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Briefing Report to the Chairman, Subcommittee on Defense, Committee on Appropriations, House of Representatives

March 1988

COMPUTER PROCUREMENT

Issues Concerning Technical Specification for Navy's CAD/CAM Acquisition

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Information Management and
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The Honorable Bill Chappell, Jr.
Chairman, Subcommittee on Defense
Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

In your January 22, 1987 letter, you expressed concern about the Navy's planned acquisition of Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) equipment and asked us to review the Navy's management of the acquisition. During subsequent discussions with your office, we agreed to (1) respond to the questions raised in your letter and (2) examine the Navy's CAD/CAM technical specification and identify any issues of concern before the Navy releases the specification as part of a request for proposals to industry. This report responds to your office's interests in the technical specification. We are continuing work to respond to your request letter. At the time we completed our review of the specification, the Navy planned to release a request for proposals in the February 1988 time frame. However, because the Navy is in the process of transferring responsibility for the program from one command to another, a release date for the request for proposals is not certain.

Since completing our work on the specification, we briefed the Navy and your office on the results. This report contains the charts used in the briefings as well as an explanatory narrative for each chart. In brief, it provides CAD/CAM vendors' concerns about the specification as well as issues or questions that we believe the Navy may want to consider as it develops a request for proposals. Consistent with our objective, we did not attempt to resolve the issues we raise in the report.

The report is based primarily on our analysis of interviews with 26 CAD/CAM vendors familiar with the specification. It is also based on our review of current literature about key specification features; a review of the January and May 1987 versions of the specification, the latest two released for comment, although the final version included in a request for proposals could differ; and interviews with the Navy, Office of the Assistant Secretary of Defense for Production and Logistics, and National Bureau of Standards officials. We conducted our work between April and November 1987. As requested by your office, we did not obtain official agency comments on a draft of the report. However, we

discussed key facts in the document with Navy CAD/CAM program officials and have incorporated their views where appropriate. These officials stated that the issues we raise are appropriate and need to be addressed. (See p. 10 for additional information on our scope and methodology.)

The Navy's CAD/CAM Acquisition

CAD/CAM is a tool for automating the engineering functions used in designing, manufacturing, and maintaining various types of plant and equipment. Using CAD/CAM, the time and costs needed to develop and maintain products can be reduced while product quality and reliability is enhanced.

The Navy competes in a world market for the design, repair, overhaul, and modernization of ships, submarines, aircraft, and shore-based support facilities. To this end, it employs over 40,000 engineering personnel, each of whom is a potential CAD/CAM user. The Navy's CAD/CAM acquisition is an effort to greatly expand its use of this technology. The Navy plans to award contracts for each of its five systems commands from which users can purchase off-the-shelf, commercially available equipment. While the Navy has not officially stated the value of the contracts, unofficial estimates range from $125 million to $5 billion over the expected 8 year life of the contract, depending on the amount of equipment purchased. However, the Navy is now reviewing the acquisition's size and, according to the acting CAD/CAM program manager, it will likely be reduced.

Key Specification Features

The Navy has prepared a technical specification defining its hardware, systems and applications software, training, documentation, maintenance, and support services requirements for its CAD/CAM systems. Major requirements include (1) using an open system architecture to allow hardware interchange and modular replacement of obsolescent hardware; (2) using standards (i.e., criteria for connecting independent software applications and for connecting systems software and hardware) to allow data exchange among applications and users, to permit software and data transfer to more powerful hardware as it becomes available, and to limit differences in how users interact with the system; and (3) integrating software applications to minimize the users' intervention in data exchange among applications.

The Navy has released several versions of the technical specification to the CAD/CAM industry for comment under the request for information

process. This process concluded in May 1987, and the Navy is finalizing the specification. Once completed, the Navy will incorporate the specification into its CAD/CAM request for proposals.

Technical Issues That the Navy May Want to Consider

Based primarily on our analysis of vendors' comments on the specification, this report raises important issues about whether (1) certain hardware requirements are essential, (2) the Navy's treatment of two key standards will produce Navy-unique versions of each, (3) the system integration requirements will produce Navy-unique systems, and (4) the distinctions between mandatory and negotiable requirements are clear.

Are All Hardware Requirements Essential?

The specification requires graphics display screens, regardless of picture resolution, to be used with any CAD/CAM workstation, regardless of power. Vendors questioned the necessity of this requirement, saying it will produce equipment mismatches. For example, if a high resolution graphics display screen is teamed with a low power workstation, the screen may overburden the workstation.

The specification also requires all computing devices to run the same application software, regardless of the computing device's power and an application's characteristics. This requirement is unrealistic, vendors said, because (1) applications normally operating on powerful mainframe computers would not be used on workstations and (2) supporting different versions of the application for each type of computing device would be expensive.

Finally, vendors said that the specification's requirements for communication methods are more complex than those used commercially. Such requirements could add extra expense to the system.

Will the Navy's Treatment of Standards Produce Navy-Unique Versions?

The specification requires vendors to modify two public standards in order to satisfy Navy needs. The first is a standard command interpreter between the application software and the operating system. The Navy is requiring this standard to decrease software to hardware interdependence (i.e., allow software and data transfer to faster hardware as it becomes available with minimal data translation). However, because this standard currently does not provide all the capabilities the Navy needs, the specification requires extensions to the standard. These extensions or additions could produce a Navy-unique version of the standard and increase software to hardware interdependence, vendors

said. The second standard is a data exchange format for transporting geometric engineering data between application programs. But since the initial version of this standard will not cover all attributes of Navy engineering drawings, the specification requires that vendors extend the standard, again possibly producing a Navy-unique version of the standard.

Will the Integration Requirements Result in a System Out of the Commercial Mainstream?

The specification requires integrating independent application software products. According to vendors, while such integration can be done, integrating software to translate data among applications would require new systems development, and would produce a Navy-unique system that is out of the commercial mainstream. Further, maintaining such a system would be difficult, and it may not be possible to incorporate new releases of application software.

Are the Navy's Mandatory Requirements Clearly Stated?

Everything in the specification is negotiable, according to Navy program officials. However, the specification states that everything is mandatory. As a result, vendors were confused about this matter. About one-half interpreted the specification's requirements as non-negotiable, mandatory deliverables, while the other half did not.

Matters for Consideration

In view of the issues we have raised about the Navy's CAD/CAM technical specification, we believe that the Navy may want to consider the following as it finalizes its request for proposals:

- Reevaluating its hardware requirements for (1) "mix and match" graphics display screens for workstations, (2) application software compatibility across workstations and servers, and (3) a wide array of communications methods;
- Modifying its treatment of certain standards in light of the current abilities of each;
- Pursuing its system integration efforts under a separate research and development effort and limiting this acquisition to commercially proven technology; and
- Clarifying which of its requirements are mandatory and which are negotiable.

We are providing copies of this report to the Secretary of Defense and the Secretary of the Navy. We will also make copies available to other interested parties upon request. If you have any questions regarding this report, please call William Franklin, Associate Director, at 275-3188.

Sincerely yours,

Ralph V. Carlone

Ralph V. Carlone
Director

Contents

Abbreviations

CAD/CAM	Computer Aided Design/Computer Aided Manufacturing
CAEDOS	Computer Aided Documentation and Engineering System
GAO	General Accounting Office
IGES	Initial Graphics Exchange Specification
IMTEC	Information Management and Technology Division
NBS	National Bureau of Standards
PDES	Product Design Exchange Standard
POSIX	Portable Operating System for Computer Environments
RFI	request for information
RFP	request for proposals

What is CAD/CAM?

- Tool for automating engineering functions
- Means of reducing cost and time in product development and maintenance cycles
- Means of improving product quality and reliability

Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) is a tool for automating the architectural, civil, structural, mechanical, and electrical engineering functions employed in the design, manufacture, and maintenance of plant and equipment. With CAD/CAM, the costs and time associated with developing and maintaining such things as buildings, ships, electronic systems, and aircraft can be reduced, while product quality and reliability can be increased.

In engineering, the product drawing or graphic is a primary communication medium. Traditionally, graphics were prepared using conventional paper and pencil techniques. This is a time consuming method, allowing only limited design options to be prepared and usually requiring a prototype for testing and analysis. With CAD/CAM, a product is quickly drawn and easily modified on a computer screen. Further, the computer can model each version of a drawing so that the product design, manufacturing, and logistics support functions can be optimized before beginning the production process.

Following product design, CAD/CAM offers the opportunity to automate product manufacture by translating the product's engineering data into numerically controlled instructions to guide computerized machine tools. Once an item is made, CAD/CAM provides a digital record to facilitate post-production maintenance, repair, and modification. This digital record provides an engineering data base which is accessible by multiple users and requires minimal storage space.

Objective, Scope, and Methodology

Objective

- To identify issues raised by CAD/CAM technical specification that the Navy may want to address before releasing its RFP

Scope and Methodology

- Interviewed 26 CAD/CAM vendors familiar with specification
- Reviewed literature on key specification features

- Analyzed latest two versions of specification released for comment
- Interviewed Navy, OSD, and NBS officials

Limitations

- Review focused on versions of specifications released for comment; specification in RFP could differ
- Results based primarily on vendor interviews

Concern about the Navy's planned acquisition of CAD/CAM equipment prompted the Chairman, Defense Subcommittee, House Appropriations Committee to request us to review the acquisition. In discussing the request with his office, we agreed to report separately on the technical specification defining the Navy's CAD/CAM needs under the acquisition before its release as part of a request for proposals (RFP). The Chairman's office asked that we identify any issues raised by the technical specification which the Navy may want to consider before releasing an RFP. His office was particularly interested in whether the technical specification called for capabilities that are not commercially available.

To accomplish our objective, we interviewed 26 of 50 vendors that the CAD/CAM program office identified as familiar with the specification. We talked to:

- vendors who may bid as prime contractors,
- vendors who provide hardware, software, or communication services, and
- vendors who provide specialized CAD/CAM or engineering application software products.

Additionally, we reviewed in detail the latest two published versions of the technical specification dated January 1987 and May 1987. We should add, however, that the version that the Navy will ultimately include in its RFP may differ from the latest of these. We researched current literature on CAD/CAM technology and key system features contained in the specification to ascertain the industry state-of-the-art. We also interviewed a past president of the National Computer Graphics Association as well as officials in the Navy CAD/CAM program office, the National Bureau of Standards (NBS), and the Office of the Assistant Secretary of Defense for Production and Logistics. The results of our review are based largely on interviews with CAD/CAM vendors. We conducted the review between April and November 1987.

We discussed key facts in this document with Navy CAD/CAM program officials and have incorporated their comments where appropriate. However, in accordance with the requester's wishes, we did not obtain official agency comments on a draft of this report. We performed our work in accordance with generally accepted government auditing standards.

The Navy as CAD/CAM User

The Navy as CAD/CAM User

- User of CAD/CAM technology since 1960s
- User of over 400 CAD/CAM workstations
- Employer of over 40,000 engineering personnel

The Navy competes in a world market for the design, repair, overhaul, and modernization of ships, submarines, aircraft, and shore-based support facilities. Historically, Navy personnel hand-drew their engineering drawings. Beginning in the 1960s, however, the Navy began using CAD/CAM to automate its engineering work.

The Navy represents a major user of CAD/CAM. It employs over 40,000 engineering personnel to design and maintain Navy weapon systems, platforms, and shore-based facilities. To support its engineers and technicians, the Navy has over 400 CAD/CAM workstations in over 64 Naval installations to support complex design work. A large number of less sophisticated microcomputers support drafting work.

The Navy's Second CAD/CAM Acquisition (CAD/CAM II)

The Navy's Second CAD/CAM Acquisition (CAD/CAM II)

- Second of three-phased CAD/CAM acquisition strategy
- Objective to award five umbrella contracts from which users can buy off-the-shelf equipment
- Contracts' size being reviewed; will likely be less than early estimates of $1-5 billion
- Recent events make timing of RFP release uncertain

The Navy's second CAD/CAM acquisition is a large, joint system command initiative to buy commercially available, state-of-the-art technology. It represents the second of a three-phased Navy acquisition strategy. Its objective is to greatly expand the Navy's current CAD/CAM capabilities by putting in place five umbrella contracts from which users can buy integrated CAD/CAM hardware and software tailored to their unique needs. As currently planned, the contracts will span 8 years. According to the former program manager, total contract life cycle costs will likely run $2.5 billion, although the Navy is reviewing the acquisition's size and it will probably be reduced. Additionally, the Navy is in the process of transferring program management responsibility for the acquisition from the Naval Sea Systems Command to the Naval Data Automation Command. Because of these events, the timing of an RFP release is currently uncertain.

Three-Phased Approach

While the Navy's early CAD/CAM acquisitions were small and fragmented, the Navy began a more coordinated acquisition approach in the early 1980s with its Computer Aided Engineering and Documentation System (CAEDOS) acquisition. CAEDOS is the first in a Navy three-phased, long-term CAD/CAM acquisition strategy. This phase has automated isolated engineering tasks within the design, construction, and maintenance processes. The Navy's current acquisition is the second phase (i.e., CAD/CAM II). It seeks to automate groups of engineering tasks within each Navy system command. The third phase intends to take the Navy into the next century by integrating engineering tasks, not only vertically within each system command, but also horizontally among all engineering data users.

Objective

The overall objective of CAD/CAM II is to put five umbrella contracts in place, one for each system command, from which individual users can buy off-the-shelf, state-of-the-art equipment. Each of the five contracts will be tailored to the unique mission needs of the respective system commands. The five system commands are: Naval Sea Systems Command, Naval Air Systems Command, Naval Facilities Engineering Command, Naval Supply Systems Command, and Space and Naval Warfare Systems Command. Each contract will invoke certain standards for data transfer among users, limit software to hardware interdependence, and minimize differences in how users interface with the system. The contracts will include hardware, systems and applications software, training, documentation, maintenance, and related services. As currently planned, the contracts will span 8 years—5 years of acquisition and 3

more years of maintenance and support. They are expected to result in thousands of CAD/CAM purchases.

Size

The Navy's second CAD/CAM acquisition spans five system commands employing over 40,000 potential users, possibly providing a workstation for one out of every two users. Additionally, it may extend beyond the Navy and include the Marine Corps. As described by the Navy's central contracting office for non-tactical computer systems, CAD/CAM II is by far the most complex, highest-value non-tactical computer acquisition the Navy has ever attempted.

Commercial publications estimate the contracts' dollar value as between $1 billion and $5 billion. While Navy officials would not officially specify the range of a delegation of procurement authority it plans to request from the General Services Administration, the former CAD/CAM program manager unofficially said that the minimum will be around $125 million and the maximum will be at least $5 billion, depending on the number of workstations bought. He also said that the acquisition will most likely be about $2.5 billion. However, the Navy is currently assessing the acquisition's size and scope, and according to the acting CAD/CAM program manager, it will probably be reduced.

Status

In May 1987, the Navy published its technical specification as a request for information (RFI) closure document (i.e., comments are no longer requested). Since then, it has been working to finalize the specification for inclusion in an RFP and complete certain program management documents. However, in late 1987, the Navy began reviewing the size and scope of CAD/CAM II; and it is now transferring CAD/CAM II program management responsibility from the Naval Sea Systems Command to the Naval Data Automation Command. As a result, the future size and scope of CAD/CAM II as well as the timing of a CAD/CAM II RFP is uncertain.

Development of Navy's CAD/CAM Technical Specification

Development of Navy's CAD/ CAM Technical Specification

- Initial specification combined two ongoing CAD/CAM procurements (Jan. 1985)
- Revised specification released as RFP I (Feb. 1986)
- Oral discussions held with CAD/CAM vendors (Sept. 1986)
- Revised specification released as RFP II (Jan. 1987)
- Revised specification released as closure document (May 1987)

Development of the CAD/CAM II technical specification spans almost 3 years and has involved hundreds of CAD/CAM vendors and Navy users. The specification has grown considerably during this time; the latest version is over ten times the length of the first.

The initial specification was drafted in January 1985 by a key program official and a few representatives from a Navy users group. This first draft merged the best features of the specifications for two CAD/CAM procurements which were underway at that time. This draft was about 125 pages.

Through a series of specification writing meetings held in August 1985, September 1985, and January 1986, and involving about 40 CAD/CAM users, the initial specification was revised and released as a draft RFI in February 1986. Included in this RFI was a 100 page questionnaire. Between 200 and 300 Navy users and about 70 vendors were asked to comment on the specification and respond to the questionnaire. User questions focused on user needs, while vendor questions dealt with commercial availability.

The Navy amended the RFI to include Naval Supply System Command requirements (i.e., printing and publishing) in March 1986 and amended it again in July 1986 to include Naval Air Systems Command requirements (i.e., aeronautics). The Navy received user and vendor responses by August 1986. The responses were placed on a relational data base and analyzed.

In September 1986, the Navy held face-to-face meetings between vendors and Navy users to discuss the specification and allow vendors to describe alternative solutions, current products, and product development efforts.

Using vendor and user comments, the Navy revised its specification and issued a second RFI in January 1987. The second RFI incorporated vendors' product forecasts and industry predictions. In this RFI, the Navy was interested in identifying "show stoppers", requirements to be eliminated because they would add unreasonable costs to the acquisition or prevent vendors from bidding on the contracts.

Following another series of specification writing sessions, the Navy distributed an RFI closure document in May 1987. This represents the Navy's final RFI document, and the Navy is not soliciting further comments. This version of the specification runs about 1,200 pages.

Key Features of Navy's CAD/CAM Technical Specification

Key Features of Navy's CAD/ CAM Technical Specification

- Hardware and software from commercial mainstream (available and in use)
- Open system architecture concept (network of inter-changeable modular components)
- Standards (i.e., connectivity criteria) to define operating system interfaces, data exchange formats, and communications criteria
- Application software integration to limit user intervention in data exchange

The CAD/CAM II technical specification defines the Navy's CAD/CAM requirements. In brief, the Navy wants state-of-the-art, user-friendly CAD/CAM products which are commercially available and which can be used to build systems possessing three fundamental features—an open systems architecture, specified standards, and system integration.

Open Systems Architecture

The technical specification requires a flexible and open systems architecture. The architecture consists of a family of engineering workstations and other special purpose computers called servers, connected together by a common communication mechanism known as a network. This architecture uses an open system philosophy, allowing hardware interchange, modular replacement of obsolescent hardware, and incremental system design.

The engineering workstations are to be constructed using interchangeable components and a common physical structure so that such things as the processing power, graphics display, or ancillary storage of any workstation can be upgraded without replacing the entire unit. By mixing these components, workstations can be tailored to user needs.

The special purpose servers will provide shared computer resources for a workstation group. They will be accessible by a designated group of workstations to support user demands. The servers will provide capabilities for advanced and high speed computations, mass storage and data base management, and special design and engineering work.

The network will connect workstations and servers. The basic unit of the network is a localized network linking workstations within a given functional engineering area (e.g. ship hull design). Functional area networks will in turn be linked together to form a command network allowing widespread data transfer.

Standards

The specification regards standards as an essential element of the system architecture. It requires existing and anticipated standards in three areas: operating system, data transfer, and communications. Standards will promote the data exchange among users and software, allow data and software portability to new computer hardware with minimal translation, and limit differences in how users interact with the system.

The specification requires an operating system that uses the Portable Operating System for Computer Environments (POSIX) standard. Developed by the Institute for Electrical and Electronics Engineers, POSIX is a common command interpreter between an operating system and application software. The specification requires that the operating system for all workstations and servers be NBS certified as meeting the POSIX standard. By using POSIX, the Navy is trying to limit hardware/software interdependence and differences in the user-to-system interfaces.

The specification also requires the Initial Graphics Exchange Specification (IGES) and the Product Design Exchange Standard (PDES) standards. IGES and PDES provide a neutral file or data format specification that different application program translators recognize. The standards will allow data exchange among Navy users, as well as between the Navy and private contractors. IGES is a mature standard for passing information about vectors (i.e., line segments with a defined size and direction). However, PDES is still being developed. PDES will standardize the format for the data needed to completely define a product (e.g., material attributes, tolerances, topology, geometry, etc.).

Last, the specification stipulates the methods and conventions for data communications. Three standards are required—International Organization for Standardization/Open Systems Interconnection, Technical and Office Protocol, and Manufacturing Automation Protocol.

System Integration

The specification describes integration as the critical issue in the acquisition and addresses the requirement from three points of reference—coexistence, data interchange, and interaction. All software programs are viewed in terms of the extent to which these features are present.

Coexistence refers to how application data and programs are stored and executed. A particular level of coexistence is required for each application program. The levels will determine on what types of hardware application software will be stored and executed, as well as which hardware will store application data.

Data interchange concerns data exchange among application programs (i.e., how applications' output information will be used by another application, and how the second application will input the data). The specification defines data interchange levels ranging from users' manual viewing and key entry of data to applications' use of a common data base.

Interaction relates to how the user will interact with the machine. Examples of interactive conventions are icons or pictures representing functions, prompts or questions requiring a response or selection, and shadow cursors highlighting a desired function from a menu of functions. The type of interaction allowed ranges from as is (i.e., use of the interaction method used by the application without influence from the Navy's specification) to common interaction (i.e., use of the same interaction method for all specified applications).

General Issues

- Are all hardware requirements essential?
- Will treatment of standards produce Navy-unique versions of each?
- Will system integration requirements result in a Navy-unique system?
- Are mandatory requirements clearly identified?

Recognizing that a CAD/CAM system developed uniquely for the Navy is unlikely to provide cost/performance characteristics as attractive as those of commercially available, off-the-shelf products, CAD/CAM program officials told us that it is the Navy's desire to stay within the commercial mainstream. Accordingly, the specification states that the Navy's objective is to buy commercially available, off-the-shelf CAD/CAM equipment. Further, the specification states that its requirements represent the Navy's minimum needs. However, based on our analysis of vendors' reactions to the specification, we believe that issues exist with regard to the commercial availability, necessity, and clarity of some requirements in the CAD/CAM II technical specification which the Navy may want to consider as it finalizes its RFP. These issues are as follows:

- Are all the Navy's hardware requirements essential?
- Will the Navy's treatment of some standards produce Navy-unique versions of each that will prove inconsistent with the standards' public evolution?
- Will the Navy's system integration requirements result in a Navy-unique CAD/CAM system, a system that is out of the commercial mainstream?
- Are the Navy's mandatory requirements clearly identified?

Hardware

- Is "mix-and-match" graphics screen requirement for work-stations essential?
- Is application software compatibility requirement across workstations and servers essential?
- Is required array of communication methods essential?

The specification requires several hardware items or features which may not be essential and could increase system complexity and cost. These include requirements for graphics display screens that can be used on any workstation, workstations and servers that can run the same application software, and a wide array of communication methods.

The specification requires that engineering workstations be constructed using interchangeable components and a modular structure so that the capabilities of any workstation can be changed without replacing an entire unit. While this requirement appears reasonable, applying this idea to graphics display components could create equipment mismatches, vendors said. For example, combining a workstation with relatively low processing power and a display device with a high-resolution picture capability could overburden the workstation. Similarly, using a powerful workstation and a low resolution graphics display device appears to be an ungainly match. Navy program officials acknowledged the potential mismatches in equipment that this requirement could produce.

The specification also requires both workstations and special purpose servers to run the same software applications. According to vendors, it is not realistic to expect a computationally intensive application that normally runs on a powerful mainframe computer to also run on a workstation. Additionally, it may not be economical because this requirement adds additional expense to software maintenance. Up to four versions of application software may have to be supported to meet the demands of the workstations and the three different compute servers. Navy program officials told us that this requirement ensures there will always be a back-up machine available in the event one fails. They added that even if the probability of a workstation being needed to back-up a compute server is very small, the Navy must be prepared for any possible contingency if it is to meet its mission.

Last, the specification requires a wide array of communication methods. For example, it requires five modem types, each having either three or four transmission speeds, producing 17 different combinations. Additionally, the specification requires seven different types of communication media. According to vendors, these communication requirements are more complex than those used commercially. For example, vendors stated that normally only one or two media types are specified. Such requirements add extra expense to the system. Navy program officials stated that they could understand the concern surrounding the communication requirements and added that they will clarify this in the RFP.

Standards

- Does Navy's treatment of POSIX and PDES standards exceed the standards' current scope and ability?
- Will required extensions to POSIX produce a Navy-unique standard inconsistent with the standard's public evolution?

The specification calls for the use of public standards to define its operating system, data exchange formats, and communications interfaces. The intent of these standards is to define connectivity criteria between different application software programs and between systems software and hardware. The specification's treatment of the POSIX and PDES standards raises the issue of whether the Navy is exceeding the current intent of these standards and, as a result, requiring versions of both which may prove inconsistent with the standards' evolution.

POSIX

The Navy has specified POSIX as the standard command interpreter between the application software and the operating system. Through POSIX, the Navy is seeking maximum software portability and minimum software to hardware interdependence. However, because the standard currently does not provide all the abilities the Navy needs, the Navy is requiring extensions to POSIX that may or may not prove consistent with the standard's evolution. As a result, the Navy may be requiring a Navy-unique version of POSIX which may not prove portable.

The Navy has specified operating system characteristics or extensions that appear to be beyond the scope of the operating system functions POSIX will likely address in the foreseeable future. Vendors stated that extending POSIX to provide some of these characteristics would require new software development and could produce a Navy-unique version of POSIX. As explained by one vendor, satisfying the configuration management system extension could produce a Navy-only version of POSIX and violate the Navy's software/hardware independency goal. Similarly, another vendor described the security extensions as conflicting with the Navy's POSIX portability goal. NBS officials said they did not know when or if POSIX would address system management or security. The Navy is also specifying its own "windowing" extension to POSIX. NBS officials indicated no plans to incorporate this extension into POSIX. In contrast, CAD/CAM program officials said that they believe POSIX will one day address the extensions required by the specification.

PDES

Through the use of the PDES standard, the Navy is trying to standardize the format for transferring between application programs the engineering data necessary to completely define a product. However, by requiring vendors to extend the current scope of the PDES standard, the Navy appears to be trying to predict or direct the standard's evolution and, as a result, runs the risk of requiring a version of PDES that may later have to be changed to make it consistent with the standard's evolution.

The Navy is requiring extensions to PDES which may or may not be consistent with later NBS certified versions of the standard. PDES is still being developed, and NBS officials estimate the earliest possible release of a first version of PDES to be late spring 1988. The specification requires vendors to implement PDES within 6 months after its release. Recognizing that the initial PDES standard is not intended to cover all attributes of an engineering drawing, the specification also requires vendors, in consultation with the Navy, to add extensions to PDES. According to the specification, when a vendor has drawing features which are not addressed by PDES, vendors are directed to translate these features into a data exchange format which transfers the most information. The Navy decides how and when to apply and implement this requirement. Navy program officials stated that the Navy is not trying to direct PDES' evolution by having a Navy-unique version of the standard. They added that the RFP will clarify their requirements for extending PDES.

Application Software Integration and Maintenance

Application Software Integration and Maintenance

- Will Navy's requirements for close coupling of application software result in a Navy-unique system, out of the commercial mainstream?
- Do system development and maintenance costs associated with application software integration outweigh the benefits?

CAD/CAM II is designed to acquire off-the-shelf CAD/CAM equipment and to enhance engineering productivity by integrating independent application packages. However, integration requires developing specific software to translate data among independent applications. This requirement raises such issues as (1) will new systems development be required to satisfy the desired level of integration; (2) will this new development produce a Navy-unique system which is out of the commercial mainstream; and (3) what will be the effect of this application integration on software maintenance?

The Navy wants to integrate a large number of independently-developed applications. However, its integration requirements may result in a one-of-a-kind Navy system. According to vendors, the Navy's integration requirements will require Navy-specific research and development and could result in a system which is out of the commercial mainstream and Navy-unique. Vendors also described the software needed to satisfy the Navy's requirements as extremely difficult and expensive to develop. In contrast, Navy program officials do not view their integration requirements as requiring research and development and producing a Navy-unique system. They described their integration requirements as normal "grooming, linking, and rehosting" of software. Further, the officials stated that their requirements are consistent with the natural evolution of CAD/CAM software, and they will push commercial research and development to a faster solution in this area.

The integration requirements may also produce a system that is very difficult to maintain. According to vendors, each change to an application program's input and output structure will require a corresponding change to the integrating software. Depending on how many software applications interact in performing a given task, multiple pieces of integrating software may need to be changed. These vendors believed that accommodating new releases of application software may not be possible. Navy program officials acknowledged that the system might be difficult to maintain; however, they believed that the benefits of integration outweighed the costs.

Mandatory Vs. Negotiable Requirements

- Are mandatory requirements clearly distinguished from negotiable requirements?

The specification raises the issue of whether mandatory versus negotiable deliverables are clearly identified. In one section, the specification describes mandatory requirements by stating that proposals which take exception to requirements will be evaluated in terms of meeting the Navy's overall requirements for reliable CAD/CAM systems. The specification recognizes that this raises the question of which requirements are negotiable and which are not. Thus, it states that in general the fewer exceptions that are taken to technical requirements, the more likely that such exceptions will be favorably viewed.

Later, the specification states that the Navy considers all requirements mandatory. However, it also states that the Navy will not automatically reject proposals which take exception to some requirements. Instead, the exceptions' impact will evaluated. The specification then adds that a proposal taking exception to substantial portions of the requirements would, in all likelihood, be rejected without discussion.

Vendors interpreted mandatory versus negotiable requirements differently. Approximately one-half of the vendors stated that the mandatory requirements were negotiable, while the other half said they were not. As a result, vendors expressed confusion about how the Navy would evaluate proposals. The Navy needs to specify those requirements that are negotiable, vendors said, or at a minimum, assign priorities to all requirements. In response to this, Navy program officials said that everything in the specification is negotiable and that this would be clarified in the RFP.

Matters for Consideration

In developing its RFP, the Navy may want to consider:

- Reevaluating its hardware requirements for (1) "mix and match" graphics display screens for workstations, (2) application software compatibility across workstations/servers, and (3) a wide array of communication methods

- Modifying its treatment of the POSIX and PDES standards in light of current abilities of both
- Pursuing its system integration objectives under a separate developmental effort and limiting CAD/CAM II to a procurement of commercially available and proven equipment (as it is portrayed in the specification)
- Clarifying its mandatory vs. negotiable requirements

The amount of thought, planning, and coordination that has gone into developing the Navy's CAD/CAM technical specification has been exceptional. Vendors described the specification as a foresighted document that could guide Navy CAD/CAM evolution over the long-term. However, they also expressed concern about some of the specification requirements. In view of the issues identified in this report concerning the Navy's CAD/CAM technical specification, we believe that the Navy may want to consider the following points as it finalizes the specification for inclusion in its CAD/CAM RFP for release to industry:

- Reevaluating its hardware requirements for (1) "mix and match" graphics display screens for workstations, (2) application software compatibility across workstations and servers, and (3) a wide array of communication methods;
- Modifying its treatment of the POSIX and PDES standards in light of the current capabilities of both;
- Pursuing its system integration objectives under a separate developmental effort and limiting this CAD/CAM acquisition to a procurement of commercially available and proven equipment as it is portrayed in the specification to be; and
- Clarifying which of its requirements are mandatory and which are negotiable.

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