Technical Report CADD-98-XX
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Tri-Service CADD/GIS Technology Center

Tri-Service Guidelines for Electronic Document Management Systems (EDMS) for Facility Management

Prepared for Tri-Service CADD/GIS Technology Center
U.S. Army Corps of Engineers, Waterways Experiment Station
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Preface

This report provides an overview of Electronic Document Management Systems for engineering and facility management documents and conveys lessons learned by organizations using EDMS for these documents. Guidelines for evaluating EDMS implementation, EDMS requirements, and commercially available hardware and software also are presented.

This report is a product of the Tri-Service CADD/GIS Technology Center 1997 Project Number 62, Engineering Document Management System. The project was funded and conducted by the Tri-Service CADD/GIS Technology Center, Information Technology Laboratory (ITL), U.S. Army Engineer Waterways Experiment Station (WES). The Tri-Service CADD/GIS Technology Center was chartered in 1992 to promote the use of CADD and GIS technologies for life-cycle facilities management within the Army, U.S. Army Corps of Engineers, Navy, and Air Force. The Center operates under the guidance of Dr. N. Radhakrishnan, Director, ITL, and Mr. Harold Smith, Chief, Tri-Service CADD/GIS Technology Center. The Center functions under the guidance of several oversight committees including the Executive Working Group (EWG), Field Technology Advisory Group (FTAG) and Facility Management Working Group (FMWG). Members of these groups are listed below.

Executive Working Group Membership		
Name	**Membership**	**Affiliation**
M. K. Miles	Chair	Corps of Engineers
Mikeual Perritt	Member	Air Force
Peter J. Sabo	Member	Army
Fredrik (Rik) Wiant	Member	Army
Ron Hatwell	Member	Corps of Engineers
N. Radhakrishnan	Member	Corps of Engineers
Thomas M. Karst	Member	Defense Logistics Agency
Jim Carberry	Member	Navy
Nancy Blyler	Alternate	Corps of Engineers
Thomas R. Rutherford	Member	OSD
Jim Whittaker	Member	OSD
Paul Herold	Member	Coast Guard
Bobby Bean	Member	Navy
Dana (Deke) Smith	Member	Navy

All EDMS projects are performed under the direction of the Facility Management Field Working Group (Facility Management FWG). This FWG represents resources from two previous FWGs: Maintenance and Repair, and Space Utilization. The two charts that follow list names of members of the Field Technology Advisory Group and Facility Management FWG.

Field Technology Advisory Group (FTAG) Membership		
Name	**Membership**	**Affiliation**
Bobby Bean	Chair	Navy
Randy Lierly	Member	Air Force
Victoria Williams	Member	Air Force
Jim Butler	Member	Army
Deborah Duncan	Member	Army
Phil O'Dell	Member	Corps of Engineers
Eugene Tickner	Member	Corps of Engineers
Thomas M. Karst	Member	Defense Logistics Agency
Carolyn Wilber	Member	Navy
Robert Wood	Member	Navy

Facility Management Field Working Group		
Name	**Membership**	**Affiliation**
Laurel Gorman	Facilitator	Tri-Service Center
Nancy Towne	Facilitator	Tri-Service Center
Betty Marchbanks	Member	Air Force
Marta Reiner	Vice Chair	Air Force
David Carr	Member	Army
Bob Riley	Member	Army
Ray Consoli	Chair	Corps of Engineers
Jeff Bryant	Member	Navy
Bill Hudson	Member	Navy
Vivian Sanchez	Member	Navy

To establish procedures and priorities for EDMS issues yet to be addressed under the overall EDMS initiative, a Task Group was formed. The Task Group is led by Ms. Vivian Sanchez, NAVFACENGCOM, Southwestern Division, who is a member of the Facilities Management FWG. Other members include Ms. Marta Reiner, USAF, member of FM FWG; Mr. Roger Porzig, COE, FY98/99 Chair of Systems Group, and Mr. Gary Boyd, NAVFACENGCOM, Southern Division, member of the Design FWG. Proponents who provided guidance and detailed

reviews of the draft documents were Ms. Jean McGinn, from HQ USACE and Mr. Bobby Bean, Director of Public Works, from Patuxent River Naval Air Station.

Michael Baker Jr., Inc. served as the prime consultant for this Task Order. TSA/ADVET served as a subconsultant to Michael Baker Jr., Inc. on this project. Key Michael Baker Jr., Inc. personnel involved in production of this report were Mr. Robert J. Hanson, Project Manager; Mr. James R. Daley, Principal Investigator, and Mr. John A. Owens, Systems Analyst. The primary TSA/ADVET contributor was Mr. Andrew J. Synnott. The Center Principal Investigator and co-author was Ms. Laurel T. Gorman, P.G.

Members of the Executive Working Group, Facility Management Field Working Group, Field Technology Advisory Group and Task Group contributed to this effort. Many other individuals, representing numerous organizations, also made substantial contributions to the project. The Tri-Service CADD/GIS Technology Center appreciates and acknowledges those persons and organizations listed on the following table that contributed to the report effort. Many contributed first-hand knowledge and experiences which do not yet exist in the public domain. Others offered critiques of the interim deliverables. All added value to the report.

Person	Organization	Primary Contribution(s)
Mr. Bobby Bean	Naval Air Station Patuxent River Public Works Department	Met to discuss the PAX EDM, got supplier (NTA) to participate, supplied presentation materials, edited PAX information in report, and reviewed some interim deliverables
Mr. Larry Condry	Baltimore Gas & Electric Gas Maps & Records Unit	Completed a user survey and furnished additional information via personal communication
Mr. Ray Consoli	U.S. Army Corps of Engineers Center for Public Works	Reviewed and commented on interim deliverables.
Mr. Dan Jave	Iowa Ntl Guard, Johnston IA Facilities & Construction Office	Completed a user survey
Mr. Edwin W. Kincaid	Tinker Air Force Base, OK Air Logistics Command	Personal communication and presentation materials on Tinker's PDM
Mr. Wayne Kuenzli	Naval Supply Systems Command, Mechanicsburg, PA	Personal communication with JEDMICS PMO regarding current status of the system
Mr. Reed MacMillan	Aberdeen Proving Ground, MD Conservation and Restoration Div.	Completed survey and follow-up site visit regarding Aberdeen's ERPMS
Ms. Connie H. Malarkey	DOE Oak Ridge Centers for Manufacturing Technology	Personal communication regarding DOE's EDMS
Ms. Louise McMonegal	HQ, Naval Facilities Engineering Command	Supplied information on NAVFAC ongoing EDMS guidelines effort
Mr. James Michonski	Norfolk NSY, Portsmouth, VA Public Works Center	Completed a user survey
Mr. Roger W. Porzig	U.S. Army Corps of Engineers Jacksonville District	Completed user survey and participated in on-site follow-up meeting. Also furnished EDMS presentation slides
Mr. Ralph Scheid	U.S. Army Corps of Engineers New Orleans District	Reviewed 90% deliverable and furnished comments
Ms. Debbie Tankersley	The Analytical Sciences Corp. (TASC, Inc.)	Personal communication regarding EDMS use for procurements at Warner Robins AFB

Conversion Factors Table

Conversion Factors

Eight Bits	=	1 Byte
1024 Bytes	=	1 Kilobyte
1024 Kilobytes	=	1 Megabyte
1024 Megabytes	=	1 Gigabyte
1024 Gigabytes	=	1 Terabyte
1024 Terabytes	=	1 Petabyte
1024 Petabytes	=	1 Exabyte

Decimal/Binary Comparison

Prefix	Decimal	Binary
kilo-	1000^1	1024^1 = 2^10 = 1,024
mega-	1000^2	1024^2 = 2^20 = 1,048,576
giga-	1000^3	1024^3 = 2^30 = 1,073,741,824
tera-	1000^4	1024^4 = 2^40 = 1,099,511,627,776
peta-	1000^5	1024^5 = 2^50 = 1,125,899,906,842,624
exa-	1000^6	1024^6 = 2^60 = 1,152,921,504,606,846,976

Definition of Terms

Note: Many of these definitions were derived from the "Pocket Glossary of Computer Terms and Definitions" (Black Box Corporation, 1997) and "PC Webopedia Encyclopedia" (PC Webopedia, Undated).

Bandwidth	The transmission capacity of a communications line
Bit	The smallest element of computer storage
BMP	Windows and OS/2 raster graphics
Byte	A unit of computer storage composed of eight bits
CAD	Computer-Aided Design
CADD	Computer-Aided Drafting and Design
CAE	Computer-Aided Engineering
CGI	Computer Graphics Interface graphics language for screens, printers, and plotters
CCITT	Comité Consultatif International Téléphonique et Télégraphique, an organization that sets international communications standards (now known as ITU)
Client	A workstation or PC in a client/server environment
COLD	COLD originally stood for Computer Output to Laser Disk. Today, it more appropriately stands for Computer On-Line Data. Either way, it is a technology that provides for the storage and retrieval of computer generated reports and documents. COLD documents are generated from a user's own computer system and captured as data.
DGN	Intergraph or Bentley CADD file format
Digitize	The process of converting an image or signal into digital code
Dot Pitch	The distance between dots on a color monitor
DPI	Dots Per Inch - the measurement of printer resolution
DWG	AutoCAD CADD file format
EDMS	Electronic Document Management System
EDMSs	Electronic Document Management Systems
Ethernet	A local area network (LAN) developed by Xerox
Firewall	A network node limiting segment traffic. Also implemented for security purposes.
FTP	File Transfer Protocol - in a TCP/IP network a set of commands used to log onto a network, list directories, and copy files
GIF	Graphics Interface Format - Compuserve raster graphics
GB	Gigabyte - 1,073,741,824 bytes or 1,024 megabytes

GUI	Graphic User Interface - a program interface that takes advantage of the computer's graphics capabilities to make the program easier to use
IP	Internet Protocol - the protocol used in gateways to connect networks at the OSI (Open System Interconnection) network level
JPEG	Joint Photographic Experts Group: an ISO/ITU standard for compressing still images
Jukebox	System containing many separate individual storage units (such as CD-ROMs or optical disks) that can be accessed one at a time
KB	Kilobyte – 1,024 bytes
LAN	Local Area Network - a communication network composed of servers, workstations, and network operating system limited to a specific geographical area.
MB	Megabyte - 1,048,576 bytes or 1,024 kilobytes
Metadata	Descriptive information pertinent to a document – i.e., date, version, title, etc.
PCX	Zsoft Corporation raster graphics
PDF	Portable Document Format, a file format developed by Adobe Systems
Pixel	The smallest element or dot on a video display
PostScript	An Adobe text/graphics programming language
RAID	Redundant Array of Inexpensive Disks - a method of storing data on multiple hard-drives
Raster	A rectangular pattern of scanning lines that produce a digital image
Scanner	A device that creates digital images of documents
SCSI	Small Computer Standard Interface - a hardware interface that supports from 7 to 15 peripheral devices
Server	A computer or device on a network that manages network resources
TCP/IP	Transmission Control Protocol/Internet Protocol - a set of layered protocols that enables shared applications among PC's, hosts, or workstations in a high-speed communications environment
Terabyte	1,099,511,627,776 bytes or 1,024 gigabytes
TIFF	Tagged Image File Format - raster graphics format developed by Aldus and Microsoft
Vector	Computer graphics represented by points, lines, and other geometric entities
WAN	Wide Area Network - a computer network that spans a relatively large geographical area. Typically, a WAN consists of two or more local-area networks (LANs).
Workflow	The automatic routing of documents to the users responsible for working on them

Workstation	A high-performance single-user microcomputer or minicomputer that is used for graphics, CAD, CAE, simulation, and scientific applications.
WORM	Write Once Read Many - An optical disk that can be recorded only once.
WYSIWYG	What You See Is What You Get. A WYSIWYG is a word processor that enables the user to see on the display screen exactly what the text will look like when printed.

Executive Summary

The focus of this report is on facility management applications for Electronic Document Management Systems (EDMSs). Because of the significant differences in managing large-scale, multiple-level, often native CADD files used by facility managers, as opposed to small-scale business documents, some software vendors have adopted another meaning for their EDM systems - - Engineering Document Management Systems. The differences in business versus engineering document EDMSs are document size, and content, and primary functions. Many EDMSs are implemented as means to scan static (released state) hard-copy documents into an electronic repository, from which they can be accessed using the improved file location and distribution capabilities offered by an effective EDMS. In these applications, for instance, creation of an electronic technical library, the usefulness of an EDMS is judged largely on its ability to effectively capture, store, and distribute information. However, an EDMS capable of supporting an engineering design or facility management role also must have a strong workflow capability and fully support file manipulation via native applications. The workflow component must be especially strong when the EDMS is used with engineering documents that are in-process as opposed to released.

Research shows that the Department of Defense has needs that mirror those in the private sector. For example, the DoD has adopted a proprietary EDMS known as the Joint Engineering Data Management Information and Control System (JEDMICS). This system has robust image capture, storage, and distribution capabilities because it was created to serve as a "DOD repository environment with 47 Army, Air Force, Marine Corps, DLA and Navy sites" (Redstone Arsenal, 1997a and b). Indeed, with a reported 55 million images transitioned to JEDMICS, a huge repository has been created. Although smaller in size, many public utility and private sector clients have used EDMSs to create readily accessible document repositories. For instance, one of the survey respondents, Baltimore Gas and Electric Company, scans current utility drawings to capture, store, and distribute up-to-date information to its district offices. In many cases, an EDMS must give end-users the ability to view and/or print current documents without a capability to alter those documents in a native application. The ability to electronically store and retrieve engineering documents offers numerous benefits to private sector firms. As an example, U.S. Steel uses an EDMS at its Edgar Thompson Works to provide direct, electronic access to its engineering drawing database from the plant floor (Formtek, undated). In U.S. Steel's case, quick access and reduced paper shuffling are decreasing equipment downtime, improving profitability.

Use of EDMSs in engineering and facility management applications is complex, largely due to the

- Much larger sized files than standard business documents
- Linkage of CADD files to reference or seed files, per tables, color tables and font reference files
- Iterative review and drawing/discipline coordination process that need a strong workflow process
- Variability in workflow, dictated by the content of individual drawings and the persons contributing to, or reviewing and redlining the drawings
- Extended life-cycle of documents when carried through from the engineering stages to the bidding, construction, as-built, facility management and subsequent rehabilitation and eventual demolition stages.

Given these disparities in the EDMS requirements for business documents versus engineering documents, organizations contemplating acquisition of an EDMS must perform a thorough analysis of its needs and expectations. Organizations must develop a vision of how EDMS will be used as a productivity improvement tool. Enterprise-wide EDMSs are a concept which may be achievable with commercially available hardware and software. However, achieving such a goal may require acquisition of two different EDMSs, one suited to the capture, storage, and distribution of legacy, often hard-copy, business documents and the other suited to engineering and facility management applications. In any case, a phased approach to implementation is needed.

This report presents a number of other specific recommendations for implementing an EDMS that meets an organization's expectations. Eight of the more important recommendations are listed below.

- Clearly understand existing systems and workflows to ensure that candidate EDM systems can be integrated into your organization.
- Establish a clear purpose and objectives for your EDMS. Identify the types of documents the system must handle, how files will be entered into the EDMS, and how and if legacy data and systems are to be addressed.
- Recognize that cultural acceptance issues will arise and foster acceptance by involving stakeholders early and often. Some persons resist change and some may even subvert process enhancements.
- Take a calculated, methodical approach to EDMS implementation. Solve simple, bounded, and measurable processes first, ensuring that these processes are representative of the complexity of other processes within the organization. Select those processes that allow for an easy and measurable return on investment.

- Use a phased approach by implementing a pilot project to prototype the proposed system. This approach will ensure success and help to define the metrics used to demonstrate success.

- Incorporate incremental versus revolutionary changes in workflow. Choose an EDMS that can digitally enable or automate existing manual processes rather than require existing processes to be re-engineered.

- Remember that training will be needed during both pilot and production phase implementation and periodically thereafter. Computer-based training can be very attractive.

- Be certain that a selected EDMS supplier fully understands your needs and expectations and has satisfactorily served other customers with similar needs and expectations in the past.

DoD may elect to conduct one or more well-documented demonstration projects to show users how to identify their specific needs, identify and select a vendor, establish an acceptance plan, and implement the EDMS following a phased approach, including training at appropriate stages. To the extent possible, all tangible benefits of implementing an EDMS should be quantified and compared to EDMS costs to determine the return-on-investment (ROI).

1 Introduction

Background

Electronic Document Management Systems (EDMSs) consist of the computer hardware and software that allow for the integrated preparation, input, distribution, storage, location, and retrieval of electronic documents, whether created initially electronically or converted from paper documents.

Continued advancements in computer hardware and software, including the proliferation of client/server networks, have made EDMSs possible. Although technological advances enabled development of EDMSs, demand for these systems has been driven by the need to intelligently manage an ever-growing warehouse of documents and data. Information is readily available on EDMSs that can manage traditional (non-graphic data, such as text files) business documents. Large-scale, graphic documents important to facility managers present special challenges for EDMSs. Therefore, this report summarizes the status of EDMSs capable of managing multiple engineering and facility management document formats. It also provides DoD personnel with guidelines for planning and implementing an EDMS. However, this report intentionally does not compare COTS EDMS products because of the sheer number of suppliers, frequent supplier name changes from mergers and acquisitions in the computer hardware and software industry and nearly continuous product upgrades that would make a comparison obsolete within weeks or months.

Purpose and Need

The study purpose and need as contained in the Tri-Service CADD/GIS Technology Center's June 25, 1997, Statement of Work, are as follows:

> A critical need across DoD installations and USACE Civil Works and Military Programs projects is the ability to access engineering and facility management documents that are in a variety of formats including digital and hard-copy. It is difficult to locate, retrieve, store and distribute data contained in these documents with today's management and retrieval processes. Customers and users of this information traditionally copy required data into unique projects, creating large storage and duplicative update requirements, and loss of an accountable edit trail. As electronic documents are being added to the inventory of engineering documents at DoD offices, the need to file and store these documents for easy management

and retrieval increases. Optimally, commercial EDMS solutions provide the framework to establish metadata (data about data) for each piece of data, enabling DoD to locate, track and access CADD drawings, geospatial data sets, computer-aided facility management information, and documents by accessing them. Additionally, EDMS solutions will save resources by allowing data to be entered only once and used many times. As installations implement EDMS technology, guidelines and resources will be critical to the adoption and sustainment of this technology.

Specific objectives for the investigation and the guidelines are:

- Evaluate EDMSs currently in use, or being installed, at various DoD offices
- Document lessons learned in using EDMS technologies
- Develop criteria and guidelines for determining EDMS requirements and evaluating commercial EDMS hardware and software

What are EDMSs?

Definition

The term Document Management is used in so many ways that confusion reigns when trying to describe what it really means. Is it a technology that is used to manage the distributed repositories of documents now dispersed throughout many organizations? Is it the set of technologies that enable organizations to disseminate information to its internal resources, its clients, and its suppliers? Is it the set of technologies such as imaging and forms processing that allow organizations to input and retrieve these paper-based documents in a convenient way? Is it technologies like workflow and groupware that manage both the transaction-oriented and collaborative ways that documents should be processed within an organization? Is it the non-technical management issues that organizations need to address to effectively process their organizational memory?

The following paragraphs give the definitions used by several leading organizations in the EDMS industry.

AIIM International (AIIM International, undated) defines document managers as the products and services that provide revision control and repository-oriented services for the electronic documents located throughout an organization. Nevertheless, effective document management includes the use of these types of products and more. The integration of imaging, workflow, groupware, document managers, optical character recognition and other technologies, together with realistic standards-compliance and intelligent organizational management of these documents are what make up effective document management.

The Gartner Group (The Gartner Group, 1993) defines document management as a highly integrated set of middleware services that integrate library services, document manufacturing, and document interchange with

critical business process applications around a client/server topology using open application interfaces.

International Data Corporation (International Data Corporation, 1993) defines document management as a software system that is capable of organizing document production, managing accessibility and distribution of volumes of textual documents, and overseeing document flow.

Interleaf (Interleaf Inc., undated) defines document management as not only the technology that manages documents, but more important, that manages the information within documents. Interleaf regards document management as a set of software and services through which business-critical information is managed by enabling the creation, assembly, control and distribution of this information. Document management is about more than documents - it's about information and strategic business processes.

Given the diversity of these definitions, the project team arrived at this simple definition to focus the study effort: EDMSs consist of the computer hardware and software that allow for the integrated preparation, input, distribution, storage, location, and retrieval of electronic documents, whether initially created electronically or converted from paper documents. By considering the life-cycle of a typical engineering document, such as an engineering drawing, the required components of an effective EDMS become clear.

A well configured EDMS certainly improves enterprise-wide operating efficiencies. However, a careful analysis of requirements and expectations is needed to avoid disappointments in terms of:

- anticipated costs and returns
- cultural issues, including user acceptance
- technology limitations
- technology transition requirements

EDMS Features and Components

Engineering, planning, and facility management documents may be created manually (requiring a separate document scanning step) or electronically. In either case, an iterative process of internal reviews and approvals is typical. For example, “Final” engineering drawings emerge from this process. Individual drawings are bundled as needed for bidding and construction purposes. Equating this process to required EDMS features, an EDMS should to be able to store documents while in progress, allow manipulation via application software, distribute full documents to appropriate reviewers, and capture digital information from paper-based documents. Effective document management requires an ability to store and track document versions/revisions that result from the iterative review process, control file access, and store documents in a secure repository.

The ability to easily locate and retrieve documents is as important as the ability to store them, since stored information that cannot be easily or readily accessed can result in poorly executed design or construction projects or poorly managed

facilities. Effective document retrieval requires linkage of metadata to the documents in a repository. Metadata enables EDMSs to locate documents for retrieval. Metadata is information about a document, such as the origination date, originator, document version, software version, content etc. Metadata can be thought of as database entries needed to retrieve a relevant document when only certain information, like the preparer, facility name or creation date is known. Depending upon design, the EDMS can require that pertinent metadata be entered before a file can be submitted to the repository.

Documents have an extended life-cycle beyond initial creation. Using the engineering drawing example, the life-cycle carries through to as-built drawings and baseline documents for future renovation, rehabilitation, or demolition efforts. This extended life cycle, characterized by evolution of documents over time, generates the need for an automated process that ensures changes in one document are reflected in related documents.

To gain a full understanding of EDMS, you can consider the individual components that comprise an EDMS and the primary functions that these various components perform. Because the individual pieces are building blocks of an EDMS, the following paragraphs introduce typical EDMS components. Recognizing that all components must interact to achieve efficient document management, Section 2 gives a detailed discussion of the typical EDMS components and primary functions an EDMS must perform or support.

Primary components and their associated function in an EDMS include:

- Input Devices These are the devices that directly, or through a conversion process, place documents into the EDMS. Any computer system can serve as an input device. Optical scanners are used to input non-digital or legacy hard-copy data to the EDMS. TIFF (tagged image file format); and Adobe's Acrobat PDF (portable document format) are the most commonly accepted image formats (Doculabs, 1997). Other accepted formats are BMP, GIF, JPEG.

- Storage Devices (Repository) The document repository "stores, controls and manages documents. Primary components include file or data servers, database servers, FTP servers, tape backups (9 track, 8mm, 4 mm, etc.), optical storage and CD ROM. These devices store information in a repository for future retrieval. Key repository functions include library services (e.g., controlling access to individual documents, document cataloging, check-in/check-out, and searching for and retrieving documents and version control, including a history of all instances of a document as it changes over time.)" (Boyle, 1997). Workflow systems are used to automate routing and processing functions, typically adhering to specifications developed by the Workflow Management Coalition (Doculabs, 1997).

- Retrieval and Distribution Devices Retrieval and distribution components consist of workstations, printers, plotters, recordable CD units, and facsimile machines. COLD (Computer Output to Laser Disk) technology is gaining

popularity since it facilitates quicker and more secure document retrieval. Formatting and rendering packages are used to allow print-on-demand capabilities. Use of Internet and Intranet technologies make documents retrievable by a wide array of users, within security access limitations.

Available EDMS Guidance

The Tri-Service CADD/GIS Technology Center had the Jordani Consulting Group prepare an EDMS overview document, entitled "Electronic Document Management Systems" (Jordani Consulting Group, 1996). This and related reports can be downloaded from the following URL: http://tsc.wes.army.mil/projects/.

The Jordani report presents a 15-page high level overview of EDMS technology and applications. It contains:

- An overview and definition of EDMS
- Business challenges that an EDMS can help overcome
- EDMS features useful to any organization or business
- Criteria for selecting an EDMS
- Implementation issues
- Anticipated future advancement in EDMS functionality

As a primer, Jordani's report has appeal to a wide audience, especially those persons with limited prior knowledge of EDMS technologies.

Publications and World Wide Web addresses furnished in the references and bibliography sections also contain pertinent information on EDMSs in general, with a focus on engineering and facility management document applications for EDMS. The Tri-Service CADD/GIS Technology Center maintains numerous world-wide links to EDMS sites; these links can be accessed at http://tsc.wes.army.mil/links/.

2 EDMS Components

Introduction

The purpose of this section is to list and define the various components involved in the EDMS process. Additional technical specifications, requirements, and suggestions are included under the sub-heading "EDMS Components – Technical Specifications."

EDMS Components and Activities

Engineering document management encompasses many different activities within the life cycle or process workflow defined by the engineering process. The activities involved in EDMS can be placed into five categories: Capture, Store, Manipulate, and Distribute activities, linked by the Manage activity. Figure 1 illustrates typical EDMS architecture and the relationship of the five primary activities. The document workflow is delineated by the arrows surrounding the "Manage" or "EDMS" activity.

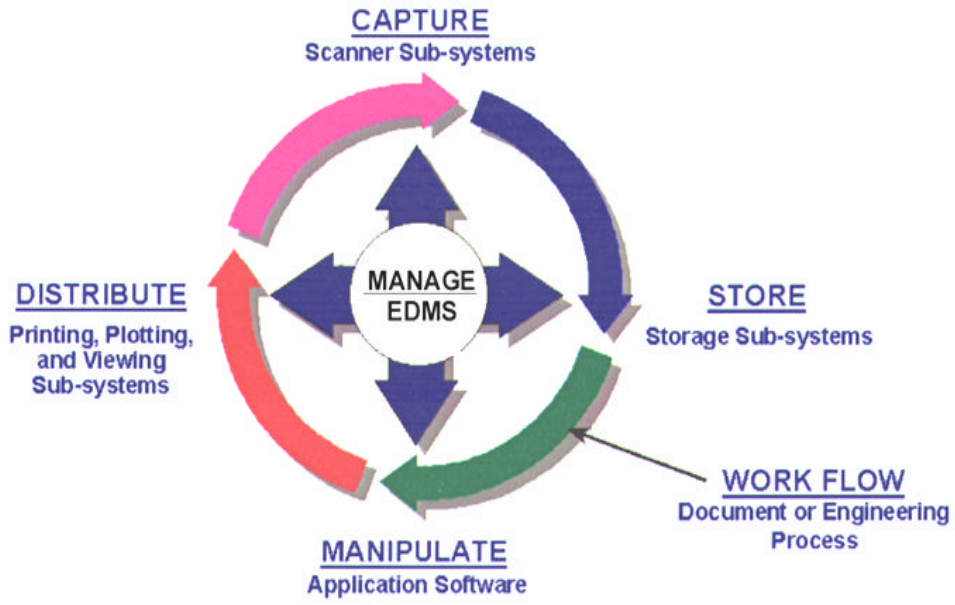


Figure 1. EDMS System Architecture

The EDMS activity must interact with each of the other four activities to allow for communication between all of the activities.

EDMS technology is supported by a network of hardware and software. The architecture of an EDMS consists of four primary elements: desktop clients, servers, databases, and system storage (Bielawski & Boyle, 1997).

Figure 2 shows a typical layout of components in the electronic engineering process. These components are defined in more detail later, specific to the engineering document management processes. The server platforms shown in Figure 2 are logical servers delineating server functions. Several or all of these server functions may reside on one physical hardware server device. Several physical server devices may also be used to manage the listed functions.

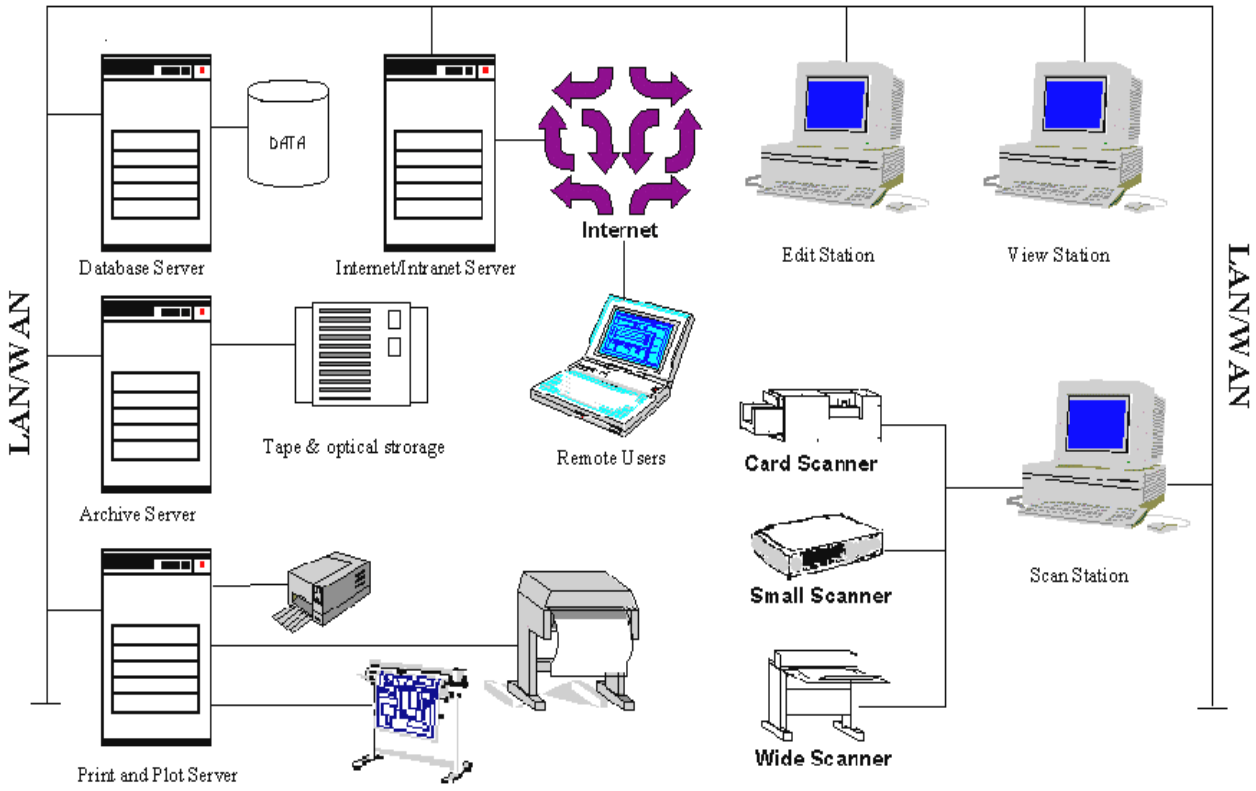


Figure 2. Components of the Electronic Engineering Process

Each of the different activities delineated in Figure 1 interact with one or more of the components delineated in Figure 2. Following are definitions of each activity and explanations of how the components interact with the EDMS.

Capture Activity

Introduction

According to the American Institute of Information Management, approximately 20% of the documents in use today are in digital form. Lately, significant efforts have been exerted to digitally capture the paper-based engineering document vaults. Many benefits accrue to users who expend the resources needed to digitally capture documents. In simplest terms, digitally capturing paper engineering documents is accomplished via scanning the paper documents (imaging) and indexing the scanned files into an EDMS.

An imaging subsystem consists of several key components (Bielawski & Boyle, 1997):

- Scanner
- Image Capture Software
- Image Processing Software
- Optical Character Recognition Software

Although some organizations adopt a "from this day forward" approach, using the EDMS to manage newly created documents, many organizations stress the ability to convert existing data warehouses into electronic repositories. Organizations that need to quickly convert hard copy information to electronic files need to carefully analyze requirements for the entire imaging subsystem.

In a paper-based engineering environment significant amounts of time are spent in simply managing the paper engineering data base rather than actually using the information stored on the paper. According to the Dephi Consulting Group (Delphi Consulting Group, 1997),

- 90% of all documents handled each day are merely shuffled
- Gathering and transferring paper documents consumes 90% of typical office tasks
- Workgroups lose 15% of all documents they handle
- 30% of the above workgroup's time is spent trying to find them

The above statistics indicate that handling paper-based information yields no "value added" time to the process of working with such information. Significant savings can be realized in improved personnel efficiencies. According to AIIM (American Institute of Information Management), companies spend 5% of their total filing costs on equipment, 20% on space, and 75% on salaries of those individuals spending time filing and requesting paper-based documents.

Figure 3 further graphically defines the traditional baseline situation using paper-based engineering document vaults. Key components of the imaging subsystem are described after Figure 3. The imaging subsystem allows organizations to move from manual vaults to electronic repositories.

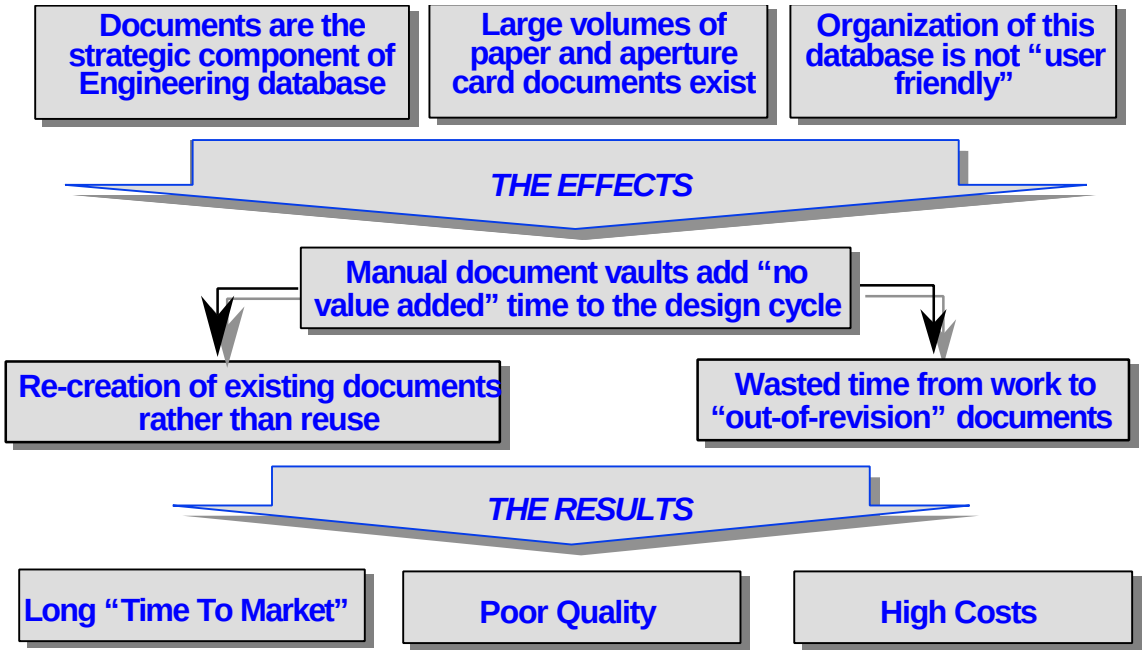


Figure 3. Paper-Based Engineering Document Vault - The Situation

Imaging Process

Scanner

Scanners are hardware devices that read hard-copy (legacy) documents. Scanners are available to generate black and white, gray-scale or color outputs with resolutions typically ranging from 200 to 1200 dots per inch. However, high resolution and color yield very large file sizes. Three scanner configurations are used, flat-bed, automatic sheet feed and roll-feed (used for large-scale engineering drawings). Aperature card scanners also are useful in an engineering environment.

Image Capture

Image capture software captures the scanned image and outputs in desired formats, most commonly TIFF. File compression also is a critical function of the image capture software due to the large file sizes associated with scanned documents.

Image Processing

The scanning process is similar to photocopying in that sheets can become skewed going through the scanner, dirt on the glass can result in spots on the images, and the document may need to be rotated 90% to be of most value to users. These functions, which Bielawski and Boyle call "de-skew," "de-speckle," and "clean-up," are performed by the image processing software.

Image capture and processing software needs to offer (Spencer, 1997):

- Detection of double feeds
- Multiple levels of image enhancement
- Document sequence number imprinting control and support
- De-skew capability especially for small documents passed through a high-speed scanner
- Detection of source documents which are blank on the back side (applies to duplex scanners).
- Automatic rotation of scanned images by 90º to 180º.

Optical Character Recognition

Once the digital image is created, it must be indexed in order to be accessible to the user community. There are multiple ways to capture document-specific information that will facilitate future document retrieval. One popular means of capturing content information is to use Optical Character Recognition (OCR) software. Normally, scanned images, which can be thought of as "electronic photocopies," contain imaged representations of text. OCR software searches for embedded text, which exists as patterns in a dot matrix and converts these patterns into text that can be used to index documents for future retrieval.

As Bielawski and Boyle state "Optical Character Recognition is the process of a software application reading the image and interpreting the characters on the page, thereby turning the image into text, making the entire document available for indexing." Once documents are indexed into the EDMS database, captured document information can help a user locate a needed document. The OCR process is very demanding of system resources and can become the bottleneck in the imaging system, operating at a slower speed than powerful scanners.

Profile or metadata information relating to a scanned document also can be manually input to the EDMS database. Metadata information can include items such as drawing description, software version drawing number, scale, revision and title block information. Manual indexing of documents can be a laborious task and efforts must be made to obtain an environment that is conducive to the indexing operation. One such conducive environment is called "heads up indexing." Heads up indexing is accomplished by software that can display both the scanned image and index fields on a screen at the same time. The user can then view the document and enter the metadata information into the database from the same application. This capability enhances the quality of the metadata information entered and improves the manual metadata entry process. To accomplish "heads up indexing," the EDMS and the scan viewing software must be tightly integrated. An example of "heads up indexing" is shown in Figure 4. Note the EDMS metadata fields shown at the bottom of the screen image (Description, Title Block 1 and 2, and Drawing #).

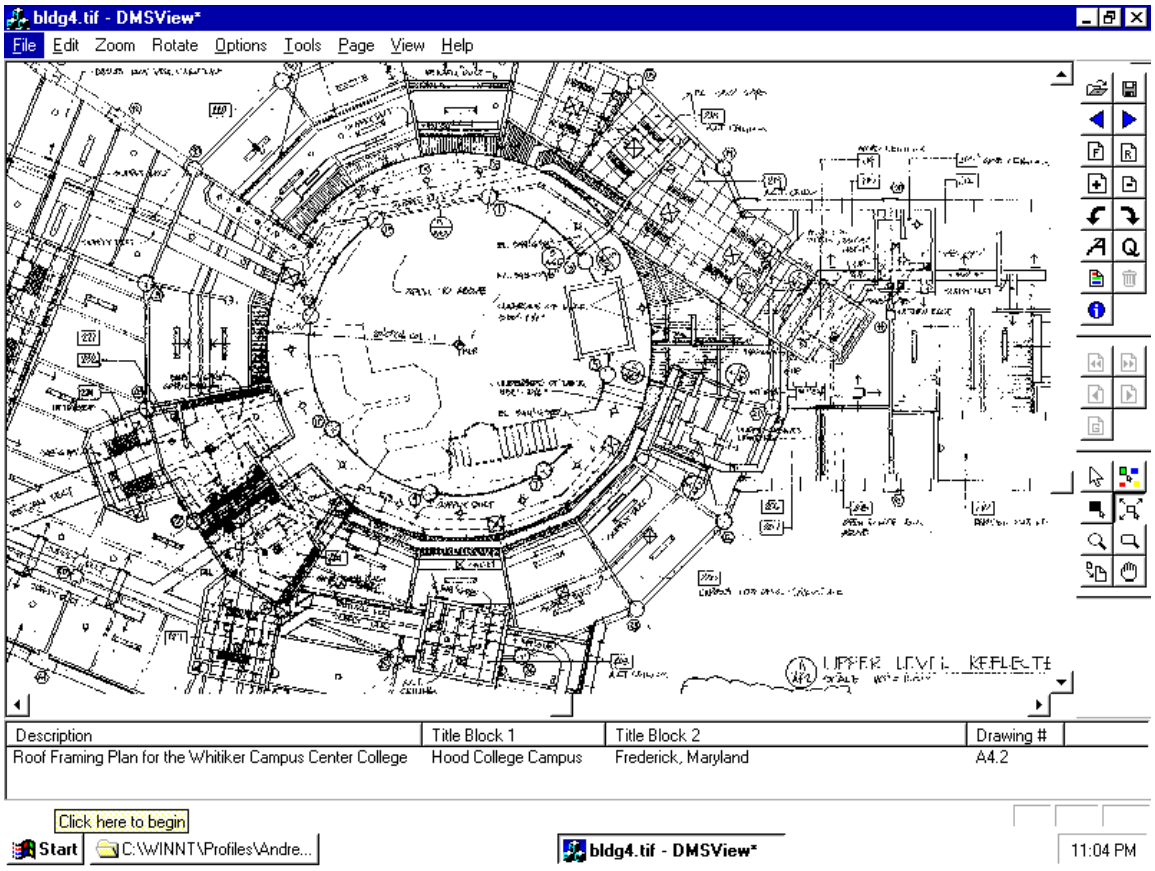


Figure 4. Example of "heads up indexing" of scanned image

Paper Conversion

When considering converting a paper-based engineering document vault into an EDMS-ready digital engineering document vault, questions can be asked to determine the methods available to accomplish the conversion and the viability of the technology in a specific environment.

For engineering and facility management personnel there are a number of methods to get paper-based documents into the automated design and drafting environment that EDMS technology supports. These methods include (Wilson, 1997)

- Manual Redraw – Manual redrawing of a paper document from scratch.
- Digitize – A quicker manual redrawing process using a digitizer tablet.
- Scan – (see Scanning Process)
- Service Bureau – Rather than converting documents with internal resources, some organizations may use external resources to accomplish the conversion process. For example, the Oklahoma City Air Logistics Center has a contract with Boeing Aircraft and ImageMax for the conversion of 238,400 E-3 weapon system aperture cards by January 1999 (Tinker AFB ALC, 1998). For many DoD components, "the Fort Leavenworth Defense

Printing Service Department Office serves as a digitizing/indexing agent, using a high-speed document imaging system" (Smithsonian Institute, 1996). FCAD2 vendors offer scanning subsystem components and access to service bureaus.

Questions which address the need for EDMS technology include:

1. Does your organization have a design review requirement that is heavily paper-based?
2. Is the drawing review process performed by various people?
3. Are documents in the review process generated or distributed externally?
4. Would the review process be faster if documents were viewed simultaneously?
5. Is misfiling or loss of documents a problem for your organization?
6. Do personnel waste time looking for documents or determining availability?
7. Is there a labor intensive process for filing and retrieving documents?
8. Is storage space rapidly dwindling or is new storage space hard to get?
9. Would immediate design availability improve other aspects of your processes?

To develop a ROI (Return on Investment) when considering converting to an EDMS-controlled digital vault from a paper-based engineering database, consider the following questions:

1. On average, how long does it take to file, retrieve, and duplicate a document?
2. How many personnel are dedicated to filing, retrieving, and duplicating paper documents?
3. How much floor space (square feet) is devoted to drawing storage and reproduction?
4. Does your organization produce "paper" copies for distribution?
5. Does your organization produce aperture cards to reduce storage space requirements?
6. Is revenue lost or costs or risks incurred because of lost or missing documents?
7. How much productivity time is lost requesting and waiting for copies of documents?

The EDMS is central to the success of a digitally-enabled paper engineering vault when scanning, indexing, finding and viewing documents. The EDMS is equally important when documents need to be distributed, manipulated, or stored.

Viewing

Users of engineering and facility management documents often do not have access to the native applications used to generate them. To facilitate document access by a wide range of users, viewing software is used. Viewer software allows users to look at documents without having to use the application used to create them (Wilson, Undated). Many document users simply need to see or refer to engineering documents, rather than create or modify them. Viewing software allows such users to access information without having to own and learn costly CADD software packages.

For organizations with a developmental or fully implemented EDMS, "a small investment in a powerful viewing software package offers immediate benefits with little capital outlay and minimal training time (Wilson, Undated)." The primary factors to consider in selecting a viewer software package are (Wilson, Undated):

- Speed
- Simplicity
- Ability to view a full range of file formats

Benefits of Electronic Document Capture

Progressive organizations invest in electronic document capture to realize benefits. Ready access to a repository of electronic documents offers many benefits compared to paper document distribution (Bielawski and Boyle, 1997):

- Lower cost of document distribution
- Easier document maintenance and updates
- Faster access to documents
- Time-consuming linear routing of paper documents avoided
- Views of documents can be customized for a better quality of presentation

Store Activity

Digital information related to the in-process engineering documents include CADD files, scanned images, data used in engineering calculations, word processing documents and spreadsheet documents, e-mail communication, and digital photographs. This information is maintained in digital form on file or data servers.

Metadata

In addition to the actual engineering data, an EDMS system also stores profile or metadata information related to a given document, including title block information, software version, description, revision number and date, document status, keywords, etc. This information is contained in a database system. Because of robust access capabilities and the ability to manage a large number of records, almost all database systems in use today are SQL systems. Therefore, databases are maintained on-line on database servers. Database server functions and file or data server functions sometimes are accomplished via a single hardware server unit.

Storage Components

When engineering documents have reached a released state or are replaced by newer versions, they may be stored off-line on tape or optical media. The information also can be stored on magnetic disk or optical media in a near on-line mode. The level of effort that is required to bring a document back to the in-process state, from a released state, dictates which mode should be used.

The store activity uses the following components. Each of the components encompasses both hardware and software.

- File or data server
- Database server
- FTP server
- Tape Backup (9-track, 8mm, 4mm, etc.)
- Optical Storage (jukebox or individual platter)
- CD-ROM

The role of the EDMS is to store documents in the proper locations on the appropriate devices. Proper, logical storage enables the retrieval of documents for the other activities. Storage and subsequent retrieval need to be accomplished automatically by the EDMS based on logical process steps. For example, when a user makes a request to modify an engineering design document, the EDMS should not require the user to know where the original document resides. Rather, the EDMS should transparently retrieve the document and automatically execute the appropriate application, focusing on the retrieved document. Any related documents, such as MicroStation reference files or AutoCAD XREF files should also be automatically managed with this access request. Conversely, when the user has completed the design session with a particular document, the EDMS should restore the document to its original location without requiring the user to know that location.

Archiving

When documents reach a released state, they may be archived. Archiving entails moving digital information from active hard disk storage to off-line or near on-line storage media, thus freeing up space on active magnetic disk drives for additional in-process documents. The EDMS should be able to manage the archived documents as well as active documents. The EDMS also should control access to the archived documents so that archived documents can not be modified. Typical archive media includes both tape backup and optical storage. Optical jukeboxes, which can store and manage hundreds of gigabytes of digital information as one logical location, have been used for archive storage for many years. Optical jukebox storage access is inherently slower than that of active hard disk storage, but this performance trait historically has been offset by the low cost of storage. However, there have been drastic reductions in the cost of ownership of hard disk drives. Any on-going decision making process involving the economics of optical versus hard disk storage must consider only the most current price information available. Besides its historic cost advantage, optical storage maintains popularity due to the useful life of optical media. Optical storage media can have a life expectancy of 100+ years.

More technically detailed discussion of optical media is included under the sub-heading "EDMS Components – Technical Specifications."

Tape storage is extremely low cost when compared to other media. Tape storage is popular when immediate or near-immediate access to data is not important to the user. Information is placed on tape sequentially. When a user

requests recovery of information from tape, it is conceivable that the operating system would have to read through an entire tape to get to the requested information. This recovery operation could take hours. However, backup tapes are reliable, low cost, and portable. Thus backup tapes are an attractive option in certain environments.

When using either tape backup or optical storage for off-line storage, the EDMS must be responsible for moving the information off-line. The EDMS must also update the metadata associated with each file or document to reflect the archived state. Access to this data should then be controlled by the EDMS so that users may access the data for viewing, but not for modification. Finally, the EDMS should update the related document's metadata to reflect the specific volume that holds the archive. If archived data ever needs to be brought back on-line, the EDMS should be used to find, access, and control this function as well.

Manipulate Activity

Modification of in-process engineering documentation is accomplished via application software packages such as CADD, scan image editing, word processing, e-mail communication, engineering application software packages, and spreadsheets. The processes related to the modification of design information falls within the manipulate activity.

During this activity, workstations are used to modify digital data. Remote users should have access to documents via a dial-up connection, wide area network, or Internet connection. Users responsible for review and redline functions utilize view stations for this activity. Detailed technical recommendations for these components can be found under the sub-heading "EDMS Components – Technical Specifications."

The EDMS should be in full use during all functions related to the manipulate activity, allowing the user to find the document that needs to be manipulated. In doing so the EDMS should also verify that the requesting user has been assigned the proper privileges to allow access to modify the document.

The EDMS also is responsible for the creation of documents. In this activity, certain metadata information such as description, drawing number, user's name etc., should be provided to allow enhanced searching for documents later. The EDMS should ensure that this data has been provided by the user before allowing the function to continue.

The access control of a document is managed by the EDMS during the manipulate activity. When a document relates to an in-process stage in an engineering workflow, users are expected to be able to modify the information as the workflow stage progresses. However, this does not necessarily pertain to all users. The EDMS should be able to differentiate between users and user's functions to control the modification of engineering documents. Therefore, access control is based not only on engineering workflow steps but also on the individual accessing the information.

The EDMS also should be able to manage the passing of a document from one workflow step to another. It also should manage the changing access control related to those workflow steps. Figure 5 shows a typical engineering workflow configuration and the rights associated to a document at the various steps. In this example User 1 is a member of a design team and User 2 is responsible for quality assurance.

Step #	Document Status	User 1 (Design Team Member) Access Control	User 2 (Quality Assurance) Access Control
1	In Revision	Modification	View Only
2	Released for Q/A	View Only	View and Redline
3	In Revision	Modification	View Only
4	Released for Q/A	View Only	View and Redline
5	Released for Construction	View Only	View Only

Figure 5. Workflow and Access Control Example

In this example the document begins at step 1 with a document status of "In Revision." At this time User 1 is expected to be making design modifications to the document. When the document is in the "In Revision" status, User 2, from the quality assurance department, would not be able to modify the document. When User 1 has determined that he/she has completed that step, the document is passed to the next step in the workflow. This step is noted in the above example as "Released for Q/A." At this time User 1 relinquishes the modification rights and User 2 is now able to view and redline the document. In this example, User 2 has determined that User 1 needs to make some changes to the document and changes the status back to "In Revision." This cycle is repeated until User 2 is satisfied with the design. User 2 then changes the status to "Released for Construction." At this step neither user can make further changes to the drawing.

The EDMS should be robust enough to allow for the dynamic changes to a document's status and the resultant access control needs. The EDMS must also take into account the individuals involved at the various steps in the life cycle of a document. Chapter 3 presents additional information on automated workflow.

Distribute Activity

The distribute activity is central to the engineering process for it allows all users to have access to the engineering documents. Those users involved in document related processes need to view paper representations of electronic documents as part of the processes. They can include management personnel acting in a review process, engineering personnel in the field at a construction site, vendors that need access to engineering documents in the form of bid sets, customers or constituents, and sub-contractors involved in the design process.

As the EDMS is central in helping users find, view, and manipulate documents in a controlled and managed environment, it is crucial in the packaging and distribution of the documents.

Distribution of digital engineering documents takes two forms: paper distribution and digital distribution.

Paper Distribution

The EDMS is used in paper distribution through the packaging and distribution of paper documents or document sets. The EDMS is used to create a "print request" and should have the ability to drive associated devices directly. These output devices include small format and large format printers and digital copiers. For many years the technical limitations of these devices prevented the cost-effective and timely production and/or reproduction of engineering outputs. With recent advances in large format print-on-demand systems automated distribution of engineering drawings is possible. Currently available large format output devices (plotters) can produce paper-based representations of engineering drawings at copier speed. In addition, units are available that can provide internal stamping (i.e. Released for Construction), distribution notations on individual pieces, advanced collating and even folding and packaging for manual distribution. While all of these features are valuable in the process, the EDMS must control the features to make them available to users of the system.

The EDMS also is used in the paper distribution to control when documents can be distributed to certain groups based on the current design process step. For example, the EDMS should prevent the production and distribution of documentation to the field before the information is officially released.

Accounting or auditing of the output production should be controlled by the EDMS. The accounting or auditing function should include the generation of transmittal information so that a history of the information distribution is maintained.

Digital Distribution

The EDMS should control and manage electronic or digital distribution, including direct Internet or CD-ROM publishing (such capabilities support creation of Electronic Bid Sets). Digital distribution includes making the electronic

information available via the user's LAN/WAN and or the Internet/Intranet. Given that an EDMS allows ready access to documents, controls must ensure the accuracy as well as the availability of the information. Web publishing capabilities illustrate the need to distribute only current, accurate information. There are several ways to distribute electronic documents via the World Wide Web. Available distribution models illustrated on Figure 6 (Boyle, 1997) are:

- Manual
- Publishing
- Access

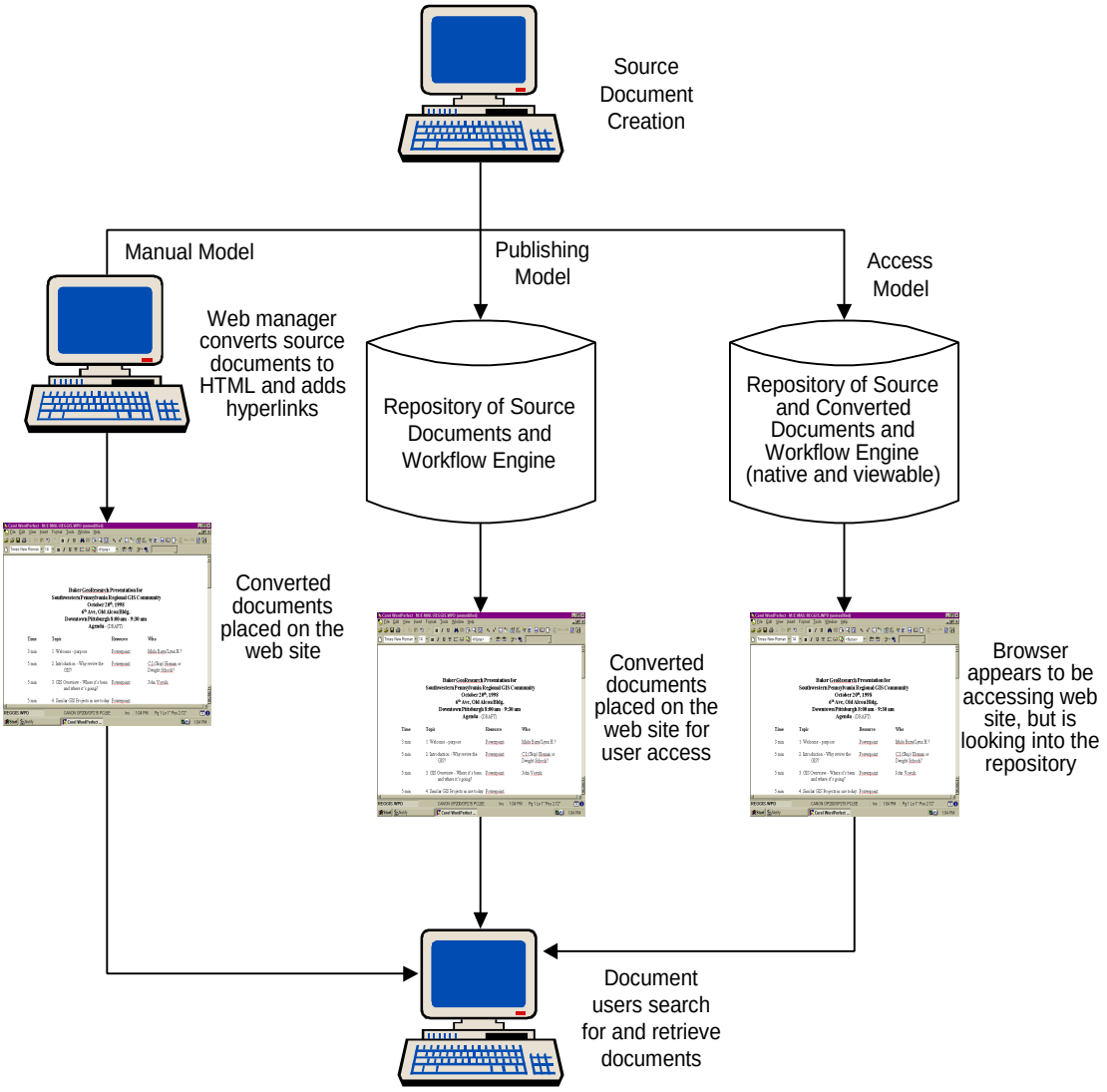


Figure 6. Document Distribution Models (Boyle, 1997)

Each of the three distribution models illustrated in Figure 6 is described below (Boyle, 1997):

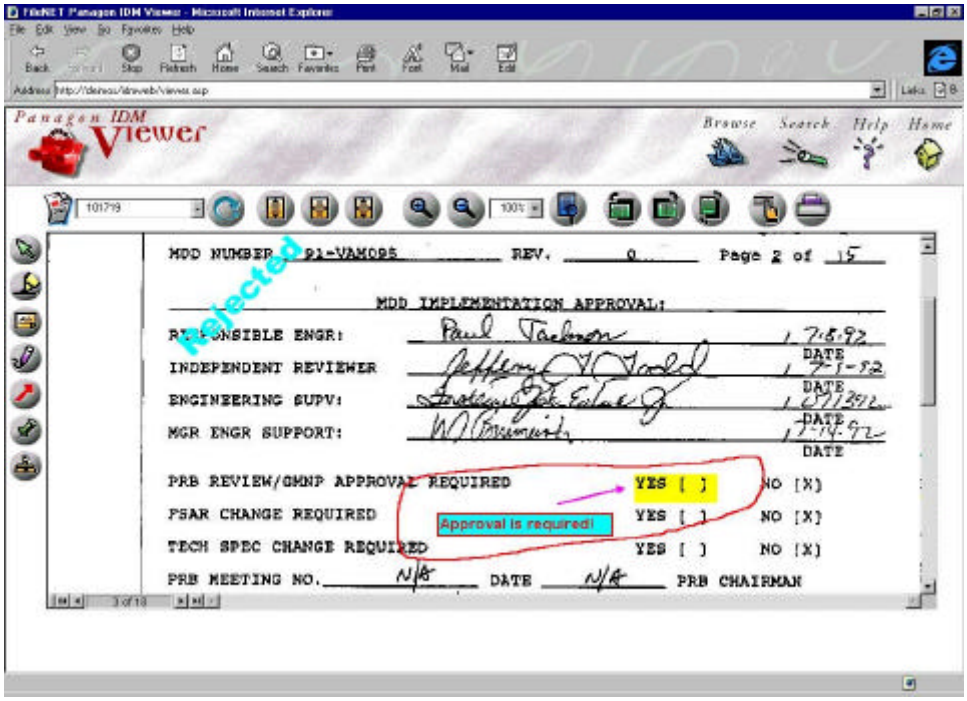
Manual Model. Using the Manual Model, source documents are forwarded to a web manager who converts them to a viewable format, adds hyperlinks, and places them on the web site. Document users browse for and retrieve converted documents from the web site. This is a labor-intensive process that has no built in mechanisms to ensure revised source documents get converted and transferred to the web.

Publishing Model. Source documents are stored in a repository and a workflow engine manages the conversion of documents and placement on a web site. Although this model removes the manual conversion and posting process, source documents reside within the repository while converted web-viewable documents reside on the web site (see Figure 7).

Access Model. The access model also uses a document repository and workflow engine. However, the repository is used to store both source (native format) documents and viewable documents. To an end user, the browser appears to access a web site when it actually is looking into the entire repository. Advantages of this model are that search capabilities and security/access controls of the repository are available.

Without an effective EDMS, Web publishing is accomplished without any consideration of the design level or status of the drawing. If a document is in the process of being revised, only those personnel involved in the process should have access to that information. Those involved in resultant construction, or having other uses for information, should not have unlimited access to the document without being aware of its status. The EDMS can and should control this distribution.

Figure 7. Digital Distribution of an EDMS Document



Also situations exist where released documents would be stored in a different digital format than that of the original document. The reasons for using another format include ease of viewing using standard plug-ins and prevention of released

document changes. For example, a designer may use a CADD package such as MicroStation or AutoCAD to create and manipulate the engineering design data. Documents stored in these formats would require complicated and high priced CADD design packages for full document access. However, those persons that only require viewing access to the same information can use an inexpensive and easy to use viewing software package. To view information via a viewing software package the data must be in a standard digital format such as TIFF, CCITT, or PDF. The EDMS should control the creation of the standard digital formats based on the steps in the design process. The EDMS also should control the distribution of this information so that it is available to the viewing user.

Manage Activity

At the heart of the four activities already described lies the manage activity. This is where the EDMS resides. As shown in Figure 1, the EDMS component is responsible for controlling and managing the communications between all the activities.

As the controlling activity, the EDMS is responsible for supporting an organization's workflow. The workflow (routing) for administrative documents, typically prepared by one or a few persons, without extensive reviews and iterations, differs tremendously from workflow for CADD documents. CADD files used for facility management typically are prepared by a number of disciplines and undergo multiple review and revision cycles. For this reason, the remainder of this discussion focuses on CADD document management.

CADD Document Management

CADD document management can be defined as the management and intelligent control of CADD files and their associated references. CADD document management includes documents that are in-process as well as documents that are in a released state. The requirements surrounding the management of CADD or engineering documents are very different from those of administrative documents. Some of the differences include:

- Engineers usually focus on a project and process as opposed to a document.
- The naming of CADD documents needs to be controlled because naming typically ties back to a drawing number. Document numbers have meaning and are pre-assigned in many organizations.
- CADD documents are associated with reference files that must be managed intelligently and automatically.
- The CADD document workflow is extremely dynamic when compared to a typical business workflow associated with business documents.
- Vendor and/or customer communications require native CADD data to be transferred for common editing.

- Design data can be object based. Native CADD encourages object management even in the most basic CADD usage (i.e. MicroStation cells and Autodesk blocks). More intelligent data may be assigned to individual elements.

- Management of CADD documents has been performed manually for many years. However, this manual control did not prevent multiple access to a representation of the same document. Nor did it recognize drawing process states that could affect access control of the information.

- The output of design data in many cases is not portrayed as WYSIWYG. Rather it is displayed as raw data or model data. Only when the design data is passed through the plotting, printing, or publishing sub-system does the resultant image (i.e. plot) emerge. Typical business documents are created and remain in a WYSIWYG environment.

Benefits of CADD File Management

- Provide CADD file consistency through standardized drawing creation methods

  The importance of standardization in document creation is especially important when CADD documents are involved. In many cases a CADD document is part of a larger set of documents or drawings. All of the documents should be subject to the same constraints. These constraints include drawing border selection, population of the drawing title block data, drawing units (i.e. feet, inches, etc.), file and document naming, base reference information, and file location.

- Provide a means to measure and analyze revision history

  The EDMS system should allow the user or document owner the opportunity to study the access history of a drawing. This capability allows the user to gain knowledge about the workflow that took place during the design and use life of the drawing. Information regarding the cumulative amount of time spent in the creation and modification of the drawing is also very useful in forecasting and budgeting future efforts.

  The collection of accounting or audit information should happen automatically without any intervention from the user. The information that is to be collected should be definable by the system manager. This definition should include the ability to include any document related metadata information such as keywords, phases, status, description, and title block information for each activity accounted for. Accounting or audit information is especially useful in studying a document's workflow.

  The historical data should be captured in standard SQL data tables or as delimited ASCII information for import to other systems.

- Eliminate "dead time" in searching for a drawing and verifying that you have the latest revision

One of the main benefits of an EDMS is the help that it gives the user in locating a drawing when the user wishes to view or edit the document. The EDMS provides an efficient way of listing drawings that fit a user defined criteria such as project and discipline. In addition the EDMS allows the user to perform more extensive searches when required. Examples of more extensive searches include searching based on keywords, revisions, and even words contained in a description or title block line.

The EDMS also ensures that the user is given modification access to only the latest revision or version of a drawing. Version control capabilities guarantee that the user's modifications are made based on the latest drawing content and that recreation of design data will not be required.

- Eliminate "dead time" spent on recreating design information because finding a lost document is uncertain

  When an engineer, designer, or draftsperson has difficulty finding an electronic document, the individual has no way to determine how long it will take to find the document or even if the document exists any more. In such situations it is not uncommon for drawings to be recreated rather than continue to search for them. An effective EDMS can completely eliminate this wasteful use of time.

- Prevent multiple simultaneous revisions to the same document

  Sometimes keeping several versions of an electronic drawing is desirable in order to maintain design information at various stages throughout the design process. Therefore, a user could access, for modification, a version of an electronic drawing that may not be the latest version or revision. If an old version was retrieved, modifications will be lost and the time spent making the changes will be lost as well. Also the information delineating the design effort at a specific version or revision level has been compromised. An effective EDMS will prevent such problems.

Basic Requirements for CADD File Management

- Provide an easy to use user interface that matches the user's process environment

  The user's interface should be a GUI (graphical user interface) and should be easy to use. When an EDMS system is installed and started up, gaining the user's acceptance of the system is important. The business impact of using the EDMS system can be profound but can be a failure if the cultural impact of the system's use is not taken into account. The user interface should match as closely as possible the manual access by the user to minimize the cultural impact that the system will have. The use of the EDMS should be viewed by the user as a tool and not as another application that they need to learn, execute, and maintain. Therefore the EDMS should be (or appear to the user to be) integrated into the CADD applications. For example, when the user is running

either MicroStation or AutoCAD, the EDMS "open document" function should appear on the screen when the user invokes the "open file" option on the standard menu.

- Enable two-way linkage between the database and the CADD drawing (intelligent data linkage)

  As users begin to depend on the EDMS search capability, the metadata and the related title block information must match.

  The EDMS should have the capability to place standard CADD text onto the drawing to match the metadata that is placed into the EDMS document database record. Metadata fields such as drawing number, revision, revision date, title, drawn by, etc., can typically be found within the title block of a drawing. The user must be able to search the database using these items. Therefore the data on the drawing itself match the data in the database record for that drawing. The software version that created the electronic file is critical for long term data storage and should be a metadata requirement for each file. CADD, especially, will require software tracking since successful plotting of a CADD file may require the right combination and version of CADD, raster and plotting software.

  Data linkage must be bi-directional. For example, if the metadata information is modified in the database, the EDMS should automatically modify the core drawing file. Also, if the user changes the text in the CADD drawing file using the text editing tools provided by the CADD software, the metadata information related to the drawing file should update automatically.

- Provide features to facilitate client packaging issues

  The EDMS should have the capability of packaging CADD and related documents for delivery to outside concerns such as vendors, contractors and customers. The user should be able to:
  - Select the documents to be transferred
  - Define the person and organization that is to receive the information
  - Determine if the documents to be transferred are to be released for modification or for view-only. If the documents are transferred as modifiable files (i.e. the recipient is expected to modify the design information), the EDMS should then set the status in the database so that local users may not modify the files.
  - Combine all the files into one document using standard compression techniques (such as Pkware's PKZIP product)
  - Create a transmittal showing the file name, drawing number, and a description as a minimum
  - Define a note to be included in the transmittal in order to pass additional information to the recipient regarding the package
  - Provide an audit trail to delineate what files have been transferred, when they were transferred, and what location and user they were transferred to.
  - Control access to EDMS functions on a user or user group basis.

The system administrator should be able to define attributes about an individual user or group of users that are related to the user's access to documents and the operations that can be performed on documents. In some cases EDMS systems can dynamically modify the GUI used for document access based on the user's rights or permissions as defined by the system administrator.

- Provide the capability for the system administrator to define document status parameters and associated access control

  The EDMS should have the ability to define a document status that controls access to a particular document. For example, a document that has a status of "Released for Construction" should modify the access control of that document, so that modification to the design data is not permitted. However, in this case, viewing (not modifying) the document should be allowed. System administrators must be able to define their own status labels to match the workflow steps that are employed in their organization.

- Interface with existing plotting sub-systems and capabilities

  Plotting is a very important function of CADD operations. This function provides the ability to create a paper copy of the digital information. The EDMS system should be able to integrate into whatever plotting system is selected by the user. The EDMS also must maintain an accounting of when plots have been created and who requested the production of the plotted output.
- Enable global database changes (i.e. revision, status, title block, etc.)

  In many cases modification of a metadata field or fields based on process changes is necessary. For example, when a project is released for construction, the user should be able to request that the status of all of the documents related to the project be changed to "Released for Construction." The EDMS should provide this feature which should allow the user to select the set of documents that would be affected and the content of the metadata field(s) to be modified. The metadata field(s) for all of the selected documents should be updated with a single operation.

- Facilitate standard drawing creation

  An EDMS must have the capability to define and enforce a standardized drawing creation function that is based on customer defined criteria. The EDMS should either have this capability built into the product or allow programmatic input to be defined. This feature should be definable on a project basis or environment basis.

- Allow for electronic sets or folders

  The EDMS should have the capability to group files together into logical grouping called electronic sets or folders. The grouping should act as one unit for all operations in the EDMS including check-in, check-out, move, copy, etc. Many engineering design software products that operate with the CADD software create multiple files such as configuration files and database files. In

these cases all related files are required for the correct operation of the engineering design software products. The EDMS should have the ability to manage all the related files and should automatically populate the EDMS database when related files are created.

- Provide control of related non-CADD documents (i.e. client specifications, project meeting notes, vendor specifications, etc.)

  The EDMS should automatically manage non-CADD format documents that are related to a specific CADD document and to the engineering process. Examples of these documents include client specifications, design specifications, project meeting notes, vendor specifications, etc.

- Provide security at the drawing level as well as the user level while respecting network security specifications

  The EDMS should allow both file level security as provided by the operating system in use and process level security as defined by project managers from within the EDMS. The EDMS should not dictate the extent of each type of security, but permit the system manager define the levels of protection.

  The EDMS security at the drawing level is used to protect the document content based on the process or workflow step at a given point. For example, if a document has been released for quality assurance, only those individuals in the quality assurance roles should be able to redline the drawing. At the same time, all other users should be allowed view only access to the document.

  Security at the user level enables the system administrator to define what EDMS operations individual users or groups of users may perform. For example, a novice user may be limited to viewing CADD drawings. In this case the EDMS should prevent the user from modifying the CADD document.

- Control the create, rename, copy, copy and replace, delete, and move document functions

  To control document operations on an individual operation basis, user level security should be configurable within the EDMS.

- Enable revision control

  The EDMS should have the ability to create and manage revisions or new versions of a CADD document. The EDMS system manager should be able to define how revisions or versions are named in order to set them apart from the latest revision or older revisions.

  The document status should be definable based on revision changes and storage. Since status control could affect access to a document, it can be used as a way to prevent the modification of archived revisions or versions of a CADD document.

Revision or version control definition should be done on a document format basis. Some document types require revision control and monitoring and other document types require no revision control. When revisions can be controlled on a document format basis, those formats that require little or no revision or version control do not suffer from the system overhead required by document format types that require revision or version control.

- Automatically control and manage all reference file information

  Many popular CADD systems allow the use of reference or overlay information. In AutoCAD these files are called XREF files and in MicroStation these files are called reference files. The EDMS should recognize when reference files are associated with a CADD document and should satisfy the need to display the reference files without any user intervention. The EDMS also should recognize associated CADD support files including pen tables, color tables, and font resource files.

EDMS Components – Technical Specifications

Network Hardware

Network hardware is the backbone of any EDMS system. It carries all digital data from client node to server, server to client, as well as from client to client. Hardware components of any network include a network interface card (NIC) within each node, various cabling, and at least one node acting as either a dedicated server or both client and server. In larger networks, repeaters and hub devices can be used to "boost" and distribute the network data transmission. The collection of equipment functioning as a single communication group is traditionally referred to as a Local Area Network or **LAN** (Figure 8). LANs are designed to enable users to create, view, and modify centrally located documents that are stored on the "server" platform. Multiple users can simultaneously access these documents. Network operating system, EDMS software, and a database system are installed onto the server hardware to provide and manage these capabilities as well as other server functions including faxing, printer sharing, Internet publishing, and database storage.

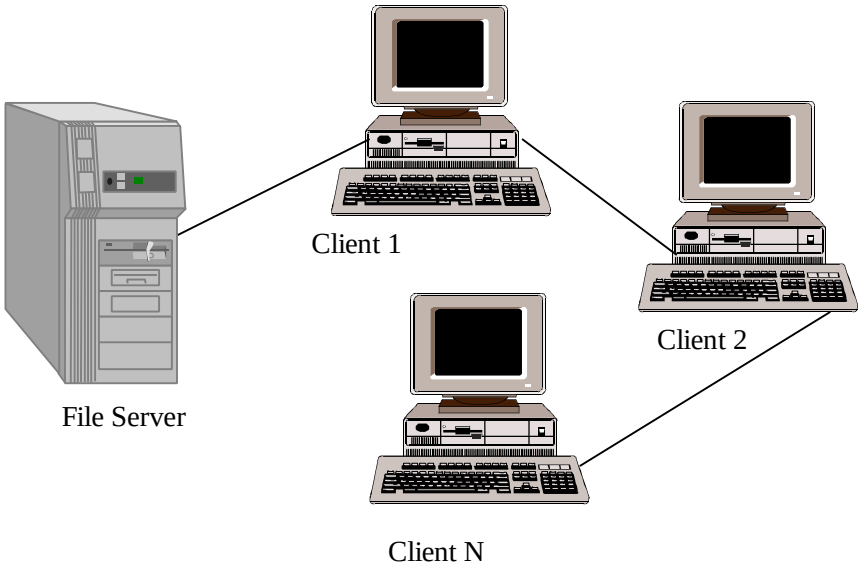


Figure 8. Basic PC Local Area Network Configuration

Network hardware devices adhere to certain specifications used to classify their compatibility and performance. The most common hardware is known as Ethernet. Ethernets can transfer data at a rate of up to 10 megabits per second (mbit/sec). Ethernet networks operate in a "highway" environment in that data transmitted to or from a client competes for the usage of a common medium. Therefore, when Ethernet communication traffic is heavy, the highway can become congested and clients may have to wait to use it. Network congestion causes a loss in performance. Frequent congestion occurrences over a small amount of time can become a serious bottleneck. With the addition of more clients transferring data on a LAN simultaneously, the network's performance will further diminish. Performance loss is exacerbated in the engineering process in that engineering documents (i.e. CADD files) tend to be much larger than documents related to the business process in a properly designed system. EDMS software can manage the engineering process and workflow to minimize this traffic.

Within the last few years, two new Ethernet solutions have been introduced to improve performance. The first solution is known as Ethernet Switching and is shown in Figure 9. Ethernet switches are hub-type devices that dramatically reduce the occurrences of data competing for the same limited bandwidth. Ethernet switches help to maintain the performance of the network as data traffic increases. A high speed "switching engine" chip is used to intelligently route network data from source node to destination node without broadcasting (repeating) it to the other nodes within the LAN. Basically, each node is given its own "dedicated lane" within the highway on which it flows. The second improvement to Ethernet has been the introduction of Fast Ethernet. Fast Ethernet works the same as Ethernet except that it transfers data at 100 mbit/sec, 10 times faster than Ethernet (10 mbit/sec). It is important to note that Ethernet and Fast Ethernet nodes cannot communicate with each other directly. An Ethernet/Fast-Ethernet Switch is required to enable the two technologies to coexist. Ethernet networks rely on either fiber-

optic, twisted pair, or coaxial cable to function. Fast-Ethernet networks require either Category 5 (CAT5) twisted-pair or Fast Ethernet fiber-optic cable and transceivers. Additionally, Fast-Ethernet NICs are able to perform at regular Ethernet speed (10 mbit/sec), but Ethernet NICs are not able to function at Fast-Ethernet (100 mbit/sec) speed.

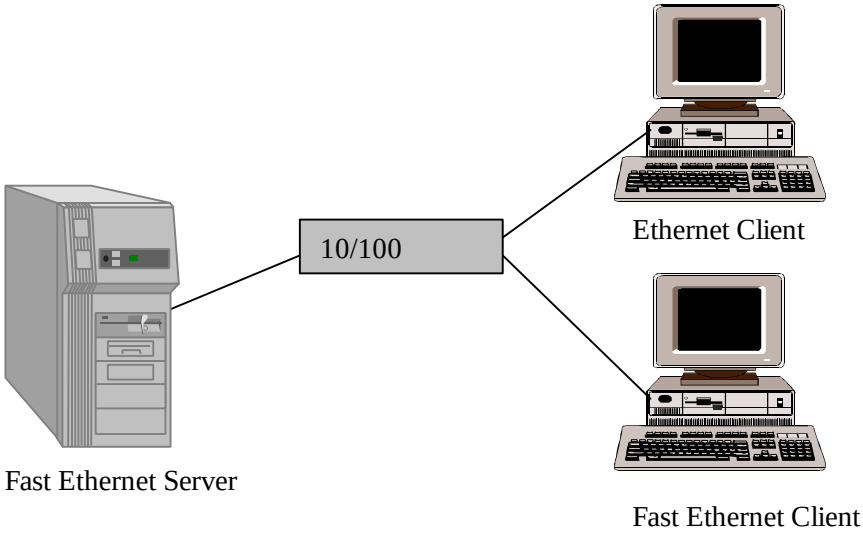


Figure 9. Modern Ethernet/Fast-Ethernet LAN

Server Node

The server node can assume many roles in the implementation of an EDMS system. The LAN server ideally is located in a central location that users access for any of the following resources:

- databases
- documents
- applications
- printing
- faxing
- web publishing
- central data backup
- data archival

The role of the server is not always as a dedicated one. It is possible with commonly available operating systems and hardware, to create a small network that will use PC hardware as both client and server to the network. Typically, networks rely on either a single PC or many PCs to take on the dedicated role of server. Within the realm of EDMS, the mission critical nature and the vast amount of documents being managed require a server to be secure, fault tolerant, and highly available. These features are common and easily acquired from today's systems vendors.

Currently, three Network Operating Systems are most commonly used within EDMS configurations: Novell Netware, various versions of UNIX, and Microsoft Windows NT Server. Each of these systems can provide:

- File and printer sharing
- Database hosting
- Internet publishing
- Primary and secondary storage
- Fault tolerance
- RAID level data guarding

The hardware requirements associated with such features vary with each operating system product and the hardware to be integrated.

Currently, Microsoft's Windows NT Server is capturing most of the market for new server installations while most hardware manufacturers and software developers are selecting it as their primary platform for new product development. The following is a list of some of the reasons why this product has gained such popularity:

- Low cost of ownership including purchase, implementation, and training
- Bundled Internet tools
- Uses common Graphical User Interface (GUI)
- Administrative Wizards for novice administrators
- Strong network connectivity with many other networks
- Flexible client licensing schemes
- Large choice of available server applications: SQL, e-mail, Internet, document management, file sharing
- Large choice of compatible hardware
- Bundled migration tools
- Fault tolerance support

Due to its popularity and emerging prominence, Microsoft Windows NT will be used as the Network Operating System within the various illustrations and explanations throughout this section on EDMS components.

System Requirements

EDMS servers utilizing Windows NT Server V4.0 as the Network Operating System demand a large amount of storage space as well as RAM memory. Windows NT Server, like other multi-tasking operating systems, performs at its best when it does not have to write memory pages out to disk when memory utilization is maximized. Windows NT Server also takes advantage of extra available memory to map contents of frequently accessed files directly to memory, thereby boosting the reading/writing performance of those files.

Processor type and speed must be considered as well. Windows NT Server supports Symmetric Multi-processing (SMP) and therefore can utilize multiple processors to further boost its processing performance. While performing typical server tasks such as file and print operations, SMP would most likely not be a significant advantage. However, when EDMS related server applications such as SQL database, network faxing, and/or e-mail are to be integrated, then SMP could be a benefit since many more processing operations would occur simultaneously.

Important note: Not all processors are available in SMP configurations. Currently, the Intel Pentium II processor in multi-processor configurations is only available from a few systems vendors. The Intel Pentium Pro is currently considered the workhorse processor in SMP configurations. All major brand name server vendors currently support SMP hardware with Windows NT Server V4.0 as a preinstalled Network Operating System.

The following guidelines (Figure 10) can be used to determine the minimum server requirements to support EDMS.

	Windows NT Server V4.0
MINIMUM SINGLE PROCESSOR	Pentium II 233 mhz
SMP processors	Pentium PRO or Pentium II
Minimum memory	128 MB
Minimum hard disk space for operating system	1.0 GB
File system	NTFS
Network interface	Fast Ethernet or Gigabit Ethernet
Primary storage type	RAID 5 HW based hot pluggable

Figure 10. EDMS Server Base System Requirements

A suggested formula for determining storage requirements is:

TOTAL PRIMARY STORAGE =
(total size of server apps + NOS (**N**etwork **O**perating **S**ystem) size + max print spooler size + total page file size + existing documents size + existing database size + future database size for future added docs + anticipated future added documents size) *1.30

NOTE: 1.30 Multiplier is used to maintain the primary storage at a maximum 70% full rate to reduce disk fragmentation.

Input/Output System

The size of an electronic document to be stored is affected by certain variables. These variables include the physical size of a document, the resolution of the scanned image, and the storage of the image as color, grayscale or black/white. Therefore, documents in an EDMS have no “typical” file size.

The core function of any server is the transfer of various types of data to and from various components within the server as well as externally to clients throughout the LAN, WAN, or Intranet and Internet. Application and document access as well as printing and database manipulation all demand substantial resources from the input/output (I/O) system. The selection of a quality high performing and expandable I/O system components is one of the most important decisions that must be made, especially when considering the large amounts of data that are involved with the engineering process. Often, the decision to select the fastest CPU processor speed is mistakenly made and consideration of the I/O system is overlooked. File and print data account for the majority of the system bus utilization within a standard server. I/O system components include memory, hard disks, disk controllers, system bus, and network interface cards.

The various storage systems within an EDMS server all lie within the I/O system and all compete for its resources. These storage systems are as follows: Primary, Secondary, Magneto-Optical (MO) Storage, and Tape/Sequential. Each of these systems has pros and cons regarding their usage, performance, and associated costs. Figure 11 depicts the relative costs and performance as well as the unique characteristics of each system. In addition, each defined storage system can be used to compliment the other as far as redundancy and protection of data, which is of extreme importance when maintaining any EDMS.

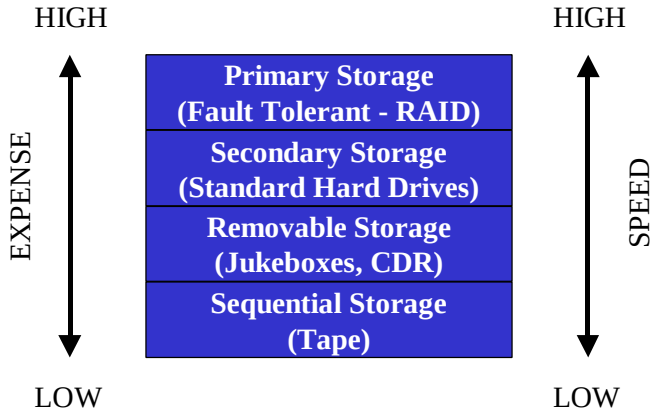


Figure 11. Storage Management Hierarchy

Primary Storage and RAID

RAID (Redundant Array of Inexpensive Disks) sets are used in many EDMS servers and give fault tolerant high availability to data servers. Of the five levels of RAID, RAID level 5 is the most popular and recommended for EDMS server's document storage. RAID 5 enables a set of disks to act as a single logical partition and uses parity information (called "parity strips") to protect data should a single disk failure occur. RAID 5 dedicates the equivalent of one disk for storing the parity strips but distributes the parity strips across all the drives in the group. The data and parity information are arranged on the disk array so that they are always on different disks. A minimum of three disks is required to create a RAID 5 set. Both software and hardware versions of RAID 5 support are available. To maintain the array of disks without impacting resources from the central I/O system the

recommended approach is to use a hardware solution since there is dedicated processor and memory included on RAID 5 disk controllers.

Secondary Storage

A secondary storage system utilizes standard hard disk technology which does not provide redundancy should a component fail. Current hard disk technology provides massive storage capability and performance at a very nominal cost. An EDMS server could contain both RAID 5 and secondary storage drive sets. Non-critical documents could be placed onto secondary storage, and performance on par with primary storage could be maintained at a cost significantly less than placing non-critical documents onto primary storage.

Removable MO Storage

Removable storage devices function similar to a hard disk, yet the media is removable and can have a life expectancy of 100+ years. The most popular attribute of these storage systems is their ability to separate the media from the storage unit and place it in off-line storage. This function can be automated if an optical disk jukebox device is integrated into an EDMS server. These devices have robot-type mechanical components that move media in and out of the drive mechanism and place the ejected media onto the unit's internal media rack or into a "mail slot" for removal. Currently, units can store up to 600 gigabytes of data or approximately 155,000,000 pages of text or 2,500,000 CADD drawings. Access time for these devices is much slower than for hard disks because of the technology used and also the fact that documents requested may be located on a stored cartridge that must be loaded into the drive mechanism prior to document retrieval.

Network operating systems do not supply software drivers to manage jukeboxes. Therefore, a software solution is required when integrating one of these units. Jukebox management software falls into a category known as HSM (Hierarchical Storage Management) which can automate the process of moving aged or inactive documents onto these devices to free primary and secondary storage for active data. With these systems, EDMS users do not need know the physical location of their documents. Retrieval is performed automatically when the documents are requested through the server operating system. HSM systems deliver the management function that migrates aged and inactive documents to near online storage (MO jukeboxes) so that the primary storage will run efficiently and not be congested with documents that are not frequently accessed. HSM is a software solution that typically can access all types of storage hardware and therefore can be utilized within very diverse hardware configurations.

COLD Technology

Computer Output to Laser Disk (COLD) technology is confused at times with the imaging world. COLD is used in organizations that require computer systems to generate large volumes of data and reports. COLD is typically not used for in-process engineering documents but rather letter/legal size business documents. The

traditional solution has been COM (Computer Output to Microfilm) systems, which record general computer documents onto microfilm.

With COLD technology, computer reports that would otherwise be printed on or sent to a microfilm recorder are instead transferred directly to an optical disk. Most COLD systems use WORM (Write Once Read Many) disks since WORM provides the large storage capacity and permanence that archived records normally require. Because COLD and image technology both use optical disk as the storage medium, sometimes the two are confused. The key distinction is that document imaging stores replicas of paper based documents that have been scanned into the system, while COLD stores raw computer data put directly into a storage application and then displays this data in a variety of report formats. COLD also automatically indexes incoming data. COLD systems are well suited to organizations that create, maintain, research, and store high volumes of statements, invoices, checks, account status documents, or other types of computer generated financial records

Benefits of COLD

- Price/Performance - low cost, high storage capacity
- Fast Access - a significant improvement over paper
- Multiple Field Indexing - Well designed software lets users locate data by any indexed key.
- Text Search - Users can search for text strings automatically, allowing retrieval of specific on-line data.
- Archivability - Optical disks have a long life well beyond 30 years.
- Legality - Rulings have determined that optically stored records are true copies of the original data.
- Return on Investment - Most COLD systems have a pay-back period of less than six months.

Worm Technology

WORM technology (Write Once Read Many) is hardware and/or media that assures that data can be written to the media only once and cannot be removed. CD-ROM, CD-R, and WORM MO media are examples of this type of technology. The rigid capability of only one writing pass to the disk track is beneficial to corporations that require archival data to be safe from possible overwriting. This technology, just as other mediums, is not tamper-proof or protected from physical misuse and damage. However, WORM media is considered to have an archival life of at least 30 years.

Sequential Storage

Sequential storage systems are low performance devices used for data that is being purged from the system due to obsolescence. Since data is stored on these devices sequentially, they are considered to be off-line from access by users. Usually, an administrator would be required to manually recover the data should it become necessary to again activate its use. Typically the media from a sequential storage device (tape or cartridge) is stored off site. Off site storage protects the data

should a catastrophe such as fire occur. These devices may require additional software to make them function with the network operating system.

Currently various sequential systems are available. Very high capacity devices use mechanisms similar to MO Jukebox devices that maintain a set of tapes as single logical tape. Such devices provide automatic tape insertion during backup and restore operations without human intervention. Figure 12 shows capacity and throughput specifications of four commonly used tape storage systems.

	TRAVAN	**4mm DAT**	**8mm Exabyte**	**DLT tape**
Max capacity/tape	20 GB	96 GB	3,200 GB	3,400 GB
MAX THROUGHPUT	600 Kbyte/Sec	2,200 Kbyte/Sec	25,000 Kbyte/Sec	20,000 Kbyte/Sec

Figure 12. Popular Tape Backup Device Specifications

3 Workflow Process

Document Workflow Process: Overview

This section presents general workflow information common to both CADD and typical business documents first. Information on CADD-specific workflow follows the more general introductory information.

Workflow is the sequence and routing of tasks performed by members of a workgroup to complete a job. Discrete tasks performed by any workgroup are associated with particular documents and/or versions required to accomplish the task at hand and ultimately the job. Most of the daily responsibilities addressed by people within an organization are somehow related to the workflow process. Each task requires an action by a person or team before advancing a document to the next step in the workflow. Whether these tasks generate new information or are undertaken as part of a quality assurance process, a pre-defined or project-specific path determines the order of progress for the required tasks.

Workflows, often in the form of standard operating procedures, exist in every organization. Automation of the workflow process, whether structured or ad-hoc, results in a timely execution of tasks, minimizing the time-consuming and sometimes redundant activities of the typical business day. Using automated workflow, the sequence of tasks and subtasks are controlled and uniform with work in progress automatically routed to the appropriate recipients.

The potential benefit of an integrated and automated workflow within the document management function, unavailable in a repository-only system, is substantial. Automated workflows allow parallel and serial tasks as well as nested workflows. Task reassignment and rerouting are effectively implemented. Status updates, document review, revisions, and user comments become streamlined activities. Security and integrity of the documents progressing along the workflow path are maintained by implementing access rights and version control or managing the read and read/write control during the life cycle of the document. Audit trails and the subsequent reports are easily defined. Automated workflow saves time and money.

For automated workflow to occur, the software must account for many access and routing attributes. Established users and teams must be recognized by the system, along with the different levels of access rights and security for the documents being managed. Versioning or revision control (the ability of the system

to recognize updated versions of a document) must be enabled. The workflow must be able to recognize the required tasks or actions at each step along the project path and prevent the advancement of the document to the next step until all requirements have been met. (Intergraph Software Solutions, 1997)

Workflow can be either structured or ad-hoc. A structured workflow typically is designed to control repetitive activities, and bring order and control to such processes. A structured workflow may apply to situations in the world of finance or a major design project. Ad-hoc workflow also has a beginning and ending point. The difference is that ad-hoc workflow can be modified while the project or activity is in progress. CADD documents typically are associated with an ad-hoc workflow, since CADD document workflow is so dynamic. CADD workflow steps often are determined at the time document content changes or when documents pass through quality assurance, resulting in a dynamic, ad-hoc workflow.

Regardless of whether workflow is structured or ad-hoc, documents are distributed in one of three forms: image-based, form-based, or coordination-based. Image-based workflow, developed to reduce the flow of paper within a business, directs scanned images of paper documents through a structured cycle. Form-based systems manage text-based documents rather than scanned documents and require a more sophisticated workflow, one that senses the status of the text fields and routes the forms accordingly. The third workflow, coordination-based, is designed to optimize the human activities associated with situations including manufacturing and general office routines.

A list of desirable workflow attributes follows (Network Imaging Corporation, 1995), (FileNet Corporation, 1996) and (TSA/ADVET, 1996). Workflow should:

- Support existing networks, legacy data, personnel, and general business model
- Recognize predefined policies, standards, rules and conditions and incorporate rules-based safeguards
- Support graphical design and portrayal of workflow
- Address individual and grouped tasks
- Determine required task sequence and identify required skill sets per task
- Enforce document security via controlled access
- Automatically route and reroute documents
- Control/track document life cycle
- Launch native applications
- Adhere to a calendar schedule (schedule control)
- Perform action notification
- Support view, pan, and zoom functions
- Permit redlining and user comments for documents in process
- Control revisions
- Recognize and track the creation of multiple versions
- Use document metadata to facilitate locating documents
- Generate audit trails
- Analyze performance and create status updates
- Generate forms automatically
- Link to e-mail, URL's, on-line documents

A description of each attribute follows.

Support Existing Networks, Legacy Data, Personnel, and General Business Model

Implementation of electronic document management workflow represents either an enhancement (automation) of existing business processes or a reengineering effort to establish an improved process that can be automated. Selection of an EDMS that can operate effectively with existing computer networks and legacy information is desirable. Given the cultural constraints associated with EDMS implementation, it is best to replicate the workflow that users are accustomed to, unless the current workflow is in need of reengineering. Replicating existing workflows will minimize the "start-up" curve and facilitate the transition to electronic workflow. Unless the existing (prior to automation) workflow is flawed, the automated workflow should mirror the existing manual processes.

Recognize Pre-Defined Policies, Standards, Rules and Conditions and Incorporate Rules-Based Safeguards

Corporate policies and standards regarding file access, security, distribution of information, and general workflow can be defined within the EDMS system at the administrative level. Standards and policies promote acceptable workflows by all users of the system.

Rules-based workflows safeguard and prevent mismatched features, components or actions. By applying rules, decision-making efforts at the production level are reduced and tasks can be accomplished in a more effective manner.

Support Graphical Design and Portrayal of Workflow

The ability to define workflow pictorially is desirable. To use graphical workflow design features, icons or symbols representing the various steps of the workflow and associated resources are "dragged" to appropriate locations and linked as required. Typically these pictorial representations show the daily business processes associated with a project. Once the steps in the workflow are established, they are linked to qualify the desired workflow. Many users more readily understand the overall workflow when they view a pictorial representation.

Address Individual and Grouped Tasks

A task, once completed, occasionally breaks into parallel subsets of tasks that either lead to other individual completion goals or converge at a point along the workflow to re-establish the single path.

Determine Required Task Sequence and Identify Required Skill Sets Per Task

Task sequencing simply determines and establishes the logical sequence of steps to be completed so that desired goals can be achieved effectively. Each completed step in the workflow should have a "beneficiary" defining the next step (if any remain) in the workflow.

A workflow should determine the person(s) most suited (skilled) to complete a task and route the task to that person. The workflow application manages queues of pending documents to balance the workload of those personnel assigned to process incoming data.

Enforce Document Security Via Controlled Access

Document security prevents unauthorized modification of a particular document. Different levels of access privilege are predetermined, such as read-only, read - write, red-line, and comment. As a rule, only files relating to a particular user's task will be displayed for that user.

Automatically Route and Reroute Documents

The EDMS should monitor the status of a document and at the appropriate time either move the document to the next step in the workflow or reroute it for modification of content.

Control/Track Document Life Cycle

Document life cycle controls individual with appropriate privileges to monitor the progress of a document, and alter the workflow.

Launch Native Applications

The ability to launch native applications allows system users with write-access to documents stored in native format to modify a document within the EDMS environment. Clicking on the selected document will launch the appropriate application to open the document. In some cases, multiple applications could be used to manipulate documents in a particular file format. When multiple application programs could be used, users should be shown available applications and be given the ability to choose the one he or she wishes to use.

Adhere to a Calendar Schedule (Schedule Control)

EDMS workflow can facilitate schedule conformance by effectively assigning resources to tasks and making adjustments to resource assignments if a schedule conflict arises.

Perform Action Notification

Action notification is a feature that sends a reminder to a user in the workflow who has not responded to a task in his or her in-basket within the required time frame. Generally a time-per-task is defined. For a workflow to be effective, each document must proceed along the charted path within a predetermined schedule.

Support View, Pan, and Zoom Functions

An EDMS viewer should allow users visual access to all or a portion of a document. Ideally multiple pages of a document can be viewed simultaneously as well as different versions of a document.

Permit Redlining and User Comments for Documents In Process

Individuals responsible for particular tasks need a mechanism to share project-related ideas, concerns, and opinions at various stages in the workflow.

The ability to comment on or markup a document, to indicate suggested revisions is important for persons who have been delegated that particular responsibility (a person given the associated access rights assignment). Redlining overlays the document in question and does not alter the document itself. This function usually includes "sticky note" annotation for lengthy comments.

Control Revisions

When the requirements of a task are met, the existence of the new version should trigger the advance of the document to the next step in the workflow. The ability compare multiple versions of a document within a workflow is a desirable attribute of the EDMS.

Recognize and Track the Creation of Multiple Versions

If a document must at some point be routed to multiple users the system must assure that if the "truth" file is modified, all clones of that file also are modified to reflect the revisions.

Use Document Metadata to Facilitate Locating Documents

An EDMS needs to recognize and search on such metadata as account numbers, client names, project names, and other information that may be queried via a key word search.

Generate Audit Trails

Audit trails track the life history of a document through the workflow process. Each milestone in the life-cycle of a document is recorded and can be referenced if

necessary.

Analyze Performance and Create Status Updates

Performance is measured by the efficiency of the resources associated with a project by gauging progress with schedule milestones. Potential bottlenecks are uncovered and, using a robust EDMS, resources are reassigned.

Project status can be extracted from the information available at each project milestone, allowing a user to generate a report reflecting current status.

Generate Forms Automatically

Templates and forms developed to address specific issues can be programmed to appear to users at appropriate places along the workflow.

Link to e-mail, URL's, On-line Documents

The ability to attach to a workflow all the vital components necessary for the efficient completion of a project is desirable. Workflow-related documents typically are not routed through a corporate e-mail system to a user's URL; however, notification of pending assignments in a user's "in-basket" is commonplace.

CADD-Specific Workflow Requirements

CADD workflow addresses many of the typical workflow processes as well as processes and tasks unique to the CADD environment. CADD files are much larger in size than standard business documents and require stricter management of repository resources. MicroStation reference files and AutoCAD XREF files associated with an accessed CADD file should be easily identifiable and displayed or downloaded with the selected drawing as well as the appropriate cell or symbology libraries.

Controlling access to documents as they pass through their life cycle is one of the most important components of automated workflow related to CADD drawings. Access control should be invoked automatically when a document status change occurs. As an example, when a document enters into a QC state or status, the document should be controlled to allow redlining of the document by those persons assigned to the QC functions, while ensuring others can not modify the file.

Metadata related to a document also may require access control features. In some instances, metadata related to a document should not be modifiable when the document status dictates that the document content itself may not be modified. Metadata should be definable on an individual status basis.

Automatic notification through corporate e-mail systems should occur based on

status change. This feature should have the capability of configuration on a project basis because mail messages and routing information can change from project to project.

Document notes should be available to allow the user to define the reason for status change and also to define document content changes as they occur at any step in the document workflow. These notes should contain at a minimum the author's name, date and time, note type (i.e. general, status change, revision, system generated etc.), note subject, and note content. These notes should be saved in a separate table within the EDMS database and remain related to an individual document. Users should be able to search the notes database by content sub-string, date range, author, subject, and note type. Wildcard searches should be employed for each metadata member.

An accounting of each workflow step should occur. This accounting should automatically delineate such items as operation (i.e. new revision, status change, etc.), user, date and time, and workstation name. This accounting would not only audit existing workflow compliance but also provide a history that may be studied and used as a tool to optimize future workflow definitions for similar projects.

The life-cycle of a typical CADD file may be transitory or lengthy, depending on project requirements. A simple CADD drawing is created based on preset criteria, usually project related. A base or seed file containing the general parameters for the project is the source for each project-required CADD-generated file. As a rule, the electronic workflow for a CADD file will closely resemble the conventional (non-automated) workflow for the same document.

The Life-Cycle of a Typical CADD Drawing

Source data, either hard copy or electronic, provides the foundation for the drawing. This information can be comprised of sketches, dimensioned details, survey data (both electronic and "field book"), or large format drawings. The information is introduced into the CADD file as symbology or coordinate points, providing the base information on which design or as-built data is input. Finally, by either referencing the information to be digitized as background or by registering a hard copy of the information on a digitizing tablet, the CADD technician inputs the information into the file.

Upon completion of the electronic file a print or plot is generated. These prints or plots are then passed on to a QA/QC reviewer to be checked for accuracy, completeness and overall compliance with the project specifications. Desired modifications and redlines are noted and, if necessary, the prints or plots are returned to the CADD technician for revision. This step in the life cycle is repeated as many times as needed to produce a final CADD file.

Once the CADD file is revised, a second file plot is created for final review. If acceptable, the file is submitted for delivery to the customer and an archive copy is created. Back-up copies of electronic files preferably on-site and off-site must be maintained. Near on-line access to the on-site files makes the revision process or the addition of as-built data more efficient. Figure 13 depicts a typical CADD workflow.

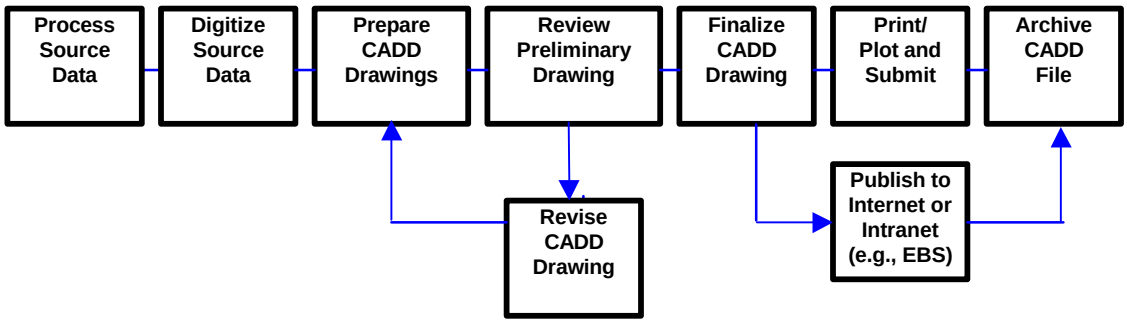


Figure 13. Typical CADD Workflow

More complex CADD design projects usually require more steps to produce required deliverables, and involve additional staff. Review by those accountable for the design detail as well as the confirmation of general information accuracy are two examples of critical steps in the production of the design file. Files may be maintained on-line or near on-line during the period that the client assesses the submitted project files.

The workflow path of an AM/FM/GIS file can be extremely complex. The process of constructing the file entails including additional peripherals such as database linkages, tables, and reference information. Preparation of complex CADD files requires full integration of spatial and attribute data.

Benefits of Automated CADD Workflow

Integration of CADD production tasks into an automated workflow results in a myriad of benefits that include:

- Productivity improvements as the workflow is streamlined
- Document access improvements for all project teams members
- Productivity improvements resulting from the decreased time required to locate drawings, facilitated by the use of metadata
- Productivity improvements from the ability to view files quickly prior to launching the associated native application
- Productivity improvements from automated document distribution and reproduction
- Analysis improvements from the ability to simultaneously view scanned legacy drawings alongside more current as-built information
- Quality and response time improvements since versioning control allows prompt response to change orders
- Quality and productivity improvements resulting from the EDMS preventing

duplicate production efforts via the check-in/check-out process
- Security improvements since documents are secured from unauthorized access
- Project accounting and forecasting improvements from automatic generation of reports reflecting time spent on individual drawings, milestone progress, backlog, etc.
- Audit trail improvements that allow document access and state changes to be tracked to evaluate existing workflows and better define or streamline future workflows.

CADD Workflow Summary

Automated electronic workflows are used to move information through a series of steps and processes to reach an end result. The process becomes more complex when applied to CADD files. In a CADD environment, any particular drawing, such as a landbase, may need to be accessed by teams of technicians and designers to support a task assignment being carried out by others. The use of reference and seed files as well as multiple drawing layers makes version control a critical aspect of CADD workflow. As any file progresses through a workflow, all associated files must be identified and accessed. All the functionality required of EDMS workflow for business documents apply to CADD file management; however, CADD files are much more expansive documents with numerous interrelationships.

4 Current Use of EDMSs in DoD

Introduction

The Tri-Services CADD/GIS Technology Center elected to employ a user's survey, follow-up telephone interviews, and site visits as a means to gather the collective experience of EDMS users within DoD and the private sector. Within the DoD community, users have experience with multiple hardware and software configurations. These range from the JEDMICS (Joint Engineering Data Management and Control Systems), adopted as a standard for DoD storage and management of engineering data in 1991, to systems employing COTS (Commercial Off The Shelf) software.

EDMS User Survey

An EDMS User Survey was developed as a means of capturing lessons learned by EDMS users and soon to be users. A copy of the survey instrument appears in Appendix A.

EDMS User Survey Distribution List

The survey instrument was distributed directly to a number of known users; other potential users were sent a widely broadcast e-mail message announcing availability of the survey instrument on the Tri-Service CADD/GIS Technology Center Worldwide Web Site.
Persons/organizations directly solicited for EDMS feedback are listed in Appendix A (see "EDMS Survey Distribution List").

[Note: The distribution list in Appendix A represents those persons contacted as of the dates specified. This list reflects the persons and organizations that were sent surveys. In some cases this list does not reflect recent changes in contact persons/organizations, since such changes occurred after the date of the survey distribution.]

EDMS User Survey Results

Of the 76 surveys distributed to personnel in the DoD and private sector, only five completed surveys were returned. A brief summary of these five responses, which are contained in Appendix B, follows:

Table 1
Summary of EDMS User Survey Responses

Organization	Contact Person	EDMS in use?	EDMS Planned?	Key Observations
Iowa National Guard HQ at Camp Dodge, IA	Dan Jave	No	Yes, but timing unknown	The current manual document management system will be ineffective as documents are made available to more users. A management system will be needed. CADD drawings are to be stored. Looking at placing documents on an Intranet also.
Navy PWC, Portsmouth (VA) Site Engineering Division	Jim Michonski	No	Yes, within 12 months	Concerns in moving forward are: 1) cost to implement, 2) system maintenance, and 3) proper storage format for compatibility with existing & proposed DoD standards. CADD drawings are to be stored.
USACE Jacksonville Dist. Engineering Dept.	Roger Porzig	Yes	---	Current user of Falcon/DMS. Has 115 system users with 35 concurrent. Primary function of EDMS is to manage CADD files, including legacy data. Not using electronic workflow. EDMS implementation hampered by LAN issues. EDMS payback was 12.5 months; it saves time searching for files.
Baltimore Gas & Electric, Gas Eng. and Construction Department	Larry Condry	Yes	---	Current user of File Magic Plus. Has 200 users with 20 concurrent. Acquired EDMS to supply most current record drawings to users in Districts. All drawings are scanned to produce TIFF files that populate EDMS, including legacy data. Current software not designed to capture CADD files. Internet & Intranet integration not being pursued.

Table 1
Summary of EDMS User Survey Responses (Cont.)

Organization	Contact Person	EDMS in use?	EDMS Planned?	Key Observations
U.S. Army Aberdeen Proving Ground, Directorate of Safety Health and Environment	Sterling "Bud" Keesee (New contact not the survey respondent)	Yes	---	The Environmental and Real Property Management System (ERPMS) has been implemented to manage all National Environmental Policy Act documents for the host and tenant activities. Document management and document approval and routing are accomplished using widely used COTS, principally Microsoft Access and Novell GroupWise. ERPMS serves 25 users, 5 concurrent. Web-based access is in the developmental stages.

U.S. Army Corps of Engineers, Jacksonville District

Additional information on the EDMS at the Corps of Engineers' Jacksonville District, beyond that collected via the survey tool, was obtained via a site visit and a review of a presentation by Mr. Roger Porzig entitled "Saving Money and Your Sanity." Mr. Porzig, the CADD Manager at USACE Jacksonville, stresses people issues when implementing an EDMS. He stresses that the EDMS must fit active systems and processes to have users embrace the new technology. User acceptance also depends upon how well users are informed of plans for an EDMS procurement and how well their concerns are heard and addressed. Mr. Porzig reports the following benefits of using an EDMS:

- Far less disk maintenance (85% reduction in time spent managing data on disk)
- Much faster access to complete data sets (now hours versus days)
- Improved information on usage patterns
- Improved productivity allowing more time to be spent on other issues

Interestingly, the payback period listed in the table above was based on a comparison of the cost of user search times before and after EDMS implementation to determine direct savings. Savings from reduced search times were compared with the cost of acquiring a functional EDMS system to yield a 12.5 month payback period. However, this conservative analysis ignores other savings, such as productivity-related cost savings from consistently working with the most current files. Consideration of such issues would decrease the payback period.

Aberdeen Proving Ground (MD) Environmental & Real Property Management System (ERPMS)

The completed survey and follow-up discussions during an on site meeting with Mr. Reed MacMillan, former Chief of Environmental Planning at Aberdeen, were used to capture information on ERPMS.

A five-year effort by the Directorate of Safety, Health and Environment at Aberdeen Proving Ground has resulted in a low cost but highly effective data management system. Based on COTS software packages including Microsoft Access, Word and Novell GroupWise, this system has enabled timely sharing of NEPA (National Environmental Policy Act) documents with the APG community. The NEPA process requires a multitude of reports and maps, ranging from environmental assessments and impact statements, which contain numerous maps, to special studies such as noise/AICUZ, cultural resources, threatened and endangered species studies, installation restoration documents, socioeconomic analysis and traffic studies. Finding appropriate information and avoiding duplicate studies requires efficient document management.

Novell GroupWise serves as the distribution tool, as well as the means of notifying users that a document's status has changed. If a document is modified by the recipient, a backup copy will be created on the recipient's machine. Hardware minimum standards were based on the criteria as defined by the Directorate of Information Management. However, many of the on-site PC's do not currently comply with these standards, thus rendering them incompatible with the system.

Using common COTS database, word processing and groupware packages to achieve EDMS functionality requires that all users have the same software versions and upgrade to higher versions at the same time. Upgrades to higher versions also can require some amount of reprogramming to retain compatibility and functionality.

The APG system effectively routes and tracks the NEPA documents from cradle to grave. This is important in that environmental issues directly affect many activities within federal agencies, including military installations. As shown on Figure 14, the APG intranet and LAN effectively enable the distribution of the documents to all interested parties within the Aberdeen Proving Ground site.

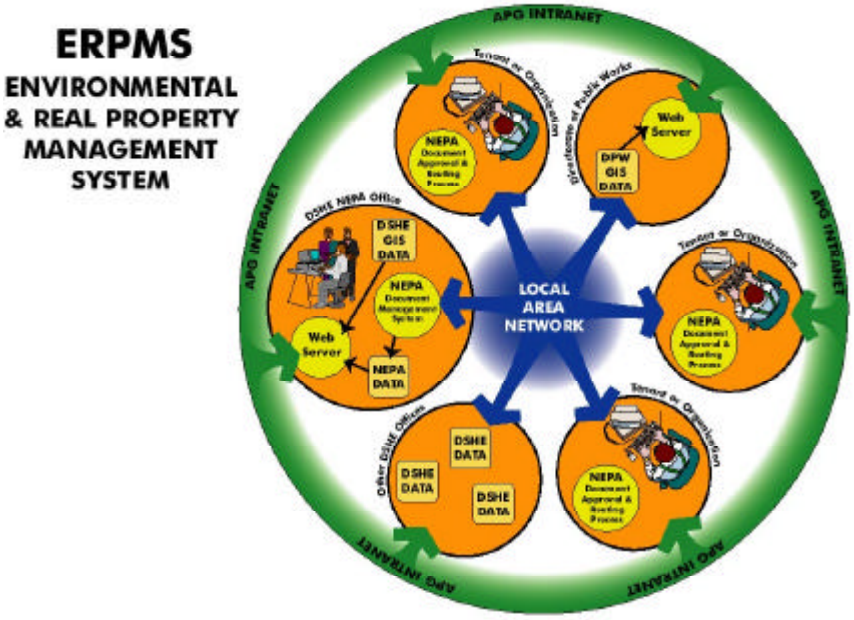


Figure 14. NEPA Document Workflow Within Aberdeen Proving Ground

The APG approach has been a very cost-effective means to implement EDMS on a day-to-day basis.

Certain system enhancements will be undertaken in the future. When upgraded and integrated with the on-base GIS, users will be able to select a location on a map and have the system identify environmentally-related documents for that site and its environs. For example, a user will be able to draw a one-mile radius and ask for all RECS within that area. The matches will be displayed on the map, and a list of the documents will be presented for review. Web access will provide an even more efficient mode of sharing the NEPA information with both the military and public sectors. A transition from the current Microsoft Access database to an Oracle database also is planned.

Information on other DoD and Federal Sector EDMS Users

To gather additional information on COTS EDMS software in use at DoD facilities, telephone calls, site visits, and World Wide Web searches were conducted. Information obtained in this manner is summarized below.

Naval Air Station Patuxent River (MD) Public Works Department

Initial information on the Electronic Document Manager at PAX River's Public Works Department (PWD) was derived from a National Technologies Associates, Inc. (NTA) web site "created for NAS Patuxent River Public Works, Contact:

Bobby Bean (NTA, 1998)." The information obtained in this manner was supplemented by a Patuxent River site visit with Mr. Bobby Bean and several personnel from NTA on 14 August 1998.

From the outset, Mr. Bean stressed that the PAX River Electronic Document Manager should not be viewed in isolation, the EDM is an integral part of a Shore Station Integrated Information System (SSIIS). SSIIS is a shore station enterprise-wide system. It integrates all steps in the typical life cycle of shore facilities, beginning with identification of facility requirements and progressing through planning, programming, budgeting, acquiring, inventorying, operating, maintaining, evaluating and disposing of assets. The SSIIS effort integrates four IT platforms: CADD, GIS, DBMS (both relational and flat file systems) and EDM.

> A Resource Management Board has broad responsibility for improving and integrating information sources. Under the Resource Management Board is an Implementation Council responsible for the implementation and execution of the strategic plan for Business Information. The Implementation Council is supported by an Applications Council, Architecture Council and Data Council. Each Council is responsible for leading and developing strategies for life cycle management to support an integrated business process approach. These Councils also are to provide a migration approach that will allow PAX River to keep in step with technological advancements

The Electronic Data Manager (EDM) being developed for PAX River will be the primary vehicle for identifying and eliminating redundancy and facilitating information sharing. It links documents, people, culture and business processes to facilitate document sharing and spawn innovation.

As depicted on Figure 15, the PAX River EDM can/will manage a broad range of electronic file types, including GIS, CADD, World Wide Web, images, audio/video, and text. Metadata regarding these files feeds libraries and databases to permit knowledge mining. Use of metadata (called "associations" in EDM lingo) allows access to individual document components that are part of larger documents. In this manner, documents can be stored once versus numerous times, reducing data redundancy.

Developmental efforts on the EDM have been underway for approximately 18 months. An early pilot was conducted that involved loading Operations and Maintenance Manual hard-copy documents for approximately 1,200 facilities into electronic readable formats that allow for full text search capability. The Public Works Department has responsibility for all building, facility and project documents, which historically were housed in a paper-based Technical Library containing over 2,000 binders and folders. The operational and maintenance manual pilot scanning project involved 458 manuals scanned, which equates to about 350,000 pages, 70,100 files and 7.6 GB. As part of the data imaging and capture process, associations (metadata) were generated, including data on building numbers, model/serial numbers, schematic/drawing numbers, equipment inventory codes, and contract item line codes.

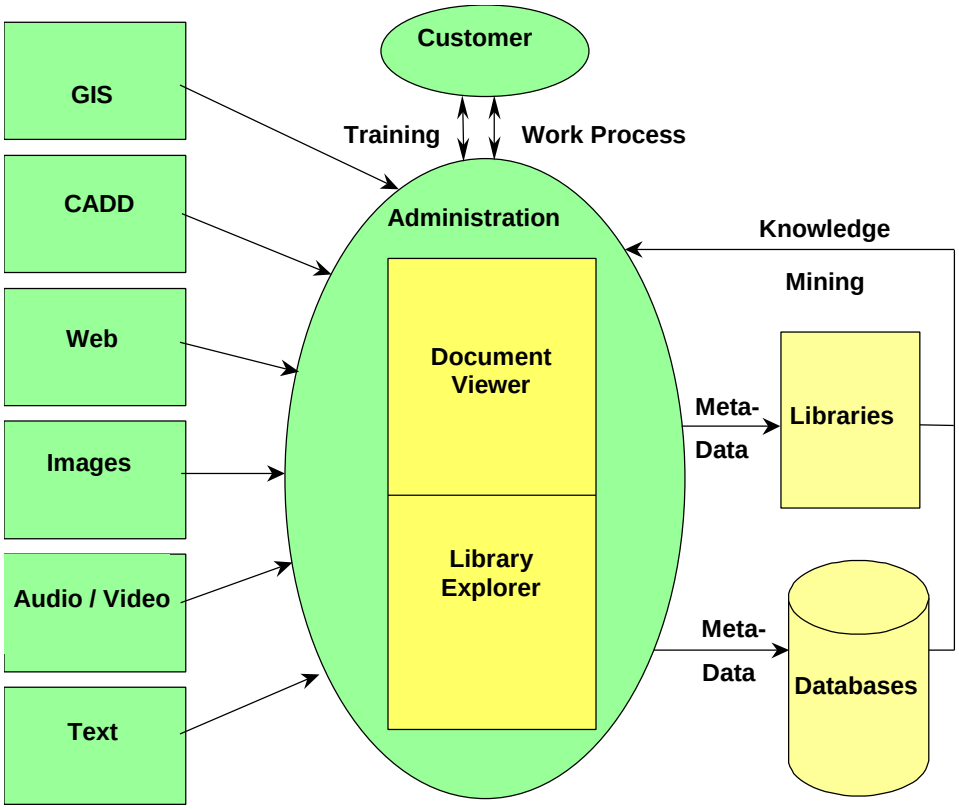


Figure 15. Electronic Document Manager Process at Patuxent River NAS

The PAX River EDM incorporates the following six functions:

- System Administration: This is the central launch point from any client. System upgrades are accomplished at the server level, giving users immediate access to the software updates upon network log-in.
- Library Explorer: The library function controls check-out and check-in, and assigns document manipulation rights (modify vs. read-only) depending upon which user signed out a document first.
- Document Viewer: Some documents are assembled using a number of different file and image types. EDM supports a large number of electronic formats and is able to launch appropriate commercial-off-the-shelf viewers for the many data types encountered as one moves through a document.
- Team: The Team function is the communications tool for collaborative work, ranging from broadly distributed new flashes to a chat system, video teleconferencing and peer communications.
- Data Mining: This function uses associations (metadata) for enhanced search capabilities to quickly find needed data.
- Training: Traditional classroom training is employed: however, Just-in-Time (JIT), Computer-Based Training (CBT) is being implemented, allowing users to tailor their learning pace to their abilities, needs and time constraints. This electronic means of training is being tailored to the daily business processes and workflow.

At this time, there are approximately 296 users who have access to the EDM functions. About 82% of these users come from Public Works (which includes the environmental functions at PAX River) and the remaining users are dispersed throughout the Shore Station. At PAX River, the EDM not only supports traditional facility management functions, but is proving useful in the National Environmental Policy Act (NEPA) planning process. Likewise, the EDM is helping to clearly define contractual requirements and limits for outsourced custodial services.

Upon completion of the ongoing software development, the Electronic Document Manager will have functionality of particular interest to engineering and facility managers. These functions include: improved CADD document viewing for AutoCAD, MicroStation, and ArcView images; image hotspots that support zoom functions; workflow via a flexible workflow builder; sticky note features to support team commenting; team messaging, including broad distribution messaging ("news flashes"); a chat system; private communications between two parties; and Computer Based Training tailored to permit progression from a novice to expert user. In the near future, the EDM will be made "smart." This means that it will interact with the DBMS and be able to initiate actions on its own, based on certain business rules. For example, once fully developed, the EDM will be able to follow rules governing document retention. Based on these rules, the EDM will delete or archive files as appropriate, without user intervention.

Tinker Air Force Base (OK) Air Logistics Center

Throughout the DoD, budget cuts have fostered initiatives to extend the service lives of weapons and associated delivery systems. Service life extension activities to date have shown that over time, replacement parts availability issues and parts obsolescence become obstacles to readiness. The magnitude of the replacement and obsolete parts problem will increase as longer service life extensions are mandated. At some point, parts needed to keep critical systems operational have, or will, become unavailable from the traditional suppliers. Recognizing the need to improve procurement systems to align with evolving service life requirements, a joint effort has been undertaken by the Army Communications Electronics Command (CECOM) and Oklahoma City – Air Logistics Center (OC – ALC) to establish a Virtual Enterprise and Integrated Data Enterprise.

Discussions with Mr. Edwin W. Kincaid, the Information Technology Manager at Tinker Air Force Base, Oklahoma, and a review of materials he furnished for the research effort, revealed a data management approach of potential interest to the readers of this report. He reported that the Air Logistics Center in Oklahoma City has piloted a Product Data Management (PDM) system that supports the parts procurement process, including the need to reverse engineer unavailable or obsolete parts. Although this PDM offers some features typically not required by facility engineers and managers, particularly the ability to generate solid models and associated production engineering drawings, it is described here because the Tinker AFB PDM incorporates many desirable EDMS features.

COTS software was chosen for the PDM backbone of the Rapid Response to Critical System Requirements (R2CSR) system. The Air

Force elected to use a COTS approach because of cost considerations and its need to stay current with industry technology standards used by its suppliers. The particular PDM software in use at Tinker AFB was acquired from Metaphase Technology, a division of Structural Dynamics Research Corporation (SDRC). Product data managed by this system includes information pertaining to:

- Design
- Analysis
- Manufacturing
- Logistics
- Contracting

Numerous file types can be viewed and manipulated within Tinker's PDM system. Commonly used raster and vector graphic images are viewable, as are text-based documents associated with product design, development, and manufacturing processes. These electronic files are routed to many persons in a virtual enterprise via a built-in workflow feature. Mark-up capabilities allow all comments pertaining to the drawings or documents to be assembled, reviewed, and integrated. The PDM offers a full range of benefits typically associated with an EDMS, including audit trail retrieval, standardization of data, security, and reduction or elimination of many time-consuming data or drawing retrieval processes. Additionally, the ability to interact with existing data management systems such as JEDMICS streamlines the data-sharing process.

An ability to create highly detailed digital models of components eliminates the time that used to be spent altering physical prototypes of component parts. Using the 3D modeling tools within the PDM, component features, such as dimensions, surface finish, and geometry can be manipulated until the optimal design is achieved for a product. All parties involved in designing, manufacturing, and procuring a component, including the potential suppliers in a virtual enterprise environment, are able to review and comment on the component prior to the actual tooling and manufacturing process.

Tinker AFB has hired a vendor to develop improved imaging software that will enhance the cleanup of electronic images, improve the ability to locate text information on drawings, use OCR to capture data and identify text data content. This improvement to the imaging process will automate the metadata capture process and facilitate future document retrieval efforts (KM World, 1998).

As the R2CSR system matures, it will be offered as a global solution within other DoD organizations. Enterprise-wide file maintenance and query capabilities, a common architecture designed to replace inefficient file storage systems, and cradle-to-grave data management will bring a new level of efficiency to the design, production and procurement of weapons systems components.

Although certain PDM functions may be of limited value to facility engineering and management personnel, a good PDM can provide EDMS functionality. Therefore, some persons or organizations may wish to adopt a PDM, which would

bring with it certain engineering/modeling capabilities of potential value, to accomplish common EDMS functions.

Joint Engineering Data Management Information and Control System (JEDMICS) (EDMS Program Management Office at Redstone Arsenal, 1997)

JEDMICS is a repository system for managing and controlling engineering data, namely legacy data stored in hard copy or legacy computer systems. This system has been developed specifically for DoD by PRC, Inc. However, JEDMICS integrates commercial-off-the-shelf hardware and software. It is a standard DoD program for managing approved engineering drawings and related digital technical data in the Army, Navy, Air Force, and DLA. As a repository system, data is input to JEDMICS primarily by scanning drawings, aperture cards, and documents, with lesser reliance on input of CADD files in a native format. The JEDMICS repository contains 55,400,000 images of engineering drawings (55% are Navy, 17 % are Air Force, 17% are Army, and 11% are DLA).

Information on JEDMICS is included here to demonstrate that for some applications, the ability to handle large numbers of released documents in a repository is paramount. It also is included to show that many components of an EDMS, even a custom system like JEDMICS, can incorporate much COTS hardware/software, notably scanning, storage, access, and printing/plotting devices. Since repository systems do not address the specific needs of users who manage files while in process, JEDMICS is not discussed further in this report.

Corps of Engineers Electronic Record-Keeping Information System (CEERIS)

Since it's inception in 1996, the internally-developed Corps of Engineers Electronic Record-Keeping Information System (CEERIS) has provided various COE sites with the ability to effectively manage, store, retrieve and share various documents used within the COE on a daily basis (Document Management & Imaging Systems, Inc., Undated). Prior to installing CEERIS, documents had been maintained as microfiche and paper hard copy. Types of documents include typical office documents, scanned images and CADD files.

The St. Paul, Minnesota and Philadelphia COE offices use CEERIS to process and manage permit applications for construction along coastlines and inland waterways (OTG Software, 1998). The St. Paul office uses CEERIS to scan, store, retrieve, and manage permit applications. Materials contained in permit applications includes text, photographs, CADD drawings and sketches. Permit applications and issued permits electronically enabled by the St. Paul District can be accessed by any COE office via the WAN. Current CEERIS users include St. Paul, Philadelphia, Tulsa and Wilmington Districts. As more sites come on-line with CEERIS the data-sharing base will be broadened to include real estate, engineering and environmental restoration information.

Oak Ridge Centers for Manufacturing Technology, Oak Ridge, Tennessee

Information on the government owned DOE-Oak Ridge Electronic Document Management System was obtained from its web site and a follow-up discussion with Ms. Connie H. Malarkey, a section head in the IT group (Oak Ridge Centers for Manufacturing Technology, 1997).

Oak Ridge has had an EDMS in use since 1987. Thus far it is used to manage 22,000 documents in text and CADD format, plus two million scanned medical records. At the time this EDMS was developed, there were no commercial systems with appropriate functionality and robustness. EDMS software development was accomplished by Lockheed Martin Energy Systems. The current system employs a VAX VMS repository. The DOE EDMS is not commercially available and its VAX environment inhibits commercialization. Core functions within the system manage the central repository for document storage, manage document workflow and provide configuration control, provide index and keyword storage, provide queries for search and retrieval, control access, manage transmittal and distribution requirements, and log document access.

A migration to PCs versus VAX workstations is underway. A current initiative at Oak Ridge is the transition to CADD/Modeling software that will work with PCs. However, the software selected for this purpose does not have versioning control and will need to be used with an EDMS to capture information to allow revisions and send files to a workflow environment. Likewise, Oak Ridge is working on a 3-D CADD application for PCs, but it too will need to be linked to a companion EDMS.

Ms. Malarkey is encouraged that commercial EDMS software has gained robustness and functionality that may allow DOE to incorporate COTS as it migrates to a client-server environment.

DoD Use of EDMSs

EDMS technology is in its infancy, but improving daily. Many DoD organizations and activities use repository functions via JEDMICS, but only a hand full of DoD activities use EDMSs for management of engineering documents while in-process. Although the preceding pages furnish information on EDMS use at some progressive activities, wide-spread EDMS use for in-process engineering applications is limited. However, faced with downsizing and budget reductions, organizations are investigating EDMS technologies to automate and share corporate information and knowledge.

Various components of the DoD use both government owned and commercially available EDM systems. EDMS needs and expectations are unique to a particular organization’s mission. In some cases, the EDMS serves a useful function as an electronic repository for final or released documents and guidelines. Use of EDMS

to manage a large repository of information often yields tremendous benefits to organizations that have little need to manage work-in-progress. A repository is valuable to organizations wishing to furnish diagrams, guidance documents, reference materials, parts lists, and related documents in a released state to many personnel located in the field. In such applications, an organization's ability to easily populate a repository, typically via a high speed scanning and indexing process, is of primary importance. Likewise, the ability of end-users to readily access information from a large repository, aided by the EDMS, is critical.

Organizations wanting to improve the creation of document sets while work is in process, have a different set of needs. Such organizations, when using EDMS for engineering and facility manage documents, have a need for

- Strong versioning and revision tracking and controls
- A flexible workflow that is adaptable to document or project-specific changes "on-the-fly"
- Scanning and plotting capabilities to handle large-scale drawings/plan sheets
- An EDMS that directly links to desired native CADD environments so that appropriate documents versus images of the actual documents can be used to redline or draw modifications.

The key element in determining whether an image-based EDMS, essentially a modern version of microfiche image distribution, is suited to an application is the anticipated completion state of documents to be indexed in the EDMS. If an organization elects to use the EDMS to disseminate current final or released documents to many users and help those users locate pertinent files, an image-based solution can be very effective. However, if the EDMS will manage the iterative workflow common in an engineering environment, requiring access to files in their native CADD environments, the system requirements change. In other words, prospective EDMSs must recognize that management of documents in a released state differs considerably from managing documents that are in process.

Looking at the bigger picture, management of both released state and in process documents requires a similar bundling of networked computer components. These components are available to DoD organizations via the CAD-2 program. Both Intergraph Corporation and Cordant (Tracor), the two CAD-2 vendors, offer vendor hardware and software that can be used to build an effective EDMS (Intergraph Corporation, 1997 and Cordant, 1997). Both organizations can furnish

- Engineering workstations and servers
- Mapping and image analysis workstations
- Software, including EDMS, facilities management, CADD, and GIS
- Networking components and
- Input, storage, and output devices.

These organizations also can furnish software engineering; systems engineering, integration and networking, installation, training, and support services.

Concurrent EDMS Guidance Efforts

Users of this report may wish to track two other DoD projects that will generate additional EDMS guidance. These efforts, described below, have been undertaken by Headquarters, Naval Facilities, Engineering Command (HQ NAVFAC) and the U.S. Army Corps of Engineers (USACE).

HQ NAVFAC

NAVFAC formed a task team in early 1998 to look at methods of improving the current document management practices throughout the command. One of the items the team is currently working on is the study of Electronic Document Management Systems. For the past few months, the task team has been collecting information on various systems, visiting trade shows, and studying an EDMS system NAVFAC currently has in place at one field activity. From all of the information collected, the team has put together a list of criteria for evaluating EDMSs. The NAVFAC criteria list, furnished courtesy of Ms. Louise McMonegal of NAVFAC HQ, is contained in Appendix C. The team is currently using this criteria list for the evaluation of systems. During the last quarter of 1998, the team will report on its findings, which will be submitted to the NAVFAC CIO office.

USACE

A FY99 EDMS initiative has been funded at HQ USACE. All information on this initiative was supplied by Ms. Jean McGinn. USACE is identifying its common technical and functional business requirements for all Districts using a task group forum. The task group is addressing engineering functional and technical requirements for an EDMS, and is concurrently performing a survey at two USACE Districts, Baltimore and Huntington (WVa) to determine the functional and technical requirements for all other functional areas within a district which interface with engineering during the programming, design, and construction phases of a project.

All facets of document management are being addressed, and have been broken into four major requirement categories:

- A core management environment featuring rules-based routing, document annotation and distribution
- A flexible environment that allows system customization to meet specific requirements
- A centralized repository environment that includes access control
- A platform and document management infrastructure capable of being accessed across the heterogeneous infrastructure of the enterprise

All traits typically associated with an EDMS are being considered, including document capture, document management, document storage, document retrieval,

document exchange, document output, DMS library functionality, system management/administration, user management/administration, workflow and recordkeeping.

Standards for operating systems, software, hardware and file formats are being outlined under the HQ Initiative. Compatibility with existing COE systems such as CEERIS will be required, and the DMS servers must be capable of supporting various network environments including TCP/IP, ISDN, FTP, SNMP, etc. Interoperability with existing DoD electronic mail/messaging systems will also be required, as defined by the DoD Defense Information System Network (DISN) standards and procedures.

The EDMS shall be web-enabled and support the total functionality of a web-based extranet and be compatible with current Internet/Intranet industry standards.

5 Implementation Issues for DoD

Common EDMS Implementation Issues

As stated in Section 4, EDMSs, regardless of the using organization, are designed to handle either released state documents or in-process documents as well. Either approach can be successful, depending upon the user's intent and application. Once a using organization, whether DoD or not, analyzes its EDMS needs and settles on EDMS and workflow requirements, an EDMS vendor will need to be selected.

Successful implementation of an EDMS requires use of an incremental approach. Those involved in system design need to

- Solve simple, bounded, and measurable problems first (see Figure 14)
- Identify processes that can be easily bounded and allow for an easily measurable return on investment

Examples of bounded processes include

- CADD engineering document management
- Document control, storage, and reproduction
- Project management, reporting, and communications
- Product design review and document sign-off
- Vendor management and communications
- Engineering change order process (ECN/ECO)

Figure 16 delineates the boundaries of a paper bound process. Each process can be studied individually to determine the EDMS requirements that are specific to the given process. EDMS techniques should then be applied to those specific requirements to effectively provide a document management solution. In practice, the EDMS is a collection of many bounded processes, as depicted by Figure 17.

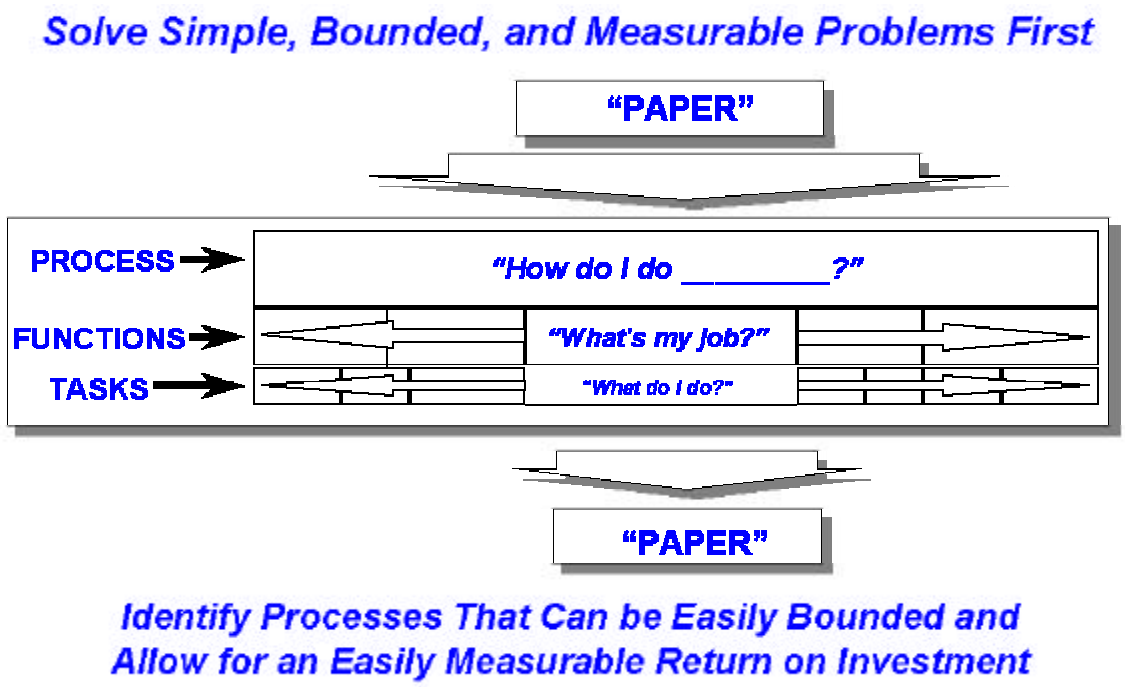


Figure 16. Paper in - Paper out Approach to defining EDMS process

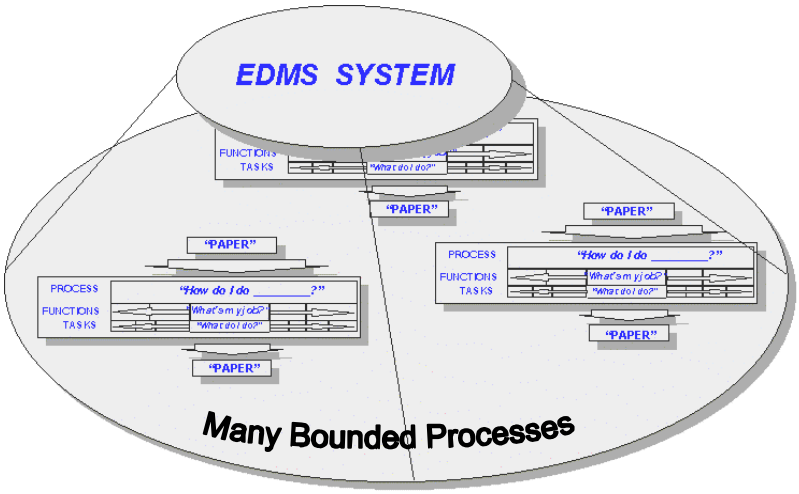


Figure 17. Full EDMS is a collection of individual processes

EDMS Phased Approach

As with any major technology project, the potential for process enhancements must be balanced against the need to avoid disruption to existing processes. Thus, a phased implementation of new technologies is recommended. Each phase paves the way for movement to the next technology level and lessens the user's exposure to risk while allowing enough time to organizationally digest each innovation as it is implemented.

Design documents are valuable assets that impact nearly all engineering and facilities management processes. Therefore, whenever new technology is incorporated into a critical process, such as the management and distribution of design data, the technology must be thoroughly evaluated before being implemented on an organization-wide basis. Typically, this evaluation should begin with a pilot program that consists of the following tasks:

- Developing an implementation plan and set of critical success factors for the pilot
- Mapping out the data requirements to develop technology specifications and configurations
- Acquiring and installing required technology to conduct the pilot phase.
- Developing pilot procedures
- Validating the pilot
- Developing a long-term plan for implementing a production capable EDMS
- Expansion plan delineating growth or upgrade potential

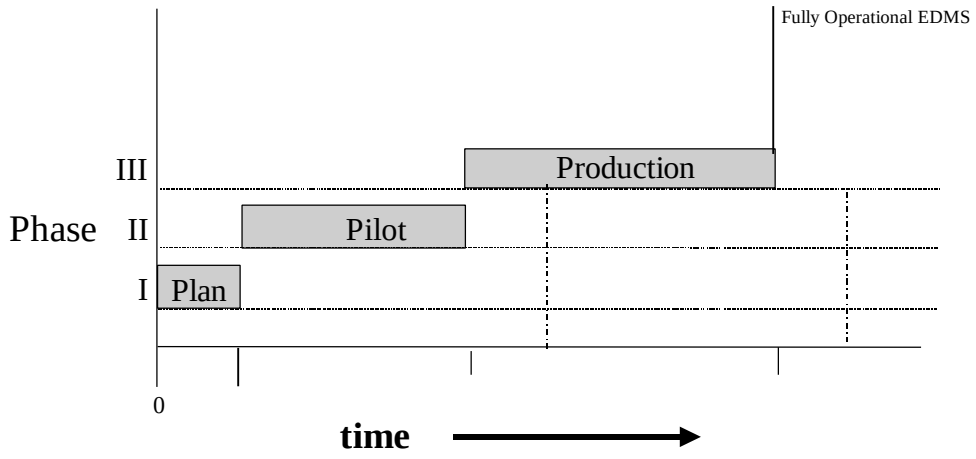
Experience shows that a three-phase approach for implementing the EDMS has the best chance for success. These three phases are

1. A "**Planning**" phase. A structured analysis of the customer's integration requirements on a business and technology level

2. A "**Pilot**" phase. A prototype implementation and demonstration of the technology to be used allowing the user to model, measure, adjust, and improve the implementation, integration, and capabilities of the technology

3. A "**Production**" phase. A full scale implementation of the piloted technology adapted to meet the requirements of a production capable system

The timeline below represents the relative execution of an overall EDMS project. The amount of time for each phase, as shown on the horizontal axis is different for each process that is enabled with EDMS technologies.



This phased approach has been developed to validate the required technology and integration services. To deliver a complete system a portion of the EDMS implementation is the integration of the varied system components into the user's environment. The suggested three-phase approach facilitates identifying and fine-tuning the integration effort required for a successful EDMS implementation. Each phase should be structured within the context of the user's unique business needs and in support of the following implementation goals:

- Minimizing the cost and time required to implement the pilot
- Minimizing disruptions to ongoing operations
- Minimizing the user's staffing requirements for implementing the pilot
- Minimizing risk when transitioning to the full production scale EDMS system

Each phase of an overall EDMS implementation strategy is described below. A cost range for each of the three listed phases is listed. These ranges reflect the direct experience of the project team and do not include any special customization that may be required by a user, based on unique requirements. These estimates also do not include the travel and living expenses that would be incurred during the consulting and installation efforts.

I. Planning Phase ($5,000 to $15,000)

The primary objective of this phase is to develop an in-depth understanding of the user's EDMS requirements and to specify an appropriate implementation strategy. The goal is to create a program plan that utilizes products and systems to be used in the pilot phase. Therefore, the systems and products specified for the pilot should satisfy a subset of the requirements for the final production EDMS. Only additions to and adaptations of the systems and products tested in the pilot phase should be required, to meet the "real world" requirements of a production-ready

EDMS. The planning phase should deliver a first cut plan for bringing a production scale system on line.

Major tasks associated with the planning phase are as follows:

- Perform a detailed assessment of the data requirements (i.e. storage, backup, archival), operating environment, technical specifications, and affected processes and procedures associated with the implementation of an EDMS.
- Establish the database configuration and the minimal data set required for the pilot as defined by the types and number of documents.
- Establish hardware and software specifications required to support the pilot, recognizing the requirements of the full production system.
- Develop an implementation plan that defines the tasks, responsibilities, and level of effort required for the pilot phase, using the pilot to define more fully the production scale EDMS.
- Develop an acceptance criterion for the pilot as a trigger to advance to full scale implementation. This criterion is in the form of success factors (metrics) for the pilot.

Those persons wishing to obtain additional information on EDMS requirements are directed to Appendix C. It contains criteria the Naval Facilities Engineering Command has set forth, criteria that should be considered when planning an EDMS, and defines them. The Technology Evaluation Criteria Definition Worksheet in Appendix C was furnished by Ms. M. Louise McMonegal of Headquarters, Naval Facilities Engineering Command.

II. Pilot Phase ($10,000 to $20,000)

The primary objective of this phase is to demonstrate the "proof of concept" for the EDMS and to validate the technology that will eventually become a production-ready EDMS. To minimize expenditures, technology acquired for this phase is based on the requirements of the pilot and is scaleable to the full production scale EDMS to preserve the customer’s investment in hardware and software.

This phase can be considered complete when the pilot program satisfies the predetermined acceptance criteria and a strategy for transitioning to a production-ready EDMS has been finalized. This phase provides the foundation for the implementation of a production-ready EDMS.

The major tasks associated with the pilot phase are as follows:

- Install EDMS as detailed in the pilot EDMS implementation plan and the user’s statement of requirements.
- Based on the pilot data model, coordinate and capture the specified pilot documents.
- Store and index the pilot documents within the EDMS.

- Validate the pilot in accordance with the predefined acceptance criterion.
- Establish production-ready EDMS integration/customization requirements.
- Develop an implementation plan that defines the tasks, responsibilities, and level of effort for the production-ready EDMS.
- Develop the acceptance criterion for the production-ready EDMS.
- Establish hardware/software requirements to support the production-ready EDMS.
- Establish the production database configuration.
- Define and document the procedures, training, and organizational responsibilities required to train for, administer, and effectively use the production-ready EDMS.

III. Production Phase (cost depends on number of users and implementation sites, but could range from $400 to $1,200 per user [non-concurrent])

The primary objective of this phase is to deliver a production-ready EDMS that meets the user's needs and expectations. This phase also includes all required systems integration to fully incorporate the EDMS into the user's overall environment.

Given the logical sequencing of phases, with an inherent emphasis on planning, the production system should perform as desired and immediately begin to contribute to improved productivity.

The major tasks of the production phase are as follows:

- Based on the production data model, coordinate and capture the remaining legacy documents.
- Store and index the remaining legacy documents within the EDMS.
- Integrate the EDMS with existing systems and applications
- Validate the production-ready EDMS in accordance with the pre-defined production acceptance criterion.

Sample Acceptance Plan

An incremental approach to EDMS implementation is recommended; it facilitates getting an EDMS in place that satisfies user needs. At certain milestones in an EDMS acquisition process users ultimately must determine if they can or should accept the EDMS. Many organizations establish a formal acceptance plan encompassing a number of pass/fail criteria. To the extent that such criteria are known before a vendor is selected, organizations often share these criteria with potential vendors during the procurement process.

To assure that all functionality is working properly, the EDMS should be tested by an independent test group against the acceptance plan. This testing by the test group should begin after the installation of the pilot and continue into the production phase.

It is recommended that there be an informal and formal testing procedure. During the installation of the EDMS, informal testing should occur prior to the final system verification. The purpose of the informal testing is to locate and remove problems before the system is formally tested. Formal testing is defined within the adopted acceptance plan.

The following criteria are part of a sample acceptance plan. Each individual organization needs to adopt an acceptance plan that is tailored to its particular needs. An acceptance plan for an EDMS used to manage in-process CADD files should include any or all of the following criteria:

1. Login

	Pass	Fail	
1.1	❑	❑	Login menu displays when EDMS is initialized.
1.2	❑	❑	User can login to the EDMS.
1.3	❑	❑	Error message is displayed when an invalid login/password combination is input.
1.4	❑	❑	User can exit the login menu.
1.5	❑	❑	User menu is displayed when EDMS is initialized for user.
1.6	❑	❑	After logging in to the system as one username, user can exit to the login menu and login again using a different login/password.

2. Check Out

	Pass	Fail	
2.1	❑	❑	Can a user check out one file?
2.2	❑	❑	Can a user check out multiple files selected from the list of items?
2.3	❑	❑	Error message appears if attempting to check out an item that is currently checked out.
2.4	❑	❑	Check out a single MicroStation design file. Verify that the related reference files automatically are brought down to the client as read-only files. Verify that the design file is brought down to the correct location.
2.5	❑	❑	User menu is displayed when EDMS is initialized for user.
2.6	❑	❑	After logging into the system as one username, the user should be able to exit to the login menu and login again using a different login/password

3. Check In

	Pass	Fail	
3.1	❑	❑	Can a user check in one file?
3.2	❑	❑	New file revision and version created on successful check in.
3.3	❑	❑	Error message appears if user attempts to check in an item that is checked out to another user.
3.4	❑	❑	After checking out an item, replace the checked out file with another file by naming the new file the same as the checked out file. Then check in the item.

4. Create File

	Pass	Fail	
4.1	❑	❑	Create file generates next available file number when the discipline is selected.
4.2	❑	❑	Create file requires user to input revision number, description, and title block information
4.3	❑	❑	Create file allows user to input all keyword fields.
4.4	❑	❑	When creating a MicroStation design file, a seed file can be selected.
4.5	❑	❑	When creating a MicroStation design file, all of the title block information that has been entered into the database fields is automatically placed in the design file at the locations defined by the seed file definition.
4.6	❑	❑	The MicroStation application is automatically invoked by the EDMS when the newly created file is checked out.

5. Search

	Pass	Fail	
5.1	❑	❑	EDM software can search on all criteria.
5.2	❑	❑	EDM able to search on file number only.
5.3	❑	❑	EDM able to search on revision number only.
5.4	❑	❑	EDM able to search on drawing number only.
5.5	❑	❑	EDM able to search on drawing title only.
5.6	❑	❑	EDM able to search on originator only.
5.7	❑	❑	EDM able to search on unit number only.
5.7	❑	❑	Clear Search function clears all criteria fields.

These are sample acceptance criteria only. Additional testing sections and criteria need to be added to fully address a particular user's requirements.

Selecting A Vendor To Implement an EDMS

A complete set of EDMS requirements and expectations as well as a thorough inventory and understanding of existing computer systems and data serve as the starting point for selecting an appropriate vendor. Such background knowledge is especially useful should procurement guidelines

require a formal competitive bidding process. With EDM systems, considerable variability exists in the capabilities of commercially available systems, primarily due to differences in intended applications. A well-defined, results-oriented approach limits the number of vendors that offer appropriate solutions.

Following are guidelines for selecting a vendor. These guidelines are a synthesis of suggested guidelines from a number of vendors and the project team.

1. Choose a vendor that has solved problems similar to your own. For instance, if you are managing large-scale documents or in-process files, avoid vendors familiar with managing only small-scale, released business documents.

2. Select a vendor that will take the time to understand your current computer systems, documents, and workflow processes and consider these when customizing your EDMS.

3. Avoid vendors that offer products from only one or a few parties. Partnerships with a large number of software and hardware suppliers are desirable, because the best pieces, regardless of supplier, can be assembled to yield a highly effective EDMS.

4. Ensure that the selected vendor and software can support expanding the scale of the EDMS. Although an EDMS may be applied to a limited number of bounded processes when implemented initially, over time it likely will be tasked with managing additional processes for more users.

5. Seek out references from organizations with similar functions and similar expectations of an EDMS. Many vendors offer valuable information on their World Wide Web sites; however, information from users should be obtained directly.

6. Be open to a potential vendor's suggestions. For instance, should a vendor suggest two different EDM systems, one for small-scale and one for large-scale in-process documents, evaluate that suggestion. Then decide what system is best for your organization. Dismissal of new ideas, without adequate analysis, may prevent optimal solutions from being employed.

6 Lessons Learned

Section 4 presents the EDMS user survey responses and highlights of other data collection efforts: World Wide Web searches, telephone interviews, review of presentation materials and site visits. These sources have been used to compile the following list of lessons learned.

U.S. Army Corps of Engineers, Jacksonville District

The following lessons learned are those of the U.S. Army Corps of Engineers, Jacksonville District. This organization has an operational, COTS, EDMS that is used in an engineering environment. Lessons learned by that organization are particularly revealing for prospective engineering and facility management users wishing to implement a COTS EDMS.

- Do not underestimate the people issues involved in implementing an EDMS. An EDMS must integrate with existing systems and processes to have users embrace and use the new technology, rather than find ways around the EDMS.

- User acceptance also depends upon how well users are informed of and participate in the EDMS procurement process and how well their concerns are heard and addressed.

- The EDMS must deliver the desired functionality. For those persons involved in engineering design or facility management, an EDMS must incorporate

    - Strong versioning and revision tracking and controls
    - A flexible workflow that is adaptable to document- or project-specific changes at any time
    - Scanning and plotting capabilities to handle large-scale drawings/plan sheets
    - Seamless links to native CADD environments so that appropriate documents versus scanned images of the actual documents, can be used to redline or draw modifications

- Since a newly acquired EDMS must integrate with existing information technology systems employed in the organization, weaknesses in those systems likely will manifest themselves. In the case of the USACE, Jacksonville District, installation of the EDMS surfaced problems with the local area network.

- To foster success, a phased implementation approach must be employed.

Patuxent River Naval Air Station (PAX)

The approach at Patuxent River has been different from that at the Jacksonville COE. At PAX, a software development firm is being used to develop an EDM that integrates with the Shore Station Integrated Information System to achieve a totally integrated approach to business information management. Although the software developers are using mostly COTS software products that are considered shareware (such as image viewers), the overall Electronic Data Manager is a Government-owned piece of software. The EDM has undergone development and customization that allows it to be tailored to support the Navy and DoD business. It also is adaptable to other DoD installations. Interestingly, the lessons learned via this approach have many similarities to those at the Jacksonville District site. Primary lessons learned, as reported by Mr. Bobby Bean and the software development team, are summarized below.

- Recognize that people issues, in the form of EDM acceptance and use, are at least as important as the technical/technological issues. Although users of the EDM can be tracked electronically, and non-users identified, user acceptance, versus policing efforts, is the key to success. User acceptance is achieved only when a user recognizes that the EDM will help him or her perform better through easier access to the right information. For wide-spread user acceptance, the EDM must add value to the users.

- Consider how a planned EDMS will fit in with existing systems and take a long-range, strategic view of how an EDMS will improve your business. Existing business information need not be transferred to the EDMS, provided it is connected (networked) to the EDM platform.

- Measure the value of an EDMS in terms of either an improved return on investment or improved customer (end-user) satisfaction. Early in the implementation cycle, it is much easier to measure customer satisfaction. For example, the PAX Technical Library provides all the instructions and legal requirements that drive the Navy's approach to installation management. Using web technology, much of the information needed to support installation management exists on a web server. Making documents accessible via the web reduces storage requirements and provides users ready access to current information, yielding improved customer satisfaction.

- Choose or develop a software package that is adaptable to your business process. Do not allow the software to dictate changes to the accepted business processes. Set cabinet and folder structures so that these can be named to support the DoD business conventions.

- Maximize your organization's IT investment by configuring "smart systems" capable of applying business rules without manual intervention. For example, automated date stamping of documents, combined with business rules governing document retention, allow the EDMS to notify a user when documents can be archived. Build the smart systems support functions around the life-cycle management concept and the Tri-Service Standards products.

- Supplement traditional classroom training and paper-based training manuals with creative, innovative, interesting computer-based training. Integrate self-testing capabilities and an ability to choose training levels suited to a particular user's level of expertise. Interactive computer-based training facilitates learning by allowing users to hear, see and do, appealing to all learning styles

- Cooperate or partner with the selected EDM supplier or developer, working together as an integrated team with shared goals and objectives.

- Consider systems administration implications of the EDMS. Systems administration is eased if the EDMS software resides on the server, allowing automatic updates for every user at the time of network log-on.

Tinker Air Force Base, Oklahoma

Tinker Air Force Base is using product data management software to improve the acquisition of repair parts for aircraft. Service life extensions for key aircraft types range from about ten years to nearly 50 years. In many cases parts must be obtained from new sources, requiring the electronic transfer of models to potential suppliers or reverse engineering when parts are unavailable to model. The PDM supports a true integrated data environment that supports a virtual enterprise. Lessons learned thus far are:

- The management software must automate the capture of metadata for both engineering drawings and associated documents.

- A multitude of documents relate to a specific part (or facility). The document manager needs to focus on the part (or facility) versus documents. At Tinker, this is defined as a part-centric versus document-centric focus.

- For virtual enterprise applications, the document manager needs to be a pervasive infrastructure rather than a repository or vault.

- Collaboration in a virtual enterprise requires access to all information, versus only released documents. At Tinker AFB, the PDM allows collaboration within the Air Force and its supplier network, enabling virtually collected electronically enabled work teams.

U.S. Army Aberdeen Proving Ground

The document management system at Aberdeen was implemented to streamline environmental assessment activities in accordance with the National Environmental Policy Act (NEPA). This system is very focused and relies on widely used database and groupware applications to perform document management and workflow (document approval and routing). Lessons learned from this approach are:

- It is very important to coordinate with all users (internal and external) when determining the requirements of the system, both hardware and software, prior to the commitment or expenditure of funds.

- The approach of customizing COTS packages such as Microsoft Word and Access and Novell Groupwise to fulfill specific needs of the organization has proved to be very cost effective. The alternatives of developing the entire system from scratch, or purchasing a complete EDMS and then customizing it to meet Aberdeen's needs specific to NEPA would have been far more expensive.

- It is important to have a contractor that you can trust and feel comfortable with prior to undertaking an EDMS implementation.

- The improved access to documents allowed by an EDMS can be inhibited by persons or organizations that believe documents are to be tightly held, not shared.

DOE Oak Ridge Center for Manufacturing Technology, Oak Ridge, Tennessee

As an early user of EDMS technology, dating back to 1987, DOE has learned a lot about the EDMS functionality needed to support its operations. According to Ms. Malarkey of the IT group, an EDMS capable of managing engineering and facility management documents should have:

- Robust versioning control and revision management to track what released version is in effect

- An ability to automatically capture file information (metadata) to ease future location and retrieval

- In the ORNL environment, consisting of model builders, approvers and end-users, Internet access by end-users (read-only) is critical; it supports electronic commerce and bidding.

- "Historical traceability" is needed to ensure current, at a given point in time, documents were used in production and manufacturing.

- Online commenting and approval, “similar to a yellow sticky note” is needed for the review and mark-up states.

- Even if native software files are managed by an EDMS, the EDMS must have the ability to manage neutral images, conforming with standards from ISO and others to avoid problems caused by frequent software version updates. Ms. Malarkey gave the example of, for instance, current word processors that in their third or fourth major release, and at some point will no longer be able to handle files from the early versions. If a neutral image format is not chosen for working documents, existing documents must be kept compatible by routine conversion to the latest version.

- Given ORNL’s application, that relies heavily on 3-D models, neutral images allow end-users to view models without the need for the native modeling application.

7 The Role of The World Wide Web for Document Management

The Internet is becoming an integral part of a corporate infrastructure. Although much of the Internet is being used for corporate communication with customers, it is also being used to distribute published information within corporations. Termed Intranet, this internal use is essentially a private network created behind a firewall for corporate use. A firewall is an electronic security barrier that protects the internal network and the Internet servers from unauthorized access. These Intranets work in the same manner as the World Wide Web, but they operate only within the confines of an organization. They are used to publish globally documents such as price lists, rules and operations directives, manuals, engineering drawings (both released and in process), and almost anything else that needs to be accessed on a corporate wide-basis. The popularity of Intranets is due to the ease of implementation, the low cost, and the ease of using Web browsers. Intranets and the Internet use the same TCP/IP communications protocol and the Hypertext Markup Language (HTML), Web presentation language.

An electronic Web document can be text, image, CADD, voice, or video and can be sent anywhere within the organization regardless of computer operating system or platform. Web servers can be used as an extension of a corporate relational database allowing the information contained therein to be published through the Internet or the Intranet as desired.

The application of Internet technology to document management is a logical and natural progression. For some time, the majority of EDMS systems have used Internet technology as the core communications protocol for the transfer of data. This protocol is TCP/IP. The integration of a browser interface now allows rapid deployment of document management systems throughout the organization.

EDMS vendors are now providing organizations the ability to access their index and document repository from the Web. This Internet capability typically includes:

- HTML interfaces to let users identify and request documents
- Security provisions for restricting access to authorized users
- Transformation of documents from their native format to a more Web-friendly format such as HTML, PDF, CGM, or SVF

- Ability to download documents through Web servers and manage them as local documents while protecting the original document left on the Web server from modification

One of the key benefits of this capability is that special purpose "client" software does not have to be installed on the user PC's. In simple applications, the browser acts as the client. In more sophisticated applications, some level of processing may be done at the user's PC. In this case, the software is automatically downloaded the first time the user accesses the Web site and is updated when required. When needed, client software makes documents available to internal users as well as customers, suppliers, and other business entities. Documents can be viewed or downloaded and printed locally as needed.

Along with this technology, however comes challenges that are not apparent when working in a controlled hard-wired network environment. These challenges include:

Security

The security of the documents over the Internet is similar to the private network security on a standard LAN environment. One of the differences is that secure communication protocols such as the Netscape "Secure Socket Layer" will manage message passing security. Security relies on encryption of the data as it is physically moving between client and server. The DoD may need this type of security for highly secure documents but typically such security is not required for engineering documents. The standard EDMS security component determines who has access to documents whether the network is private or the Internet.

Communication of Document Status

When information from work in progress is made available to remote users, it is important to communicate that information may not be ready for publication or for its intended use. Document use limitations occur when documents are being revised or contain obsolete information. The EDMS should be able to determine whether a document may be viewed (published) over the Internet or Intranet, based on the document status or state.

Data Conversion

Internet browsers, such as Netscape and Internet Explorer, only offer support for HTML documents. Simple text based information can be displayed on browsers without problems. However, more sophisticated document formats such as Postscript, MicroStation, and AutoCAD cannot be readily displayed on a standard browser. Special software must be available to display these more sophisticated document formats within the browser. These software applications are called "plug-ins" and can support many formats. Some of the most popular formats for Engineering CADD documents include Computer Graphics Metafile (CGM) and Simple Vector Format (SVF). Both of these formats are vector formats that allow users to zoom in on the image without loss of resolution as would be the case with

scanned images. Products such as Bentley Systems ModelServer Publisher can be used to dynamically convert AutoCAD or MicroStation format documents to either CGM or SVF format, thereby making these files compatible with the browser plug-ins. CGM or SVF formats allow users to view native CADD documents over the Internet.

Viewing software such as Cimmetry Systems' AutoVue and Informative Graphics Myriad also provide browser plug-ins that allow the viewing and redlining of many different formats including engineering and desktop formats-CAD, Vector, raster, hybrid, word processor, spreadsheet, and database documents. These viewing systems are typically interfaced with the EDMS that allows for the delivery of the document to the viewer.

When CADD document access is needed to modify the original data in the file, no data conversion is necessary. In this case the CADD document is copied from the Web accessible server to the local client workstation without any format change. Standard CADD software is used to make the modifications and the document is then checked back into the server.

Speed of Access

Engineering documents tend to be much larger than typical business documents. The size of CADD files and images that are a result of scanning engineering drawings can cause very slow transfers over the Internet. Compression techniques can be employed such as publishing into more compact formats such as CGM and SVF. However, when transferring data in its native format, such as DGN or DWG, significant download times can occur. The Internet bandwidth continues to expand; however, the ever-growing number of users slows the net gain in bandwidth.

8 Conclusions and Recommendations

Conclusions

This report addresses the specific needs of DoD personnel responsible for facility design and management. The needs of facility designers and managers are unique because the management of engineering documents differs from the management of typical business documents in the following ways.

- Engineering drawings are large-scale documents, requiring large-scale scanning and plotting capabilities not required for typical business documents.

- Engineering documents are prepared by a number of persons from different disciplines and undergo an iterative series of quality and coordination reviews prior to reaching a "released state." Engineering documents have an extended in-process life, characterized by a dynamic, project-specific workflow. Pre-defined standard workflows, useful for business documents, are often too static to be used with engineering documents.

- EDMSs well suited to small-scale business documents can be linked to EDMSs particularly well suited to large-scale engineering documents to meet differing needs. A "one-size-fits-all" approach to EDMS is unnecessary and may be ineffective with today's EDMSs.

- A typical business document can have multiple authors, each working on particular sections simultaneously. Collaborative approaches have received much attention and promise improved creativity and efficiency. However, it would be dangerous to have multiple users modifying CADD files simultaneously. Any changes made by one contributor/discipline have the potential to impact upon designs by other contributors/disciplines. Therefore EDMSs for CADD files and engineering documents, unlike business documents, must prevent simultaneous modify access to files by multiple users.

- The engineering environment consists of many document types ranging from word processing to spreadsheets to engineering CADD files. A completed design can be made up of several or even dozens of file components, which can make engineering CADD files the most difficult for an EDMS to handle. A typical design is made up of a master file, reference files, and other associated files. To work on, or even display a completed design properly, these individual

files must be brought together for the CADD design software to function properly. This complexity makes the choice of EDMS software particularly crucial. EDMSs originally designed to manage simple text-based documents often are not well suited to handle engineering designs. However, EDMSs designed from the ground up to handle CADD files are able to manage complex engineering documents. Software that can handle engineering documents is generally adept at any document type, whether text, image, or other file formats.

- CADD drawings are unique in that they employ reference files. Without safeguards in place, reference file updates would not be reflected in documents retrieved after a particular document release (e.g., a set of bidding documents). An EDMS for engineering documents must be able to track drawing versions and/or freeze all reference files upon release of a document.

- CADD users often need to track the amount of time spent creating and modifying files and benefit from a session and application based accounting module in the EDMS. This feature has little benefit for most business document users.

Recommendations for Implementing an EDMS

EDMS is strategic to obtaining a competitive advantage. Intelligently designed and implemented EDMS technology can deliver significant productivity improvements.

Various sections of the report have presented particular suggestions and recommendations with respect to such items as defining your needs, integrating Internet/Intranet file access, and selecting a vendor.

Recommendations worth repeating or stressing follow.

- Clearly understand your existing systems and workflows to ensure that candidate EDM systems can be integrated into your organization.

- Establish a clear purpose and objectives for your EDMS. Be certain as to what document types the system must handle, how files will be entered into the EDMS, and how and if legacy data and systems are to be addressed.

- Recognize that cultural acceptance issues will arise and foster acceptance by involving stakeholders early and often. Some persons despise change and some may even subvert process enhancements.

- Take a calculated, methodical approach to EDMS implementation. Solve simple, bounded, and measurable processes first, ensuring that these are representative of the complexity of other processes your organization may handle. Select those processes that allow for an easy and measurable return on investment.

- Use a phased approach by implementing a pilot project to prototype the proposed system. This phased approach will ensure success and define the metrics used to demonstrate success.

- Incorporate incremental versus revolutionary changes in workflow (digitally enable first and re-engineer second). Choose an EDMS that is configurable enough to digitally enable or automate existing manual processes rather than require existing processes to be re-engineered.

- Remember that training likely will be needed during both pilot and production phase implementation and periodically thereafter.

- Be certain that your selected EDMS supplier fully understands your needs and expectations and has satisfactorily served other customers with like needs and expectations.

DoD likely should conduct one or more well-documented demonstration projects to show users how to identify their specific needs, identify and select a vendor, establish an acceptance plan, and implement the EDMS following a phased approach, including training at appropriate stages. To the extent possible, all tangible benefits of implementing an EDMS should be quantified and compared to EDMS costs to determine the return-on-investment (ROI).

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Appendix A

EDMS User Survey Form and Distribution List

Tri-Service CADD/GIS Technology Center
Electronic Document Management System (EDMS) User Survey

Name of Point of Contact: _____ **Phone:** _____

Title of POC: _____ **FAX:** _____

Internet E mail address: _____

Installation or Office Name: _____

Office or Department Title: _____

Office or Department Code: _____

Mailing Address:

_____

_____

_____

_____

_____

Organization Branch: (check one)

- 9 **Air Force**
- 9 **Army**
- 9 **Army Corps of Engineers**
- 9 **Marines**
- 9 **Navy**
- 9 **Coast Guard**
- 9 **Other :**

_____

Tri-Service CADD/GIS Technology Center

Electronic Document Management System (EDMS) User Survey

Category Number Listing-(Other categories may be added as needed)

1. *EDMS Software* COTS, (Bentley Teammate, Intergraph NFM, Intergraph AIM, TSA Advet Falcon DMS, FileNet, Other) GOTS, Other
2. *Client* CLIX, DOS/Windows 3.1x, Windows 95, Windows NT, Sun Sparc
3. *Server* UNIX, NT, Novell Netware, Sun Sparc
4. *Storage/Repository* Desktop, RAID, CD-ROM, Optical
5. *Database DBMS* SQL, Oracle
6. *Viewing/Markup/Module* Spicer Imagenation, Imageview, Other
7. *Workflow Product/Module* FileNet Visual Workflow, FileNet Ensemble, Other
8. *Network* Novell, NFS, Other
9. *OCR Engine* Caere OmniPage Pro, Other
10. *Type Files Stored* DGN, DWG, CGM, TIFF, PDF, Other native formats
11. *Associated CAD2 Product(s)* Intergraph, Cordant
12. *Associated Non-CAD2 Product(s)*
13. *Customization Tools* Visual Basic 4, PowerBuilder, Other
14. *Internet/Intranet* Microsoft Internet Explorer, Netscape Navigator, Saros Mezzanine, Other

(Example)

Category Number: 1

COTS=Commercial Off The Shelf Software GOTS=Government Off The Shelf Software

Status	Software Name	Type Software	Brief Functional Description
☒ In Use	*Intergraph AIM*	☒ COTS	*Document Management Suite*
☐ Initiative		☐ GOTS	
		☐ Custom	

Survey of EDMS Work Performed Or Initiatives Under Development

Tri-Service CADD/GIS Technology Center, Electronic Document Management System (EDMS) User Survey

Category Number: ________________

Status	Software Name	Type Software	Brief Functional Description
9 **In Use** 9 **Initiative**	______________________ ______________________	9 **COTS** 9 **GOTS** 9 **Custom**	______________________________ ______________________________

Category Number: ________________

Status	Software Name	Type Software	Brief Functional Description
9 **In Use** 9 **Initiative**	______________________ ______________________	9 **COTS** 9 **GOTS** 9 **Custom**	______________________________ ______________________________

Category Number: ________________

Status	Software Name	Type Software	Brief Functional Description
9 **In Use** 9 **Initiative**	______________________ ______________________	9 **COTS** 9 **GOTS** 9 **Custom**	______________________________ ______________________________

Category Number: ________________

Status	Software Name	Type Software	Brief Functional Description
9 **In Use** 9 **Initiative**	______________________ ______________________	9 **COTS** 9 **GOTS** 9 **Custom**	______________________________ ______________________________

Installation Name: ____ **Page ______ of ______**

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Survey of EDMS Hardware/Software Currently In Use

1) Do you have an operating EDMS system in place? 9 **Yes** 9 **No** 9 **Future procurement planned**
(If no current operating EDMS system please skip to question 30)

2) How many users of the system? _____ How many concurrent users? _____

3) How many files are currently stored? _____ What is your average file size? _____

4) What is the primary function of your EDMS system?_____

_____

5) Describe the primary hardware components of your system:
(If available please provide a diagram describing the components of your system)

Server(s) _____

Input Device(s) _____

Storage Repository _____

Primary Workstation(s) _____

Printer(s) and/or Plotter(s) _____

Other associated hardware components _____

Note: Information pertaining to software and operating system (client) data is detailed in the section entitled "* Survey of EDMS Work Performed Or Initiatives Under Development*"

6) Do you store and retrieve engineering (CADD) drawings on a regular basis? 9 **Yes** 9 **No**

7) If yes, in what format are the drawings ? 9 **Native CADD** 9 **Scanned Image** 9 **Other (describe) _____**

_____

8) Was Legacy data transferred to your EDMS system? 9 **Yes** 9 **No**

9) If yes, describe the means by which it was captured _____

_____

10) Describe your data capture process for inclusion of native format files (word processing, CADD, etc.) into your EDMS system _____

_____

11) Describe your digital document indexing process _____

_____

12) Describe your digital document retrieval or query process _____

_____

13) Describe, if applicable, your digital workflow process _____

_____

14) Have security, version control and redundancy issues associated with your EDMS system been adequately addressed?
9 **Yes** 9 **No**

15) If no, what improvements to your EDMS system would be required to meet desired security requirements? _____

_____

16) Is an efficient archive/backup process a component of your system? 9 **Yes** 9 **No**

17) If no, what modifications would be required to improve this activity? _____

_____

18) Is Internet/Intranet integration a desired or current component of your system? 9 **Yes** 9 **No**

19) Does your site have a training program for system users? 9 **Yes** 9 **No**

20) What resources are required to maintain your system on a day-to-day basis? _____

_____

_____

21) How long did it take to install your system? _____

_____

22) What problems were you setting out to resolve with the implementation of EDMS?_____

_____

_____

23) What challenges did you encounter during the implementation process?_____

_____

_____

24) Was an ROI done prior to the installation of your EDMS system? 9 **Yes** 9 **No**

25) If yes, what were the results? (*If available attach ROI table*)_____

_____

26) Describe the tangible and intangible benefits realized by the inception of your EDMS system. _____

_____

_____

_____

27) What user acceptance issues were addressed as your system was brought on-line? _____

_____

_____

_____

_____

_____

_____

28) What are the "Lessons Learned" that you would credit to the implementation of your system?_____

_____

_____

_____

_____

_____

29) Additional Comments: _____

_____

_____

_____

_____

_____

30) Are you planning to implement an EDMS system in the future? 9 **Yes** 9 **No**

31) If yes, within what time frame? 9 **0 - 12 mo** 9 **12 - 24 mo** 9 **24 - 36 mo** 9 **Undetermined**

32) In what format are your documents currently maintained? 9 **digital** 9 **paper** 9 **microfilm** 9 **microfiche**

9 **aperture card** 9 **other (describe) _____**

33) How are your documents currently indexed? 9 **card catalog** 9 **digital data base** 9 **other (describe) _____**

_____

34) Do your stored documents include plotted CADD drawings? 9 **Yes** 9 **No**

35) If yes, will the CADD drawings be stored on your EDMS system? 9 **Yes** 9 **No**

36) How would you capture the CADD drawing for electronic storage? 9 **scan** 9 **native format** 9 **other (describe)**

_____

37) Describe any issues or concerns you might associate with the implementation of an EDMS system_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Installation Name: _____	**Page _____ of _____**

Thanks for taking your valuable time to complete this survey. A copy of the final report will be sent to you. In addition to assisting us with development of the Electronic Document Management Standards, the report should provide you with an overview of automation tools being used across DOD for Document Management. If you have any questions relating to the content of this survey please contact Jack Owens, Michael Baker, Jr., Inc. at 800-642-2537 ext. 4348 or 412-495-4348. Tri -Service related questions should be directed to Laurel T. Gorman, P.G. at 601-634-4484.

EDMS Survey Distribution List

PART I - DoD

Name	Office	EDMS Interest	Phone	Fax	e-mail
Military					
Worthington, Linda	HQ USACE	Archival Doc.	202-761-0332	202-761-8776	
Porzig, Roger	COE- Jacksonville Dist	Eng.Drwgs-Falcon	904-232-1189		roger.w.porzig@saj02.usace.army
Bean, Bobby	NAS-Pax. River	Sp. Mgmt.	301-342-3103		bean_bobby%pax9a@nawcad.nav
Krishack, John	Eglin AFB	Scanning EISs	850-882-7791x1002		
Kraszewski, Bob	Edwards AFB	Fac. Manag.	805-277-1448	805-277-6145	kraszewb%tw@mhs.elan.af.mil
Marchbanks, Betty	McCllelan AFB	Fac. Manag.	916-643-4875	916-643-0720	betty@ce_mgr.mcclellan.af.mil
FWG Members					
Grams, Calvin	Peterson AFB	Eng. Drwgs.	719-556-1422		cgrams@spacecom.af.mil
Reiner, Marta	Falcon AFB		719-567-6556		
Carr, David	Army		210-221-5441		
Hamaguchi, Wayne	Army- Hawaii		808-438-7620		hamagucw@shafter-emh3.army.n
Smith, Ellis	Army		318-531-1428		epsd@polk-emh2.army.mil
Miner, Bryan	Army		716-879-4208		bryan.c.miner@ncb01.usace.army
Bryant, Jeff	Navy- Atl. Div.		804-322-4636		bryantjl@efdlant.navfac.navy.mil
Hudson, Bill	Navy- Crane		812-854-3453		bjh289@nwscc.sea06.navy.mil
Sanchez, Vivian	Navy - SW Div.		619-532-1168		vysanchez@efdswest.navfac.navy
Other Interests					
Boyd, Gary	Navy - Atl. Div.		803-820-7303		rgboyd@efdsouth.navfac.navy.mil
Wilber, Carol	Navy HQ		703-325-1274		cwilber@ng.navfac.navy.mil
JEDMICS					
Younger, Henry			205-876-8251		younger-cic-ed@redstone.army.m
Austin, Jerry			205-842-6387		austin-jw@redstone.army.mil
Baddley, Eddy			205-876-2523		baddley-er@redstone.army.mil
Barrett, Earl			205-842-8279		barrett-ew@redstone.army.mil
Behrens, Paul			205-313-0219		behrens-pw@redstone.army.mil
Booker, Gayle			205-842-8277		gayles@redstone.army.mil
Collier, Dawna			205-876-4891		collier-cic-ed@redstone.army.mil
Falkner, Dave			205-842-2893		davidf@michp10.redstone.army.m
Gaver, Steve			205-955-6522		gaver-cic-ed@redstone.army.mil

EDMS Survey Distribution List (Cont.)

Name	Office	EDMS Interest	Phone	Fax	e-mail
JEDMICS (cont'd)					
Gibbs, A.J.			205-842-2893		ajgibbs@michp10.redstone.army.r
Howard, Gerald			205-842-0641		howard-cic-ed@redstone.army.mil
Infinger, Gary			205-313-0389		infinger-gc@redstone.army.mil
Leach, Jimmy			205-842-7389		leach-jl@redstone.army.mil
Mattern, Ken			205-313-0392		mattern-kj@redstone.army.mil
McCutcheon, Chris			205-955-0197		cmccutch@michp15.redstone.arm
Montgomery, John			205-876-9842		montgomery-jf@redstone.army.mi
Morgan, Johnnie			205-842-2893		johnniem@redstone.army.mil
Mountain, Stephen			205-842-9942		mountain-sw@redstone.army.mil
Owens, Linda			205-842-2893		owens-lg@redstone.army.mil
Slayton, Ken			205-842-7962		kslayton@redstone.army.mil
Stephens, Violet			205-842-6377		stephens-cic-ed@redstone.army.r
Tate, Judy			205-876-8251		younger-cic-ed-sec@redstone.arn
Thompson, Pete			205-842-2893		petet@michp10.redstone.army.mil
Walker, Cindy			205-842-2893		cindy@michp10.redstone.army.mi
Warnick, Greg			205-842-0862		warnick-gg@redstone.army.mil
DISC Philadelphia					
Horne, Johnnie					johnnie_horne@navsup.navy.mil
Norfolk Navy Yard					
Gormley, Sam					sam_gormley@navsup.navy.mil
NAVICP Mechanicsburg					
Pusti, Bob					bob_pusti@icpmech.navy.mil
Anniston Army Depot					
Lovelady, Lynn					llovela@anniston-emh2.army.mil
Corpus Christi Army Depot, TX					
Bosquez, Ana					abosquez@CCAD-CCADGATE.ar
DISC - Defense Industrial Supply Center, Philadelphia, PA					
Gillespie, Robert					rgillespie@disc.dla.mil

EDMS Survey Distribution List (Cont.)

Name	Office	EDMS Interest	Phone	Fax	e-mail
DSCC - Defense Supply Center, Columbus, OH					
Ballard, Lawrence					lballard@dcsc.dla.mil
DSCR - Defense Supply Center, Richmond, VA					
Logan, Lawrence					
Hill AFB, Ogden, UT					
Waggoner, Tom					waggonet@hillwpos.hill.af.mil
Iowa National Guard, Facilities and Construction Office, Johnston, IA					
Jaye, Dan			515-252-4180	515-252-4589	Jayed@IA-ARNG.ngb.army.mil
Kelly AFB, San Antonio, TX					
Calvillo, David					dcalvill@sadis05.kelly.af.mil
Letterkenny Army Depot					
Augustine, Doug					daugusti@letterkenn-emh1.army.r
MCLB, Albany, GA					
Bryant, Jim					bryanti@ala.usmc.mil
NADEP JAX - Naval Aviation Depot, Jacksonville, FL					
Waggy, Patricia					waggy%jx%psd@mr.navair.navy.r
NATSF Philadelphia, PA					
Abramson, Arthur					arthur_abramson@natsfgw.natsf.r
NAWC - TSD - Naval Air Warfare Center, Orlando, FL (formerly NTSC)					
Westervelt, Elizabeth					beth_westervelt@ntsc.navy.mil
Norfolk NSY, Portsmouth, VA – Forwarded to Navy Public Works Center					
Hollandsworth, Paul to Michonki, Jim		Engineering Division	757-396-8425	757-396-8233	Phollandsworth@nnsy_ns00.nnsy. Jmichons@pweast.pwc.com
NSWC - Port Hueneme, CA					
Menken, Richard					menken_richard@phdnswc.nswse

EDMS Survey Distribution List (Cont.)

Name	Office	EDMS Interest	Phone	Fax	e-mail
NSWC - Crane (Louisville Det)					
Sydoriak, Eugene					gene_s@smtp.nosl.sea06.navy.m
Pearl Harbor NSY					
Miura, James					James=Miura%C240%PHNSY@ns nsy.navy.mil
Portsmouth NSY, NH					
Phair, Pamela					pwp_c202@ns01.ports.navy.mil
Puget Sound NSY, WA					
Carpenter, Valoree					carpenterv@psns.navy.mil
Red River Army Depot, Texarcana, TX					
Smith, Don					dlsmith@redriverad-emh1.army.m
Robins Air Force Base, Warner Robins, GA					
Richardson, James					jrichard@ti.robins.af.mil
Rock Island Arsenal, IL (formerly AMCCOM)					
Bender, John					jbender@ria-emh2.army.mil
SRF Yokosuka, Japan					
Gabayan, Leroy					c204@srf_emh1.yoko.mrms.navy.
Tinker AFB, OK					
Barker, Marilyn					mbarker@ocdis.oc.af.mil
Tobyhanna Army Depot, PA					
Laise, Steve					slaise@tobyhanna-emh3.army.mil

EDMS Survey Distribution List (Cont.)

PART II – PRIVATE SECTOR

EDMS User	Contacted to Determine Participation Interest	EDMS Interest	Phone	Fax	e-mail
Private Sector					
AETNA	David A. Kirshenbaum		860-636-5045		Direct - Web Site
Allegheny Co. PA					Direct - Web site
Amoco					webmaster@amoco.com
Amtrak	Peter Blum	Ticket Processing & Research	215-349-2693		amtrak_p@ix.netcom.com
Anheiser-Busch					BudCentral@budweiser.com
Baltimore Gas & Electric	Lawrence Condry	Gas Maps & Records Unit	410-291-4960		lawrence.w.condry@bge.com
Bank of America Investment Services		.			Direct - Web site
Betty Crocker	Mike Meinz	Direct Marketing	612-540-3652		webmaster@bettycrocker.co
Chevron USA					webmaster@www.chevron.c
CISCO Systems	Donna Soave		408-526-8383		dsoave@cisco.com
	Jan Johnston-Tyler		408-526-8355		jjohnsto@cisco.com
Cummins Engine					powermaster@cummins.com
Diebold	Denis Martini	Card Based Transactions			Direct - Web site
Dietzgen					webmaster@dietzgen.com
Draper Laboratory					communications@draper.co
Ernst & Young LLP		Tax Return Prep			webmaster@ey.com
FEDEX	Betty Clayborne		901-369-3410		Direct - Web site
General Dynamics L					cookm@gdls.com
General Dynamics B					webmaster@gdeb.com
Haagen Daz	D. Winters	Track Deliveries & Billing	612-330-5370		answers@haagen-dazs.com
Houston Lighting & Power	Mark Herzig	Claims Dept.			info1@hlp.com
Jacksonville Electric Authority	Bob Neyer				neyefr@jea.com
Lucent Technologies					webmaster@lucent.com
Marathon Oil Co.					webmaster@marathon.com

EDMS Survey Distribution List (Cont.)

EDMS User	Contacted to Determine Participation Interest	EDMS Interest	Phone	Fax	e-mail
PRIVATE SECTOR (cont'd)					
Monsanto					webguru@monsanto.com
Motorola	Bill Johnson		602-244-6606		webmaster@mot.com
Northeast Utilities	Karoll Wiater		860-665-5432		wiater@nu.com
NYNEX					Joe_Arena@SMTP.NYNEX.c
Omaha Public Power District	Sue Forbes	Procedure Tracking			(oppd_pr)sforbes@oppd.gov
Rockwell Automation	Pete Fowler	Image Design Data			baudman@rb.rockwell.com
Spalding Sports					sports@spalding.com
Stanford Health Services					webmaster@mednet.stanfor
Tenet Healthcare	James Wight		972-789-2587		james.wight@tenethealth.cor
Toshiba					webmaster@toshiba.com
Union Pacific	Frank Lilly		402-280-6316		flilly@notes.up.com
Railroad	Paul McGee		314-768-6690		pamcgee@notes.up.com
Union Switch & Signal	Ted Davidson	Production/ Financial Analysis	412-688-2400		webmaster@switch.com
University of Washington		Biological Experiment Documentation			forman@cs.washington.edu
Utah State University	Robert Dixon	Dorm Assignment	801-797-3731		webmaster@www.usu.edu
USAir, Inc.					Direct - Web site
U.S. DOE Oak Ridge National Laboratory.	Bob Price		424-576-5103		juanfc@oro.doe.gov
US Steel					bill.wolf@tippins.com

Appendix B

EDMS User Survey Responses

Tri-Service CADD/GIS Technology Center
Electronic Document Management System (EDMS) User Survey

Name of Point of Contact: Roger Porzig **Phone:** (904) 232-1189

Title of POC: CADD Manager **FAX:** (904) 232-3424

Internet E mail address: roger.w.porzig@saj02.usace.army.mil

Installation or Office Name: Jacksonville District

Office or Department Title: Engineering

Office or Department Code: EN-F

Mailing Address:

Jacksonville District – COE

Attention: EN-F/Porzig

P.O. Box 4970

Jacksonville, Florida 32232-0019

Organization Branch: (check one)

- 9 **Air Force**
- 9 **Army**
- ☑ **Army Corps of Engineers**
- 9 **Marines**
- 9 **Navy**
- 9 **Coast Guard**
- 9 **Other :**

Enclosure 1

Tri-Service CADD/GIS Technology Center

Electronic Document Management System (EDMS) User Survey

Category Number Listing-(Other categories may be added as needed)

1. *EDMS Software* COTS, (Bentley Teammate, Intergraph NFM, Intergraph AIM, TSA Advet Falcon DMS, FileNet, Other) GOTS, Other
2. *Client* CLIX, DOS/Windows 3.1x, Windows 95, Windows NT, Sun Sparc
3. *Server* UNIX, NT, Novell Netware, Sun Sparc
4. *Storage/Repository* Desktop, RAID, CD-ROM, Optical
5. *Database DBMS* SQL, Oracle
6. *Viewing/Markup/Module* Spicer Imagenation, Imageview, Other
7. *Workflow Product/Module* FileNet Visual Workflow, FileNet Ensemble, Other
8. *Network* Novell, NFS, Other
9. *OCR Engine* Caere OmniPage Pro, Other
10. *Type Files Stored* DGN, DWG, CGM, TIFF, PDF, Other native formats
11. *Associated CAD2 Product(s)* Intergraph, Cordant
12. *Associated Non-CAD2 Product(s)*
13. *Customization Tools* Visual Basic 4, PowerBuilder, Other
14. *Internet/Intranet* Microsoft Internet Explorer, Netscape Navigator, Saros Mezzanine, Other

(Example)

Category Number: 1

COTS=Commercial Off The Shelf Software GOTS=Government Off The Shelf Software

Status	Software Name	Type Software	Brief Functional Description
☒ In Use	*Intergraph AIM*	☒ COTS	*Document Management Suite*
☐ Initiative		☐ GOTS	
		☐ Custom	

Survey of EDMS Work Performed Or Initiatives Under Development

Tri-Service CADD/GIS Technology Center, Electronic Document Management System (EDMS) User Survey

Category Number: 1

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	Falcon DMS	☑ COTS	EDMS
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 2

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	Win 3.X, Win 95, Win NT	☑ COTS	OS
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 3

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	Win NT, Server 4.0	☑ COTS	OS
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 4

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	RAID	☑ COTS	Win NT, Intergraph HW
9 Initiative		9 GOTS	
		9 Custom	

Installation Name: _____ **Page _____ of _____**

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Survey of EDMS Work Performed Or Initiatives Under Development

Tri-Service CADD/GIS Technology Center, Electronic Document Management System (EDMS) User Survey

Category Number: 5

Status	Software Name	Type Software	Brief Functional Description
9 In Use		☑ COTS	MS SQL Server 6.5
☑ Initiative		9 GOTS	
	SQL Server 6.5	9 Custom	

Category Number: 8

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	Windows Network	☑ COTS	Using Shares
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 8

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	Windows Network	☑ COTS	FTP
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 10

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	Ustation	☑ COTS	.DGN, .TIFF, .COT, .CIT
9 Initiative		9 GOTS	
		9 Custom	

Installation Name: _____ **Page** _____ **of** _____

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Survey of EDMS Work Performed Or Initiatives Under Development

Tri-Service CADD/GIS Technology Center, Electronic Document Management System (EDMS) User Survey

Category Number: 10

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	MS Word, MS Excel	☑ COTS	.DOC, .XLS
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 10

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	EditPad	9 COTS	
9 Initiative		9 GOTS	
		☑ Custom	Postcard Ware (.TXT)

Category Number: 14

Status	Software Name	Type Software	Brief Functional Description
9 In Use		☑ COTS	Web Access to Data Via EDMS
☑ Initiative		9 GOTS	
	Netscape, Internet Explorer	9 Custom	

Category Number: _____

Status	Software Name	Type Software	Brief Functional Description
9 In Use		9 COTS	
9 Initiative		9 GOTS	
		9 Custom	

Installation Name: _____ **Page _____ of _____**

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Survey of EDMS Hardware/Software Currently In Use

1) Do you have an operating EDMS system in place? ☑ **Yes** 9 **No** 9 **Future procurement planned**
(If no current operating EDMS system please skip to question 30)

2) How many users of the system? 115 **How many concurrent users?** Aug., 35

3) How many files are currently stored? _____ **What is your average file size?** _____

4) What is the primary function of your EDMS system? Manage CADD Data

5) Describe the primary hardware components of your system:
(If available please provide a diagram describing the components of your system)

Server(s) Intel based NT 4.0 Server

Input Device(s) _____

Storage Repository Raid arrays (Intergraph Interaid 6)

Primary Workstation(s) Win NT and Win 95

Printer(s) and/or Plotter(s) OCE 9400 and HP755CM

Other associated hardware components _____

***Note: Information pertaining to software and operating system (client) data is detailed in the section entitled* "Survey of EDMS Work Performed Or Initiatives Under Development"**

6) Do you store and retrieve engineering (CADD) drawings on a regular basis? ☑ **Yes** 9 **No**

7) If yes, in what format are the drawings ? ☑ **Native CADD** ☑ **Scanned Image** 9 **Other (describe)** _____

8) Was Legacy data transferred to your EDMS system? ☑ **Yes** 9 **No**

9) If yes, describe the means by which it was captured Mass add operation of COTS

10) Describe your data capture process for inclusion of native format files (word processing, CADD, etc.) into your EDMS system Using Interface to EDMS, users add data to system when appropriate

11) Describe your digital document indexing process Via Falcon/DMS

12) Describe your digital document retrieval or query process See 11

13) Describe, if applicable, your digital workflow process N/A

14) Have security, version control and redundancy issues associated with your EDMS system been adequately addressed?
☑ **Yes** 9 **No**

15) If no, what improvements to your EDMS system would be required to meet desired security requirements?

16) Is an efficient archive/backup process a component of your system? ☑ **Yes** 9 **No**

17) If no, what modifications would be required to improve this activity?

18) Is Internet/Intranet integration a desired or current component of your system? ☑ **Yes** 9 **No**

19) Does your site have a training program for system users? ☑ **Yes** 9 **No**

20) What resources are required to maintain your system on a day-to-day basis? Minimal Administrator

21) How long did it take to install your system? Four Hours

22) What problems were you setting out to resolve with the implementation ofEDMS? Timely access by users

23) What challenges did you encounter during the implementation process?

There were (are) many network related issues that can (still) hamper a fully successful EDMS install

24) Was an ROI done prior to the installation of your EDMS system? ☑ **Yes** 9 **No**

25) If yes, what were the results? (*If available attach ROI table*) Payback of investment in 12.5 months

26) Describe the tangible and intangible benefits realized by the inception of your EDMS system.

Access to drawings does not depend on "special" knowledge of the network layout. Users do not have to waste time searching for project data.

27) What user acceptance issues were addressed as your system was brought on-line? _____

28) What are the "Lessons Learned" that you would credit to the implementation of your system? _____

Much richer understanding of various LAN related issues

29) Additional Comments: Overall, I am very pleased with our choice of Falcon/DMS.

30) Are you planning to implement an EDMS system in the future? 9 **Yes** 9 **No**

31) If yes, within what time frame? 9 **0 - 12 mo** 9 **12 - 24 mo** 9 **24 - 36 mo** 9 **Undetermined**

32) In what format are your documents currently maintained? 9 **digital** 9 **paper** 9 **microfilm** 9 **microfiche**

9 **aperture card** 9 **other (describe)** _____

33) How are your documents currently indexed? 9 **card catalog** 9 **digital data base** 9 **other (describe)** _____

34) Do your stored documents include plotted CADD drawings? 9 **Yes** 9 **No**

35) If yes, will the CADD drawings be stored on your EDMS system? 9 **Yes** 9 **No**

36) How would you capture the CADD drawing for electronic storage? 9 **scan** 9 **native format** 9 **other (describe)**

37) Describe any issues or concerns you might associate with the implementation of an EDMS system_____

_____

_____

_____

_____

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_____

_____

_____

Installation Name: _Jacksonville District_____ **Page** __4____ **of** ___4___

Thanks for taking your valuable time to complete this survey. A copy of the final report will be sent to you. In addition to assisting us with development of the Electronic Document Management Standards, the report should provide you with an overview of automation tools being used across DOD for Document Management. If you have any questions relating to the content of this survey please contact Jack Owens, Michael Baker, Jr., Inc. at 800-642-2537 ext. 4348 or 412-495-4348. Tri -Service related questions should be directed to Laurel T. Gorman, P.G. at 601-634-4484.

Tri-Service CADD/GIS Technology Center
Electronic Document Management System (EDMS) User Survey

Name of Point of Contact: Jim Michonski **Phone:** (757) 396-8425

Title of POC: Mechanical Engineer **Fax:** (757) 396-8233

Internet E mail address: jmichons@pwceast.pwc.com

Installation or Office Name: Navy Public Works Center Engineering Division

Office or Department Title: Portsmouth Site Engineering Division

Office or Department Code: Code 214

Mailing Address:

Jim Michonski

PWC Code 214.3

Building 1500 NNSY

Portsmouth, Virginia 23709

Organization Branch: (check one)

- 9 **Air Force**
- 9 **Army**
- 9 **Army Corps of Engineers**
- 9 **Marines**
- ☑ **Navy**
- 9 **Coast Guard**
- 9 **Other :**

Tri-Service CADD/GIS Technology Center

Electronic Document Management System (EDMS) User Survey

Category Number Listing-(Other categories may be added as needed)

1. *EDMS Software* COTS, (Bentley Teammate, Intergraph NFM, Intergraph AIM, TSA Advet Falcon DMS, FileNet, Other) GOTS, Other
2. *Client* CLIX, DOS/Windows 3.1x, Windows 95, Windows NT, Sun Sparc
3. *Server* UNIX, NT, Novell Netware, Sun Sparc
4. *Storage/Repository* Desktop, RAID, CD-ROM, Optical
5. *Database DBMS* SQL, Oracle
6. *Viewing/Markup/Module* Spicer Imagenation, Imageview, Other
7. *Workflow Product/Module* FileNet Visual Workflow, FileNet Ensemble, Other
8. *Network* Novell, NFS, Other
9. *OCR Engine* Caere OmniPage Pro, Other
10. *Type Files Stored* DGN, DWG, CGM, TIFF, PDF, Other native formats
11. *Associated CAD2 Product(s)* Intergraph, Cordant
12. *Associated Non-CAD2 Product(s)*
13. *Customization Tools* Visual Basic 4, PowerBuilder, Other
14. *Internet/Intranet* Microsoft Internet Explorer, Netscape Navigator, Saros Mezzanine, Other

(Example)

Category Number: 1

COTS=Commercial Off The Shelf Software GOTS=Government Off The Shelf Software

Status	Software Name	Type Software	Brief Functional Description
☒ In Use	*Intergraph AIM*	☒ COTS	*Document Management Suite*
☐ Initiative		☐ GOTS	
		☐ Custom	

Survey of EDMS Work Performed Or Initiatives Under Development

Tri-Service CADD/GIS Technology Center, Electronic Document Management System (EDMS) User Survey

Category Number: 1

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	File Magic Plus	☑ COTS	
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 2

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	Dos/Windows	☑ COTS	
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 3

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	Novell	☑ COTS	
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 4

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	Desktop and Optical	☑ COTS	
9 Initiative		9 GOTS	
		9 Custom	

Installation Name: _____ **Page _____ of _____**

Please duplicate before using

Survey of EDMS Hardware/Software Currently In Use

1) Do you have an operating EDMS system in place? 9 **Yes** ☑ **No** ☑ **Future procurement planned**
(If no current operating EDMS system please skip to question 30)

2) How many users of the system? _____ How many concurrent users? _____

3) How many files are currently stored? _____ What is your average file size? _____

4) What is the primary function of your EDMS system?_____

_____

5) Describe the primary hardware components of your system:
(If available please provide a diagram describing the components of your system)

Server(s) _____

Input Device(s) _____

Storage Repository _____

Primary Workstation(s) _____

Printer(s) and/or Plotter(s) _____

Other associated hardware components _____

***Note: Information pertaining to software and operating system (client) data is detailed in the section entitled* "Survey of EDMS Work Performed Or Initiatives Under Development"**

6) Do you store and retrieve engineering (CADD) drawings on a regular basis? 9 **Yes** 9 **No**

7) If yes, in what format are the drawings ? 9 **Native CADD** 9 **Scanned Image** 9 **Other (describe) _____**

_____

8) Was Legacy data transferred to your EDMS system? 9 **Yes** 9 **No**

9) If yes, describe the means by which it was captured _____

_____

10) Describe your data capture process for inclusion of native format files (word processing, CADD, etc.) into your EDMS system _____

_____

11) Describe your digital document indexing process _____

_____

12) Describe your digital document retrieval or query process _____

_____

13) Describe, if applicable, your digital workflow process _____

_____

14) Have security, version control and redundancy issues associated with your EDMS system been adequately addressed?
9 **Yes** 9 **No**

15) If no, what improvements to your EDMS system would be required to meet desired security requirements? _____

_____

16) Is an efficient archive/backup process a component of your system? 9 **Yes** 9 **No**

17) If no, what modifications would be required to improve this activity? _____

_____

18) Is Internet/Intranet integration a desired or current component of your system? 9 **Yes** 9 **No**

19) Does your site have a training program for system users? 9 **Yes** 9 **No**

20) What resources are required to maintain your system on a day-to-day basis? _____

_____

_____

21) How long did it take to install your system? _____

_____

22) What problems were you setting out to resolve with the implementation of EDMS?_____

_____

_____

23) What challenges did you encounter during the implementation process?_____

_____

_____

24) Was an ROI done prior to the installation of your EDMS system? 9 **Yes** 9 **No**

25) If yes, what were the results? (*If available attach ROI table*)_____

_____

26) Describe the tangible and intangible benefits realized by the inception of your EDMS system. _____

_____

_____

_____

27) What user acceptance issues were addressed as your system was brought on-line? _____

_____

_____

_____

_____

_____

_____

28) What are the "Lessons Learned" that you would credit to the implementation of your system?_____

_____

_____

_____

_____

_____

29) Additional Comments: _____

_____

_____

_____

_____

_____

30) Are you planning to implement an EDMS system in the future? ☑ **Yes** 9 **No**

31) If yes, within what time frame? ☑ **0 - 12 mo** 9 **12 - 24 mo** 9 **24 - 36 mo** 9 **Undetermined**

32) In what format are your documents currently maintained? ☑ **digital** ☑ **paper** 9 **microfilm** ☑ **microfiche**

☑ **aperture card** 9 **other (describe) _____**

33) How are your documents currently indexed? ☑ **card catalog** 9 **digital data base** 9 **other (describe) _____**

_____

34) Do your stored documents include plotted CADD drawings? ☑ **Yes** 9 **No**

35) If yes, will the CADD drawings be stored on your EDMS system? ☑ **Yes** 9 **No**

36) How would you capture the CADD drawing for electronic storage? ☑ **scan** ☑ **native format** 9 **other (describe)**

Both

37) Describe any issues or concerns you might associate with the implementation of an EDMS system_____

1. Cost to implement

2. Maintenance of system

3. Proper storage format for compatibility with established and proposed DoD Standards.

Installation Name: Norfolk Naval Shipyard/PWC Norfolk **Page** 4 **of** 4

Thanks for taking your valuable time to complete this survey. A copy of the final report will be sent to you. In addition to assisting us with development of the Electronic Document Management Standards, the report should provide you with an overview of automation tools being used across DOD for Document Management. If you have any questions relating to the content of this survey please contact Jack Owens, Michael Baker, Jr., Inc. at 800-642-2537 ext. 4348 or 412-495-4348. Tri -Service related questions should be directed to Laurel T. Gorman, P.G. at 601-634-4484.

Tri-Service CADD/GIS Technology Center, Electronic Document Management System (EDMS) User Survey

Tri-Service CADD/GIS Technology Center
Electronic Document Management System (EDMS) User Survey

Name of Point of Contact: Mr. Reed MacMillan **Phone:** (410)278-0534

Title of POC: Environmental Planning Chief **FAX:** (410)278-6779

Internet E mail address: dmacmil@dshe.apg.army.mil

Installation or Office Name: Aberdeen Proving Ground

Office or Department Title: Directorate of Safety, Health and Environment

Office or Department Code: Environmental Planning

Mailing Address:

Attn: STEAP-SH-ER

Mitchell House, #5650

Aberdeen Proving Ground, MD 21203-1715

Organization Branch: (check one)

9 **Air Force**
9 **Army**
9 **Army Corps of Engineers**
9 **Marines**
9 **Navy**
9 **Coast Guard**
9 **Other :** _____

Survey of EDMS Hardware/Software Currently In Use

1) Do you have an operating EDMS system in place? 9 **Yes** 9 **No** 9 **Future procurement planned**
(If no current operating EDMS system please skip to question 30)

2) How many users of the system? ____*25*____ How many concurrent users? ____*5*____

3) How many files are currently stored? _____*5000*_____ What is your average file size? _____*500kb*_____

4) What is the primary function of your EDMS system?
To organize, store and retrieve NEPA Documents (RECs, RONA, CR106, etc)

5) Describe the primary hardware components of your system:
(If available please provide a diagram describing the components of your system)

Server(s) *Intergraph IP625*
Input Device(s) *HP ScanJet 5*

Storage Repository *12 GB Hard Disk utilizing RAID technology*

Primary Workstation(s) *Pentium 166, 32 Mb RAM*

Printer(s) and/or Plotter(s) *HP650c*

Other associated hardware components _____

***Note: Information pertaining to software and operating system (client) data is detailed in the section entitled "* Survey of EDMS Work Performed Or Initiatives Under Development"**

6) Do you store and retrieve engineering (CADD) drawings on a regular basis? 9 **Yes** 9 **No**

7) If yes, in what format are the drawings ? 9 **Native CADD** 9 **Scanned Image** 9 **Other (describe) _____**

_____

8) Was Legacy data transferred to your EDMS system? 9 **Yes** 9 **No**

9) If yes, describe the means by which it was captured _____

_____

10) Describe your data capture process for inclusion of native format files (word processing, CADD, etc.) into your EDMS system

See Attached Diagram

11) Describe your digital document indexing process _____
See Attached Diagram

_____

12) Describe your digital document retrieval or query process _____

User are provided a series of predefined filters (i.e. show me all the RECS), but also have access to a query form that provides a means for Ad-Hoc searches

13) Describe, if applicable, your digital workflow process __*See Attached Diagram*

---

14) Have security, version control and redundancy issues associated with your EDMS system been adequately addressed?
9 **Yes** 9 **No**

15) If no, what improvements to your EDMS system would be required to meet desired security requirements? _____

Currently the data exists in Microsoft Access, but in order to provide tighter security it is being ported to ORACLE. Additionally, a web based front end is being developed for those users that have a View-Only role. However the implementation of this tool dependent on the acquisition and installation of an intranet firewall.

16) Is an efficient archive/backup process a component of your system? 9 **Yes** 9 **No**

17) If no, what modifications would be required to improve this activity? _____

---

18) Is Internet/Intranet integration a desired or current component of your system? 9 **Yes** 9 **No**

19) Does your site have a training program for system users? 9 **Yes** 9 **No**

20) What resources are required to maintain your system on a day-to-day basis? _____

Currently the data entry portion of the day-to-day operation falls primarily on two individuals. The first is an internal employee that spends 25% of her time working with the system. The second individual is a contractor that works 3 days per week and focuses on scanning/linking historical documents.

21) How long did it take to install your system?

The entire ERPMS has been in development/implementation for the past 5 years. During the life of the application there have been long breaks in the development due to budget restrictions, personnel turnover, and a change in contractors.

22) What problems were you setting out to resolve with the implementation of EDMS?_____

There were several goals, they were; A) Allow for a faster turn-around for NEPA Documents. B) Provide access to the NEPA Document through the GIS, C) Share information with other Garrison Organizations and Tenants, D) Public Access to ALL NEPA Documents.

23) What challenges did you encounter during the implementation process?

See question 21

24) Was an ROI done prior to the installation of your EDMS system? 9 **Yes** 9 **No**

25) If yes, what were the results? (*If available attach ROI table*)_____

---

26) Describe the tangible and intangible benefits realized by the inception of your EDMS system. _____

See Question 22

27) What user acceptance issues were addressed as your system was brought on-line? _____

The standard for PCs (hardware/software) as defined by the Directorate of Information Management was used when determining the systems minimum requirements. However, many of the PC being used by the tenant organization did not comply with these standards and therefore could not utilize the system.

28) What are the "Lessons Learned" that you would credit to the implementation of your system?

A.) It is very important to coordinate with ALL users (internal and external) when determining the requirements of the system, both hardware and software, so prior to the expenditure of funds.

B.) The approach of customizing COTS packages such as Microsoft Word and Access to fulfill this specific needs of the organization has proved to be very cost effective. The alternatives of developing the entire system from scratch, or purchasing a complete EDMS and then customizing it to meet our specific needs would have been far more expensive.

29) Additional Comments:

It is important to have a contractor that you can trust and feel comfortable with prior to undertaking a project of this magnitude.

Additionally, you must be aware of the "Empire Builder" within the organizations. They can put up barriers that can be difficult and in some cases impossible to eliminate.

30) Are you planning to implement an EDMS system in the future? 9 **Yes** 9 **No**

31) If yes, within what time frame? 9 **0 - 12 mo** 9 **12 - 24 mo** 9 **24 - 36 mo** 9 **Undetermined**

32) In what format are your documents currently maintained? 9 **digital** 9 **paper** 9 **microfilm** 9 **microfiche**

9 **aperture card** 9 **other (describe) _____**

33) How are your documents currently indexed? 9 **card catalog** 9 **digital data base** 9 **other (describe) _____**

_____

34) Do your stored documents include plotted CADD drawings? 9 **Yes** 9 **No**

35) If yes, will the CADD drawings be stored on your EDMS system? 9 **Yes** 9 **No**

36) How would you capture the CADD drawing for electronic storage? ? 9 **scan** 9 **native format** 9 **other (describe)**

_____

37) Describe any issues or concerns you might associate with the implementation of an EDMS system_____

_____

_____

_____

_____

_____

_____

_____

Installation Name: _____ **Page _____ of _____**

Thanks for taking your valuable time to complete this survey. A copy of the final report will be sent to you. In addition to assisting us with development of the Electronic Document Management Standards, the report should provide you with an overview of automation tools being used across DOD for Document Management. If you have any questions relating to the content of this survey please contact Jack Owens, Michael Baker, Jr., Inc. at 800-642-2537 ext. 4348 or 412-495-4348. Tri -Service related questions should be directed to Laurel T. Gorman, P.G. at 601-634-4484.

Tri-Service CADD/GIS Technology Center, Electronic Document Management System (EDMS) User Survey

Tri-Service CADD/GIS Technology Center
Electronic Document Management System (EDMS) User Survey

Name of Point of Contact: Dan Jave **Phone:** (515) 252-4180

Title of POC: Project Manager **Fax:** (515) 252-4589

Internet E mail address: javed@ia-arng.ngb.army.mil

Installation or Office Name: Facilities and Construction Office

Office or Department Title:

Office or Department Code:

Mailing Address:

Iowa National Guard

7700 NW Beaver Road

Johnston, Iowa 50131

Note: At Camp Dodge – http:/www.guard.state.ia.us

Organization Branch: (check one)

- 9 **Air Force**
- 9 **Army**
- 9 **Army Corps of Engineers**
- 9 **Marines**
- 9 **Navy**
- 9 **Coast Guard**
- ☑ **Other :** ARNG

Tri-Service CADD/GIS Technology Center

Electronic Document Management System (EDMS) User Survey

Category Number Listing-(Other categories may be added as needed)

1. *EDMS Software* COTS, (Bentley Teammate, Intergraph NFM, Intergraph AIM, TSA Advet Falcon DMS, FileNet, Other) GOTS, Other
2. *Client* CLIX, DOS/Windows 3.1x, Windows 95, Windows NT, Sun Sparc
3. *Server* UNIX, NT, Novell Netware, Sun Sparc
4. *Storage/Repository* Desktop, RAID, CD-ROM, Optical
5. *Database DBMS* SQL, Oracle
6. *Viewing/Markup/Module* Spicer Imagenation, Imageview, Other
7. *Workflow Product/Module* FileNet Visual Workflow, FileNet Ensemble, Other
8. *Network* Novell, NFS, Other
9. *OCR Engine* Caere OmniPage Pro, Other
10. *Type Files Stored* DGN, DWG, CGM, TIFF, PDF, Other native formats
11. *Associated CAD2 Product(s)* Intergraph, Cordant
12. *Associated Non-CAD2 Product(s)*
13. *Customization Tools* Visual Basic 4, PowerBuilder, Other
14. *Internet/Intranet* Microsoft Internet Explorer, Netscape Navigator, Saros Mezzanine, Other

(Example)

Category Number: 1

COTS=Commercial Off The Shelf Software GOTS=Government Off The Shelf Software

Status	Software Name	Type Software	Brief Functional Description
☒ In Use	*Intergraph AIM*	☒ COTS	*Document Management Suite*
☐ Initiative		☐ GOTS	
		☐ Custom	

Survey of EDMS Work Performed Or Initiatives Under Development

Tri-Service CADD/GIS Technology Center, Electronic Document Management System (EDMS) User Survey

Category Number: 2

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	Windows NT 4.0	☑ COTS	
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 3

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	NT	☑ COTS	
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 4

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	RAID	☑ COTS	
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 5

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	Access	☑ COTS	
9 Initiative		9 GOTS	
		9 Custom	

Installation Name: _____ **Page** 1 **of** 3

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Survey of EDMS Work Performed Or Initiatives Under Development

Tri-Service CADD/GIS Technology Center, Electronic Document Management System (EDMS) User Survey

Category Number: 6

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	Ice View	☑ COTS	.CAL Viewer
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 6

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	Drag and View	☑ COTS	AutoCAD Viewer (limted success)
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 6

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	ARCView	☑ COTS	AutoCAD (limited information) Viewer, GIS
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 8

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	RCAS	9 COTS	Reserve Component Automation System, NT 4.0 Network
9 Initiative		☑ GOTS	
		9 Custom	

Installation Name: _____ **Page** 2 **of** 3

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Survey of EDMS Work Performed Or Initiatives Under Development

Tri-Service CADD/GIS Technology Center, Electronic Document Management System (EDMS) User Survey

Category Number: 10

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	.DWG, CAL.	☑ COTS	CAD Documents
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 14

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	MSIE	☑ COTS	RCAS Supported
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 14

Status	Software Name	Type Software	Brief Functional Description
9 In Use		☑ COTS	.ASP for Intranet, .HTM for Intranet
☑ Initiative		9 GOTS	
	Inter Dev, Front Page	9 Custom	

Category Number: 14

Status	Software Name	Type Software	Brief Functional Description
9 In Use		☑ COTS	Web GIS Viewer
9 Initiative		9 GOTS	
	ESRI IMS Extension for ARCView	9 Custom	

Installation Name: _____ **Page** 3 **of** 3

Please duplicate before using

Survey of EDMS Hardware/Software Currently In Use

1) Do you have an operating EDMS system in place? 9 **Yes** ☑ **No** 9 **Future procurement planned**
(If no current operating EDMS system please skip to question 30)

2) How many users of the system? _____ How many concurrent users? _____

3) How many files are currently stored? _____ What is your average file size? _____

4) What is the primary function of your EDMS system?_____

_____

5) Describe the primary hardware components of your system:
(If available please provide a diagram describing the components of your system)

Server(s) _____

Input Device(s) _____

Storage Repository _____

Primary Workstation(s) _____

Printer(s) and/or Plotter(s) _____

Other associated hardware components _____

***Note: Information pertaining to software and operating system (client) data is detailed in the section entitled* "Survey of EDMS Work Performed Or Initiatives Under Development"**

6) Do you store and retrieve engineering (CADD) drawings on a regular basis? 9 **Yes** 9 **No**

7) If yes, in what format are the drawings ? 9 **Native CADD** 9 **Scanned Image** 9 **Other (describe) _____**

_____

8) Was Legacy data transferred to your EDMS system? 9 **Yes** 9 **No**

9) If yes, describe the means by which it was captured _____

_____

10) Describe your data capture process for inclusion of native format files (word processing, CADD, etc.) into your EDMS system _____

_____

11) Describe your digital document indexing process _____

_____

12) Describe your digital document retrieval or query process _____

_____

13) Describe, if applicable, your digital workflow process _____

_____

14) Have security, version control and redundancy issues associated with your EDMS system been adequately addressed?
9 **Yes** 9 **No**

15) If no, what improvements to your EDMS system would be required to meet desired security requirements? _____

_____

16) Is an efficient archive/backup process a component of your system? 9 **Yes** 9 **No**

17) If no, what modifications would be required to improve this activity? _____

_____

18) Is Internet/Intranet integration a desired or current component of your system? 9 **Yes** 9 **No**

19) Does your site have a training program for system users? 9 **Yes** 9 **No**

20) What resources are required to maintain your system on a day-to-day basis? _____

_____

_____

21) How long did it take to install your system? _____

_____

22) What problems were you setting out to resolve with the implementation of EDMS?_____

_____

_____

23) What challenges did you encounter during the implementation process?_____

_____

_____

24) Was an ROI done prior to the installation of your EDMS system? 9 **Yes** 9 **No**

25) If yes, what were the results? (*If available attach ROI table*)_____

_____

26) Describe the tangible and intangible benefits realized by the inception of your EDMS system. _____

_____

_____

_____

27) What user acceptance issues were addressed as your system was brought on-line? _____

_____

_____

_____

_____

_____

_____

28) What are the "Lessons Learned" that you would credit to the implementation of your system?_____

_____

_____

_____

_____

_____

29) Additional Comments: _____

_____

_____

_____

_____

_____

30) Are you planning to implement an EDMS system in the future? ☑ **Yes** 9 **No**

31) If yes, within what time frame? 9 **0 - 12 mo** 9 **12 - 24 mo** 9 **24 - 36 mo** ☑ **Undetermined**

32) In what format are your documents currently maintained? ☑ **digital** ☑ **paper** 9 **microfilm** 9 **microfiche**

9 **aperture card** 9 **other (describe)** _____

33) How are your documents currently indexed? 9 **card catalog** 9 **digital data base** 9 **other (describe)** _____

Directory Tree/Files _____

34) Do your stored documents include plotted CADD drawings? ☑ **Yes** 9 **No** Some

35) If yes, will the CADD drawings be stored on your EDMS system? ☑ **Yes** 9 **No**

36) How would you capture the CADD drawing for electronic storage? ☑ **scan** ☑ **native format** 9 **other (describe)**

Scan – some .CAL

37) Describe any issues or concerns you might associate with the implementation of an EDMS system

We are using a manual system now because of the low volume of users. As we make documents available to more people we may need a management application. We are looking into placing documents on the Intranet as well

Installation Name: Camp Dodge **Page** 4 **of** 4

Thanks for taking your valuable time to complete this survey. A copy of the final report will be sent to you. In addition to assisting us with development of the Electronic Document Management Standards, the report should provide you with an overview of automation tools being used across DOD for Document Management. If you have any questions relating to the content of this survey please contact Jack Owens, Michael Baker, Jr., Inc. at 800-642-2537 ext. 4348 or 412-495-4348. Tri -Service related questions should be directed to Laurel T. Gorman, P.G. at 601-634-4484.

Tri-Service CADD/GIS Technology Center
Electronic Document Management System (EDMS) User Survey

Name of Point of Contact: Lawrence W. Condry **Phone:** (410) 291-4960

Title of POC: Project Manager Gas Supply **Fax:** (410) 291-4974

Internet E mail address: lawrence.w.condry@BGE.com

Installation or Office Name: Spring Gardens Plant

Office or Department Title: Gas Engineering and Construction Department

Office or Department Code:

Mailing Address:

1699 Leadenhall St., 2nd floor

Service Building – Spring Gardens

Baltimore, MD 21230

Organization Branch: (check one)

9 **Air Force**
9 **Army**
9 **Army Corps of Engineers**
9 **Marines**
9 **Navy**
9 **Coast Guard**
☑ **Other :**

Public Utility

Enclosure 1

Tri-Service CADD/GIS Technology Center

Electronic Document Management System (EDMS) User Survey

Category Number Listing-(Other categories may be added as needed)

1. *EDMS Software* COTS, (Bentley Teammate, Intergraph NFM, Intergraph AIM, TSA Advet Falcon DMS, FileNet, Other) GOTS, Other
2. *Client* CLIX, DOS/Windows 3.1x, Windows 95, Windows NT, Sun Sparc
3. *Server* UNIX, NT, Novell Netware, Sun Sparc
4. *Storage/Repository* Desktop, RAID, CD-ROM, Optical
5. *Database DBMS* SQL, Oracle
6. *Viewing/Markup/Module* Spicer Imagenation, Imageview, Other
7. *Workflow Product/Module* FileNet Visual Workflow, FileNet Ensemble, Other
8. *Network* Novell, NFS, Other
9. *OCR Engine* Caere OmniPage Pro, Other
10. *Type Files Stored* DGN, DWG, CGM, TIFF, PDF, Other native formats
11. *Associated CAD2 Product(s)* Intergraph, Cordant
12. *Associated Non-CAD2 Product(s)*
13. *Customization Tools* Visual Basic 4, PowerBuilder, Other
14. *Internet/Intranet* Microsoft Internet Explorer, Netscape Navigator, Saros Mezzanine, Other

(Example)

Category Number: 1

COTS=Commercial Off The Shelf Software GOTS=Government Off The Shelf Software

Status	Software Name	Type Software	Brief Functional Description
☒ In Use	*Intergraph AIM*	☒ COTS	*Document Management Suite*
☐ Initiative		☐ GOTS	
		☐ Custom	

Survey of EDMS Work Performed Or Initiatives Under Development

Tri-Service CADD/GIS Technology Center, Electronic Document Management System (EDMS) User Survey

Category Number: 5

Status	Software Name	Type Software	Brief Functional Description
☑ In Use		9 COTS	
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 6

Status	Software Name	Type Software	Brief Functional Description
9 In Use		9 COTS	
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 7

Status	Software Name	Type Software	Brief Functional Description
9 In Use		9 COTS	
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 8

Status	Software Name	Type Software	Brief Functional Description
9 In Use	RAID	9 COTS	
9 Initiative		9 GOTS	
		9 Custom	

Installation Name: _____ **Page** _____ **of** _____

Please duplicate before using

Survey of EDMS Work Performed Or Initiatives Under Development

Tri-Service CADD/GIS Technology Center, Electronic Document Management System (EDMS) User Survey

Category Number: 9

Status	Software Name	Type Software	Brief Functional Description
9 In Use		9 COTS	
9 Initiative		9 GOTS	
		9 Custom	

Category Number: 10

Status	Software Name	Type Software	Brief Functional Description
☑ In Use	.TIFF	9 COTS	
9 Initiative		9 GOTS	
		9 Custom	

Category Number: _____

Status	Software Name	Type Software	Brief Functional Description
9 In Use		9 COTS	
9 Initiative		9 GOTS	
		9 Custom	

Category Number: _____

Status	Software Name	Type Software	Brief Functional Description
9 In Use		9 COTS	
9 Initiative		9 GOTS	
		9 Custom	

Installation Name: _____ **Page** _____ **of** _____

Please duplicate before using

Survey of EDMS Hardware/Software Currently In Use

1) Do you have an operating EDMS system in place? 9 **Yes** ☑ **No** 9 **Future procurement planned**
(If no current operating EDMS system please skip to question 30)

2) How many users of the system? 200 **How many concurrent users?** 20

3) How many files are currently stored? 64,558 **What is your average file size?** 10 MB

4) What is the primary function of your EDMS system? To supply the latest and most up to date version of our record drawings to the users.

5) Describe the primary hardware components of your system:
(If available please provide a diagram describing the components of your system)

Server(s) Gateway 2000

Input Device(s) Ideal Scanner

Storage Repository Gateway 2000 and HP Jukebox (20 disc – upgradeable to 40)

Primary Workstation(s) Gateway 2000

Printer(s) and/or Plotter(s) HP Design Jet 600

Other associated hardware components _____

***Note: Information pertaining to software and operating system (client) data is detailed in the section entitled "* Survey of EDMS Work Performed Or Initiatives Under Development"**

6) Do you store and retrieve engineering (CADD) drawings on a regular basis? ☑ **Yes** 9 **No**

7) If yes, in what format are the drawings ? 9 **Native CADD** ☑ **Scanned Image** 9 **Other (describe)** .TIFF
We store and retrieve drawings but not in a CADD format

8) Was Legacy data transferred to your EDMS system? ☑ **Yes** 9 **No**

9) If yes, describe the means by which it was captured Some data scanned in on site – other data sent out to vendor and scanned onto optical disks.

10) Describe your data capture process for inclusion of native format files (word processing, CADD, etc.) into your EDMS system All data is scanned in to system. Nothing is entered electronically

11) Describe your digital document indexing process All documents are indexed under street name, job number, date scanned community name, electric grid and gas grid

12) Describe your digital document retrieval or query process See Above

13) Describe, if applicable, your digital workflow process _____

_____

14) Have security, version control and redundancy issues associated with your EDMS system been adequately addressed?
☑ **Yes** 9 **No**

15) If no, what improvements to your EDMS system would be required to meet desired security requirements? _____

_____

16) Is an efficient archive/backup process a component of your system? 9 **Yes** ☑ **No**

17) If no, what modifications would be required to improve this activity? _____

_____

18) Is Internet/Intranet integration a desired or current component of your system? ☑ **Yes** 9 **No**

19) Does your site have a training program for system users? ☑ **Yes** 9 **No**

20) What resources are required to maintain your system on a day-to-day basis? One full time employee

_____

_____

21) How long did it take to install your system? Approximately 4 months

_____

22) What problems were you setting out to resolve with the implementation of EDMS? Reduce amount of time from new jobs being plotted on drawings until received by users in Districts

_____

23) What challenges did you encounter during the implementation process? _____

_____

_____

24) Was an ROI done prior to the installation of your EDMS system? 9 **Yes** 9 **No**

25) If yes, what were the results? (*If available attach ROI table*) _____

_____

26) Describe the tangible and intangible benefits realized by the inception of your EDMS system. _____

_____

_____

_____

27) What user acceptance issues were addressed as your system was brought on-line? _____

_____

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_____

_____

28) What are the "Lessons Learned" that you would credit to the implementation of your system?_____

_____

_____

_____

_____

_____

29) Additional Comments: _____

_____

_____

_____

_____

_____

30) Are you planning to implement an EDMS system in the future? 9 **Yes** 9 **No**

31) If yes, within what time frame? 9 **0 - 12 mo** 9 **12 - 24 mo** 9 **24 - 36 mo** 9 **Undetermined**

32) In what format are your documents currently maintained? 9 **digital** 9 **paper** 9 **microfilm** 9 **microfiche**

9 **aperture card** 9 **other (describe) _____**

33) How are your documents currently indexed? 9 **card catalog** 9 **digital data base** 9 **other (describe) _____**

_____

34) Do your stored documents include plotted CADD drawings? 9 **Yes** ☑ **No**

35) If yes, will the CADD drawings be stored on your EDMS system? 9 **Yes** 9 **No**

36) How would you capture the CADD drawing for electronic storage? 9 **scan** 9 **native format** ☑ **other (describe)**

Software must be replaced to capture CADD

37) Describe any issues or concerns you might associate with the implementation of an EDMS system_____

_____

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Installation Name: _____ Page _____ of _____

Thanks for taking your valuable time to complete this survey. A copy of the final report will be sent to you. In addition to assisting us with development of the Electronic Document Management Standards, the report should provide you with an overview of automation tools being used across DOD for Document Management. If you have any questions relating to the content of this survey please contact Jack Owens, Michael Baker, Jr., Inc. at 800-642-2537 ext. 4348 or 412-495-4348. Tri -Service related questions should be directed to Laurel T. Gorman, P.G. at 601-634-4484.

Tri-Service CADD/GIS Technology Center, Electronic Document Management System (EDMS) User Survey

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Appendix C

NAVFAC EDMS Criteria Worksheet

Naval Facilities Engineering Command

Technology Evaluation System

Criteria Definition Worksheet

ELECTRONIC DOCUMENT MANAGEMENT SYSTEM (EDMS)

Corporate Technology Requirements

Criterion #1

Name: **COTS APPLICATION FOR NT, NT SERVER**
Definition: Commercial-off-the-shelf software with out-of-the-box functionality for LAN/WAN distribution of data. Client desktop operating system is Windows NT (some legacy Windows 95); the server operating system is Windows NT Server.

Criterion #2

Name: **ORACLE RDBMS**
Definition: Uses corporate RDBMS.

Criterion #3

Name: WEB THIN-CLIENT BASED
Definition: Browser-client with dynamically downloaded applets, full user application functionality over the web. Works with both Netscape Navigator/Communicator and Internet Explorer.

Criterion #4

Name: **OBJECT-ORIENTED OLE (ACTIVE X) COMPLIANT**
Definition: The object oriented approach views systems as collections of "objects." Objects encapsulate data and functions. They model real-life entities and concepts in programs. Objects interact with each other through well-defined interfaces. Object-Oriented can simplify complex system structures and increase their performance, robustness and extensibility. OLE ObjectLinking and Embedding is a Microsoft Windows facility that allows you to use several Windows applications to produce a single document.

Criterion #5

Name: **MIGRATION PATH FROM EXISTING SYSTEMS**
Definition: Method available to convert existing EDMS systems to the selected system, e.g., keyfile.

Criterion #6

Name: **INTEGRATABLE WITH RMS**
Definition: Specify RMS-compatible application, whether internal, add-on, or third party.

Criterion #7

Name: **SCALABLE/RELIABLE**
Definition: Software has a flexible architectural design, with the ability to expand the system as corporate usage increases. Services can be distributed on multiple machines and the system supports multi-threading. Software has solid transaction integrity features. The system has the ability to replicate repositories between geographically separate locations for recovery purposes.

Courtesy of Ms. M. Louise McMonegal, HQ NAVFAC

EDMS CRITERIA RECOMMENDATIONS

Capture & Storage

Criterion #8

Name: **STORED AND CUSTOMIZABLE DOCUMENT METADATA**
Definition: The system supports storedMetadata (attributes, index values, profiles/properties or characteristics of documents) are supplied with the applications. The software must be customizable so that themetadata can be changed or supplemented.

Criterion #9

Name: **SEAMLESS STORAGE FEATURES**
Definition: The system has the capability to locate engineering documents within the system, without the end user's knowledge of the physical location.

Criterion #10

Name: **MULTIPLE VERSION STORAGE FEATURES**
Definition: The application's ability to track and store multiple revisions of documents and ensure that users have the correct/current version of a single named document. The ability to track access and revision activities for each document and allow purging of obsolete documents.

Criterion #11

Name: **UTILIZES MULTIPLE STORAGE MEDIA**
Definition: Software is capable of storing documents to varied media, e.g., CD-ROM, optical disk including Computer Output to Laser Disk (COLD), magnetic tape, etc., and is capable of storing data on-line, near-line, and off-site for disaster recovery purposes.

Criterion #12

Name: **OCR SUPPORT**
Definition: Software supports or integrates with Optical Character Recognition, the process of turning an image into computer-editable text.

Criterion #13

Name: **FAX SUPPORT**
Definition: **Software can receive, transmit, track and capture faxed documents to the end-user.**

Criterion #14
Name: EMAIL SUPPORT
Definition: Software can receive, transmit, capture and track electronic mail via integration with corporate email system MS-Exchange/Outlook.

Criterion #15

Name: **ODBC COMPLIANT**
Definition: Can use Open Database Connectivity to access databases.

Criterion #16

Name: STORE ALL BINARY FORMATS

Definition: Software must be capable of capturing, retrieving, and storing data in all binary file formats, whether or not view is supported.

RETRIEVAL

Criterion #17

Name: **FULL-TEXT SEARCH AND RETRIEVAL**
Definition: Access documents by words or phrases or bymetadata.

Criterion #18

Name: **POWERFUL DISTRIBUTED SEARCH ENGINE CAPABILITY**
Definition: Ability to query corporate documents in real time within one's own department, organization or corporate wide. Provides response to content search of multiple document servers and remote network sites and delivers unifiedhit-list.

Criterion #19

Name: **CUSTOMIZED SEARCH**
Definition: Provides query by example to novice end-users and advanced search features for experienced users. To include drag and drop capabilities frommetadata, pick lists, etc.

Criterion #20

Name: **SAVED SEARCH CAPABILITIES**
Definition: Ability to name and save searches for repeated use.

Criterion #21

Name: **FLEXIBLE VIEWING CAPABILITIES**
Definition: Software has the capability to deliver documents to the desktop for display, review, annotation, printing, and copying multiple common electronic file formats such as .doc, .xls, .pdf, .tif, .gif, .jpg, .txt, .ppt, .dwg, .dxf, etc. Supports CCITT Group IV compression formats.

	Viewed by		
File Type	Native File Type Viewer (provided by EDMS)	Browser Plug-In	Helper Application
.doc			
.xls			
.pdf			
etc.			

WORKFLOW

Criterion #22

Name: **SUPPORT OF AD HOC AND PRODUCTION WORKFLOW**

Definition: Able to accommodate real-time changes including restarting or revising routing from any step at any time. (**User created templates, ad-hoc and production workflow).

Criterion #23

Name: **GRAPHICAL DOCUMENT ROUTING AND TRACKING**
Definition: Visual representation of tasks defined with the status and location of routing and tracking. A variety of data types can be supported. Work routing defines the order in which the items flow. Work may be routed graphically without third party programming. Once implemented, the status of all transactions can be checked.

Criterion #24

Name: **EMAIL NOTIFICATION**
Definition: Software leverages corporate email system MS-Outlook/Exchange, for event notification, but does not require an email system for document delivery. Documents can be distributed in sequence, parallel or broadcast modes with automated inactivity notification.

SECURITY/TRANSMISSION

Criterion #25

Name: **REVISION CONTROL**
Definition: Ability to allow or restrict multiple levels of access to an individual or group. Software locks 'checked out' files from access, allows offline edit, and prompts users for checkin. All revisions to a document should be distinguished from one another.

Criterion #26

Name: **MULTIPLE DOCUMENT SECURITY LEVELS**
Definition: Ability to assign levels of security to a project, file folder, document or versions.

Criterion #27

Name: **SECURITY 'ROLES' AND INDIVIDUAL/GROUP PRIVILEGES**
Definition: Ability to assign levels of security from a Department down to an individual. Software leverages operating system and database security, using standard directories. Software prevents access to documents from outside the EDMS.

ADDITIONAL

Criterion #28

Name: SOFTWARE APPLICATION COST
Definition: Require pricing for 1500, 7500 and 15000 seats of both web thin client and thick client. Details on pricing structure are required (licensing per seat, per named user or concurrent).

Criterion #29

Name: FULLY-REMOTE ADMINISTRATION
Definition: Allow one point or distributed administration of system, end-users and software upgrades (remote console, web interface, etc.) through an intuitive interface. Utilities are available to perform reporting on audit trail data.

Criterion #30

Name: API (APPLICATION PROGRAMMING INTERFACE) FOR CUSTOM APPLICATIONS

Definition: Software provides methods to customize and present different user interfaces. API's are available and aforms designer is provided or industry standard tools are supported to work with the product such as Visual Basic, C++, Delphi, etc.

Criterion #31

Name: MINIMAL TRAINING REQUIREMENTS

Definition: Less than one day of training for end-user and less than one week of training for the administrator.

Criterion #32

Name: **ANNOTATION OF DATA**

Definition: Layers of annotations including redlining, sticky notes, highlighting, redacting, typed notes and freehand line drawing with the ability to track the annotations in an audit trail and to provide security. The annotations are separate from and do not directly modify the content of the original document.

Criterion #33

Name: **PRODUCT MAINTENANCE AND SUPPORT**

Definition: Notification or access to patches and maintenance releases. Level of support (i.e., 24/7 unlimited telephone assistance).

RECORDS MANAGEMENT SYSTEMS (RMS) CRITERIA INTEGRATABLE WITH RECOMMENDED EDMS

DOCUMENT FILING

Criterion #34

Name: **NON-ELECTRONIC RECORDS**

Definition: Ability to manage all non-electronic records (i.e., paper, audio, video, microfiche, maps, drawings, 105mm, 35mm and photos, etc.) without the requirement of converting the records into electronic format.

Criterion #35

Name: **ELECTRONIC MAIL RECORDS SUPPORT**

Definition: Ability to capture and manage selected electronic mail messages and to catalog essential and required information (i.e., message header, text, attachments, etc.) and to secure the documents as official records.

Criterion #36

Name: **DOCUMENT FILING SUPPORT**

Definition: Ability to capture essential and required records management information from a document determined ("declared") to be an official record from the EDMS without duplicating the document or the document's metadata (properties/profile.)

END-USER SERVICES

Criterion #37

Name: CLASSIFICATION

Definition: Ability to classify "declared" documents from the EDMS into the appropriate Standard Subject Identification Code (SSIC). Ability to classify documents quickly, easily and accurately by building pick lists or automatically classifying documents by individuals, business lines, or projects, etc. Software includes identifying and tracking vital records.

Criterion #38

Name: **RESERVATIONS**
Definition: Ability for the end-user to reserve and checkout non-electronic records tracked and managed by the records management system. Notifies records manager of request and tracks physical location of those records (i.e., who checked-out, expected due date, date of return.) Also allows records manager to produce reports.

Criterion #39

Name: **REPORT WRITER**
Definition: Ability to query and produce records management reports related to file plans and "records" inventories, scheduling, transfer, and final disposition.

Criterion #40

Name: **FILE PLAN**
Definition: Identifies and describes business line or organization's records' life cycle structure by subject grouping. The basis for records retention and final disposition.

Criterion #41

Name: **RECORDS SCHEDULING**
Definition: Ability to inventory and cut-off records at a designated time (date) or event, allowing human intervention for review or automatic records transfer. Also includes transfer of non-electronic records to the Federal Records Centers or transfer control of records to the National Archives and Records Administration.

Criterion #42

Name: **FILE PLAN RE-ORGANIZATION**
Definition: Ability to change single subject groups, business lines or global changes to accommodate updates to regulations or changes to business operations or corporate restructuring/reorgranization.

Criterion #43

Name: **DoD 5015.2-STD Certified**
Definition: Meeting DoD required certification and compliance with the DoD 5015.2-STD, Design Criteria Standard for Electronic Records Management Software Applications.

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13. ABSTRACT (*Maximum 200 Words)*

This guideline is written for DoD organizations wishing to manage engineering and facility management documents more effectively. It presents general guidelines applicable to any Electronic Document Management System (EDMS), with particular emphasis on managing large-scale engineering drawings, whether paper-based or CADD-generated. Topics addressed are EDMS technologies for standard business and engineering documents, a description of document management processes and associated hardware and software components, automated workflow, EDMS user survey results, additional information on DoD and federal agency use of EDMS, lessons learned by DoD/federal users, implementation issues, use of the Internet and Intranets for document management, conclusions, and recommendations. Recommendations for implementing an EDMS relate to the need to understand existing systems andworkflows, establish a clear purpose and objectives for the EDMS, anticipate cultural acceptance issues, phase implementation using a pilot project approach, ensure existing manualworkflows can be duplicated, provide training, and choose an EDMS vendor wisely.

14. SUBJECT TERMS

Electronic Document Management Systems, EDMS, EDM, PDM, Automated workflow, File sharing, Collaborative engineering, Imaging, Scanning, Electronic repositories

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