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Report to the Committee on Commerce, Science, and Transportation, U.S. Senate, and the Committee on Science, House of Representatives

April 2003

BUSINESS MODERNIZATION

Improvements Needed in Management of NASA's Integrated Financial Management Program

GAO-03-507

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Highlights

Highlights of GAO-03-507, a report to the Committee on Commerce, Science, and Transportation, U.S. Senate, and the Committee on Science, House of Representatives

Why GAO Did This Study

The National Aeronautics and Space Administration's (NASA) nonintegrated financial management systems have weakened its ability to oversee its contractors, and its contract management has been on GAO's high-risk list since 1990. In April 2000, NASA began its Integrated Financial Management Program (IFMP), its third attempt in recent years at modernizing financial management processes and systems. GAO was asked to review whether NASA was following key best practices in acquiring IFMP components and implementing one of the first components—the core financial module.

What GAO Recommends

GAO is recommending that NASA develop and implement (1) a short-term plan to identify and mitigate the risks currently associated with relying on already deployed IFMP commercial components and (2) a longer term strategy for acquiring additional IFMP components that includes implementing a methodology for commercial system component dependency analysis. NASA agreed with GAO's recommendation related to a short-term plan but disagreed with many of the findings related to user needs and requirements management. NASA also agreed with the importance of having an approach for acquiring additional IFMP components, but stated that it already has an effective strategy in place. GAO reaffirms its recommendations.

www.gao.gov/cgi-bin/getrpt?GAO-03-507.

To view the full report, including the scope and methodology, click on the link above. For more information, contact Gregory D. Kutz at (202) 512-9095 or kutzg@gao.gov.

What GAO Found

The core financial module, if implemented as planned, may provide some improvement to NASA's accounting system environment. However, NASA is not following key best practices for acquiring and implementing IFMP. In acquiring IFMP components, NASA is facing risks in understanding dependencies among commercial components. NASA has not analyzed the interdependencies among selected and proposed IFMP components, and it does not have a methodology for doing so. For programs like IFMP, which involve building a system from commercial components, it is essential to understand the characteristics and credentials of each component to select ones that are compatible and can be integrated without having to build and maintain expensive interfaces. By acquiring IFMP components without first understanding system component relationships, NASA has increased its risks of implementing a system that will not optimize mission performance and will cost more and take longer to implement than necessary.

In implementing the core financial module, NASA is facing risks in two additional areas:

- **User needs.** NASA did not consider the information needs of key system users and deferred addressing the requirements of program managers, cost estimators, and the Congress. Although this module should eliminate NASA's separate, incompatible accounting systems, little has been done to reengineer acquisition management processes. Program managers and cost estimators indicated that they will continue to rely on other means to capture the data needed to manage programs such as the International Space Station.
- **Requirements management.** NASA is relying on a requirements management process that does not require documentation of detailed system requirements prior to system implementation and testing. Over 80 percent of the requirements GAO reviewed lacked specificity, and several could not be traced among various documents. These defects also significantly impaired the testing phase of the system implementation effort. Further, NASA has not implemented metrics to help gauge the effectiveness of its requirements management process. NASA's approach will likely result in increasing amounts of time spent on costly rework and reduced progress.

Unless these issues are successfully addressed, NASA is at increased risk of having IFMP become its third unsuccessful attempt to transform its financial management and business operations.

Contents

Abbreviations

CSC	Computer Services Corporation
ERP	Enterprise Resource Planning
FFMIA	Federal Financial Management Improvement Act
IBM	International Business Machines
IEEE	Institute of Electrical and Electronics Engineers
IFMP	Integrated Financial Management Program
IMCE	International Space Station Management and Cost Evaluation
ISS	International Space Station
NASA	National Aeronautics and Space Administration
OMB	Office of Management and Budget
SEI	Software Engineering Institute

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Accountability * Integrity * Reliability

United States General Accounting Office
Washington, D.C. 20548

April 30, 2003

The Honorable John McCain
Chairman
The Honorable Ernest Hollings
Ranking Minority Member
Committee on Commerce, Science,
and Transportation
United States Senate

The Honorable Sherwood L. Boehlert
Chairman
The Honorable Ralph Hall
Ranking Minority Member
Committee on Science
House of Representatives

Much of the National Aeronautics and Space Administration's (NASA) success depends on the work of its contractors—on which it spends $12.7 billion, or 90 percent of its annual budget. For many years, NASA has not effectively overseen its contracts, principally because it has lacked accurate and reliable information on contract spending and performance and it has placed insufficient emphasis on end results, product performance, and cost control. Since 1990 we have identified NASA's contract management function as an area at high risk.[1] NASA's ability to collect, maintain, and analyze cost and performance data has been weakened by nonintegrated, incompatible financial management systems and processes, and uneven and nonstandard cost-reporting capabilities. NASA made two efforts in the past to improve its financial management processes and develop a supporting system intended to produce the kind of accurate and reliable information needed to manage its contracts effectively, but both of these efforts were eventually abandoned after a total of 12 years and a reported $180 million in spending.

[1]At that time, we began a special effort to review and report on the federal program areas that our work had identified as high risk because of vulnerabilities to waste, fraud, abuse, and mismanagement. We first issued our *High-Risk Series* in December 1992 and have continued to include NASA's contract management as an area of high risk since. See U.S. General Accounting Office, *High-Risk Series: NASA Contract Management*, GAO/HR-93-11 (Washington, D.C.: December 1992) and *High-Risk Series: NASA Contract Management*, GAO-03-119 (Washington, D.C.: January 2003).

In April 2000, NASA began its third attempt at modernizing its financial management processes and systems. NASA has estimated the life cycle cost of this effort through 2008 to be $861 million.[2] This effort, known as the Integrated Financial Management Program (IFMP), is expected to produce an integrated, NASA-wide financial management system through the acquisition and incremental implementation of commercial software packages and related hardware and software components.[3] Through the proven business processes and centralized data management capabilities embedded in these commercial components, NASA intends to reengineer its management operations to "do business the way business does business." The core financial management module, which NASA considers to be the backbone of IFMP, is currently operating at NASA headquarters and 6 of NASA's 10 centers[4] and is expected to be fully operational in June 2003. According to NASA's business case analysis for the system, the core financial module will provide NASA's financial and program managers with timely, consistent, and reliable cost and performance information for management decisions.

Given the importance of IFMP to NASA's mission performance, you asked us to review the program. The purpose of this report is to alert you now to concerns we have based on our work to date and to provide NASA management with constructive recommendations for improvement that it can initiate as soon as possible. We are continuing our work and plan to fully respond to your request later this year.

Our work to date has focused on whether NASA has management processes in place for effective system acquisition and implementation. This report addresses three issues concerning the acquisition of IFMP components and the implementation of one of the first components—the core financial module. Specifically, we determined whether NASA (1) was

[2]For this estimate, NASA has defined life cycle costs to include implementation efforts through fiscal year 2008 and major upgrades, plus operation and support costs for each system module for the first 2 years after the module goes live.

[3]The system is to consist of nine modules: core financial management, resume management, travel management, position description management, human resource management, payroll, budget formulation, contract administration, and asset management.

[4]NASA is comprised of its headquarters offices, nine Centers located throughout the country, and the Jet Propulsion Laboratory. The Jet Propulsion Laboratory is operated by the California Institute of Technology, but for purposes of this report, we treat the Jet Propulsion Laboratory as a center.

effectively evaluating the relationship among commercial systems component options before acquiring them, (2) had adequately considered the information needs of key users in implementing the core financial module, and (3) had established and implemented an effective requirements management process to support implementation of the core financial module.

We performed our work from April 2002 through February 2003 in accordance with generally accepted government auditing standards. We had intended to include our assessment of a key element of NASA's acquisition strategy—whether NASA was acquiring IFMP components in the context of an agencywide blueprint, commonly called an enterprise architecture—in this report. However, because NASA did not provide the data needed to complete our assessment until after the conclusion of our fieldwork, we plan to address NASA's enterprise architecture in a future product. Details on our objectives, scope, and methodology are in appendix I.

Results in Brief

If implemented as planned, IFMP may provide some improvement to NASA's current accounting system environment because it should eliminate the separate, incompatible systems that have previously been used at each of NASA's 10 centers and should result in standardized accounting data. However, NASA is not following key best practices for acquiring and implementing IFMP. Specifically, NASA has not established an analytical capability to guide and constrain its acquisition of IFMP commercial components. Further, in implementing the core financial module component, NASA has deferred addressing the needs of key system users and has not properly developed detailed system requirements. Consequently, the agency is at risk of making a substantial investment in a system that will fall far short of its stated goal of providing meaningful and reliable information to support effective program management and congressional oversight.

NASA has not analyzed the interdependencies among selected and proposed IFMP components, and it does not have a methodology for doing so. For programs like IFMP, which involve building a system from commercial components, it is essential to understand the characteristics and credentials of each component in order to select ones that are compatible and can be integrated without having to build and maintain expensive interfaces. The alternative to such a structured and disciplined approach to building a commercial component-based system is trial and

error, which is fraught with risk. Although NASA has already acquired the core financial module and three other IFMP commercial components, the agency has not performed the analysis necessary to understand the logical and physical relationships among the component parts it has acquired. By acquiring these IFMP components without first understanding system component relationships, NASA has increased its risks of implementing a system that will not optimize mission performance, and will cost more and take longer to implement than necessary.

For the core financial module, NASA did not consider the information needs of key system users and deferred addressing the requirements of program managers, cost estimators, and the Congress. Since 1990, we have identified NASA's contract management function as an area at high risk, in part because of the lack of effective systems and processes for managing and overseeing its procurement dollars, producing credible cost estimates, and providing the Congress with appropriate visibility over its large, complex programs. However, despite these previous problems, program managers, cost estimators, and congressional staffs were not included in defining system requirements for NASA's core financial module. Instead, NASA's financial managers and accountants have primary responsibility for this process. In addition, little has been done to reengineer acquisition management processes, particularly with respect to the consistency and detail of budget and actual cost data provided by contractors. Although capable of accepting the data needed to satisfy the information needs of these key users, NASA's new core financial module is not being implemented to accommodate this information. According to IFMP program officials, they chose to defer certain system capabilities and related user requirements in order to expedite implementation of the core financial module. As a result, program managers and cost estimators told us that they will not rely on the core financial module and instead will continue to rely on other systems or use other labor-intensive means to capture the data they need to manage programs such as the International Space Station (ISS).

Further, NASA did not have an effective requirements management process to support the implementation of the core financial module. Specifically, NASA was relying on a systems requirements management process that did not require documentation of detailed system requirements prior to system implementation and testing. Although industry best practices and NASA's own system planning documents indicate that detailed requirements are needed to serve as the basis for effective system testing, NASA's approach instead relied on certain subject matter experts' knowledge of the detailed

requirements necessary to evaluate the functionality actually provided. As a result of this approach, our review of the core financial module requirements found that, for many of them, (1) the functionality to be delivered was not adequately described or stated in a manner that allowed for quantitative evaluation and (2) the traceability between the various requirement documents was not maintained. Accordingly, the potential for these requirements defects to result in costly rework is significant and increases the risk that the project will not meet its cost, schedule, and performance objectives. Because of the direct relationship between requirements and testing, the lack of complete and unambiguous requirements also significantly impairs the testing phase of the system implementation effort. For example, the core financial module could not process vendor invoices that contained over 200 line items—a common occurrence on NASA's large contracts—because NASA did not design an appropriate test case. If NASA had documented its requirements, it would have recognized that a properly designed test case had not been developed to cover this necessary functionality. Furthermore, NASA has not effectively implemented the types of metrics that can help the organization understand the effectiveness of its requirements management process, such as identifying and quantifying any weaknesses and then developing the corrective actions needed.

We are making recommendations that address the need for NASA to (1) develop and implement a short-term plan to identify and mitigate the risks currently associated with relying on already deployed IFMP commercial components and to expeditiously stabilize these components' operation capability and performance, (2) as part of the short-term plan, develop and properly document requirements, reengineer acquisition management processes, and fully engage stakeholders—including program managers, cost estimators, and the Congress—in the development of user requirements, and (3) develop a longer term strategy for acquiring additional IFMP components that includes implementing a methodology for commercial system component dependency analysis.

In written comments, which are reprinted in appendix II, NASA concurred with the need for a short-term plan but disagreed with most of our findings related to user needs and requirements and testing. We remain convinced that, as we have stated, NASA needs to (1) reengineer its acquisition management processes to ensure that program and financial managers as well as the Congress have needed budget and actual cost and schedule data and (2) document detailed requirements to reduce, to acceptable levels, the risks in implementing the selected processes. NASA also agreed with the

importance of having an approach for acquiring additional IFMP components, but stated that it already has an effective strategy in place. We did not find convincing evidence to support NASA's contention that it is using methodologically based dependency analysis—a best practice for implementing commercial component-based systems—in acquiring IFMP.

Background

NASA has a long and well-documented history of problems overseeing its procurement dollars, producing credible cost estimates, and providing the Congress with appropriate visibility over its large, complex programs. We first identified NASA's contract management as an area at high risk in 1990 because NASA lacked effective systems and processes for overseeing contractor activities. Over the past decade, other GAO, Inspector General, and task force reports have shown that NASA's cost estimates lack credibility, in part because NASA does not collect the historical cost data needed to accurately project future costs or assess the validity of past estimates. Finally, because NASA had not provided the Congress with adequate visibility over the ISS program, the Congress had little advance warning when NASA reported that the estimated cost to complete the ISS had grown by about $5 billion in 1 year.

Since we first identified NASA's contract management as an area of high risk, we have reported that one of NASA's most formidable barriers to sound contract management is the lack of a modern, integrated financial management system. NASA's ability to collect, maintain, and analyze cost and performance data has been weakened by nonintegrated, incompatible accounting systems and processes, and uneven and nonstandard cost-reporting capabilities. The weaknesses in NASA's financial management systems also caused its independent auditor, PricewaterhouseCoopers, to conclude for fiscal years 2001 and 2002 that NASA's financial management systems do not substantially comply with the requirements of the Federal Financial Management Improvement Act (FFMIA). FFMIA builds on previous financial management reform legislation by emphasizing the need for agencies to have systems that can generate timely, accurate, and useful information with which to make informed decisions and to ensure accountability on an ongoing basis.

While NASA's efforts to design and implement a new financial management system certainly move NASA forward in this area, technology alone will not solve NASA's problems. Our reviews, as well as NASA's, show that finance is not viewed as an integral part of NASA's program management decision process. Moreover, an independent task force created by NASA to review

and assess ISS costs, budget, and management reached a similar conclusion. In its November 1, 2001, report, the International Space Station Management and Cost Evaluation (IMCE) Task Force found that the ISS program office does not collect the historical cost data needed to project future costs accurately and thus perform major program-level financial forecasting and strategic planning. The task force also reported that NASA's ability to forecast and plan is weakened by diverse and often incompatible center-level accounting systems and uneven and non-standard cost reporting capabilities. The IMCE Task Force also concluded that the current weaknesses in financial reporting are a symptom, not a cause, of the problem and that enhanced reporting capabilities, by way of a new integrated financial management system, will not thoroughly solve the problem. The root of the problem, according to the task force, is that finance is not viewed as intrinsic to NASA's program management decision process.

NASA's IFMP includes nine module projects supporting a range of financial, administrative, and functional areas. According to NASA officials, of the nine module projects, two are in operation, three are currently in implementation, and four are future modules. The two projects in operation are resume management and position description management; the three projects in implementation are travel management, core financial, and budget formulation; and the four future module projects are human resources, payroll, asset management, and contract administration.

The core financial module project, which utilizes the SAP R/3 system, is the backbone of IFMP and will become NASA's standard, integrated accounting system used agencywide. The other IFMP module projects will be integrated/interfaced with the core financial module, where applicable. The scope of the core financial module, when fully implemented, includes: standard general ledger, budget execution, purchasing, accounts receivable, accounts payable, and cost management. NASA plans to implement the core financial module at all 10 NASA centers by June 2003. The pilot for the core financial module—conducted at Marshall Space Flight Center—was implemented in October 2002. NASA is rolling out or deploying the core financial module at the other nine NASA centers and headquarters in three waves. The first wave, which consisted of Glenn Research Center, rolled out in October 2002. The second wave, which consisted of NASA headquarters, Johnson Space Center, Kennedy Space Center, and the Jet Propulsion Laboratory rolled out in February 2003. Ames Research Center, considered a second wave center, rolled out in April 2003. Finally, NASA plans to roll out the third wave, which consists of

Dryden Flight Research Center, Goddard Space Flight Center, Langley Research Center, and Stennis Space Center, in June 2003.

IFMP Acquisition Management Structure

NASA is contracting with multiple companies to assist in the acquisition management, integration, and implementation of its IFMP "system of system components." As shown in table 1, five contractors are assisting in the integration and implementation of the core financial module. However, none of these five contractors is responsible and accountable for successfully implementing the entire IFMP system. Instead, NASA has structured its IFMP acquisition so that NASA is the system integrator, meaning that NASA is responsible for integrating multiple commercial components and ensuring that they collectively perform in a manner that meets the defined requirements.

Table 1: Five Contractors and Their Responsibilities

Entity	Responsibility/function
Accenture	Implement the core financial module in accordance with agency requirements, including interfacing it with NASA's existing systems environment.[a]
CSC (Computer Services Corporation)	Support the operations, maintenance, and administration of the new module, including integration efforts.
IBM (International Business Machines)	Develop training and user procedures and perform security and internal control reviews to ensure that the core financial module complies with accounting and financial reporting standards.
SAP	Provide technical implementation support and training on NASA's implementation of the core financial module.[b]
Titan Systems Corporation-Civil Government Services Group	Perform independent verification and validation of requirements and testing processes and results, such as tracing requirements to test cases.

Source: NASA.

[a]NASA plans to solicit additional contracts for implementation of other selected and acquired modules.

[b]NASA has acquired SAP's enterprise resource planning package and has thus far planned to implement the core financial and budget formulation modules. NASA has also acquired three other commercial software products—Travel Manager, Resumix, and Position Description Management.

NASA's Acquisition Management Strategy Does Not Include Analyzing Component Interdependencies

A key to effectively acquiring commercial component-based systems that are intended to support agencywide business needs, like IFMP, is employing recognized acquisition management controls. One such control is to acquire system components only after deliberate and comprehensive analysis and understanding of the components' interdependencies. Although NASA has already acquired the core financial module and three other IFMP commercial components, the agency has not performed the analysis necessary to understand the logical and physical relationships among the component parts it has acquired. By acquiring these IFMP components without first understanding system component relationships, NASA has increased its risks of implementing a system that will not optimize mission performance and will cost more and take longer to implement than necessary.

When acquiring a commercial component-based system or system of systems, such as IFMP, industry best practices[5] recognize the critical importance of understanding the logical and physical relationships among the component parts. To provide for this understanding, these practices advocate that the system integrator, which in the case of IFMP is NASA, employ an explicit methodology, including a risk-based process for deciding among product alternatives, that collects and verifies information about each component's characteristics and credentials, evaluates the dependencies and constraints among these components, and permits informed decisions about which products to acquire and how to implement them. This is necessary because commercial products are built around each vendor's functional and architectural assumptions and paradigms, such as approaches to error handling and data access, and these assumptions and paradigms are likely to be different among products from different sources. Such differences complicate product integration. Further, some commercial products have built-in dependencies with other products that if not known can further complicate integration. For these reasons, a structured and disciplined approach to systematically evaluating product to product relationships is critical. The alternative to such a structured and disciplined approach to building a commercial component-based system is trial and error, which is fraught with risk.

[5]See for example, Tricia Oberndorf, Lisa Brownsword, and Carol A. Sledge, Ph.D., *An Activity Framework for COTS-Based Systems*, Technical Report CMU/SEI-2000-TR-010 (Pittsburgh, Pa.: Software Engineering Institute, Carnegie Mellon University, October 2000).

In acquiring its IFMP components to date, NASA has not performed the above-cited dependency analysis, and it does not have a methodology for doing so. Despite this, NASA has acquired and is in the process of implementing a commercial product (SAP's R/3 core financial module) to meet its needs in one business area (financial management), and it has acquired three additional commercial products from three separate vendors that are intended to meet its needs in other business areas (travel management, resume management, and human capital position description needs).[6] Beyond the four products that it has already acquired, NASA plans to acquire an unspecified number of additional commercial components that are intended to meet its needs in other business areas. To integrate those separate commercial products into a "system of system components," NASA has executed several contracts and plans to execute more to build interfaces (hardware and software) to permit the components to interoperate. For example, a contractor is currently building an interface between the core financial module of the SAP product and the travel manager product.

When acquiring and implementing commercial hardware and software solutions, organizations can generally pursue one of two basic courses of action. That is, an organization can opt for a single package of already integrated software components, which is referred to as the "best of suite" approach, or it can opt for different software components from different vendors, which is referred to as the "best of breed" approach. NASA is currently following the "best of breed" approach. According to the Integration Office Deputy Program Manager, NASA has not performed dependency analyses among the various components acquired to date, and those being considered for later acquisition, because NASA's initial acquisition strategy was to acquire a single commercial solution (i.e., "best of suite") and thus it did not consider product interoperability to be a concern. While NASA has since adopted a "best of breed" approach, the Integration Office Deputy Program Manager stated that it still does not plan to perform these analyses in the future because NASA will rely upon commercial tools that support the development of interfaces between commercial products, which the Integration Office Deputy Program Manager claimed will make integration easy and relatively inexpensive and negate the need for proactive dependency analysis. However, best

[6]NASA has acquired the following commercial products: (1) SAP AG's R/3, version 4.62, (2) Gelco's Travel Manager, version 8.0, (3) Resumix, version 6, and (4) Avue Digital Services' Position Description Management, which is a subscription service.

practices advocate that proactive dependency analysis and evaluation are necessary for informed decision making regardless of whether integration tools will be used, and particularly when a "best of breed" approach is employed.

What this means is that NASA is implementing its "best of breed" approach using trial and error. This reactive method does not allow for adequate understanding of commercial product dependencies until the only alternative to integrating them is building and maintaining complex interfaces, which unnecessarily increase system acquisition and maintenance costs, delay promised capabilities and benefits, and do not optimize agency performance. The results of a recent study[7] commissioned by NASA recognize the added risk associated with the "best of breed" approach, and thus the importance of proactive dependency analysis and evaluation to minimize this risk. Specifically, the study states that NASA's "best of breed" approach will result in a higher total cost of ownership because the agency will need to (1) acquire and maintain multiple software licenses, (2) hire and maintain technical staff knowledgeable about each commercial product, (3) build and maintain interfaces to integrate the various products, and (4) provide training to system users on each commercial product.

Core Financial Module Does Not Fully Address Key User Information Requirements

If implemented as planned, the core financial module may improve NASA's current system environment by eliminating the separate, incompatible accounting systems that have been used at each of NASA's 10 centers previously. However, the core financial module currently being implemented does not fully address the information requirements of key users, such as program managers, cost estimators, or the Congress. Our previous work at leading public and private sector organizations[8] has shown that user involvement and effectively reengineering business processes are major factors in successfully implementing financial management systems. In contrast, at NASA, key users such as program managers and cost estimators were not involved in defining or implementing NASA's system requirements and have played a limited role

[7]Gartner, Inc., *A Report for NASA: IFMP Lessons Learned and Key Considerations for Future Module Projects*, January 20, 2003.

[8]U.S. General Accounting Office, *Executive Guide: Creating Value Through World-class Financial Management*, GAO/AIMD-00-134 (Washington, D.C.: April 2000).

in all aspects of the implementation of the core financial module. Instead, NASA's financial managers and accountants have primary responsibility for this process. Consequently, NASA has not effectively used this opportunity to reengineer the way it does business and implement a financial management system that addresses many of its most significant management challenges, including improving contract management, producing credible cost estimates, and providing the Congress with appropriate visibility over its large, complex programs. According to IFMP officials, they chose to forgo certain system capabilities to expedite implementation of the core financial module and have stated that these capabilities can be added at a later date. In the meantime, program managers and cost estimators will continue to rely on other nonintegrated systems outside of IFMP and use other labor-intensive means to capture the data they need to manage programs such as the ISS.

If Implemented as Planned, Core Financial Module May Provide Some Improvements

The core financial module, if implemented as planned, may provide some improvement to NASA's current accounting system environment. According to IFMP planning documents, the core financial module should (1) eliminate much of the inconsistent data and lack of standardization, (2) collect agency costs and allocate those costs to cost centers, including civil service personnel costs, and (3) maintain a standard general ledger to provide control over financial transactions, resource balances, and assets and liabilities. If NASA is successful, the core financial module could reduce the extensive amount of time and resources currently required to consolidate NASA's 10 different reporting entities and close the books each accounting period. However, as discussed later, our findings relating to NASA's requirements management and testing processes may affect NASA's ability to achieve these improvements.

Key Users Were Not Involved in the Implementation of the Core Financial Module

The IFMP core financial module, although technologically capable of meeting the needs of program managers, cost estimators, and the Congress, is not being configured to do so because these key users have not been actively involved in the implementation of the module. Our previous work at leading public and private sector organizations has shown that user involvement in reengineering business processes and establishing and implementing system requirements are major factors in successfully

implementing financial management systems.[9] In fact, at these leading organizations, not only did program and business managers participate in the design and implementation of financial management systems, they typically were responsible for driving the effort and played a key role in reengineering core business processes. In contrast, at NASA, financial managers and accountants have had primary responsibility for the implementation of the core financial module, while the other key users mentioned above have been largely excluded.

According to IFMP planning documents, financial managers and accountants are considered direct customers responsible for the administrative processes that will be reengineered and automated. Therefore, these individuals, to date, have been engaged in defining system requirements and priorities. On the other hand, stakeholders—including program mangers, cost estimators, and the Congress—are described in NASA documents as the ultimate beneficiaries of system improvements but are not expected to be actively involved in the system's implementation. While NASA has formed teams to reengineer portions of the agency's administrative process, these teams primarily consisted of financial managers. As a result, NASA has neither reengineered its core business processes nor established adequate requirements of the system to address many of its most significant management challenges, including improving contract management, producing credible cost estimates, and providing the Congress with appropriate visibility over its large, complex programs.

The Core Financial Module Will Not Provide the Information Needed to Manage Contracts

The core financial module is not being implemented to provide program managers with the information they need to fully monitor the work being performed by contractors. Based on our review of NASA's three largest

[9] GAO/AIMD-00-134.

space flight programs—Space Launch Initiative,[10] ISS, and Space Shuttle—we found that the core financial module, as currently planned, will not accommodate much of the information provided by NASA's contractors and needed by program managers to monitor contractor performance. Specifically, the core financial module is not being implemented to (1) accommodate the contract schedule information received from contractors and needed by program managers to monitor contractor performance and (2) maintain cost data at a sufficient level of detail for certain contracts.

Core Financial Module Does Not Integrate Cost and Schedule Data Needed by Program Managers

To adequately oversee NASA's largest contracts, program managers need reliable contract cost data—both budgeted and actual—and the ability to integrate these data with contract schedule information to monitor progress on the contract. However, because program managers were not involved in defining system requirements or reengineering business processes, the core financial module is not being designed to integrate cost and schedule data needed by program managers. As a result, program managers are resorting to using other systems that will result in additional cost over and above IFMP costs.

The primary source of contract schedule information used by program managers comes directly from NASA's contractors in the form of monthly hard copy or electronic cost and schedule performance reports. NASA tracks contract schedule status by comparing the budgeted and actual cost of work planned with budgeted and actual cost of work completed for specific time periods. The term "schedule" incorporates both the concept of status of work and whether a project or task is being completed within planned time frames. Depending on the nature of the work being performed, the method of measuring work progress varies. Work is measured in terms of tasks when a specific end product or end result is

[10]During the time of our review, NASA was pursuing a program—known as the Space Launch Initiative—to build a new generation of space vehicles to replace its aging space shuttle. This was part of NASA's broader plan for the future of space travel—known as NASA's Integrated Space Transportation Plan. On October 21, 2002, NASA postponed further implementation of the program to focus on defining the Department of Defense's role, determining future requirements of the ISS, and establishing the agency's future space transportation needs. In November 2002, the administration submitted to the Congress an amendment to NASA's fiscal year 2003 budget request to implement a new Integrated Space Transportation Plan. The new plan makes investments to extend the space shuttle's operational life and refocuses the Space Launch Initiative program on developing an orbital space plane—which provides crew transfer capability to and from the space station—and next generation launch technology.

produced. But when work does not produce a specific end product or result, level-of-effort or a more time-oriented method of measurement is used. The type of information, level of detail, and reporting format provided by contractors are determined during the contract negotiation process and vary from contract to contract depending on the size, complexity, and duration of the contract. In general, however, these reports show contractor progress against cost and schedule targets set by the program manager and against which contractor performance can be measured. Contractors also report any significant variances from the targets and explain how they will be mitigated.

NASA's program managers need this contractor information to plan and manage their programs effectively. However, the information from cost and schedule performance reports is not recorded in the core financial module. Instead, NASA uses only data from monthly contractor financial management reports, commonly referred to as NASA form 533 reports, to update the core financial module. NASA form 533 reports contain estimated and actual contractor cost data but, according to NASA program managers, do not contain the data needed to adequately assess schedule performance. According to IFMP officials, the information needed to perform cost and schedule analysis by program managers is outside the scope of the core financial module and IFMP. IFMP program officials told us that they chose to forgo certain system capabilities to expedite implementation of the core financial module and have stated that these capabilities can be added at a later date. However, NASA does not currently have a plan for maintaining the data contained in cost and schedule performance reports in the core financial module or IFMP.

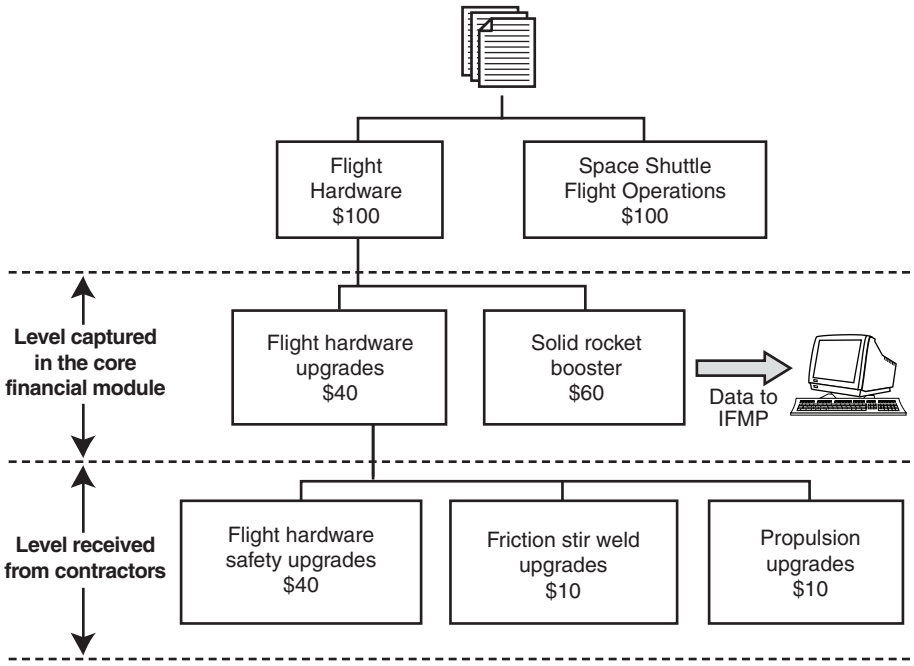
Because contract schedule information is not currently maintained through the core financial module, program managers will continue to rely on hard copy reports, electronic spreadsheets, or other means to monitor contractor performance. Several of NASA's programs, including the Space Launch Initiative and the ISS, are currently using other systems to monitor contract cost and schedule performance, but these are stand-alone efforts and have not been part of a coordinated NASA plan. Officials at Marshall Space Flight Center have recognized the importance of maintaining common cost and schedule performance data in a single integrated system that is available to all NASA managers at all locations. As such, these officials have proposed that NASA establish the system they currently use as a NASA-wide standard.

NASA has stated that the core financial module is expected to result in a single, integrated financial management system that is intended to serve the needs of its program managers. By not including the cost and schedule information needed by program managers in the core financial module, NASA risks operating with two sets of books—one that is used to report to management and the Congress and another that is used to manage NASA's programs.

Core Financial Module Will Rely on Legacy Coding Structure

Because NASA has not fundamentally changed the way it operates by involving key users in business process reengineering efforts, the core financial module is not being implemented to capture cost information at the same level of detail that it is received from NASA's contractors. Instead of implementing an accounting code structure that would meet the information needs of program managers, NASA has embedded the same accounting code structure that it uses in its legacy reporting system in the core financial module. As a result, the availability of detailed cost data is dependent on the adequacy of NASA's legacy coding structure. In some cases, the cost information received by NASA on monthly contractor reports must be aggregated to a higher, less detailed level before it is posted against the old accounting code structure. For example, as shown in figure 1, program managers for the Space Shuttle receive monthly contractor reports on the space flight operations contract that track costs related to friction stir weld and propulsion safety upgrades separately.

Figure 1: Space Shuttle Flight Operations Contract



Source: GAO analysis of NASA cost data.

Note: Amounts shown are for illustrative purposes only.

However, because the NASA legacy accounting code structure embedded in the core financial module only tracks the cost of space shuttle flight hardware upgrades, the more detailed costs that program managers need, such as friction stir weld and propulsion safety upgrades, are not available through the core financial module. According to NASA officials, the core financial module is capable of capturing this more detailed cost data; however, due to the complexity associated with converting detailed data from the centers' legacy systems, NASA has deferred this capability. While this information is available to program managers from the contractor, it is not available through the core financial module. In fact, on this particular contract, program managers have access to the contractor's system and, therefore, have access to an even greater level of detail than that reported by the contractor on hard copy reports.

On the other hand, in cases where the legacy coding structure adequately reflects the programs' information needs, the cost data received from

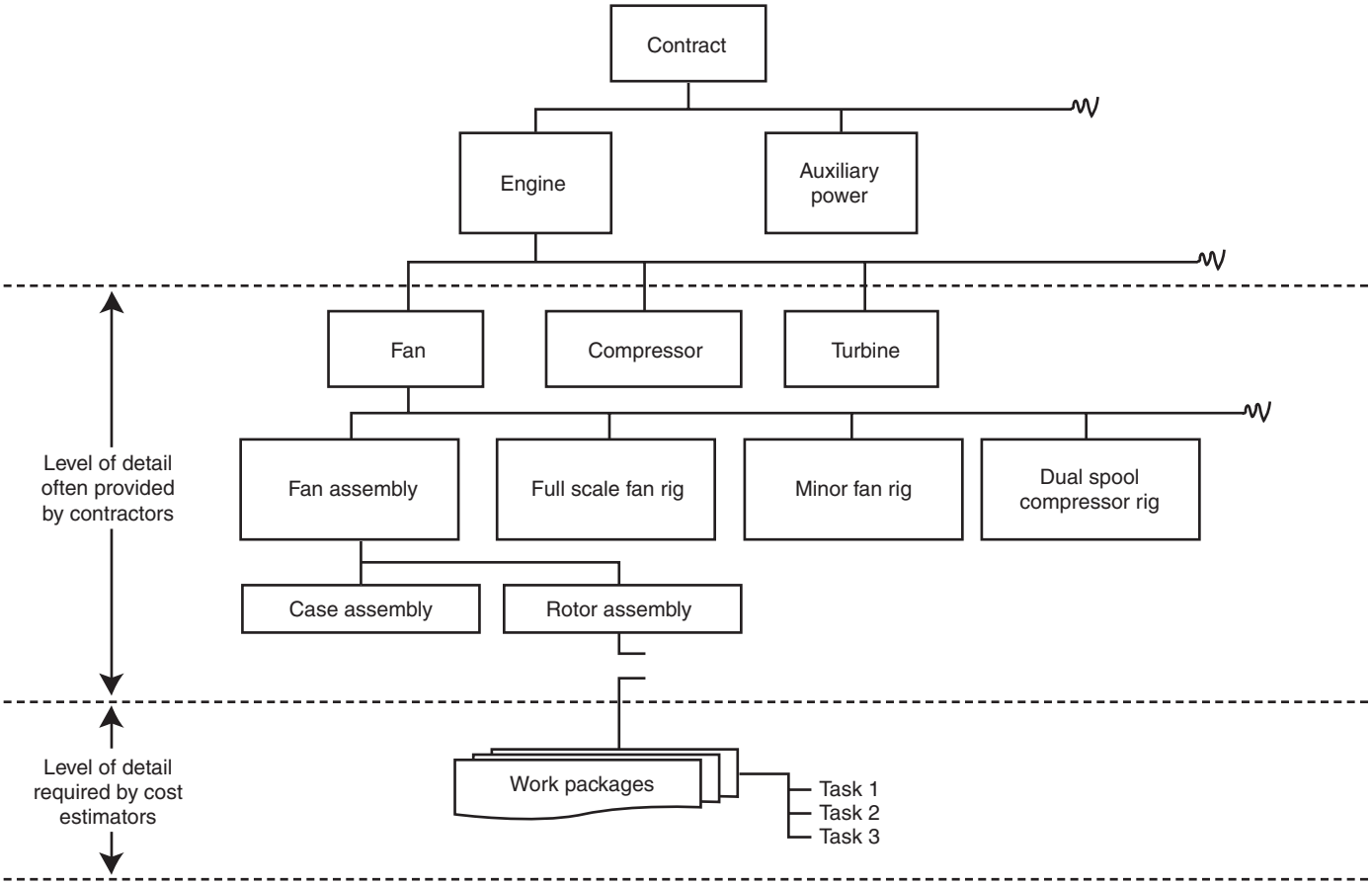
contractors do not have to be aggregated prior to posting. For example, program officials with the ISS program recently redesigned the program's cost coding structure in order to more precisely identify the cost of specific work. This was not done as part of an IFMP reengineering effort, but in response to external criticisms of the program's failure to manage its costs. Regardless of the reason, the program's reengineering effort has to some extent improved the usefulness of the cost data being entered into the core financial module.

Core Financial Module Will Not Provide the Information Needed to Prepare Credible Cost Estimates

The core financial module, as currently planned, will not provide sufficiently detailed data for cost estimators. Although the core financial module is technologically capable of maintaining the detailed data required by cost estimators, cost estimators were not involved in defining the system requirements or reengineering business processes. As a result, NASA has not determined the most cost-effective way to satisfy the information needs of its cost estimators nor reengineered its business process to ensure that their needs are met.

According to members of NASA's cost estimating community, they typically need cost data at an even greater level of detail than that currently being provided by NASA's contractors. The cost estimators we spoke with told us that their requests for more detailed cost data are often not satisfied through the contract negotiation process. For example, as shown in figure 2, while program managers may want—and contractors may provide—the cost of an engine fan, cost estimators need to know more detailed information, including the cost of the various tasks needed to make a rotor assembly, which ultimately becomes part of the fan.

Figure 2: Example of Level of Detail Reported versus That Required by Cost Estimators



Source: NASA *Work Breakdown Structure Reference Guide.*

The lack of sufficiently detailed information for cost estimators is due to NASA's lack of reengineering efforts for the acquisition management process, which should have been done prior to implementing the core financial module. Because the core financial module will not contain sufficiently detailed historical cost data necessary for projecting future costs, cost estimators will continue to rely on labor-intensive data collection efforts after a program is completed. These efforts involve searching through old hard copy and electronic contractor reports to extract all relevant data. NASA pays its contractors extra to provide data required but not contained in these reports, usually at a later point in time.

Data collection after the fact is expensive but, according to some NASA officials, is more cost effective than requiring contractors to provide detailed cost data throughout the course of the contract. However, NASA has not done the analysis needed to determine the appropriate mix of routinely requiring contractors to provide detailed cost data and capturing that data in the core financial module versus purchasing the data after a contract is complete.

Core Financial Module May Not Provide Better Information for Congressional Oversight

NASA has identified the Congress as a key stakeholder and ultimate beneficiary of system improvements. However, based on our discussions with congressional staffs from NASA's authorizing committees, the agency did not consult with them regarding their information needs. Consequently, NASA cannot be sure that it is implementing a system that will provide the Congress with the information it needs for oversight. As discussed previously, according to IFMP planning documents, financial managers and accountants are considered direct customers and are responsible for defining system requirements and priorities. On the other hand, NASA considered the Congress a stakeholder and, therefore, did not seek input from congressional staffs in defining system requirements.

Similar to the problems faced by program managers and cost estimators, the core financial module may not address many of the information needs of the Congress. To properly assess the agency's annual budget submission and make funding decisions, the Congress needs timely, reliable cost and schedule information on the status of large, high-risk programs, such as the ISS. As previously described, the module will not provide the type of cost and schedule information that program managers need to adequately monitor the status of NASA's major programs and may not maintain sufficient information to readily address any special congressional needs that arise.

Nevertheless, the Congress should be able to receive somewhat better information about NASA's finances than it has in the past because, as previously described, the core financial module may improve some aspects of NASA's ability to produce reliable financial information. For example, the use of a standard general ledger will provide more standardized accounting data and general ledger controls. As a result, the core financial module should enable NASA to provide timelier, more reliable high-level cost information to the Congress on some issues, such as annual spending limits.

NASA's Requirements Management Process for the Core Financial Module Is Ineffective

NASA has not effectively implemented a requirements management process[11] to support the implementation of the core financial module and therefore has increased the risk that the agency will not be able to effectively identify and manage the detailed system requirements that system developers and program managers use to acquire, implement, and test a system. Specifically, based on discussions with IFMP officials and a review of the process documents related to the core financial module, we found that NASA was relying on a requirements management process that did not require detailed documentation of system requirements prior to system testing. Industry best practices, as well as NASA's own system planning documents, indicate that detailed system requirements should be documented to serve as the basis for effective system testing. Instead, NASA's approach relied on the expertise of certain subject matter experts to remember the detailed requirements necessary to evaluate the functionality actually provided.

As a result of this approach, we found that (1) for over 80 percent of the 132 core financial module requirements we reviewed, the functionality to be delivered was not adequately described or stated in a manner that allowed for quantitative evaluation and (2) the traceability among the various requirement documents was not maintained. Accordingly, the potential for these requirements defects to result in costly rework is significant and increases the risk that the core financial module will not meet its cost, schedule, and performance objectives. Because of the direct relationship between requirements and testing, the lack of complete and unambiguous requirements also significantly impairs the testing phase. Furthermore, NASA has not effectively implemented the types of metrics that can help it understand the effectiveness of its requirements management process, such as identifying and quantifying any weaknesses in its process and then developing the corrective actions needed.

[11]According to the Software Engineering Institute, requirements management is a process that establishes a common understanding between the customer and the software project manager regarding the customer's business needs that will be addressed by a project. A critical part of this process is to ensure that the requirements development portion of the effort documents, at a sufficient level of detail, the problems that need to be solved and the objectives that need to be achieved.

NASA Requirements Management Process Was Not Designed to Provide Detailed System Requirements

Requirements are the specifications that system developers and program managers use to acquire, implement, and test a system. Requirements should be consistent with one another, verifiable, and directly traceable to higher-level business or functional requirements. It is critical that requirements be carefully defined and that they flow directly from the organization's concept of operations (how the organization's day-to-day operations are or will be carried out to meet mission needs).[12] Improperly defined or incomplete requirements have been commonly identified as a root cause of system failure and systems that do not meet their cost, schedule, or performance goals. Without adequately defined requirements that have been properly reviewed and validated, a significant risk exists that the system will need extensive and costly changes before it will meet NASA's needs.

As discussed previously, NASA is designing and fielding the core financial module without having determined the specific information needs of its key stakeholders, including program managers, cost estimators, and the Congress. The omission of this critical step increased the risk that the project would not effectively include all the detailed system requirements that were needed to achieve management's vision of a core financial management module that provides timely, consistent, and reliable cost and performance information for management decisions.

IFMP officials stated that their basic approach to developing the core financial module system requirements was (1) defining high-level requirements that could be used for making a software selection, (2) defining the business processes that the core financial module needed to address, (3) linking the requirements that were originally defined for the software selection to those business processes, and (4) using subject matter experts to determine whether the application met the business processes envisioned by the users during their discussions of the needed functionality. A key feature of the NASA approach is that the detailed requirements covered in the discussion of the business processes are not

[12]According to Institue of Electrical and Electronics Engineers Standard 1362-1998, a concept of operations document is normally one of the first documents that is produced during a disciplined development effort since it describes system characteristics for a proposed system from the user's viewpoint. This is important since a good concept of operations document can be used to communicate overall quantitative and qualitative system characteristics to the user, developer, and other organizational elements. This allows the reader to understand the user organizations, missions, and organizational objectives from an integrated systems point of view.

required to be documented prior to testing. Rather, NASA depends on subject matter experts, who are assigned to ensure that the core financial module has the needed functionality, to know the detailed requirements necessary to evaluate the functionality actually provided. Such an approach relies on the subject matter expert being available throughout the process and on the expert remembering the undocumented requirements completely and consistently. Specifically, an individual assigned to develop a test case[13] is relied on to understand the detailed requirements associated with all facets of that test case and then to ensure that the test will provide the information needed to understand whether the functionality was actually provided.

IFMP officials also stated that the current approach was based on discussions with their contractors and eliminated the need for detailed documented requirements normally associated with efforts such as IFMP. They also recognized that this approach was somewhat inconsistent with their own *Requirements Management Framework*, issued in October 2000, which stated that "[i]n order to test the software, a more detailed statement of a requirement or process may be required to insure [sic] the successful completion of a test." This document also recognized that these detailed requirements would be needed for "a more refined testable set of requirements . . . and needed to serve as a basis for the testing that will occur . . ." In a January 2003 report[14] by a contractor on the lessons learned on the IFMP effort, the contractor noted that NASA would need to develop a set of requirements and design specifications that had been validated by the individuals responsible for managing each process. The contractor also noted that although such an approach delays the first phase of the project design, it reduces the overall implementation time.

As a result of NASA's stated approach to requirements management, our review of NASA's system requirements related to the process documents for the core financial module found that key attributes of effective requirements were missing for many requirements. According to the Institute of Electrical and Electronics Engineers (IEEE)—a leading source

[13]A test case is a series of actions, performed serially, in parallel, or in some combination, that creates the desired test conditions. Rex Black, *Managing the Testing Process: Practical Tools and Techniques For Managing Hardware and Software Testing* (Redmond, Wash.: Microsoft Press, 1999).

[14]Gartner, Inc.

for defining the best practices for efforts such as this—good requirements have several characteristics, including the following:[15]

- The requirements document contains all the requirements identified by the customer, as well as those needed for the definition of the system.
- The requirements fully describe the software functionality to be delivered. Functionality is a defined objective or characteristic action of a system or component. For example, a system may have inventory control as its primary functionality.
- The requirements are stated in clear terms that allow for quantitative evaluation. Specifically, all readers of a requirement should arrive at a single, consistent interpretation of it.
- Traceability among various requirement documents is maintained. Requirements for projects such as IFMP can be expressed at various levels depending on user needs. They range from agencywide business requirements to increasingly detailed functional requirements that eventually permit the software project managers and other technicians to design and build the required functionality in the new system. Adequate traceability ensures that a requirement in one document is consistent with and linked to applicable requirements in another document.

NASA established about 590 requirements for the core financial module.[16] We reviewed in detail one business process area of this module—the "Manage Accounts Payable" process—that included 132 of these requirements. We found that (1) for over 80 percent of the 132 requirements the functionality to be delivered was not adequately described or stated in a manner that allowed for quantitative evaluation and (2) the traceability between the various requirement documents was not maintained.

Requirements Were Not Specific

For over 80 percent of the 132 "Manage Accounts Payable" requirements, the process documents lacked the specific information necessary to understand the required functionality that should be provided and how to

[15]IEEE 830-1998.

[16]NASA originally identified about 590 requirements. However, 51 of these were deleted and 86 were deferred.

determine quantitatively, through testing or other analysis, whether the system will meet NASA's needs. The following are examples of core financial module requirements that lacked the necessary specificity.

- One requirement stated that the system must "[a]llow the information contained in the system to be queried to present detailed data as requested (such as payee information). The capability to perform a Print Screen must be available to all user screens." This requirement did not clearly state such items as (1) the data elements that must be supported, (2) how the user would obtain the data definitions for the data elements that could be used, (3) the tool or process that would be used to perform these queries, and (4) the relationship between the ability to perform such queries and the requirement to be able to print the screen.

- The core financial module was required to support "multiple payment addresses and/or bank information for a single payee." This requirement did not clearly state the maximum number of payment address and bank information entries that should be allowed.

- Several requirements called for the core financial module to make accounting entries; however, these requirements did not define the specific accounting entries that should be made.

The lack of documented requirements that are complete and unambiguous not only increases the risk that the project's functionality goals will not be met, but also significantly impairs the testing phase of the system implementation efforts, as discussed later in this report.

Traceability Was Not Maintained

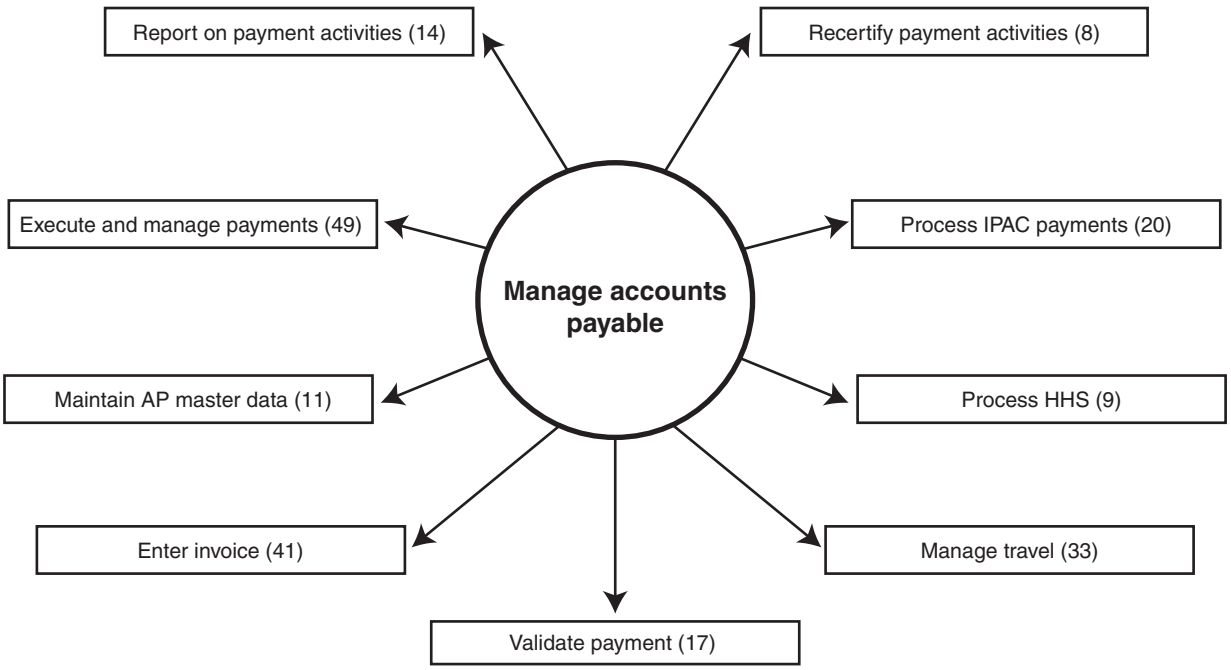
NASA has adopted a four-level approach to defining its requirements—processes, subprocesses, activities, and tasks, with processes stating high-level requirements and tasks providing the most detailed level. In reviewing the various requirement documents, we found that (1) traceability was not always maintained through the various documents and (2) the level of detail did not provide additional specificity for a given requirement as it progressed through the hierarchy.

Traceability allows the user to follow the life of the requirement both forward and backward through these documents and from origin through implementation. Traceability is also critical to understanding the parentage, interconnections, and dependencies among the individual requirements. This information in turn is critical to understanding the impact when a requirement is changed or deleted. Without an effective

traceability approach, it is very difficult to perform such actions as (1) accurately determining the impact of changes and making value-based decisions when considering requirement changes, (2) maintaining the system once it goes into production, (3) tracking the project's progress, and (4) understanding the impact of a defect discovered during testing.

To illustrate these issues, we attempted to follow the hierarchy of requirements for one of the core financial module's seven processes through the four levels of requirements utilized by NASA for this project. As shown in figure 3, the “Manage Accounts Payable” process area has 132 requirements associated with nine subprocesses. However, one of the 132 requirements, "Multiple User Access," contained in the “Manage Accounts Payable” process, was not shown in any of the subprocesses, and it was unclear where this requirement would be further defined.

Figure 3: System Requirements for the "Manage Accounts Payable" Process



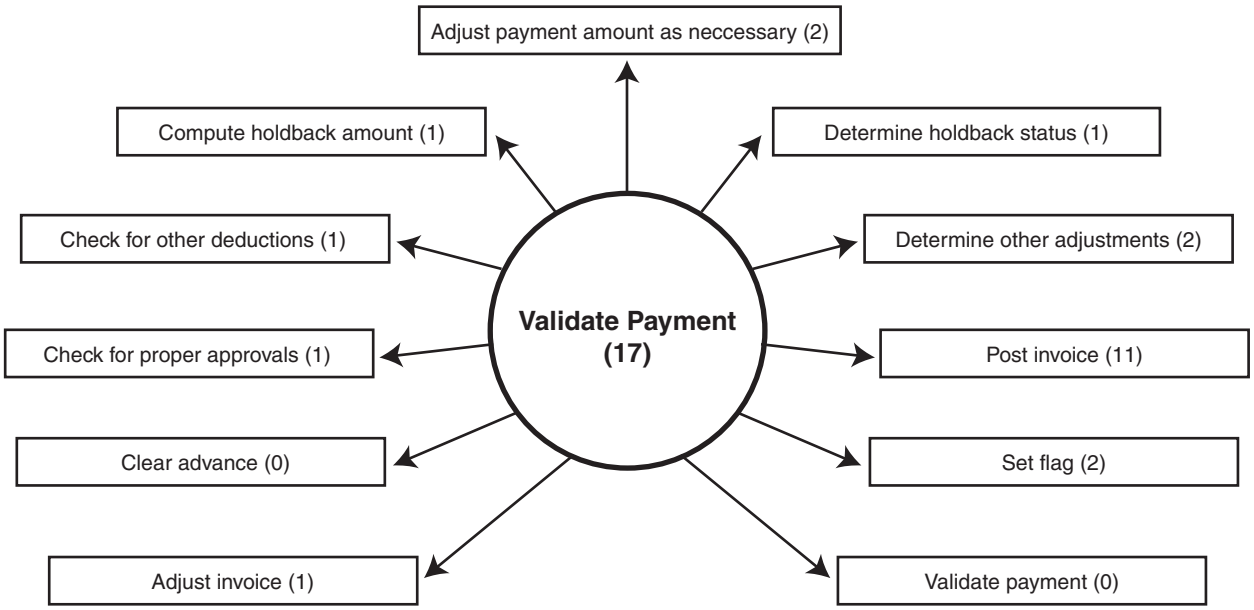
Source: NASA.

Note: The total number of requirements shown for the subprocesses (202) exceeds the number of requirements shown for the "Manage Accounts Payable" process (132) because some requirements apply to more than one activity.

Our review of the nine subprocesses found that 5 of the remaining 131 requirements contained in the subprocesses were not linked to any activity. For example, a requirement that applies to all federal agencies and is designed to ensure compliance with the Internal Revenue Service's 1099 reporting requirements was not included in any of the activities. Therefore, the individuals responsible for implementing the requirements contained in the activities would not have the full universe of requirements they must address. Conversely, as shown in figure 4, several of the activities for the "Validate Payment" subprocess did not contain any related requirements. Therefore, it was unclear whether these activities should have been associated with this subprocess. For example, the "clear advance" and "adjust invoice" activities did not include any requirements related to validating payments. Further, the lack of requirements for these activities may cause confusion for the individuals assigned to test the functionality

associated with this subprocess. We were also unable to trace the requirements from activities to tasks, which should be the most detailed level of requirements because, for the activities associated with the "Validate Payment" subprocess, NASA used the same information for the activities and tasks. In other words, the requirements for the tasks were identical to those listed for the activities and therefore did not provide any additional details.

Figure 4: Requirements for "Validate Payment" Subprocess



Source: NASA.

Note: The total number of requirements shown for the activities (22) exceeds the number of requirements shown for the "Validate Payment" subprocess (17) because some requirements apply to more than one activity.

As can been seen in this example, NASA was unable to maintain adequate traceability of the requirements for this subprocess as it progressed through the hierarchy. More important, the level of specificity associated with these requirements did not change. Based on our review, we generally found that the wording of a given requirement was identical regardless of

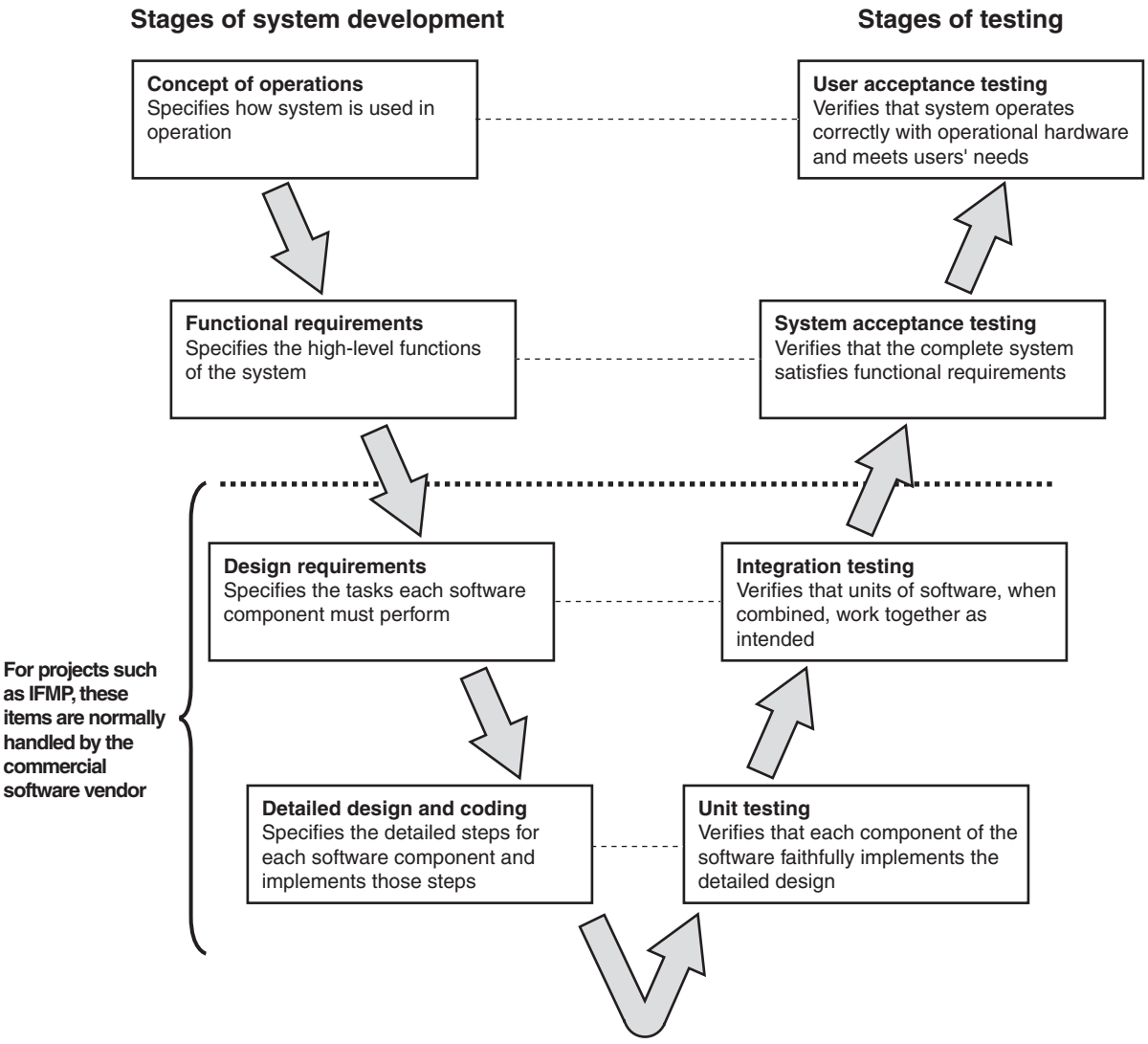
the requirement document reviewed. For example, if a requirement was listed in a subprocess area and flowed to an activity, the same wording was used and the needed level of specificity to help ensure proper implementation was not available. Therefore, although NASA appeared to have adopted a requirements hierarchy that would facilitate the needed specificity as the requirements flowed from subprocesses to tasks and activities, the implementation of this approach did not address the specificity problems discussed earlier. Accordingly, this is another factor that increases the risk that this project will not meet its schedule, cost, and functionality goals. A NASA contractor hired to help evaluate the implementation of the core financial module had similar findings. For example, the contractor found that NASA had not developed documentation that explicitly details the relationship between lower-level requirements and requirements of the next level.

Requirements Defects Adversely Affect Testing of the Core Financial Module

Because requirements provide the foundation for system testing, the specificity and traceability defects in the system requirements preclude NASA from implementing a disciplined testing process. That is, requirements must be complete, clear, and well documented to design and implement an effective testing program. Consequently, NASA is taking a significant risk that its testing efforts will not detect significant defects until after the system is placed into production. Industry best practices indicate that the sooner a defect is recognized and corrected, the cheaper it is to fix. This is especially true since NASA is depending on the subject matter experts' knowledge, rather than documented requirements, to ensure that the application does not have any significant defects before the system is placed into production.

As shown in figure 5, there is a direct relationship between requirements and testing.

Figure 5: Relationship between Requirements Development and Testing



Source: GAO.

Although the actual testing activities occur late in the development cycle, test planning can help disciplined activities reduce requirements-related defects. For example, developing conceptual test cases based on the requirements derived from the concept of operations and functional requirements stages can identify errors, omissions, and ambiguities long

before any code is written or a system is configured. Disciplined organizations also recognize that planning testing activities in coordination with the requirements development process has major benefits.

We have identified several indications that NASA's testing program has been adversely affected by the lack of complete and specific requirements. Although we plan to continue our review of NASA's testing plan for IFMP implementation, we noted (1) significant defects that appeared to be related to requirements occurred in the application after it was placed into production and (2) several cases where NASA did not ensure that modifications made to the application did not cause unintended effects and that the system or component still complied with its specified requirements after the change.

Significant Defects Appeared in Production System

Our review of the system test defect reports for the core financial module disclosed that several defects considered by NASA to have an initial severity rating of critical[17] or high[18] had been identified after the system was placed into production at Marshall Space Flight Center and Glenn Research Center. Detecting such problems after the system goes into production may lead to costly rework due to factors such as having to reenter transactions and adjust reports manually. Furthermore, the manual processes required to make these adjustments may introduce data integrity errors. Our preliminary review indicated that the root cause of many of these defects could be linked to the lack of complete requirements. For example, see the following:

- Shortly after the system was placed into production, NASA found that the core financial module was not properly executing certain business rules. An emergency fix was developed, and the defect report noted that a long-term solution and requirements would need to be developed. It was unclear why the subject matter experts did not include the business rules in the test cases used to evaluate the functionality of the

[17]NASA defines critical defects as those that "impact the ability to move forward or complete an entire business function or task, and impacts multiple business functions, multiple users and/or locations. [It] presents a failure that has no workaround or alternative."

[18]NASA defines high defects as those that have "a significant impact on the completion of a business function or task, however, activities can continue as far as the next function. A limited number of business functions, business users, or locations are impacted, and may be an impact to only one."

application. However, we believe one cause is the lack of documented requirements that the testers could use to develop effective test cases.

- NASA was unable to process vendor invoices that contained over 200 line items, which, according to NASA officials, is a common occurrence on NASA's large contracts. It was unclear why the subject matter experts responsible for testing this functionality had not developed the test cases to ensure that large invoices were properly processed before the system was placed into production. IFMP officials recognized that this was an oversight in their testing process. If NASA had documented its requirements, it would have recognized that a properly developed test case had not been designed to cover this necessary functionality.

- About 3 months after the core financial module was placed into production at one center, it was found that when the system produced multiple bills for the same customer, only the first bill was sure to have the proper account classification code printed. The remaining bills often contained incorrect values since the program improperly assumed that the account classification code would not change until the customer changed. Since the account classification code is critical for these types of bills, the center was required to manually make the necessary corrections on the bills.

Adequate Regression Testing Is Not Being Performed

Efforts such as the core financial module undergo change constantly at this stage of their development as functionality is being added and defects are being corrected. However, before the revised application is released, testing needs to be performed to ensure that any modifications have not caused unintended effects and that the system or component still complies with its specified requirements. This practice is commonly referred to as regression testing. An effective regression testing program is critical for ensuring that the functionality associated with requirements that has been validated during previous testing efforts has not been impaired by subsequent changes in the application.

Although NASA officials stated that they require regression testing before deploying any changes, we found that they do not have an effective method to ensure that adequate regression testing is being performed or that a consistent approach is being taken in performing such testing. According to NASA officials, the individual identifying a defect is responsible for ensuring that the defect is corrected and for determining the amount of testing necessary to ensure that the defect has been corrected. For example, if a defect is identified when executing a test case, the tester may

only test the section of the case where the error was originally identified rather than performing all the steps in the test case. This approach increases the risks that defects introduced into the application during enhancements or defect corrections will not be detected until after the application is deployed, which results in costly rework. We noted several examples where NASA appeared to perform inadequate regression testing. These include the following:

- After adding an interface, it was found that an application screen for recording advances did not operate as it had before the change was made.

- A process for recording transactions provided by the Department of the Treasury failed after an update to the application program.

- One center was testing a certain type of invoice and received an error message. This error was attributed to a system patch that had been applied to the application.

IFMP officials agreed that they did not have a comprehensive regression testing program with a consistent approach. However, they told us that they believed that any defects would be detected by the centers as the application progresses through its releases because they encourage each center to completely retest the application before placing the application into production. This approach is particularly risky in light of the requirements defects discussed previously, which substantially increase the risk that the testing conducted by the centers not yet operational may not detect any negative impacts associated with a system change. However, IFMP officials recognized that, after all centers are in production, a regression testing program will be needed.

A NASA contractor monitoring this project also identified potential problems relating to regression testing. According to the contractor performing this work, NASA has not implemented the testing tools necessary to adequately perform the regression testing to provide NASA reasonable assurance that changes made in a given software release do not have any adverse consequences for future releases.

Performance Metrics Could Be Used to Assess Potential Risks of Identified Weaknesses

Without a well-documented set of requirements, it is impossible to place an error in context and understand the cause of the defect—for example, determining whether the error was caused by the underlying requirements or by some other process failure, such as inadequate testing or inadequate controls over system configuration. NASA has not effectively captured the types of metrics that can help the organization understand the effectiveness of its management processes, such as identifying and quantifying any weaknesses in its requirements management process. Accordingly, NASA is unable to implement a metrics measurement process that allows it to understand (1) its capabilities to manage the IFMP effort, (2) how its process problems will affect its cost, schedule, and performance objectives, and (3) the corrective actions needed to reduce the risks associated with the problems identified.

The Software Engineering Institute (SEI) has found that metrics identifying important events and trends are invaluable in guiding software organizations to informed decisions. Key SEI findings relating to metrics include the following:

- The success of any software organization depends on its ability to make predictions and commitments relative to the products it produces.
- Effective measurement processes help software groups succeed by enabling them to understand their capabilities, so that they can develop achievable plans for producing and delivering products and services.
- Measurements enable people to detect trends and to anticipate problems, thus providing better control of costs, reducing risks, improving quality, and ensuring that business objectives are achieved.[19]

A critical element in helping to ensure that a project meets its cost, schedule, and performance goals is to ensure that defects are minimized and corrected as early in the process as possible. Although NASA has a system that captures the defects that have been identified during testing, we found that the agency did not analyze its identified defects to determine their root causes. Understanding the root cause of a defect is critical to evaluating the effectiveness of a process. For example, if a significant

[19]William A. Florac, Robert E. Park, and Anita D. Carleton, *Practical Software Measurement: Measuring for Process Management and Improvement* (Pittsburgh, Pa.: Software Engineering Institute, Carnegie Mellon University, 1997).

number of defects are caused by inadequate requirements definition, then the organization knows that the requirements management process it has adopted is not effectively reducing risks to acceptable levels. IFMP officials stated that they do not capture the root causes of their defects.

Our initial observations identified that the root cause of many defects appeared to relate directly to the requirements management process. For example, see the following:

- About a week after the system was placed into production at a center, NASA found that it was making payments to its vendors 1 day earlier than required by Treasury regulations. This occurred because NASA thought that Treasury would warehouse its payments. If NASA had researched and documented the requirements associated with payment warehousing for cash management purposes, it would have known that Treasury does not warehouse payments such as these.

- About 3 weeks after the system went into production, NASA found that one of the payment processing tools was not working as required. It was unclear whether this was caused by a requirements defect or failure to properly test the functionality. A review of the requirements documents relating to this functionality provided a different description of the requirement than that included in the defect report.

- In early October 2002, NASA found that the accounting entries for certain advance transactions were incorrect. Properly documenting the requirements, developing a test case that ensured the requirements were met by the application, and executing that test case after the change was made should have detected this problem.

- After a patch was applied to the system, it was found that some code was duplicated, which caused an error. The apparent reason for the duplication of code was that manual adjustments were made to the code after the patch had been applied.

By analyzing the root causes of its identified defects, NASA could determine whether the requirements management approach it has adopted sufficiently reduces its risks of the system not meeting cost, schedule, and functionality goals to acceptable levels. Root cause analysis would also help to quantify the risks inherent in the testing process that NASA has selected for the core financial module. Because, as discussed previously, its approach in both these areas includes elements that are not considered

industry best practices, such metrics would be particularly important to NASA's being reasonably assured that its processes will result in a system that meets its business needs.

Conclusions

NASA has established the right goal for IFMP, and its ongoing implementation of several already-acquired system components, particularly the core financial module, may provide some improvements to NASA's accounting data. However, implementation of these components will only partially address NASA's information needs related to its complex space programs and contracts because NASA has deferred implementation of the system capabilities needed to provide this information and has not reengineered key business processes such as acquisition management. NASA's long-standing weaknesses in this area have been central to our designation of NASA contract management as high risk. Moreover, NASA's approach to acquiring and implementing IFMP components has and will continue to introduce risk and increase the chances that the agency will fall short of meeting its IFMP goal.

NASA faces serious near-term risks in implementing the commercial components that it has already acquired, including the core financial module. However, it is too far along in deploying these components to its centers, and relying on them to support operations, to stop and first acquire and then implement them properly. Instead, NASA will be forced to make the best of what it has acquired and implemented, meaning that NASA will have to stabilize the components while they are operational by identifying and correcting requirements defects and adequately testing the components to ensure that completed requirements are met. Such rework of already-deployed system components is a much more costly approach to implementing systems than adequately defining requirements and effectively testing system capabilities before they are deployed. However, NASA has left itself no other viable option.

In the longer term, NASA has an opportunity to avoid the mistakes it has made to date in acquiring system components, such as the core financial module, by first determining whether proposed components are the best solutions to meeting the agency's corporate needs before it acquires them. It is critically important that NASA's acquisition management strategy for future components includes a well-defined, risk-based methodology for understanding the dependencies among commercial component options before it acquires any additional components. Once these components are acquired, it is also critically important that NASA employ effective

requirements management, testing, and performance metrics practices in implementing the components. To do less will increase the risk of IFMP becoming NASA's third unsuccessful attempt to transform its financial management and business operations.

Recommendations for Executive Action

Given that NASA has already largely deployed and placed into production the IFMP commercial components acquired to date, we recommend that the NASA Administrator direct the Program Executive Officer for IFMP to focus near-term attention on stabilizing the operational effectiveness of these deployed commercial components.

Specifically, to mitigate the risks associated with relying on already-deployed IFMP commercial components and to expeditiously stabilize these components' operational capability and performance, we recommend that the Administrator direct the Program Executive Officer for IFMP to develop and implement a corrective action plan. At a minimum, this plan should provide for

- identifying known and potential risks,
- assessing the severity of the risks on the basis of probability and impact,
- developing risk mitigation strategies,
- assigning accountability and responsibility for implementing these strategies,
- tracking progress in implementing these strategies, and
- reporting progress regularly and frequently to relevant congressional committees.

Additionally, this plan should provide for

- developing and properly documenting requirements that are consistent, verifiable, and traceable, and that contain the necessary specificity to minimize requirement-related defects;
- conducting thorough regression testing before placing modified components into production;

- implementing a metrics program that will identify and address the root causes of system defects;

- reengineering acquisition management processes, particularly with respect to the consistency and detail of budget and actual cost and schedule data provided by contractors; and

- engaging stakeholders—including program managers, cost estimators, and the Congress—in developing a complete and correct set of user requirements.

To mitigate future risks, we further recommend that the Administrator require the Program Executive Officer for IFMP to complete the following actions before the acquisition of any additional IFMP components:

- establish and implement a methodology for commercial system component dependency analysis and decision making, and

- evaluate the suitability of already acquired, but not yet implemented, IFMP component products within the context of a component dependency analysis methodology.

Agency Comments and Our Evaluation

In its written comments on a draft of this report, NASA stated that it recognized and was addressing several of the concerns we raised and had already implemented some of the recommendations. NASA also stated that it disagreed with some of the issues in the report. NASA's comments on our recommendations included the following:

- With regard to our recommendation to establish and implement a methodology for IFMP commercial system component dependency analysis and decision-making, NASA stated that it agreed with the importance of having an approach for acquiring additional IFMP components and believes that it has an effective strategy already in place. We disagree that NASA has an effective strategy because it did not provide convincing evidence to support its position that it is using methodologically based dependency analysis—a best practice for implementing commercial component-based systems—in acquiring IFMP.

- Although NASA concurred with our recommendation regarding the need for a short-term plan to mitigate the risks currently associated with

relying on already-deployed IFMP commercial components, it disagreed with many of our findings in the areas of (1) its efforts to involve users and reengineer its business process to ensure that the core financial module would meet the needs of program managers and cost estimators and (2) the need for detailed system requirements. We continue to believe that any effort that falls short of end-to-end business process reengineering will not result in a system that substantially improves the data available for contract oversight and decision-making and that documented, detailed requirements are necessary to reduce the risks of implementing the selected processes to acceptable levels.

Overall, NASA disagreed with our findings related to three issues—dependency analysis, user needs, and requirements and testing—which are addressed in the following sections. NASA also included several technical comments, which we have addressed as appropriate throughout the report.

Dependency Analysis

In its written comments on our recommendation to establish and implement a methodology for IFMP commercial component dependency analysis and decision making, NASA stated that it agreed with the importance of having an approach for acquiring additional IFMP components but disagreed with our finding that it has not performed such dependency analysis to date in acquiring four IFMP commercial components. It also disagreed that it lacked a methodology to guide its analysis, and subsequent decision making, for future IFMP component acquisitions. According to NASA's comments, the agency already has an effective strategy in place and it has followed this strategy to date in acquiring four IFMP commercial components. NASA described this strategy as consisting of two factors: following an enterprise resource planning (ERP) suite integration strategy (i.e, "best of suite" approach) and using an enterprise application integration framework and associated tool set for integrating current and future IFMP components.

NASA said that prior to receiving our draft report, it had provided us detailed documentation describing how it began performing its component dependency analysis before selecting the SAP ERP product for IFMP's core financial module. The agency also noted that in a meeting following its receipt of our draft report, it had provided us with clear evidence that the program began performing dependency analysis before selecting the SAP product. Further, NASA's comments stated that it was using an enterprise application integration tool to facilitate product integration and ease the associated complexities of integrating multiple products. NASA added that

there were "perhaps miscommunications" and "some misunderstanding" of its approach, and opined that much of our concern about component dependency stems from our belief that NASA is not following a "best of suite" approach but rather a "best of breed" approach. To support its view that it is following a "best of suite" approach, NASA offered several statements, including that it is (1) on record in presentations and letters, including responses to congressional inquiries, that it is following "best of suite," (2) developing business cases before implementing an IFMP module, (3) working with SAP to extend its ERP product, and (4) following a prioritization process when considering how to introduce functionality that the SAP ERP product does not provide.

We agree with several of NASA's comments and disagree with others. Collectively, NASA's comments do not change our finding and recommendation. Specifically, we do not question that NASA is using an enterprise application integration product and that this product facilitates integration of system components, both commercial and legacy components. Further, we do not challenge NASA's statements regarding its representation in presentations and briefings that it is following a "best of suite" approach, its development of business cases, its interactions with SAP, and its use of a prioritization process.

However, we do challenge NASA's assertion that much of our concern is based on our belief that it is following a "best of breed" approach. On the contrary, our finding and recommendation do not hinge on the distinctions between "best of breed" versus "best of suite," despite evidence supporting our statements in the report that NASA is indeed following a best of breed approach. Such evidence includes (1) a report from a NASA contractor hired to provide an independent evaluation of IFMP stating that NASA is following a "best of breed" approach, (2) NASA's acquisition of four separate commercial products from four vendors to satisfy the first five of nine planned IFMP system modules, and (3) NASA's statement in its comments that additional products may be selected in the future. We fully appreciate that when implementing an ERP solution, other vendor products will likely be needed to fill gaps between agency requirements and the ERP product's capabilities. Accordingly, we state in our report that proactive, methodologically based dependency analysis and evaluation is needed regardless of whether an agency is following a "best of breed" or a "best of suite" approach, although we appropriately recognize that this analysis and evaluation is more vital in a "best of breed" effort.

Instead, our finding and recommendation is based on whether NASA is following, and plans to follow, methodologically based dependency analysis—a best practice for implementing commercial component-based systems—in acquiring IFMP. In this regard, documentation that NASA provided us during the course of our review, and that it provided following its receipt of our draft report, both of which NASA cited in its comments, does not offer convincing evidence that NASA is following this best practice. For example, the documentation lacked product descriptions and comparisons as well as any analysis of integration requirements. Moreover, the Deputy Program Manager responsible for IFMP integration told us during the course of our review that proactive analysis of prospective IFMP components' dependencies had not been performed and was not planned, and that NASA did not have a methodology for doing such analysis. The Deputy Program Manager for IFMP integration added, similar to NASA's comments on a draft of this report, that the agency's use of an enterprise application integration product and its associated tools will make integration easy and will negate the need for proactive dependency analysis. As noted above, we recognize that this product and tool set facilitates integration of multiple system components. However, it does not negate the need for dependency analysis and understanding to support informed decision-making before integration begins. As we state in our report, without such a proactive approach to acquiring system components, the risk of component product incompatibilities increases, as do the challenges and complexities that integration products and tools must overcome in integrating the products.

User Needs

NASA agreed that deployed and in-deployment modules do not yet meet all the needs of program managers. NASA indicated that this was the result of its "step-wise" approach in implementing the core financial module first and then integrating follow-on modules at a later date. As noted in our report, however, the deferral of many basic management functions has resulted in critical NASA programs, such as the ISS, using other systems to monitor contract cost and schedule performance. By not including the cost and schedule information needed by program managers in the core financial module, NASA risks operating with two sets of books—one that is used to report to management and the Congress and another that is used to manage NASA's programs. NASA disagreed with our specific findings related to user needs in three key areas:

- NASA believes that we have understated its accomplishments and the significance of the current capabilities delivered by the core financial module.

- NASA took issue with our assessment of the level of detail maintained in the core financial module, but did not comment specifically on our recommendation that the agency reengineer its acquisition management processes, particularly with respect to the consistency and detail of budgeted and actual cost and schedule data provided by contractors.

- NASA disagrees with our characterization that key users were not actively involved in the implementation of the core financial module or defining system requirements, although NASA indicates that better coordination was needed between program managers and the financial management community.

First, we acknowledge again the significant effort that NASA has put into this project. Moving from 10 separate, incompatible systems to a single integrated financial management system is a major, complex undertaking. However, as we discussed previously in this report, the core financial module falls short of NASA's own representation of the module's capabilities, which was to provide program managers with the information required for day-to-day decision making. Specifically, it does not provide integrated cost and schedule performance information needed by program managers to oversee many of NASA's largest and most complex contracts. In commenting on a draft of this report, NASA officials stated that it was never NASA's intent to integrate schedule data with the initial core financial module implementation. However, IFMP planning documents (including its program plan and business case analysis), congressional testimony by NASA's Administrator, and NASA's own press releases clearly established an expectation that the core financial module would remedy many of NASA's long-standing management challenges by providing program managers and other users with integrated financial and performance information. For example, according to his testimony before the House of Representatives Committee on Science on February 27, 2002, the NASA Administrator stated that while all components of IFMP are important, the successful completion of the core financial project will satisfy the Office of Management and Budget requirement that the financial and performance management systems supporting day-to-day operations are fully

integrated.[20] NASA responded that it is currently in the process of engaging program managers and defining specific requirements related to needed cost and schedule performance data.

Second, we recognize that the commercial components NASA has selected for its core financial module are technologically capable of capturing and maintaining the detailed cost data required by program managers and cost estimators. However, the level of detailed cost data currently maintained in the core financial module depends on the level of detail provided by NASA's contractors and the coding structure embedded in the core financial module. With respect to the level of detail provided by contractors, we reported that NASA has not reengineered its acquisition management processes to ensure that contractors are consistently providing the detailed cost data needed by program managers and cost estimators and recommended that NASA do so.

NASA did not specifically address our recommendation but stated that it is incumbent upon program managers and cost estimators to learn and understand the capabilities of the new module and take advantage of them for their specific purposes. NASA's comments also indicate that the data structure in the core financial module would be extended beyond the current legacy capabilities (i.e., the module will be able to record a greater level of detail) in fiscal year 2004. However, increasing the module's capacity to store greater detail will not ensure that the information needed by program managers and cost estimators is requested and received from contractors and subsequently updated in the module. Although NASA commented that it would review its current project management process to ensure that its contractors provide the appropriate levels of cost data, we continue to believe that any effort that falls short of end-to-end business process reengineering will not result in a system that substantially improves the data available for contract oversight and decision making.

Third, we acknowledge that the IFMP implementation team made an effort to include resource management staff from program management offices in various process teams. However, as we discussed previously in this report, no effort was made to include the cost estimating community in these

[20]The Chief Financial Officers Act of 1990 and subsequent related financial management reform legislation, among other things, set expectations for agencies to develop and deploy more modern financial management systems, produce sound cost and operating performance information, and design results oriented reports on the government's financial condition by integrating budget, accounting, and program information.

efforts. While program management office staff did participate, these efforts did not address the program cost and schedule needs of program managers or cost estimators. For example, the program management staff with whom we spoke, who worked on three of NASA's largest programs (ISS, Space Shuttle, and Space Launch Initiative), viewed the core financial module as an "accounting system" that would be used by the accountants but was not necessarily going to change the way that program managers manage their programs. With this understanding, it is not surprising that the core financial module does not meet the needs of program managers or cost estimators. Implementing an integrated financial management system that is intended to change the way an organization does business is extremely complex and involves cultural, organizational, and process improvements. It also means making financial management an agency-wide priority. Our work at leading public and private sector organizations has shown that implementing a financial management system that meets the organization's business needs takes more than just placing a handful of business or line management representatives on the implementation team. NASA's approach has resulted in a core financial module that will be of limited value to program managers and cost estimators, who will continue to rely on other systems or ad hoc processes to get the data they need. As such, implementation of the core financial module to date continues to foster the concern that, at NASA, finance is not viewed as an integral part of NASA's program management decision process.

Requirements and Testing

NASA generally agreed that improvements were needed in its requirements management and testing processes and has stated that it has already begun to make improvements. For example, NASA recognized the need to implement a more rigorous regression testing methodology and stated that by October 2003 it would have an improved regression testing program. NASA also recognized that its process for tracing requirements and testing needed improvement and stated that it planned to implement improved capability and functionality for traceability over the next few months.

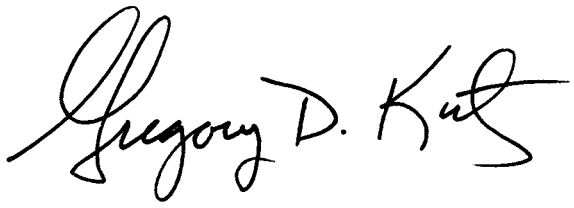
However, according to NASA officials, they are following best practices for implementing an ERP solution and have "defined and implemented rigorous, closed-loop requirements and testing processes." Further, regarding the applicability of requirements management standards, NASA did not agree that IEEE 830-1998 was applicable to the IFMP since it was an ERP implementation effort. NASA stated that specifying detailed requirements for already-developed software is high risk and that other leading industry experts have told them that NASA needed to change its

processes to conform to the capabilities of the commercial software selected rather than attempt to change the software to conform to the existing NASA processes. We agree with NASA's position that it needs to change its business processes to conform to the software; however, we do not agree with the agency's position that detailed requirements are not needed. We continue to believe that NASA needs to properly configure the software based on detailed requirements in a manner that supports the business processes that have been adopted from the selected ERP solution. Because it has not done so, we continue to believe that NASA has not effectively implemented the types of disciplined processes necessary to reduce this project's risks to acceptable levels. Acceptable levels refer to the fact that any systems acquisition effort, such as that being undertaken by NASA, will have some requirements-related defects. However, the goal is to reduce the risks and prevent significant requirements defects in order to limit the negative impact of these defects on cost, timeliness, and performance of the project.

During our review, we discussed with IFMP officials our concerns about the lack of documented, detailed system requirements for implementing the core financial module. In those meetings, we recognized that NASA's approach for developing requirements was based on a business process model and did not disagree that this approach could be used to define how NASA would implement the necessary functionality. However, we continue to believe that once the business processes are defined and selected, documented, detailed requirements are necessary to reduce the risks of implementing the selected processes to acceptable levels. As NASA noted in its comments, its consultants also recommended that NASA needed to "determine the requirements while putting together the design process." Therefore, guidance provided by the IEEE standard is applicable to the successful configuration and implementation of commercial software packages and is useful to help gauge the effectiveness of those efforts.

As agreed with your offices, unless you announce its contents earlier, we will not distribute this report further until 30 days from its date. At that time, we will send copies to interested congressional committees, the NASA Administrator, and the Director of the Office of Management and Budget. We will make copies available to others upon request. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staffs have any questions concerning this report, please contact Gregory D. Kutz at (202) 512-9505 or kutzg@gao.gov, Randolph C. Hite at (202) 512-6256 or hiter@gao.gov, Allen Li at (202) 512-4841 or lia@gao.gov, or Keith A. Rhodes at (202) 512-6412 or rhodesk@gao.gov. Key contributors to this report are acknowledged in appendix III.



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Objectives, Scope, and Methodology

To determine whether the National Aeronautics and Space Administration (NASA) is effectively managing the Integrated Financial Management Program (IFMP) acquisition, we reviewed relevant program-level acquisition management documentation to obtain an understanding of NASA's plans and strategy, including the program overview, program- and project-level management plans, the acquisition strategy, implementation and integration plans, briefing materials on the agency's plans to develop an information architecture, and a report on IFMP lessons learned by NASA's consultant, Gartner, Inc. We also interviewed various program officials, including the Program Executive Officer for IFMP, the IFMP Program Director, the IFMP Deputy Program Director, the Core Financial Project Manager, the Integration Office Deputy Program Manager, and the Chief Information Officer to clarify our understanding of the agency's strategy and obtain current information on the status of the agency's efforts. Specifically, we inquired as to NASA's basis for selecting already-acquired commercial products and its plans for selecting future modules. We then compared NASA's plans and activities to relevant best practices, Office of Management and Budget (OMB) requirements, federal guidance, and NASA procedures and guidance.

We had also intended to include our assessment of a key element of NASA's acquisition strategy—whether NASA was acquiring IFMP components in the context of an enterprise architecture—in this report. However, because NASA did not provide the data needed to complete our assessment until after the conclusion of our fieldwork, we plan to address NASA's enterprise architecture in a future product.

To determine whether NASA had adequately considered the information needs of key users in implementing the core financial module of IFMP, we reviewed IFMP documents discussing the business case and properties of the core financial module and spoke with IFMP implementers at Marshall Space Flight Center—the lead center on this project—and NASA headquarters. To determine whether the data requirements, as established by the IFMP implementers, would address NASA's known problems with cost control and cost tracking, we spoke with program managers involved in three of NASA's largest programs and other NASA program and business management staff at three centers—Marshall Space Flight Center, Johnson Space Center, and Glenn Research Center. We also reviewed prior work on NASA's cost problems, including the report by the International Space Station Management and Cost Evaluation Task Force, which reviewed the recent cost growth in that program and identified causes and necessary actions.

In addition to speaking with program managers and their staffs, we spoke with cost estimators at the three centers mentioned above as well as Langley Research Center and NASA headquarters. We also spoke with center staff who oversee and support earned value management for programs that use that tool, and with the congressional staffs of NASA's authorization committees. We asked them about the extent to which they had been asked by IFMP implementers for input on their data needs, the extent to which they had been involved in IFMP's design and implementation, and whether they had been briefed by IFMP implementers on the capabilities of the core financial module.

To determine what kind of cost information program managers use to oversee their programs, we reviewed selected large, cost-type contracts for NASA's three largest space flight programs—the International Space Station, the Space Shuttle, and the Space Launch Initiative project (intended to develop technologies for the next generation replacement for the Space Shuttle.) For all three of these programs, cost control and cost tracking have been issues of concern. The three programs together involve most of NASA's work in the human space flight area, which accounts for most of the agency's spending. These programs range from relatively new (Space Launch Initiative) to quite mature (Space Shuttle) programs and require the procurement of a wide range of goods and services. Each of these programs is being run at multiple centers, involves the work of multiple contractors, and uses cost-type contracts[1] that run for multiple years.

For the contracts we selected, we spoke to responsible personnel about how costs are tracked and monitored, including the level of detail provided by contractors, the format in which cost data are available, and how contract cost data reporting requirements are developed. We also obtained and reviewed copies of contractor financial management reports and cost and schedule performance reports that we compared with contract or program work breakdown structures, as well as contract cost data reporting requirements and statements of work. We analyzed and discussed with agency officials how all these documents and reports related to each other and to the work breakdown structure. We also discussed how the

[1]Cost-reimbursement contracts are often the most appropriate type for developmental items or those for which the exact price of the goods or services being purchased cannot be definitely known prior to contract award. This type of procurement instrument places greater risk on the government than contracts based on firm fixed prices.

reported information was used by the programs and the extent to which that information would be included in the core financial module. We did not, however, evaluate whether the information currently received from contractors, or represented as needed by program managers and cost estimators, was adequate for management purposes.

IFMP's core financial module is intended to address known problems with NASA's program cost accounting and with its financial reporting. We did not, however, review how the core financial module will address the agency's financial reporting issues, including property accounting and budgetary information, and whether the module will reduce the time and resources needed to close the books each accounting period and reduce the number of postclosing adjusting entries. We plan to review and report on these issues at a later date.

To assess whether NASA had established and implemented an effective requirements management process to support implementation of the core financial module, we wanted to determine whether NASA had effectively implemented (1) the disciplined processes that can reduce project risks to acceptable levels for its requirements management process and (2) the types of metrics to identify and quantify any weaknesses in its requirements management process. To accomplish these objectives, we

- reviewed various requirements documents produced for the core financial module project, including the over 500 contract requirements used to acquire the SAP software;

- performed an in-depth review and analysis of the 132 requirements, which represent about 22 percent of the contract requirements, developed for the "Managing Accounts Payable" process to determine whether they had the attributes normally associated with good requirements and whether these requirements traced between the various requirements documents;

- reviewed NASA's procedures for defining its requirements management framework and compared these procedures to its current practices;

- reviewed business processes, problem defect reports, test conditions, test cases, and test execution logs contained in Accenture's Method Delivery Management system—NASA's project management tool; and

- reviewed guidance published by the Institute of Electrical and Electronics Engineers (IEEE), Software Engineering Institute (SEI), and publications by experts to determine the attributes that should be used for developing good requirements and for identifying and quantifying performance metrics.

To augment these document reviews and analyses, we interviewed officials from NASA headquarters, Marshall Space Flight Center, and NASA's independent verification and validation contractor—Titan Systems Corporation. In addition, we discussed with NASA officials the processes they used to measure the effectiveness of their requirements management process and compared NASA's process to those used by disciplined organizations. In order to determine the processes that can be used to help an organization understand the effectiveness of its processes, we used information from IEEE, SEI, and subject matter experts.

We conducted our work at NASA headquarters in Washington, D.C.; Marshall Space Flight Center in Huntsville, Alabama; Glenn Research Center in Cleveland, Ohio; Johnson Space Center in Houston, Texas; Langley Research Center in Hampton Roads, Virginia; and Goddard Space Flight Center in Greenbelt, Maryland. We received written comments on a draft of this report from the NASA Deputy Administrator. These comments are addressed in the "Agency Comments and Our Evaluation" section of this report and are reprinted in appendix II. We performed our work from April 2002 through February 2003 in accordance with generally accepted government auditing standards.

Comments from the National Aeronautics and Space Administration

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

National Aeronautics and
Space Administration
Office of the Administrator
Washington, DC 20546-0001

March 25, 2003

Mr. Gregory D. Kutz
Director
Financial Management and Assurance
United States General Accounting Office
Washington, DC 20548

Dear Mr. Kutz:

Thank you for the opportunity to review and comment on the draft report entitled, *Business Modernization: Improvements Needed in Management of NASA's Integrated Financial Management Program* (GAO-03-507). We appreciate the GAO's continued interest in this vital program and desire to see this undertaking successfully completed.

One of the lessons learned from our previous Integrated Financial Management Program (IFMP) effort was that we should not try to develop and implement the ultimate functionality of the system all at once. In its previous effort, NASA did not adopt a scaled deployment strategy which is a recommended best practice approach for large-scale Enterprise Resource Planning (ERP) implementation such as our IFM Program. That effort failed due, in part, to trying to immediately satisfy all functional requirements by developing a complete all-encompassing custom system.

See comment 1.

Although we are recognizing and addressing several of the GAO's concerns raised in the report, including already implementing some of the proposed recommendations, we are also in disagreement with some of the issues identified in the report. Summarized below is our responses to each individual recommendation. The detail of our responses is found in the enclosure to this letter.

Recommendation #1: Develop and implement a short-term plan to identify and mitigate the risks currently associated with relying on already deployed IFMP commercial components.

NASA concurs with this recommendation.

Related to this recommendation is an implication that IFMP's operations are highly unstable due to inadequate requirements and testing processes. This assertion was based on a "snapshot in time" taken by the GAO when the Core Financials (CF) module was still in stabilization phase after the initial "go live" at the first two Centers, Marshall Space Flight Center (MSFC) and Glenn Research Center (GRC). The larger challenges encountered during the initial days of operation under the CF module at those two Centers have not been repeated in the recent "go live" at our Wave 2 Centers, Johnson

Space Center (JSC), Kennedy Space Center (KSC), NASA Headquarters, and the NASA Management Office at the Jet Propulsion Laboratory. While there have been operational issues identified with the Wave 2 deployment, they have been more quickly resolved through concerted data clean up and/or follow up user instruction. Illustratively, JSC was able to eliminate their payment backlog within 2 weeks of their "go live" date. Additionally, the volume of trouble tickets for Wave 2 was significantly reduced (65 percent less per day average for the first 21 days of operations) in relation to the MSFC and GRC deployment.

See comment 1.

In its concern of NASA's requirements processes, the report relies on the requirements management standard IEEE 830-1998. However, this standard does not appear to be directly applicable to our program. The upfront scope of the published standard states, "This recommended practice is aimed at specifying requirements of software to be developed but also can be applied to assist in the selection of in-house and commercial software products. However, application to already-developed software could be counterproductive." NASA is implementing already developed, commercial software, and, as stated earlier, is now following best practices for an ERP implementation in this current effort. The IFM program has defined and implemented rigorous, closed-loop requirements and testing processes, and is using commercial tools and metrics to manage these processes. Though the capabilities in place provide for requirements testing traceability, NASA agrees that they can be cumbersome, unwieldy, and in some cases, opaque and that improvements should and will be made. The IFMP will be implementing those improvements over the next few months on the current Budget Formulation Project and, following GAO's recommendation, will also require that future implementors and integrators use improved capability and functionality for traceability in predeployment process testing.

See comment 1.

With respect to regression testing, IFMP's maturity in this area is consistent with most organizations at this phase of implementation. However, NASA recognizes the need for a more rigorous regression testing methodology as the Core Financial project moves from implementation to long-term operational support. Following our final Wave 3 implementation, IFMP will be implementing a plan, coordinated with its IV&V contractors, to ensure that structured regression testing methods are employed on the Agencywide system to fully identify and capture all facets of specific process-related issues. This plan will be in place by October 2003.

Going forward, IFMP will also continue to improve its requirements and testing processes and associated plans. However, there might still be differences between NASA and the GAO with respect to how ERP implementations should be managed. I propose that NASA and the GAO meet jointly with industry-leading ERP experts to better understand and ensure that IFMP is indeed following best practices.

See comment 1.

Finally, in the relationship between the new Core Financials system and the level of detail for cost estimation, our new system has been configured to accept many additional elements beyond those available in the existing Agency coding structure. The use of these additional capabilitie is a function of the Centers and Program/Project management constituencies' ability and interest, including cost estimators, to learn and understand the capabilities of the new module and to take advantage of them for their specific purposes. We do acknowledge that this education has not been consistently applied throughout the Agency. NASA has committed to immediately review its current project management processes to ensure that management, at the initiation of new projects, rigorously defines and implements the appropriate levels of cost reporting based on future analytical needs, and better coordinate with the financial management community to ensure that the Core Financials system is appropriately configured.

Recommendation #2: Develop and implement a longer-term strategy for acquiring additional IFMP components that includes implementing a methodology for commercial system component dependency analysis.

NASA agrees with the importance of having a long-term approach for acquiring additional IFM components and believes it has an effective strategy already in place.

See comment 1.

Detailed documentation had been previously provided to GAO describing how the IFM program began performing component dependency analysis prior to the final ERP product (SAP) selection for its Core Financials module, and that NASA was developing an Enterprise Application Integration (EAI) architecture to be used as a framework for both managing the integration process and addressing associated complexities. The risks associated with integration were identified early in the process, and appropriate mitigation strategies were developed and implemented. As noted in the report, the need for extensive dependency analysis and associated integration risks can be mitigated by using an ERP suite integration strategy (Best of Suite) rather than trying to integrate third-party products (Best of Breed). However, we take exception to the assertion that NASA is not following that approach. NASA has been following this approach and is, in fact, recognized by SAP as a "platinum" customer, SAP's highest level used as a reference for other customers.

The third-party products identified in the report, as evidence that NASA is not using a "Best of Suite" strategy, provided required functionality that either did not exist in a SAP suite model or, if available from SAP, did not meet published Federal requirements. Codependency with the Core Financials functionality was fully evaluated and ranked before final product selection was performed. Furthermore, NASA has, and continues to follow, a rigorous process for gap identification and management. Consequently, our Core Financials implementation required only 15 extensions (which are unique software capabilities, necessary to meet customer-driven business needs, developed and

maintained using SAP tools), a single third-party product (a credit card tracking and reconciliation tool), and no modifications to the COTS core software. In comparison to widely used industry benchmarks, NASA's has implemented few additional custom capabilities relative to its basic COTS configuration which helped reduce operational risk.

The new e-Gov initiatives and other Federal mandates to cross-service applications (e.g., e-Payroll) have the potential to weaken our "Best of Suite" strategy. Nevertheless, NASA has not deviated from its "Best of Suite" strategy, wherever feasible. This is most clearly evidenced by the fact that every major product selection since selecting SAP for its Core Financials module has resulted in extending the SAP suite rather than adopting "Best of Breed" third party applications. These selections include Business Warehouse (for reporting), Strategic Enterprise Management (for Budget Formulation), and Asset Management. Furthermore, we have initiated efforts with SAP to improve their products in support of future projects where we identified gaps in functionality.

See comment 2.

We would like to also point out that since FY 2000, (which was when this critical program was reformulated), the IFM program has fully and successfully deployed its Resume Management and Position Description Management modules Agencywide, and has implemented its Travel Management module at nine of 10 Centers (the 10th Center will be operational next month). Since becoming operational in late 2001, the Resume Management system (NASA STARS) has been recognized as a model in the Federal Government for staffing and recruiting systems, has received numerous accolades, and is the benchmark that Office of Personnel Management (OPM) has selected for the Recruitment One e-Gov initiative.

See comment 3.

Our "backbone" system module for Financial Management, Core Financials, has been implemented at six Centers and is on schedule to complete implementation at the remaining Centers this coming June. In comparison to similar ERP implementations of the size and complexity of our Core Financial project where each Center is actually a new implementation due to their historical incompatibilities, NASA's rollout to date has been relatively "quiet". Accenture, the implementation contractor for the Core Financial Project, has implemented SAP on over 750 engagements. Their characterization of the most recent implementation at JSC is that it was probably the smoothest they've ever witnessed.

See comment 4.

Finally, it should be noted that our IFM program is on budget and on schedule. Please do not hesitate to contact me, or the Program's PEO, if you have any further questions about this response.

Cordially,

Frederick D. Gregory
Deputy Administrator

Enclosure

See comment 1.

NASA Response to GAO Report (GAO-03-507)

NASA'S ACQUISITION MANAGEMENT STRATEGY DOES NOT INCLUDE ANALYZING COMPONENT DEPENDENCIES

Much of the GAO's concern in this area stems from their belief that NASA is following a "best of breed" approach. We believe there is some misunderstanding and, perhaps, miscommunications with the GAO on NASA's strategy with respect to "best of breed" versus "best of suite." Cited below are several statements related to NASA's business systems strategy, which is still considered "best of suite":

- Before IFMP acquired the Core Financials module in late FY 2000, there was a desire for a "best of suite" strategy; however, there was a degree of uncertainty as to how successful that could be given unique Federal requirements, and the variability of offerings from potential ERP providers. Our "best of suite" strategy was finalized after selecting SAP. The IFMP is on record with numerous documents (presentations and letters) documenting this strategy, including several responses to Congress.
- Even with a "best of suite" strategy, IFMP has processes in place to confirm that an ERP suite can still meet NASA's requirements. Primarily, the Program develops business case analyses (BCA's) to assess areas such as alternatives, costs, risks, and benefits, before starting a project (module implementation). This is a prudent business practice that IFMP performs, and that OMB, GAO, and other external oversight organizations expect the Program to perform. It is therefore possible that, moving forward, a feasible alternative could eventually be selected outside of a "best of suite" model.
- Even with the "suite" strategy, NASA recognizes that the ERP product may need further evolution to meet Federal needs. This is evidenced by NASA's partnership with SAP to help the software provider better understand Federal requirements and to evolve their Budget Formulation and Human Resources functionality. IFMP would not continue to work with SAP in this partnership arrangement if it did not have intentions to extend the suite for NASA's use.
- The COTS software used in the three projects identified by GAO provides functionality not found in ERP suite software (i.e., SAP). This "functionality not found" is termed "gap." NASA has established a prioritization process for filling gaps that assess:
  - ◊ Alternative configuration approaches to achieve targeted functionality;
  - ◊ Adapt NASA business processes consistent with COTS capability;
  - ◊ Use functionality extensions based on SAP tools and user exits;
  - ◊ Integrate third-party products; and finally,
  - ◊ Modify the basic software base.

  Although this process does allow the potential to fill functionality gaps using third party software solutions, our prioritization ensures that such an approach is adopted only if there are critical losses of functionality. This process necessarily involves a detailed evaluation of data dependencies. Furthermore in the report, the three products selected have limited or no integration requirements with the Core Financial function.

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These selection decisions do not imply that the program deviated from "best of suite". In the larger groupings of finance, budgeting, asset management, and Human Resources, NASA still has a "best of suite" strategy. The new e-Gov initiatives and other Federal mandates to cross-service applications (e.g., e-Payroll) might potentially impact NASA's overall "best of suite" model. Nevertheless, to date, NASA has not yet deviated from its established "best of suite" strategy.

- Since selecting SAP for Core Financials, IFMP has made three major "selection" decisions which have extended the SAP suite. These are Business Warehouse (for reporting), Strategic Enterprise Management (for Budget Formulation), and Asset Management.

See comment 1.

The report also contends that NASA has not performed a detailed enough dependency analysis, and does not have a methodology for doing so, and lacking such analysis will lead to a more complicated and risk-prone integration. We believe this GAO concern was addressed at a March 10 meeting that occurred after the initial report draft. At this meeting, the GAO was provided detailed documentation tracing the evolution of NASA's current Enterprise architecture and the linkage to the architecture that was employed in the acquisition, priorities, and decisions made by the IFMP. Included in this documentation was clear evidence that the program began performing dependency analysis prior to ERP product (SAP) selection (Core Financials module), and was developing an Enterprise Application Integration (EAI) architecture which would serve as a framework for both managing the process of integration and for easing the associated complexities. The risks associated with the integration were recognized, and appropriate mitigation strategies were followed. To date, the Core Financials system has been successfully integrated with one third party product and 35 legacy systems.

In summary, the GAO's concern about complex product integration is mitigated in two ways: (1) IFMP does have a "best of suite" strategy focused around the SAP product; and (2) IFMP has developed an EAI framework and is already successfully using this EAI tool set supporting requirements for legacy system interfaces and third-party product integration.

CORE FINANCIALS MODULE DOES NOT FULLY ADDRESS KEY USER INFORMATION REQUIREMENTS

If Implemented as Planned, the Core Financials Module May Provide Some Improvements

See comment 1.

The report understates the significance of the current capabilities delivered by the Core Financials module.

- The Core Financials module has clear improvements over NASA's previous accounting systems providing plan and actual financial expenditures with seamless visibility across Center and organization lines. This has been a fundamental limitation on Program and Project management for large activities that cross Center lines.

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- The module also has real-time processing and reporting capabilities that provide immediate access to key financial information and eliminates the separate databases for procurement and financial activities which had existed previously.
- Finally, this module is the backbone of the IFMP, establishing the SAP suite, creating a business warehouse for enhanced data access and information delivery and an integration architecture to tie in legacy systems, external data repositories, and other software products. When it becomes an Agencywide operation in June, it will enable NASA to transition to full cost management practices.

See comment 5.

As an enabler of NASA's full cost initiative, the Core Financials system will provide the tools for applying full cost practices that will help lead to more efficient, optimal use of institutional resources such as:

- ◊ Justification of Institutional resources based on real-time project requirements;
- ◊ Elimination of "free" resources. Program and project managers will have the insight necessary in defining more accurately institutional capabilities; and
- ◊ Funding for service pool allocations based on demand/consumption rather than with a parametric formula used with old program support accounts.

As stated in the report, the Core Financials system will eliminate inconsistent data through single data entry and provide for data standardization. The module will provide NASA with an integrated, on-line access to standard information across different business processes, NASA sites, and programs. This is a major leap forward for NASA. Furthermore, the Core Financials system is a highly scalable and configurable commercial solution that is flexible enough to respond to the ever present and continuously evolving Financial Management and Reporting requirements.

Key Users Were Not Involved in the Implementation of the Core Financials Module

See comment 1.

The report observes that since financial managers were the primary source of the subject matter expertise for the Core Financial Project, NASA did not reengineer its financial management processes to support broader management challenges. We disagree with this assumption. Representatives from our project resource management and procurement communities were heavily involved in the requirement definition and process design activities for the Core Financials module. These communities participated in baselining the original requirement set and processes, in adapting these requirements and processes to the realities and best practices inherent in the selected Commercial Off-the-Shelf (COTS) software products, and in the implementation of those resulting processes at the Centers.

When the IFMP set out on its current effort to acquire and implement a core financial system for the Agency, it had an extensive experiencebase in defining NASA's requirements for such a system. NASA began its work by updating its requirements from previous efforts to focus on the specific scope that the Core Financial Project was charged with fulfilling. The scope of the Core Financial module was guided by lessons learned from the previous effort, as well as recommendations from a NASA OIG audit report on the reasons for failure of the prior effort. The JFMIP Framework for Federal

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Financial Management Systems was also used to guide the scope definition for the project. The latest JFMIP Core Financial System Requirements document was used to update the requirement set to match the latest Federal financial system guidance. NASA also revised its core financial requirement set to incorporate lessons learned from the previous efforts, and to confirm that the new requirement sets were in line with the scope of the project. Per the direction of the IFMP Steering Council, the new requirements set were to include budget execution, purchasing, accounts payable, accounts receivable, cost management, standard general ledger, and fixed assets.

To finalize these new Core Financial requirements, NASA assembled an Agencywide team composed of representatives from across the financial, resource/project management, procurement, and asset management communities. This Agencywide Process Team started out with approximately 40 team members and quickly grew to over 50 core team members with another 100 members participating on a part time basis throughout the Agency Design and Pilot Center implementation. Within this group of subject matter experts, the budget execution and cost management subprocess teams included participants from the project resource management community. The purchasing subprocess team was heavily leveraged with representatives from the procurement management community.

During the Pilot Center implementation, Core Financial team members met with the Project office representatives and focus groups on numerous occasions to understand their information needs. Detailed working sessions were conducted as the team developed the final inventory of interfaces required for legacy Center systems, many of which were resident in the project offices across the Center. By working with representatives from each of these offices, the Core Financial team was able to ensure that the information needs of these organizations would be provided through the reporting capability in the SAP Business Warehouse solution being delivered as part of the Core Financial implementation. The team met on a scheduled basis with project office representatives to understand their current use of the legacy coding structure as they planned for the conversion of legacy data into the new financial classification structure in SAP. In addition, the team conducted focus group discussions with key Center project resource management representatives to understand the priorities of the project office community among the functional drivers defined for the Core Financial Project. Further, the team utilized an anonymous electronic polling tool to gather objective input and rankings from the participants. These prioritized project functional drivers, as documented in the Business Case Analysis for the Core Financial Project, have been used throughout the design and implementation effort to support issue resolution and to weigh advantages and disadvantages among alternative solutions.

As the Core Financial project began Agency rollout, each NASA Center formed an implementation team for the Core Financial deployment. These teams included participation from the resources and project management communities. Of particular significance is the degree of participation by the International Space Station (ISS) Program Office at JSC. The JSC Core Financial Implementation Team included a full-time member from the ISS Program Office. This team member was instrumental in

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ensuring that Space Station reporting requirements were considered in the implementation at JSC.

The Core Financial Modules Will Not Provide the Information Needed to Manage Contracts

See comment 1.

The report states that "the core financial module is not being implemented to ……. maintain cost data at a sufficient level of detail for certain contracts." However, the Core Financials module has significant ability to capture contract costs at very detailed levels of a work breakdown structure (WBS). The SAP system has been configured to capture approximately 30 additional elements above those accommodated in the existing Agency coding structure. However, as noted correctly in the report, the use of these additional capabilities is incumbent on the Center and Program/Project management communities, including cost estimators, to understand the possibilities and to take advantage of them for their specific purposes. NASA's current policy for contractor cost capture (NPD 9501.1G) also recognizes this upfront coordination, stating that "reporting requirements necessary for the management of a project will be determined as early as possible in the project planning stage, as a team effort involving all organizations which will play a role in monitoring the contract during the performance period. The cognizant procurement, technical, project, financial, and resources management offices shall be a part of the reporting structure development and approval process."

Acknowledging that contractor cost capture has not been consistently applied, NASA has committed to immediately review its current project management processes to ensure that project management, at the initiation of new projects, rigorously review and establish the appropriate levels of cost reporting based on future analysis needs (e.g., cost estimating), and coordinate with their financial counterparts to affirm that the Core Financial system is configured appropriately.

The Core Financial Module Does Not Integrate Cost and Schedule Data Needed by Program Managers

See comment 1.

Though NASA agrees with the GAO that schedule integration is needed with the Core Financial module, it was never NASA's intent to integrate schedule data with the initial Core Financial implementation. One of the lessons learned from the previous effort is that we cannot develop and implement all required functionality at once. This step-wise approach is a fundamental best practice of large-scale ERP implementations which NASA did not follow on that previous effort. That effort failed. Trying to satisfy all requirements needs for an initial rollout of an ERP system bears a level of risk that was judged unacceptable by the Program. For this reason, NASA's approach was to first implement the Core Financial module. Once this financial "backbone" is built (to be complete this summer), NASA plans to integrate the follow-on modules needed to complete the overall IFM Enterprise system environment.

Part of this planned follow-on is an evaluation of additional project management capabilities. Schedule integration capability is inherent in the Project Systems module of the SAP product on which the Core Financial system is built. Additionally, interfaces are available to integrate SAP with NASA's two primary schedule tools, Primavera and

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Microsoft Project. In addition, SAP has very powerful mechanisms for capturing and reporting performance metrics related to earned value. Over the past year, NASA has performed two separate studies related to the use of SAP's Project Systems. Both studies confirmed the robust capabilities inherent in the tool, as well as its ability to interface with leading third-party schedule tools. The IFMP has been working closely with the Office of the Chief Engineer and the Program Management Committee Working Group (PMCWG) in defining the requirements for a pilot on one or two new projects using Project Systems capabilities. This process is currently underway and is due to completed this summer.

Currently, it is indeed correct that the deployed and in-deployment modules do not yet meet all the needs of the Program management community. Our Program and Project management activities have a need to use information not only from Budget Execution (Core Financials), but also integrate data from Budget Formulation, Human Capital, Asset Management and Contract Administration to get the full benefits of the IFM system. Those modules are on schedule to be deployed as planned.

The Core Financials Module Will Rely on Legacy Coding Structure

The heading within this section of the report could imply that NASA will continue to rely on its legacy coding and that the system will not meet Project Manager needs for lower levels of detail. As the GAO recognized in its report, "...the core financial module is capable of capturing this more detailed cost data, however, due to the complexity associated with converting detailed data from the center's legacy systems, NASA has deferred this capability." It is true that these capabilities, although designed into the system, have not been fully used during the FY 2003 transition year. The major constraint in FY 2003 is that Centers are "going live" throughout the year and the primary driver for the level of detail is the conversion of existing legacy systems. To attempt to transform the legacy data into a lower level of detail as part of the conversion process would destroy the integrity of the information being converted as well as the audit traceability from the legacy system to SAP. Since part of the year will utilize the legacy systems and the other part will utilize the new systems, it is not appropriate to change the level of detail partway through the fiscal year. In FY 2004, however, NASA will operate fully under the new financial module, and the data structures can and will be extended beyond the legacy capabilities. These decisions will be driven by the needs of Program and Project managers. Further, the data structure is scheduled to be adapted to implement the forthcoming full cost accounting and reporting requirements.

See comment 1.

For future processing, the configuration of the SAP system provides extensive capabilities beyond those available today in the current Agencywide coding structure (AWCS). The SAP system has been configured to capture approximately 30 additional elements beyond those accommodated in the existing Agency coding structure. Currently, NASA has fielded a Full Cost Implementation team to define the budget structure to be used in FY 2004, and to be configured in the Core Financial system. This team consists of nine working groups, includes many Program and Project managers and representatives, as well as cost estimators, and works closely with the IFMP to ensure

See comment 1.

that the configuration will be ready to receive and execute the budget under the new environment.

Core Financial Module Will Not Provide The Information Needed To Prepare Credible Cost Estimates

The report observes that "…the core financial module will not contain sufficiently detailed historical cost data necessary for projecting future costs, cost estimators will continue to rely on labor-intensive data collection efforts after a program is completed." As noted earlier in this response, it was never NASA's intent to convert low levels of historical cost data from legacy systems into the new financial system. The Core Financial system is capable of tracking costs at a very detailed level; however, as explained previously, NASA cannot fully transition lower levels of reporting until FY 2004. At that time, the project manager will ensure that the appropriate levels of costs are captured using NASA's contractor cost reporting (i.e., 533 process) so that, going forward, the project can be effectively managed and an appropriate level of detail is available to support cost estimators' needs.

With respect to the detail required for cost estimating, the granularity and fidelity of the cost estimates within NASA vary by program phase, purpose of the cost estimate, and the availability of estimating resources. Some estimates are done at the lower levels of the WBS, as suggested by GAO. However, other estimates are done at a much higher levels of the WBS. For example, commitment estimates in NASA are performed near the Preliminary Design Review (PDR) at which the designs are typically at the "fan, compressor, turbine level" (e.g., GAO Report Figure 2) or, at most, one level below.

As previously noted, the SAP system has specifically been configured to capture many additional elements above those accommodated in the existing Agency coding structure. The use of these additional capabilities is in some cases a function of the Center and Program/Project management communities, including cost estimators, to understand the possibilities and to take advantage of them for their specific purposes. Recognizing that this has not been consistently applied within this Agency, NASA has committed to review its current project management processes (e.g., NPG 7120.5) to ensure that project management, at the initiation of new projects, rigorously review and establish the appropriate levels of cost reporting based on future analysis needs, and coordinate with their financial counterparts to affirm that the Core Financial system is configured appropriately.

Even with an appropriate cost capture system in place, there might be occasions when cost estimators require levels of detail or specific data elements that are not stored in its financial systems. It is NASA's position that it is more cost effective to research these information needs from various sources, rather than attempt, upfront, to forecast the universe of information required for cost estimators and then develop the means to capture that information into a single source system.

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Core Financial Module May Not Provide Better Information for Congressional Oversight

We acknowledge that NASA did not specifically consult with congressional staff concerning the specifics for the design of the new system. They have been clear in laws (e.g., the Chief Financial Officer Act), report language, briefings, and hearings concerning their expectations for the results of IFMP. This direction has established a number of specific requirements embodied in the Joint Financial Management Improvement Program Federal requirements and enabling certification process. These requirements were mandatory design requirements for NASA. In addition, key system features were confirmed with Agency process owners who respond to congressional inquiries and other external regulatory Agency requirements on a daily basis. Based on the GAO concern, we will increase our efforts to interact with congressional staff on a regular basis and to ensure that their requirements are identified and addressed.

NASA'S REQUIREMENTS MANAGEMENT PROCESS FOR THE CORE FINANCIAL MODULE IS INEFFECTIVE

See comment 1.

NASA Requirements Management Process Was Not Designed to Provide Detailed System Requirements

The report appears to base its review of the Program's requirements processes on a standard which is primarily aimed at software development projects akin to other NASA efforts. In this instance, NASA is using already developed commercial software. The report refers to IEEE 830-1998 (Recommended Practice for Software Requirements Specifications) in which the upfront scope states: "This recommended practice is aimed at specifying requirements of software to be developed but also can be applied to assist in the selection of in-house and commercial software products. However, application to already-developed software could be counterproductive."

Lessons learned from other organizations like Microsoft, Northrop Grumman, and Apple computers are very consistent. To be successful with ongoing ERP implementations, NASA needs to change its processes to fit the capabilities of the system, not the other way around. Using traditional detailed process requirements driving a high level of modifications to the core software is extremely high risk. In fact, recommendations from a recent Gartner report (the same document cited in the GAO report) confirm this: "Rather than flushing out requirements and then asking the implementor to implement them – the requirements can change, or are so strongly set that they require a rigorous design process to meet them even though they don't meet best practices – work with the integrator or someone who knows SAP and mutually determine the requirements while putting together the design process."

Part of any organization's ERP implementation effort includes an adjustment and paradigm shift regarding project approach and methodology. This is particularly true when compared to "custom-developed" software implementations. One reason to pursue a COTS implementation, such as ours, is the benefit of proven software functionality and vendor support/maintenance. The SAP R/3 product is widely used in many commercial industries (over 12,000 customers at 20,000 installations worldwide). The core R/3

See comment 6.

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foundation has been enhanced and extended to meet U.S. Federal Government specifics, and has successfully been JFMIP certified. JFMIP uses an extensive qualification test to determine whether a software package complies with all mandatory core Federal accounting requirements.

Requirements Were Not Specific

The two requirements noted by the report are JFMIP requirements that were used in the COTS acquisition. In the first requirement, related to the ability to query information contained in the system, the report has concerns about the level of specificity because the requirement did not clearly state the data elements to be supported in the query. NASA established that the SAP system has basic query capabilities. As part of the implementation services acquisition effort, NASA delivered additional requirements for reporting (over 100 reports were defined including report purpose, selection options, data elements, report media, and frequency). As part of the configuration effort, NASA subject-matter experts established detailed reporting requirements that not only include what data was to be addressed but, also, whether or not the query would be done through formal reporting or "ad hoc" queries for analytical purposes. Those configurations were then validated by each of the 10 Centers implementing the system.

Traceability Was Not Maintained

An Independent Validation and Verification (IV&V) contractor (Titan Corp) was utilized on the Core Financial project with the stated objective to minimize the risk of the SAP software implementation and maximize confidence in operational readiness. The IV&V's ongoing review focused on requirements traceability and testing and included an analysis of the configuration of the Core Financial solution. A recap of the IV&V summary of Level IV to V Configuration Traceability Analysis is included below:

> *"In terms of the Level IV to Level V configuration traceability analysis, IV&V found, with one exception, that the key SAP configuration and master data elements are configured to support NASA H.2 requirements. The exception is the SAP "demonstration" code values for the key SAP fields of plant code and storeroom, which IV&V strongly recommends be removed from the production configuration.*
>
> *IV&V commends the Accenture and NASA teams on their approach, recommendations and choices regarding SAP configuration options. Unnecessary complexities were carefully avoided, resulting in a very streamlined and straightforward SAP configuration, reserving a great deal of flexibility for the future.*
>
> *IV&V also notes information regarding NASA centers has been configured in a consistent and parallel fashion within the various underlying SAP configuration/master data tables, that tables added to SAP specifically for NASA use are referentially consistent with appropriate SAP master validation tables, and that the use of custom code for the NASA deployment has been minimized."*

However, on a negative note, the IV&V also noted that traceability:

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"...was found to be maintained in a fragmented manner in the Accenture provided Lotus Notes Method Delivery Management (MDM) system, by a linkage of both levels of requirements through business processes. The IV&V Team recommends that future IFMP implementations develop documentation that explicitly details the relationship between lower level requirements and the requirements of the next higher level."

Although NASA has maintained adequate traceability, as noted by the IV&V, and can identify the linkages between the various requirements and testing levels, the method in which this is performed is cumbersome and needs improvement. NASA agrees with this recommendation and has already taken steps to improve traceability within the Budget Formulation Project, noting lessons learned and areas for improvement. Additionally, IFMP will ensure that future implementors/integrators of IFMP modules have improved capabilities for traceability.

See comment 7.

Requirements Defects Adversely Affect Testing Of The Core Financial Module

The report emphasizes the direct relationship between requirements and testing, stating that "NASA's testing program has been adversely affected by the lack of complete and specific requirements." Figure 5 in this section illustrates the report's stated relationship between requirements and testing. In this figure, the report points out that integration testing and unit testing "are normally handled by the COTS vendor"; but does not reflect the fact that NASA has and is performing extensive unit testing, through each Center's Conference Room Pilots (CRP's), and System and Integration Testing (SIT). The Core Financial Project has in place a rigorous, closed-loop testing program to ensure that NASA's configuration of the core SAP software, as well as interfaces to existing legacy systems, are functioning as intended.

Initially, NASA completed a series of 3 prototype tests of SAP functions and configuration, consisting of over 490 business scenarios. NASA further tested the configured and interfaced solution through 5 rounds of SIT testing at MSFC and 4 rounds at GRC. For the MSFC testing, over 100 subject matter experts from across the Agency participated in the Agency level testing. In preparation for the SIT tests, NASA's requirements were decomposed into over 1700 lower level test conditions. These test conditions were validated in 114 test cases executed 325 times at the two Centers. Two rounds of SIT testing were conducted against data converted into SAP from legacy systems at both MSFC and GRC. And although, the Project felt that the testing completed for first two Centers was extensive and thorough, additional test execution from each Wave implementation team was planned and required. Each additional team and test effort provides additional confirmation, additional details and scenario variations of business processing, plus provides additional insight and suggestions for continuous improvement. These subsequent test efforts also ensure that the Center teams validate the "Center-specific" components (e.g., configuration build out of Center defined values, Center interfaces, and Center converted data). As the Center resources' knowledge and understanding grows, the Center is better positioned to support the new system and provide assistance to other business end-users. They are then also able to provide input

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for enhancement and suggestions for future additional capabilities. The information gathered and incorporated based on actual production operations is also used to improve the subsequent implementation efforts and provide guidance and suggestions to the Wave Centers.

This extensive level of testing exceeded the requirements found in the Joint Financial Management Improvement Program (JFMIP) as part of their extensive qualification test to determine whether a software package complies with all mandatory core Federal accounting requirements. NASA's selection of the SAP software to satisfy its Core Financial requirements was predicated, in part, upon the successful certification testing completed by the U.S. Department of Treasury in accordance with the Joint Financial Management Improvement Program (JFMIP). The intent of this certification is to ensure that software implemented by Federal agencies in the area of financial management meets minimum Federal requirements. In addition to this certification, SAP core software has been implemented by over 20,000 clients worldwide. This is a proven software product supported by a robust software development vendor with over 80percent of the market share in the Enterprise Resource Planning (ERP) space.

When implementing ERP software products, not only do the design and implementation approaches change compared to "custom-developed" efforts, the specifics of the different testing phases change somewhat as well. Since the primary software functions are pre-defined and validated, the customer focus should be on a different type of testing and verification. Specifically this focus should be on the execution of the new business processes (utilizing the new tools and system functions) and on the verification of any customer-specific components (such as an interface or custom report) to ensure the total solution meets the business requirements.

Significant Defects Appeared in Production System

See comment 8.

The report underlines critical and high severity problems discovered after the Core Financial system was placed in production at MSFC and GRC, noting that the "defects could be linked back to the lack of complete requirements." These problems, which resulted in some delays in payment processing, stemmed mostly from issues related to the internal posting of the software that were not previously evident during the testing efforts. The issues were not related to a lack of complete requirements. These posting issues occurred when invoices against very large, multifunded, service contracts were being processed. Some documents had hundreds of funding citations. During NASA's testing efforts, test conditions were included to address multifunded service contracts; however, they could not simulate processing for the volume of line items encountered in a production environment. These problems have all been identified and corrected and were not experienced by any of the Wave 2 Centers. The payment backlogs at MSFC and GRC have been reduced to that expected from normal business operations. In addition, one of the Wave 2 Centers, JSC, was able to process their payment backlog within their first 14 days of operations on the Core Financial system.

See comment 1.

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Adequate Regression Testing Is Not Being Performed

Based on interaction with other customers who have implemented large ERP solutions and discussions with a leading ERP consulting firm, NASA believes that the maturity of its planning in this area regression testing is consistent with most organizations at this phase in their implementation. Nevertheless, as noted in the report, NASA recognizes the need for a more rigorous regression testing methodology as the Core Financial project moves from implementation into long term sustaining support. The IFMP Competency Center, which is the organization responsible for Core Financials operational support, is in the process of developing a sustaining support release strategy that defines major, minor, and emergency releases and the associated types of regression testing required for different types of releases. They are also investigating the use of automated regression tools to determine if they can deliver efficiencies in the execution of regression scripts and allow for more comprehensive regression testing.

As the IFMP continues with implementation, it has defined and applied processes for testing every facet of the system. The report notes that in large ERP implementations, such as this one, it is typical for the new application to undergo constant change as it is introduced into the organization and stabilized. NASA's approach has been to process reported system defects and change requests using a methodology that allows for the application of high-priority fixes or enhancements, with all other changes allocated to the next scheduled "wave" of NASA Center deployments. Each wave deployment includes three phases of system integration testing that serve as a fairly comprehensive regression test for that release of the software. Those changes or fixes that must be applied because of business criticality are tested based on the applicable business scenarios. Complete regression testing of all possible requirements impacted by these types of changes is not feasible or practical during this stage of the implementation. The report cites three examples where system changes have negatively impacted system functionality. NASA acknowledges that these types of problems have occurred, but believe that they are isolated cases and that the continued improvement of system performance indicates that these problems have not been pervasive.

The GAO report cites one example of a SAP-provided patch that broke system functionality. Though there have been some issues with SAP patches, the IFMP Competency Center continues to improve its ability to seamlessly deploy patches. As an example, after the Wave 1 Centers were in production with SAP, and prior to bringing up the Wave 2 Centers, the team implemented SAP patch numbers 7, 8, and 9. These patches contained several hundred individual repairs to the standard and public sector SAP R/3 application code. The patches were deployed using a staged approach, being first introduced into a separate "sandbox" landscape, where preliminary testing was performed. The patches were subsequently applied to a stand-alone quality assurance system, where the team executed a formalized set of regression test cases. During this round of testing, several significant problems were identified, including the reoccurrence of a purchase order "short dump" issue that had been corrected in an earlier vendor patch, as well as a problem with the business warehouse extractors. Due to these issues, the application of the patch to the development instance was postponed. Further testing was performed. After the issues were addressed, the patch was applied over a weekend to the

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production instance. There was only one issue that affected production after the patch application, which turned out to be a vendor problem that was quickly addressed by SAP. There was no impact to any custom developed objects or interfaces.

Performance Metrics Could Be Used To Assess Potential Risks Of Identified Weaknesses

The report states that "NASA is unable to implement a metrics measurement process that allows it to understand (1) its capabilities to manage the IFMP effort, (2) how its process problems will affect its cost, schedule, and performance objectives, and (3) the corrective actions needed to reduce the risks associated with the problems identified. The IFM Program does use metrics as part of its management processes. Metrics are extensively used on the Core Financial project to track, analyze, and report problems to all levels of management, including the Core Financial Project Steering Committee. Metrics on problem reports graphically depict problems by priority, status, category, closure rates, etc. Other metrics utilized on a recurring basis (weekly, monthly, quarterly) include cost plan versus actual, cost trending, schedule and accomplishment hit rates, and others.

See comment 9.

Within the context of this discussion, the report further asserts that NASA does not appropriately analyze its defects. We respectfully disagree with the GAO on this point. IFMP does have structured testing and problem analysis processes in place. Additionally, the project team works closely with SAP and its other software vendors to obtain a clearer understanding of the specific causes of problems to ensure that systemic problems do not arise. This is evidenced through the recent Wave 2 implementation. While there have been operational issues identified with the Wave 2 cutover, they have been quickly resolved through data clean up and/or follow up user instruction. In this instance, JSC was able to catch up their payment backlog in the new system within 2 weeks of their go live date. The volume of trouble tickets for Wave 2 is significantly reduced (65% less per day average for first 14 days of operations) from those seen in the early days of the MSFC and GRC deployment (see Figure 1 below).

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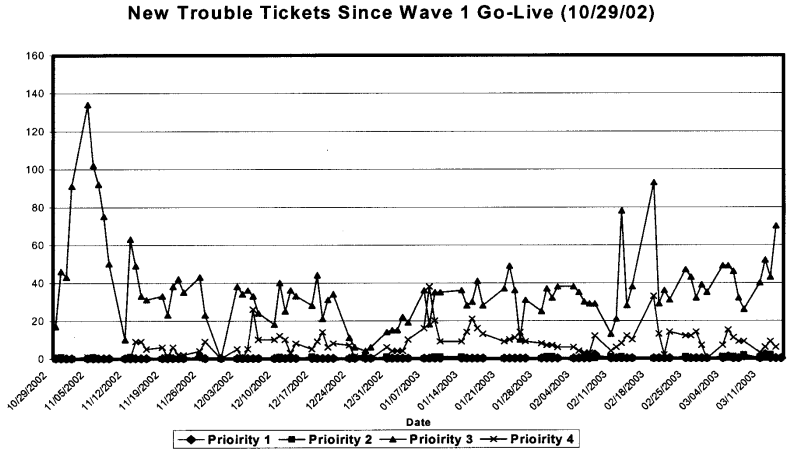

Figure 1 History - New Trouble Tickets

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The following are GAO's comments on the National Aeronautics and Space Administration's (NASA) letter dated March 25, 2003.

GAO Comments

1. See the "Agency Comments and Our Evaluation" section of this report.

2. Although NASA indicates that it has extended the SAP suite to include Business Warehouse (for reporting) and Asset Management, it did not provide us any documentation to support these selections during the course of our fieldwork.

3. We did not assess the deployment and operation of the three modules to which NASA referred. We understand that the NASA Inspector General has recently begun a review of the Travel Management module.

4. The scope of our work did not include a review of the Integrated Financial Management Program (IFMP) budget or schedule. We plan to address these issues in a future product.

5. As stated in this report, although the core financial module will provide some improvement to NASA's current accounting system environment, certain system capabilities have been deferred and will not be available when the system becomes an agencywide operation in June. Without an effort to reengineer NASA's acquisition management processes, it is unlikely that detailed cost information will be available to meet the needs of program managers, cost estimators, and the Congress. Thus, NASA's assertion that it will be able to transition to "full cost management practices" in June of 2003 is questionable.

6. NASA's comments refer to the "Accounts Payable" process illustrated in figure 3 of the report. While we did not verify or evaluate the extent to which the additional requirements to which NASA refers in its response were established or validated, the accounts payable requirements, as described, do not provide for quantitative evaluation to determine whether the system meets NASA's needs. Furthermore, the additional requirements did not provide the needed clarification for the requirement cited in our report related to the ability to query information. Moreover, given that NASA added new requirements for reporting, it is unclear whether the existing accounts payable requirement was to provide some other query functionality not included in the other general reporting requirements.

7. As noted in our report, requirements provide the foundation for system testing. In meetings with NASA, we acknowledged that the "process-centric" approach that the agency adopted was an acceptable methodology for understanding how the processes supported by the selected enterprise resource planning (ERP) solution could be implemented at NASA. However, we believe that this approach still requires the development and documentation of the necessary requirements to fully understand the functionality to be provided by a given process. Without such requirements, a disciplined testing process is very difficult to implement since requirements are a fundamental attribute of an effective testing process. As discussed in our report, we continue to believe that the lack of an effective requirements management process hampered NASA's testing efforts since significant defects in the production system should have been detected before system implementation.

   Although NASA stated that it will repeat its testing efforts at each center implementing the system, without adequately documenting its requirements and ensuring that the testing process adequately tests those requirements, it does not have reasonable assurance that the testing process will identify significant defects before a center is converted to the production system. For example, NASA stated that it had developed over 1,700 test conditions. However, it was not until the system was placed into production that NASA identified several significant weaknesses, as discussed in our report. We continue to believe that NASA will not have reasonable assurance that it has adequately tested the system until it (1) documents its requirements and (2) develops test conditions that fully test those requirements.

8. As noted in our report, discussions with IFMP officials recognized that a test case was not properly developed to test large contracts that contained over 200 line items—a common occurrence according to IFMP officials—and that this was an oversight in their testing process. Had NASA developed and documented a detailed requirement for this functionality and then mapped its test conditions against those requirements, it would have recognized that it had not developed a test condition to properly demonstrate and test the functionality prior to the system going into production. Properly processing these types of payments may have enabled NASA to reduce the impact of the payment backlog.

9. As noted in our report, NASA does not have metrics that properly analyze the cause of the defects so that it can improve its processes. For example, although NASA was able to show the number of defects that were related to subsequent implementation, referred to as the second wave, it did not have information that could be used to analyze whether these defects were caused by, for example, requirements or testing problems or by not adequately correcting prior defects. Therefore, although NASA states that it has a structured testing and problem analysis process in place, we continue to believe that the examples provided in NASA's comments do not provide the data necessary to identify the causes of defects or assess the effectiveness of processes such as the requirements management and testing processes. As noted in our report, these types of data can be used to prevent or anticipate problems before they occur, resulting in less rework.

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