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United States
Department of Defense
Computer-aided Acquisition &
Logistic Support (CALS)

March 1990

CALS INFRASTRUCTURE ANALYSIS

DRAFT

Prepared by

U. S. Department of Transportation
Research and Special Programs
Administration
Transportation Systems Center
Cambridge, MA 02142

Prepared for

U. S. Department of Defense
Office of the Secretary of Defense
CALS Policy Office
The Pentagon
Washington, DC 20301-8000

EXECUTIVE OVERVIEW

This executive overview to the *DoD CALS Infrastructure Analysis Report* summarizes the Components' current efforts to modernize the DoD technical data infrastructure. This infrastructure includes all existing and planned capabilities to acquire, manage, and use technical data in the weapon system life cycle. The infrastructure should support the cycle of technical data from its creation to use. Technical data is created during the weapon system design and development process and is then stored in repositories to facilitate management and distribution to functions that support the weapon system over its life cycle.

Nine current and planned programs within the Services have been selected and analyzed. Each program is mapped against an infrastructure framework model was developed by the Transportation Systems Center to enhance the understanding of ongoing programs and their relationship to one another. The analysis is designed to promote an understanding of the role of each program in the context of the overall Service information systems development, and of how each program facilitates the exchange of technical data related to weapon systems. The objective of the analysis is to identify gaps in the infrastructure, identify technology transfer opportunities, and establish priorities for infrastructure development within the CALS domain.

The infrastructure development is being coordinated by a senior level CALS planning group comprised of OSD, Service and DLA executives; they are providing direction in defining the priorities for infrastructure efforts and identifying opportunities for shared development and acquisition. An ad-hoc inter-Service group, representing Service organizations responsible for CALS implementation, has coordinated Service response and provided information on the current efforts.

Program managers provided the information required to analyze each program, including detailed inputs regarding their own plans and schedules, and have also provided valuable insights once each program was mapped to its appropriate infrastructure framework.

This overview includes the following:

- Key observations on all programs
- A brief description of the infrastructure framework model
- Overview charts summarizing program capabilities for each of the three classifications:
    - Product Definition
    - Integrated Logistics Support
    - Data Management
- Recommendations

AGGREGATE MAPPING OF INFRASTRUCTURE PROGRAMS

The main report includes a detailed analysis of nine programs, and maps each of the programs by its existing and planned functional capabilities to its appropriate conceptual framework. The programs included are:

- DSREDS - Digital Storage and Retrieval Engineering Data System
- EDCARS - Engineering Data Computer-Assisted Retrieval System
- EDMICS - Engineering Data Management Information and Control System
- CAD-2 - Computer-Aided Design-2
- NPODS - Navy Print on Demand System
- AFTOMS - Air Force Technical Order Management System
- MEDALS - Military Engineering Data Asset Locator System
- TD/CMS - Technical Data/Configuration Management System
- ACALS - Army CALS

In the main report, the capabilities of each program are analyzed and compared to its appropriate infrastructure. From the analysis of the individual programs three summary infrastructure framework charts were developed which depict the total functional capability represented by each program area.provide an across Service perspective of the programs and an overview of infrastructure capability. These summary charts are presented in this overview. The following discussion provides an overview of the scope of each program area, identifies technology transfer opportunities and suggests areas where there are gaps in the current infrastructure.

Product Definition Programs

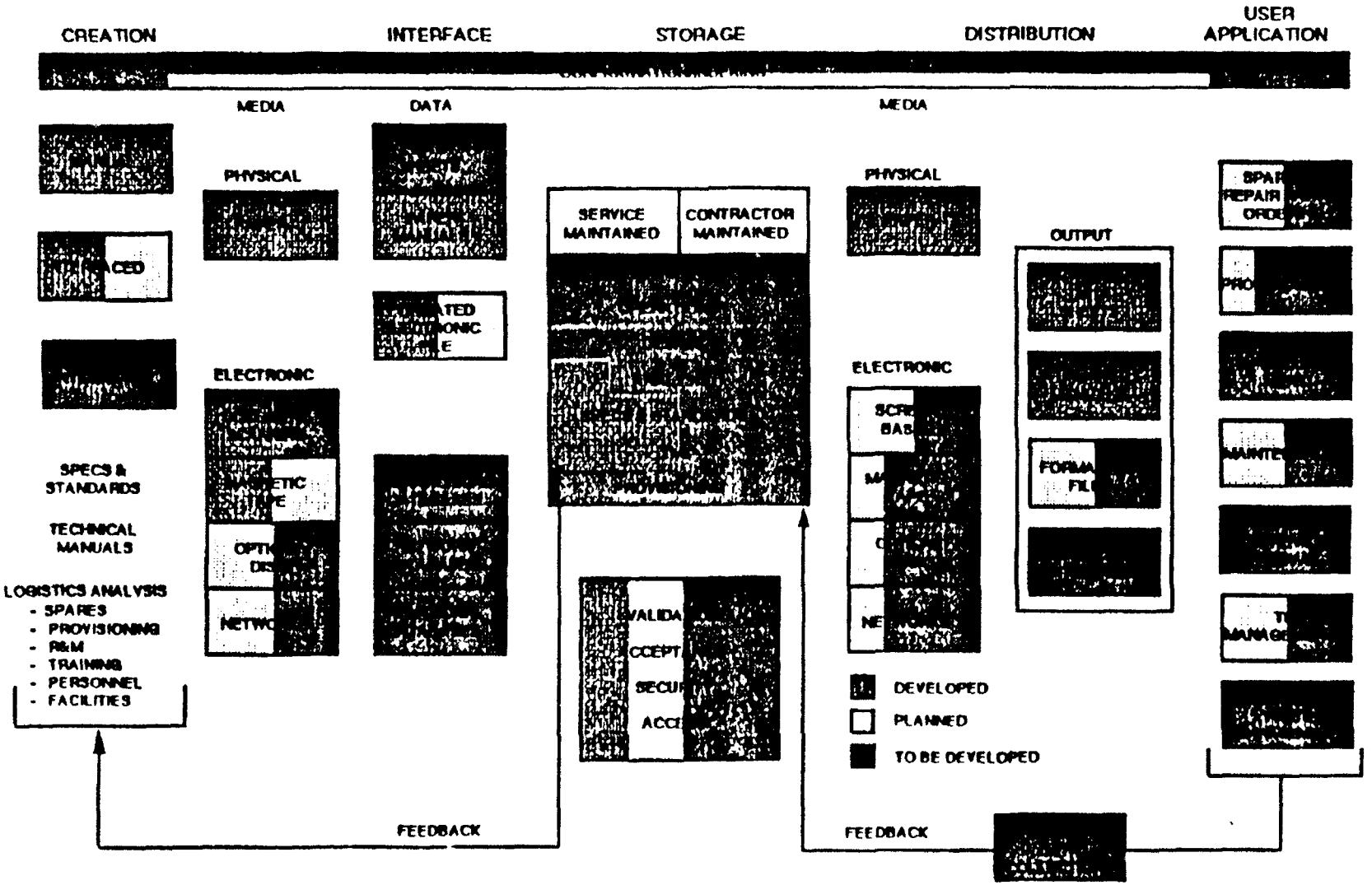
- SCOPE

The four Service specific programs analyzed are DSREDS, EDCARS, EDMICS and CAD-2. FIGURE EX-1 summarizes the scope of the product definition programs and represents the DoD infrastructure for data creation, management, and use.

- **Development of Repositories** - The programs support the development of repositories for information storage. They support the existing technical data assets which include paper drawings and aperture cards. They support the management of hard copy products by automating the index data related to the drawings, and by scanning the graphic images for storage and retrieval in raster format.
- **Raster Image Management** - The primary thrust of product data infrastructure development efforts are currently oriented towards raster image management. The main application of raster technology is limited to converting existing drawings, and in some cases text, into a digitized format.

- **Integrated Information Exchange** – The CAD-2 program is a major effort to change the way technical data is created. By providing an engineering data development platform for the specific functional areas, it provides functional area users who are equipped with a similar platform with the capability for an integrated information exchange.

- TECHNOLOGY TRANSFER OPPORTUNITIES
  - **Optical Disk Transfer** – The Army (DSREDS) and Air Force (EDCARS) repositories lack the capability to transfer optical disks directly to and from storage. If this capability were available, loading repositories with new data would be more efficient and there would be more flexibility in supporting data transfer between repositories. The Navy's (EDMICS) program is developing this capability and this can be reviewed for applicability to other Services.
  - **Automated Validation** – One of the major bottlenecks in loading data into repositories is that each drawing must be manually reviewed before transferring to optical disk. The Navy's (EDMICS) program is developing an automated quality assurance capability that could detect most unacceptable scanned images. The Army and Air Force systems could benefit from this development. This could increase throughput of data entry by rescanning poorly scanned drawings and leaving only a small number that require manual corrections.
- GAPS IN THE INFRASTRUCTURE
  - **Need for Vector Technology** – Since all new automated generation of technical data is based on vector technology, the acceptance, storage and distribution of digital data related to new acquisition will require the development within the Services of an infrastructure capacity to deal with vector technology.
  - **Data Management** – Existing product definition infrastructure programs do not provide an adequate data management (data configuration and indexing) capability. The EDMICS system plans to implement a capability to manage the configuration of data in repositories, and the Army DSREDS programs is linked to the TD/CMS program which provides that capability for its repositories. The product definition data infrastructure should be linked to an overall data management infrastructure to provide consistent data configuration and indexing.
  - **Contractor Interface** – The overall product definition data infrastructure concept includes extensions to interface with contractor managed repositories containing government-owned data. However, present infrastructure efforts do not establish the necessary links to include contractor-based repositories nor the infrastructure to provide DoD users access to data at contractor sites.
  - **User Interface** – Existing programs automate the storage of data but still rely heavily on distributing data as hardcopy products. The distribution of raster images is an improvement over paper distribution but serves only a limited set of users.



NOTE: PROGRAMS REPRESENTED BY SUMMARY CHART ARE AFTOMS, NPODS & ACALS

FIGURE EX-2. AGGREGATE MAPPING OF ILS PROGRAMS

DATA MANAGEMENT	
FUNCTIONAL REQUIREMENTS	TECHNICAL REQUIREMENTS
MACRO LEVEL - DoD & Services	
Extend utility of existing and new data Provide for efficient exchange of information between Service and Industry, and amongst government organization	Provide uniform access to all technical data Insure data currency through a global configuration management system
MICRO LEVEL - Data management functions	
Integrate weapon system information Enable effective management of technical data	Maintain consistency of data through data dictionary functions Control access based on security requirements

FIGURE EX-3. DATA MANAGEMENT REQUIREMENTS

designed to facilitate inter-Service exchange of engineering data through a cross-reference matrix based on standard CALS data keys. MEDALS also provides a hub connecting various Service repositories. It provides an indexing scheme which allows users to determine the availability and location of drawings across DoD.

- TECHNOLOGY TRANSFER OPPORTUNITIES
  - Distributed Databases - The ACALS program is preparing to build an architecture which includes the development of a global directory supported by a distributed schema. In addition, the ACALS architecture will include the definition of concepts to support configuration management and data security for electronic repositories. These concepts are applicable and relevant to the support similar functions in other Services.
- GAPS IN THE INFRASTRUCTURE
  - No Common User Access - Each implementation of technical data storage includes some method of referencing and managing that data. However, each implementation describes the data being stored in a unique way that does not contribute to creating an overall infrastructure. For example, the way data items are described in MEDALS, TD/CMS and repository systems such as DSREDS and EDCARS and EDMICS are inconsistent, thereby preventing common user access to the related technical data.
  - Developing Logistics Data Models -The development of a data management infrastructure is largely dependent on the definition of a common view of the technical data that the entire infrastructure supports. This common view includes describing the data requirements for each class of data (such as product data and logistics data) the structure of that data, and the relationship between data entities. This common view must include a standard set of data item representations. For

product data this initial effort is being undertaken by various organizations under the PDES umbrella. A similar effort is required to define logistics data requirements.

- **Developing a Cross-reference** – The capability of current data management programs is limited to data exchange through such media as tape exchanges. The future vision of data management is of data integration through shared databases that provide the user with a transparent access to all related data. This will require the development of new data management concepts such as global and distributed data dictionaries. An interim step to integrating current assets and linking "islands of automation" could be achieved through developing cross-references and indexes designed to link existing databases.

SUMMARY OF RECOMMENDATIONS

Recommendations related to the DoD technical data infrastructure modernization are designed to help guide discussions related to the longer term CALS Master Plan. If implemented, these should move the Services towards a more integrated data environment as envisioned by the CALS objectives. Major recommendations are as follows:

1 Develop Vector Repositories

Data for new weapon system and major modifications is being developed using computer-aided design systems. These systems use vector data to construct product geometry and features. The Services need to be able to store and distribute this data in vector format to support future engineering, maintenance, and manufacturing functions.

2 Extend Distribution of Raster Data

Extraction of data from raster-based repositories is limited to a process of converting the digital data back to paper or aperture cards for distribution. Electronic access via raster workstations is limited to users directly connected to the repository hardware. To fully utilize the repository data the distribution infrastructure should be extended to allow and geographically remote users to pull information from major storage locations to their own workstations.

3 Develop CAD and CAM Capability

Development of organic engineering and manufacturing capability within the Services will depend on the ability to utilize the data acquired and stored in vector repositories. This requires the acquisition and integration of hardware and software platforms that can support CAD and CAM functional requirements. CAD-2 program defines this capability for specific Navy commands. Other DoD components need to develop similar capabilities and integrate them into the overall infrastructure.

important for ensuring that data is correct and for developing user confidence in the whole technical data infrastructure.

9 Integrate Maintenance Functions

Major benefits of digital data delivery can only be realized by applying the data to user needs. Maintenance function efficiency directly translates into level of readiness. A major effort is required in delivering data to end-users in a form that supports computer-aided diagnostics, numerical control machining, and electronic technical manuals.

10 Institute Data Management Across Weapon System Life Cycle

Acquisition of new systems presents an opportunity to manage technical data in a way that allows the development of an integrated database. This includes aggregating design and development data, logistics data, and systems operations data. Such a capability requires linking the product definition data, logistics data, and operational logistics systems to support and manage data throughout the weapon system life cycle.

11 Operational Feedback

The CALS infrastructure can only be complete if the flow of data is not simply from developers to users but also from users to developers. The operational areas within the Services collect data on reliability of weapon systems. However, there is no effective way to integrate this information into developers' systems to enhance future acquisitions.

CONCLUSIONS

This analysis has reviewed the DoD infrastructure, as represented by major programs, in the context of the CALS vision. The review included a consideration of the functional requirements and the implementation of technology alternatives, The result of this analysis is summarized in statements regarding the scope of the the infrastructure, infrastructure gaps and opportunities for technology transfer. The recommendations identify a list of areas requiring further infrastructure development. This report provides a basis for:

- Technical information infrastructure baseline as required by the CIM development process;
- Establishment of infrastructure priority areas to be considered in the CIM review; and
- Review of on-going R&D programs to address infrastructure gaps.

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SECTION 1: Introduction

1.1 Purpose

Computer-aided Acquisition and Logistic Support (CALS) is a joint DoD and Industry initiative that is changing the way DoD and Industry do business. CALS is creating an environment which facilitates the integration and use of automated digital technical information for weapon system design, manufacture and support. The CALS Policy Office within the Office of the Secretary of Defense (OSD) encourages and supports the successful implementation of the CALS program throughout DoD.

As part of this effort, the CALS Policy Office is in the process of developing information models to analyze the technical data infrastructure. This report analyses the DoD technical data infrastructure by reviewing several of the major infrastructure modernization programs from all the Services from the perspective of their significance for the overall DoD effort to transition to the acquisition of technical data in digital format.

By examining these programs and by considering the structure into which they fit, a broad picture of the overall infrastructure functional requirements emerges. The report is intended to provide planning groups within DoD with a better understanding of the overall picture which will then assist them in focusing their own programs to meet the CALS goals. The study also establishes a baseline by describing the current environment of ongoing infrastructure modernization programs. This baseline provides planners with a basis for comparisons, helps identify gaps in the infrastructure and can assist in establishing priorities for infrastructure development.

1.2 Infrastructure Programs in CALS Planning

CALS related efforts are taking place in four key areas to support the DoD technical data infrastructure development. These areas include development and testing of standards, technology development and demonstration, acquisition guidelines and policy, and infrastructure programs. This report is part of the infrastructure component of the CALS effort. Development of DoD infrastructure systems is required to receive, integrate, access and use digital technical data effectively in weapon system life cycle processes. The DoD Components have undertaken a wide range of projects for modernization of their infrastructures to support the development of an operating environment envisioned in CALS.

The infrastructure development is being coordinated by a senior level CALS planning group comprised of OSD, Service and DLA executives; they are providing direction in defining the priorities for infrastructure efforts and identifying opportunities for shared development and acquisition. An ad-hoc inter-Service group, representing Service organizations responsible for CALS implementation, has coordinated Service response and provided the necessary input for the development of the infrastructure.

SECTION 2: DoD Infrastructure Programs Mapping

DoD CALS Policy Office, Army, Navy, Air Force and Defense Logistics Agency have identified specific on-going and planned systems development efforts as "infrastructure" programs. The criteria for designating a program as an infrastructure effort included, the breadth of the proposed program implementations, and its inclusion in current and proposed funding plans. The infrastructure programs are listed below and reviewed in detail in this section.

The Product Definition Data infrastructure programs are:

- DSREDS
- EDCARS
- EDMICS and
- CAD-2

The Integrated Logistics Support Data infrastructure programs are:

- NPODS and
- AFTOMS

The Data Management infrastructure programs are:

- MEDALS and
- TD/CMS

One program addresses all three areas:

- ACALS

Each program is analyzed in terms of its existing and planned functional capabilities, and each is mapped against one of three related infrastructure frameworks. The model used to analyze these programs is described in Appendix A. Each program description is accompanied by a chart which represents the degree to which each program meets the infrastructure requirements presented by the overall framework. These charts are color coded to show the developed, planned, and future enhancements for each program. Each chart, therefore, shows the functional capability of the program relative to the appropriate infrastructure framework. The areas mapped in green indicate existing functional capabilities. Those represented in yellow indicate planned developments that are in the process of procurement. The remaining areas have been left blank to indicate functional capabilities not considered to be within the scope of the program. The amount of coloring in a particular box indicates the extent to which that functionality is implemented or proposed to be implemented by the program. For example, a box colored half green indicates that the program has implemented about half of the total function and that no further extension is planned.

FIGURE 2-1. DSREDS

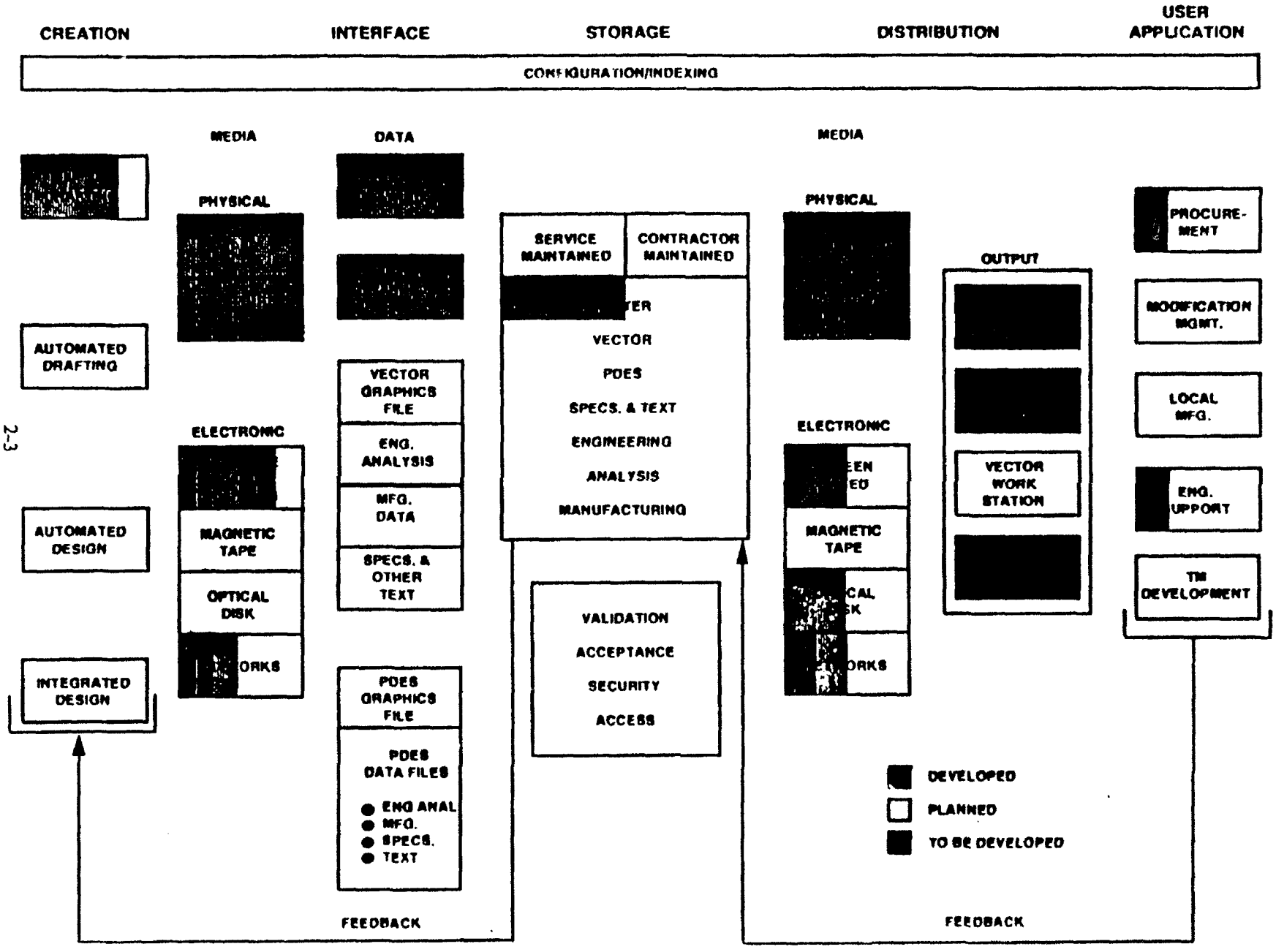
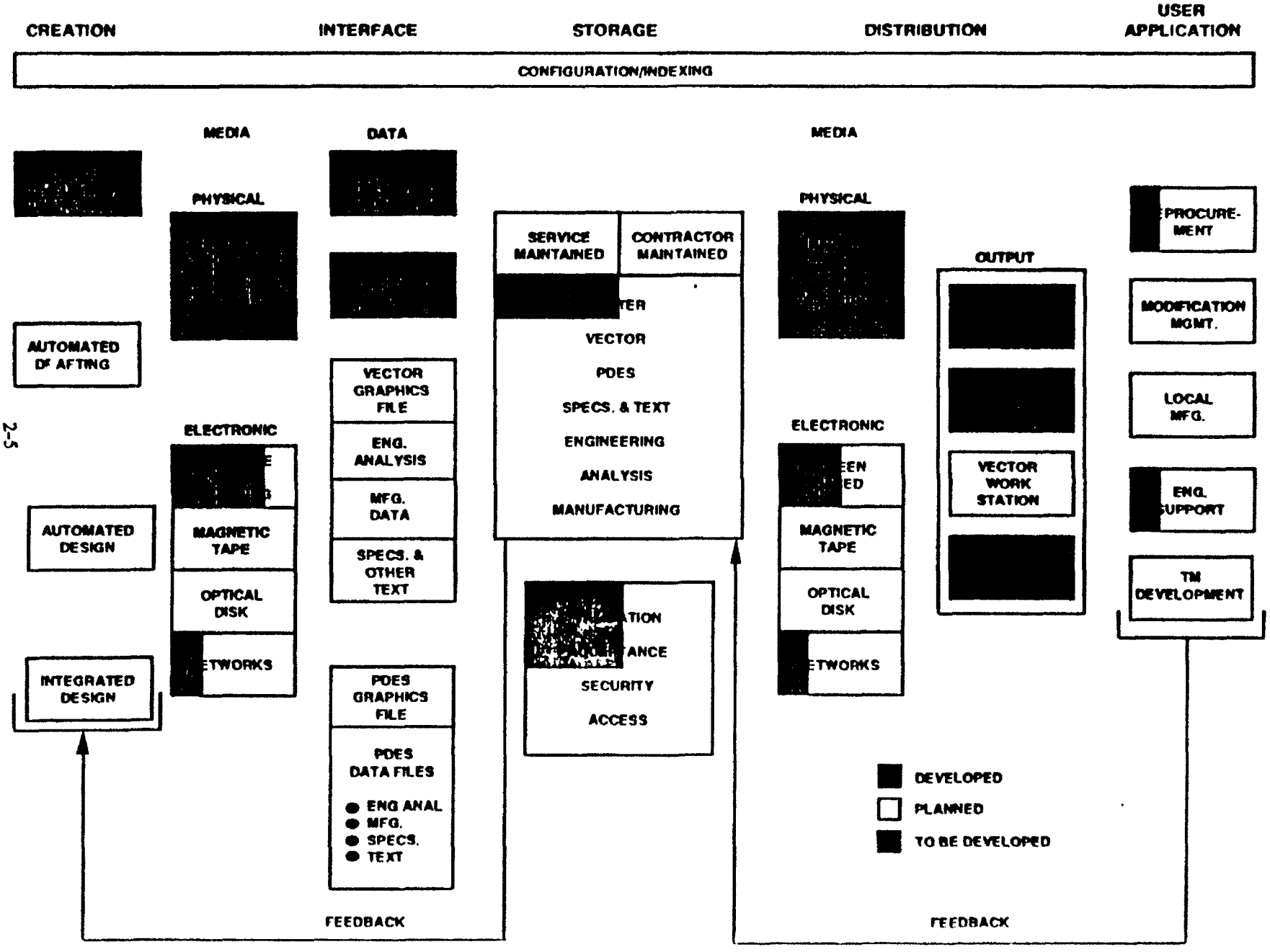


FIGURE 2-2. EDCARS



Screen/Work Station	Raster file output are viewed on screens directly connected to the storage system. The system supports limited editing of raster images through bit-map deletes and vector specification of simple entities. The edited files are stored as a raster image.
Magnetic Tape	Plans exist for raster image and index data distribution on magnetic tape.
Optical Disk	The planned optical disk interface will allow bulk drawings to be output on optical disk and then directly input into other systems or compatible sites.
Networks	There is limited low volume access for remote users over DDN and for base users over a LAN.

- DATA FOR USER APPLICATIONS

Reprocurement	Reprocurement functions include: bid package generation, RFP preparation, contracting, evaluation, award and monitoring. The system only supports bid package development by providing the user with the capability to identify and locate appropriate drawings.
Engineering Support	*Engineering analysis, redesign and assessments are partially helped* by drawings from DSREDS and EDCARS. The CAD, CAM, CAE automated systems, principally used in engineering support, employ vector data not raster images. DSREDS and EDCARS do not retain vector data; however, they do provide a source for existing drawings.

2.1.2 Major Observations

CONFORMANCE TO CALS STANDARDS

Because DSREDS and EDCARS were designed before the introduction of CALS standards, they do not follow CALS standards for raster storage. The CALS standard chosen for raster image storage is MIL-R-28002, known in Industry as the CCITT Group 4 Raster Standard, which uses the non-wrap tile format. DSREDS and EDCARS use the wrap tile format, which is not compatible with MIL-R-28002.

Plans for making DSREDS and EDCARS compliant with CALS standards are being explored. Stored images in DSREDS and EDCARS are not useable by other CALS compliant systems. DSREDS and EDCARS could become compatible with the other CALS programs by either:

- large scale conversion of all stored images to conform to MIL-R-28002, or
- accepting non-wrap format drawings and converting them to the DSREDS/EDCARS format for storage and providing an output capability for translating to

- **PREPROCESSING OF APERTURE CARDS TO BE SCANNED**

Aperture card scanners in DSREDS/EDCARS programs will only accept 80–column punched cards with index information across the top in 'H' format and a center "window" that holds the photographic film with the engineering drawing image. There are a large number of aperture cards that do not conform to 'H' format punched index information. These cards can not be processed without duplicating the cards and reformatting them according to the 'H' format specification.

The preprocessing of aperture cards is an intensive manual operation. However, the Navy EDMICS program is developing a capability which will allow processing aperture cards that contain index information in any DoD format.

- **NEED FOR CONFIGURATION MANAGEMENT**

DSREDS/EDCARS do not handle configuration management of engineering drawings. There is no way of identifying drawing trees of related drawings, or recognizing the different versions of configurations, nor a way of handling drawing changes so that the drawing tree is keep current. Neither program supports configuration status accounting or configuration audits. DSREDS/EDCARS ability to extract the right set of drawings for a procurement bid set with all the updated and current drawings is limited to accepting a manually generated list of drawings. The TD/CMS program is the Army system which supports configuration management requirements. A TD/CMS interface with DSREDS is being considered to provide a configuration management capability for engineering drawings. However, EDCARS has no such support or plans for the development of configuration management functions.

- **SIGNIFICANCE FOR CALS**

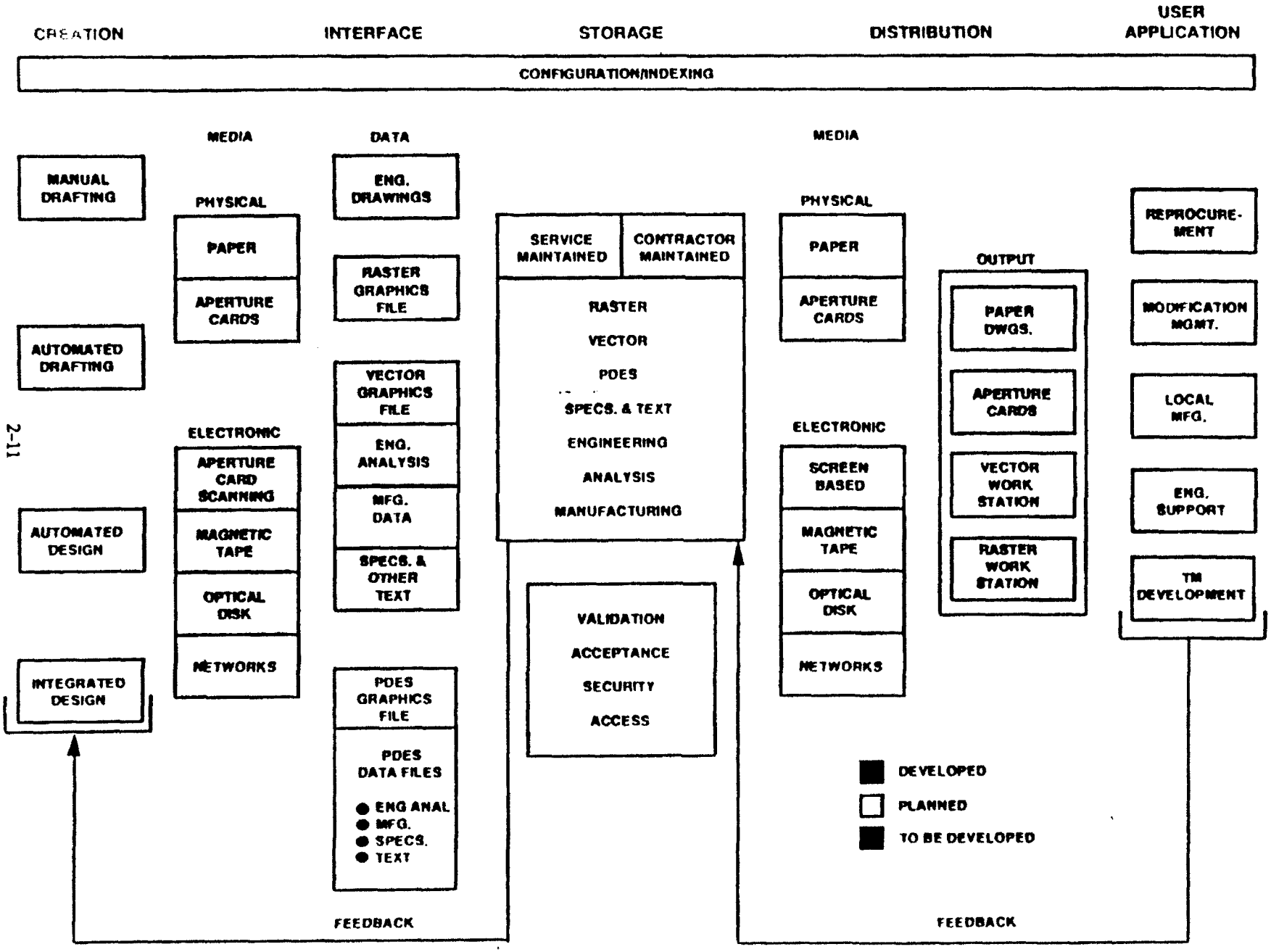
The implementation of EDCARS and DSREDS will provide the capability to:

- Take delivery of raster drawings on magnetic tape and optical disk;
- Store raster drawings and related index data in electronic format;
- Output drawing in hardcopy and aperture card format on demand;
- Allow low volume digital distribution of drawings via communication networks;
- Facilitate the automation of bid sets;
- Scan engineering drawings from paper or aperture cards;
- Reduce access and retrieval time for engineering drawings; and
- Communicate with remote sites.

2.2 EDMICS

EDMICS, the Engineering Data Management Information and Control System, is the Navy program designed to automate the storage and retrieval of engineering drawings and associated data. Repositories, which manage and maintain the engineering data, support engineering activities, field maintenance and competitive procurement organizations in the Navy.

FIGURE 2-3. EDMICS



- **DATA STORAGE**

Service Maintained	The current EDMICS concept is based on a government maintained repository, supporting primarily local users.
Raster	The raster file storage format will conform to CALS raster standard MIL-R-28002.
	Between two and ten million images will be kept on optical disk mass storage platters in EDMICS. There will be a self contained directory on the platter and the platters can be shipped to other EDMICS sites.
Vector	EDMICS can accept, store and transmit IGES or CGM vector data, but there will be no EDMICS capability to display or edit this data.
Specs. & Text	EDMICS will store technical reports in SGML or ASCII format.
Validation	Automatic quality assurance during the scanning process will detect images that are too light, too dark or out of focus. The image enhancement function will allow the viewing and enhancing of the scanned image through a limited raster edit capability. Index data within the system can be manually verified.
Acceptance	The Data Integrity Control Workstation will allow a manual review of statistically sampled images on a workstation. The raster file awaiting acceptance can be reviewed on magnetic disk and once it is acceptable it will be copied onto the optical platters.
Security	User identification and passwords will provide primary security for the system. Class C2 Controlled Access Protection will be used for EDMICS which is consistent with CSC-STD-001-83. There will be no capability to secure classified drawings.
Access	The DBMS will support access by allowing ad hoc queries on index data. The basic access mechanism will be the drawing number. The index search function will be based on a system dictionary and a platter directory.
Configuration	Drawing and document change information will be kept up to date through the implementation of a relational database.

- **DATA DISTRIBUTION**

Magnetic Tape	The information stored in EDMICS can be transferred to another site via magnetic tape.
Optical Disk	Both 5 1/4 inch WORM and 12 inch optical disk platters will be available for transfer to other EDMICS sites.

tions will be enhanced by ensuring that drawings will be readily available on demand. However, engineering functions which require modification of existing drawings will only gain marginal benefits. The drawing modification capability will be constrained by the nature of raster images.

- **CATALOGING OF DATA IN ALL EDMICS SITES**

Cataloging of drawings will be limited to a particular site. There is no planned implementation of an index of all data in EDMICS databases. In addition, cataloging is hampered by the lack of a standard way of specifying and indexing drawings across all Navy functions.

- **IMPLEMENTATION STRATEGY**

The contribution of EDMICS to infrastructure development will largely depend on the implementation strategy. A strategy based upon a small number of large centralized EDMICS sites requires the development of distribution channels. On the other hand, a large number of smaller EDMICS sites will require developing a coordinated data management scheme.

- **CONFIGURATION MANAGEMENT RELATIVE TO WEAPON SYSTEM CONFIGURATION**

Support for configuration management is provided in the form of a relational database linked to the stored graphics. However, the effectiveness of configuration management will depend on the ability to load existing configuration data associated with drawings and the ability to update this information based on changes that may be registered in other systems such as SNAP.

- **DATA LINKS TO SHIPS AT SEA**

Ships at sea represent a unique remote user situation. Once ships leave port, the only links are satellite based communication. Distribution of drawings to ships at sea will require the development of special capabilities which are not addressed in the present implementation.

- **SIGNIFICANCE FOR CALS**

The implementation of EDMICS will provide the Navy/DLA with a capability for:

- Acceptance of raster data checked for conformance to CALS standards;
- Automated quality assurance;
- Storage of raster and IGES files; and
- Distribution of data via conversion to hardcopy, local area networks and optical disk transfers.

2.3 CAD-2

CAD-2 program will allow the Navy to acquire CAD workstations through a common hardware and system software specification. The potentially unique engineering requirements of each Navy Systems Command (SYSCOM) will be addressed by modifications to the applications software. Thus the acquisition will be in five parts, one for each command. Each acqui-

FIGURE 2-4. CAD-2

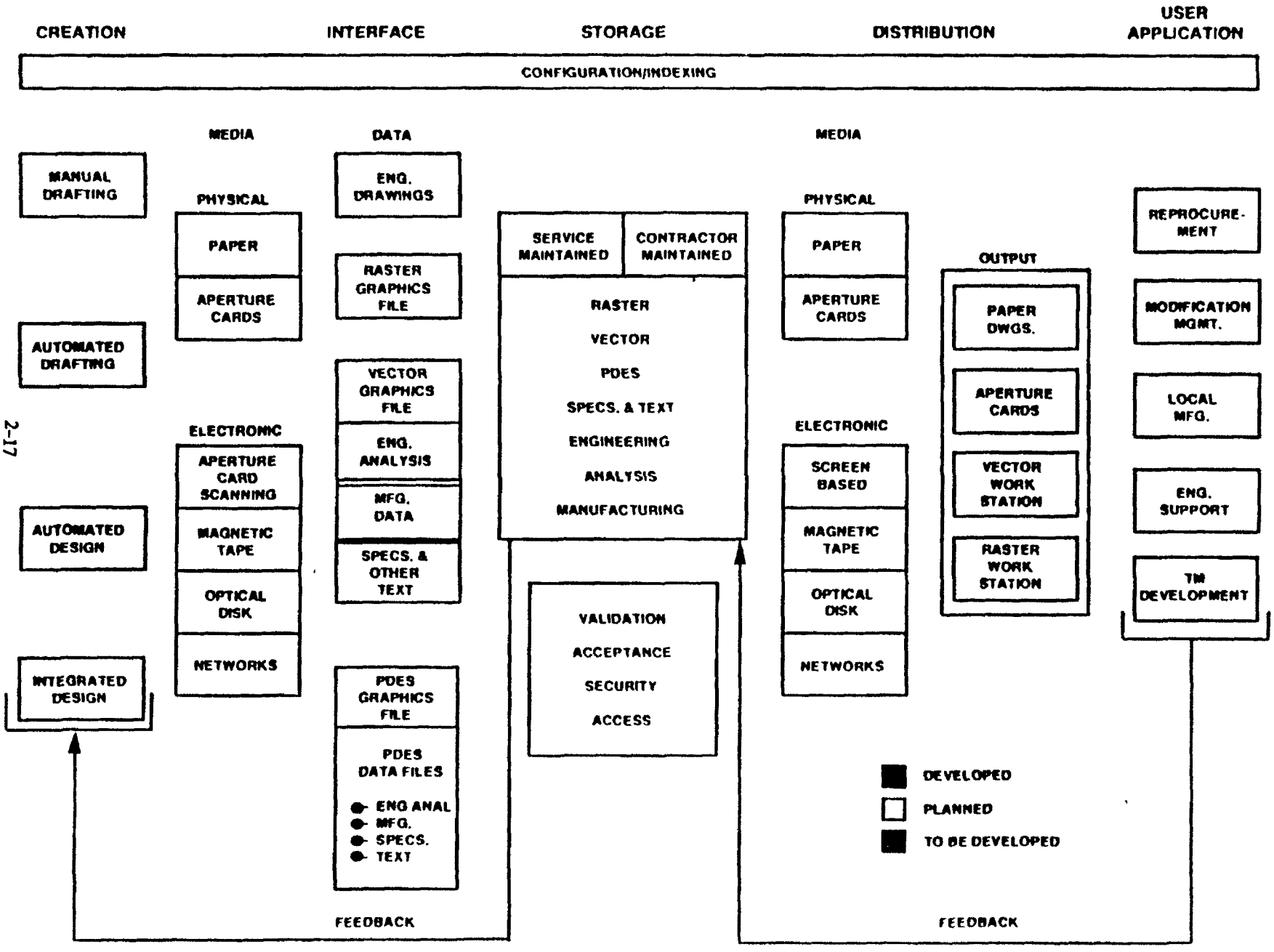
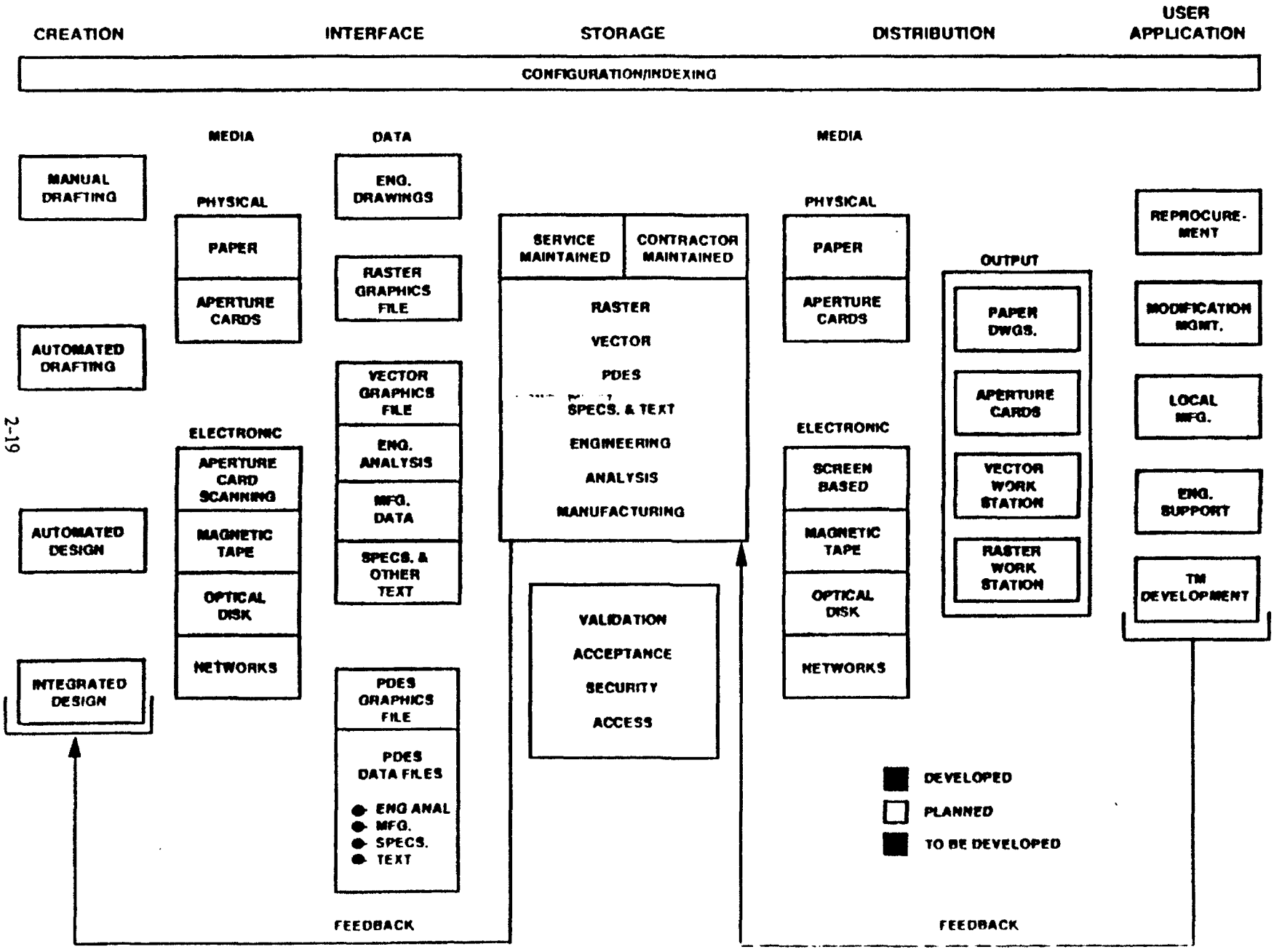


FIGURE 2-5. CAD-2 – FUNCTIONAL



Specifications and Text	Documents created in CAD–2 applications or transferred in can be stored. Manufacturing and design libraries of shapes, sizes, forms, materials, standard equipment or parts will be stored. Libraries of models, systems documentation, weapon or platform documents will be stored for use with the applications of CAD–2.
Engineering Analysis	Engineering analysis data input from other systems or created by CAD–2 applications will be stored. These can be models, results, evaluations, and tradeoffs resulting from kinematic, linear, finite element, piping, HVAC, thermal or electrical system analysis.
Manufacturing	Manufacturing data created by the CAD–2 applications and other applications can be stored. Computer integrated manufacturing (CIM), numerical controlled (NC) and computer numerical controlled (CNC) machining procedures, distributed numerical control and computer aided process planning (CAPP) will be included in CAD–2.
Validation	Review package creation, review package distribution, and model or design test software will be available with CAD–2. Verification and error checking will be supported through a capability to access the GDBMS without entering the graphics mode.
Acceptance	System level checking of data files for conformance to specified standard formats will be available.
Security	Standard network, computer systems, and application security capability will be offered. Some data packs will be removable for physical secure storage. Nodes will be removable from the network to operate on secure data. Encryption will be an option.
Access	Network, system, and application accounts and passwords will be provided to control system and data access. Access logs and audit trails will record user interactions.
Configuration	CAD–2 will support drawing release control, document trees, ECP management, and hardware configuration management. Configurations of related information across applications will not be supported. Indexing will be addressed as a part of the database modules but not as a part of the application modules.
•	**DATA DISTRIBUTION**
Magnetic Tape	CAD–2 will include two kinds of magnetic tape; – 8mm digital tape; mass storage; 2 gigabytes capacity; – 9 track tape serve; mass storage; 1600 and 6250 bpi and 125 ips.

	CAD-2 will provide the ability to document modification requirements, to design modifications and to review submissions from contractors.
Local Manufacturing	CAD-2 will support distributed manufacturing management, computer numerical control, machining, process planning and the ability to manufacture parts in a CIM environment.
Engineering Support	The engineering support activity will benefit from the design, analysis, comparison, modeling, debugging, battle damage repair, maintenance, part substitution, analysis, capability provided by CAD-2.

2.3.2 Major Observations

Discussions with the Navy CAD-2 procurement office and a review of procurement documents form the basis for the following observations about CAD-2.

- **INTERFACE WITH EDMICS REPOSITORIES**

Presently, there is no plan for interfacing with the EDMICS repositories of raster data. CAD-2 users will be limited in their ability to benefit from data stored in Navy and to provide data to repositories for wide distribution.

- **CONVERSION OF RASTER TO VECTOR FILES**

The raster to vector conversion capability is limited by current knowledge. The proposal requests such a capability but this is not a currently well developed function.

- **FEEDBACK OF RELIABILITY AND MAINTAINABILITY DATA**

CAD-2 does not address any requirements to integrate R&M data from operational systems into the design workstations. This integration of R & M with design is important to the development of a concurrent engineering process within the Navy.

- **MANAGEMENT OF DATA**

CAD-2 will support the common use of systems and databases but there will be no overall management of data. There is no overall plan for a global data dictionary, index, directory, data security, or system and data configuration management.

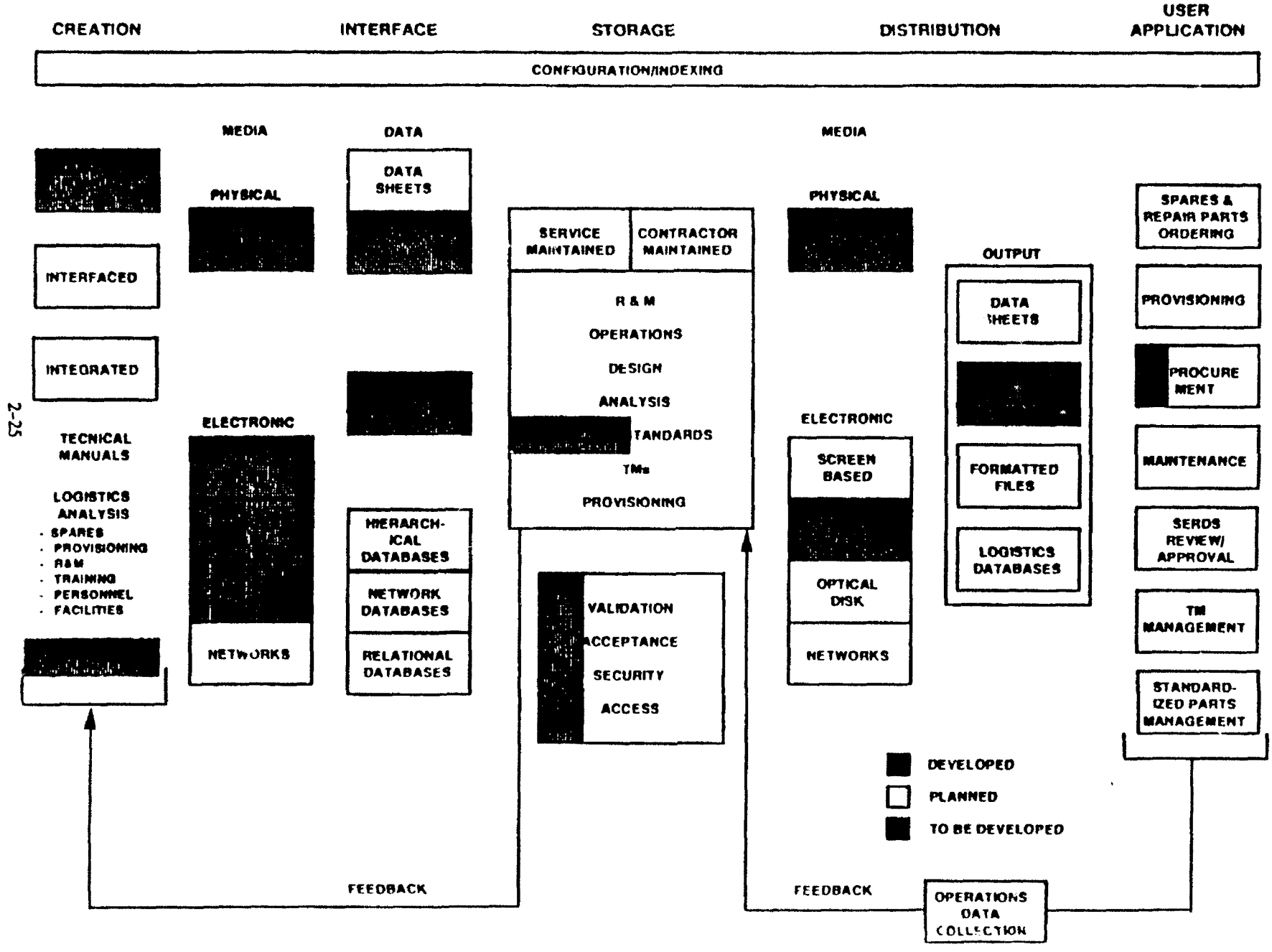
- **FIVE SEPARATE CAD-2 ACQUISITIONS**

The hardware and core support systems specifications are common to all systems. The applications are unique. Within the applications there is a reasonable level of integration. However, there is no planned integration of data for use across applications. Thus, application integration will be largely dependent on the system support for CALS standards.

- **FUNCTIONAL INTEGRATION**

CAD-2 will provide a high level of integration within a suite of applications that support a particular function, but the integration across functions that have a joint responsibility for different aspects of a facility, system or equipment will be minimal.

FIGURE 2-6. NPODS



Access	Only on site users can access the document images, while remote users can send mail or use the telephone ordering system for document retrieval.

- **DATA DISTRIBUTION**

Magnetic Tape	Documents can be distributed by magnetic tape. It is especially used for formatted report distribution of management information to other Navy systems.
Paper Manual	NPODS has a high speed document printing capability for the distribution of paper manuals. It also keeps some documents in inventory for distribution. NPODS combines the name and address ordering information for the completion of the orders when printed.

- **DATA FOR USER APPLICATIONS**

Reprocurement	The reprocurement function is supported by NPODS. The ability of the many small potential contractors to acquire the identified MILSPEC/STDs in RFPs permits them to bid on contracts and increase the number of bids.

2.4.2 Major Observations

- PROTOTYPE REPOSITORY FOR DIGITAL DOCUMENTS

NPODS is the first large scale implementation of an electronic repository for documents within the Services. While it is currently limited to specifications and standards, it can provide the basis for building similar repositories for existing printed materials such as technical manuals.

- DIGITAL DISTRIBUTION OF DATA

The present thrust of NPODS replaces the warehousing function with a print on demand system. However, NPODS needs to evolve to a distribution system based on electronic media such as optical disks or magnetic tapes based on CALS standard formats.

- SIGNIFICANCE FOR CALS

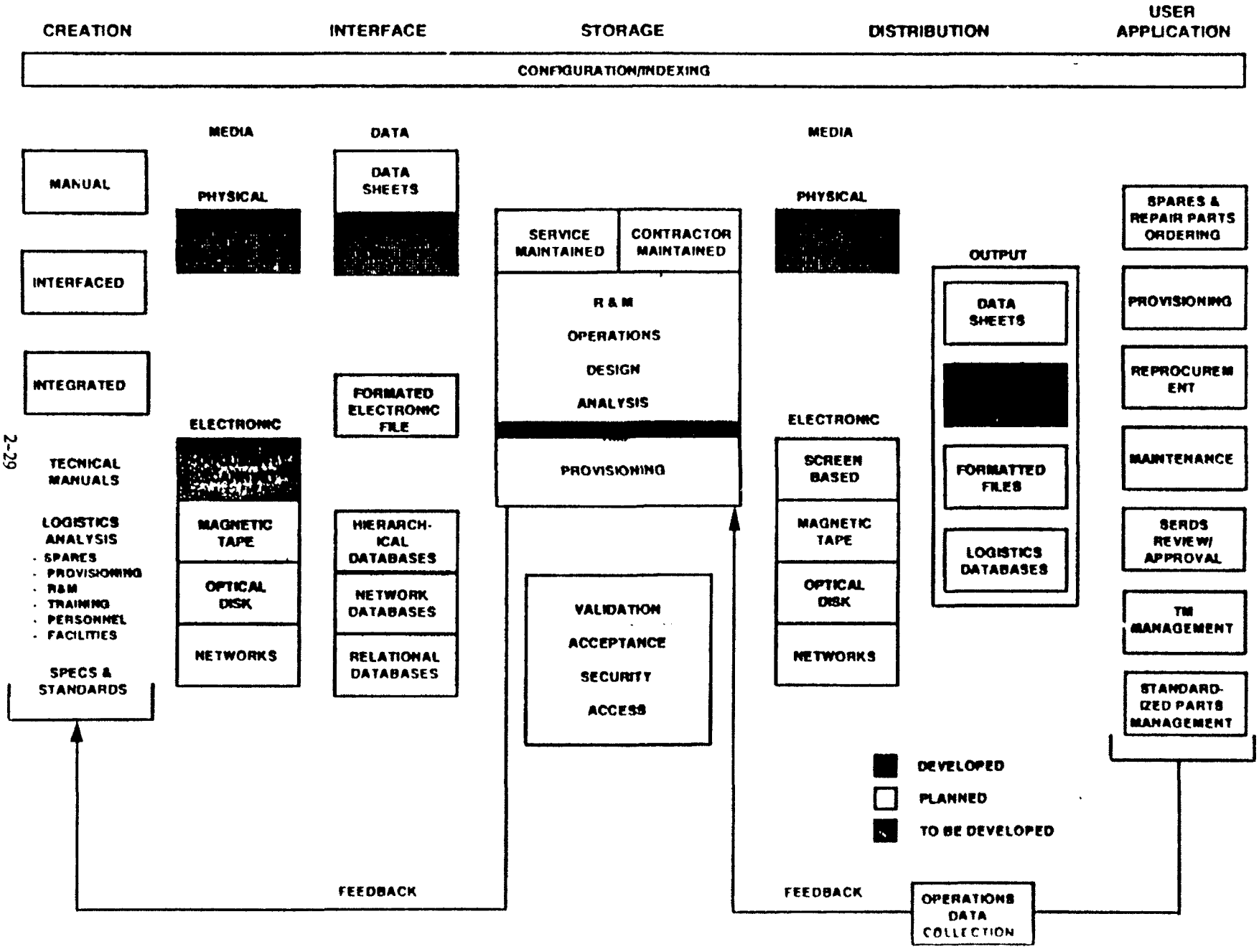
The implementation of NPODS will provide the Navy with a capability for:

- Government maintained electronic repository for specifications and standards;
- Distribution of documents based on digital data printed on demand; and
- Establishing a basis for a digital distribution of documents in MIL-M-28001 format.

2.5 AFTOMS

The AFTOMS program is designed to modernize the production, distribution and maintenance of Air Force Technical Orders by the mid 1990s. AFTOMS will manage all types of Technical Orders from early planning stages of development to their use at depots and bases.

FIGURE 2-7. AFTOMS



Validation	There is, currently, no automated capability available for fully checking the content of Technical Orders for consistency and accuracy. However, AFTOMS will include automated format checking to assist in validating newly accepted Technical Orders. AFTOMS will support Technical Order validation through the distribution and management of review packages.
Acceptance	AFTOMS will automatically accept multiple kinds of information: - digital Technical Orders, updates, requests for changes; - catalogue and index additions and changes; and - work area profiles and changes.
Security	Systems security covering protection from loss of data and protection from unauthorized change of data will be managed by customary systems management – regular backups, access logs, audit trails and user identification with passwords. It will not contain classified Technical Orders.
Access	AFTOMS will provide different access to information through user and data segregation. Access will be based on user profiles maintained by the system. *Users will be granted multiple privileges to read, write or update data.*
Configuration	AFTOMS will support configuration management through an ability to manage Technical Order revisions. In addition an indexing scheme will support managing the Technical Order catalog. It will also allow Technical Order updates based on user profiles. It will not be linked to the EDCARS systems; changes made to the engineering drawings recorded in EDCARS or changes made to AFTOMS will not be automatically exchanged.
•	DATA DISTRIBUTION
Paper	AFTOMS will include an inventory management function for paper based Technical Orders.
Screen Based	AFTOMS will present digital Technical Orders and the management information present in the databases through screens that will be directly supported by AFTOMS.
Optical Disk	AFTOMS principal means of distribution will be the CD–ROM optical disks which will have the current digital Technical Orders with all of the updates. Optical disks will be used for circulating review packages.

- Provide an on-line system which will allow the Air Force user quick and easy access to Technical Order changes;
- Distribute Technical Orders in hard copy or optical disk format;
- Scan paper technical Technical Orders for conversion into digitized format;
- Provide indexes and inventories of Technical Orders on magnetic tape; and
- Improve the timely distribution and accuracy of Technical Orders.

2.6 MEDALS

MEDALS, Military Engineering Data Asset Locator System, is a DOD wide system that will provide a central DoD wide index to engineering drawings, so that the correct DoD repository can be identified and the extent of available information by weapon system or component can be determined. MEDALS will enable one DoD Service to determine whether another Service has the required drawing. It will also enable comparison of parts in different Services to determine if engineering data is identical or could be standardized, and lead to cross Service buys.

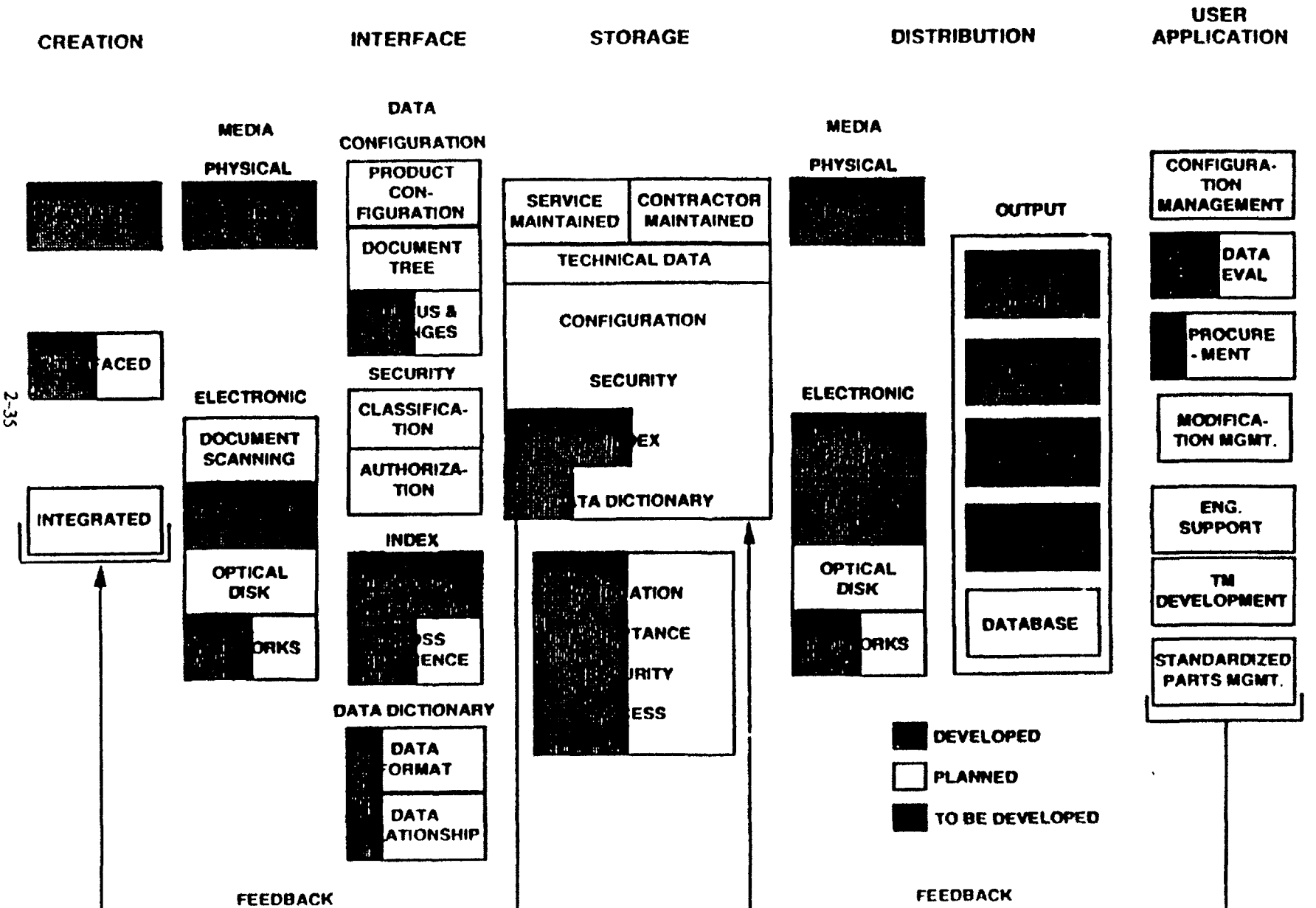
The data is used in reprocurement of spare parts, maintenance, provisioning, engineering support and other functions. Each Service has repositories of this data. Locating data is not always easy. Users of this data often use a process of elimination to find and acquire the desired data. This process can take too long and cost too much because it will leave too little time to assemble and inspect document packages suitable for spare part acquisition. Delays often result in late arrival and higher cost of spare and repair parts. This can sometimes result in unavailable parts.

MEDALS was implemented in 1988 and lets logisticians quickly locate sources of technical data in more than 20 DoD repositories. MEDALS has a large database of over 200 million records. MEDALS contains unclassified locator information for data maintained by Air Force Air Logistics Centers, Defense Logistics Agency Supply Centers, Army Inventory Control Points, the Navy Ships Parts Control Center and Aviation Supply Office, and the Marine Corps Logistics Base.

The database will index about 90 million technical data assets like engineering drawings and technical manuals which are kept at the repositories. It will tell the user what information is available, where it can be obtained and the contact name, address and phone number. Only DoD repositories have on-line computer terminal access to the database via networks such as DDN or DLANET. The repositories, in turn, support DoD and other federal activities as well as private industry.

MEDALS has three indexes; part number, national stock number and document number. These indexes facilitate the data cross referencing function.

FIGURE 2-8. MEDALS



Magnetic Tape	Some batched queries are returned to the requesting depots on magnetic tape.
Network	Screen based queries via networks are accepted from depots.
Interactive Queries	The software supports ad hoc requests for screen based and printed output.
Interactive Reports	Standard report requests for screen based and printed delivery are supported.
Batch Reports	MEDALS prints batch reports or places them on tape. This output is sent to the requesting depots who distribute the output to Service or contractor individuals.
Formatted Files	Output of batch reports and ad hoc queries are placed in formatted files for network or tape distribution.

- **DATA FOR USER APPLICATIONS**

Technical Data Retrieval	MEDALS identifies and locates engineering data. It does not extract those documents. It can submit request lists to the engineering drawing repositories for extraction.
Reprocurement	Location of engineering drawing document lists is very important for the creation of bid set packages for procurement of spares. MEDALS supports the reprocurement function by providing a capability to locate specific drawings. MEDALS does not always identify the full set of documents necessary for the reprocurement nor whether the identified documents are current or of the right version.

2.6.2 Major Observations

The observations which have emerged about the MEDALS program are discussed below.

- **LOCATES ENGINEERING DOCUMENTS IN 28 DOD REPOSITORIES**

The MEDALS program does not provide the capability to locate all engineering documents digitally. MEDALS does not index all engineering documents. Many potential DoD users of engineering documents who require direct digital access do not have it. Not all documents at the connected repositories are indexed in the repository systems. Only twenty eight of the DoD repositories are connected to MEDALS.

- **THREE INDEXES FOR CROSS REFERENCE**

MEDALS has three indexes; part number, national stock number and document number. There is no index that includes configuration or version, and no links to other kinds of cross reference information used by the particular Service and function. The Services and functions which use unique indexes must maintain their own links to one of these three MEDALS indexes.

through implementation. The configuration status accounting is facilitated through a capability to define and maintain Technical Data Package family trees. The tree structure allows an organized reference to associated documents and related data. It shows availability of documents and the impact of deficient documents on other related documents. In addition, a variety of interactive reports related to engineering lists, generation breakdown lists, parts lists and technical data package lists provide timely configuration management control.

Eventual linking of TD/CMS with DSREDS will provide configuration management for engineering drawings; and further plans call for TD/CMS to be used to support other ACALS data repositories

2.7.1 TD/CMS Mapping

TD/CMS is an operational system as shown in FIGURE 2-9.

- DATA CREATION

Manual Creation	TD/CMS supports the creation of configuration trees from the initial drawings or from other configuration documents.
Interfaced Creation	TD/CMS accepts the electronic transfer of some drawing trees.
Integrated Creation	Some limited systems capability exists to create the drawing trees as the drawings are being created.

- DATA INTERFACE

MEDIA

Paper Media	TD/CMS can accept input from drawings, from reports or other configuration reports.
Mag Tape Interface	Configuration baselines, engineering changes, or versions can be transferred on magnetic tape. Data loaded on other TD/CMS systems can be transferred to new depots using magnetic tape.
Optical Disk Interface	Plans exist to accept electronic formatted files from other systems.
Network Interface	There is limited interface to TD/CMS through remote terminals and systems such as DDN.

DATA

Product Configuration	The data collected includes the product baseline, the product versions, and product variants.
Document Tree	Product configurations are supported by drawing trees.
Config. Status/Changes	Engineering change proposals, acceptances and rejections are all kept in TD/CMS. The system also performs the status accounting function.
Data Format	Data formats are specified using the dictionary capabilities of the DBMS.

Data Relationship	Relationships between data entities are recorded in the relational table specification.
•	**DATA STORAGE**
Service Maintained	TD/CMS data is maintained by the appropriate Service.
Configuration	TD/CMS provides configuration data on baseline, version, status accounting and changes.
Data Dictionary	The format and relationship information about the system itself is kept in the system.
Validation	TD/CMS has limited capability for review or validation of information that has been input. There is no automated way of validating the data.
Acceptance	There is no automated assistance in the acceptance tests or criteria evaluation for acceptance of data coming into TD/CMS.
Security	TD/CMS is supported by normal network, user and application security enforced by user accounts and passwords.
Access	Access is regulated by link access and user security limits. Data is segregated into categories for different kinds of access; create, read, update or delete.
•	**DATA DISTRIBUTION**
Magnetic Tape	Batch reports, queries or other formatted files can be distributed on magnetic tape.
Network	Formatted electronic files, batch reports, and interactive dialogues can be distributed via networks.
Interactive Queries	Ad hoc queries can be performed at terminals to locate the desired records and display the required data elements.
Interactive Reports	Standard reports can be selected at terminals for interactive display.
Batch Reports	Requests can be issued for large batch reports that will be processed for distribution via networks, screens, magnetic tape, or printed output.
Formatted Files	Electronic files are used for information distribution on magnetic tape, via network, or printing.
•	**DATA USER APPLICATION**
Config. Management	TD/CMS supports the configuration management function. TD/CMS does keep change and status accounting information to assist in bringing these different views together.

SECTION 3: DoD Programs Assessment

The previous section reviewed each of the CALS infrastructure programs separately and mapped each one to the appropriate framework. This section aggregates that information for each technical data type, namely, product data, logistics data and data management. For each of the three types of technical data the functional capabilities of programs are analyzed; opportunities for technology transfer between programs and across Services are identified; and substantive issues that are not addressed by the current programs are discussed. These opportunities and gaps suggest the need for enhancements to current programs or the introduction of new programs.

3.1 Product Definition Program Assessment

The four programs analyzed are DSREDS, EDCARS, EDMICS and CAD-2. In addition, the functionality of the ACALS program is considered. FIGURE 3-1 summarizes the functional capabilities of the programs. The delivery of data in the DSREDS and EDCARS programs needs to be enhanced to support the acquisition function. Each program strongly supports the current and planned development of repositories, although moving data in and out of repositories is still a limited capability. Data management capability, which includes configuration management and indexing, needs development across the Services. In addition, the ability to access and accept data from related contractor repositories needs to be developed.

	Acquisition			Management			Use			
	Creation	Delivery	Access	Accep-tance	Reposi-tories	Distri-bution	Training	Mainte-nance	Organic Manuf.	Procure-ment
DSREDS		◐	▨	▨	●	◐	▨	▨	▨	○
EDCARS		◐	▨	▨	●	◐	▨	▨	▨	○
EDMICS		●	▨	○	●	◐	▨	○	▨	○
CAD-2	●		○		○	▨	▨		○	
ACALS		○				○				○

○ **Limited Capability** ▨ **Needs to be Developed**
● **Extensive Capability** ◐ **Needs to be Extended**

FIGURE 3-1. ASSESSMENT OF CAPABILITIES OF PRODUCT DEFINITION PROGRAMS

- AUTOMATED VALIDATION

One of the major bottlenecks in loading data into repositories is that each drawing must be manually reviewed before transferring to optical disk. The Navy's (EDMICS) program is developing an automated quality assurance capability that could detect most unacceptable scanned images. The Army and Air Force systems could benefit from this development. This could increase throughput of data entry by rescanning poorly scanned drawings and leaving only a small number that require manual corrections.

3.1.3 Product Definition Infrastructure Gaps

- MANAGEMENT OF VECTOR DATA

The entire product definition data infrastructure is oriented towards the management of raster images. The main application of raster technology is to convert existing drawings and in some cases into a digitized format. All new automated generation of technical data is based on vector technology. Thus, to support the acceptance, storage and distribution of digital data related to new acquisition will require the development within the Services of an infrastructure capacity to deal with vector technology.

- MANAGEMENT OF NON-GEOMETRIC DATA

The raster and vector images relate only to item geometry. Associated with an item designed using Computer-Aided Design systems is a host of data related to engineering analysis and manufacturing activities. This data forms the baseline upon which future changes and modifications are based. There is no present or planned infrastructure capability to accept and manage such data as it relates to particular weapon systems.

- CONTRACTOR INTERFACE

The overall product definition infrastructure concept includes extensions to interface with contractor managed repositories containing government owned data. This is intended to provide flexibility for the acquisition and management of technical data in a way that locates repositories based on frequency of use, source of data updates and the efficiency of data availability. The present infrastructure efforts do not establish the necessary links to include contractor based repositories or the infrastructure to provide DoD users access to data at contractor sites.

- USER INTERFACE

Existing programs automate the storage of data in electronic formats but still rely heavily on distributing data as hardcopy products. The distribution of raster images is an improvement over paper distribution but serves only a limited set of users. Most users still do not have access to repositories from other functional areas. It would be advantageous to directly link end-users to storage repositories. It should also be possible to transfer large subsets of data from repositories to departmental systems to effectively compliment paper distribution.

- CONFIGURATION MANAGEMENT/INDEXING

The existing product definition data infrastructure does not have a stand alone capability to manage the configuration of data in its repositories. The Navy EDMICS system plans to im-

agement and retrieval. Some efforts are underway to define logistics database models. The infrastructure capability needs to be extended to implement these models, accept logistics data in database formats and be able to distribute database subsets to end-users.

- TRANSFER OF LOGISTICS DATA

The existing infrastructure is still based on accepting and producing paper based logistics data products. These paper products generally relate to existing logistics data which is being converted into digital form for storage. For example, NPODS is geared towards scanning large volumes of specifications and standards, storing them in raster format and reproducing them on paper when required. It does not support the acceptance of previously scanned documents or other digital document files which can be edited and transferred to end-users. However, AFTOMS development will advance the Air Force capability to accept and transmit technical manual data in electronic format.

3.2.2 Integrated Logistics Technology Transfer Opportunities

- OPTICAL DISK TRANSFERS

AFTOMS development will provide the first infrastructure capability to accept and distribute technical manuals on optical disk media. This capability could be transferred to other Services through enhancements to programs such as NPODS and TMPODS.

- DOCUMENT SCANNING

NPODS has developed a raster document scanning capability for input of large volumes of text data. The AFTOMS development needs to include document scanning to input existing technical manuals into the system. The NPODS implementation could provide a basis for implementing a document scanning capability in other infrastructure development efforts.

3.2.3 Integrated Logistics Infrastructure Gaps

- CREATION OF LOGISTICS PRODUCTS

None of the infrastructure programs support the development of logistics data and products. In the past these products have primarily been created in the industry and transferred to the Services. As a result there may be no perceived need to develop such capabilities. However, in the future context of digital information management the effective use of digital data will also require its continuous update, management and regeneration. Thus, the logistics infrastructure development needs to address this area of logistics data creation and generation.

- LOGISTICS DATABASE DEVELOPMENT

Logistics data management and use can only be effective if the various process of logistics data share an integrated structure. This necessitates the application of database technologies to support the storage and retrieval of the data. Therefore, the infrastructure development efforts need to define logistics database models, develop dictionaries for implementation of models and the ability to transfer data into and out of repositories as a subset of a database..

weapon system information. FIGURE 3–4 presents this perspective and lists the functional requirements that need to be addressed together with a parallel list of technical requirements that can translate these requirements into an infrastructure capability.

DATA MANAGEMENT	
FUNCTIONAL REQUIREMENTS	TECHNICAL REQUIREMENTS
MACRO LEVEL – DoD & Services	
Extend utility of existing and new data	Provide uniform access to all technical data
Provide for efficient exchange of information between Service and Industry, and amongst government organization	Insure data currency through a global configuration management system
MICRO LEVEL – Data management functions	
Integrate weapon system information	Maintain consistency of data through data dictionary functions
Enable effective management of technical data	Control access based on security requirements

FIGURE 3–4. DATA MANAGEMENT REQUIREMENTS

FIGURE 3–5 shows the evolutionary capability that needs to be developed to support an integrated data environment. The focus of current data management programs is only to enable data exchange. The target needs to be an infrastructure that supports data integration through shared databases linked such that they provide the user with a transparent access to all related data. This will require the development of new data management concepts such as global and distributed data dictionaries. In certain cases an interim step to facilitate the management of related data sources could be achieved through the development of cross references designed to link existing databases.

3.3.1 Infrastructure Scope

- **ACQUISITION OF MANAGEMENT DATA**

The acquisition of management data is largely in the form of paper products that detail configuration data. This data then is manually re–entered into the appropriate systems. However, MEDALS which is the primary locator system is capable of accepting index information on magnetic tapes from other repository systems. Thus the utilization of the data management infrastructure is dependent on the form and format of reference data acquired along with weapon system technical data.

- **INCORPORATION OF MANAGEMENT DATA INTO REPOSITORIES**

Each implementation of storage of technical data includes some way to reference and manage that data. However, each implementation describes the data being stored in a unique way that does not contribute to creating an overall infrastructure. The way data items are de-

view includes describing the data requirements for each class of data (such as product data and logistics data), the structure of that data, and the relationship of data entities to each other. This common view must include a standard set of data item representations. For product data this initial effort is being undertaken by various organizations under the PDES umbrella. A similar effort is required to define logistics data requirements.

- DATA DICTIONARY DEVELOPMENT SYSTEMS

A data dictionary is the implementation of the data models. A capability to define data dictionaries in a standard manner would allow the development of data repositories and functional area databases in a way that will allow consistent data exchange. Thus, the capability of the data management infrastructure can be greatly enhanced through the development of standard data dictionary definition systems.

- DATA CROSS-REFERENCES

The ability to exchange data resident in existing systems is restricted due to the lack of any cross reference structure to facilitate that exchange. The utility of existing data assets could be greatly enhanced through the development of appropriate cross references which will allow the implementations that can bridge existing data repositories.

SECTION 4: Recommendations

Recommendations related to the DoD technical data infrastructure modernization are designed to help guide discussions related to the longer term CALS Master Plan. If implemented, these should move the Services towards a more integrated data environment as envisioned by the CALS objectives. Major recommendations are as follows:

1 Develop Vector Repositories

Data for new weapon system and major modifications is being developed using computer-aided design systems. These systems use vector data to construct product geometry and features. The Services need to be able to store and distribute this data in vector format to support future engineering, maintenance, and manufacturing functions.

2 Extend Distribution of Raster Data

Extraction of data from raster-based repositories is limited to a process of converting the digital data back to paper or aperture cards for distribution. Electronic access via raster workstations is limited to users directly connected to the repository hardware. To fully utilize the repository data the distribution infrastructure should be extended to allow base-wide and geographically remote users to pull information from major storage locations to their own workstations.

3 Develop CAD and CAM Capability

Development of organic engineering and manufacturing capability within the Services will depend on the ability to utilize the data acquired and stored in vector repositories. This requires the acquisition and integration of hardware and software platforms that can support CAD and CAM functional requirements. CAD-2 program defines this capability for specific Navy commands. Other DoD components need to develop similar capabilities and integrate them into the overall infrastructure.

4 Build Repositories for Logistics Data and Technical Manuals

Utilization of logistics analysis data over the weapon system life cycle is hampered by the lack of well-defined sources of such data within the Services. The current use of logistics data is restricted to the acquisition phase where the logistics data is managed and used within the contractor environment. The DoD infrastructure needs to provide similar capabilities to the weapon system support functions through a network of global and local repositories of logistics data. The Air Force AFTOMS program plans include the development of these repositories for Technical Manuals. Similar efforts are required in other Services for Technical Manuals and for logistics data in all Services.

development data, in addition to logistics data and systems operations data. Such a capability requires linking infrastructure capabilities for product definition data, logistics data, and operational logistics systems.

11 Operational Feedback

The CALS infrastructure can only be complete if the flow of data is not simply from developers to users but also from users to developers. The operational problems within the Services collect a list of data on reliability of weapon systems. However, there is no effective way to integrate this information into developers' systems to enhance future acquisitions.

APPENDIX A: INFRASTRUCTURE MODEL DESCRIPTION

INFRASTRUCTURE MODEL DESCRIPTION

The infrastructure framework model represents the weapon system technical data cycle across all Services and provides a common frame of reference to assess and analyze the scope of the selected infrastructure development programs. The model depicts the possible range of functional requirements and each functional area depicts a range of options that represent increasing levels of functional capability and technology.

The program examined as part of the infrastructure analysis fall into three broad categories: Product Definition Data, Integrated Logistics Support Data and Data Management. Therefore, three variations of the framework were developed to represent the complete data life cycle of each program area. The conceptual model is based on the premise that the technical data are generated, transferred to repositories for storage and then distributed for use to support weapon system life cycle functions and activities. Five major functional areas are depicted: data creation; data interface; data storage; data distribution; and user application. The frameworks differ in the data they focus on and in the scope of the functions necessary to create, manage, and use the data.

This appendix describes the framework concept and defines the infrastructure in detail; this includes all the potential infrastructure capabilities within each functional representation. This structure forms the basis against which each program is measured to understand its scope and to what extent its functional capability meets overall infrastructure requirements.

The elements of each framework are similar except for distinctions in data and functions. These elements are individually described in the context of the product definition framework. The integrated logistics and data management framework descriptions are discussed only at a high level, because the individual elements are similar in all three infrastructures.

A.1 Product Definition Data Framework

Product definition data includes all technical data related to product design, engineering, and manufacturing. Figure A-1 depicts the framework developed for functionally representing the product definition technical information life cycle. The major phases of the life cycle are product definition creation, interface, storage, distribution and delivery to support end-user system applications and functions.

A.1.1 Data Creation

By creation we refer to the sources and the ways in which product definition data can be generated. Each subdivision represents a distinct approach, level of technology and form of technical data used to define the characteristics of a product. The purpose of product definition data in each case is to completely describe the geometry, features, and associated manufacturing processes of a product such that it can be transferred from the original designer to other functional areas without loss of information. Traditionally, this has been accomplished

through paper drawings depicting various views of the object to allow a trained user to visualize the object in their mind. New computer-based technologies facilitate this visualization by allowing an explicit graphic display of the object on a screen thus requiring little interpretation and thereby reducing erroneous information transfer. In addition, the graphic image of the object is associated with other related data such as engineering analysis, tolerance specification and material properties that provide a complete understanding of the product from a design, engineering and manufacturing perspectives.

The product definition data creation options are briefly described below:

- **Manual Drafting** – is the conventional production of drawings on paper and drawings that have been converted to microfilm and are generally delivered as aperture cards. Aperture cards consist of the microfilm mounted on an 80–column data card. Most of the current technical data exists in this format. Therefore, the infrastructure must be capable of accepting this type of data as input and converting it to digital format for storage and dissemination.

- **Automated Drafting** – incorporates the use of electronic systems for the generation of 2–dimensional and 3–dimensional drawings. It includes graphic representation of mechanical objects using 3–dimensional wire frame images: the 3–dimensional image is used to extract specific views of the object. The visualization of product designs can be given additional realism through the use of shading and image rotation techniques.

- **Automated Design** – includes, in addition to automated drafting, support for doing engineering analysis and incorporating design rules. The 3–D design and drafting capability is extended by the use of surface modeling which provides mass property and section analysis of parts. The traditional 2–D drawings can be derived based on the preferred view of the model. Further, the models provide a basis for deriving tool paths for machining operations. Dynamic graphic display of the tool path allows visual verification of the machining process. Other functions included in this design process are specification of non–geometric attribute data, generation of bills of material, and tolerance specification for part production.

- **Integrated Design** – provides a single source of product data to all engineering and manufacturing functions. In mechanical design this capability is centered around 3–D solids model. Solids design allows the simultaneous verification of certain design aspects such as interferences and fit of solid parts and concurrent development of process specifications. The solids model also becomes the basis for additional engineering analysis of mass properties, finite element modeling, process planning and N/C machining. In addition, the solids model can be displayed in a variety of ways from

This enables the repository to become the focus of data management. The network interface includes the ability to transfer data over Wide Area Networks (WANs) in conjunction with Local Area Networks (LANs) linked to storage repositories.

Interface Data Format

The format of product definition data depends on the systems used in creating the product design. For example, a manual design process based on paper, results in what is traditionally known as engineering drawings. Scanning of paper and aperture cards produces raster graphic files. The direct transfer of CAD data takes the form of vector graphics and related analysis files. The PDES graphics and data files result from a process of integrated design which stores all the data that is created in a standard database structure. Ultimately, a repository needs to have the ability to accept data in all of these possible forms.

A.1.3 Data Storage Repositories

Storage refers to all aspects of data storage and data management. Storage includes the physical repository for electronic and hardcopy data products, as well as the automated ability to validate, accept, store and provide for controlled access to the data.

The functional capability of a storage repository is analogous to a library which can be managed by either Service or Industry. Regardless of who manages it, the repository can be implemented either as a centralized function or as a geographically distributed function and coordinated to appear as a single source. The role of repositories in the infrastructure is to facilitate the management and distribution of data to the user in a consistent manner.

The key functions included in the repository function are:

- Validation – refers to the automated support for verifying the quality and content of technical data products. It includes the capability to do automated quality assurance to detect graphics images that may be too light, too dark or out-of-focus. For numeric data it includes automated checking to insure accuracy of the number.
- Acceptance – insures the conformance of technical data to specified standards. Test data files can be selectively tested against previously established test criteria to ensure the compatibility of data accepted into repositories.
- Security – requirements relate to the protection of the expanded Trusted Computing Base which includes data, the computing environment comprised of the operating systems and related utilities, and the communication backbone providing user access to the data. In addition, a fully functional security capability must include an ability to simultaneously store and distribute data at varying levels of security and apply security constraints to data aggregations.

as landing gear and engines for airplanes. The functional requirements include access to previously developed programs for producing parts on NC machines, ability to add manufacturing related data, such as tolerances to existing part geometry, and access technical specifications related to manufacturing processes.

- **Engineering Support** – This includes the on-going analysis of Engineering Change Proposals (ECPs) resulting from field operations. The support function involves the review of existing PDD and making engineering changes to designs and specifications as necessary.
- **TM Development** – This involves the coordinated update of the various technical manuals used in product support functions resulting from engineering and design changes implemented in weapon systems. This requires the availability of current drawings and illustrations and the ability to directly incorporate these in the technical manuals as necessary. This is necessary to insure the consistency of actual drawings and the technical manuals in which they are referenced.

A.1.6 Data Configuration/Indexing

An indexing scheme provides the basis for identifying, referencing and locating data. A comprehensive indexing capability must also include an ability to cross-reference a number of index schemes which exist throughout the present infrastructure.

A.1.7 Data Feedback

Data feedback provides a mechanism to keep the repositories current and to allow a cross-functional access to product data. This means that any changes in data resulting from modification of design are reflected in the repository. In addition, the functional organizations where technical data is created, such as the engineering design and manufacturing have a single source of history of data updates resulting from field operations. Thus, the feedback process is comprised of two steps: feedback from the users to the repositories, and feedback from repositories to data creation functions.

A.2 Integrated Logistics Support Data Framework

The integrated logistics support infrastructure encompasses the functions and data required to support the weapon system throughout its operational life.

The integrated logistics support infrastructure requirements and functional capabilities include the creation, management and use of the various logistics support data. Figure A-2 shows the overall infrastructure functions for integrated logistics support. The following sections briefly describe the Integrated Logistics framework concepts which are in most part similar to the concepts of the product definition data framework.

A.2.1 Data Creation

The generation of logistics data is the result of the interaction of a number of support activities such as provisioning, maintenance, support facilities and personnel requirements with the preliminary design process. The support requirements are analyzed by imposing some basic reliability assumptions on the design to determine the expected frequency of repair and required level of spare parts. This exchange of information between the various support activities can be done manually, through automated systems that support particular analysis and transfer information on electronic media (such as tapes) with human intervention (Interfaced), or in a shared data environment requiring no manual intervention (Integrated).

- **Interfaced Logistics** – is based on automation of independent logistic functions. These include logistics support analysis, technical manual authoring and other functions associated with logistics support systems design, acquisition, and deployment for optimal base and depot logistics support. The exchange of information with other related functions is characterized by batch electronic media such as tapes or disks. As a result this exchange can only be accomplished through manual intervention. Thus, while a particular function by itself is automated, the interface to data generated through other analysis may not be automated. For example, if the spares requirement analysis is based on the reliability prediction analysis, the reliability data is not automatically available to the spares analysis function. The reliability data, however, can be extracted in a pre-specified format and made available to the spares analysis function.
- **Integrated Logistics** – is based on the idea of a completely shared data environment. In addition to the automation of a particular function, the interface between functions is also automated. The transfer of information between functions happens without any manual intervention to generate specific output files.

While this distinction between interfaced and integrated capabilities appears to be small, it has enormous implications for differences in functional capability, technology requirements, and implementation effort.

The integrated logistics support technical data that is created with the systems design and transferred into repositories can be considered in three broad categories, Technical Manuals, Logistics Analysis and specifications.

- **Technical Manuals** – These contain the information required to support the maintenance, repair, operation and overhaul of weapon systems.
- **Logistics analysis data** – This data includes a wide range of analysis done in conjunction with system design to assess system reliability

A.2.4 Data Distribution

The ILS infrastructure for data distribution is defined in terms of the media used for data distribution and in terms of the output products being distributed. The media used to distribute ILS data are similar to those described for PDD in Sections A.1.2.1 and A.1.4, however, the data products distributed to users are different.

Logistics data is primarily disseminated in three forms. Paper product will continue to be distributed to users who have not developed a capability to accept and use digital outputs. This includes providing paper based Logistics Support Analysis Reports (LSAR) and Technical Manuals. The master file output makes it possible to extract specified data items from the repositories and format them according to the end-user requirements. Thus the distribution of master files requires the ability to translate repositories file structures and databases into formats that can be directly incorporated into end-user applications. In the case of Technical Manuals this function also includes the capability to distribute digital files of page-oriented electronic manuals. The logistics database output provides the ability to transfer a subset of the repository database directly into a database that supports specific sets of user applications

A.2.5 Data for User Applications

The user applications identified as part of the infrastructure represent major uses of logistic support data in supporting weapon system operations. While there may be other specific applications throughout the Service support functions, the applications identified span the broadest specifications of support activities and organizations.

A.2.6 Data Feed back

Some support activities generate new information which may be useful in the next design cycle or for altering certain aspects of the weapon support strategy. Tracking scheduled and unscheduled rates of failure provides data to assess actual failure rates relative to design predictions. Thus, the infrastructure needs to provide a capability for the feedback of the new data.

A.2.7 Data Configuration/Indexing

Configuration management and indexing for logistics data are similar to those described for PDD. However, a configurable item is generally a system, subsystem or a part. Any changes in configuration of these items must be correctly reflected in the related logistics data.

Indexing refers to the ability to uniquely identify, store, access and locate various logistics definition data items. Since all logistics data relates to products, indexing schemes for logistics data need to be related to product definition data indexing schemes. In addition, the logistics data is pertinent to specific support functions.

A.3 Data Management Infrastructure Framework

The Data Management infrastructure framework includes the functions and data required to preserve and maintain the integrity, currency, and accessibility of weapon system technical

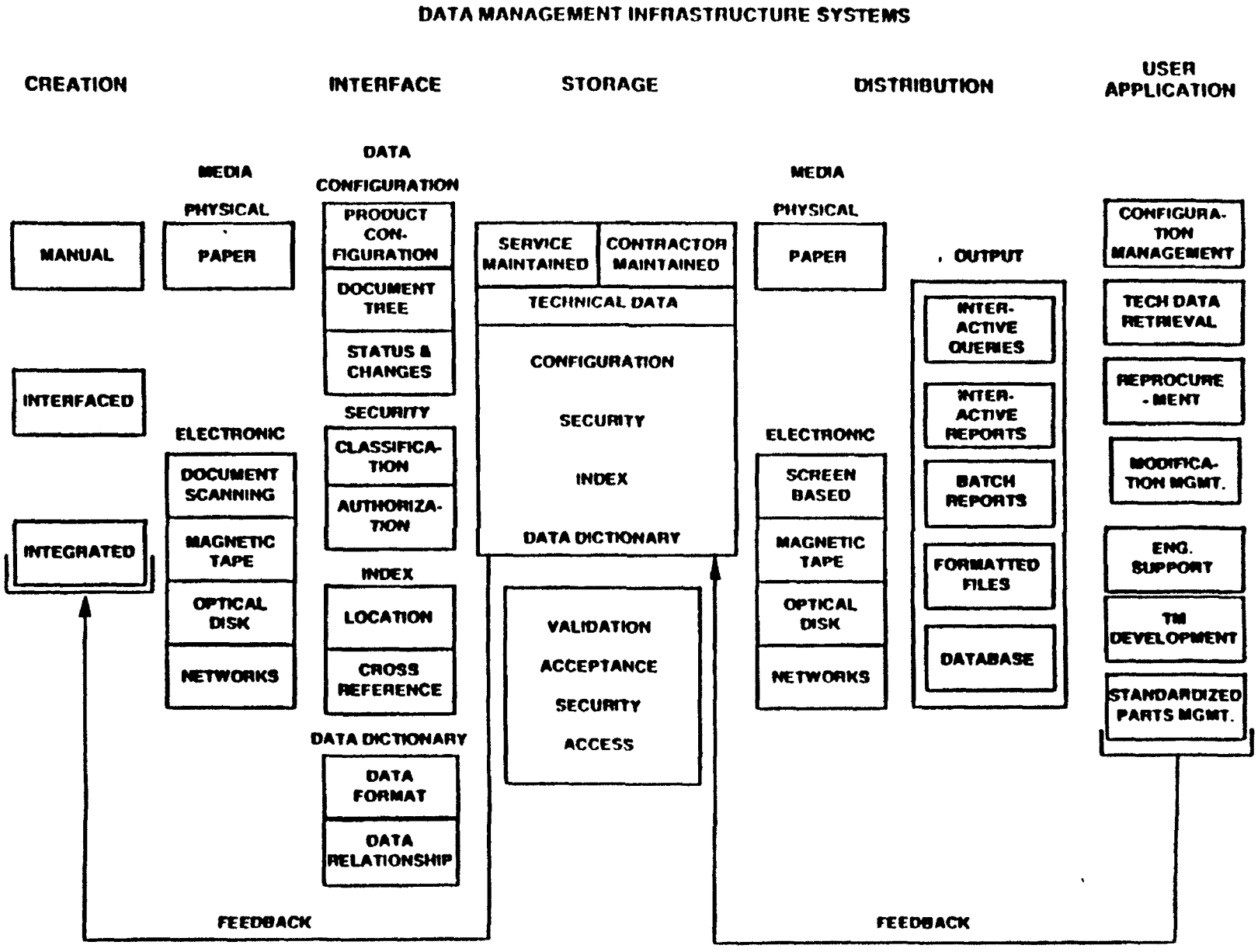


Figure A-3 DM Framework

A.3.4 Data Distribution

The distribution function is similar in terms of media to that described for the product definition and integrated logistic support data in Sections A.1 and A.2. The output products consist of batch reports and interactive queries and reports relating to the current status of the management data. The formatted files and database output products support the transfer of data dictionary and other management data along with the technical data to local user storage.

A.3.5 Data for User Applications

User applications that need to be supported by the data management infrastructure relate to the management of data structures. Configuration management includes conducting configuration status accounting and configuration audits of products.

The technical data retrieval supports user identification of data, its location and automated retrieval. Other applications related to reprocurement, modifications, engineering and technical manual development all need to locate data, extract the description and allow the update of management data based on product changes.

These applications provide an automated link for management activities related to management data. This assures the integrity of the entire product definition and logistics data infrastructure.