage capacity. Many of these limitations are being overcome since minicomputer manufacturers are continually announcing new products and services and users are continually becoming more experienced.

For example, an organization encountered problems with the minicomputer's memory capacity and some of the application programs had to be sectioned into parts because of the small size of the available memory, but this situation appeared to result more from the user's lack of knowledge about the equipment's capabilities than from faults in the equipment itself. Therefore the justification of acquiring a minicomputer should be based on an evaluation of its capabilities as well as on its price.

NBS efforts in providing guidance to agencies using minicomputers

The Brooks Act authorized the Secretary of Commerce 1/ to provide agencies and GSA with scientific and advisory services relating to ADP systems and to make recommendations to the President relative to the establishment of uniform ADP standards. The act also authorized the Secretary to undertake research in ADP sciences and technologies. This authority was granted subject to the fiscal and policy control exercised by OMB.

Executive Order 11717, effective April 15, 1973, transferred to the Secretary of Commerce functions being performed by OMB relating to the establishment of Government-wide ADP standards, including the function of approving standards on behalf of the President.

NBS's stated objectives of its ADP standards program are to:

1. Increase interchange and sharing of data, programs, and equipment by Federal agencies and the public.

2. Improve performance and quality of ADP products and services developed by or acquired by Federal agencies.

3. Increase awareness by Government and industry of the needs for standards to achieve compatibility and enhance the effective utilization of ADP products and services.

1/The Secretary of Commerce delegated this responsibility to NBS.

In developing its Federal ADP standards, NBS participates with the American National Standards Institute, a private organization established to develop and adopt national voluntary standards for industry, and, when appropriate, it adopts the standards approved by this organization as the Federal standard.

One of the principal means NBS uses to carry out its responsibilities of establishing Government-wide ADP standards is through the development and issuance of Federal Information Processing Standards (FIPS). NBS made a study of the FIPS standards it had issued and of those under development to ascertain which ones were applicable to minicomputers and whether any of them might have to be changed to consider the characteristics of minicomputers. The study, completed in the spring of 1975, concluded that most of the published FIPS standards were applicable to minicomputers; COBOL standards, however, needed to be changed to accommodate minicomputer needs. Additional work on the standards being developed for FORTRAN and BASIC and on the linking of peripheral equipment with the computer was needed to recognize the minicomputers' characteristics.

With respect to the COBOL standard, NBS told us that the simplest version of COBOL 1/ could be adapted for minicomputers. This view corresponds with that expressed by the Department of the Navy, which was developing a simple version of COBOL for use on minicomputers. NBS officials told us that the subcommittee on COBOL of the American National Standards Institute held similar views.

We questioned what efforts NBS was making to develop Federal standards for FORTRAN and BASIC. An NBS official told us that development of standards for these languages was well underway and that the standards should be published about mid-1976. He also indicated that some manufacturers' versions of FORTRAN and BASIC varied very little and that the problem of converting programs written in these languages for each computer system should not be difficult or costly.

Issuance of Federal ADP standards for high level programing languages is desirable because it would help reduce computer program conversion problems and related costs.

1/COBOL has been developed in four versions, referred to as levels. Levels are based on programing capability.

ACQUISITION PROBLEMS

Federal agency officials told us that certain policies GSA established have caused them to have problems in acquiring minicomputers costing over $10,000; 1/ minicomputer manufacturers also told us that policies GSA established caused them to have problems in selling to the Government. For the most part, computer equipment procurement is based on GSA policies established about 10 years ago. Although these policies were appropriate when the range of computer products on the market was limited, they may not always be appropriate today with the far greater range of computer resources available to users.

In response to our questionnaire, 56 officials (38 percent of the respondents) said that they experienced delays in acquiring minicomputers. Of this group, 26 officials (45 percent) cited the time required to get approval of the procurement as the principal factor contributing to these delays.

We made a further inquiry to find out why the approval process delayed minicomputer acquisition. The problems most frequently cited were the numerous levels of review and the approvals required to justify and acquire a minicomputer. Agency officials indicated that these levels of review existed even on procurements up to $50,000 where agencies were given a blanket delegation of procurement authority by GSA.

For example, a Navy Department laboratory study of ADP discussed problems in the acquisition process and stated that delays were caused both by internal (Navy) requirements and by GSA requirements. The study indicated that the costs of meeting these requirements were a major portion of the cost of the ADP resource itself and that "this is particularly true for low cost ADPE (equipment)."

The study also detailed a case where, for a given task, two equipment options were available: one using flexible, minicomputer-based gear at a cost of $17,000; the other, a single-purpose (hardwired) piece of gear at $21,000. Although the minicomputer-based equipment cost less and could do more, the decision was made to buy the other equipment because the difficulties of ADP procurement could be avoided and the system could be installed without delay.

The study also included another case where the cost ($30,000) and time to justify (under existing policy)

1/Public Law 93-356, enacted in July 1974, provided for the use of simplified procedures in the procurement of property when the cost does not exceed $10,000.

upgrading of a minicomputer system exceeded the total cost of acquiring the system and resulted in a 2-year delay of the project on which it was needed.

The Navy laboratory study commented that:

> "The present type of control over ADP acquisition tends to encourage overkill in procurement (at extra expense) to avoid potential requirements to go back to the ADP chain for additional resources when needed."

NASA and ERDA officials expressed similar thoughts on the complicated approval process for minicomputers.

In our opinion, at least some of the internal problems of the agencies could be alleviated if GSA simplified the requirements for procuring minicomputers in small quantities.

Problems vendors encountered

We met with officials of several minicomputer manufacturers to obtain their views on Federal ADP policies and procedures. They were concerned with problems experienced in attempting to sell minicomputers to Government agencies. They considered Government procurement procedures--as applied to purchase of small quantities--too complex, too lengthy, and too detailed. Some manufacturers said that the limited profit potential from the sale of small quantities of minicomputers frequently made the cost of analyzing and responding to a Government solicitation prohibitive. For example, one major minicomputer manufacturer told us that it did not respond to Government solicitations for equipment valued under $50,000 because of the high cost to prepare a response.

In a meeting with GSA officials in July 1975, an industry association representing many computer equipment manufacturers expressed opposition to GSA's proposed use of indefinite quantity requirements contracts 1/ for obtaining minicomputers. The association's position was that computer

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1/This type of contract provides for the furnishing of an indefinite quantity (within stated limits) of specific property or services during a specified contract period. The contract provides that, during the contract period, the the Government order a stated minimum quantity and that the contractor furnish property or services ordered up to a stated maximum quantity.

equipment should not be procured the same way as many other items since it was a high-technology item, mission dependent, and subject to a high rate of change. Its opinion was that the agency should be the ultimate authority on application requirements.

Association members were concerned that a user would have to adapt its applications to fit the equipment available under the contracts rather than obtain the equipment that best meets its needs. The association said quantity procurements were valid when (1) users would define the applications for which minicomputers would be used and (2) quantities to be ordered were known.

GSA responded to the association's position in a letter dated August 26, 1975. GSA agreed that:

--High-technology items should not be procured like commodities.

--No single solution meets Government-wide users' needs, but in a population as large as the Government, there probably were "like" needs.

--The user was the ultimate authority on application requirements.

--Laws, regulations, and procedures should be adopted as requirements changed or were more clearly understood.

With respect to GSA using indefinite quantity requirements contracts to procure minicomputers and other high-technology ADP equipment items, GSA said it was a complex problem and needed careful consideration. GSA believes that use of this type of contract is an appropriate contractual vehicle for quantity procurements provided that:

--The base or major equipment requirements are identified to a specific application.

--Interested agencies participate in both the specification preparation and the evaluation.

--Some level of additional uses of this equipment can be assumed.

GSA also stated that:

--Since these contracts were not mandatory (except for the minimum quantity stated in the contract), primary

user agencies would make the final determination as to whether the equipment specified in the contract met their requirements.

--Technical obsolescence would be diminished through the use of a 2-year ordering period, subject at midpoint to an annual renewal option.

--Past experience had shown that these contracts resulted in considerable savings and improved terms and conditions to all Government agencies.

With respect to low-dollar and small-quantity procurements, GSA agreed with the objective of streamlining the ADP procurement procedures while at the same time assuring that maximum practicable competition is achieved. In this context, GSA advised the association that:

"The problem for us is to define the area where informal competition (or some other method of simplified evaluation and selection) is applicable and to establish assurance in that area that the Government obtains the best available prices."

Although acquisition cost of minicomputer equipment is important, we believe agencies should be aware that other factors also bear on their decision to acquire. Software costs, for example, generally exceed equipment costs, as indicated on page 15, and agencies should determine which course of action will produce their desired results at lowest total cost, not merely the lowest equipment cost, over the life of the system.

CHAPTER 4

CONCLUSIONS, RECOMMENDATION, AND AGENCY COMMENTS

CONCLUSIONS

Additional opportunities exist for Federal agencies to use minicomputers as an efficient alternative to using larger computers to meet their expanding data processing needs.

The minicomputer equipment itself is generally not the principal cost of the ADP system. Software development and maintenance costs, plus operating costs, are far greater. Therefore the cost of the equipment itself should not be the overriding factor in determining what equipment to acquire. Problems that managers should consider in using minicomputers were discussed in chapter 3.

We believe GSA has satisfactorily responded to the data processing industry's concern that use of indefinite quantity requirements contracts are appropriate to acquire rapidly changing technology items. These contracts have only a 2-year ordering period and are subject to review after 1 year; GSA has a procedure which should permit determining whether equipment is becoming obsolescent.

An agency should not obtain minicomputers that are not appropriate to its needs simply because the equipment can be obtained more readily on an existing contract. When the procurement will exceed $50,000, the agency has the option to request a delegation of procurement authority from GSA to obtain the appropriate equipment.

Some of the agency problems in buying low-dollar-value minicomputers or equipment containing a minicomputer could be alleviated if GSA simplified its requirements for such procurements.

RECOMMENDATION

We recommend that GSA, through forums with other Government agencies and industry associations, simplify Government-wide procurement requirements for minicomputers giving recognition to the difficulties cited by agencies pertaining to the purchase of minicomputers with a low-aggregate-dollar value.

AGENCY COMMENTS

GSA agreed, in general, that there was a need for simplified procurement and indicated that it was considering

steps to accomplish these purposes. Its reply is included as appendix I.

We plan to review the effectiveness of their actions when they have been fully implemented.

Copies of the responses to our proposed report that we received from NBS and from the Department of Defense are also included as appendixes.

We are sending copies of the report to Federal agency heads for their information and use in considering minicomputer use as one means of meeting their agencies' ADP requirements.

UNITED STATES OF AMERICA
GENERAL SERVICES ADMINISTRATION
WASHINGTON, DC 20405

DEC 9 1975

Honorable Elmer B. Staats
Comptroller General of the United States
General Accounting Office
Washington, DC 20548

Dear Mr. Staats:

Thank you for the opportunity to review your draft report, "Uses of Minicomputer in the Federal Government: Trends, Benefits, and Problems", dated August 15, 1975.

We agree with the basic thrust of the report relating to the need for simplified procurement procedures. However, it should be noted that these simplified procedures could adversely affect the full and free competition in ADP equipment procurements. Nevertheless, some ADP items must be acquired even though the opportunity for realistic overall price/cost reductions is remote. Under these conditions, the administrative cost of conducting a formal competitive procurement is not warranted and, therefore, placing an order against one of our ADP Schedule contracts would constitute an economical and efficient procurement action.

The problem, however, is to define that ADP equipment where simplified evaluation and selection may be used in lieu of full competition and at the same time assure that the Government's needs are satisfied at the lowest overall cost, price and other factors considered. The significance of this problem was recognized in the following statement on page 1 of the draft report, "...Although the term minicomputer has been extensively used by the data processing community, it defies a precise definition..."

Since there is no commonly accepted description of a minicomputer that we believe would be suitable for use in the procurement process, we suggest that a dollar threshold is more appropriate. It would appear that a threshold of $50,000 is reasonable. In addition to being reasonable for minicomputers, we believe that this same dollar threshold also could be applied to other ADP equipment.

However, to preclude quantity buys under schedule contracts where there is a good probability of obtaining significant quantity discounts, a maximum order limitation (MOL) should be placed on the number of the same type and model devices that could be acquired under a single procurement transaction. Such MOLs already are incorporated in our existing ADP Schedule contracts for this purpose. Accordingly, what we propose is a $50,000 MOL and a quantity MOL in each contract with the lesser MOL to govern.

In addition, there are several areas that could be clarified and our specific comments are attached.

If there are any questions, please let us know.

Sincerely,

Dwight A. [illegible]nk
Acting Administrator

Enclosure [See GAO note.]

GAO note: The deleted comments were considered in finalizing the report.

APPENDIX II

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Administration
Washington, D.C. 20230

October 16, 1975

Mr. Victor L. Lowe
Director, General Government Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Lowe:

This is in reply to your letter of August 19, 1975, requesting comments on the draft report entitled "Uses of Minicomputers in the Federal Government: Trends, Benefits and Problems."

We have reviewed the enclosed comments of the Assistant Secretary for Science and Technology and believe they are responsive to the matters discussed in the report.

Sincerely,

Guy W. Chamberlin, Jr.
Acting Assistant Secretary
for Administration

Enclosure

APPENDIX II

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington, D.C. 20230

SEP 25 1975

Mr. Victor L. Lowe
Director, General Government Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Lowe:

Thank you for sending to the Secretary copies of the draft report "Uses of Minicomputers in the Federal Government: Trends, Benefits, and Problems".

The National Bureau of Standards' Institute for Computer Sciences and Technology, which provided inputs to the General Accounting Office staff during preparation of the report, has reviewed the draft report. The Institute believes that the report is good and that, in keeping with the established pattern of General Accounting Office reports in the computer area, will be a valuable aid to Federal agencies. The Institute has prepared a brief set of detailed comments on the report; these are attached.

Thank you again for giving the Department an opportunity to review and comment on the report.

Sincerely,

Betsy Ancker-Johnson, Ph.D.

Enclosure [See GAO note.]

GAO note: The deleted comments were considered in finalizing the report.

APPENDIX III

ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301

COMPTROLLER

28 OCT 1975

Mr. D. L. Scantlebury
Director, Division of Financial &
General Management Studies
U. S. General Accounting Office

Dear Mr. Scantlebury:

The Secretary of Defense has asked us to respond to your proposed report on uses of minicomputers in the Federal Government: trends, benefits and problems, forwarded by your letter of August 28, 1975 (OSD Case #4154).

We strongly support your conclusions regarding (1) the opportunities which exist to improve efficiency and increase productivity through the use of minicomputers and associated technology, (2) the fact that ADP equipment cost is a rapidly reducing factor in the overall cost of ADP systems, and (3) the need for simplification of procurement policies and practices of GSA and other Federal Agencies relating to acquisition of minicomputers and related low cost computer systems to reduce time and administrative cost.

We recommend minor modifications of your recommendations on pages 46 and 47 to increase specificity as follows:

[See GAO note 1, p. 31.]

APPENDIX III

[See GAO note 2.]

Sincerely,

Terence E. McClary
Assistant Secretary of Defense

GAO notes:

1. Page references in this appendix may not correspond to pages of this report.

2. The deleted recommendations in the letter were considered in finalizing this report.

EXAMPLES OF MINICOMPUTER APPLICATIONS

Application area	Function	Application
Industrial control	Process control	To control the electrolytic process that converts alumina ore into molten aluminum.
	Data collection	To monitor and control the production and shipment of truck axles. The system provides data for shipping and inventory control and production management control.
	Product testing and calibration	To run a battery of tests of automobile carburetors designed to meet 1975 auto emission standards. The carburetor is adjusted automatically by computer-driven screwdrivers and wrenches.
Scientific/ engineering data processing	Data acquisition and reduction	To process and display data acquired in real time from optional and developmental testing of aircraft.
	Laboratory automation	To provide automatic operation of 10 gas chromographs giving complete quantitative analyses and printouts of all analytical reports.
	Mathematical problem solving	To perform a variety of astronomical tasks to obtain more accurate results at a national observatory.
Management data processing	Administration operations	To prepare a city payroll.
		To provide computer-aided instruction in undergraduate sciences and engineering courses.
		To process college registration information.
		To define causes of accidents at the scene.

APPENDIX IV

Application area	Function	Application
		To assist in the routine analysis for nature and extent of pulmonary diseases.
Data communications	Message switching	To manage the flow of data and messages throughout the multiple field locations and the home office of a manufacturer of truck trailers.
	Preprocessors	To preprocess bank information before it is sent to large central computers.
	Data concentrator	To concentrate nationwide computer time-sharing network data. Each minicomputer interfaces between a number of relatively low-speed communication links and one or two high-speed lines between cities.
	Terminals	To monitor and collect data, and to report changes to a central computer in an oil transmission system, and to respond to change controls from the central computer.

GAO MINICOMPUTER QUESTIONNAIRE AND RESULTS

According to the General Services Administration's inventory of Federal Government computer systems, as of December 31, 1973, your organization possesses a minicomputer. The following questions relate to the performance of the computer and your experience in using the minicomputer.

1. What is the minicomputer primarily used for? (Please check one)

a) Process control device	13
b) Communication device	12
c) Input/output device	4
d) Management data processing system	2
e) Scientific experiments data processing system	78
f) Other (describe)	35
g) Multi-purpose	7
Total	151

2. Was the minicomputer acquired to:

a) Automate something that was previously done manually	108
b) Replace a larger computer system	7
c) Augment another computer	19
d) Other (describe)	17
e) Multi-purpose	0
Total	151

3. Was a larger scale computer considered as an alternative prior to the acquisition of the mini? Yes 25 No 118

4. Please rate each of the categories below according to your experience with the computer.

	Excellent	Good	Fair	Poor	Total
Overall performance	57	80	7	1	145
Manfacturer's software	22	85	31	5	143
Ease of programing	32	89	11	11	143
Ease of installation	57	73	11	3	144
Ease of operation	42	98	5	1	146
Hardware reliability	58	62	17	7	144
Manufacturer's technical support	23	61	43	14	141
Hiring, training, and retention of personnel	19	68	23	7	117

5. Who primarily developed the application software? (please check one)

a) In-house personnel	98
b) Minicomputer manufacturer	14
c) Independent software developer	17
d) Computer system supplier	17
e) Multi-sources	5
Total	151

6. What programing language is used for the system?

Multi-programed		40
a) Basic		11
b) Fortran		17
c) Cobol		0
d) Other (describe)	Assembly	45
	Machine	21
	Other	17
	Total	151

7. Have you experienced problems due to some of the limitations of the minicomputer's system characteristics?

a) Instruction set	Yes	14	No	132
b) Word size	Yes	17	No	130
c) Number of registers	Yes	18	No	129
d) Storage capacity	Yes	59	No	87
e) Other (describe)		20		130

8. What is the estimated breakdown of acquisition costs associated with the minicomputer system, by percentage?

a) CPU, including add-on memory	42 %
b) Peripherals	42 %
c) Software	16 %
	100 %

9. Did you experience unreasonable delay in acquiring and/or implementing the mini? Yes 58 No 91

10. If the answer to question 9 is yes, in which areas did you experience delays?

a) Approval	26
b) Delivery of hardware	3
c) Delivery of software	4
d) Implementing the system	4
e) Other (describe)	1
f) More than one problem	20
Total	58

11. Do you envision wider use of minicomputers to satisfy certain data processing requirements within your organization? Yes 133 No 18

12. If the answer to question 11 is yes, in which areas do you envision wider utilization?

a) Process control device	71
b) Communication device	57
c) Input/output device	62
d) General data processing system	42
e) Scientific experiments' data processing system	108
f) Other (describe)	31