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REPORT TO THE CONGRESS

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Improved Planning And Management Of Information Systems Development Needed

Federal Aviation Administration
Department of Transportation

The Federal Aviation Administration needs to improve its planning and management control over the approval and development of management information systems to

- shorten prolonged system development cycles,
- reduce cost overruns,
- prevent the premature acquisition of costly equipment, and
- initiate system development efforts that will satisfy the demands placed upon them.

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COMPTROLLER GENERAL OF THE UNITED STATES

WASHINGTON, D.C. 20548

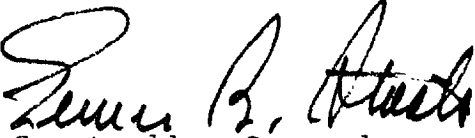
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(1) To the President of the Senate and the
Speaker of the House of Representatives

This is our report on why the Federal Aviation Administration is having difficulty in developing and implementing several management information systems. This difficulty has resulted in prolonged system development cycles, the premature acquisition of costly equipment, and a systems development effort that has been unable to satisfy the demands placed upon it.

GAO evaluated Federal Aviation Administration procedures and alternatives to determine its information needs. 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, and the Secretary of Transportation.


Comptroller General
of the United States

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ABBREVIATIONS

FAA Federal Aviation Administration
GAO General Accounting Office

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

IMPROVED PLANNING AND
MANAGEMENT OF INFORMATION
SYSTEMS DEVELOPMENT NEEDED
Federal Aviation Administration
Department of Transportation

D I G E S T

While the findings in this report are directed toward the difficulty the Federal Aviation Administration has had in developing and putting into use management information systems, similar conditions have existed in other Government agencies.

Findings and recommendations in this report should be of special interest to the House Committees on Appropriations and Government Operations because of their continual concern with the cost, efficiency, and effectiveness of data processing management in the Federal Government. Since these conditions described have existed in other Federal agencies, these Committees may wish to be apprised of agency actions aimed at assuring sound management control in developing new data processing programs.

In the case of the Federal Aviation Administration, \$7.7 million was spent in developing and implementing several management information systems over a period of 9 years. None was fully operational as of March 1974. The agency has taken action to revise and improve its procedures.

The Federal Aviation Administration approved the design and development of these systems without

- defining objectives clearly,
- quantifying expected benefits adequately,
- determining their requirements for use of the equipment, or
- determining costs of alternatives.

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The result was prolonged system development cycles, cost overruns, premature acquisition of costly equipment, and systems developments that were unable to satisfy the demands placed upon them. (See pp. 2 and 14.)

GAO recommends that the agency

- establish procedures for systematically evaluating the need for new system development projects;
- establish procedures for validating estimated development costs of new systems and the value of expected benefits and for arriving at more realistic development costs;
- reevaluate system development projects already underway and state the specific benefits expected from each;
- identify and document how each project under development will help the agency perform its functions, cost out alternatives so that the most economical means of meeting its information needs can be identified and pursued, and terminate further development effort if the project no longer meets user needs; and
- reevaluate the need for computer equipment, even if this requires releasing some equipment. (See p. 18.)

The Assistant Secretary for Administration, Department of Transportation, generally agreed with these recommendations, which have either been incorporated into current procedure of the Federal Aviation Administration or were in the process of being implemented with the systems under development.

CHAPTER 1

INTRODUCTION

GAO reviewed the Federal Aviation Administration's (FAA's) development of selected administrative data processing systems, including the acquisition of computer equipment installed at its Aeronautical Center, Oklahoma City, Oklahoma. The Center has a Data Services Division, which provides automated data processing operations, systems development, and computer programming services for agencywide activities. This division is responsible for conducting the studies and surveys that support recommendations for proposed data systems.

Since 1965 FAA has authorized the development of a manpower and personnel information system, a data base management system, an airman information system, and a logistics information system. These systems were still being developed as of March 1974, although two large-scale computers had already been acquired for processing the expected workload. Development costs, including the acquisition of the two computers, total about \$7.7 million.

We wanted to evaluate the procedures FAA used to establish its information systems needs. We examined its procedures for planning, approving, and developing systems; its management of system development activities; its justifications for the two computers; and its current and planned use of that equipment. We also compared FAA management practices with Government-wide guidance on systems development provided to Federal agencies. We examined various documents and reports and held discussions with responsible officials at FAA headquarters in Washington, D.C., and at the Center.

CHAPTER 2

NEED FOR IMPROVED PLANNING AND MANAGEMENT OF INFORMATION SYSTEMS DEVELOPMENT

FAA needs to strengthen its planning and management control over approving and developing new systems projects. It has been spending substantial resources for the design, development, and implementation of new systems without clearly defining measurable objectives. In addition, FAA has begun or modified new systems development efforts without obtaining the formal approval and active participation of its top management. As a result, the development cycle has been prolonged, equipment has been acquired prematurely, and systems have not satisfied the demands placed on them. Furthermore, without predetermined system objectives and performance measurement criteria, FAA's top management has not been able to determine whether design efforts will provide any improvements over existing systems.

SYSTEMS DEVELOPMENT CRITERIA

The Office of Management and Budget was responsible for providing Federal agencies with guidance on developing automated data systems until April 15, 1973, when Executive Order 11717 transferred this responsibility to the General Services Administration. This guidance, formerly in Circular Numbers A-54, dated October 14, 1961, and A-61, dated August 3, 1963, and Bulletin Number 60-6, dated March 18, 1960, is currently reflected in Federal Management Circular 74-5, dated July 30, 1974.

The guidance specifies the studies' top management needs to insure that it has adequate information at key points during the systems development cycle. The guidance also states that studies should be made before any design or redesign effort is begun and that such studies should be concerned with identifying the best method of accomplishing an agency's mission and not with merely substituting an electronic computer for present manual or mechanical methods, since the existing methods may include unnecessary operations. Also, so management can decide if the system is justified from a cost-benefit

standpoint, the guidance states that specific and measurable improvements expected through automation should be shown with their costs.

This guidance is intended to prevent unnecessary expenditures for systems development and hardware by determining beforehand (1) whether automation can really meet agency needs, (2) whether the benefits expected from new systems are worth their costs, and (3) whether the development and implementation of new systems are the least costly means of meeting agency data processing needs. In the past the failure of other governmental and business organizations to follow this sound managerial guidance has resulted in extended periods of development, unnecessary expenditure of resources, and systems that did not satisfy the demands placed upon them. These examples were cited to the Congress in "Review of Problems Relating to Management and Administration of Electronic Data Processing Systems in the Federal Government," B-115369, Apr. 30, 1964; "Incomplete Installation of the Management Accounting System for Procurement of Equipment and Missiles," B-163074, Feb. 18, 1972; and "Ways to Improve Management of Automated Data Processing Resources," LCD-74-110, Apr. 16, 1975.

FAA has initiated and approved development of systems without preparing sufficiently detailed studies establishing a need for these systems. The studies did not

- identify specific management or organization objectives on which to base a design effort,
- identify criteria for measuring performance before and after systems development was completed,
- determine users' requirements,
- identify or cost out alternatives,
- establish or cost out possible benefits from the proposed systems, or
- review or evaluate existing systems to eliminate data processing activities no longer needed.

These systems are not yet fully operational and do not fully satisfy demands placed upon them. These conditions were common to all the systems included in our review.

MANPOWER AND PERSONNEL INFORMATION SYSTEM

In 1965 FAA contracted for the study and design of an automated manpower and personnel information system. In 1966 FAA received the contractor's report proposing a concept for the development of an automated personnel system.

The report showed that FAA's personnel operations were decentralized in 18 personnel offices, which caused problems in gathering and compiling agencywide data. The primary problem was the lack of central control over personnel data, resulting in the various personnel offices' maintaining and using nonstandard information.

To remedy this situation, the contractor proposed a system concept using remote data processing terminals connected to a large central data processing unit. The terminals would be located in offices where personnel information originated. The central processing unit was to have the capability of storing large quantities of data and providing ready access to this information for the nontechnical manager. In addition, the contractor provided the general design concept for a data base management system and recommended its use for storing and retrieving data in the manpower and personnel information system. The data base management system would allow users to put information into the system when it originated and to quickly retrieve information when needed. However, the contractor's report contained major deficiencies, such as the omission of (1) a statement describing management's objectives and information requirements, (2) a concise and complete statement of system specifications, and (3) a clear presentation of how the system would help accomplish FAA's programs.

Since the contractor's report did not quantify the system's benefits, FAA was unable to accurately estimate the system's potential for achieving cost reductions. Thus, the system's cost effectiveness could not be meaningfully evaluated, though reductions in manpower costs were represented as one of the system's expected benefits. For example, in 1972 FAA officials reported to the Office of Management and Budget that their 1969 estimated annual cost reductions of \$168,000 would not be attained but that system operating costs would not exceed current processing costs. However, these

estimates were based not on detailed cost-accounting techniques but on general statements of anticipated benefits.

We believe that general statements of benefits and cost reductions do not enable management to determine if a proposed system is cost effective. When new systems are proposed, specific studies and analyses should be made. The Office of Management and Budget requires such detailed studies before a system design effort is begun so that management will know if the system will be cost effective.

In December 1968 FAA estimated that the development of the manpower and personnel information system would cost about \$318,200. Through June 1974, development costs exceeded \$1.9 million, or about six times the original cost estimate. These costs excluded \$3.1 million for two new computers and about \$480,000 for remote terminals.

A contract for developing detailed system specifications was awarded to another contractor, since these specifications were not provided by the initial contractor. The second contractor also recommended using a data base management system.

In 1968 FAA decided to complete the design effort using its own staff resources. In 1969 FAA, deciding that the proposed data base management system was flexible enough to use with other systems, expanded its development to include requirements for other systems.

DATA BASE MANAGEMENT SYSTEM

This system is intended to be a general-purpose information storage and retrieval system. It is being developed for nontechnical managers so they can store and retrieve data from the other systems included in this review. In July 1969 FAA estimated that the development of this system would require about 34 months of additional effort.

Lack of justification

Normally, a general-use data base management system is developed only after a need for such a system is demonstrated. FAA, however, did not develop the information to demonstrate this need. FAA's data base management system

was conceived as part of the manpower and personnel system. When FAA decided to develop the data base system as a general-use system, no additional studies were made to identify requirements or expected benefits. Thus, the only studies were the ones concerned with the manpower and personnel system.

FAA has a review board of top agency officials to approve data processing projects. This board approved the manpower and personnel system, including the data base management concept. However, it did not review the decision to develop the data base system as a general-use system. The board considered the decision a technical matter not needing formal approval.

The design of the manpower and personnel system required the commitment of substantial resources and much effort over an extended period of time. We believe top management should have considered the system's merits and costs as specifically related to its expanded role as a general-use system. Also, the general-use system should have received specific approval by the FAA review board.

Consideration of alternatives

Before the allocation of agency resources to develop a system is approved, such allocation should be demonstrably more economical than the purchase of a similar system already available. FAA officials advised us that they had informally compared the anticipated capabilities of their general-use data base management system with that of other data base management systems. Although the only basis of the comparison was a January 1969 publication entitled "Data Management Systems Survey," they had decided that commercially available systems were not adequate. This comparison was inadequate not only because it was made after board approval for FAA development of a data base management system but also because it was not formalized to include an evaluation of the advantages and capabilities of each commercially available system and the cost trade-offs between those systems.

Generally, such a comparison would include, but not be limited to, evaluating system requirements and capabilities, such as the amount of core storage required to operate the

computer and the data base management system. Other factors that may be evaluated are the file structure and design; ease of updating and changing records; ease of use by non-technical personnel; ability to handle the required workload volumes; and costs involved in acquiring, operating, and maintaining the system. Obviously, selecting a data base management system is a complex task involving comparison of many important and diverse issues.

Since 1969 many such systems have become commercially available. One of the more capable systems now on the market costs approximately \$150,000. Its capacity to handle, as a single entity, more than 60 files of over 16 million records, with each record having up to 1,000 types of data, would more than meet FAA's stated operational requirements. FAA's stated operational requirements consist of 12 files, with about 180,000 total records, in its manpower and personnel system and 18 files, with about 5.3 million total records, in its airman system. The commercially available system could be used with time-shared computers at the Aeronautical Center, and the computer memory required to operate this system would be half that required for the FAA system.

There is also a Government-sponsored system available which would more than meet FAA's stated operational requirements. It is used by several other agencies and is available to Government users at no cost. Some costs are incurred for training and for adapting the system to differing needs, but these costs are nominal. This system can handle 99 files of 20 million records, with each record having up to 500 types of data. In 1972 this system was selected by the FAA National Flight Data Center for use with its aeronautical charting and related systems. The Flight Data Center uses this system on the same computers that the Center acquired for the four systems in this review. In 4 months the system was modified and made operational. An additional 24 months were required to enhance the system and to make it fully adequate. The total cost to FAA was about \$20,000. This cost is nominal when compared with the more than \$662,000 costs of the similar FAA-developed system.

Any data base management system necessitates an intensive effort to structure the interfacing systems into a workable format. FAA's manpower and personnel, airman, and

logistic systems needed to be tailored to work with the data management system. However, the adaptation cost for using an in-house-developed data base management system is unwarranted if the use of an adequate commercial or other Government system is much less expensive.

Evaluation by the Department of Agriculture

The FAA-developed data base management system was tested and evaluated in late 1972 by the Department of Agriculture, which was considering using this system for its personnel and payroll data processing systems. Although it saw many advantages, Agriculture decided against the system primarily because it would have had to acquire a large-scale computer for the exclusive use of the system. It also noted other weaknesses in the system design which it felt could lead to less than efficient use of computer equipment capabilities.

Agriculture recognized that FAA was still developing the system and that further consideration would be necessary. But it recommended that other commercially available data base management systems be evaluated in the meantime. Agriculture's suggestion about evaluating other systems before trying to convert the FAA system to its own use is a logical management practice.

We believe improved planning and management of the system development effort by FAA could have produced substantial savings. For example, a thorough comparison of needs with the capabilities of commercially available systems would have better informed management about whether to purchase a system or develop one with FAA resources.

The absence of definite objectives and needs at the time the FAA system was adopted precluded the determination that any of the commercial or Government-sponsored systems should have been adopted. We believe, however, that, if the progress and costs of the FAA system had been monitored, in 1972 FAA would have been able to consider adopting the data base management system that was used by the National Flight Data Center. At least this alternative should have been considered and possibly would have given the Center an operational system long ago.

After deciding to develop this system with agency resources, FAA should have kept abreast of the computer industry's progress and improvements in similar systems. With this information, and as new systems became commercially available, FAA could have reevaluated the need to develop the system with its own resources. Had this been done, FAA would have been better able to decide whether its system development effort should have been abandoned in favor of available commercial systems. Also, FAA should have prepared an economic analysis for comparing system development performance and costs against planned or anticipated performance and costs.

In 1968 FAA estimated that development of the data base management system would cost about \$360,000. By July 1969 a revised estimate indicated that the costs would about double, without appreciable changes in the scope of the project or the design effort. In June 1973, when FAA stopped recording development costs, nearly \$662,000 had been spent on the project. During fiscal year 1974 FAA estimated that \$23,000 was spent on what it termed "maintenance of the system." Future costs will depend on efforts needed to provide additional features, routines, and enhancements to improve system efficiency.

COMPREHENSIVE AIRMAN SYSTEM

"Airman" refers to all pilots, mechanics, navigators, and others that are required by law to be licensed by FAA. FAA maintains a great deal of information on each individual for administrative and evaluative purposes. Some of the information, for example, pertains to accidents, air or safety violations, individual certification histories, and individual medical histories. Presently, there are over 1,500,000 hard copy manually maintained records as well as numerous magnetic tape and microfilm records in 10 different systems used by the Center. During the past 10 years several unsuccessful attempts have been made to develop a single system that would consolidate this information. The comprehensive airman system is the latest attempt.

When initiating the design effort, FAA wanted to resolve several problems it was having with existing systems. The main problems concerned the medical certification system.

During 1970 the Center received about 70,000 inquiries for medical information. In many cases the inquiries pertained to documents recently received. Because of the slow processing of new data, followup action was needed before inquiries could be answered, and the workload increased accordingly. Even if a record was already in a computer file, approximately 24 hours were required to receive a reply because the limited availability of computer time necessitated night processing. This timelag caused the user to depend more on manual records. Extensive use of manual files not only duplicated recordkeeping but also contributed to other records management problems, such as misfiled, out-of-file, and lost records.

The principal effort for the airman system development was described in system concept and system description reports. As cited in these reports, the system's two main objectives were to enhance the operational aspects of the 10 existing systems and to develop a data base which would improve management access to information. Some steps to achieve those objectives were a more sophisticated and current data base, an improved input-update capability, and improved record quality. These steps were never quantified to state how much improvement was expected of the new consolidated system. The two reports recommended a system which would provide user access to and response from the computer through terminals located initially at the Center and later at other locations including FAA headquarters in Washington.

The system description report expanded the concept of the airman system and recommended using the general-use data base management system. However, the report contained no analysis of recurring reporting requirements nor an analysis of field organizations' procedures for preparing documents entering the systems. (Such analyses help eliminate unneeded reports and documents and tend to make the system more responsive to users.)

The head of the Center's Management Analysis Division disclosed weaknesses in the development effort to the Director of the Center in the following terms.

- No requirement for consolidating airman data had been established.
- No alternatives to the proposed on-line system had been developed.
- No visible benefits or savings had been demonstrated.
- Decisions were being made on the basis of subjective judgments only.
- The omission of a study of output requirements and field procedures from the system description package failed to assure management that the system would provide users with the information needed to manage their resources.

Nevertheless, the Center's Director wrote to FAA Washington officials, since they had final responsibility to approve systems development, that the Center agreed with the system concept. Thus, the Center supported a system that was based on studies that failed to clearly define information needs and alternatives for meeting these needs. In doing so, the Center did not follow the guidelines of the Office of Management and Budget which were established to minimize system development cycles and related development costs.

As a result, neither a documented study nor a cost-benefit analysis was required before the review board approved development of this system. In essence, the board authorized expenditures for implementing the system without (1) defined objectives, (2) identified and costed alternatives, (3) identified management information requirements, and (4) an in-depth study for streamlining or improving the 10 existing systems.

In 1971 the estimated cost for the complete implementation of the airman system was \$1.8 million. Although this estimate included the costs for special equipment to support the system, it excluded any costs applicable to the main computer. Through June 1974, FAA had spent \$2 million for system implementation--including special equipment--and estimated that an additional \$600,000 would be necessary to

complete implementation. This represents a total cost of about \$2.6 million, or about \$800,000 more than the 1971 estimate.

LOGISTICS INFORMATION SYSTEM

FAA envisioned the logistics information system as an integrated system encompassing all facets of logistics support, from funding to the disposition of supplies and services. This system was conceived to exploit the unused capacity and capability of the new large-scale computer equipment being acquired by the Center. A 1970 FAA report set forth the changes that could be made in the existing supply system during the conversion to this new equipment. This report was adopted, and in June 1971 the Center advised FAA Washington headquarters that it was going to begin developing this system.

The development team decided that an on-line automated system with a common data base would best serve FAA needs. This decision was reached without making any feasibility study or survey to determine the objectives and needs in the supply area, without considering alternatives for meeting the Center's objectives and needs, and without making any cost-benefit analysis before or during the development effort.

Development was halted in late 1972 after \$118,000 had been spent on such efforts as determining what data should be included in the system. FAA stated that personnel restrictions caused the termination. It was estimated that an additional \$318,000 would be required to complete this phase of the development. Center officials did not know if or when development would be resumed.

This is another example of the Center's not following the sound management practice of determining needs, considering alternative methods to fulfill those needs, and then proceeding with system development within a disciplined environment of objectives and timeframes with corresponding milestone measurements. As discussed below, these factors also contributed to the premature acquisition of equipment.

PREMATURE ACQUISITION OF EQUIPMENT

In July 1971 and June 1972 FAA purchased and installed two computers and related peripheral equipment at a cost of about \$3.1 million to support the previously described systems. Its primary justification, stated in a capability study, was that the existing computer equipment was not able to handle the expected workload growth of existing and proposed systems. However, FAA had not critically reviewed and analyzed the existing computer workload to determine if each of its processes was needed and designed to operate effectively and economically. (Development of the systems previously discussed in this report also was not preceded by a workload assessment.)

A critical review of agency requirements may identify instances when data processing applications no longer respond to a current information need and should be eliminated, or it may identify systems which should be streamlined for more efficient data processing. For example, computer-processing time for the Accident/Incident/Violation Analysis increased 305 percent over a 4-year period because, although the volume of data processed into the computer each year had not increased, the files were never purged. If the older records had been placed in an inactive file or retained in some other media, processing time could have been reduced.

The capability study also stated that two computer systems were needed to provide adequate backup for teleprocessing activities. Although some form of backup capability is desirable to insure continued operations of essential activities, the study did not indicate the consequences of a system failure, nor did it consider any alternatives to acquiring a second computer--costing \$1.5 million--to provide a full backup capability and full system operation. FAA management should have considered backup alternatives, such as arranging to have some other computer installation with similar equipment process critical workloads in the event of serious disruption to the Center's processing capability. Such an arrangement might be possible with another Government agency or by contract with a commercial firm. In devising a backup plan, FAA should weigh costs against the consequences.

A common indicator of performance at an automatic data processing installation is the utilization of the central processing unit. Utilization is the ratio of time units that the central processing unit is working to the total time units that it has available to work. A recent Government-sponsored study shows that, if central processing unit utilization exceeds 70 percent, it is a prima facie assumption that operations are reasonably efficient; conversely, if utilization falls below 30 percent, the assumption is that operations are inefficient.

We computed the central processing unit utilization for the two computers at the Center for a 6-month period ending 17 months after the installation of the first computer. (The second computer was installed 1 year after the first.) The computation showed the combined central processing work utilization to be 7.3 percent for all work categories, including program testing. Thus, the two computers were not being utilized effectively from 6 to 17 months after installation.

Also, at the time of FAA's \$3.1 million equipment acquisition, the Office of Management and Budget required a readiness review before equipment acquisition to insure that a reasonable amount of productive work could be placed on the computer immediately after installation. FAA did not conduct such a review, since its officials knew that the computers would be primarily used for the systems discussed in this report and believed, therefore, that such a review was not needed. The Office of Management and Budget did not offer any comments on FAA's failure to follow its requirement to perform a readiness study.

IMPROVEMENTS NECESSARY IN THE CONTROL OF PROJECT COSTS

Targets for costs and for completion dates of phases of development are one of the management control features used in data processing systems development. During development actual costs should be recorded by specific tasks and phases. As the target dates arrive or the tasks are completed or delayed, comparisons should be made between estimated and actual accomplishments and costs. A corresponding evaluation of deviations should then be provided to top management. This evaluation informs management whether systems should be continued, revised, or terminated. Without such information

management control is incomplete and continued changes can be made to the system without management awareness. This may result in prolonged development cycles, extensive cost growth (actual cost exceeding estimated costs), and deficient system performance.

FAA did not adequately control costs in the systems developments discussed in this report. While most projects had initial estimates for development costs, these costs were not supported by detailed studies nor were scheduled review dates established. Furthermore, FAA did not record actual costs by project. Although the FAA accounting system records costs by operational appropriation--personnel, travel, etc.--it does not detail these costs enough to insure that total project costs were identifiable. For example, costs applicable to personnel at the regional offices that were involved in the development of the manpower and personnel information system were not identified with that project. These costs were lumped with other regional office costs. Another example was the costs associated with computer programmers at the Center. These costs were primarily apportioned to projects as part of the general costs of operating the data processing facility; they were not allocated to specific projects.

Although the projects discussed in this report were not charged for all applicable costs, they experienced cost growth as well as prolonged development cycles. For example, in 1968 the data base management system was estimated to cost \$360,000. Costs incurred through June 1974 approached \$700,000. Similarly, the manpower and personnel system was estimated to cost \$318,000 in 1968; however, FAA estimated that, as of June 1974, over \$1.9 million had been spent on it and the system was not yet operational even though it had been initiated in 1965--a development period of 9 years. This prolonged development cycle can be blamed, in part, on FAA's failure to establish cost goals and specific milestones for reviewing the progress of systems development.

Had FAA established such checkpoints, the prolonged and costly development cycles would have been visible to top management. By evaluating the reasons for lack of progress, top management would be better able to decide whether to continue development, revise the approach, or terminate

development. Also, unless top management has the means to compare expected development costs to expected benefits, either of which may change during a prolonged development cycle, it will have no assurance that the system will be cost beneficial.

CHAPTER 3

CONCLUSIONS, RECOMMENDATIONS, AGENCY

COMMENTS, AND OUR EVALUATION

CONCLUSIONS

FAA needs to improve its planning and management of the approval and development of automated data processing systems and of the justification and acquisition of automatic data processing equipment. FAA approved the design and development of several systems without conducting studies detailed enough to determine and document specific management needs, without comparing alternative ways to meet their information needs, and without performing cost-benefit analyses. As a result, expenditures are being made for systems which FAA has not shown to be necessary and cost effective.

FAA management has apparently viewed the development of these systems as technical matters not requiring its attention; however, management must always be involved in the allocation and control of its resources. These systems involve not only time, money, and personnel but also the resource of management information.

FAA's failure to follow good management practices has resulted in prolonged systems development, as seen in the manpower and personnel information system and the data base management system. The absence of cost-benefit analyses has precluded any cost-effectiveness comparisons of these systems with needs and existing systems. Also, the premature acquisition of computer equipment has resulted in the unnecessary expenditure of Government resources.

In addition, FAA has not closely monitored the costs of developing its systems and has experienced significant cost overruns to the extent that the expected completion cost for at least one system is now six times the original estimate. Because FAA's accounting system does not accumulate and record all in-house development costs, FAA cannot rely on recorded development cost, when compared with initial estimates, to determine whether proposed systems are meeting

predetermined objectives and milestones or whether systems are cost effective. Thus, FAA lacks an important form of management control over its data processing resources.

RECOMMENDATIONS

We recommend that, to provide for more orderly development of automated data processing systems and systematic assessment of agency needs, the Secretary of Transportation direct the Administrator, FAA, to establish procedures for (1) systematically and periodically evaluating the need for proposed systems, (2) validating estimated development costs and the value of any expected benefits, and (3) arriving at more realistic development costs through cost-finding techniques or accounting system improvements.

Since FAA currently has systems under development for which feasibility or need has not adequately been established, we also recommend that the Secretary of Transportation have the Administrator:

--Reevaluate these systems to (1) state the specific benefits expected from each, (2) identify and document how each project under development will help the agency to perform its functions, (3) cost out alternatives so that the most economical means of meeting its information needs can be identified and pursued, and (4) terminate further development effort if the project no longer meets user needs.

--Reevaluate the needs for computer equipment, even if this means releasing some computer equipment.

AGENCY COMMENTS AND OUR EVALUATION

On behalf of the Secretary of Agriculture, the Director, Office of Automated Data Systems, said that our findings, as they related to the Department of Agriculture, were accurate. (See app. I.)

The Assistant Secretary for Administration, Department of Transportation, told us that FAA generally agreed with our recommendations. (See app. II.) He stated that many of our recommended actions have been incorporated into current FAA procedures or into parts of the overall management system under development.

Although the Assistant Secretary agreed that none of the systems discussed in this review were completely operational, he said that, except for the terminated logistical system, a partial interim operation had been achieved with each of the others. We agree that FAA has achieved partial interim operation on some of the systems but still believe that FAA has experienced exceptionally prolonged system development efforts. For example, the manpower and personnel information system will take at least 10 years to develop, and the airman system will take more than 4 years.

The Assistant Secretary stated that FAA decisions on the design and development of the Manpower and Personnel Information System had been based on system objectives and accompanying costs estimates. Also, the design and development effort continuously considered management requirements through system managers, who were established in each region, center, and in Washington, and always kept paramount the needs of the ultimate customer, line management officials.

Our review showed that FAA's approval to proceed with the design of this system was based on a contractor's report which was primarily concerned with establishing the feasibility of a specific system design that would improve the existing deficiencies in FAA's personnel operations. These deficiencies resulted from the absence of an information system framework and from the difficulty of tracing management's information requirements. Although the report specified information to be included in subsystems recommended for automation, it failed to include statements on (1) management information requirements and manpower and personnel objectives requiring support and (2) how the system would help FAA accomplish its program. Thus, while FAA said that it has been continuously concerned with management requirements and system objectives during system design and development, its decision to commence design of this system was made without clearly identifying such requirements and objectives.

Also, the Assistant Secretary stated that virtually all of the objectives and goals of the approved Comprehensive Airman Information System were sufficiently concrete to permit attainment verification. For example, elimination of the several redundant paper files was a goal of the system that has been realized. He also said a summary cost-benefit analysis was presented to top management which indicated that operational savings would be realized but that such savings would not offset project costs; therefore, management was required to make a subjective judgment.

Our review disclosed that the documented studies that normally precede system design and development were not prepared, because such studies would be considered redundant since the FAA personnel involved in the design of the system were familiar with the existing systems and the related problems. Although the Assistant Secretary stated that all objectives and goals were sufficiently concrete to permit objective verification, such objectives and goals did not specifically relate to how FAA operations would be improved. Also, the cost-benefit analysis presented to top management was not formalized and did not consider alternatives.

The Assistant Secretary said that management approval for in-house development of the data base system was obtained when the manpower and personnel information system development was approved and that the data base system design had not been significantly altered. He agreed that management should have been advised of the revised estimated development costs.

Although FAA approved the use of a data base system when in-house development of the manpower and personnel system was authorized, this approval was not for a general-use data base system. When FAA decided to expand this system's use to other FAA uses, top agency officials considered the decision to be a technical matter not requiring their approval, even though such action would double costs and system design and development would take an additional 34 months without any requirements or expected benefits being identified.

The Assistant Secretary also said the FAA decision to develop the general-use data base system was subsequent to a comparison of the features and capabilities of 10 of the best

systems available commercially. He said this comparison was more extensive than our report implied. Most of the commercial systems had limited security safeguards, limited data retrieval, and only provided limited data base maintenance and update capabilities; five of these systems have subsequently been abandoned by their developers.

The FAA analysis was primarily based on a study conducted for a Department of Defense agency; however, there was at least one other study conducted within the Department of Defense which would have given FAA useful information. In May 1969, prior to FAA's decision, another study which considered 18 data base management systems--9 of which FAA included in its analysis--was issued and could have been used by FAA. The highest rated system in this study was not considered for use by the Aeronautical Center; however, it was selected in 1972 for use on the same computers by the FAA National Flight Data Center. This same system could have satisfied the Aeronautical Center's stated requirements and could have provided an operational system at a lower cost. Thus, FAA's comparison was neither documented nor sufficiently comprehensive, and FAA did not periodically reevaluate its decision. Also, the FAA decision was based on a study of representative data management systems that was not intended to be a complete representation or description of the state-of-the-art.

The Assistant Secretary also stated that our quantitative analysis of computer utilization does not reflect normal operations. Our analysis was performed over a 6-month period when FAA was engaged in extensive file and program loading in order to make the systems fully operational on the new computers. Since this startup period, central processing utilization has been measured at 55 and 62 percent, respectively, for the two computers.

As indicated in our report, the central processing utilization was measured over a 6-month period which ended 17 months after installation of the first computer and 6 months after the second computer was installed. This analysis was based on FAA computer utilization reports that showed FAA did not have any large amount of utilization, because the computer programs had not been developed. FAA procured these two computers prematurely, long before they were ready

or capable of using them. Thus, we agree with FAA that they were not operated under normal conditions. However, they should not have acquired \$3.1 million in computer equipment until FAA was ready to operate them productively.

The Assistant Secretary stated that FAA found many of our recommended actions paralleled those that had either existed for some time or were integral parts of the overall management system under development. To strengthen control over the system development cycle, FAA has initiated actions to revise or develop policy precedural directives which provide for

- specifically involving management in information system and automatic data processing decisionmaking on a systematic basis;
- improving content standards for feasibility studies, system specifications, and other documents by defining functional requirements, examining alternative solutions to problems, and analyzing cost-benefits as a basis for management decisions;
- developing and maintaining longer range integrated plans for the development of information systems and the acquisition, use, and release of automatic data processing equipment;
- quantifying evaluation of alternative actions for several important system development efforts, including the Manpower and Personnel Information System and the Comprehensive Airman Information System;
- making a functional and quantitative comparison of several data base management systems to systems in use by FAA; and
- implementing continuous reevaluation efforts to determine continuing needs and benefits for both current and future development projects.

The proposed FAA actions are consistent with our recommendations and should improve planning and management control if properly implemented.

UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20250

Office of Automated Data Systems

February 14, 1975

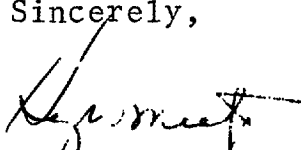
Mr. Henry Eschwege
Director
Resources and Economic
Development Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

The Department of Agriculture has reviewed your draft report to Congress on the Need for Improved Planning and Management of Information Systems Development, Federal Aviation Administration. That particular portion of the report which is attributed to the Department is shown on page 16 and is accurate as stated.

If you wish any additional information, please feel free to contact me.

Sincerely,


HENRY W. MEETZE
Director



OFFICE OF THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

ASSISTANT SECRETARY
FOR ADMINISTRATION

April 7, 1975

Mr. Henry Eschwege
Director
Resources and Economic Development
Division
U. S. General Accounting Office
Washington, D. C. 20548

Dear Mr. Eschwege:

This is in response to your letter of January 31, 1975, requesting our comments on the General Accounting Office (GAO) report on need for improved planning and management of information systems development in the Federal Aviation Administration (FAA).

The GAO report indicates that the FAA was experiencing considerable difficulty in developing and implementing four information systems. GAO recommends that the Federal Aviation Administrator (1) establish procedures for systematic/periodic evaluation of the need for systems proposed or under development, including the validation of estimated development costs and value of expected benefits, (2) reevaluate those systems under development for which feasibility or need was not adequately established to determine continuing need/benefits expected, and terminate further development of those systems not meeting current user needs, and (3) reevaluate the need for computer equipment with intent of increased utilization even if this requires the release of some equipment at the present time.

FAA generally agrees with the GAO recommendations. However, many of the recommended actions parallel those that the FAA has either been doing for some time or are integral parts of the overall management system which is under development. These actions are explained in detail in the enclosed Departmental reply.

I have enclosed two copies of the Department's reply.

Sincerely,

Handwritten signature of William S. Heffelfinger in black ink.

William S. Heffelfinger

Enclosure
(two copies)

DEPARTMENT OF TRANSPORTATION REPLY
TO
GAO DRAFT REPORT OF JANUARY 1975
ON
NEED FOR IMPROVED PLANNING AND MANAGEMENT
OF INFORMATION SYSTEMS DEVELOPMENT

SUMMARY OF GAO FINDINGS AND RECOMMENDATIONS

The General Accounting Office (GAO) review indicates that the Federal Aviation Administration (FAA) was experiencing considerable difficulty in developing/implementing (1) a standard automated personnel system initiated in 1965 to centralize the personnel function, (2) a general purpose data base management system initiated in 1968, (3) an airman information system initiated in 1971, and (4) an improved logistics information system initiated in 1970, but later terminated in 1972. The GAO reports that despite the fact that FAA had spent about \$7.7 million to develop these systems and acquire the large scale computers required, none were operational at the completion of their review in March 1974.

The GAO states that the FAA had approved the design/development of these systems without clearly defining their objectives, and had committed substantial resources to this effort without adequately quantifying expected benefits, determining the user's requirements, nor costing out alternative courses of action. As a result, there was a prolonged system development effort that was unable to satisfy the demands placed upon it. The GAO also states that, in at least one instance, FAA spent considerable time/money to develop a system when similar systems were available commercially.

The GAO recommends that the Administrator of FAA (1) establish procedures for systematic/periodic evaluation of the need for systems proposed or under development, including the validation of estimated development costs and value of expected benefits, (2) reevaluate those systems under development for which feasibility or need was not adequately established to determine continuing need/benefits expected, and terminate further development of those systems not meeting current user needs, and (3) reevaluate the need for computer equipment with intent of increased utilization even if this requires the release of some equipment at the present time.

SUMMARY OF DEPARTMENT OF TRANSPORTATION POSITION

We generally agree with the GAO recommendations, however, many of the recommended actions parallel those that the FAA has either been doing for some time or are integral parts of the overall management system

which is under development. Some of the conclusions/findings are correct and pertinent; others, however, reflect misunderstandings that should be clarified prior to issuance of the final report as discussed under the General Comments section below. In addition, some of the conclusions apparently are based on actions possible under the present state of the art, but not feasible at the time agency management made the decisions to initiate these actions. It is not our intent to provide point by point acceptance of the GAO findings/conclusions, but rather we shall focus on the specific recommendations, commenting on related findings/conclusions only to illustrate the basis for the agency position.

1. The FAA has initiated actions to revise and/or develop policy/procedural directives to improve management control by providing for:
 - a. Specifically involving management in information system and automatic data processing (ADP) decision-making on a systematic and regular basis. This will be related to requirements for regular reporting to management of work performance in terms of costs, schedules, results and problems.
 - b. More definitive standards as to the required contents of documents such as feasibility studies, system specifications, etc. These standards specifically call for defining functional requirements, examining alternative solutions to the problem, and analyzing cost/benefits as a basis for management decision.
 - c. Developing and maintaining longer range and better integrated plans for the development of information systems and the acquisition, use, and release of ADP equipment. In this connection, we have and are enlisting independent contractual assistance to assess information system/equipment requirements, and to develop alternative system development/equipment acquisition concepts and strategies. This kind of integrated planning is, we believe, exceedingly important in an environment where several systems are under development at one time, each requiring equipment support from various shared and independently used computer, peripheral, telecommunication, and data entry equipments/facilities.
2. During the last two years we have initiated studies designed specifically to examine system-related efforts and to quantify alternative courses of action as follows:
 - a. The Federal Computer Simulation Center (FEDSIM) has been evaluating several significant system development efforts including the Manpower and Personnel Information System (MPIS)

and the Comprehensive Airman Information System (CAIS) in order to provide us quantified information on alternative development approaches and the most equipment-efficient ways to structure systems.

- b. The National Bureau of Standards (NBS) is making comparisons between four data base management systems in both functional and quantitative terms. Unfortunately, as a single agency we can only make a limited beginning on assessing the whole range of data base management systems. This effort compares systems in use in FAA today with two other widely used systems. However, we believe there is a government-wide problem that can best be solved on a government-wide basis. The NBS study referred to above will give FAA insight on a few systems. It will not give us systematic information on many other data management systems that are available today. Such a study is well beyond FAA's resources. Virtually all government agencies are in a similar situation. We believe that a government-wide evaluation of the whole range of available data management systems would be of great value to all agencies and we would encourage the GAO to recommend such an evaluation by some organization acting for the government as a whole.
3. Regarding continuous reevaluation efforts to determine continuing need/benefits, such evaluations are an integral part of the management control processes now being installed in FAA. Further, FAA has underway or planned for the near future such evaluations as a part of each significant development project now underway. For example, the previously referenced reassessment of the further development of the CAIS will give management an opportunity to decide among alternative courses of action based on cost/benefit analyses of these alternatives. Other systems under development which will be subjected to management review and decision on costs/benefits, alternatives, etc. during the next few months include the new Aircraft Registry System, the Uniform Accounting System, the Uniform Payroll System, and the FAA Aircraft Program Management System.
4. Regarding the reevaluation of computer equipment needs, FAA employed the services of FEDSIM early in 1974 and is continuing to use them to analyze the performance/use of the two computers mentioned in the GAO report to determine ways of increasing the efficiency/effectiveness of the overall computer facilities. FEDSIM findings show very high utilization of both computers. The FEDSIM simulation models will be used in the future to assess the impact of new and revised systems on computer capacity and efficiency.

GENERAL COMMENTS

We feel there are misleading statements contained in the draft report which should be corrected prior to its issuance as discussed below.

1. The GAO indicates that none of the systems it reviewed were operational at the completion of their audit in March 1974. (Pages 1 and 6)

While it is true that none of the systems were completely operational, some were partially in operation. The user request language data base system was operational in July 1972, with an interim communications interface. The interim airman portion of the CAIS has been operational since August 1973. Also, the training subsystem of the MPIS became operational in September 1974, subsequent to completion of the GAO audit.

2. The GAO indicates that the FAA approved the design and development of the MPIS without clearly identifying the objectives of the system, and determining users' requirements. (Pages 2 and 10)

This is not correct. System objectives were presented to management and the decision to proceed with system development was made in light of those objectives and accompanying cost estimates. From the very beginning of the development effort, system managers were established in each region, center, and in the Washington personnel operations organization. These people were regularly consulted during the design effort so that local management requirements would be continuously considered. In addition, all program segments of the agency were consulted periodically to define in greater detail their particular needs for a variety of information. Throughout the design and development of this system, the needs of the ultimate customer, line management officials, were kept paramount.

3. The GAO reported that FAA's decision in 1969 to develop the general use data base management system (DBMS) at an estimated cost to exceed \$700,000 was not submitted to top management for approval, and that the capabilities of commercially available DBMS systems were not assessed. (Page 3)

Regarding the first point, agency management approved the in-house development of DBMS when they approved the MPIS development. The DBMS design was not significantly altered after management approval was obtained. However, management should have been advised of the revised estimated development cost.

GAO note: Page references in this appendix refer to our draft report and may not correspond to the pages of this final report.

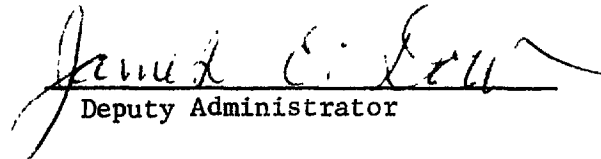
With regard to the second point, FAA did make a study to determine whether existing DBMSs were commercially available at the time the proposal was being considered for in-house development of a DBMS. The features/capabilities of ten data base or information management systems, supposedly the best in the market place at that time were analyzed before the decision was made to develop a new DBMS. This comparison was more extensive than the report implies. Based on our analysis, none of the ten DBMSs provided all the features required by MPIS. Most DBMSs at that time had limited security safeguards and only provided either immediate retrieval with very limited data base maintenance, or immediate update with very limited/slow data retrieval. Of the ten systems originally analyzed, five have since been abandoned by their developers.

4. The GAO states that the development of the CAIS was authorized without defining specific objectives or establishing quantifiable goals, and that a cost/benefit analysis was not required before this system was approved by the Review Board. (Pages 4 and 20)

The implications of these conclusions are incorrect. Virtually all of the objectives and goals of the approved system were sufficiently concrete as to permit objective verification of their attainment. For example, elimination of the several, redundant paper files in favor of on-line access to computerized records was the goal in one subsystem. Today, the paper files in question have been eliminated and on-line access to computerized records is an operating reality. In addition, a summary of the cost/benefit analysis was prepared and presented to the Review Board. The analysis indicated that there would be operational savings, but that these savings would not offset the cost of the project in total. Therefore, management was asked to make a subjective judgment as to the value of the added safety-related management information capability as against a predicted cost increase for operations. Such a judgment is sometimes necessary and we believe an entirely proper management option.

5. The GAO states that its computation of the central processing unit utilization of the two computers at the Aeronautical Center was only 7.3 percent for all categories including program testing. GAO concludes that this low utilization indicates the computers were installed before the Center was ready to make reasonable use of them. (Pages 24 and 25)

The GAO's quantitative assessment of computer utilization reflected in this report is based on incomplete data at a point in time not reflective of normal operations. At the time, FAA was engaged in extensive work related to loading files and programs in order to make systems fully operational in the new equipment. At such times, the central processing unit is likely to be utilized at a low rate, and input/output operations are likely to represent a very heavy workload. The total elapsed time when the computer was being utilized for all purposes was several times the 7.3 percent figure cited by the GAO. Computer operations shifted from the initial "start-up" mode to normal operations shortly after the time cited in the report. Subsequently, the FEDSIM measured the total system utilization of the two systems to be averaging between 85 and 99 percent, while the central processing unit use was 55 and 62 percent respectively for Systems I and II.


Deputy Administrator

PRINCIPAL OFFICIALS
RESPONSIBLE FOR ADMINISTERING ACTIVITIES
DISCUSSED IN THIS REPORT

Tenure of office
From To

DEPARTMENT OF TRANSPORTATION

SECRETARY OF TRANSPORTATION:

William T. Coleman, Jr.	Mar. 1975	Present
Claude S. Brinegar	Feb. 1973	Feb. 1975
John A. Volpe	Jan. 1969	Feb. 1973
Alan S. Boyd	Jan. 1967	Dec. 1968

FEDERAL AVIATION ADMINISTRATION:

James E. Dow	Apr. 1975	Present
Alexander P. Butterfield	Mar. 1973	Mar. 1975
John H. Shaffer	Mar. 1969	Mar. 1973
David D. Thomas (acting)	Aug. 1968	Mar. 1969
Gen. William F. McKee	July 1965	July 1968

DIRECTOR, AERONAUTICAL CENTER:

Thomas J. Creswell	Sept. 1973	Present
Alfred L. Coulter	Aug. 1970	Sept. 1973
Christopher B. Walk, Jr. (acting)	Mar. 1970	Aug. 1970
W. Lloyd Lanes	Oct. 1965	Mar. 1970

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