

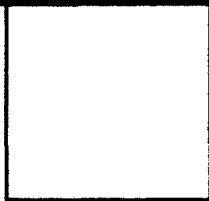
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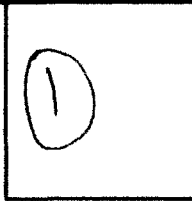
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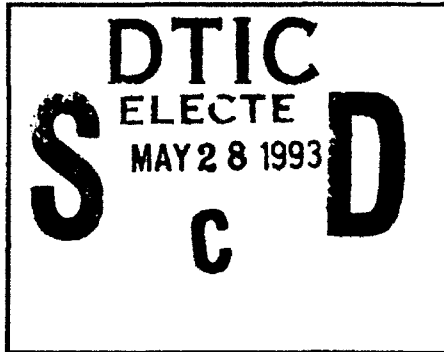
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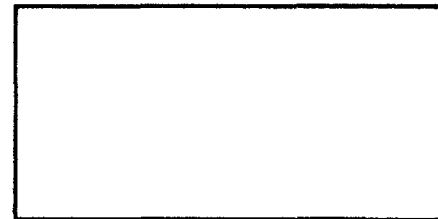
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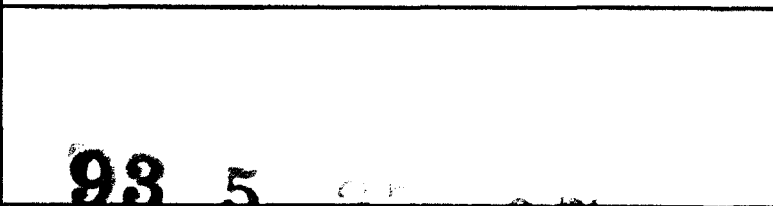
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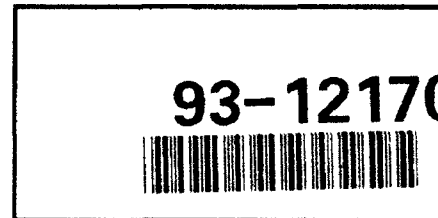
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VOLUME 25
Navy CALS Vision
Draft 2.0

**Computer-aided Acquisition &
Logistic Support (CALs)**

NAVY CALS VISION

DRAFT 2.0

October 1990

Prepared by

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PREFACE

CALS – a joint initiative with industry

While the second half of the nineteenth century and most of the twentieth century are regarded as the Industrial Age, the last half of the twentieth century and the beginning of the twenty first century are characterized as the Information Age. CALS (Computer-aided Acquisition and Logistic Support) is a joint initiative that provides a focus for both DoD's and Industry's transition into the Information Age.

Improved weapon system availability and readiness

Implementation of CALS within the Navy is based upon the philosophy that significant process improvements and productivity innovations can be achieved through an integrated information environment. By adopting the DoD CALS vision as a target of the future, the Navy is exploring a wide range of opportunities to radically improve how work is performed and thereby improve weapon system availability and readiness in an era of declining budgets.

Within the Navy, the realization of CALS is based on:

- An environment of integrated technical information, and
- A series of networked business relationships that extend the boundaries of individual organizations into larger cohesive "virtual organizations."

Needed – cohesive infrastructure of information technology

Both of these prerequisite elements need a cohesive infrastructure of information technology. This infrastructure must be constructed and managed to provide a series of information services to creators, managers, and users of technical information. It is this bundled set of services that will logically integrate various sets of data and allow organizations to interact cohesively regardless of location or organization affiliation.

Needed – dialogue among stakeholders

This paper presents a vision of how weapon system availability and readiness will be improved in the Navy and the role that CALS and information technology will fill in achieving this objective. Its intent is to convey a progressive view of the future and encourage a dialogue among the key stakeholders responsible for the success of Navy CALS, namely OSD, the Navy Commands, the defense industry, information technology companies, and standards organizations.

Establish priorities as a foundation

This document begins the process of establishing priorities by defining the target of process improvements that the Navy is pursuing through CALS. After consensus has been obtained on the process improvements that the Navy desires to pursue, this document will provide a foundation for the creation of an implementation plan that can guide the overall Navy CALS effort.

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INTRODUCTION

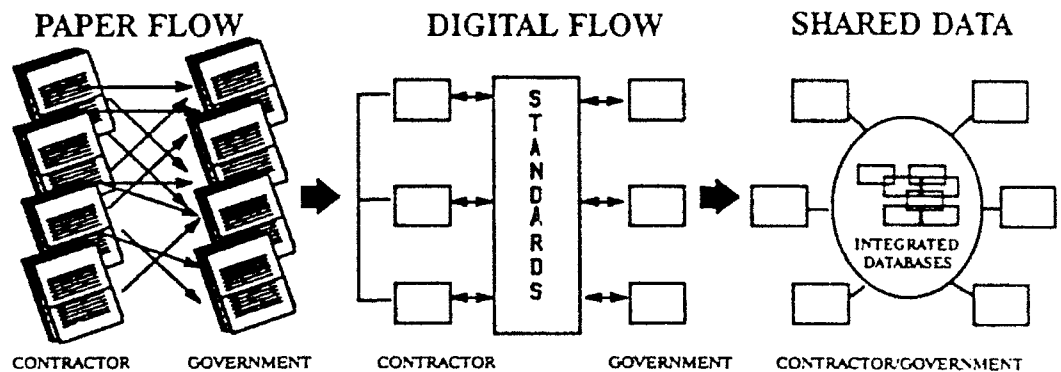
CALS Overview

Computer-aided Acquisition and Logistic Support (CALS) is a joint initiative between industry and the Department of Defense (DoD) that is targeted at:

- Improving designs for weapon systems.
- Reducing both acquisition and logistic support costs for weapon systems.
- Improving weapon system technical information accuracy and timeliness.

The CALS initiative represents a commitment on the part of both industry and DoD to change the way business is conducted. Today business is conducted primarily through the exchange of documents and other paper products. As information technology matures and becomes more widely used, the paper flow of information is being replaced by a digital flow of information. The digital exchange of information represents an interim solution; the longer term solution involves conducting business in a shared data environment that relies upon logically integrated databases.

THE CALS EVOLUTION



The Navy Challenge - Weapon System Management

As weapon systems become more complex, they demand more intricate designs, more exacting production techniques, and more complex procedures for maintenance and operations. In addition, the technical information needed to design, manufacture, maintain, support, and operate these systems has grown exponentially. For example, twenty years ago the technical manuals needed to support a *Spruance* Class ship averaged 50 pages per manual. Today, to support the *Aegis* Class, these manuals average 150 pages *and add 27.5 tons above the water line.*

Localized information systems discourage integration and information reusability

The Navy has responded to this explosion of technical information by developing localized information systems that capture specific sets of information. These information systems have been developed by individual Commands and offices that have had different and sometimes divergent responsibilities. Unfortunately, because individual commands have had different reporting requirements, different ADP equipment and software, and different approaches to problem solving, little emphasis was placed on integration or information reusability. Applications were typically designed to be self-contained, or to interface with a few specific additional applications.

Numerous consolidation opportunities exist

This type of development has produced a large inventory of information technology. This inventory acts as an infrastructure to manage information needed to maintain weapon system availability and readiness. Regrettably, the current Navy infrastructure, having been acquired over the last 40 years, allows little integration applications. Many potential consolidation and/or replacement opportunities have not been implemented or addressed.

CALS - an opportunity to innovate

Confronted with a declining budget and personnel allocations, the Navy is finding it ever more difficult to maintain and operate the increasingly complex weapon systems and the plethora of diverse information systems. The hope for the future is to develop new and innovative ways to improve weapon system support. CALS can be the facilitator for achieving these improvements.

Integration leads to productivity gains

As the pace of innovation in information technology accelerates, the degree of integration is actually decreasing at a time when it should be increasing. Without a concerted effort to organize, manage, and integrate information technology, information applications, and data, the innovative process improvements and productivity gains achievable through automation will be in jeopardy and our ability to acquire, maintain, support and use our increasingly sophisticated weapon systems will be seriously strained.

CALS - the smart management of information technology

As the Navy continues to strive for improved productivity and quality, the management of information technology needs to be viewed as a mechanism to facilitate desired improvements. Through the "smart" or strategic management of information technology investments, the Navy will maximize the benefits of information technology, while improving overall efficiency and productivity. The application of information technology in the Navy environment offers tremendous opportunities to improve readiness and availability, involves unique challenges in leadership, and represents a significant commitment of time, money, and personnel. An arduous challenge, but a goal the Navy must achieve, is to define, acquire, and manage information technology in a way that maximizes readiness and availability with reduced resources for the entire range of Naval assets throughout their life cycle.

The Navy Response

The initial Navy-wide response to this challenge is to anticipate needs by establishing a target for the future. By using this target as a guide to mold the future Naval business environment, needed capabilities will be defined, and major areas of information technology emphasis will be identified. Definition of this target relies upon a leveraged planning approach that incorporates three elements:

- the Navy vision of CALS implementation which is a result of an assessment of the future Navy business environment, and emerging trends and user requirements at both the Navy and DoD level;
- assessments of critical technologies that define a performance envelope for the future, and are reflected in the vision; and
- consensus of key players in industry and in various organizations within the Navy.

The resulting target will then be compared to a baseline of current initiatives, and from this comparison a set of strategic programs will be defined to help the Navy achieve its goal.

The Navy Vision

The Navy CALS vision of the future is focused on improved business processes that support capabilities necessary to accomplish the Navy mission. These improvements in business processes will be enabled by:

- integrated information environments, and
- information networks providing on-line data access.

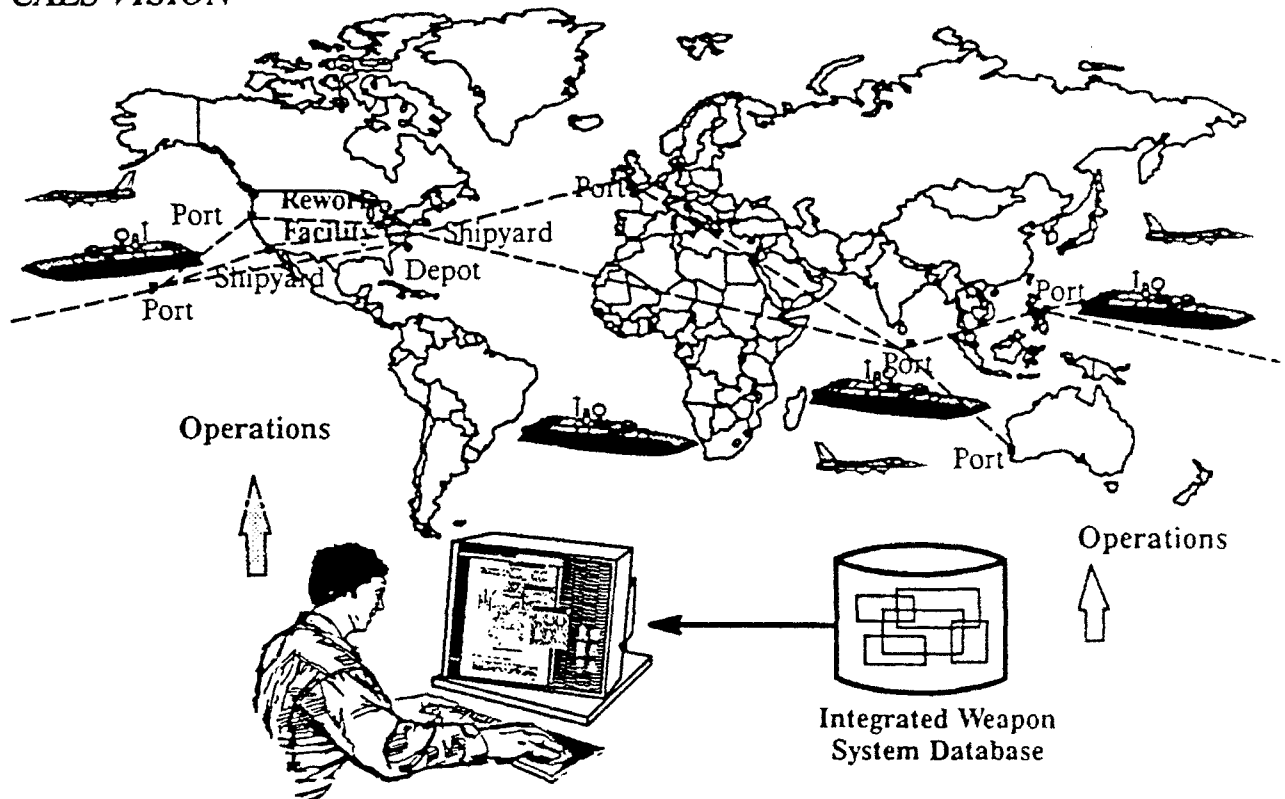
Existing "legacy" data will be integrated with newly created digital data

Navy integrated information environments will be composed of robust sets of technical data and a complementary infrastructure of information technology. Navy technical data will be defined and structured in a manner that facilitates the integration of existing "legacy data" (e.g., paper technical manuals and drawings) with newly created data. The infrastructure of information technology will be the platform to assure accurate, current, and readily accessible technical information. Information technology platforms are the tool sets needed to effectively manage the data and improve weapon systems readiness and availability through improved operations and processes.

Information networks will link ship and shore

The second critical enabler, information networks, are the "glue" that will link ship and shore personnel with accurate and current information associated with a ship's actual equipment. It is through these information networks that data will be accessed, thereby enabling improvements in productivity, maintenance reliability, and readiness.

THE CALS VISION



Process improvements increase readiness and availability

Organizational relationships and work procedures will be transformed through CALS. Networked business relationships will be established, extending the boundaries of numerous individual organizations into larger cohesive "virtual organizations." As described below, this transformation will facilitate process innovation in disciplines such as weapon system acquisition, engineering, manufacturing, maintenance, and logistic support and will result in improved readiness and availability.

Acquisition cycle - streamlined and accelerated

Weapon system acquisition will be significantly streamlined, resulting in shorter acquisition cycles and reductions in costs. Some processes, such as data calls, will be essentially eliminated. Other processes, such as preparation, notification and distribution of solicitation documents will be made more efficient through the application of automation. Automated templates; digitized libraries of drawings, parts descriptions, and standardized clauses; electronic mail and conferencing; and standardized digital transactions will significantly enhance the solicitation process. Receipt and review of technical documentation (which will evolve from today's conventional documents to

database-like structures of technical information) will be enhanced by automated validation routines and software tailored to enhance productivity. This software, often called *groupware*, includes productivity tools such as document management systems and electronic conferencing.

**Logically unified
databases
support concurrent
design and
engineering**

Engineering and design processes will continue to be executed both organically and in the contractor environment. Regardless of the organization undertaking the work, design and engineering will migrate from a series of semi-autonomous processes to an integrated, interdependent process with multiple disciplines acting concurrently on a logically unified (but geographically distributed) database. An integral aspect of the concurrent engineering capability will be implementation of engineering management procedures that will be housed within an environment that will provide for centralized engineering control of data access and automatic change notifications.

**Flexible Computer
Integrated
Manufacturing
increases
availability**

Manufacturing processes will be enhanced by Flexible Computer Integrated Manufacturing (FCIM) applications. This technology will provide the Navy with a capability to fabricate components, subsystems, and systems at a greatly increased number of sites. Access to digital repositories of product data coupled with FCIM technology will enable even intermediate and small activities to take design information and fabricate complex items. This capability enhances maintenance and repair capabilities, reduces down time, and increases availability and readiness of assets.

**Interactive
Electronic
Technical Manuals
improve
maintenance**

Maintenance and repair actions will be greatly influenced by CALS-related technologies such as FCIM, Interactive Electronic Technical Manuals (IETM), and sophisticated three-dimensional (3-D) product models. CALS will enable value-added capabilities, such as embedded readiness assessments and user-defined displays to identify unscheduled maintenance requirements. Increasingly sophisticated on-board diagnostics will guide the maintenance technician in identifying failures. Technical manuals will be created as a digital database of related information, allowing technical IETM work packages to be customized to specific job requirements. Zone technology applications will be integrated with these interactive manuals to plan and schedule maintenance actions that reflect supply, equipment, and manpower constraints.

**Ship-to-shore
information
networks**

Logistic support actions will be significantly improved by CALS at sea and ashore. In particular, ship operations will be supported through information networks that will enable various ship departments to access and store data. Distributed data will remain totally integrated with other systems throughout the shipboard network and will increase the survivability of the overall system. Information will be shared by all functional areas to support management decisions and analysis. The coordination of supply levels ashore and afloat via satellite communications will increase efficiency of logistic actions.

These examples represent only a few of the improvements that will result from CALS implementation and are meant to be illustrative of the process improvements that will be realized throughout the Navy.

Benefits

CALS technology will provide the Navy with tools to create, manage, and use digital technical data efficiently, improving availability and readiness, streamlining the acquisition process, and making logistic support more effective and efficient. CALS payoffs include the following:

- **Improved support with reduced resources**

The improved quality of systems achieved through automation and data integration will not only reduce the number of systems required, but will also result in dramatically lower life cycle costs in terms of procurement and maintenance, as well as people and facilities.

- **Shortened turn-around for support and maintenance leading to a higher percentage of systems available to perform missions**

The integration of technical information from concept through operation and support, and across programs and systems will enable more weapon systems to be *Fully Mission Capable (FMC)*. Maintenance precision will be increased through control of information contained in IETMs, and support costs and turn around times reduced.

- **Rapid response to changes in requirements**

Integration of technical data with weapon system operations will support rapid configuration changes, thereby addressing new mission requirements resulting from changes in operating requirements.

- **Improved command information**

Commands will be able to electronically monitor the performance of their systems, assets or personnel and simulate and evaluate proposed changes. Decision making will be assisted by this improved information.

- **Leveraged information technology investments**

The strategic management of information technology will empower the Navy to acquire the hardware, software, and communication networks that are needed by the sailor "to do the job right the first time." CALS is the strategy that will allow the Navy to "do more with less." In an era of declining budgets, leveraged investments are a necessity that can no longer be ignored.

THE VISION OF CALS IMPLEMENTATION – IMPROVED PROCESSES

Improved Processes

Implementation of CALS within the Navy is based upon the philosophy that significant process improvements and productivity innovations can be facilitated through the achievement of an integrated information environment. By making acquisition, engineering and design, manufacturing, maintenance, and other logistic functions more efficient and cost effective, CALS will improve the readiness and availability of weapon systems.

Navy CALS within Acquisition

CALS will significantly improve actions associated with the acquisition of new systems and the modernization and modification of existing systems. Digital data repositories, electronic networks, and automated validation, verification, and annotation applications will drastically streamline system acquisitions. Three areas in the acquisition process that will be significantly influenced by CALS include solicitation, design review, and technical data acquisition.

- **Solicitation**

Solicitation currently includes authoring and assembly of a solicitation document or bid package, notifying prospective bidders and providing them with the bid request, receipt and evaluation of bids, and award of a contract. The way these processes are undertaken will be significantly changed by CALS.

Requirements definition incorporates historical data

Preparation of the solicitation document, bid set, or procurement package will involve defining technical requirements and data requirements, and assembling text, numeric data, and graphics into an integrated package. Definition of technical requirements will rely on access to digital data repositories of various engineering, performance, and planning information. Definition of contract data requirements will be based on subject databases or logical data models instead of reports, drawings, and other paper media.

Digital information transfers shorten the solicitation process

Information transfer and distribution, a critical requirement throughout the solicitation process, will be done in an electronic mode. Preparation of the solicitation document, announcements and responses; and the review, evaluation, and award process require information transfers between organizations and among various staff members within organizations. Wide and local area networks (LANs) will be the backbone for transactional

information transfers, while a variety of digital media will be used to capture and physically transfer more voluminous information. Digital transfer of information will shorten the solicitation process and reduce the level of effort required to enter and constantly re-enter the same or derivative information.

- **Design Reviews**

Concurrent Engineering
- radical change to the design review process

The design review process will be radically changed due to the shared database environment and the implementation of true concurrent engineering approaches. Today, design reviews are laborious, time-consuming and costly. Available time of highly skilled staff is often spent in a review process that requires the review of thousands of pages for completeness, consistency, and technical accuracy. Numerous staff are then often required to travel to a single site where detailed discussion is undertaken on literally thousands of issues.

Review of data
- part of the design process

Through the application of CALS technology, design approaches will be employed that eliminate much of the effort in the review of data and the face-to-face meetings associated with today's design reviews. Review of data that has been historically considered logistic data (i.e., logistic support analysis records) will be done as part of the engineering design process. The limited data review that will still be necessary will be done on-line, with much of the routine checking accomplished through automated validation. Comments and changes can be consolidated electronically, and electronic conferencing can be used to address most comments and suggested changes. When face-to-face meetings are required, only significant technical issues will be on the table, thereby allowing for a more thorough review of issues critical to system success.

- **Technical Data Acquisition**

Present technical data acquisition often deals with incomplete data in a variety of formats that are often incompatible. This variation in data form and format often results in ineffective reviews, and therefore, data of suspect quality.

Automated data review facilities will control data quality

As part of future technical data acquisition and acceptance, the Navy will utilize automated data review facilities as a quality control mechanism and undertake a series of information management actions to facilitate life cycle utility of the information. The data review facility will either convert information into a digital form, or more commonly, perform a series of automated checks and provide tools for human review on a selected basis. The automated checks will incorporate multiple path logic routines (i.e., *fuzzy logic*) to check for completeness, consistency, and compliance to mandated standards, formats, and other contract requirements. As data is being accepted, many information management actions will be performed before the information formally enters the inventory of repositored technical data. Data will be cataloged, indexed and cross-referenced to facilitate control, access, and distribution.

Navy CALS for Design and Engineering

CALS will improve the efficiency of design and engineering by integrating processes undertaken by numerous organizations within the weapon system life cycle. Design and engineering efforts will increasingly rely on networked business relationships between departments, field activities, commands, and industry. Logically integrated databases, robust information management services, and communication technologies and standards will be the crucial tools needed for concurrent engineering and design processes.

Logically integrated databases support design verification

Future engineering and design activities will be focused by the creation and concurrent use of a logically integrated database of design, engineering, and logistic information shared among various organizations and disciplines. Accurate representation of design, engineering, and logistic concepts in an open computing environment will facilitate design iterations, verification of design functionality, and accurate technical documentation, while reducing the number of weapon system component prototypes.

Product models – the main source of information for ships and aircraft

Over time, an integrated database of weapon system information will evolve from a series of product models that capture one view or dimension of a design. These product models, which are becoming the main source of information for ships and aircraft, will be organized to provide user views that support life cycle requirements for a ship or aircraft. A 3-Dimensional (3-D) solid model will represent the weapon system in a manner that supports modular design, maintenance, and repair.

The concurrent engineering process – reliance on logically integrated databases

Concurrent engineering will rely on this integrated database to provide a single source of product data to all engineering, logistic, and manufacturing functions. An integrated network of databases, accessed via work stations, will support numerous Computer-Aided Design (CAD)/Computer-Aided-Engineering (CAE) tools. These tools will support geometric modeling, mechanical and electrical design, reliability and maintainability analysis, support equipment specification and design, scientific visualization, various simulations, and numerous other laboratory or scientific operations.

Logically integrated databases incorporate version control and change notification

An integral aspect of concurrent engineering will be implementation of engineering data management procedures that provide a secure environment for a database. These procedures will provide centralized engineering control and automatic change notifications. Event-driven alerts will be distributed throughout the database to provide change notification. A cross-referencing system will facilitate version control and release management, and assure a singular, non-redundant, accurate description of the product. Quick analysis of logistic performance will provide data feedback and flag-detected deficiencies to system designers.

Navy CALS for Manufacturing

Flexible CIM supports new acquisitions and existing assets

Readiness and availability improved - downtime reduced

Standardized part descriptions

CALS will facilitate more rapid design prototyping, and reduce lead times and production costs to fabricate and assemble components and systems. Systems will be acquired and fielded more quickly. CALS will accomplish this by promoting FCIM environments both for the acquisition of new systems and for the maintenance, repair, and overhaul of existing assets.

In the Navy, the local manufacturing of components and assemblies is necessary to repair ships, planes, and various systems and subsystems. Future developments aboard ships and at shore facilities will stress FCIM systems for production and fabrication. By interacting with production databases, FCIM systems provide the capability to manage the numerous manufacturing processes and resources that are required to produce mechanical parts in small shops, large depots, or shipyard facilities.

Job planning, equipment and manpower scheduling, work execution, and performance measurement will be controlled by FCIM systems. Material flow requirements will be integrated with work schedules to optimize shop floor configurations, enabling multiple work orders and job requirements to be satisfied simultaneously. Milling, grinding, polishing, drilling, and other operations that historically have been done separately can often be combined into single operations.

FCIM will provide Navy Inventory Control Points (ICP), material managers, and intermediate maintenance activities with the capability to rapidly manufacture and acquire parts, assemblies, and kits. This FCIM capability will lower inventory costs, reduce storage and handling of outdated parts, optimally use space required for critical inventory, and reduce depot level maintenance. It will also improve readiness and availability through reduced down time.

A key requirement for FCIM operations is access to digital part and assembly descriptions. A comprehensive database of digital part descriptions will become part of the Navy CALS environment and support spares production or acquisition. In instances where the parts are locally procured, vendors will be provided with digital part descriptions from in-house repositories so that they can fabricate the parts using their own FCIM systems. In order to assure compatibility among vendors and Navy activities, part descriptions will be standardized, initially with IGES, and ultimately with PDES or STEP.

Navy CALS for Maintenance

CALS implementation will change maintenance procedures for almost all Navy assets and facilities. Changes in the form, presentation, completeness, accuracy, and currency of technical information will radically alter *how* the job is accomplished. Procedural changes brought on by CALS technology at the organizational, intermediate, and depot levels of maintenance will improve system availability and reduce life cycle costs.

At the organizational level of maintenance, portable testing and maintenance devices will be used by the technician to improve trouble-shooting procedures and to identify failures. Knowledge-based systems, databases of historical occurrences and experience, will adjust standard test routines to "fit" the failure profile. As failures are diagnosed, on-line assessments of required repairs will be performed and associated repair support requirements defined. The precise maintenance procedure will then be presented to the technician using IETM presentation, reducing down time and improving readiness.

Logistic feedback improves reliability and maintainability

Improved collection of maintenance information through diagnostic modules and improved interfaces with reliability and maintainability (R&M) data systems will provide repositories with the information needed to develop more effective failure diagnostics and preventive maintenance procedures. Integrated logistic information systems will be provided with data directly from field service engineering agents through automatic data relays and uploads. These collection techniques will also capture material usage data needed to improve the availability of consumables and the inventory management of spare parts. Fault and reliability information will be captured, analyzed, and used to project replenishment factors, thereby improving readiness.

Automated job planning and scheduling tools reduce repair time

At the intermediate maintenance level, systems will plan work with engineered time-value standards and pre-planned jobs from other intermediate maintenance activities (IMAs). Eventually, naval maintenance facilities from shipyards and depots to IMAs will exchange component-oriented work procedures and job-oriented integrated work packages. Automated job planning and scheduling tools will significantly reduce the time needed to repair components and subsystems. Maintenance technicians will have an array of "information tools" that include such items as a planner's desk top containing inventory and equipment availabilities, configuration and logistic information indices, optical disk-based 3-D images, and digital information-based technical manuals. These desk top "information tools" may be stand alone or be located in consolidated automated test stations.

Assembled work packages fit job requirements

By linking various graphic, textual, and geometric data files in the desk top environment, the maintenance technician can assemble and integrate a work package to concisely "fit" job requirements. A desk top will check availability of required support equipment and indicate status to the technician. Repair parts will be requisitioned from local inventories using the desk top. When the repair parts are not in local inventory, the technician will decide to either order it, based upon projected delivery times and cost, or to manufacture it, based upon projected schedule and cost. With CIM, digital part descriptions from technical libraries can be quickly transformed into numerical control instructions to direct multi-axis metal forming machine tools.

Maintenance information relayed upline to track status

The maintenance technician will perform repair procedures for the component in question. In some instances, consolidated automated test stations will automatically record needed information about the maintenance and repair action, parts and supplies consumed, and any associated configuration changes. In other instances, the technician will enter this information onto the desk top which will interface with the appropriate local data sets. This maintenance information will be collected and relayed upline to track production progress and resource expenditures, as well as warranty information; life usage indices (LUIs); and to support reliability and maintainability analysis.

At the depot level, CALS technology will be applied at both a macro level, preparing work schedules for an entire shore facility or major weapon system, and at a more detailed level that corresponds to innovations applied at the intermediate and organizational maintenance levels. Overhaul work tasks will be isolated and defined by a geographical area, or a zone. A series of job guides or other data products will then be identified for each zone, and work breakdown structures for each guide or product will then be defined.

Navy CALS for Logistic Support

CALS will improve the Navy's ability to acquire and provide required *push/pull* logistic support at minimum cost. CALS will improve support acquisition and distribution in a near-paperless environment at sea and ashore through an integrated network of information repositories capable of storing and distributing numerous types of information including manuals, drawings, specifications, and various other reference documentation. This integrated network will provide ship and shore personnel with accurate, current information that is linked to a ship's actual equipment, thereby improving productivity, maintenance reliability, and readiness. Improved logistic support will be evident in areas such as supply support and training.

CALS will improve support at sea and ashore

Supply support will be more effective and efficient. Effectiveness of supply support will be improved through integration of repair diagnostics with inventory information. The diagnosis of a failure will trigger inventory queries and provide management with recommendations to locate and requisition required items. For unavailable items, logic subroutines will search for likely cannibalization sources based on utilization and priorities. This information will be provided to management for decision.

On shore inventory requirements will be lowered

Supply support efficiency on shore will be improved through Just-In Time (JIT) inventory management which systematically lowers inventory. Supply requirements will be more accurately defined through improved reliability assessments and diagnostic monitoring. Improved failure estimates will allow JIT inventory management for many items. In other instances, on-hand quantities will be reduced rather than eliminated, effecting significant savings.

Computer based training will support customized self study

Training in the Navy CALS environment will rely upon Computer Based Training) CBT which will radically transform training material authoring, delivery, and use. CBT will include tutorials, drills, practice simulations, and skill/knowledge assessment and validation. As CBT matures, the distinction between training aids and maintenance manuals will become blurred, and both will be generated from common data and tailored to the specific application.

Training materials will be derived from databases of information

Regardless of its classification, training and maintenance material will be authored using automated tools and be targeted for presentation in both a screen (sets of linked information units and objects) and page-oriented environment. Automated authoring will involve creating databases of information associated with both the system and the user who will access the information. Once the basic information (including relationships and other data characteristics) is authored, training and maintenance products will be created by entering specific application criteria pertaining to system or user.

Shore-based facilities will be the central repositories for training and maintenance information. These facilities will customize information to satisfy specific configurations, operational requirements, and user populations. Once customized, these facilities will provide digital products (databases) to ships either through media transfer or through satellite links. Once delivered, these products will continue to be customized at sea to maintain consistency with configuration changes and unique operating requirements.

Integrated training environments - improved comprehension and retention

Creation of various views will allow users to enter or access information in numerous ways (e.g., by maintenance task, by item, by duration, by zone and area, by subsystem, etc.). As CBT and IETM technology matures, video and audio information will complement text, drawings, and graphics. This integrated training environment will take advantage of the most appropriate presentation of information to improve comprehension and retention.

Realizing Process Improvements

Cohesive infrastructure leads to process improvements

This future vision of the Navy offers many opportunities to radically improve how work is performed and thereby improve productivity and operations in an era of declining budgets. This vision of process improvements can only be realized through through a long term commitment of Navy leaders to CALS.

This commitment needs to be focused on two critical factors. First, the Navy needs to invest the resources necessary for a cohesive infrastructure of information technology. Second, the Navy needs to adopt a set of standards governing technical information and information services. Only through data standards and a standard set of information management services will the Navy be able to cohesively integrate various sets of data and organizations regardless of location or organizational affiliation.

THE NAVY CALS MODEL

A Framework for an IWSDB

The Navy and industry will continue to invest in information technology regardless of CALS. The primary challenge facing Navy CALS is to improve weapon system readiness and availability through the most efficient information technology investments possible. To do this, the Navy must identify and prioritize the areas of greatest impact. Once defined, they must acquire, and manage this information technology in a manner that will maximize weapon system readiness, availability, quality, and cost reductions. CALS can facilitate reaching this goal through the adoption of a shared data environment, often called the Integrated Weapon System DataBase (IWSDB).

**The goal of IWSDB
Create data once –
Use many times re-
gardless of location**

An IWSDB environment is the key element in improving process efficiency, and in maximizing the productivity of the Navy information technology infrastructure. The cornerstone of an IWSDB environment is the capability to create data once and the ability to use it for many applications, regardless of geographic location of organizational affiliation.

The evolution to an IWSDB environment requires a commitment to ensure interoperability and a significant investment in information technology. To optimize these investments the Navy must identify user requirements and establish the “performance envelope” that the information technology must satisfy. A framework is needed to define the basic functionality required to support an IWSDB in the Navy.

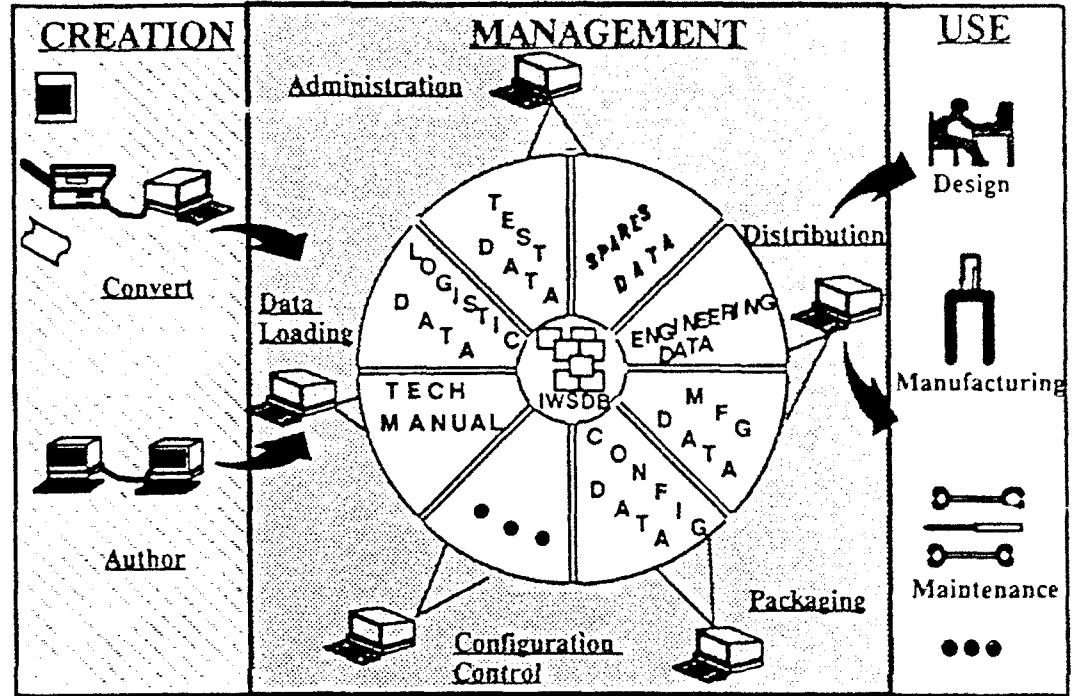
**Navy CALS Model –
a framework to
define IWSDB
requirements**

The Navy CALS Model (shown on the following page) provides a framework to identify and assess user requirements and establishes an initial set of performance requirements that need to be considered for IWSDB adoption. This framework facilitates the identification of requirements associated with five major processes; acquisition, engineering/design, manufacturing, maintenance, and logistic support. It also accommodates placing proposed Navy CALS investments and initiatives into a context, so that their overall contribution toward satisfying IWSDB service requirements can be evaluated.

The Navy CALS Model is composed of three logical sets of services that will enable the Navy to control and access technical data over its life cycle. These services or functions are:

- Creation of data,
- Management of data, and
- Use of data.

THE NAVY CALS MODEL



Data creation involves authoring and conversion

Data creation, the process of authoring, converting, modifying, and preparing technical data, will continue to be done both organically and by contractors. Authoring involves the initial creation of technical data in a digital form (e.g., structured text, data tables, raster images, vector models, etc). Conversion involves capturing data residing on paper-based or other media, and transferring it to digital media.

Data conversion – major Navy focus for rest of century

The majority of newly authored technical data (documents, drawings, etc.) will be generated as the weapon system is being designed and manufactured. Authoring tools that support the creation of specialized data, such as CAD or documents, will continue to mature, providing greater efficiency and flexibility.

Since the overwhelming amount of Navy technical data exists in forms other than digital, data conversion will be a major focus for the Navy for at least the remainder of the century. The planning required to convert this data needs to consider conversion costs, the life cycle of the weapon system (i.e., proximity to retirement), usage patterns, and the type and number of changes in the data.

Conversion processes can involve either a paper-to-digital conversion, or a digital-to-digital conversion. The digital-to-digital conversion typically will be undertaken to increase flexibility, by converting raster data to vector data, by

converting from a 2-dimensional model to 3-dimensional engineering model, or by converting text into structured text that can be tagged for revisions.

Data management assures availability and accuracy

Management of technical information ensures timely availability and accessibility of current, accurate data. As the complexity of weapon systems increases, requirements to deliver timely, accurate technical data becomes more important and yet, more difficult to achieve.

There are five major IWSDB service requirements that data management needs to satisfy; 1) *loading of validated data*, 2) *packaging of data*, 3) *administration of data*, 4) *configuration control of data*, and 5) *distribution of data*. These five requirements need to be applied to the entire range of Navy technical data including legacy data such as paper based drawings and technical manuals.

Data management must service legacy data and digital data

The requirement to manage both legacy data and digital technical information makes data management service requirements even more complex. In some instances, dual systems will be need; one for digital data and another for paper. In other instances management may determine it more cost effective to convert legacy data. Even when data is converted, special practices may be required since converted data may not be equivalent to newly created digital data.

Data use – the ultimate measure of success

Data use, the process of utilizing data in multiple ways to execute tasks, is slowly evolving from primarily human usage of documents to knowledge based systems applying integrated data bases. Data usage is the ultimate yard stick by which CALS will be measured. The effective and efficient servicing of the end-user community with accurate, complete, and timely technical information is the ultimate measure of success for CALS.

Four components – retrieval, display, analysis, and update

Data usage has four components: retrieval, display, analysis, and update. These four components are incorporated into five major CALS data application functions – acquisition, engineering/design, manufacturing, maintenance, and logistic support. These five functional areas are the critical CALS users. Each area applies the four use components in different ways to accomplish work.

By providing technical information that empowers users to be more productive and effective, CALS will provide benefits throughout the Navy. By enabling process improvements, the Navy will realize not only the streamlining of procedures but the innovation of totally new operating procedures.

The Role of Standards in an IWSDB Environment

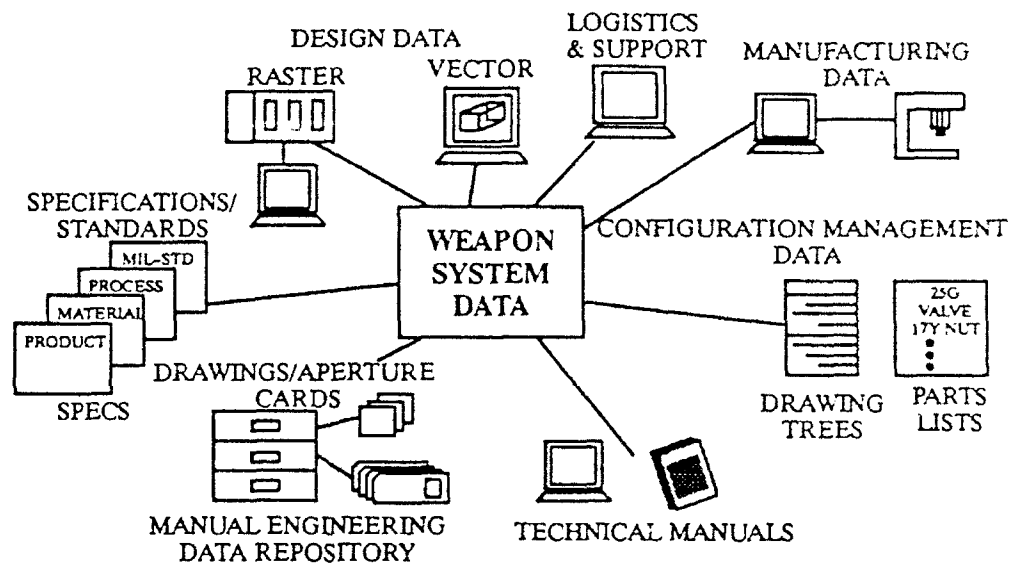
While an infrastructure of information technology is necessary to realize gains in productivity and quality, and reductions in costs; information technology, by itself, is not sufficient to attain these goals. To achieve desired process improvements, the infrastructure must be harnessed to create, manage, and use the various sets of technical information in a way that integrates weapon system

data. Information interchange methodologies, structured around a core of data definition and data interchange standards, will help attain this goal.

Legacy data presents unique challenges

Integrating weapon system data is a significant challenge. Today's paper/hard copy technical manuals, engineering drawings, and technical specifications represent legacy data that the Navy will need to deal with well into the next century. In addition, much of today's digital engineering data is in non-standard, proprietary forms, making it difficult to integrate among users.

CALS WEAPON SYSTEM DATA
- heterogeneous environment



Standards for data definition and distribution

Robust standards need to be adopted by the Navy to assure that data definitions are consistent, that data structures are complementary, and that access and distribution protocols are shared. Special mechanisms and procedures will need to be developed for data that over time is not digitized and standardized. For newly created data, standardized definitions and structures will need to be followed to assure the highest degree of possible integration.

CALS Information Management - Putting it Together

As highlighted above, the achievement of an integrated environment involves a web of complex issues that need to be sorted out and systematically addressed. It would be unwise to assume that this sorting out process is a one-time occurrence. As the Navy strives to attain improvements in productivity, quality and reductions in costs through CALS, it must periodically review desired changes and update its target of the future to ensure changes in weapon system functions and information technology are a part of its Navy CALS model.

THE STRATEGY

Guiding Principles

Navy implementation strategies for its CALS vision are based on several principles. These principles are derived from the basic assumption that innovative process improvements must occur in an era of declining budgets. The magnitude of these improvements can only be attained in conjunction with automation. Given this reality, the challenge is the “smart” or strategic management and implementation of information technology. Five principles provide general direction for Navy CALS implementation.

- The Navy must demonstrate leadership and long-term commitment to attain the CALS vision.

Navy must take a position of CALS leadership

A position of Navy leadership in CALS technology is needed to assure the successful implementation of CALS. Leadership needs to be demonstrated to both the industrial and Navy communities. Without Navy leadership, many in the industrial community will not undertake the investments so necessary in the CALS partnership. Within the Navy community, leadership needs to show to the different Commands, field activities, and acquisition managers that the path of Navy CALS offers payoffs far in excess of any risks involved.

A sustained commitment is needed

The Navy must also demonstrate a long term commitment to CALS. Successful acquisition and implementation of CALS information technology will require a sustained commitment from the Navy. This commitment needs to result in undertaking complex, multi-year initiatives that span across Commands. The level of Navy commitment also needs to be reflected in the level of funds that are targeted at CALS readiness and availability initiatives.

- The Navy must adopt an integrated and coordinated approach to the acquisition and management of its information technology.

A holistic view of the infrastructure is needed

The Navy has invested significant resources in the modernization of computer hardware, software, and communications technology that creates, stores and transfers, and uses weapon systems life cycle information. In order to maximize the utilization of existing assets, and to optimize future investments, a holistic view of the infrastructure needs to be developed. Existing standards, interoperability of systems, and system modularity all need to be coordinated and incorporated into decision making for additional infrastructure investments or modifications.

- Navy standardization is a necessity, not an option.

Integration requires standards

CALS cannot succeed without integration, and integration cannot succeed without standardization. Standardization of Navy infrastructure and technical information needs to be undertaken.

Infrastructure standards need to be adopted for hardware, software and communications. Data standards for the meaning, representation, and structure of technical information need to be established. Procedures for the creation, management, and use of technical information need to be defined and administered in a standardized manner.

- **The Navy must designate one authority who will devise a master plan to acquire, manage, and use technical information.**

**Centralized
CALs planning
~ decentralized
implementation**

One activity needs to devise a master plan to acquire, manage, and use technical information. Procedures for activities such as cataloging, categorizing, indexing, and cross-referencing must be devised, integrated, and coordinated Navy-wide. Implementation can be delegated, as appropriate, to various organizations throughout the Navy.

- **The Navy must embrace ongoing cultural changes, organizational adjustments, and planning to realize envisioned process improvements.**

**The nature of work
and technology
continuously change**

Over the next twenty years, CALS will substantially change how work is accomplished. Information technology will radically alter the nature of work activities performed by the Navy. The nature of activities ranging from maintenance and engineering to management and work supervision will change, requiring different skill mixes.

**The Navy must
continuously adapt**

To realize the range of potential benefits that CALS will offer, the Navy will need to make significant changes. System complexity will necessitate ever-increasing skill levels from some personnel while simplifying work requirements for others. Technology will provide levels of validation currently provided by supervisory personnel. Organizations will need to be less hierarchical as communications technology expands the span of control for individual managers.

**The management of
change requires
ongoing planning**

The process of change and adapting is not a one time occurrence. Change is not a discrete, discontinuous phenomenon, but rather a continuous, ongoing process. An ever vigilant watch needs to be maintained for opportunities to innovate, reduce costs and improve productivity. To man this "watch," the Navy needs to establish an ongoing planning activity. Technology futures need to be constantly examined within the Navy context in order to maximize readiness and availability in an era of declining budgets.

**Elements of
the Strategy**

This is undeniably a time of global transformation of unparalleled magnitude. The economic and political restructuring of Eastern Europe, the economic integration of European Economic Community, the emergence of the Pacific rim countries as global competitors, the accelerating pace of armaments

reductions, and the exploding growth of information technology are the forces that will drive this transformation into the next millennium. The 1990s and early 2000s will be a time of change for the Navy. To reach the potential of Navy CALS, an approach involving three critical elements is needed.

Define a Vision

The first element to the Navy approach must be to prepare for this transformation by defining a Vision of the future. The Vision needs to incorporate the goals and objectives of Navy leadership and reflect key trends that are shaping the future. The Vision needs to be the target of the future that is agreed to across the Navy.

Establish a set of strategic programs

The second element of the Navy strategy is to manage information and technology to its advantage by developing a set of strategic programs that will move the Navy towards implementing its future vision. A gap analysis needs to be undertaken to establish a baseline and identify areas of the integrated environment that are currently not supported. A set of strategic programs will then be defined that will incorporate existing initiatives and extend the scope of these initiatives as appropriate.

Institute ongoing cooperative planning process

The final element to the Navy strategy is the institution of a cooperative planning approach, enlisting industry as well as organizations throughout the Navy. Industry can provide the planning process with valuable inputs concerning technology, and, in some instances, provide future operational considerations that will have an influence or effect on the work flow processes.

The CALS evolutionary path will be driven by the Navy's and industry's ability to plan for the future and execute those plans. Implementation success will be contingent on the Navy's ability to absorb change and the ability acquire and deploy needed information technology investments.

Two factors are critical to successfully travel along this evolutionary path:

- Executive Commitment
- Industry and Navy Teamwork

Upper level executive commitment is crucial for the continuing success of CALS. CALS will require both significant investment and radical organizational changes in the way business is conducted. Neither of these ingredients are possible without visible, top-level commitment.

As investments continue to be made and organizations modified, industry and Navy need to be confronted with a win/win situation. Cooperation, sharing of risks, pooling of resources, and the undertaking of joint development efforts are all crucial for continuing Navy CALS success.