United States General Accounting Office

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Report to the Chairman, Committee on Government Operations, House of Representatives

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MAJOR NIH COMPUTER SYSTEM

Poor Management Resulted in Unmet Scientists' Needs and Wasted Millions

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GAO

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Information Management and
Technology Division

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November 4, 1991

The Honorable John Conyers, Jr.
Chairman, Committee on Government
Operations
House of Representatives

Dear Mr. Chairman:

This report responds to your February 1989 request and subsequent agreements with your office that we review how effectively NIH managed the acquisition process leading to its 1988 IBM total system contract. This report makes recommendations to the Secretary of Health and Human Services on improvements to acquisition and system management.

As requested, we did not obtain written agency comments on this report. We conducted our review between June 1989 and October 1991 in accordance with generally accepted government auditing standards.

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the date of this letter. We will then send copies to the appropriate House and Senate committees; the Secretary, Department of Health and Human Services; the Assistant Secretary for Health, Public Health Service; the Director, NIH; the Director, Office of Management and Budget; and the Administrator of General Services. Copies will also be made available to others upon request.

This report was prepared under the direction of Jack L. Brock, Jr., Director, Government Information and Financial Management, who can be reached at (202) 275-3195. Other major contributors are listed in appendix I.

Sincerely yours,

Ralph V. Carlone
Assistant Comptroller General

Executive Summary

Purpose

The National Institutes of Health (NIH) has extensive computing resources to support its mission of improving the health of the American people. One of NIH's major computer systems is provided through a contract with the International Business Machines Corporation (IBM).

The Chairman of the House Committee on Government Operations requested that we review how effectively NIH managed the acquisition process leading to its 1988 IBM total system contract.

Background

In September 1988, NIH awarded IBM a total system contract that encompassed all aspects of a major computer system including hardware, software, and related services. The contract, with a term of 1 year and nine 1-year options, has a potential value of almost $806 million. The contract provides access to IBM-compatible computer systems to a diverse community of about 19,000 users.

NIH uses the IBM system to process administrative data, while some scientists use the system to support research. Additionally, the system is operated as a Federal Data Processing Center that provides computer processing time to other components of the Department of Health and Human Services and about 30 other federal agencies. Portions of NIH's IBM system are operated on a fee-for-service basis whereby user fees are charged to fund the system's operations.

Federal policies and regulations require agencies to conduct specific activities to help ensure that their computer resources are effectively and economically managed. For example, agencies must prepare a strategic plan and determine system requirements to help ensure that systems will meet user needs.

Results in Brief

NIH did not effectively manage four key aspects of the IBM total system contract, resulting in unnecessary costs and a system which did not meet scientists' computing needs. First, NIH's information resources management (IRM) organization did not assert leadership or exercise its authority over the acquisition. Second, the acquisition was not addressed in strategic planning efforts. Third, computer center personnel did not collect or analyze data to identify the needs of scientific users. Fourth, as a result of ineffective capacity management, NIH (1) acquired excess computer capacity and (2) spent over $16 million on unnecessary computers since the contract was initiated in October 1988.

In addition, while NIH officials attempted to foster competition for the contract, they did not succeed.

Principal Findings

IRM Organization Not Involved in Acquisition

NIH established a council, headed by its senior IRM official, to oversee and coordinate IRM functions. However, this council did not provide leadership or oversight to the acquisition. Further, committees that were supposed to support this IRM Council were not involved. For example, the Computing Resources Group was established to review acquisition proposals and provide advice and assistance to the Council on acquisition requirements. Despite its potentially major role in NIH's acquisition, this committee was never asked to provide advice or assistance. Lacking leadership and oversight, NIH's computer center mismanaged the acquisition.

Strategic Planning Was Deficient

The IRM Council did not address this major computer contract in its strategic plans. The 1986 and 1988 plans it prepared did not discuss the acquisition. Further, a strategic planning effort undertaken by the Division of Computer Research and Technology identified a trend away from mainframe computing toward greater use of personal computers, but did not discuss the implications of this trend for the total system acquisition, which was in progress. In the absence of a strategic plan that included the total system contract, the computer center adopted an acquisition approach that did not consider whether the contract would meet scientists' changing needs.

Requirements Were Inaccurate

NIH officials stated that the IBM system was being acquired for use by biomedical research scientists. However, they did not obtain detailed input from the scientific community to identify needs. As a result, the scientists' need for the UNIX operating system was not identified and was not met by the initial system under the contract. Also, the computer center did not collect and analyze data to justify its requirements for the latest technology and a full-sized dedicated backup computer. After the contract was awarded, two NIH committees independently determined that the contract did not effectively meet the needs of NIH's scientific community.

Inadequate Capacity Management Resulted in Unneeded Computers

NIH overestimated the capacity requirements for its IBM contract. Consequently, NIH acquired more computer capacity than it needed and subsequently upgraded its already underutilized computers. This situation occurred in part because computer center managers limited their capacity management primarily to monitoring system responsiveness. Further, NIH did not take steps to identify excess capacity and opportunities for efficient operation. Our estimate of NIH's computer needs showed that two of its six computers were unnecessary. Over $16 million in equipment leasing costs have been wasted on these two computers and additional millions can be saved by eliminating them. In July 1991, NIH eliminated one of these computers after assessing the data we requested for our analysis.

Efforts to Obtain Competition Were Unsuccessful

NIH took several steps to promote competition, including soliciting industry comments on its draft request for proposals, offering up to $1 million to offerors who successfully completed a required benchmark, and extending its deadline for submission of proposals specifically at the request of a potential competitor. However, only IBM bid on the system. A major acquisition feature NIH used that limited competition was the total system approach. Under this approach, one contractor is responsible for meeting all system requirements including hardware, software, maintenance, training, system integration, and communications. NIH officials used this approach because they believed it was necessary to facilitate management of the computer center. However, they did not collect data or perform any analysis to justify this approach. Although NIH officials believed they struck an appropriate balance between features that inhibited and enhanced competition, they were ultimately unsuccessful in attracting more than one vendor.

Recommendations to the Secretary of Health and Human Services

GAO recommends that the Secretary of Health and Human Services require the Director of NIH to take the following actions.

Improve NIH's computer operations by implementing a capacity management program that includes frequent analysis and modeling of all computers in the IBM system using historic and projected data. Until an effective program is implemented, the NIH Director should report the lack of effective capacity management as a material weakness under the Federal Managers' Financial Integrity Act.

Use the capacity management program to identify and eliminate excess capacity and unnecessary equipment. The assessment should also determine if the current approach of dedicating a full-sized computer to backup, testing, and development is necessary. At a minimum, adjustments should include the elimination of one IBM 3090 computer from NIH's system, in addition to the computer NIH eliminated in July 1991.

Determine whether the total system approach is necessary to meet NIH's actual needs in future acquisitions. This determination should be based on analysis that weighs the advantage of facilitating computer center management against the disadvantage of limiting competition.

Require NIH's senior IRM official to take the lead role in future major system acquisitions by conducting activities which include the following:

- Developing a strategic plan that addresses the role of information technology in supporting NIH's mission of conducting biomedical research. This strategy should include identifying and addressing changes in scientific computing. Also, it should address how NIH's systems should be configured to most effectively complement each other in meeting NIH's diverse automation needs.

- Ensuring that future acquisitions adequately support NIH's mission. As part of this effort, NIH should solicit data on scientists' needs in identifying the requirements that form the basis for contract specifications.

Contents

Abbreviations

ADP	automated data processing
AIX	Advanced Interactive Executive
FIRMR	Federal Information Resources Management Regulation
GAO	General Accounting Office
HHS	Department of Health and Human Services
IBM	International Business Machines Corporation
IMTEC	Information Management and Technology Division
IRM	information resources management
NIH	National Institutes of Health

Introduction

The National Institutes of Health (NIH) is a collection of institutes, centers, and divisions whose overall mission is to improve the nation's health. Located within the U.S. Public Health Service, which in turn is a part of the Department of Health and Human Services, NIH conducts and sponsors biomedical research on diseases, supports research training and resource development, and disseminates biomedical information.

IBM Mainframes Are a Major Part of NIH's Extensive Computer Resources

NIH has extensive computers and related resources that are used in performing or supporting biomedical research. The Division of Computer Research and Technology, which has operational responsibility for NIH's central computer center, operates a system of five IBM mainframe computers—available for scientific and administrative processing—that is the cornerstone of NIH's computer systems.[1] The computer center also has a Convex minisupercomputer dedicated to processing scientific data. Other NIH computers that are outside the computer center include a Cray supercomputer facility, about 40 minicomputers that are used primarily for scientific work, and over 6,500 personal computers.

The NIH computer center's IBM system is used by about 19,000 individual users. About 51 percent of total users are NIH personnel who perform biomedical research or administrative processing. The remaining 49 percent are users in non-NIH organizations, including components of the Department of Health and Human Services and about 30 other federal agencies. NIH does not have official estimates of the extent of actual research-related use, but some senior NIH officials estimate that biomedical research accounts for 10 to 15 percent of overall system use. Use of the system is mostly on a fee-for-service basis, whereby users are charged for computer processing and data storage. In addition to computer processing time, other services are offered to users by the computer center, including training and a help desk. Historically, NIH has enjoyed a reputation for providing excellent service to system users.

NIH's IBM Contract Is Based on a Total System Concept

The computer center's current mainframe system has evolved through a series of contracts since the 1960s, when NIH converted its Honeywell-based system to IBM. NIH's 1981 contract with IBM was its first based on a total system concept, whereby a single contractor is responsible for system operation and is required to supply specified levels of computing resources—including hardware, software, communications, personnel,

[1] In July 1991, NIH used data we had requested for our analysis and determined the computer center did not need a sixth IBM mainframe computer that had been part of its system.

maintenance, and related services. The current total system contract, which started in October 1988, is for 10 years (1 year with nine 1-year options), with a maximum value of almost $806 million. The contract provides for upgrades and enhancements to increase computer capacity and keep the system technologically current over the 10-year contract period.

IRM Organization Has Broad Responsibilities Related to Computers

NIH's information resources management (IRM) organization consists primarily of the IRM Council, headed by NIH's senior IRM official, with supporting committees staffed by NIH personnel on a part-time basis. While the Council's responsibilities are broad-based, they include some specific activities such as strategic planning. In general, it is responsible for (1) overseeing and coordinating NIH-wide IRM functions and (2) providing leadership to the NIH staff and offices, such as the computer center, that have functional responsibility for IRM. The Deputy Director is the Council's chairperson.[2] Council membership includes high-level NIH officials as both permanent and rotating members.

The NIH Director established four permanent committees and designated four adjunct committees and work groups to support the IRM Council. The permanent committees are the Acquisition Committee, Administrative Data Base Steering Committee, Computing Resources Group, and Telecommunications Committee—each with specific responsibilities. For example, the Acquisition Committee was assigned the role of developing strategies for conducting automated data processing (ADP)-related procurements and promoting the understanding of procurement regulations and procedures. Also, the Computing Resources Group is responsible for reviewing acquisition and system development proposals, providing advice and assistance on requirements, and staying abreast of the various major NIH computer system programs and initiatives. In addition, an adjunct committee, the Advisory Committee on Computer Usage, which is composed of NIH research scientists, could provide input to the IRM Council based on its contacts in the scientific community.

While the IRM Council provides a central managerial focus for computer-related activities, operational responsibility for computers is both centralized and decentralized. For instance, NIH's National Cancer Institute

[2]In July 1991, NIH's Director designated the Deputy Director as senior official for IRM and Council chairperson. Prior to this time, the Associate Director for Administration chaired the Council.

operates some of its own computer systems, while the Division of Computer Research and Technology is responsible for the central computer center, including the IBM mainframe system.

Objectives, Scope, and Methodology

The Chairman of the House Committee on Government Operations requested that we review how effectively NIH managed the acquisition process leading to its 1988 IBM total system contract. In subsequent discussions with the Chairman's office we agreed to focus our review on the (1) adequacy of NIH's strategic planning for the total system acquisition, (2) appropriateness of requirements identified in planning the acquisition, (3) effectiveness of the organization NIH used to manage the acquisition, (4) adequacy of NIH's computer capacity management activities as related to computers supplied under the contract, and (5) extent to which NIH was able to conduct a fully competitive acquisition for its total system.

To evaluate the adequacy of NIH's strategic plan, requirements, and organization, we met with agency officials who were responsible for planning, executing, and overseeing the total system acquisition. We also discussed the above topics with selected research scientists. In addition to the total system contract, we reviewed key documents such as the strategic plans, requirements analysis, request for proposals, and minutes of relevant committees and compared them with the Federal Acquisition Regulation, the Federal Information Resources Management Regulation (FIRMR),[3] and Department of Health and Human Services policies.

To review the adequacy of NIH's capacity management efforts, we discussed the agency's capacity management program with computer center personnel. To determine the level of system use, we analyzed system performance measurement data generated by the computers themselves, which describes the use of computer resources at specific points in time. We analyzed this data for each of the week-long periods starting on August 8, 1988, March 13, 1989, and February 4, 1991, for each of the job classes NIH processes. These classes are used to define guaranteed turnaround times. For example, the guaranteed turnaround

[3]The General Services Administration issued a new version of the FIRMR that became effective April 29, 1991. NIH's total system acquisition was conducted under a previous version. FIRMR citations throughout this report are to the previous version, which was used throughout our review.

time for class E is 1 hour, while class C has guaranteed overnight turnaround. Class G, which does not have a guaranteed turnaround time, is processed on a best effort basis.

NIH selected the three specific weeks based on our requests for data representing normal system activity (1) shortly before the total system contract started, (2) after the initial upgrade of all or most of the computers under the contract but before one computer was reserved to test the UNIX operating system, and (3) which was current at the time of our review. After analyzing this data, we recognized that, while it was useful for determining the level of computer utilization, it was not sufficient for system modeling.

In April 1991, we requested that NIH collect the data necessary for modeling. Accordingly, NIH collected data for the week beginning May 6, 1991. We determined that this data was representative of system activity because (1) NIH computer center officials told us their work load does not fluctuate from week-to-week and (2) the May 1991 data was generally consistent with the patterns of utilization from the other three weeks.

We used BGS Systems' BEST/1 software to model NIH's system based on the May 1991 data. In accordance with BGS Systems' recommended procedures, we did not base our model on NIH's work load for the entire week. Instead, we selected the week's two busiest periods during the prime hours of 8 a.m. and 5 p.m. We used the modeling software to analyze "what if" changes in computer system hardware configurations and increases in work loads. This allowed us to identify potential system changes that would result in greater efficiency by simulating changes and observing their effect on system performance. Additionally, we compared the model's estimated turnaround times for various scenarios with NIH's guaranteed turnaround times for individual job classes. We also discussed our modeling approach, methodology, and results with NIH and BGS Systems officials in October 1991.

To assess NIH's efforts to conduct a competitive total system acquisition, we interviewed agency and contractor officials about how the acquisition was conducted and analyzed actions NIH officials took to promote competition. We also analyzed NIH's requirements analysis and request for proposals to identify any features that could inhibit competition. Further, we interviewed officials of selected major computer manufacturers and system integrators who had an interest in the total system acquisition. These included representatives of Amdahl Corporation,

Electronic Data Systems Corporation, IBM Corporation, PacifiCorp Capital Incorporated, and ViON Corporation.

To gain a broad perspective on scientific computing, computer acquisitions, and management of computer centers, we talked with managers of computer installations at the Public Health Service, including the Parklawn Computer Center, the Centers for Disease Control, and the National Cancer Institute's supercomputer facility. We also interviewed officials at the Census Bureau, the Department of Agriculture's National Finance Center, and ADP Incorporated for their insights on conducting computer system procurements and managing large computer installations.

We performed our work at NIH in Bethesda, Maryland; the National Cancer Institute in Frederick, Maryland; the Public Health Service in Rockville, Maryland; the Centers for Disease Control in Atlanta, Georgia; the Census Bureau in Suitland, Maryland; Agriculture's National Finance Center in New Orleans, Louisiana; and ADP Incorporated in Towson, Maryland. We also interviewed an Amdahl Corporation official in Sunnyvale, California; Electronic Data Systems Corporation representatives in Herndon, Virginia; ViON Corporation staff in Washington, D.C.; PacifiCorp Capital Incorporated personnel in Washington, D.C.; and IBM representatives in Bethesda, Maryland. We conducted our review between June 1989 and October 1991, in accordance with generally accepted government auditing standards.

Poor Management of the Total System Contract Resulted in a System That Did Not Meet Scientists' Needs

NIH's IRM organization did not provide leadership to the total system acquisition. Further, IRM managers made little effort to determine how the new system would complement existing systems in meeting scientists' computing needs. Instead of providing leadership and formulating a strategy that included the acquisition, the IRM organization allowed the computer center to plan, contract for, and implement the total system without oversight. Although computer center management justified the new system by stating that it was being acquired to meet scientists' needs, they did not solicit data from the scientists on their current or future needs. As a result, the new system did not effectively support scientific computing.

IRM Organization Had Little Involvement in the Total System Acquisition

In 1985 NIH established its IRM organization, which included the IRM Council, senior official, and various committees. Although this organization was responsible for overseeing NIH's major acquisitions, it did not provide leadership to the total system acquisition. Instead, it allowed this responsibility to be assumed by the computer center and did not ensure that the acquisition was properly planned and implemented. The IRM Council's involvement consisted primarily of receiving one informational presentation and one status report from computer center management. The former IRM Council chairman explained that the Council looked at the total system acquisition only from an overall conceptual perspective. One member added that the Council involved itself at only the most general level.

The IRM Council also did not request or receive support from its affiliated committees even though the committees were established to help the Council. For example, the Acquisition Committee chairman told us the Council did not ask this committee for help and the committee was not directly involved in the acquisition. The chairman of the Computing Resources Group said his group was not asked for its services and never met. The Advisory Committee on Computer Usage, which is composed of NIH research scientists, also was not involved, even though it was developing useful information. While the total system acquisition was in progress, this committee was identifying the scientific communities' needs through an NIH-wide study of scientific computing.

Strategic Planning Did Not Include the Total System Acquisition

During the total system acquisition process, NIH prepared three strategic plans that discussed scientific and administrative computing. However, none of these plans identified the critical computing needs that the acquisition should have met. In 1986 and again in 1988, NIH's IRM Council produced agencywide strategic plans for information technology. These plans made only general references to the computer center's operations and did not address the total system acquisition. Important topics, such as (1) the acquisition's role in supporting NIH's biomedical research mission and (2) how the acquisition should be configured to most effectively complement other NIH systems in meeting NIH's diverse computing needs, were not addressed.

In 1987 the Division of Computer Research and Technology—which includes the computer center—independently formulated a scientific computing strategy. However, this plan also did not address whether the total system acquisition (in progress at the time) would appropriately support scientific computing needs. While the plan noted that scientists would likely use personal computers for their primary computing resource, it did not address how this changing trend would affect the total system's requirements. Instead, it provided only general comments stating that the new system would need to link to personal computers and may need to serve as an electronic mail hub.

Inadequate Analysis Resulted in Excessive and Inaccurate Requirements

Without the benefit of oversight from the IRM Council and guidance from a strategic plan, the computer center used an inadequate approach that resulted in excessive requirements in some areas and failed to identify a needed requirement in another area. Although the computer center justified the acquisition by stating that its primary objective was to meet scientists' needs, little effort was made to identify those needs. Instead, it limited its assessment primarily to determining user satisfaction with the existing system and using this information to update a previous analysis.

Inadequate Approach to Requirements Determination

The computer center updated the previous requirements analysis using input from its own user services organization. This organization helps users identify and correct problems encountered during daily use of the existing system. While the organization was in a good position to know what users wanted changed about the existing system, it could not provide input regarding the needs of scientists who were not using this system or NIH's long-range needs.

Computer center management said they thought their approach was the appropriate way to identify user needs. They stated that they did not believe it was worthwhile to spend time surveying scientists. They described an unsuccessful attempt to survey scientists about 20 years ago that produced unmanageable results and was ultimately regarded as a waste of time and money. They attributed this failure to the tendency of individual scientists to unhesitatingly present their current needs in general terms, but with few specifics of what their future needs might be. However, as discussed below, in 1989 NIH's Advisory Committee on Computer Usage demonstrated that this view was unfounded when it successfully surveyed scientists.

When the General Services Administration reviewed NIH's acquisition in 1989, it concluded that the supporting studies, including the requirements analysis, complied with the FIRMR. However, we identified excessive requirements and one requirement that was not identified. Thus, the computer center's methodology resulted in a requirements analysis and system that did not fully meet scientists' needs.

Excessive Requirements

The computer center relied on generalizations about biomedical research to justify the system requirements. For example, the requirements analysis stated, "Researchers pushing the frontiers of biomedical research require the most modern tools available at all times. Effective exploitation of the cost-effectiveness of the continuously advancing hardware and software technologies is the only mechanism capable of meeting the demands of computation-intensive research. The latest in technology must be made available to the research community to ensure access to the leading-edge tools necessary to advance bio-medical (sic) research." This generalization was the basis for the conclusion in the analysis that NIH's "installation must continue at the leading edge of the computer field in order to satisfactorily meet the evolving demands of the NIH research program."

Because they did not survey users, computer center management could not differentiate among the various NIH scientists or determine their needs. In addition, they did not attempt to identify who was currently using the IBM facility or how it was being used. Lacking specific information on scientists' use of the IBM system, the computer center staff treated all scientists' needs the same and combined them in one generalized requirement for availability of the "latest technology."

In February 1989, NIH's Advisory Committee on Computer Usage completed a broad-based survey of the scientists in NIH's institutes, centers, and divisions. The committee was able to differentiate among the needs of the various areas of biomedical research and, in so doing, determined that the latest in technology—specified as needed in the requirements—was not needed in all areas.

The total system contract calls for one full-sized computer dedicated to backup, testing, and development activities. The computer center chief told us he believed NIH needed a full-sized dedicated computer for backup, testing, and development so that the backup computer replicated the computers used for processing production work loads. However, NIH has not justified the requirement or demonstrated a need for such a backup computer. In fact, the computers are connected in a manner that allows any one computer to back up any other computer during a system failure. In addition, the individual IBM 3090 computers contain multiple processors, allowing for internal backup. Consequently, NIH's mainframes virtually never fail and have been so reliable that NIH no longer keeps mainframe failure data. Further, because the backup computer is located next to the other computers and shares the same power supply, it would be useless as a backup to the other computers in situations such as a power failure or fire. NIH also could not support its requirement to dedicate this full-sized computer to the test and development functions. NIH officials did not monitor the performance of their previous backup, testing, and development computer or conduct a workload analysis to determine the size of computer necessary to process current or projected testing or development work loads.

Initially, the requirements analysis provided for, at a minimum, a test and development computer with one-half the capacity of the largest production computer installed. However, later specifications provided for a "production-sized" test and development computer. The computer center chief explained that although he estimated that testing and development utilized only about 5 percent of this computer's capacity, he believed a production-sized computer was necessary because the "testing environment needed to replicate the actual production environment." Other federal computer center operators, however, have found this comparability to be unnecessary. In fact, they do not reserve a separate computer for such work. Instead they partition one of their production computers for test and development. This option is being successfully used in such federal operations as the Food and Drug Administration's Parklawn Computer Center and the Department of

Agriculture's National Finance Center. Both centers partition IBM 3090 computers, similar to NIH's, to test and develop their systems.

Unidentified Requirement

The computer center's approach of updating its previous requirements analysis rather than soliciting data on scientists' needs led to a key unidentified requirement—the scientists' need for the UNIX operating system.[1] The center's approach followed the previous requirements analysis by requiring only compatibility with IBM's MVS operating system. However, other NIH studies and computer center actions demonstrated that the UNIX operating system was also required by scientists and should have been included as a requirement. For example, at the same time that the center was identifying its requirements, the Division of Computer Research and Technology reported on scientific computing requirements and stated that the UNIX operating system should be considered for use on all NIH computers. Further, in February 1989, the Advisory Committee on Computer Usage reported that many scientists do not use the IBM MVS operating system but instead need UNIX on a large computer. Finally, within 8 months after the total system contract was awarded, the computer center responded to the scientists' needs and switched one of the MVS computers to IBM's version of UNIX. By switching an MVS computer to UNIX, NIH also demonstrated that its requirement for computers with MVS compatibility was overstated.

Scientists Questioned IBM System's Support for Scientific Computing

In February 1989, 4 months after the total system contract was awarded, the Advisory Committee on Computer Usage reported on scientific computing at NIH. The report stated that, apart from some statistical work, the IBM mainframes were rarely used for scientific computing projects. While the scientists considered the computers to have considerable potential for scientific computing, they said that achieving this potential required a more user friendly operating system and reduced charges for system use. Moreover, the report said that the proliferation of specialized analysis and graphics software for personal computers, workstations, and minicomputers had resulted in the transfer of mathematical and statistical modeling from the central mainframes to computers in researchers' laboratories.

[1]UNIX is widely used in the scientific community because it is intended to allow portability of programs between (1) computers made by different manufacturers and (2) different types of computers, including personal computers, workstations, and mainframes.

A year-and-a-half later, in August 1990, an NIH review panel concluded that the contract favored administrative and outside agencies' computing over the needs of the scientific community. It expressed concern that scientists were using sources outside the computer center's mainframes for most of their scientific computing because the system was not meeting their needs. The panel also recommended that the computer center develop a 10-year strategic plan and specified that the center survey the NIH scientific and administrative communities for their computing needs and related support services. In September 1991, the Director of the Division of Computer Research and Technology told us that the Division's strategic plan would be completed in mid-1992.

NIH's Computer Capacity Management Program Resulted in Excessive Capacity Requirements, Overcapacity, and Wasted Funds

Federal guidance requires government agencies to conduct capacity management activities in planning, acquiring, and using their computer resources. However, because NIH does not have an effective capacity management program, the agency initially overstated the capacity requirement of its 1988 total system contract and has continued to pay for excess capacity through a system upgrade. Consequently, NIH spent millions of dollars for unnecessary equipment and NIH's users have paid more than necessary to use the system.

Capacity Management Should Support Acquisitions

FIRMR Section 201-16.002 required agencies to identify trends in data processing work loads to determine if and when existing system capabilities will be saturated. Further, Section 201-30.007 required agencies to use present and projected work loads to justify the acquisition of additional computer capacity.

A capacity management program controls, measures, and plans the system configuration required to meet current and future information processing requirements. Capacity management includes three major functions—service management, performance management, and capacity planning. Service management focuses on providing acceptable service to users on a daily basis. Performance management includes system monitoring and modeling activities, which are used to determine (1) how to balance work loads to obtain the most efficient use of computers, (2) when to upgrade systems, and (3) how much increased capacity to include in the upgrade. Capacity planning focuses on determining the resources needed to meet future work loads and satisfy required service levels. Further, capacity planning supports the procurement process by identifying and justifying system upgrades that will be required in the near and long term.

NIH's Capacity Management Efforts Focus on Service to Users

Computer center personnel told us they emphasize service-level monitoring as their primary means of managing capacity. They explained that they monitor turnaround and response times to ensure that the system is providing an appropriate level of service to users. Their users' guide identifies various job classes and specifies maximum turnaround times for batch jobs. They begin planning to upgrade system capacity when the turnaround and response times approach the published service level maximums.

Computer center managers initially told us they do not monitor equipment utilization or perform modeling as part of their capacity management program. NIH's computer center managers told us they believed that modeling was not necessary to improve their operations. However, in August 1991, after we had conducted our own modeling, NIH officials contracted with BGS Systems Incorporated to model their system.

Through our analysis of utilization data, we found that the agency initially bought too much capacity and then later acquired additional system capacity that was not needed. Our modeling determined that NIH's work load could be efficiently processed with two fewer computers.

Contract Requires Substantial and Frequent Capacity Upgrades

Included in NIH's request for proposals and contract was a 10-year schedule of capacity increases specifying the number of equivalent computers required to meet NIH's anticipated work load. At the start of the contract, NIH anticipated that its work load could be processed by the functional equivalent of six IBM 3090-200s. According to the contract upgrade schedule, after 18 months the work load was expected to double to the equivalent of almost 13 3090-200 computers. (NIH officials told us this large increase was needed to compensate for the previous 2-year period, where they were prohibited from expanding their system until the total system contract was awarded.) After the 18th month, the contractor had to provide upgrades that reflected 29-percent annual growth every 12 months. By the end of the 10-year contract (month 120), the total accumulated computers would be equivalent to 162 IBM 3090-200s, 27 times more than the original six. In anticipation that advances in technology will result in more powerful yet physically smaller computers, the contract requires that no more than nine computers be installed at any time.

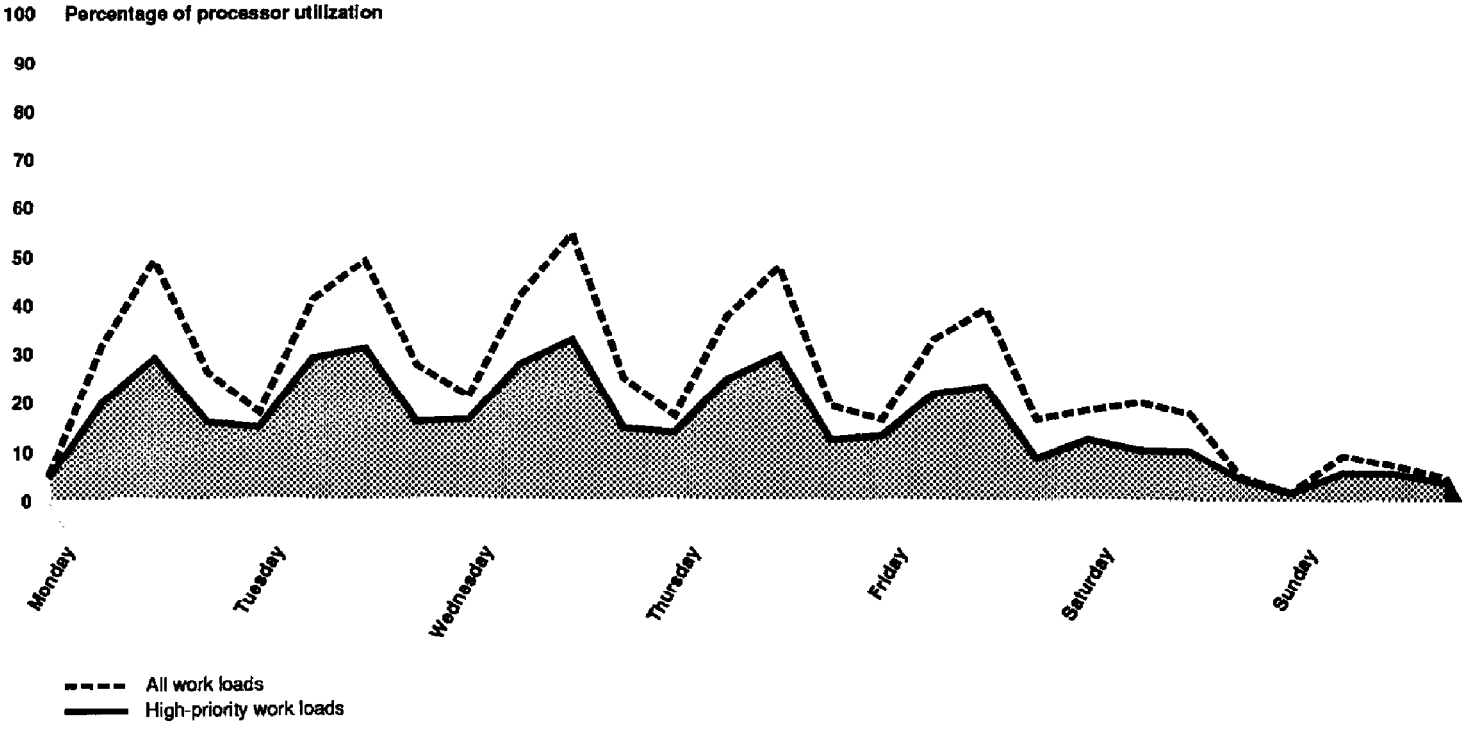
The processor upgrades described above are triggered by a schedule contained in the contract. According to the computer center chief, IBM submits a proposal several months before a required upgrade describing how the contract's upgrade requirements will be met. At that time, NIH can either accept the proposal, reject it, or ask for a modified proposal. Contract provisions also allow NIH to either reduce quantities by as much as 75 percent or increase them by up to 25 percent. These contract provisions are intended to allow NIH to closely match capacities with actual work load.

NIH acquired an initial system and one additional upgrade. However, the computer center chief said that they have not always acquired the capacity upgrades specified in their contract. Rather, they once exercised their prerogative to refuse a contractually required upgrade proposal when they believed the upgrade was unnecessary. For example, the contract required an upgrade offer in April 1991, but NIH notified IBM that this upgrade was not necessary because the work load had not grown as much as anticipated.

NIH Acquired Capacity That Was Not Needed

We analyzed capacity utilization of NIH's system for three representative weeks including one week between Monday, August 8, and Friday, August 12, 1988, shortly before NIH began doubling its capacity through the 1988 total system contract. This analysis included five of NIH's six IBM 3090-200 computers. (Because the sixth computer was reserved for backup, testing, and development activities, NIH did not collect utilization data for this computer.) We found that use for the five IBM 3090-200 computers during prime hours (8:00 a.m. to 5:00 p.m.) averaged 45 percent of total system capacity. High-priority work loads used only 30 percent of the computers' capacity. Figure 3.1 depicts utilization for the entire week.

Figure 3.1: NIH Processor Utilization for August 8-14, 1988 (Prior to System Upgrade)



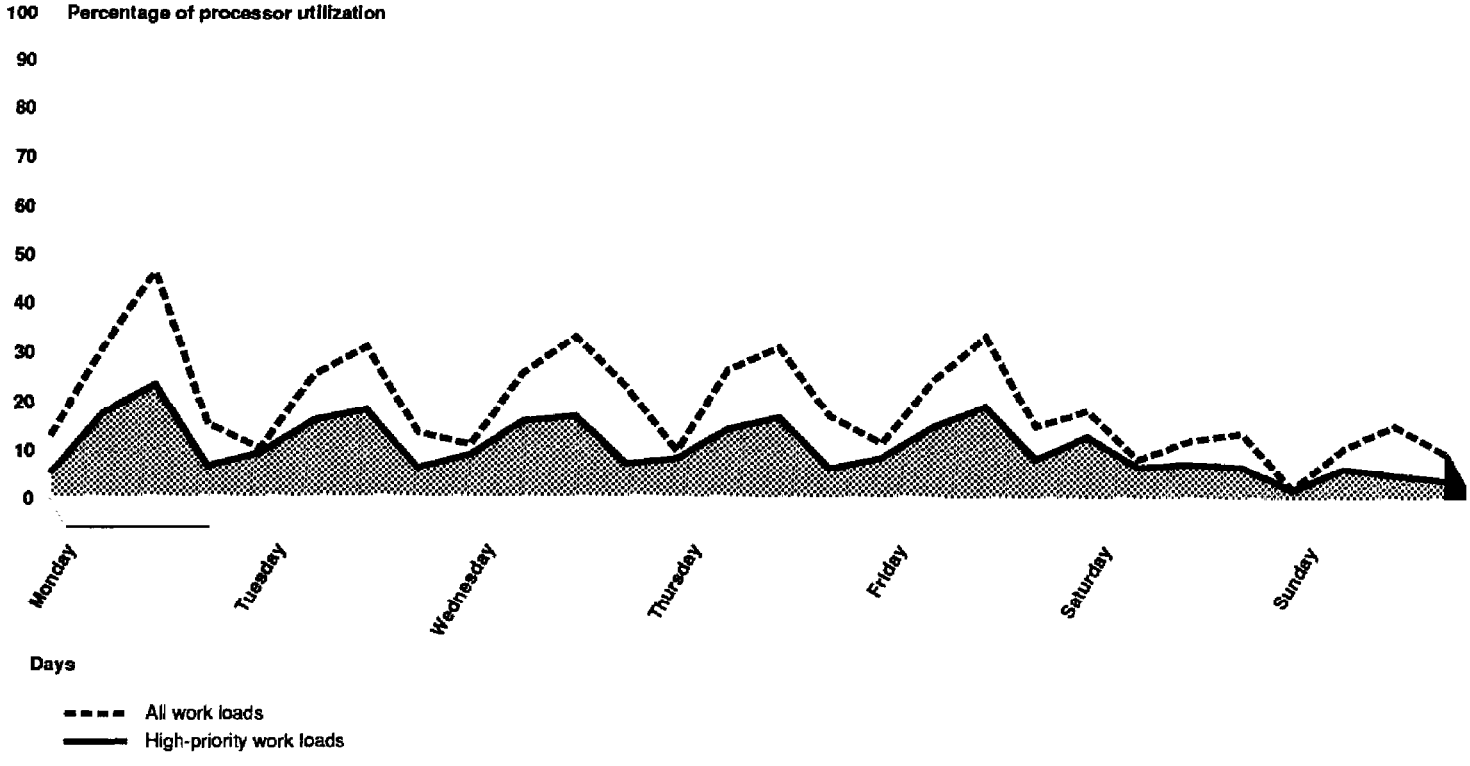
Since NIH did not monitor its utilization statistics, it became unnecessarily concerned about its ability to process its work load. NIH officials told us that during the 2 years prior to the 1988 contract they restricted the use of new applications because they were concerned that the computers were reaching their capacity and service response time would deteriorate. However, our analysis showed that NIH was well within its published turnaround time limits and the system was in no danger of deteriorating service. For example, job class E, which is one of the most heavily used, has a turnaround time objective of 1 hour. During this period, the mean turnaround time for class E jobs during prime time was 1 minute, 33 seconds; 95 percent were completed within 5 minutes, 22 seconds; and 99 percent were completed within 14 minutes, 16 seconds.

Even though NIH had excess capacity and service was well within published response-time objectives, NIH began a gradual upgrade to meet the initial configuration requirements of the new contract. This was accomplished over several months and involved upgrading the six original

computers to larger, more powerful models. NIH officials told us this upgrade was needed to meet expected growth in their work load.

We analyzed computer utilization during a week in March 1989—after NIH had upgraded five of its six computers. We found that utilization between Monday and Friday, during the prime hours, averaged 33 percent. High-priority work loads during the same period utilized only 19 percent. NIH did not need to acquire such substantial excess capacity at the first opportunity because its contract provides for IBM to offer periodic upgrades. Our analysis again showed that the system was operating well within the published maximum response and turnaround times. Figure 3.2 below shows utilization for the week of March 13, 1989.

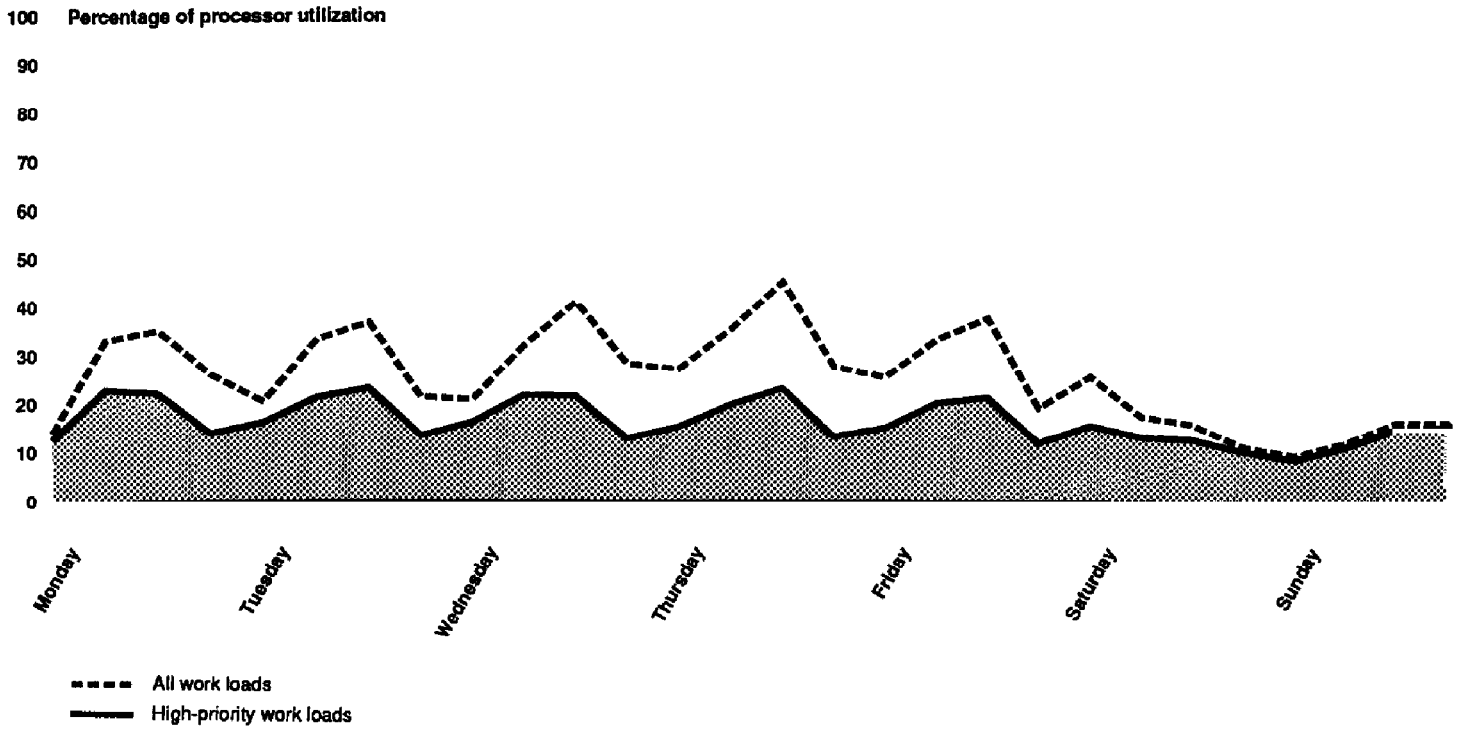
Figure 3.2: NIH Processor Utilization for March 13-19, 1989 (After Partial System Upgrade)



We also analyzed data for a week in February 1991, after IBM had upgraded all six computers to larger, faster models, and we again found

low levels of utilization. Total utilization for the four production computers averaged 37 percent during peak hours and high-priority work utilized only 23 percent of total capacity. Again, our analysis of actual response times for on-line jobs and turnaround time for batch jobs showed that NIH was well within its service-level objectives for all job classes—even though there was one less computer to process the work load.[1] The mean time to complete class E jobs was 45 seconds; 95 percent were completed within 2 minutes, 23 seconds; and 99 percent were completed within 8 minutes, 25 seconds. Figure 3.3 illustrates utilization for the week of February 4, 1991.

Figure 3.3: NIH Processor Utilization for February 4-10, 1991 (After System Was Reduced by 20 Percent)



Throughout the analysis described above, we were not able to analyze the use of NIH's backup, testing, and development computer because the

[1]In June 1989, NIH stopped using one of the five production computers for production work and devoted it to a test of AIX, which is IBM's version of the UNIX operating system.

computer center does not collect complete utilization data for it. However, the computer center chief estimated that use of the backup, testing, and development computer is about 5 percent of available capacity.

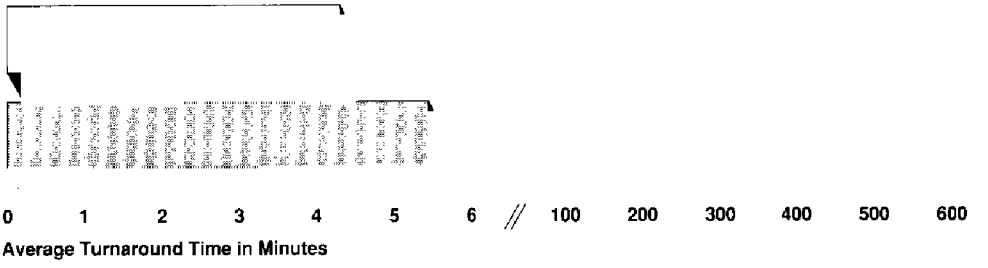
Lack of Performance Management Continued a System That Is Larger Than Necessary

We modeled NIH's four production computers using data that represented normal system work load for a 1-week period from May 6 through May 12, 1991. This modeling showed that NIH did not need two of the four production computers. Our analysis showed that the total production work load on two of the computers could be combined without (1) decreasing service below published service-level agreements, (2) unnecessarily restricting room for production growth, and (3) exceeding the processing capacity of two computers. Further, NIH's backup, testing, and development computer could provide additional capacity if required. Because current technology allows partitioning of NIH's computers, this backup computer could be partitioned to process additional production work, without disrupting testing and development activities.

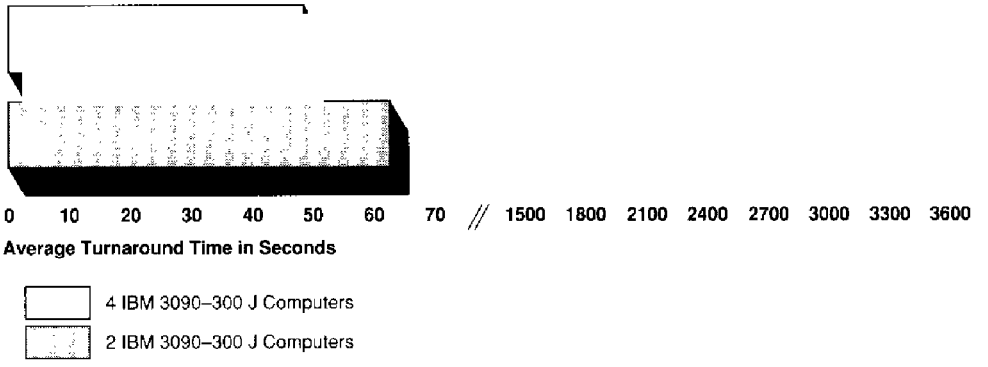
While cutting the production capacity in half obviously reduces processing capability and increases turnaround times, our model shows that turnaround times would not significantly increase and that work loads in all job classes would be completed within the guaranteed turnaround times. For example, the average turnaround time for class C jobs during prime time was 4 minutes, 19 seconds when four computers were used. Our model shows this time would increase to 5 minutes, 28 seconds if NIH used two computers for production processing. NIH's objective in processing class C jobs is "overnight"—jobs submitted by 10:00 p.m. are to be completed by 8:00 a.m. the next morning. Similarly, the average turnaround time for class E jobs during prime time was 49 seconds when four computers were used. According to our model, this average turnaround time would increase to 68 seconds—well within the response time maximum of 1 hour for class E jobs—if NIH used two computers for production processing. While these results might seem to indicate that NIH's response and turnaround time objectives could be met by only one production computer, our model indicated that two computers are necessary to provide the necessary processing capacity.

Figure 3.4: Average Class C and Class E Turnaround Time—Two Computers Versus Four

Class C:
Guaranteed Turnaround Time is 10 Hours (600 Minutes).



Class E:
Guaranteed Turnaround Time is 1 Hour (3600 Seconds).



Many low-priority class G jobs, which receive a price discount and do not require prime time processing, would need to be processed during the night and weekend shifts. This shift of some class G jobs to non-peak periods is entirely consistent with NIH's service objectives for class G work. NIH's user's guide commits the computer center to process the class G work load only on a "best effort" basis. Further, computer center managers told us they only accept class G jobs on a space available basis. However, even under this reduced configuration, some class G jobs could still be accommodated during prime time.

We were not able to include NIH's computer that uses the AIX operating system in our model. Computer center managers initially told us that AIX was a new product that did not have good software to collect and show the extent of computer use. However, they later provided us with data

for the 1-week period in May 1991. Although this data was not sufficient for modeling, it showed that the AIX computer had an average utilization of 69 percent during that week.

In September 1991, we discussed these modeling results with NIH officials. At that time, they told us that in July 1991, based on their own study of the data we requested for our analysis, they eliminated one mainframe from the computer center's system and transferred it to NIH's National Library of Medicine for use in upgrading its own existing system. Further, the officials said they contracted with BGS Systems to model their system. We discussed our modeling with NIH officials and representatives of BGS Systems in October 1991. They agreed with our modeling results but believe it would be inappropriate to eliminate another production computer because it may be needed to handle future growth. However, the modeling BGS Systems performed is based on eliminating the full-sized dedicated backup, testing, and development computer and conducting these activities as necessary on the remaining three production computers.

Unnecessary Computers Waste Money

NIH's total system contract with IBM is estimated to cost almost $806 million over the anticipated 10-year life of the contract. This figure includes many deliverables such as equipment, software, maintenance, and other services. By acquiring two computers that were not needed to process its work load NIH wasted over $16 million during the first 3 years of its contract.[2] Elimination of unnecessary computers should save additional millions in annual contract costs.

Because the total system contract contains provisions that permit NIH to obtain and pay for only the quantities that are needed, cost savings could be realized without incurring related contract penalties. Ultimately, because NIH sets its user rates based on its expenses, these millions of dollars in contract cost savings should result in lower rates for NIH's users.

[2]This figure represents the approximate amount NIH paid for two of the six computers supplied during the first 3 contract years.

NIH's Efforts to Promote Competition for Its Contract Were Unsuccessful

Federal regulations require managers to promote full and open competition when procuring information technology.[1] Management of a major information technology acquisition, such as NIH's system, requires that managers make decisions about acquisition alternatives and select approaches that promote competition while meeting the needs of the agency. For example, decisions about system specifications, proposal evaluation criteria, and contract terms can affect an agency's success in attracting competition without compromising requirements. Although NIH officials initially believed their acquisition approach would attract competition, ultimately they received only IBM's proposal.

Poor Planning Delayed Competitive Acquisition

Poor planning contributed to NIH's failure to start its total system acquisition in a timely manner. NIH's previous contract was initially awarded to IBM for 10 years but was later shortened to 5 years in compliance with an October 1981 bid protest decision. While this 5-year reduction had the obvious result of requiring earlier planning for a replacement contract, this need was not recognized by NIH officials until it was too late to initiate a competitive procurement to replace the existing contract. The computer center chief told us that planning for a replacement contract, which started in August 1985, did not start sooner because he believed the contract could be extended back to its original 10-year duration. When the need for a new contract was realized in August 1985, officials estimated that a competitive acquisition would require 3 years. Faced with the prospect of a contract that would expire in 13 months (September 1986) and an estimated 3-year replacement process, NIH believed it had no reasonable alternative but to extend the existing contract for 2 years. Thus, IBM was able to provide an extra 2 years of service without competition.

NIH Attempted to Promote Competition

Once they recognized the need to plan the total system acquisition, NIH officials developed a process that they intended to promote competition. This included soliciting industry comments on a draft of the request for

[1]The FIRMR requires federal agencies to promote full and open competition in their ADP acquisitions. FIRMR Section 201-11.001 stated "The basic procurement objective in satisfying ADP and telecommunications requirements is to obtain full and open competition through the use of competitive procedures...which permit all responsible sources...that can satisfy the needs of the Government to submit offers." FIRMR Section 201-30.007 required that ADP acquisitions be based on mission needs and that the needs should be appropriately specified to achieve full and open competition. FIRMR Section 201-30.013 discussed various types of specifications and stated that functional specifications are the most desirable for maximizing competition.

proposals, offering up to $1 million to offerors who successfully completed a required benchmark, and extending the deadline for submission of proposals.

Prior to formally issuing the final request for proposals, NIH publicized the planned acquisition and worked to clarify or eliminate requirements that industry members believed would unnecessarily restrict competition. NIH officials advertised their planned acquisition in the Commerce Business Daily, provided draft copies of the request for proposals to interested parties, and made changes to the final version based on comments they received. After advertising the availability of the draft in the Commerce Business Daily in April 1987, NIH provided copies of the draft to 180 interested parties. In response, it received a total of 98 comments from vendors.

Computer center staff reviewed all the comments and answered each of them in writing. In responding, NIH made numerous modifications to the request for proposals, in several cases to accommodate specific vendors. For example, the Amdahl Corporation requested that NIH change its specification for a certain feature—called a vector facility—from a mandatory requirement to an optional feature. On the basis of Amdahl's request, the agency modified the request for proposals to make the vector facility optional. After finalizing a new version and releasing it to 200 requestors in August 1987, NIH received 21 additional comments. The agency responded to these comments, amended the request for proposals, and issued it in September 1987.

NIH also responded to late comments from one vendor even though a response was not required. Representatives of Electronic Data Systems Corporation expressed interest in the total system acquisition and notified NIH's project officer that they intended to provide comments on the amended request for proposals. However, Electronic Data Systems missed the deadline for commenting on the August 1987 amended version. Nevertheless, Electronic Data Systems officials continued to assure the project officer that comments on the request for proposals were forthcoming. Finally, in November 1987—almost 2 months late—Electronic Data Systems provided 47 comments. Even though the deadline for commenting had passed, agency officials responded to the late comments because they considered Electronic Data Systems to be a potential competitor and wanted to fully address all industry concerns. As a result, NIH amended its request for proposals a second time and extended the deadline for submission of proposals by 60 days to allow

Electronic Data Systems and all other competitors an opportunity to consider the amended version.

Part of NIH's mandatory process for evaluating vendors' proposals was a benchmark that demonstrated the ability of a prospective vendor to successfully process a sample of the NIH computer center's projected work. Electronic Data Systems expressed concern about the cost of preparing the benchmark and asked that NIH consider paying benchmark preparation costs. NIH considered this request, decided that it would enhance competition, and planned to pay up to $1 million to unsuccessful offerors who submitted an acceptable proposal and successfully executed the benchmark.

Some Companies Said They Would Compete But Did Not

NIH officials believed they had successfully attracted competition to the total system acquisition. This belief was supported by the actions of Amdahl and Electronic Data Systems. Both firms formally indicated their intent to submit offers and actively participated in commenting on NIH's request for proposals. However, both companies withdrew from the acquisition within days of the February 16, 1988, deadline for submitting offers.

In withdrawing from the competition, Amdahl stated that NIH's request for proposals was noncompetitive, but did not offer an explanation for this allegation. Amdahl subsequently discussed its concerns about NIH's conduct of the acquisition with HHS's Assistant Secretary for Management and Budget. As a result of this discussion, HHS requested that the General Services Administration review NIH's handling of industry comments. This review indicated that NIH gave industry adequate opportunity to comment on the request for proposals, gave full consideration to industry comments, and made reasonable changes. Electronic Data Systems officials gave no reason for withdrawing, but stated that NIH was thorough in responding to their comments and that they appreciated the amount of time and thought given to their concerns. Electronic Data Systems representatives later stated that they made a business decision not to compete. Ultimately, IBM was the only company that submitted an offer, and it was subsequently awarded the total system contract.

Contract Features Increased Vendor Risk and Limited Competition

NIH based its contract on the concept of a total system, whereby all hardware, software, maintenance, training, and system integration are required from a single contractor. This approach limited the competition to vendors with the extensive resources necessary to meet all of NIH's requirements. The contract contained provisions that allowed a high degree of flexibility in the quantities of equipment acquired. While this feature can be advantageous to the agency, it also increased the level of risk facing potential competitors. Additionally, the contract was based in part on excessive requirements that increased contractor risk by causing the contract to be larger and more difficult to implement than was necessary to meet NIH's needs.

Total System Approach

In considering the implications of using the total system approach, NIH officials weighed several potential advantages and disadvantages. They said they believed a primary advantage of this approach was its single point of accountability for system operation. Making a single contractor responsible for all aspects of system operation eliminates the possibility of finger-pointing that NIH officials said is inherent in operations involving a mix of vendors. Additionally, they said their previous contract, which was also based on the total system concept, had resulted in the successful operation of their system. NIH's computer center chief said the total system acquisition was not too large from a technological point of view, and that there were large vendors capable of handling the contract. However, he added that vendors might be reluctant to assume the business risk associated with such a large contract. Even though the agency chose the total system because of its perceived advantages, NIH's deputy director told us he recognized that competition would likely increase if vendors were allowed to compete for the various components of the system. Managers of other large computer centers in civilian agencies told us that finger-pointing is generally not a problem with their operations. They said they prefer systems with a mix of equipment because they believe it leads to more competitive acquisitions and lower-priced contracts.

Contract Flexibility

In addition to the overall size of NIH's contract, the high degree of flexibility the contract affords also contributes to risk for vendors. Because NIH recognized that actual capacity requirements might vary from the estimated requirements, due to changing work load and technology throughout the 10-year life of the contract, it included provisions that provide great flexibility in the quantities of equipment that can be ordered. The contract states that, "Actual capacities installed (and

expenditures made) under the contract will be only that necessary to satisfy the actual workload at any point throughout the life of the contract." It further specifies that, "The Government requires the right to order up to 25 percent more or 75 percent less ... than the quantities specified ... [in the contract]." This provision allows NIH to fine-tune the quantities of goods and services to meet actual needs over a 10-year period, with the government only paying for what it needs. While this flexibility benefits NIH, the wide range of flexibility, which could result in a 75-percent reduction in equipment, substantially increases contractor risk.

Excessive Requirements

The specifications in NIH's request for proposals reflected unnecessary requirements that presented an unrealistic picture of NIH's needs. By including overstated specifications in its request for proposals, NIH unnecessarily increased the size of its contract. When used in conjunction with the total system approach and extreme contract flexibility, NIH's excessive requirements unnecessarily compounded contractor risk and may have further limited competition.

Conclusions and Recommendations

Conclusions

NIH has achieved mixed results in operating its computer center. On the one hand, the center enjoys a reputation of excellent service to thousands of users throughout government. Yet, the center's basic mission—satisfying the needs of NIH's scientific community—has not been satisfactorily met. Further, ineffective management of the computer center's plentiful resources resulted in wasted money and unnecessary customer charges.

NIH's problems with its computer center result, in large part, from lack of leadership. For example, oversight was virtually nonexistent when the total system procurement was planned. The IRM organization did not ensure that the contract would result in a cost-effective, user responsive system. Instead, the computer center had almost complete autonomy to determine what it would acquire, and to select the contracting approach.

The computer center used the critical nature of the scientists' work to justify the large computers it wanted, without anyone questioning its decisions. Left to its own strategy, the center did not collect data on what the scientists needed or whether this equipment complemented NIH's other computers. As a result, the scientists' needs were not fully met and the equipment was hardly discussed in NIH's long-range strategic plans.

NIH can continue to provide excellent service without paying for equipment that it does not need. Computer center officials did not justify a full-sized backup computer, and, until GAO began questioning their capacity management program, made no effort to monitor computer usage and model the system to ensure that they did not pay for unneeded computers. Consequently, for 3 years, since October 1988 when the total system contract started, NIH has wasted over $16 million by paying for two computers they did not need. By eliminating these unnecessary computers, NIH will save additional millions, which can then be passed on to its users.

A consequence of NIH's total system approach, contract flexibility, and excessive requirements was that the resulting contract was exceptionally large and limited competition.

Recommendations

We recommend that the Secretary of Health and Human Services require the Director of NIH to take the following actions.

Improve NIH's computer operations by implementing a capacity management program that includes frequent analysis and modeling of all computers in the IBM system using historic and projected data. Until an effective program is implemented, the NIH Director should report the lack of effective capacity management as a material weakness under the Federal Managers' Financial Integrity Act.

Use the capacity management program to identify and eliminate excess capacity and unnecessary equipment. The assessment should also determine if the current approach of dedicating a full-sized computer to backup, testing, and development is necessary. At a minimum, adjustments should include the elimination of one IBM 3090 computer from NIH's system, in addition to the computer NIH eliminated in July 1991.

Determine whether the total system approach is necessary to meet NIH's actual needs in future acquisitions. This determination should be based on analysis that weighs the advantage of facilitating computer center management against the disadvantage of limiting competition.

Require NIH's senior IRM official to take the lead role in future major system acquisitions by initiating activities which include the following:

- Developing a strategic plan that addresses the role of information technology in supporting NIH's mission of conducting biomedical research. This strategy should include identifying and addressing changes in scientific computing. Also, it should address how NIH's systems should be configured to most effectively complement each other in meeting NIH's diverse automation needs.
- Ensuring that future acquisitions adequately support NIH's mission. As part of this effort, NIH should solicit data on scientists' needs in identifying the requirements that form the basis for contract specifications.

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