BY THE COMPTROLLER GENERAL

Report To The Chairman, Committee On Appropriations House Of Representatives

OF THE UNITED STATES

Conversion: A Costly, Disruptive Process That Must Be Considered When Buying Computers

Federal agencies have invested billions in computer programs. When an agency outgrows its present computer, the computer must be replaced. If the agency simply buys a larger computer from its present supplier, competition is denied. If there is a competitive procurement--and a new supplier is selected--the agency may face the complex job of converting its present programs to work on the new computer. How does one weigh the tradeoffs?

GAO studied six computer procurements and found inconsistencies in what conversion costs had been included in evaluating competing vendor proposals, gross underestimates of these costs, and problems in managing a conversion. Considering conversion costs would not necessarily eliminate competition and in fact should provide greater assurance that a lower total cost would result.

The General Services Administration should issue guidance on the treatment of conversion costs and develop technical guidelines to help agencies avoid problems.

FGMSD-80-35
JUNE 3, 1980

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

B-197681

The Honorable Jamie Whitten
Chairman, Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

The Honorable George Mahon, then Chairman of your Committee, wrote us on October 5, 1978, expressing views on some matters concerning automatic data processing system acquisitions and costing.

We had planned an assignment dealing with many of these matters, and on August 8, 1979, we briefed Committee staff members on our findings to that date. They requested that we complete our assignment in time for the next cycle of appropriations hearings. To be responsive to that request, we issued a letter report (FGMSD-80-34, Feb. 15, 1980) summarizing our findings and established our position on the treatment of conversion costs in evaluating competing vendor proposals. We promised that at a later date a more detailed version would be distributed to agencies that could act on our findings.

This report covers our work in this area. We did not obtain official comments from the agencies visited or from the General Services Administration. We discussed our position with General Services officials concerning the proposed changes to the procurement regulations dealing with treatment of conversion costs in evaluating vendor proposals.

We will be in touch with your office regarding distribution of this report.

Sincerely yours,

Comptroller General
of the United States

COMPTROLLER GENERAL'S REPORT
TO THE COMMITTEE
ON APPROPRIATIONS
HOUSE OF REPRESENTATIVES

CONVERSION: A COSTLY, DISRUPTIVE PROCESS THAT MUST BE CONSIDERED WHEN BUYING COMPUTERS

D I G E S T

Federal procurement policy requires, to the extent practicable, competitive acquisition of needed goods and services. The objectives of the procurement process are to obtain the best prices for goods and services and give all responsible vendors an opportunity to compete for the business. However, the process for acquiring computers has been complicated by (1) the lack of clear and concise procurement policy on the treatment of conversion costs in evaluating vendor proposals and (2) difficulties in estimating these costs.

When an agency's computer system is no longer adequate or will not be able to meet future needs, it must be replaced. This presents immediate problems.

--If the agency buys a larger, compatible computer from the same manufacturer on a sole source basis, other manufacturers are denied an opportunity to compete.

--On the other hand, if competition is held, the agency may face substantial effort, high costs, and operational disruption to convert its application software and change over to the new equipment.

Because the Government tries for fairness and competition in procurement, conversion from one manufacturer's equipment to another's often takes place. Sometimes conversion is more economical because the competitive process may bring hardware and other costs down from what might be paid on a sole source basis.

However, procurement from a different manufacturer at what appears to be a cheaper price can cause an agency to incur certain hidden costs in the conversion process that can result in a higher total (life cycle) cost.

Conversion costs can vary greatly, depending on the complexity and condition of an agency's application programs and the characteristics of the new hardware. In addition to incurring software conversion costs, an agency can spend substantial amounts to retrain its personnel, operate both the old and new computers during the conversion, and modify the computer facility to house both the old and new computers during this period. By staying within the incumbent vendor's product line or acquiring compatible computer equipment, an agency can avoid most of these conversion costs.

Would including conversion costs in computer procurements result in selecting the system that would cost the Government the least over the life of the system?

INCONSISTENCIES AND POOR ESTIMATING

GAO examined six competitive computer procurements involving conversions and concluded that even though conversion costs are frequently substantial, changing to a different brand can be less costly on a life cycle basis. Conversion costs considered in the six competitive procurements varied significantly from case to case, and each installation had underestimated the cost and time necessary to convert its application software to the replacement system. The potential costs are considerable because millions of dollars of conversion costs may be incurred at a single installation and the Government has hundreds of installations.

GAO adjusted the costs used in selecting the winning vendors by including appropriate conversion costs and correcting for significant underestimates. GAO found that:

--In two cases, the procurement decisions would have been different and the incumbent vendors would have been selected.

--In one case the same nonincumbent vendor would have been selected because it offered a lower price despite including conversion costs in the selection of the lowest cost alternative.

--In three cases the same nonincumbents would have been selected because the incumbent vendors either had declined to submit proposals, were no longer manufacturing computer equipment, or had been disqualified from the competition. In one of the cases when the incumbent vendor did not submit a proposal, the agency may have decided not to convert had better, more accurate conversion cost estimates been made. (See p. 5.)

A primary cause of the poor conversion cost estimating is that adequate data has not been collected on the experiences of installations that have converted. At any single installation, a conversion might occur only once in 8 years. The personnel who took part in one conversion may not be around for the next, and adequate conversion cost data may not have been collected. GAO estimates that if better, more accurate conversion cost estimates had been made, about $5.1 million could have been saved in the six procurements reviewed. (See p. 9.)

GSA GUIDANCE NEEDED

The problems GAO found point out the need for (1) guidance to agencies as to what conversion costs should be considered in evaluating vendor proposals and (2) better conversion cost estimating techniques. The General Services Administration's recent efforts to clarify this situation represent a big step forward. It has drafted regulations calling for consistent treatment of conversion costs in evaluating proposals. These draft regulations should provide for consistent treatment of conversion costs. Also, the agency has announced the establishment of the Federal Conversion Support Center which, if properly staffed and operated, will, by providing technical guidance, help agencies make better cost estimates and improve conversion management. (See pp. 8 and 14.)

PLANNING IS CRITICAL

Managing conversion is difficult because most data processing professionals are not accustomed to conversion work. Furthermore, it is

viewed essentially as nonproductive and involves many interrelated tasks.

A conversion must be carefully planned and controlled to minimize costs and disruption to the organization. In most cases GAO reviewed, the lack of adequate planning contributed to the disruption and higher costs. (See app. II.)

To avoid these problems, an agency must carefully develop a conversion strategy and plan before initiating procurement action for a replacement computer. The strategy should permit a cost effective transition. The plan should identify resources needed to do specific conversion tasks and define measurable milestones for each task.

The Navy has developed a project management and control system to estimate the time and programmer resources needed to accomplish a software conversion and to track the conversion project's progress. The system could be adapted for Government-wide use. (See pp. 15 and 17.)

Agency management can reduce conversion costs and disruption by placing greater emphasis on developing better quality application software in the first place. Even so, an agency can still incur substantial conversion costs because of the complexity of many data processing systems. (See p. 20.)

GAO's suggestions about actions Federal agency management can take to ease conversion are set forth on page 25.

RECOMMENDATIONS

To improve the acquisition and management of data processing resources, the Administrator of General Services should:

--Issue, for agency guidance, the provisions contained in the draft regulations covering treatment of conversion costs in evaluating competing vendor proposals.

--Develop technical guidelines to help Federal agencies (1) determine conversion requirements, (2) plan for and manage conversion, (3) contract for conversion support services, and (4) evaluate life cycle costs of vendor proposals.

--Consider adapting for Government-wide use the Navy's project management and control system for estimating software conversion costs and managing conversions.

Contents

ABBREVIATIONS

ADP	automatic data processing
CROHMS	Columbia River Operational Hydromet Management System
DBMS	data base management system
DPA	delegation of procurement authority
EPA	Environmental Protection Agency
GAO	General Accounting Office
GSA	General Services Administration
IBM	International Business Machines Corporation
NBS	National Bureau of Standards
OMB	Office of Management and Budget
RCA	Radio Corporation of America
RFP	request for proposal
USDA	Department of Agriculture
VA	Veterans Administration

GLOSSARY

Application program	A set of instructions (called program statements or code) to do a specific job, such as payroll computation, inventory control, and accounting. It is also called application software.
Assembly language	A lower level computer language in which the programmer represents single machine language statements, or groups of them, by terse mnemonic codes. Programs written in assembly language typically can run only on the make of computer for which they were originally developed. It is also called assembler language.
Batch processing	A data processing technique in which jobs are collected and grouped before processing.
Benchmark	A user-witnessed processing of a group (mix) of application programs representative of the user's proposed computer system in order to validate system performance.
COBOL	(Common Business Oriented Language) A high level programming language originally developed around 1960 to provide an easily learned English-like language for business data processing applications. The latest revision is COBOL 74, a Federal standard.
Compiler	A computer program which translates high level programming language statements into a form that can directly activate the computer hardware.
Data base management system	A computer software package which can facilitate the management, manipulation, and control of data.
Emulation	A hardware and software technique used to execute programs developed for a different computer system.
FORTRAN	(FORmula TRANslator) A high level programming language used for computer programs which automate scientific or mathematical calculations.

Hardware	The physical equipment of a computer system; e.g., mechanical, magnetic, electrical, or electronic devices; contrasts with software.
High level language	A computer programming language which is independent of a particular computer's limitations. Such a language adapts the computer to the needs of the programmer.
Job control language	A computer language unique to each vendor's equipment that directs the operating system to reserve and use system resources, such as data files required for a particular job.
Main memory	The storage component that is considered integral, internal, and primary to the computer system.
Online processing	Pertains to fast response computer processing. It obtains data from an activity or a process; performs computations; and returns a response rapidly enough to control, direct, or influence the outcome of the activity or process.
Operating system	A group of computer programs that monitors and controls the operation of a computer system while the application programs are running.
PL/1	(Programming language one) A general purpose high level programming language which combines many features of earlier languages, such as COBOL and FORTRAN. It was designed to be suitable for either scientific or business applications.
Redesign	Change to application software that involves a change to the functional specifications for that software. The application software will provide new functions and capabilities; it is akin to new development.
Reprogramming	Any change to application software that conforms to the functional specifications for that software, but causes changes to the methodology/techniques for meeting functional requirements of the user. It is also called technical redesign and rewrite.

Software	A set of computer programs, procedures, and associated documentation concerned with operating a data processing system. Three categories of software are (1) application software, (2) operating system software, and (3) utility software.
Software conversion	The act of making computer programs run on a computer system other than the one for which they were originally devised. Software conversion can be accomplished by translation or reprogramming.
Software package	Software, in the form of a prepared "package," which is often sold by a vendor and which consists of the program(s) itself and documentation, such as flowcharts and users manuals.
Translation	A largely automated process of application software conversion in which the functional requirements and software design specifications are preserved. It is also called recoding when the process is largely manual.

CHAPTER 1

INTRODUCTION

Automatic data processing (ADP) has an enormous impact on the way the Federal Government conducts its operations. Computers and related resources, such as personnel, supplies, and communications, are now used extensively throughout the Government for highly complex applications--from payroll to energy, from space to weapon to weather systems. Over the years, the acquisition of hardware, software, and data has grown into a multibillion dollar investment. Many agencies would find it impractical, if not impossible, to accomplish their missions without computers.

In the early days of computers, the price of the equipment (hardware) was the major part of the cost. The programs (application software), which made the equipment operate, cost relatively little. However, the cost of the hardware has steadily declined due to technological advances while the cost of application software has increased. Today, the application software costs considerably more than the equipment in most systems.

WHEN IT'S TIME TO REPLACE A COMPUTER SYSTEM

When an agency's computer system is no longer adequate or will not be able to meet future needs, it must be replaced. This presents immediate problems. If the agency acquires a larger, compatible computer from the same manufacturer on a sole source basis, other manufacturers are denied an opportunity to compete. On the other hand, if competition is held, the agency may face substantial effort, high costs, and operational disruption to convert its application software and change over to the new equipment. Millions of dollars may be involved in this process at a single computer installation and the Government has hundreds of installations.

The Government tries for fairness and competition in procurement, and as a result conversion from one manufacturer's equipment to another's often takes place. Sometimes conversion is more economical because the competitive process may bring hardware (and other) costs down from what might be paid on a sole source basis. However, procurement from a different manufacturer, at what appears to be a cheaper price, can cause an agency to incur certain hidden costs in the conversion process that can result in a higher total cost. The proper recognition, consideration, and treatment of these costs is the subject of this report.

Problems of conversion

Conversion can cause both technical and managerial problems. Technical problems arise because of differences among hardware and system software products. Managerial problems arise because (1) most data processing professionals are not familiar with conversion, (2) conversion is viewed essentially as nonproductive, and (3) conversion involves many interdependent tasks.

Conversion costs can vary greatly, depending on the complexity and condition of an agency's application programs and the system characteristics of the new hardware. In addition to incurring software conversion costs, an agency can spend substantial amounts to (1) retrain its personnel on the new system, (2) operate both the old and new computers during conversion, and (3) modify the computer facility to house both the old and new computers during this period. By staying within the incumbent vendor's product line or acquiring compatible 1/ computer equipment, an agency can avoid most of these conversion costs.

Procurement problems arise because there are no clear guidelines to determine when and which conversion costs are to be considered in evaluating competing vendor proposals. Conversion presents a fundamental problem for the procurement process because it causes an apparent conflict between two goals--lowest total overall cost and free and open competition. How to treat conversion costs in the competitive procurement process has been under active consideration for some time. We learned, for several selected procurements, what costs had been considered in evaluating vendor proposals and what conversion costs had been incurred.

RESPONSIBILITY FOR FEDERAL ADP MANAGEMENT

The Brooks Act (Public Law 89-306), enacted in October 1965, provides for the economic and efficient purchase, lease, maintenance, operation, and use of ADP equipment. The responsibilities under the act are assigned to several agencies. The General Services Administration (GSA) is responsible for developing, implementing, and monitoring Government-wide policy for the acquisition, use, and management of ADP resources. The Department of Commerce, primarily through the National Bureau of Standards (NBS), is responsible for

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1/Several manufacturers offer computers which are compatible with various models of International Business Machines Corporation (IBM) equipment.

providing scientific and technological advisory services and for developing Federal Information Processing Standards. The Office of Management and Budget (OMB) is responsible for fiscal and policy control. In addition, each Federal agency has certain responsibilities for managing its own ADP resources.

CONCERN OF THE HOUSE APPROPRIATIONS COMMITTEE

The subject of computer acquisition costs--including life cycle costing, which looks at all costs related to a computer system over its life--has been a concern of the Committee for some time. The Chairman wrote to the Comptroller General on October 5, 1978, (see app. III) asking several questions about the area. He was particularly interested in knowing whether including conversion costs in computer procurements would result in selecting the system that would cost the Government the least over the life of the system; that is, not only the lowest hardware procurement cost, but also conversion, installation, operation, training, and other costs.

SCOPE OF REVIEW

We reviewed the legislative history of the Brooks Act, OMB circulars, GSA regulations and procedures, and NBS publications. We discussed the treatment of conversion costs in the ADP procurement process with staff members of the House Committees on Government Operations and Appropriations. We analyzed selected agency procedures pertaining to seven major ADP procurement actions. We interviewed officials of OMB, GSA, NBS, and 10 selected civil and defense agencies that have either completed conversions, are in the process of converting, or are planning to replace their computer equipment in the near future. We also talked with representatives of the computer industry and academia and researched computer industry trade journals, technical documents, and other publications.

CHAPTER 2

COSTS OF $5.1 MILLION MIGHT HAVE BEEN SAVED WITH BETTER PROCUREMENT PRACTICES

Federal procurement policy requires, to the extent practicable, competitive acquisition of needed goods and services. The objectives of the Federal procurement process are to obtain the best price for goods and services and give all responsible vendors an opportunity to compete for the business. However, the process for acquiring computers has been complicated by (1) the lack of clear and concise procurement policy on the treatment of conversion costs in evaluating vendor proposals and (2) difficulties in estimating these costs. For analytical purposes, each factor is discussed separately below, but in combination, these factors resulted in $5.1 million in avoidable cost in two of the six competitive procurements we studied.

When an agency needs to replace its ADP system, it may face a substantial effort, high costs, and operational disruption to convert its application software so that it will work on the new computer. Conversion problems can be reduced and savings achieved, given

--regulations which provide a structure for consistent treatment of conversion costs in evaluating vendor proposals and

--technical guidance as to how best to plan for (including cost estimation) and manage conversion.

This chapter summarizes the six competitive procurements studied, discusses the inconsistent treatment of conversion costs by agencies in evaluating proposals for replacement computers, and suggests a solution. The following chapter covers a related matter, that better ADP management can reduce conversion problems. These matters are closely related because once a consistent approach is taken in evaluating vendor proposals, accurately estimating conversion costs and managing the conversion to keep costs within those estimates becomes critical to the success of the transition to the new computer system.

We reviewed six competitive procurements in which the replacement computers were from different manufacturers, as shown in the table below.

Agency	Manufacturer of Existing equipment	Replacement equipment
Department of Energy	Control Data Corporation	Univac
Environmental Protection Agency (EPA)	IBM	Univac
Department of the Navy	Radio Corporation of America, IBM	Univac
Department of Agriculture (USDA) (two cases)	IBM, Burroughs	Honeywell
	IBM	Honeywell
Veterans Administration (VA)	IBM	Honeywell

We adjusted the costs used in selecting the winning vendor by including conversion costs we believe should have been considered and correcting for significant underestimates.

--In two cases the procurement decisions would have been different and the incumbent vendors would have been selected.

--In one case the same nonincumbent vendor would have been selected because it offered a lower price despite inclusion of conversion costs in the selection of the lowest cost alternative.

--In three cases the same nonincumbent vendors would have been selected because the incumbent vendors either declined to submit proposals, were no longer manufacturing computer equipment, or had been disqualified from the competition. In one of the cases when the incumbent vendor did not submit a proposal, the agency may well have decided not to convert had better, more accurate conversion cost estimates been made.

Details of these differences are not shown because vendors' proprietary rights to the data prevent us from disclosing the amounts of unsuccessful proposals.

We believe that these cases illustrate that consistent consideration of appropriate conversion costs in evaluating vendor proposals would not necessarily result in eliminating competition, but would result in more cost effective decisions. (App. II summarizes the procurement actions and describes how conversion costs affected the selection of the winning vendors in the six procurements.)

NOT ALL CONVERSION COSTS WERE CONSIDERED

Federal agencies have taken different approaches to the treatment of conversion costs in evaluating vendor proposals. Some have considered most conversion costs which would be encountered (but underestimated them), while others have included only a few. The table below shows the conversion factors that were considered in the procurements we analyzed.

Factor	Energy	EPA	Navy	USDA (note a)	VA
Site modification/ installation (note b)	Yes	Yes	Yes	Yes	Yes
Software conversion	Yes	Yes	No	Yes (note b)	No
Dual equipment operations	No	Yes (note b)	No	No	No
Training:					
Tuition	Yes	Yes	Yes	Yes	Yes
Salaries and other	No	No	No	No	No

a/The cost factors for both USDA procurements were identical.

b/Not all costs were considered.

Software conversion costs were considered in four of the procurements, but were underestimated, or some application programs that had to be converted were excluded from consideration, or both. Some installation/site modification costs were considered in each procurement, but none included all cost elements.

Dual equipment operation costs were included in only one procurement, but even in this case, they were underestimated because the software conversion took longer than expected. In addition, not all cost elements, such as power and cooling, were included. All agencies included the cost of vendor-provided training (i.e., tuition), but none included the salaries of personnel attending classes or their travel and other training support costs.

Besides analyzing the six cases in detail, we analyzed several solicitation documents (requests for proposal (RFPs)) for other procurements to ascertain how conversion had been treated. Some agencies addressed conversion under the "desirable feature" category. (See p. 31.) For example, if a vendor could provide conversion and/or emulation aids, the

agency estimated it would be worth $100,000 for that support. Other agencies required conversion of existing application software. One agency estimated an amount for conversion ($1,254,415) and specified that existing programs must be converted on a line-by-line basis and be completed within 11 months after contract award or 30 days after the system had been accepted, whichever was later. Another agency required that, in order to meet operational commitments, its data base had to be converted to work on the new computer system within 5 days from the successful completion of acceptance testing.

Recent efforts to improve ADP procurement policy on conversion costs

Conversion presents a fundamental problem for the procurement process because it causes an apparent conflict between two goals--lowest total overall cost and free and open competition. Furthermore, agency ADP management and programming practices can significantly affect the cost of conversion. How best to consider conversion costs in the competitive procurement process has been under consideration for some time. There is now no written policy or regulation dealing adequately with the treatment of conversion costs in evaluating vendor proposals. Federal Property Management Regulations 101-35.2 (formerly Federal Management Circular 74-5), which establishes policies for managing, acquiring, and utilizing ADP equipment, recognizes conversion as a cost factor but, in our view, provides only general guidance which is both unclear and subject to misinterpretation.

The interpretation of the Federal regulations on the treatment of conversion costs was also a concern of Congressman John N. Erlenborn. In an October 3, 1978, letter to the Comptroller General, he questioned the practices followed by the Government when acquiring ADP equipment. He stated:

> "* * * Public Law 89-306 1/ was adopted by Congress in 1965 and is the predominant influence on the ADP acquisition process as implemented and practiced by GSA and set forth in the GSA Federal Management Circular FMC 74-5 dated July 30, 1974. The intent of Public Law 89-306 was directed to the economic and efficient procurement of ADP and for its efficient and economic use by Federal departments and agencies. However, in practice GSA has stipulated in the above document and in their Federal Property Management Regulations that certain costs that are involved in

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1/The Brooks Act.

the acquisition process, notably conversion costs, must be treated in such a manner as to not be prejudicial to free and open competition. In actuality conversion costs are not duly considered, even though they are in many instances extremely costly to the Government.* * *"

He asked the Comptroller General to render an opinion on whether Public Law 89-306 restricts the implementation and use of those life cycle costs set forth in OMB Circular A-109 (Major System Acquisitions) in the ADP procurement process. In his May 10, 1979, response (see app. IV), the Comptroller General concluded that the Brooks Act does not preclude consideration of conversion costs, but leaves to the discretion of GSA the determination of when it is appropriate to consider them.

GSA actions toward a consistent approach

In July 1979, GSA developed a draft guideline for its internal use on how to handle agency procurement requests which involve augmenting or replacing an agency's installed ADP equipment. The draft guideline provides for the inclusion of most conversion costs in the evaluation of vendor proposals for determining the lowest overall cost. It also promotes the use of good programming practices, such as the use of standard programming languages, to minimize potential conversion problems. In January 1980, GSA incorporated the guidance into draft versions of the Federal Property Management Regulations and the Federal Procurement Regulations, but has yet to issue either. (GSA's draft regulation for treating conversion costs is contained in app. V.).

In our view GSA's proposed regulation, as it covers treatment of conversion costs, is sound. The revisions not only spell out what costs should be considered--basically the software conversion, site modification, dual equipment operations, and training costs mentioned earlier--but they specifically prohibit consideration of costs that are a normal operating function. In its evaluation of proposals, an agency cannot consider costs to

--convert existing software and data bases which are to be redesigned,

--purge duplicate or obsolete software and data bases,

--develop documentation for existing application software, and

--improve management and operating procedures.

This prohibition precludes agencies from "loading up" estimated conversion costs so that the incumbent is favored to the detriment of competition. We believe this is an appropriate restriction.

By ignoring conversion costs to foster competition, an agency could acquire a replacement computer that is far more costly than acquiring one that is compatible with its existing software. We fully endorse the principle of competition. However, the purpose of competition is not to insure that all vendors face exactly the same odds in competing for Government contracts. Rather, the purpose is to insure that the Government obtains its minimum requirements at the lowest cost. The lack of an effective Federal ADP standards program and the increasing complexity of today's application software contribute to the magnitude of the conversion problem. 1/

Because of these factors, we believe the provisions concerning the treatment of conversion costs contained in GSA's draft regulation should be issued and that the principle of the lowest overall cost, price and other factors considered, should be the basis for selecting the winning vendor.

CONVERSION COSTS WERE UNDERESTIMATED

In the cases reviewed, conversion costs and the time it would take to convert were significantly underestimated by the agencies that used these factors in evaluating vendor proposals. In the aggregate, the agencies considered about $6 million of conversion costs. It now appears that actual conversion costs will exceed $56 million. Part of this difference is due to not considering certain conversion costs. The remainder is due to poor estimating. The table on the following page shows details of the conversion costs considered in the six procurements and what conversion costs will actually be incurred.

A primary cause of the poor conversion cost estimating is that adequate data has not been collected on the experiences of computer installations that have converted. At any single installation, a conversion might occur only once in 8 years. The personnel who took part in one may not be around for the next, and adequate conversion cost data may not have been collected. We believe that in at least three of the six procurements, agency actions would have been different,

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1/See ch. 3 for a discussion of the impact of ADP standards.

Conversion Costs Considered in Selected Procurements as Compared With Actual Costs To Be Incurred (note a)

Conversion cost element	Energy	EPA	Navy (note b)	USDA (Kansas City)	USDA (New Orleans)	VA	Total
Site modification/ installation:							
Considered	$ 651,000	$ 5,800	$ 46,099	$ 10,591	$ 11,640	$ 1,806,592	
Actual/estimated	672,590	490,261	1,474,956	45,791	222,466	3,783,963	
Application software:							
Considered	366,424	446,177	None	582,000	731,000	None	
Actual/estimated	3,412,300	1,529,647	9,810,581	3,408,753	1,364,031	4,582,243	
Dual equipment operations:							
Considered	None	130,083	None	None	None	None	
Actual/estimated	3,655,390	605,978	3,576,132	3,054,976	5,167,332	3,892,997	
Training:							
Considered	(c)	(c)	(c)	494,429	328,750	407,776	
Actual/estimated	151,535	234,890	972,296	1,833,155	700,236	1,512,806	
Total:							
Considered	$1,017,424	$ 582,060	$ 46,099	$1,087,020	$1,071,390	$ 2,214,368	$ 6,018,361
Actual/estimated	$7,891,815	$2,860,776	$15,833,965	$8,342,675	$7,454,065	$13,772,009	$56,155,305

a/In cases when the conversions were not complete at the time of our review, the amounts shown reflect the best estimate to complete them.

b/The conversion costs shown include only three of the Navy's six computer centers being converted plus the cost to convert and implement Navy-standard application software at all six centers. The Navy could have avoided substantial conversion costs at only one center.

c/Training tuition costs were considered; however, the winning vendor did not charge separately for training.

and about $5.1 million could have been saved had better, more accurate conversion cost estimates been made. This section discusses two of the three cases in detail and the third, EPA, is discussed in appendix II.

VA might not have converted had it known the costs

VA is developing a new computer system to modernize the veterans' compensation, pension, and education benefit payment system and to improve services to veterans. The new system, called Target, is expected to provide (1) more timely delivery of initial benefit checks, (2) faster response to veterans' inquiries, and (3) major savings from workload reductions in regional offices because of more efficient procedures and workflow. The present system was converted on an interim basis, pending implementation of Target. Had VA been able to more accurately estimate the cost and time it would take to convert the present system, it would have determined that more than $2.5 million could have been saved by not converting. Instead, VA could have continued to operate the old equipment until the Target redesign is completed in April 1983.

In January 1976, VA solicited vendor proposals for the computer equipment that would support the planned Target system. Initially, VA did not plan to convert the existing system. However, in June 1976, the House Appropriations Committee recommended that VA prepare a detailed step-by-step conversion plan to design and develop Target. In his letter of November 26, 1976, transmitting the conversion plan to the Committee, the Administrator of Veterans Affairs stated:

> "* * * We have modified our plan regarding the conversion of the Central (Hines) System and have adopted what we believe to be a far more realistic and pragmatic approach. Rather than deal with the uncertainties of complete redesign in establishing a final completion date, and avoiding what could be substantial costs, we have adopted the position that a conversion of existing programs to run on selected equipment will enable us to release the existing equipment on schedule and at the same time allow the agency to proceed on a completely redesigned system at the central site as originally planned.* * *"

VA estimated that the conversion would be completed with the release of the IBM 370/168 computer in June 1978, would cost $1,244,280 for contract conversion service, and would require 15 VA programmers for 1 year to support the contractor.

However, there was nearly a 7-month delay in the hardware contract award and installation of the new equipment at the VA computer center in Hines, Illinois. Instead of taking 12 months to convert 260 batch application programs as estimated, it will take 26 months if the IBM 370/168 is released in February 1980 (current plans at the time of our review). 1/ VA will have spent nearly $8.5 million to convert its present system on an interim basis, as follows:

Application software conversion:	
Rand Information Systems, Inc.	$1,426,975
Potomac Research, Inc.	295,081
VA personnel	2,860,187
Software conversion total	4,582,243
Dual equipment operation:	
Equipment rental	2,897,634
Equipment maintenance	50,981
Operator personnel	930,907
Power	13,475
Dual equipment operation total	3,892,997
TOTAL	$8,475,240

Contributing to these higher conversion costs were that VA had to (1) rewrite (optimize) many of the converted programs to achieve acceptable processing times on the new computer (see p. 22) and (2) modify existing application programs on the old computer in response to changes mandated by legislation. These modifications then had to be made to the programs already converted by the contractor and running on the new computer.

We estimate that the VA would have saved more than $2.5 million by not converting and continuing to use the old system until the Target redesign is completed. The cost to continue to operate the old system is computed below and assumes that (1) VA would have exercised its purchase option during July 1979 and (2) the Target central system redesign will be completed by April 30, 1983.

1/We recently learned that VA plans to complete the conversion during May 1980. We have not adjusted the conversion costs to reflect the additional slippage.

Cost of Continuing to Operate
Existing System Until April 1983

Item	Cost
Equipment	$2,495,353
Equipment maintenance	481,602
Operator personnel	2,886,041
Power	44,865
Total	$5,907,861

In addition, the VA could have used its programmers who had worked on the interim conversion more productively by assigning them to the Target redesign, and the Government would own a large-scale computer that could be used by another agency when VA released it.

Department of Energy would have bought a different computer

Energy's research center in Richland, Washington, underestimated the cost to convert its application software by more than $3 million--nine times the original estimate. The estimated cost to convert the application software was included in the evaluation of vendor proposals. Had Energy been able to predict conversion costs more accurately, we believe it would have selected the incumbent vendor's proposal.

The Richland computer center, a Government-owned contractor-operated facility, is replacing a Control Data Corporation Cyber 74 computer with a Univac 1100/44 computer. Energy's ADP contractor conducted the procurement and before contract award in February 1977 estimated that converting the application software would cost $366,424. In February 1979, this contractor estimated that application software conversion costs would total $3,412,300. In addition, the ADP contractor decided to redesign 12 application systems at a cost of about $2 million rather than risk converting them.

The contractor based its 1977 cost estimate on the number of program statements which had to be rewritten for the benchmark 1/ programs. The benchmark consisted of a sample of 18 of about 1,000 application programs which would have to be converted. The contractor used $5.88 as the cost to manually rewrite a line of code. A count was made of the number of program statements that had to be manually rewritten to convert

1/See glossary.

the benchmark sample programs. The offerors were then assessed $163 for each line of program code rewritten on the benchmark programs as an attempt to project the software conversion cost for all the application programs.

Although the contractor's method appears logical, the resulting estimate was grossly understated. We believe that the benchmark programs were not representative of the complexity and condition of the application programs that had to be converted. Generally, benchmark programs are not complex and do not use unusual features of the current machine. They are also well documented so that the vendor can prepare for the benchmark demonstration. This is not always the case for application programs in the Federal inventory.

FEDERAL CONVERSION SUPPORT CENTER AND NAVY TAKING STEPS TO IMPROVE CONVERSION COST ESTIMATING

Efforts have been underway since 1976 to establish a center of Federal expertise for software conversion. On October 31, 1979, the General Services Administration announced the establishment of the Federal Conversion Support Center as the primary source for software conversion technology within the Federal Government. The Conversion Center will give Federal agencies specialized expertise, techniques, and tools to conduct conversion studies and accomplish software conversions. It is expected to be fully operational by May 1, 1980.

The temporary regulation notifying agencies of the establishment of the Center also requires software conversion studies and evaluations when any one of the following conditions exists:

--The estimated purchase price of the ADP equipment and software is expected to exceed $2,500,000, excluding the maintenance and support costs.

--The estimated system life cost for ADP or telecommunication services is expected to exceed $2,500,000.

--The estimated conversion costs are expected to exceed $500,000.

--The source code to be converted is expected to exceed 300,000 lines.

--The cost of conversion is to be used as the primary justification for a sole source procurement or specific make or model procurement when the estimated value of the procurement exceeds $300,000.

An agency may conduct its own software conversion study, contract for the study, or request the Center to make it. However, software conversion studies, whether agency or contractor performed, must be sent to the Conversion Center for evaluation. When an agency submits either an ADP services or procurement request to GSA, it must also submit the software conversion study performed by the Conversion Center or the agency-prepared study with the Conversion Center's evaluation report.

The Center will reportedly emphasize conversion support services. These include

--performing conversion feasibility studies;

--evaluating conversion studies submitted by agencies;

--planning, developing, reviewing, and evaluating conversion requirements;

--providing technical and contractual assistance and advice; and

--procuring conversion services.

The Center also plans to participate in agency conversions on a limited basis to maintain technical proficiency. However, it has an authorized staffing level of only 14 professionals, which will severely limit the number of actual conversions in which it can participate.

The problems we found while visiting Federal agencies illustrate the need for technical assistance on how to (1) estimate the cost and time it will take to convert an agency's application software, (2) manage a conversion project, and (3) contract for conversion services. We believe that the Conversion Center, if properly staffed and operated, can provide considerable assistance of these kinds.

The Navy has developed a conversion-cost-estimating tool

Based on a study conducted in 1975 on the costs and problems of conversion, the Navy established a centralized conversion office within its Data Automation Command. The office develops policies, methodologies, and techniques for managing the Navy's major ADP conversion projects. To help do this, the Navy has developed a project management and control system to (1) estimate the time and programmer/analyst resources needed for a conversion and (2) monitor the conversion project's progress. This system is used to track the

progress of specific interrelated conversion tasks that have to be completed for each application system. The tasks include planning, test data preparation and validation, documentation preparation, program translation, compile, component program testing, preparation for production, production data conversion, system test, inserting changes, full system test, parallel operations, and production cutover.

Information on the progress toward completion of each task is entered into the system. Based on an analysis of the input, the project management and control system gives managers advance workload predictions which allow the most effective use of personnel; it also can focus management attention on potential problems. The Navy is expanding the system so that additional tasks can be tracked. The Navy used the system to help manage its data processing service center conversion project which will replace 23 computer systems of varying capacities, ages, and manufacturers with Univac 1100 series computer systems at 6 regional data processing centers.

The Navy has collected a lot of data on the programmer/analyst resources needed for a software conversion. Its conversion experience has been primarily in converting batch data processing systems using high level programming languages. More information is needed on converting online and/or data base processing systems so that the project management and control system can be used to estimate software conversion costs in all types of data processing environments. We believe that the system could be adapted for Government-wide use. (App. II discusses the Navy's data processing service center procurement.)

CHAPTER 3

BETTER ADP MANAGEMENT

CAN MINIMIZE CONVERSION PROBLEMS

A computer system conversion can be a very difficult and costly task which causes both technical and managerial problems. Technical problems arise because of differences among hardware and system software products. Managerial problems arise because (1) most data processing professionals are not familiar with the conversion process, (2) conversion is viewed essentially as nonproductive, and (3) conversion involves many interdependent tasks. Effective planning and management are essential to minimizing conversion costs and user disruption.

Appendix II discusses several cases when agencies converted and the conversions (1) cost much more than what was estimated, (2) took much longer than anticipated, and (3) were very disruptive to users and ADP organizations. Many factors contributed to these problems, but with better planning and control of the conversion and greater emphasis on developing better quality application software in the first place, these problems could have been reduced.

NEED FOR CONVERSION PLANNING

Unless there is a good plan laying out various steps and their phasing, conversion can consume several times the originally estimated resources and can take much longer to complete than predicted. In most of our cases (see app. II), the lack of adequate planning has contributed to the disruption and higher costs.

Conversion strategy should be developed

An agency planning to replace its computer equipment should develop a conversion strategy before soliciting vendor proposals. The strategy should provide for the most cost-effective approach to the transition. Several alternatives can be considered when developing a strategy.

--Application programs can be translated 1/ on a line-for-line basis, meaning that they will be changed only enough to make them run on the new computer. Generally, this means that software fine-tuned over the

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1/See glossary.

years for the old computer system will not be as efficient on the new equipment. The line-for-line approach reduces the length of the conversion period and its costs, but requires later modification of the programs to take advantage of the new computer's capabilities. (See p. 47 for a discussion of the Navy's experience with this approach.)

--In some situations, an agency can emulate 1/ existing application programs on the new computer system. Emulation is not an acceptable long term alternative to conversion; it merely postpones the eventual conversion problem, but it can significantly reduce dual equipment operation costs. It can also relieve the pressure to convert old programs quickly; instead, the programs can be rewritten or redesigned when resources become available. With this approach agencies should consider (1) the emulator's cost (generally not included in the basic hardware cost), (2) the limitations that may be imposed on the programs that would be run under emulation, (3) the useful life of the application programs being emulated, and (4) the cost of converting the programs. (See p. 26 for a discussion of the VA's experience with emulation.)

--Some existing application programs can be processed on the same model (or compatible model) computer equipment at a different site, such as a commercial service bureau or another Government agency. This may be a less costly alternative than conversion for application programs which have short expected useful lives.

--Existing application programs can be reprogrammed 1/ to take full advantage of the new computer system's capabilities. The cost, complexity and time required for this approach make it unacceptable in most cases.

An agency must determine whether to perform the conversion in house or have a contractor do it. Frequently, contracting out is better because in-house personnel usually are not familiar with the conversion process or the new vendor's computer equipment and often agencies do not have sufficient ADP staff for the conversion. However, contracting out the entire conversion is not feasible under any circumstances. Even when the conversion is to be done by a contractor, in-house personnel will be heavily involved. They must

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1/See glossary.

develop a conversion plan, prepare documentation and test data for the contractor, participate in the testing to verify the accuracy of the converted programs, and monitor the contractor's progress.

Contracting for conversion support

If an agency has determined that the conversion process will be contracted out, it must determine the most suitable method of obtaining contractor services. There are basically two types of contracts (with variations and combinations) and several procurement methods to obtain conversion services.

The types of contracts are cost reimbursable and firm-fixed-price. A firm-fixed-price contract is suitable when the agency can define precisely the scope of the conversion effort. We have found that agencies normally do not keep track of information--such as the number of application programs and lines of code in them--which is essential to the firm-fixed-price contract. Often an agency's application program inventory is constantly changing, which makes the firm-fixed-price approach difficult. The cost reimbursable contract may be more suitable for situations such as the conversion of application programs designed for use with a data base management system (DBMS) 1/ where automated translation tools are not readily available.

Methods for procuring conversion services follow.

--Bundle the service, i.e., include the services in the hardware procurement cost. (See p. 40 for a discussion of EPA's experience with this approach.)

--Issue a separate RFP for conversion services before awarding the hardware contract.

--Issue a separate RFP for conversion services after the hardware contract has been awarded.

--Issue an RFP for the hardware with a "mandatory option" that the hardware vendor submit a separate proposal for software conversion. It would be mandatory that the hardware vendor submit a separate price for software conversion and optional that the Government accept it. A second RFP would be issued for software conversion services after award of the hardware contract to allow firms specializing in software to bid on the

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1/See glossary.

conversion. (See pp. 53 and 59 for a discussion of USDA's experience with this approach.)

--Issue two distinct RFPs at the same time--one for hardware alone and one for conversion. Conversion proposals would contain a single technical response, but could contain several price proposals depending on the target hardware.

Conversion plan

Once a strategy has been devised, a detailed conversion plan is needed to minimize conversion costs and user disruption. The plan must:

--Identify resources to do specific tasks and define measurable milestones for those tasks.

--Assign overall responsibility for the conversion and define what is to be expected of the user and ADP organizations during the conversion.

--Provide the means to accommodate necessary changes to the application programs during the conversion.

--Provide the means to measure progress toward goals specified in the plan and take corrective action when needed.

--Be approved by agency management.

Conversion is primarily management's problem, and without a detailed plan, management will not be able to properly control it. (See p. 42 for a discussion of a poorly planned conversion.)

BETTER MANAGEMENT NEEDED AT TIME OF ORIGINAL DESIGN

Federal agency management can reduce conversion costs and user disruption by placing greater emphasis on developing better quality application software in the first place. This can be done by using standard high level programming languages 1/ and instituting sound programming and documentation practices. Conversion should be planned for during application program development. This requires well-structured

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1/See glossary.

and well-documented programs which are maintainable, readable, and understandable. Even with such efforts, an agency may still incur substantial costs when replacing its computer equipment because of the complexity of many ADP systems, but better management certainly helps.

Impact of standard high level programming languages

Most Federal agency officials we talked with believed that the use of standard high level programming languages would make, and, in some cases, had made, conversion easier. However, using a standard high level programming language 1/ does not eliminate all conversion problems because of the inherent differences in the operating characteristics of computers of different manufacture and architecture. Computer characteristics which can cause conversion problems include:

--The job control language 2/ which directs the operating system to reserve and use the computer's resources must be replaced by the job control language of the new vendor--there is no standard for control languages.

--The replacement computer may have a different word length (for example, 36 bit vs. 32 bit). When a computer is storing more than one piece of information in the same word (called packing data), difficulties can arise in the data conversion.

--The replacement computer may use different (1) sort sequences, (2) file and data handling techniques, and (3) precision for mathematical computations.

--The new computer may accept the same program statement, but with a somewhat different meaning than on the old one.

In addition, when an agency acquires a compiler 2/ which has been validated to the Federal standard, this means only that the language features defined in the standard are present in the vendor's compiler and that they work as the standard says they should. Most hardware vendors provide extensions

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1/As of December 1979, Common Business Oriented Language (COBOL) is the only application programming language for which a Federal standard now exists. Industry standards exist for three other commonly used programming languages. (FORTRAN, BASIC, and PL/1). (See glossary.)

2/See glossary.

to the standard programming languages with their compilers. These extensions are unique to these manufacturers' equipment and as convenient for programmers to use. Some extensions do provide for more efficient processing on the specific equipment, while others may provide no advantage at all. There is a tradeoff in operating efficiency and costs (from the use of some extensions) versus the costs of conversion (removing them to make the programs run on different computers) at some later date. The complexity and cost of the eventual conversion may be determined on the day the application program is written. Complexity and cost can be affected by undisciplined changes to the original program--for example, changes that are not documented or are written using nonstandard language features.

Federal agency management, anticipating eventual conversion, can and should direct that vendor-unique features be avoided when possible in developing new applications for existing equipment. When vendor-unique features must be used, management should require that (1) such use be justified by savings in operating costs, (2) the justification be documented, and (3) the use of unique features be isolated into separable parts of the application program (called modules). By instituting such procedures, management would ease eventual conversion to a noncompatible computer.

VA is using good programming practices

The Veterans Administration instituted such procedures when it converted its veterans compensation, pension, and education system from an IBM 370/168 computer to a Honeywell 66/60 computer. The application programs were written in COBOL 68 with IBM extensions and some IBM assembler language and were converted on a line-for-line basis to standard COBOL 74. VA had anticipated that the converted programs would take longer to process after conversion because the IBM 370/168 is a more powerful computer than Honeywell's. However, early experience indicated that the converted programs would have unacceptable processing times and could cause delays in making payments to veterans. In February 1979, VA developed a plan to achieve acceptable processing times for the converted application programs.

Application programs and program modules were identified that needed to be rewritten to operate more efficiently on the Honeywell computer. The programs were selected primarily on the basis of computer resources they consumed. For the most part, VA programmers were able to improve the processing times of most programs to an acceptable level by using standard COBOL. However, VA identified six program modules where

the use of Honeywell assembler language was more appropriate. The use of the assembler language was documented and approved by VA management.

VA has instituted a good programming practice by requiring that its application programs be written in standard high level programming languages and that any deviation from the standard be justified and documented. The decision to use assembler language for some program modules was made only after a comparative analysis showed that assembler language was more suitable. In addition to minimizing potential conversion problems, the use of standard high level programming languages will increase programmer productivity by making it easier to (1) develop new application programs, (2) make needed changes to existing programs, and (3) maintain adequate documentation. It will also be easier to hire programmers already trained in the languages' use.

Federal Crop Insurance Corporation

Most agencies visited used high level programming languages for their applications, but many of the programs were written before the current version of the COBOL standard was available and contained vendor-unique features. In one case, the use of standard COBOL greatly minimized the cost and time it took to convert the agency's application software.

The Federal Crop Insurance Corporation, one of the four major users of USDA's Kansas City Computer Center, had designed its application programs with portability in mind and had adhered to the COBOL 74 standard programming language. Before 1976, nearly all Crop Insurance's applications were processed on the computer center's IBM 7074 and 1401 computers and were written in assembler language and an early version of COBOL. At that time, the center was trying to procure new computer equipment.

Crop Insurance ADP managers did not know what type of computer would be procured, but decided to begin to redesign their applications to conform to the 1968 version of the COBOL standard and be processed on the center's IBM 360/50 computers. As soon as the 1974 COBOL standard manuals became available, they were used in the redesign and the few programs which had already been written in the 1968 version of COBOL were rewritten to conform to the 1974 COBOL standard.

When the Honeywell 66/80 computer was installed in May 1978, Crop Insurance had three of its major application systems redesigned and operating on the IBM 360/50 computers. The three applications (Sales, Acreage Reporting, and Actuarial Systems) consisted of 232 programs and 312,600 lines

of program code. The conversion was performed by Crop Insurance ADP personnel without contractor support and was completed in 2 months at a cost of only $47,430, about 15 cents per line. This is the lowest conversion cost we encountered.

The use of the 1974 COBOL standard greatly minimized Crop Insurance's conversion costs and problems. Also contributing to the ease of conversion were that (1) the programs were designed with portability in mind, (2) program documentation was up to date, (3) the same programmers who had written the programs were present to convert them, and (4) the programs were developed for relatively simple batch processing 1/ support.

Federal application software inventory has often not been designed for portability

The Federal Crop Insurance Corporation's experience shows that conversion does not have to be costly and totally disruptive. However, the Crop Insurance application software is not representative of that of most Federal agencies. Application programs are often hastily designed and written to meet deadlines and are often tested and documented inadequately or not at all. The typical programmer is not judged on how portable his programs are, but rather on how fast he can get the programs up and working while using as few of the computer's resources as possible. This can promote the use of vendor-unique features. Little or no consideration is given to the probable eventual conversion of the program when it is written.

The lack of an effective Federal ADP standards program 2/ and the increasing complexity of application software also contributes to the magnitude of conversion problems. Federal standards have not been developed for most high level programming languages, and no Federal or industry standards exist for data base management systems. While the use of standard COBOL can minimize conversion problems in a batch data processing environment, agencies which have developed more complex applications which use teleprocessing and/or DBMS software

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1/See glossary.

2/For further discussion of the Federal ADP standards program, see our report "The Federal Information Processing Standards Program: Many Potential Benefits, Little Progress, and Many Problems," FGMSD-78-23, April 19, 1978.

packages will likely face long and costly conversions. 1/ Each ADP installation we visited was using or planned to use DBMS software for some of its applications.

WHAT CAN AN AGENCY DO?

Conversion presents many potential problems. However, management can take a number of actions to ease conversion. Among the most important of these are:

--Advance planning, including setting up a mechanism for project management and control.

--Developing, adopting, and enforcing standard documentation and programming techniques.

--Setting up and maintaining comprehensive source program and test data libraries.

--Developing and maintaining an accurate inventory describing the characteristics of existing application software.

--Identifying application programs that have had a history of problems and may be candidates for redesign rather than conversion.

--Educating the staffs and management of the ADP and user organizations to the potential benefits of the new computer system to minimize resistance to change.

By taking these actions and recognizing that conversion is primarily a management concern, an agency can (1) minimize potential conversion problems, (2) determine the complexity of the conversion, and (3) obtain a sound basis for estimating conversion costs. For further discussion of what an agency can do to prepare for a conversion, a provisional checklist for software conversion projects is available. It was prepared as a supplement to our report, "Millions in Savings Possible in Converting Programs From One Computer to Another," (FGMSD-77-34, Sept. 15, 1977) and is available upon request.

1/For further discussion on DBMS software, see our report "Data Base Management Systems--Without Careful Planning There Can Be Problems," FGMSD-79-35, June 29, 1979.

EMULATION IS NOT A LONG TERM ALTERNATIVE TO CONVERSION

Many factors must be considered by an agency when making replacement computer equipment decisions. The availability of an emulator can affect that decision, and can increase the range of options available to management for converting to a new computer system. While emulation is generally not an acceptable long term alternative to conversion, it can significantly reduce the length of time of dual equipment operation and its costs. It can also relieve the pressure to convert old programs quickly; instead the programs can be rewritten or redesigned when resources become available. The two Agriculture computer centers visited could have emulated their second generation computers had IBM been awarded the contracts, while the VA computer center in Hines, Illinois, has been using emulation to process some of its applications since 1969. (App. II discusses the USDA procurements.)

The USDA official responsible for the replacement computer procurement for both centers stated that emulation was not considered an acceptable alternative primarily because it would not make efficient use of the new computer. Officials at both the Kansas City and New Orleans computer centers believed that emulation would have been an acceptable alternative only if it were a temporary action while the old application software was either reprogrammed or redesigned. 1/

The Director of the Kansas City Computer Center and ADP management officials in the user organizations expressed concern that if emulation were used, the software might remain in the emulation mode indefinitely. VA's experience supports that notion. As stated earlier, emulation does not take advantage of the full capabilities of the new computer equipment.

Long term use of emulation can cause problems

VA developed the vocational rehabilitation and education benefit payment system in 1960 to serve severely handicapped veterans. The application programs were developed for use on an IBM 705-III computer 2/ and were written in 705

1/See glossary.

2/A first-generation computer.

assembler language. 1/ VA has since upgraded its computer equipment three times and now uses an IBM 370/168 computer to process benefit payments. While the other application programs were eventually converted to COBOL, the vocational rehabilitation system was not because of the relatively small number of veterans eligible for this type of benefits (currently about 16,000). The system was first emulated on an IBM 360/65 computer and is now emulated on the IBM 370/168 computer. It will be emulated until 1981 when VA plans to have the system redesign completed.

One VA ADP management official stated that she "would not wish emulation on one's worst enemy." Because an emulated system usually works, funds are frequently not provided to redesign or convert it. The major problem VA has with the emulated system is finding programmers familiar with the outdated programming language. No significant changes or improvements can be made to the vocational rehabilitation system because (1) VA no longer has programmers familiar with the IBM 705-III assembler language and (2) hardware characteristics of the IBM 705-III computer limit what can be automated. Because the system cannot be modified, some payments must be manually processed.

We believe that emulation can be a viable short term alternative to conversion. When making a replacement computer decision, an agency should consider the cost and feasibility of emulation compared with the cost of continued operation of the old equipment. When emulation is used, an agency should provide in its conversion plan for converting or redesigning the emulated programs and ensure that the project is adequately funded and backed by management to avoid problems such as those VA is now having.

1/See glossary.

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

When an agency needs to replace its computer equipment, it faces a substantial effort, high costs, and potential risk to convert its application software so that it will operate on the new computer equipment. These factors must be considered by an agency when making replacement computer equipment decisions: (1) the managerial and technical problems of conversion, (2) the relationship of the conversion costs to the evaluation of the new systems being considered, (3) procurement of contractor conversion services, (4) conversion cost and time estimates, and (5) alternatives to conversion--such as emulation or obtaining offsite processing support.

The objectives of the Federal ADP procurement process are to obtain the best price for ADP resources and give all responsible vendors an opportunity to compete for the business. However, the process for acquiring replacement computers has been complicated by (1) the lack of clear and concise procurement policy on the treatment of conversion costs in evaluating vendor proposals and (2) difficulties in estimating these costs.

The inconsistency in treatment of conversion costs is traceable to a lack of clarity in governing regulations. Some policies are unwritten, while others are unclear. The upshot is that agencies are not clearly guided, and the variations in treatment of certain elements of cost reflect that confusion. The increasing use of computers by agencies and the large investment they have made in existing computer systems (software, people, procedures) emphasize the need for GSA to establish appropriate policy and issue procurement regulations that emphasize the principle of lowest overall costs and promote sound ADP management practices. GSA has drafted such a policy, but has yet to issue it.

The question of whether conversion costs should be considered, and if so, which costs and to what extent, has been one of long standing. A primary concern has been whether considering conversion costs would preclude effective competition. In our view, the Government should obtain its minimum requirements at the lowest possible cost, and our review has shown that considering conversion costs would not necessarily eliminate competition and in fact should result in a lower total cost.

As discussed in detail in our case studies (see app. II), computer system conversion can be very costly and highly disruptive, but it need not be. Effective planning for and management of the conversion are essential to minimizing costs and user disruption. The Navy has developed a project management and control system to (1) estimate the time and programmer resources needed for a software conversion and (2) track the conversion project's progress. The system could be adapted for Government-wide use.

Management can reduce future conversion costs by placing greater emphasis on developing better quality application software in the first place. This can be done by using standard high level programming languages and instituting sound programming practices. Conversion must be planned for during application program development. This requires well structured and documented programs which are maintainable, readable, and understandable. However, even with such efforts, an agency can still incur substantial costs when replacing its computer equipment because of the complexity of many ADP systems.

RECOMMENDATIONS

To improve the acquisition and management of ADP resources, we recommend that the Administrator of General Services:

- --Issue, for agency guidance, the provisions contained in the draft regulation covering treatment of conversion costs in evaluating competing vendor proposals.

- --Develop technical guidelines to help Federal agencies (1) determine conversion requirements, (2) plan for and manage conversion, (3) contract for conversion support services, and (4) evaluate life cycle costs of vendor proposals.

- --Consider adapting for Government-wide use the Navy's project management and control system for estimating software conversion costs and managing conversion.

THE PROCUREMENT DECISION

The planning, design, development, implementation, and operation of an ADP system represents a considerable investment in hardware, software, procedures, and personnel over a system's life cycle. When an agency's ADP system does not have sufficient capacity to process existing applications or will not be able to meet future needs, the agency must identify and analyze alternatives for satisfying those needs. The impact of the computer on an agency's operations can be so important that this matter requires top management participation and direction to assure that costs are appropriately treated and the accomplishment of the agency's mission is not jeopardized by the changeover.

LIFE CYCLE COSTING OF ALTERNATIVES

The procurement decision should be preceded by a thorough economic analysis of all costs over the system's life. Life cycle costing is an economic analysis technique used to evaluate the cost of alternative means of doing a job. Costs considered in the analysis include all anticipated expenditures directly or indirectly associated with an alternative. The first decision to be made is whether an existing ADP system (with enhancements) can do the job. If so, the costs of enhancing and operating the existing system are compared with the costs of acquiring and operating a new one. "Cost" in this context is all future costs associated with either alternative--for example, operating costs and maintenance costs, which will be incurred over the projected useful life of the system and present value (cost of money). Should it be determined that an enhanced existing system cannot do the job, the alternatives to be considered include only the costs of other systems. Irrespective of the path taken, the analysis concerns itself only with future costs over the life cycle of the system; sunk costs in the existing system are ignored.

Life cycle costing as a technique thus pertains to evaluations of alternatives and not solely to the procurement decision itself. Once an alternative has been selected, an agency must evaluate competing vendor proposals on the basis of: (1) the capability to fulfill the ADP system specifications and (2) the overall life cycle costs, both hardware and other. The costs that can be incurred over the life cycle are not synonymous with the costs used to select the winning vendor. For example, application software development and maintenance are life cycle costs, but do not affect the selection of the winning vendor.

COSTS AFFECTING THE SELECTION DECISION

After systems suitable to meet agency needs have been identified, one major factor in selecting hardware and software should be its overall cost in terms of acquisition, preparation for use, and operation. The cost elements and system life period used to evaluate vendor proposals varied among the agencies we visited. Appendix II summarizes the cost factors included in bid proposal evaluations of the six competitive procurements analyzed. We have categorized the cost factors that can affect the selection decision into four major groups: (1) computer equipment, (2) operating costs, (3) financing, and (4) conversion. Each is discussed below.

Computer equipment

Computer equipment includes such cost elements as

--the central processing unit, main memory, and peripheral devices;

--remote terminals and printers;

--data communications equipment, such as front-end processors, line concentrators, and modems;

--operating system 1/ software;

--utility software; and

--specialized software such as data base management system, 1/ report generator, and mathematical programming package.

Also included in the computer equipment category are two additional factors: (1) desirable features and (2) residual value. Desirable features are capabilities that an agency would like to have, but are not essential to meet its minimum data processing requirements. An agency must indicate the assigned dollar value of such desirable features in its request for proposal. (This dollar value is the amount the agency estimates it would cost to obtain the feature from other commercial sources or to develop it using in-house resources. The value represents the assessment (penalty) which would be levied against a vendor's proposal if the feature were not provided.)

1/See glossary.

The residual value is the expected worth of the hardware at the end of the system life. It is determined by multiplying the hardware purchase price, first by a percentage and then by the present value discount factor for the last month of the system life. The residual value is then deducted from the cost of each vendor's proposal. GSA requires Federal agencies to deduct residual value from the system life cost for any procurement option that results in the Government owning the equipment.

Operating costs

The list of operating costs can be extensive; however, the operating costs which can vary among competing vendors and affect the selection decision include

--the cost to maintain the hardware and vendor-supplied software;

--costs associated with running the computer, such as salaries for operators and tape handlers;

--utility costs to provide the power and cooling for the hardware; and

--floorspace costs.

Financing

A comparative cost analysis of the various procurement methods (e.g., lease, purchase) should be performed to determine which is the most advantageous. To use this technique properly, it is necessary to bring together all relevant costs over the stated system life and prepare a present value analysis of the various procurement methods offered.

An agency must determine the system life based upon its requirements and stipulate it in the solicitation document. The system life is a projection of the time period which begins with the installation of the computer system and ends when it will no longer be needed. (The system life is not synonymous with the actual life of the equipment, the application software life, or the life of the function being supported; it is used to evaluate vendor proposals on an equal economic basis.)

Vendors normally submit proposals which incur different costs at different times. For two or more proposals to be compared on an equal economic basis, the costs of each proposal at the same point in time or at their "present values"

must be considered. 1/ GSA has established a uniform present value discount rate of 10 percent, which approximates the longrun opportunity cost of capital in the private sector.

Present value analysis over the stated system life should be calculated for each procurement method offered. Examples of procurement methods are

--outright purchase (after installation and acceptance),

--lease with option to purchase at predetermined intervals,

--long-term lease,

--lease to ownership whereby title transfers after a predetermined number of months of rental, and

--installment purchase whereby the Government exercises an option to purchase the equipment after a predetermined number of months.

Conversion costs

We have broadly defined "conversion costs" to include all costs that can be incurred in converting to a new computer system. As noted earlier, these costs can run into millions of dollars and include costs for such items as application software conversion, site modification, installation, dual equipment operation, and retraining. While an agency cannot avoid all conversion costs, the costs can vary greatly among competing vendors.

Application software conversion

The most significant conversion factor is the cost required to convert application software. Application software conversion is labor intensive. Costs for this task include costs for such items as (1) converting the application programs, (2) changing the documentation, (3) converting the data files, (4) rewriting the job control language statements associated with each application program, and (5) conducting program and system testing. The length of time needed to convert the application software also affects the length of time, and hence the costs, of dual equipment operation and "lost opportunity costs" associated with delays in automating user tasks

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1/Present values must be determined because money has earning power over time.

due to resources being applied to conversion, rather than to new tasks.

Essentially there are four ways an agency could accomplish the transfer of its application software from one computer system to another: (1) translation, 1/ (2) reprogramming 1/, (3) redesign, 1/ and (4) emulation 1/. Both translation and reprogramming involve a "one-for-one" replacement of an agency's application programs without a change in functional capabilities. Redesign occurs when additional functional capability is required. From a cost standpoint, the difference in approaches is significant because translation and reprogramming can be viewed as a cost of moving from one computer to another with no new functional capability added. It is an investment that is strictly attributed to the procurement of new computer equipment--a conversion cost. Redesign, on the other hand, is an ongoing cost of system evolution and not an acquisition cost per se. Emulation is generally not an acceptable long term alternative to conversion, but it can significantly reduce the length of time of dual equipment operation and its costs.

Dual equipment operations

Conversion requires a dual equipment operation period; that is, both the old and new computers are in operation until all the application programs can be processed on the new one. Dual equipment operation costs are those costs of operating the old equipment during the transition and can include costs for

--additional operator personnel and/or extensive overtime,

--lease and/or maintenance,

--power and cooling,

--additional supplies, and

--additional floorspace rental.

Factors such as the size and complexity of the conversion and the resources available for conversion also affect the length of the dual equipment operation period. In some cases, a full changeover takes years. If an agency stays within the

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1/See glossary.

incumbent vendor's product line or acquires a compatible computer, the changeover may be accomplished within weeks.

Site modification and installation

Site modification and installation costs can be substantial depending on the specifics of each computer facility. Extensive modification or expansion of the facility may be necessary to house both the old and new computers during the conversion period. Site modification and installation costs include costs for such items as additional powerlines, wall outlets, transformers, air-conditioning units, a raised floor, fire protection equipment, vendor installation fees, transportation of the computer, and local handling to move the new computer into the facility and (later) the old one out.

Retraining

An agency also incurs costs to retrain its personnel on the new computer. These costs, which are almost always greater when the new system is bought from a different vendor, include costs of retraining system programmers; computer operations staff; application programmers; managers; and, in some cases, users. Cost elements include tuition, salaries while attending training, travel and per diem for offsite training, supplies, and classroom and equipment rental. Intangible costs associated with retraining are reduced programmer productivity and ADP staff turnover. Data processing officials interviewed felt that the average programmer needed 1 to 2 years to become as proficient on the new system as on the old. In some cases, ADP staff left the agencies rather than be retrained on the new vendor's equipment. There is a cost associated with replacing people who leave.

APPENDIX II

CASE STUDIES OF PROCUREMENT ACTIONS AND CONVERSION EXPERIENCES OF SEVEN COMPUTER SYSTEM ACQUISITIONS

The acquisitions we reviewed consisted of six competitive procurements and one sole source upgrade within the incumbent vendor's product line. The case studies illustrate that:

--The ADP acquisition process can be lengthy.

--The system life used in evaluating vendor proposals has ranged from 5 to 8 years.

--The cost factors agencies have considered in evaluating proposals have varied.

--Including appropriate conversion costs in evaluating proposals would not eliminate competition.

--It is difficult to estimate the cost and time needed to convert application software.

--A conversion project must be carefully planned and controlled.

The table on the following page shows what cost factors were evaluated in the six competitive procurements.

Cost Element	Energy	EPA	Navy	USDA (note a)	VA
New computer system:					
Computer equipment	Yes	Yes	Yes (note b)	Yes	Yes
Maintenance	Yes	Yes	Yes	Yes	Yes
Operator personnel	Yes	No	No	Yes	Yes
Space occupancy	Yes	No	No	No	No
Power	Yes	No	Yes	Yes	Yes
Desirable features	Yes	Yes	Yes	Yes	No
Residual value	Yes	Yes	No	Yes	Yes
Conversion costs:					
Site modification and installation (note b)	Yes	Yes	Yes	Yes	Yes
Software conversion	Yes (note c)	Yes (note c)	No	Yes (notes b and c)	No
Dual equipment operation	No	Yes (notes b and c)	No	No	No
Training:					
Tuition	Yes	Yes	Yes	Yes	Yes
Salaries and other	No	No	No	No	No

a/The cost factors for both USDA procurements were identical.

b/Not all costs were considered

c/Costs were underestimated.

CASE 1: DEPARTMENT OF ENERGY, RICHLAND, WASHINGTON

The computer center at Energy's research center in Richland is Government owned and contractor operated. The users, who are also contractors, are located from 10 to 30 miles from the computer center and need a computer system with a telecommunications network. The ADP contractor operates the computer center and provides software development support. The users are billed by the ADP contractor for ADP services and in turn apply these costs to their Energy contracts.

Why the procurement was needed

The Richland research center has a Control Data Corporation Cyber 74 computer system that was installed in May 1973 and was soon saturated. Offsite processing was then used. Extensive computer processing time was obtained from Energy research centers in Berkeley, California, and Brookhaven, New York. Because of workload growth and the uncertainty of continued availability of the offsite support, Energy decided that it was impractical to continue to depend on offsite support.

The procurement

Energy's ADP contractor conducted the procurement. The procurement action was synopsized in the Commerce Business Daily. Nine firms requested a copy of the request for proposal, and only Control Data Corporation and Univac submitted proposals. Best and final offers were received in November 1976 and the contract was awarded to Univac in February 1977 based on the lowest 6-year system life cost. The Univac bid represents a 55-percent discount from the GSA ADP Schedule price. The following is a chronology of the major events leading to the acquisition of the Univac 1100/44 computer system.

August	1974	Requirement analysis completed
June	1975	Acquisition decision made
February	1976	RFP issued
August	1976	Proposals received
November	1976	Best and final offers received
February	1977	Contract awarded
October	1977	Computer equipment accepted

Energy's ADP contractor included the following cost factors in evaluating vendor proposals:

--Computer equipment (both hardware and system software).

--Maintenance.

--Power and cooling.

--Operator personnel.

--Space occupancy.

--Trade-in allowance for existing equipment.

--Site modification/installation.

--Training tuition.

--Desirable features.

--Residual value.

--Application software conversion.

Impact of conversion

Because Energy's ADP contractor underestimated the cost of application software conversion by more than $3 million (see p. 13) and did not include dual equipment operation cost as an evaluation factor, we estimate that the Univac computer system will cost about $2.6 million more over the 6-year system life than if the Control Data Corporation had been selected. Contributing to the higher conversion costs was that Energy placed a priority on developing new application programs and modifying ongoing systems, rather than converting existing applications. This decision extended the conversion period by 1 year (to a total of 3) and increased conversion costs by about $1.2 million. Energy officials do not feel that it is appropriate to include the third year of dual equipment operation as a conversion cost because placing a priority on new development and modifications was a management decision. In our view, the additional costs of dual equipment operation caused by that decision are appropriately classified as a conversion cost because there are lost opportunity costs associated with delays in automating user tasks (e.g., new development) as a result of a conversion. The lost opportunity costs are, therefore, reflected in the additional year of dual equipment operation.

Summary assessment

Had all appropriate costs been included and accurately estimated, the incumbent vendor would have been selected. About $2.6 million could have been saved.

CASE 2: EPA, RESEARCH TRIANGLE PARK, NORTH CAROLINA

EPA's computer center in Research Triangle Park provides batch and online data processing support to the following three EPA user groups:

--The Office of Air Quality Planning and Standards.

--The Office of Research and Development, which consists of four major environmental research laboratories.

--EPA regional offices and smaller laboratories throughout the country.

The center operates like a service bureau; that is, the users develop their own application software and are charged by the center for computer resources used.

Why the procurement was needed

In 1970, the year EPA was established, the agency acquired an IBM 360/50 computer from the Department of Health, Education, and Welfare. The computer was saturated with work from the start and EPA recognized that the IBM computer would not be suitable for long term support. Based on a study of its data processing requirements in August 1970, EPA determined that a computer with 20 times the processing capacity of its existing system would be needed within 3 years.

The procurement

In June 1971, EPA solicited vendor proposals and in December 1972 completed a technical evaluation of the proposals received from IBM, the Control Data Corporation, and Univac. All three were responsive to the RFP and all three passed the benchmark test.

GSA handled the negotiations with the vendors, which started in February 1973. The contract was awarded to Univac in June 1973 based on the lowest 5-year system life cost. The Univac bid represents nearly a 61-percent discount off the list price. In its proposal, Univac agreed to convert 898 application programs and 408,100 lines of program code for a fixed price of $200,000 within 8 months. Univac's approach was to convert EPA's application programs on a line-for-line basis, and it subcontracted the conversion to a firm specializing in software conversion. The following is a chronology of major events leading to the acquisition of the Univac 1110 computer system.

August	1970	Requirement analysis initiated
June	1971	RFP issued
August	1972	Benchmark completed
December	1972	Technical evaluation completed
February	1973	Best and final offers received
June	1973	Contract awarded
March	1974	Computer equipment accepted

EPA included the following cost factors in evaluating vendor proposals:

--Computer equipment (both hardware and system software).

--Maintenance.

--Site modification/installation.

--Desirable features.

--Residual value.

--Application software conversion.

--The cost to operate the old equipment during the conversion period.

--Training tuition.

EPA did not include power and cooling or operator personnel costs for the new equipment.

Impact of conversion

EPA's computer center experienced a very painful conversion, both in terms of resources expended and adverse impact on its mission to provide environmental data for decisionmaking. The software conversion began in June 1973; acceptance testing of the Univac 1110 computer was completed in March 1974. The IBM 360/50 was released in September 1974, 3 months later than planned, but, according to the center's largest user, at least a year before it should have been released. The center was still experiencing conversion-related problems as recently as January 1978. EPA spent more than $1.5 million to convert its software, about $516,000 to operate the old computer after the Univac computer was available for productive use, about $235,000 to retrain its ADP personnel, and $90,000 for offsite processing support.

We adjusted the costs used to determine the winning vendor to reflect actual conversion costs and found that the

Univac 5-year system life cost was somewhat less than that of the incumbent, IBM. However, EPA's evaluation of proposals was based on a combination of technical capability as well as cost. Thirty percent of each vendor's score was based on technical capability and the remaining 70 percent upon total cost. The system proposed by IBM received the highest technical score in each major evaluation category. Based on EPA's evaluation methodology and including actual conversion costs, the incumbent vendor would have been selected rather than Univac.

We have not tried to quantify the intangible costs of disruption caused by the conversion (discussed below), but had EPA kept the old computer until the users had enough programs converted to operate, between $387,300 and $774,650 would have been added to the costs of conversion. This would have reduced the disruption to the users. EPA officials estimated that the IBM 360/50 computer should have been kept at least 6 months and probably a year longer than it was. Each additional month of dual equipment operation would have added $64,550 to the costs of conversion.

Conversion was very disruptive

The conversion was very disruptive to the EPA user organizations. Poor relationships developed between the users and the data processing center. Users cited the following problems.

--Work was not getting done; so many jobs had to be rerun that users demanded and got refunds from the computer center. The users experienced job rerun problems until January 1978.

--The Office of Air Quality Planning and Standards could not retrieve data for 6 months after the IBM computer was released; for some types of data the time was a whole year. As a result, EPA made decisions concerning strategies with States without adequate information on air quality.

--The programs converted by the conversion subcontractor were very inefficient, and some did not work properly or at all. For example, one application program which supports EPA's monitoring of air quality that took 5 hours to process before conversion took 22 hours after conversion. (Subsequently, the application was rewritten to take advantage of the Univac 1110 architecture and now takes only 3 hours to process.) The Health Effects Research Laboratory decided not to use any programs converted by the subcontractor

because they were very inefficient. For example, one small program that took 3 to 5 minutes to process before conversion took 47 minutes after conversion. Some programs did not give the same results on the Univac computer that they had given on the IBM computer.

--To make their application programs work on the Univac computer, the users had to pay for contractor support from funds earmarked for environmental research programs. In addition, substantial work and much overtime was spent on the conversion by user personnel who had thought that the conversion subcontractor would provide neat, clean, efficient application programs ready to run.

--A statistical analysis software package which was written in the IBM assembler, PL/1, and FORTRAN programming languages was converted to COBOL and FORTRAN on the Univac. But the new version was so inefficient it was not used. Users had to spend $90,000 to obtain offsite computer support for statistical analysis work. (A replacement statistical analysis program was later developed in-house for about $37,000.)

--The scheduled development of the Community Health Environment Surveillance System was delayed a year because of the conversion. Other planned application systems development work was also delayed because of the conversion.

--The conversion delayed environmental research work because needed data was not available.

What went wrong?

A major cause of the conversion problems was that EPA had not developed a comprehensive plan to enable management to control the conversion. The computer center's ADP staff developed a "suggested" conversion plan before awarding the hardware contract to Univac; however, the plan did not

--have agency management approval,

--assign overall responsibility for the conversion effort,

--define what was expected of the user and ADP organizations during the conversion,

--identify resources needed to do specific conversion tasks or define measurable milestones for those tasks, or

--provide the means to measure progress toward goals specified in the plan and take corrective action when needed.

The poor planning was compounded by several management, technical, and other factors. These were:

--EPA did not have an accurate inventory of the application programs that had to be converted. As a result, the scope of the contractor's work changed, as did the contract amount and scheduled completion date.

--EPA users continued to develop new and modify existing application programs on the old computer until it was released. Many of the programs converted by the conversion subcontractor had been modified by EPA during this time, and they could not be used on the new equipment without further modification. The changes that had been made to the application programs running on the old computer after the conversion began then had to be made to the programs converted by the conversion subcontractor.

--EPA released the IBM 360/50 computer before the conversion was completed because no funds had been budgeted to keep it. Another factor in the decision to release the IBM computer was management's perception that the user organizations' programmers were reluctant to change to Univac. EPA management felt that as long as the IBM computer was there, the Univac computer would not be used.

--The computer center assigned six ADP specialists to monitor the conversion activity and assist users. However, three of the six quit rather than retrain on the Univac equipment. These personnel were not replaced because of EPA personnel hiring policies and limitations.

--The conversion proposal submitted by Univac, and agreed to by EPA, did not provide for a clear understanding of what was to be done. Also, the proposal did not provide for the operating efficiency or reliability of the converted programs.

--EPA did not prepare adequate test data or verify the accuracy of the converted programs.

--EPA was a developing organization during the nearly 3-year procurement cycle and experienced rapid growth in its data processing requirements; most of this growth is attributed to environmental programs required by new legislation.

--A Univac computer was not available for new development for the 9-month period from contract award through completion of acceptance testing.

--The Univac 1110 computer was newly introduced to the marketplace when it was acquired. EPA experienced a high system failure rate due to technical problems associated with both the hardware and vendor provided software. One EPA official commented that "Pioneers get arrows" when referring to EPA's problems associated with being one of the first users of a newly offered computer system.

--There was no interaction between the conversion subcontractor and the programming staffs of the user organization during the conversion period.

We believe that EPA greatly underestimated the technical and managerial problems in the conversion process by not developing a comprehensive conversion plan. Because of this, the conversion was very disruptive to the user organizations and hampered their ability to carry out EPA's mission. EPA has learned several valuable lessons from its conversion experience and is applying these to its current planning process for acquiring computer equipment to satisfy its data processing needs for the 1981-90 timeframe.

Summary assessment

EPA's conversion was very disruptive and was poorly planned and managed. Had costs been properly estimated, the incumbent vendor would have been selected. With proper management of the conversion process, the magnitude of the problems encountered by EPA could have been reduced.

CASE 3: DEPARTMENT OF THE NAVY, DATA PROCESSING SERVICE CENTER PROJECT

The Navy initiated this project to standardize and modernize computer equipment at seven regional data processing centers. The reasons cited for replacing the existing equipment were that it was outmoded, batch oriented, and saturated and was falling apart. Of the seven centers initially planned for equipment replacement, only two had upward compatible options; that is, replacement computers were available that could run those two centers' application programs without a lengthy and costly software conversion. The Navy decided not to replace the computer equipment at one of the two centers, Port Hueneme, California, because of potentially high conversion costs.

The procurement

The planning process to establish the Navy's regional data processing service center concept and to replace aging RCA equipment began in January 1973. The Navy issued an RFP in June 1975 and held discussions with five interested vendors starting in August 1975. Univac, Honeywell, and Burroughs submitted proposals in January 1976. Benchmark tests were completed in April 1976; all three vendors passed the benchmark.

GSA did not delegate the Navy procurement authority; the procurement was conducted jointly by GSA and the Navy's ADP Selection Office. Best and final offers were received on May 4, 1976. However, Honeywell filed a bid protest with us on July 19, 1976. Honeywell believed that GSA was improperly evaluating its "discontinuance of installed equipment clause." The Comptroller General, in his decision of December 9, 1976, ruled that Honeywell's proposed separate charges violated statutory restrictions on appropriations and that the "fixed price options" clause in the RFP was inappropriate and misleading. He suggested another round of negotiations with the fixed price option clause modified.

On January 19, 1977, GSA again solicited best and final offers; they were received on February 10, 1977. The contract was awarded to Univac on March 4, 1977, based on the lowest 8-year system life cost. The Univac proposal represents a 77-percent discount off the GSA ADP Schedule list price and savings of $107 million from the list price. The hardware lease cost represents a 90-percent discount off the list price. The following is a chronology of major events leading to the acquisition of the Univac computers.

January	1973	Requirements analysis initiated
February	1974	Plan approved
June	1975	RFP issued
January	1976	Proposals received
April	1976	Benchmark completed
May	1976	First best and final offers received
July	1976	Bid protest made
December	1976	Protest denied
February	1977	Second best and final offers received
March	1977	Contract awarded
March	1978	Computer equipment accepted (first site)

The Navy considered the following cost factors over an 8-year system life:

--Computer equipment (both hardware and system software).

--Maintenance.

--Desirable features.

--Site modification/installation.

--Power and cooling.

--Training tuition.

The Navy did not include (1) the terminal equipment requirements of the Naval Education and Training Command's online data base processing system, (2) operator personnel costs for the new computer equipment, or (3) software conversion or dual equipment operation costs.

Impact of conversion

For the most part, conversion costs could not have been avoided because one incumbent, RCA, is no longer manufacturing computer equipment and the other, IBM, did not submit a proposal.

The Navy's approach to conversion is to convert existing application software on a line-for-line basis to minimize the dual equipment operation period and its costs. However, the application software which had been fine tuned for the old computer over the years would not be optimal when processed on the new one. The Navy contracted for conversion support through three separate RFPs and by using GSA contractor support.

The first software conversion contract was primarily for converting the standard application software that supported

the Naval Air Rework Facilities (implemented at six of the data processing centers). A combination time and materials and firm-fixed-price contract was awarded to the Computer Sciences Corporation in June 1976, 9 months before the hardware contract award.

The second software conversion contract was to convert the application software which supported the Training Command in Pensacola, Florida. This was a cost-plus-fixed-fee contract and was awarded to the Computer Sciences Corporation in April 1978.

The third conversion contract was awarded to Computer Data Systems in July 1978 to convert the application software which was unique to each of the six centers. It was also a cost-plus-fixed-fee contract.

In addition, the Navy is using GSA contract programmers on a task order basis to support the Training Command's conversion.

The Navy is replacing 23 computer systems of varying capacities, ages, and manufacturers with Univac 1100 series computer systems at six regional data processing centers as part of its Data Processing Service Center project. We visited data processing service centers at Norfolk, Virginia; Jacksonville, Florida; and Pensacola to gather information on conversion costs and problems.

Norfolk computer center

The data processing center here is one of the Navy's largest centers and provides support to the Atlantic Fleet and other activities in the Norfolk area; it performs primarily batch-oriented jobs. A Univac 1100/42 computer system replaced two RCA 3301 computers and an RCA Spectra 70/45 computer. The Norfolk center converted 620 application programs and nearly 531,000 lines of program code at a cost of about $950,000. The software conversion effort began in March 1977, acceptance testing of the Univac computer was completed in March 1978, and the RCA computers were released during June and July 1978. The center encountered no major problems and accomplished the conversion with only a 1-month slippage in the scheduled release of the old equipment. Good planning and management contributed greatly to the success of the conversion. Conversion costs and user disruption were minimized.

After the conversion, the center began a project to identify application programs that needed to be modified for more efficient operation on the new computer. The applications

will be selected on the basis of computer resources presently consumed, processing frequency, and whether the application has had a history of problems. A Navy official estimated that 80 percent of the converted programs would be candidates for modification and that it would take 3 years.

Jacksonville computer center

This center provides support to users in the Jacksonville area; it also performs primarily batch-oriented jobs. The major user is the Naval Air Rework Facility. A Univac 1100/41 computer system replaced two RCA 3301 computers. The center converted 207 application programs and nearly 125,000 lines of program code at a cost of about $559,000. To accomplish the conversion, the center used its own ADP personnel, personnel from another Navy data processing center, and contractor personnel from Computer Data Systems and Univac. The software conversion began in August 1977; the Univac computer was installed in October 1978; and the RCA computers were removed in April 1979.

The major problem encountered was not software conversion, but frequent breakdowns of the old computers during the conversion. Because of the age and condition of the RCA equipment, Navy officials were reluctant to move it. Consequently, the Univac computer equipment was installed around the RCA computers. About 1,600 square feet of warehouse space was modified to accommodate the new equipment at a cost of about $315,000. The center had experienced breakdown problems with the RCA computers for several years; however, the problems were magnified because of the conversion due to a combination of several factors:

--The RCA computers were 13 years old and in poor mechanical condition.

--Repair parts were costly and difficult to obtain.

--Site modification construction created a lot of dust and caused power outages and air conditioning failures.

--The equipment maintenance contractor was nonresponsive and used inexperienced repair technicians once it realized that a followon contract would not be awarded. The inexperienced technicians were not qualified to troubleshoot the RCA equipment and fixed the computers by mass replacement of components which were already in short supply.

The frequent breakdowns of the RCA computers during the conversion were very disruptive to the Naval Air Rework

Facility operations. The facility studied the impact the breakdowns had on its operations and identified about $110,000 in monetary losses for unacceptable data processing services for July 1978. The frequent breakdowns lasted about 5 months during the conversion period. The facility's study concluded that the most significant impact was intangible and summarized the problems as follows:

--Key management reports had not been received or had been received late.

--The validity of the reports was questionable, resulting in constant manual checking to verify data on reports.

--The unreliability and nonreceipt of the reports had caused low morale, thereby creating low efficiency in some work sections.

--About 200 staff-hours at regular rates and another 352 unscheduled overtime hours had been expended in various departments on functions normally done by the computer or manually checking information generated by the computer.

Pensacola computer center

This center provides batch and online support to the Naval Air Rework Facility and the Naval Education and Training Command. A Univac 1100/42 computer system is replacing two RCA 3301 computers, an IBM 360/65 computer, and an IBM 360/50 computer. The RCA computers were used primarily by the Rework Facility, while the IBM computers support the Training Command. The Rework Facility and Training Command software conversion have been managed as separate efforts.

Rework Facility

The center converted 322 application programs that supported the Rework Facility at a cost of about $486,000. The software conversion began in March 1978; acceptance testing of the Univac computer was completed in July 1978; and the RCA computers were released during May and July 1979. The center encountered no major problems during the software conversion, but many little problems caused the conversion to take 5 months longer than planned.

Naval Training Command

The conversion of the Training Command's application software has not progressed as planned, primarily due to the complexity of the system. The Command's application programs

were developed for use with a commercial data base management system and teleprocessing software package and provide batch and online support. The conversion of the Command's application software began in February 1978 and was planned to be completed in August 1979. However, the projected completion date is now September 1980. Major reasons cited for the delay follow.

--The contractor personnel assigned to the conversion were not experienced in using Univac's DBMS software package, which caused a 6-month delay at the outset of the project.

--The Command did not know what terminal equipment would be used for the online system. Conversion of many of the application programs is critically dependent on the specific characteristics and capabilities of the terminal equipment to be installed for online access to the data base.

The Navy orginally planned to include the Training Command's application software in its initial conversion contract awarded in June 1976. However, the command concluded that the RFP would not provide the necessary contractor support because it did not address the more complex conversion effort inherent in the conversion of an online data base system. The Navy's ADP Selection Office later solicited proposals for converting the command's application software and awarded a conversion contract in April 1978 (also to the Computer Sciences Corporation).

Command officials felt that this RFP was also deficient because it did not require that contractor personnel assigned to the conversion project be experienced in using Univac's DBMS and teleprocessing software packages. As the RFP was written, a vendor could still be responsive by assigning personnel (project manager, conversion analyst, programmer) who were not experienced with Univac's or any other DBMS software package. A Training Command official stated that the experience factors had been written in a manner to enable more vendors to compete. However, only one responded.

The estimated cost of the software conversion contract was about $2.2 million to convert 1,131 application programs. The Navy paid the Computer Sciences Corporation about $2.5 million and terminated the contract in August 1979, when 291 application programs had been converted. The command is using GSA contract programmers on a task order basis to assist in the conversion. The GSA contractor providing programmer services in the Atlanta region is the Computer Sciences Corporation.

Software conversion costs for the command's online data base system will cost an estimated $4.5 million if conversion is completed according to the current schedule. In addition, the Pensacola data processing center and the Training Command spent about (1) $705,000 to modify warehouse space to house both the old and new computers during the conversion, (2) $495,000 to train ADP personnel, and (3) $3 million to operate the old computers after the new Univac computer became available for productive use.

We believe that the Navy did not appreciate the magnitude of the conversion problem in an online data base environment, or it would have required the contractor to be experienced in using both Univac's DBMS and teleprocessing packages. One of the main reasons for hiring contractors is to obtain resources familiar with the new computer system, but this was neither required in the RFP nor achieved in this case. Furthermore, the Navy compounded the conversion problem by not specifying the command's terminal requirements when soliciting proposals for the hardware.

Summary assessment

Since the incumbent vendor was no longer manufacturing computer equipment and another incumbent vendor did not submit a proposal, conversion was unavoidable. For the most part, the Navy did a good job in planning and managing its data processing service center project conversion.

CASE 4: USDA, KANSAS CITY COMPUTER CENTER

The Department of Agriculture's Kansas City Computer Center provides primarily batch data processing support to four USDA organizations:

--The Management Field Office and the Kansas City Commodity Office of the Agricultural Stabilization and Conservation Service.

--The Federal Crop Insurance Corporation.

--The Finance Office of the Farmers Home Administration.

The center operates like a service bureau in that the user organizations develop their own application software and are charged by the center for computer resources used.

Why the procurement was needed

Based on a study in January 1976 of user workload at both the Kansas City and St. Louis computer centers, USDA determined that a single center in Kansas City would satisfy its needs. The computers being replaced included two IBM 360/50 computers, two IBM 1401 computers, and two IBM 7074 computers at Kansas City as well as Burroughs B-3500 and B-4781 computers at St. Louis. Reasons cited for replacing the existing equipment were that it was obsolete and saturated and could not meet growing user requirements.

The procurement

USDA developed the two-step mandatory option method of procuring hardware and software conversion services to satisfy Federal procurement policy and regulations and to allow both hardware and software vendors to compete for the firm-fixed-price software conversion contract. Application programs included in the conversion portion of the RFP were limited to those programs written in standard high level programming languages which had expected useful lives at least equal to the hardware system life and were being processed on third generation computers. The approach to software conversion for the application programs meeting this criteria follows.

--Conversion was a mandatory-option item in the competition for computer equipment. That is, it was mandatory for each hardware vendor to quote a separate price for the conversion described in the RFP and optional that USDA accept that offer. Award of the

contract for equipment was based on the lowest total cost, including conversion.

--After an award for equipment was made, an RFP was issued for conversion only. At that time the successful equipment vendor, and any other vendor, including any whose business was exclusively software, was allowed to bid.

--The conversion contract price ceiling was the difference between the successful equipment vendor's total cost (less conversion) and the next lowest bidder's total cost. The reason for the price ceiling was that if the total price of the equipment and conversion contracts exceeded the total bid of the second low bidder, that bidder would have been justified in protesting.

USDA requested a delegation of procurement authority (DPA) in August 1976 from GSA to conduct the procurement. The authority was granted in April 1977. USDA then sent the RFP to 55 interested vendors. However, before any proposals were received, Burroughs Corporation submitted a bid protest to the Comptroller General based largely on USDA's requirement that hardware vendors submit proposals for software conversion. Burroughs' contention was that USDA was forcing hardware vendors into the software field in order to remain competitive, contrary to Federal procurement law and regulations.

The Comptroller General, in his decision of November 29, 1977, ruled that the requirement that hardware vendors must submit separate proposals for software conversion does not restrict competition because, despite the allegation that hardware vendors are being forced into the software field, the RFP contained no restriction on subcontracting.

IBM, Univac, Honeywell, Itel, and the Federal Data Corporation submitted proposals. Subsequently, Itel and the Federal Data Corporation withdrew from the competition. Benchmark tests were completed during November 1977; all three remaining firms passed the benchmark. Best and final offers were received by January 24, 1978, and the contract was awarded to Honeywell on January 27, 1978, based on the lowest 6-year system life cost. The Honeywell proposal represents nearly a 60-percent discount off the GSA ADP Schedule list price.

Consistent with its procurement strategy, USDA then solicited proposals for the software conversion. Two firms specializing in software submitted proposals in addition to

the Honeywell proposal already submitted. USDA then evaluated the three software conversion proposals on the basis of technical and experience factors, and cost. The software conversion contract was awarded to Rand Information Systems on May 15, 1978.

The following is a chronology of major events leading to the acquisition of the Honeywell 66/80 computer system.

January	1976	Site location study completed
June	1976	Requirement analysis completed
August	1976	DPA requested
April	1977	DPA granted
May	1977	RFP issued
July	1977	Bid protest submitted
August	1977	Proposals received
November	1977	Protest denied
November	1977	Benchmark completed
January	1978	Best and final offers received
January	1978	Hardware contract awarded
May	1978	Software contract awarded
May	1978	Computer equipment installed

USDA included the following cost factors in evaluating proposals:

--Computer equipment (both hardware and system software).

--Maintenance.

--Desirable features.

--Residual value.

--Site modification/installation.

--Operator personnel.

--Training tuition.

--Power and cooling.

--Application software conversion.

Impact of conversion

The application programs considered for conversion in the bid evaluation represented about 80 percent of the COBOL and FORTRAN programs being processed on the IBM 360/50 computers and supported only the Management Field Office applications.

Management Field Office officials stated that although they had not formally estimated conversion costs, three alternatives for handling application software conversion had been considered before soliciting proposals. These were (1) to translate existing programs on a line-for-line basis, (2) to rewrite existing programs to take advantage of the new equipment's capabilities, and (3) to redesign the application software to provide additional functional capability.

Because of limited ADP staff, the Management Field Office decided to convert the majority of its application programs on a line-for-line basis through two firm-fixed price contracts. The other Kansas City Computer Center users either converted their application programs in-house or had already begun to redesign their application systems.

The first software conversion contract was the mandatory-option portion of the hardware procurement already described. It was awarded to Rand Information Systems, a firm specializing in software conversion, on May 15, 1978, and was originally expected to last 12 months and cost $811,348. The second fixed-price software conversion contract called for converting application programs running on the center's second generation computers as well as some of the application programs that were runnning on the IBM 360/50 computers. It was awarded to the Computer Sciences Corporation on September 18, 1978, and was expected to take 24 months and cost $636,392.

The Management Field Office has made several modifications to the Rand Information Systems software conversion contract. As a result:

--The contractor portion of the conversion was completed in 18 months instead of the 12 originally contracted for.

--Over 140,000 lines of program code were deleted from the contractor's scope of work.

--The contract will cost about $40,000 more than the $811,348 originally contracted.

A Management Field Office official stated that the programs had been eliminated from the contract because the farm legislation they supported was no longer in effect and that some should not have been included in the contract in the first place.

Contributing to the longer conversion period and higher cost was the fact that USDA placed a priority on changes to application software to minimize disruption to the farm

programs they supported; some changes were mandated by legislation. Having been assigned to make such changes, in-house programmers were not available to prepare the required documentation (that should accompany the application programs when they go to the contractor) in time to meet contract deadlines. Placing a priority on application software changes has also delayed the implementation of the programs converted by the contractor.

As of January 1980, only 14 of the 571 application programs converted by Rand have been put into production. The changes made to the application programs after the conversion began now have to be made to the application programs converted by Rand. The Management Field Office estimates that the software conversion will be completed by December 1980. Although the Office did not evaluate the impact on conversion costs, USDA officials believe that placing priority on application program changes was justified because effective support of Federal programs affecting farmers was considered far more important than delays or added expense in the conversion. This is a judgment call.

Application programs not considered in the evaluation of vendor proposals but which still had to be converted were those programs

--developed and/or implemented after the RFP was issued,

--having expected useful lives of less than 6 years, and

--processed on the IBM 7074 and IBM 1401 computers.

Also, in-house personnel costs associated with the software conversion were not considered.

USDA also did not consider dual equipment operation costs or in-house training costs. We estimate that software conversion costs for all the Kansas City computer center users will total more than $3.4 million. This includes all in-house support of the contractor conversion efforts and the in-house conversion of other application programs that must be converted but did not fall within the criteria developed by USDA for consideration in the hardware proposal evaluation. In addition to incurring costs for software conversion, the center and its users will spend about $1.8 million to train their ADP staffs on the new computer and about 3 million to operate the old computers after the installation of the replacement computer.

We adjusted the costs used to determine the winning vendor to reflect appropriate conversion costs and found that the Honeywell 6-year system life cost was about $2.2 million less than if the incumbent, IBM, had been selected. Also, had USDA considered emulation to reduce the time and costs of dual equipment operation, the cost difference between the two proposals could have been reduced by about $410,530. We estimate that the IBM 7074 emulator cost would have been about $143,750 while the cost to operate the IBM 7074 computers for the same period will total about $554,280. We have not included the cost of emulation versus the cost of operating the old equipment in determining the lowest system life cost because the benchmark did not call for emulation. If it had done so, IBM may have had to propose a more powerful hardware configuration.

Summary assessment

The price obtained through competitive acquisition more than offset conversion costs. Some management difficulties were caused by external factors (e.g., changes mandated by legislation).

CASE 5: USDA, NEW ORLEANS COMPUTER CENTER

The New Orleans computer center provides USDA's National Finance Center with batch and on-line data processing services to support centralized administrative functions, such as payroll, personnel, billings and collections, and accounting and financial reporting. The Finance Center is replacing an IBM 360/65 computer, two IBM 7080 computers, and two IBM 1401 computers with a Honeywell 66/80 computer system. The IBM 7080 and 1401 computers are used to process USDA's payroll and personnel system. This system is being redesigned rather than converted; that is, the system will provide new functions and capabilities.

Why the procurement was needed

Based on a study of user requirements in April 1976, the Finance Center determined that it would have to augment its IBM 360/65 on an interim basis and then competitively acquire a replacement computer in January 1978. Subsequently, the Finance Center revised its analysis and improved the existing system. 1/ The revised analysis was used as the basis for the replacement procurement. Reasons cited for replacing the existing equipment were that it was saturated and/or obsolete and could not meet growing user requirements.

The procurement

USDA also used the two-step mandatory-option method of procuring hardware and software conversion services. (See p. 53.) USDA requested a DPA in December 1976 from GSA to conduct the procurement. The DPA was granted in June 1977. Agriculture sent the RFP to 59 interested vendors and 6 requested benchmark materials. The Burroughs Corporation's bid protest already discussed also applied to this procurement.

IBM, Univac, Honeywell, Itel, and the Federal Data Corporation submitted proposals. Subsequently, Itel and the Federal Data Corporation withdrew from the competition. Benchmark tests were completed during December 1977; all three remaining firms passed the benchmark. Negotiations were then held with the vendors, and best and final offers were received in February 1978. The contract was awarded on March 3, 1978,

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1/For further discussion of the requirement analysis, see our report "Cooperative Actions Result in More Economical Computer Acquisition and Improved Security at the New Orleans Computer Center," LCD-77-118, December 23, 1977.

to Honeywell based on the lowest 6-year system life cost. The Honeywell proposal represents a 75-percent discount off the ADP Schedule list price.

The following is a chronology of major events leading to the acquisition of the Honeywell 66/80 computer system.

April	1976	Requirement analysis made
December	1976	DPA requested
June	1977	DPA granted
July	1977	RFP issued
July	1977	Bid protest submitted
August	1977	Software conversion RFP issued
September	1977	Proposals received
November	1977	Bid protest denied
December	1977	Benchmark completed
February	1978	Best and final offers received
March	1978	Hardware contract awarded
July	1978	Computer equipment accepted

USDA included the following cost factors in evaluating proposals:

--Computer equipment (both hardware and system software).

--Maintenance.

--Desirable features.

--Residual value.

--Site modification/installation.

--Operator personnel.

--Training tuition.

--Power and cooling.

--Application software conversion.

Impact of conversion

The application programs considered for conversion in the hardware proposal evaluation included 951 COBOL programs that were processed on the IBM 360/65 computer. Application programs not included in the proposal evaluation but which still had to be converted were those programs

--written in assembly level language, 1/

--using a commercial DBMS software package, 1/

--using a commercial teleprocessing software package, and

--developed and/or implemented after the RFP was issued in August 1977.

USDA also did not consider dual equipment operation costs or in-house training costs in evaluating proposals.

Consistent with its procurement strategy, USDA solicited best and final proposals for the software conversion after the hardware contract was awarded to Honeywell in March 1978. Two firms specializing in software submitted proposals in addition to the Honeywell proposal. However, in July 1978, the Finance Center determined that it would be less costly to accomplish the conversion without contractor support. USDA then informed the vendors that a software conversion contract would not be awarded.

The study developed by the Finance Center to support its contention that the conversion effort should be performed without contractor support underestimated the cost, time, and complexity of the conversion process. Of greater significance, the study did not assess the impact of in-house conversion efforts on available ADP staff resources or the costs of prolonged dual equipment operation. In addition, the Finance Center did not develop an adequate plan that identified resources to do specific conversion tasks and defined milestones for each task.

The poor planning was compounded by technical problems associated with the new computer's system software and by competing commitments to redesign the payroll and personnel system and modify existing application programs. As a result, all work on the conversion was suspended in June 1979; about 750 application programs were yet to be converted. As of December 1979, no determination had been made as to when the conversion would resume.

When the conversion was suspended, the Finance Center had converted 296 application programs and performed some work on 127 others at a cost of about $338,000. It had also spent about $1.7 million through September 30, 1979, to operate the IBM 360/65 computer after the Honeywell 66/80 computer

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1/See glossary.

became available for productive use. The IBM 360/65 computer cannot be released until the software conversion is complete. Each month's delay in completing the software conversion will add nearly $120,000 to the total conversion cost.

The IBM proposal was considered to be nonresponsive to the RFP. We could not determine why the proposal had been considered nonresponsive or what the total cost of the proposal was because USDA officials responsible for the procurement were no longer employed by USDA and the information was not available in the procurement files at Agriculture Headquarters or at the National Finance Center.

Of the nearly $7.5 million that we estimate it will cost the Finance center to convert, about $6.4 million was not included in the evaluation of proposals. In addition, there were potential savings and reduced maintenance problems by emulating the IBM 7080 computers rather than operating them during the redesign of the payroll and personnel system. In early 1976, IBM announced that, effective December 31, 1979, maintenance support for its 7080 computers would depend on the availability of skills and other resources such as parts, tools, and test equipment, and that orders for maintenance parts, in reasonable quantities, would continue to be accepted until stocks were depleted. (See p. 49 for discussion of problems of maintaining equipment no longer supported by the manufacturer.)

Summary assessment

Given that the incumbent's proposal was considered nonresponsive, conversion became unavoidable. Management of the conversion was deficient.

CASE 6: VA TARGET SYSTEM PROJECT

The Veterans Administration is developing a new computer system to modernize the veterans' benefit payment system and improve services to veterans. The system is called Target and, once implemented, is expected to provide (1) more timely delivery of initial benefit checks, (2) faster response to veterans' inquiries, and (3) major savings from workload reductions in the regional offices because of more efficient procedures and workflow.

Target will use computers in three regional computer centers to provide data entry and automated claims-processing capabilities to the VA regional offices. The system will have a central computer facility--the Target Central System--for maintaining master records; centralized reporting and accounting; and generating payment notices to the Treasury Department, which prints the benefit checks. The stated key operational features of Target are:

--Computerized processing and control of claims in the regional offices, including automatic calculation of benefit awards, control of pending claims, and workload reporting.

--Immediate response to veterans' inquiries concerning (1) the status of claims in process, (2) the status and amounts of award checks, and (3) information in the master records.

--Automated printing of awards, acknowledgments, and other routine letters.

--Ready access to information for reporting.

Terminals, installed in 57 of the 58 regional offices and the records processing center, will be connected to the three regional computers by telecommunications lines. Input data will be transmitted from the regional offices to the regional computers, each of which will maintain online work-in-process control files on pending claims within its region. These files will be updated automatically as a by-product of claims processing. The regional offices will be able to obtain (1) information concerning pending claims from the regional computer files and (2) information from the master files at the central computer facility through the regional computers. In addition, the regional computers will link the regional offices to a claimant locator system at Austin, Texas.

Why the procurement was needed

The present compensation, pension, and education benefit payment system was initially designed and installed in the late 1950s. It is primarily a manual system; only the claims payment process is automated. Claims processing and financial activities are performed in all regional offices. These activities include (1) awarding or disallowing claims, (2) interacting with veterans and beneficiaries, and (3) maintaining veterans' and beneficiaries' claim folders. The regional offices prepare various input for computer processing, accumulate the input into batches, and send it to the Hines, Illinois, computer center. Once at the computer center, the input is transferred onto magnetic tape and sequentially processed to

--update the compensation, pension, and education master files;

--generate payment notices to Treasury;

--generate various operational and management reports; and

--perform various accounting functions.

VA characterized the present benefit payment system as technically limited, labor intensive, and paperbound and proposed Target to improve efficiency and take advantage of new ADP technology.

In April 1972, a task force established to study ways to improve the present benefit payment system concluded that service to veterans was being impeded by file folder control problems, slow access to status information on claimants, error rates and repeat processing of cases, and delays in obtaining data from sources outside VA. The task force devised and recommended an "ideal," or "target," system which could serve as a design goal for VA. After evaluating the task force's report, the Administrator of Veterans Affairs in July 1972 adopted the Target system as a policy goal and designated a team to complete a comprehensive system redesign by December 31, 1973.

VA decided to test the operational feasibility of the Target concept and requested a DPA in August 1973 from GSA to acquire equipment for a pilot test. The DPA was granted in December 1973. In September 1974, VA began a pilot test of Target processing concepts in Philadelphia and Baltimore using IBM computer equipment. Terminals in selected units of the Philadelphia and Baltimore regional offices were linked

with the computer center in Philadelphia, which served as a regional computer center. The Philadelphia center was also linked with the computerized claimant locator system in Austin, and the centralized master files of the benefit claims system at Hines.

The procurement

In June 1975, VA delivered the RFP for the Target computer equipment to GSA for release to industry. On July 17, 1975, VA was officially notified that GSA would conduct negotiations and procure the needed hardware, software, and services. GSA had been working with VA informally on the procurement since March 1974.

The RFP was issued on January 5, 1976. However, on February 19, 1976, all potential offerors were informed that the procurement was being suspended pending the outcome of an investigation by the House Appropriations Committee. On June 15, 1976, the procurement resumed; the number of regional data processing sites had been reduced from four to three.

Vendors were allowed to submit proposals for the computer equipment at the regional data processing sites or for the terminal system. Combined proposals were allowed, but had to be accompanied by a separate proposal for the computer equipment. Six vendors--Honeywell; Burroughs; GTE Information Systems; FPMR, Inc.; Four Phase Systems; and Delta Data Systems--submitted proposals on December 1, 1976. Subsequently, FPMR, Inc., Four Phase Systems; and Delta Data Systems either withdrew from the competition for the terminal system or were declared nonresponsive. Of the three remaining vendors, only Honeywell submitted a combined proposal; that is, Honeywell proposed to provide the equipment for both the regional processing and terminal systems.

Benchmark tests were completed during August 1977; all three remaining firms passed the benchmark. Best and final offers were received on September 12, 1977, and the contract was awarded to Honeywell on October 25, 1977, based on the lowest 102-month system life cost. VA has the option to extend the contract for 7 more years. The Honeywell proposal represents a 58-percent discount off the GSA ADP Schedule list price and savings over the list price of about $52.5 million. The following is a chronology of major events leading to the acquisition of the Honeywell system.

February	1972	Problems defined
September	1972	Requirement analysis for redesign made
August	1973	DPA for pilot requested
December	1973	DPA granted

September	1974	Target pilot test begun
June	1975	RFP delivered to GSA
January	1976	RFP issued
February	1976	RFP suspended
June	1976	RFP suspension lifted
December	1976	Proposals received
August	1977	Benchmark completed
September	1977	Best and final offers received
October	1977	Contract awarded
June	1978	Computer equipment accepted (first site)

VA included the following cost factors in evaluating proposals:

--Computer equipment (both hardware and system software).

--Maintenance.

--Operator personnel.

--Power and cooling.

--Residual value.

--Site modification/installation.

--Training (tuition only).

Impact of conversion

VA did not include software conversion costs, dual equipment operation costs, or in-house training costs in the evaluation of proposals. The Target concept is a complete system redesign; that is, the system will provide new functions and capabilities. Nonetheless, VA incurred substantial conversion costs to operate the IBM computers after the Honeywell computer became available for productive use and to train its ADP personnel.

As discussed in the main section of this report (see p. 11), VA decided to make an interim conversion of its old system to an automated system which would serve until Target was installed. We estimate that Target conversion costs, including the interim conversion, will total about $13.8 million, as follows:

Conversion cost element	Amount
Application software conversion	$4,582,243
Site modification/installation	3,783,963
Dual equipment operation	3,892,997
Training	1,512,806
Total	$13,772,009

This amount includes training costs for VA ADP personnel at the Central Office and the regional processing centers in Los Angeles, Philadelphia, and Hines. It also includes the site modification/installation costs for those three centers. We did not include the cost to convert the application software developed for the Pilot test because VA would have faced substantial costs to convert the Pilot software whether IBM was the winning vendor or not. Pilot was only a test of the operational feasibility of the Target concept on VA operations. As such, the data base was much smaller and only five regional offices were involved. VA officials believed that a complete technical redesign using a different DBMS software package would have been necessary to convert from the Pilot system to the planned Target system on a larger IBM computer with a nationwide data communications network.

After the RFP was released, VA, at the direction of the House Appropriations Committee, tried to include conversion costs as an evaluation factor. However, GSA would not allow VA to do this. In this procurement, conversion would not have affected the selection decision because the incumbent vendor did not submit a proposal. One reason IBM cited for not submitting a proposal was that conversion costs were not a factor in determining the lowest overall cost to the Government.

Summary assessment

Had VA better estimated its conversion costs, it could have concluded that the interim conversion would be so costly that it should not be tried. Had this occurred, over $2.5 million would have been saved. Contributing to the high software conversion costs were the fact that VA had to (1) rewrite (optimize) many of the converted programs to achieve acceptable processing times on the new computer and (2) modify existing application programs on the old computer in response to changes mandated by legislation. These modifications then had to be made to the programs already converted by the contractor and running on the new computer.

CASE 7: CORPS OF ENGINEERS, PORTLAND, OREGON

The North Pacific Division of the Army Corps of Engineers replaced its IBM 360/50 computer with a larger, compatible IBM 370/155 computer. The primary mission of the corps' computer center is to support the Columbia River Operational Hydromet Management System (CROHMS). CROHMS serves five other Federal agencies: (1) the Bonneville Power Administration, (2) the Bureau of Reclamation, (3) the National Weather Service, (4) the U.S. Geological Survey, and (5) the Soil Conservation Service. The objective of the management system is to achieve multiple purpose water uses, such as flood control, power production, recreation, and fisheries migration.

Why the procurement was needed

CROHMS originally consisted of a series of simulation models that used manual inputs to predict riverflows. As the models became more sophisticated and automatic monitoring stations were installed (400 are now in operation), the elapsed time to process the models became unacceptable. By the spring of 1973, the IBM 360/50 computer was already 90 percent central processor unit bound. To improve system's performance, the corps

--increased the computer's main memory, 1/

--changed hardware configurations,

--continually tuned the system by decreasing the operating system 1/ overhead through improvements available from IBM user groups, and

--optimized application programs through COBOL and FORTRAN optimizers.

The procurement

In May 1975, the corps' North Pacific Division requested a sole source procurement to replace the IBM 360/50 computer. The request was reviewed by the corps and Army Headquarters and finally by us at the request of the House Government Operations Committee. After our review, the Committee instructed GSA to direct the corps to replace the IBM 360/50 computer with an IBM 370/155 computer or its equivalent, but

1/See glossary.

to limit the interim use of this computer to 42 months and accomplish a competitive procurement.

For the interim upgrade procurement, 11 proposals were submitted by 10 vendors. The contract was awarded to COMDISCO on August 5, 1977, and the computer was installed in September 1977. The IBM 360/50 computer was kept for 6 weeks as a back-up but was not used. Conversion costs totaled an estimated $33,000, as follows:

Cost element	Amount
Site modification/installation	$ 4,839
Software conversion	13,930
Dual equipment operation	4,936
Training	9,230
Total	$32,935

Conversion costs were very low because the IBM 370/155 computer is compatible with the corps' IBM 360/50 computer. The software conversion costs were incurred primarily to change job control language statements.

We had visited the Corps of Engineers to find out what conversion costs were going to be considered when the corps competitively replaced its IBM 370/155 computer. The corps estimated that application software conversion costs for a noncompatible replacement computer would total more than $2.5 million. On August 28, 1979, the Department of the Army (for the corps) requested a DPA from GSA for the competitive replacement of the IBM 370/155 computer with a plug and software compatible computer. GSA granted the authority on November 23, 1979.

APPENDIX III

Congress of the United States
House of Representatives
Committee on Appropriations
Washington, D.C. 20515

October 5, 1978

Honorable Elmer B. Staats
The Comptroller General
General Accounting Office
441 G Street, N.W.
Washington, D. C. 20548

Dear Mr. Staats:

We have reviewed with great interest your letter of August 23 concerning ADP acquisition costs. The question of the type of cost analyses that should be used in the procurement of automatic data processing machines is an important one since Federal ADP costs have been estimated at over $5 billion annually. That figure is probably a bare minimum since estimates run to three times as high.

The Committee, after long experience in the area of setting funding levels in the appropriation process, feels that lowest overall cost should be a primary consideration in the execution of Federal programs. Consequently, our objectives are to ask the industry and the using agencies to consider total costs, to develop products and solutions which will deal with total costs and requirements, and to derive maximum benefits from computer technology. We have been advocating lowest total cost which includes not only hardware procurement costs, but conversion, operation, installation, training, and other costs over the life cycle of the system. Thus, inclusion of all relevant costs in the selection process is designed to yield a least cost alternative over the life of a system. On the other hand, it is our opinion that exclusion of certain costs may yield uncertain and intangible results.

These observations have been fortified recently by a study done by the Committee's Surveys and Investigations Staff. Our investigators,

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after reviewing several procurements, discovered that "too little consideration is given to the other 'cost drivers' associated with ADP acquisition and operation, i.e., lowest total overall cost (LTOC) is not being achieved because certain cost factors are ignored."

The Committee does not support the notion of "lock-ins" or limited competition. The idea that the exclusion of certain costs will encourage competition warrants further scrutiny. How can competition be increased or encouraged if vendors are not asked either to bid on a complete package or at least have their proposals included in a comprehensive analysis that considers total cost? We will never have healthy competition in the Federal marketplace unless vendors and agencies are forced to deal with these realities. Certainly, the industry is capable of designing conversion aids and otherwise proposing systems that will deal with this problem. To stop short of that expectation will foster a quasi-competition that does not fit any model of "free and perfect" nor does it promise to achieve least cost. Instead, we should examine the prospect of turning the policy around--make the ADP procurement process deal with total cost -- then we will truly have the type of full and open competition (including "third-party" vendors) that will produce meaningful savings.

In this regard, the investigative study states that, in carrying out their procurement responsibilities: "GSA has concluded that a complete evaluation of costs somehow prohibits competition -- a position which the Investigations Staff does not support. Competition is indeed a major cost factor and the Government's program must continue to encourage competitive procurements. Competition is best, however, when the Government does not sublimate its true need, but instead, challenges industry to respond with the best solution. This is not being done".

Hardware technology represents another component of the problem. Computer hardware "families", upward compatible with significant savings over complete replacement, have been developed by the industry at a cost of hundreds of millions, perhaps billions, of dollars. Much of this development effort has been subsidized by the Federal government since these costs are normally passed through to purchase and lease prices. When we ignore certain cost components, we implicitly bias the procurement decision away from the selection of an upward compatible component or system. We are thus rejecting the fruits of the computer industry's enviable R&D progression, while at the same time paying for its advances. Serious questions should be raised about a procurement principal that encourages this practice.

Finally, the seemingly unanimous acceptance of the superiority of standard languages should be examined in some detail. Has the General Accounting Office developed any specific benchmarks which conclusively demonstrate the desirability of converting systems to standard languages?

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Certainly, there must be instances where maniframe oriented software renders more effective and economic operational results to more than offset the development cost savings associated with standard languages. Also, has the conversion of existing systems to a standard language been proven cost-beneficial? Why not wait until the next software generation of a particular system and then decide, based upon impartial and objective procedures, the software that should be used to operate a computer application?

There are many elements in the ADP matter that should be reevaluated. We want to be sure that Federal procurement policies are arrived at based on a thorough and in-depth analysis of all the factors.

I am pleased you plan to conduct a review of this subject and trust it will shed further light for all of us.

Sincerely,

Chairman

APPENDIX IV

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

B-115369 May 10, 1979

The Honorable John N. Erlenborn
House of Representatives

Dear Mr. Erlenborn:

Your letter of October 3, 1978, requested our opinion as to whether the Brooks Act, Public Law 89-306, 40 U.S.C. § 759 (1976), restricts the implementation and use in procurement for automatic data processing equipment (ADPE) of those life cycle costs set out in Office of Management and Budget (OMB) Circular No. A-109. In this connection you point out that the General Services Administration (GSA) requires that the conversion costs of acquiring ADPE not be allowed to prejudice free and open competition and you believe that in practice conversion costs are not being duly considered.

We believe the Brooks Act imposes no constraints upon evaluation of conversion costs or other life cycle costs except that their consideration must promote the economic and efficient purchase, lease and maintenance of ADPE. The wording and the legislative history of the Brooks Act contain no indication of an intent to require treatment of life cycle costs, including conversion costs, in a manner unique to ADPE procurements. The promotion of economy and efficiency compels consideration in each ADPE procurement of the appropriateness of evaluating software conversion and other life cycle costs. This consideration requires a balancing of many varying factors such as the predicted useful life of the system, the reliability and magnitude of the estimates of such costs and the impact on short and long range competition. In any particular case, these factors may or may not indicate that a selection without regard to life cycle costs may contribute more to economy and efficiency than a selection where all or a portion of such costs have been included in the evaluation. Thus, we believe the Brooks Act does not preclude consideration of conversion costs, but leaves to the reasonable discretion of GSA the determination of when it is and is not appropriate to consider such costs.

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Federal Procurement Regulations, Temporary Regulation 47, September 12, 1978, expresses the current policy of GSA with respect to ADPE acquisitions and OMB Circular A-109. It provides that major ADP systems shall be acquired in accordance with, among other things, the agency's A-109 implementing procedures and that where evaluation criteria include technical considerations or points, GSA will insure that such criteria result in a selection meeting the agency's needs at the "lowest ultimate overall cost, price and other factors considered." We see nothing in the Brooks Act prohibiting this policy.

GSA reports that where it has been previously determined that technical superiority is not more important than cost, the basis for contract award is the lowest overall cost over the life of the ADP system or item. The term lowest overall cost is defined in Federal Procurement Regulations (FPR) § 1-4.1102-14 and Federal Property Management Regulations (FPMR) § 101.35.206(c) (2)(ii). While the FPR definition does not refer specifically to conversion costs, it does enumerate such cost elements as site preparation, installation, programming and training which account for the major costs of converting from the product line of one vendor to that of another. The FPMR definition specifically includes conversion costs and states that in some instances the evaluation of all conversion costs may not be in the best interest of the Government over the long term. GSA is studying the feasibility of amending its regulations to address specifically the evaluation of conversion costs in order to check the tendency of agencies to upgrade repeatedly within the product line of one vendor without effective competition. In our view, the present regulations do not conflict with the mandates of the Brooks Act.

The comments of December 12, 1978, from GSA have been considered in the preparation of this letter. Although requested on October 31, 1978, no comments from OFPP have been received.

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B-115369

Unless you publicly announce its contents earlier, we plan no further distribution of this opinion until 30 days from its date. At that time, we will send copies to interested parties and make copies available to others upon request.

Sincerely yours,

Comptroller General
of the United States

GSA DRAFT REGULATIONS ON THE TREATMENT OF CONVERSION COSTS IN EVALUATING VENDOR PROPOSALS

"* * * 1-4.1109-12 Evaluation of conversion costs.
(a) Conversion costs which can be stated in dollars for software, including data base management systems and data base conversion, system test, parallel operations and other expenses directly related to the conversion from installed ADPE [automatic data processing equipment] and software to augmentation or replacement ADPE and software shall be included in the evaluation for determining the lowest overall cost, price and other factors considered. The following are examples of other factors that should be considered:

(1) Economic benefits clearly attributable to increased agency productivity.

(2) Direct savings that would accrue to the Government from the release of rented ADPE, discontinuance of commercial ADP services, or reduction in telecommunications costs.

(3) Indirect savings derived from reductions in other than ADPE or ADP service costs such as space and/or non-ADP personnel support expenses.

(4) Benefits from being able to implement new applications which otherwise would have to be deferred, either indefinitely or to a significantly distant point-in-time.

(5) Economic advantages resulting from providing the capability to accommodate projected increases in workload without contracting for further augmentation or replacement of the ADPE or acquisition of commercial ADP services.

(6) Potential savings due to the availability of software already developed and available from the Federal inventory or commercial market place which could be used to meet additional agency requirements.

(7) Proven reliability of the equipment and operating system software in similar operating environments.

(8) The continued availability of operating system software support and maintenance services beyond the initial system/item life that would enhance the probability of reutilization of the ADPE within the Government.

(9) The potential for supporting other agencies through the ADP sharing program."

"(b) The statement of requirements for an augmentation or replacement acquisition that is limited to ADPE or software compatible with the installed system shall be:

(i) Supported by a conversion cost study, and

(ii) Justified on the basis of agency mission essential data processing requirements and economy and efficiency, provided the requirements of 1-4, 1109-15 are met. ***

*** 1-4.1109-14 Determination of Conversion Costs

(a) Costs directly related to the conversion from the installed ADPE, software, data bases, and telecommunications software to the replacement system and project management costs shall include but are not limited to:

(1) Conversion of the following software by reprogramming, recoding, or translation:

(i) Existing software written in Federal Standard or other ANSI [American National Standards Institute] Standard higher level language; and

(ii) Application software written in assembly or other nonstandard languages that will continue to meet essential agency mission needs without redesign, provided that continued use of the nonstandard software can be justified on the basis of economy and efficiency; and

(iii) Mission essential application software to be developed for operational use before the augmentation or replacement ADPE and operating system software is installed provided the software is written in Federal Standard or other ANSI Standard languages;

(2) Conversion of data bases, data base design changes, and data base management systems to the extent necessary to permit the continued use of existing application software.

(3) Firmware required solely to permit the continued use of application software;

(4) Site preparation and modifications to installed environmental controls;

(5) Parallel system operation to support mission essential data processing requirements, including off-site data processing support,"

"(6) Travel and training expenses, including pay and fringe benefits of Government employees during attendance at formal classroom training courses; and

(7) General expenses directly related to the conversion effort, e.g., conversion planning, preparation, and management and supplies and any additional general purpose software required to support the conversion.

(b) Changes in agency data processing requirements, operating system software and equipment technology limit the useful and economic life of application software. Normally, the life expectancy of application software is about five to ten years before redesign and reprogramming is necessary. The costs of technology updating which are deferred must eventually be reckoned with, regardless of whether application software is converted from one ADP system architecture to another. The costs incurred for the redesign of application software in technology updating are not bona fide conversion costs and they shall not be evaluated for the purpose of determining the lowest total overall cost offer/bid. These technology updating costs include:

(1) The conversion of existing software and data bases which are to be redesigned.

(2) Purging duplicate or obsolete software and data bases;

(3) Development of documentation for existing application software; and

(4) Improvements in management and operating procedures.

(c) Standard cost factors, such as those contained in the OMB Cost Comparison Handbook (Supplement No. 1 to OMB Circular A-76) shall be used to the maximum practicable extent in preparing conversion cost studies and estimates. These cost factors may be supplemented by industry standards or agency developed cost factors, as necessary. ***"

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