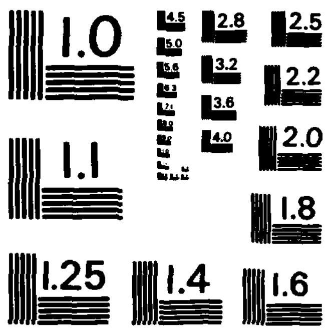
AD-A161 777 REPORT OF THE JOINT INDUSTRY - DOD TASK FORCE ON COMPUTER AIDED LOGISTIC..(U) INSTITUTE FOR DEFENSE ANALYSES ALEXANDRIA VA F R RIDDELL ET AL. JUN 85 1/2

UNCLASSIFIED IDA-R-285-VOL-1 IDA/HQ-84-29446 F/G 15/5 NL



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IDA REPORT R-285

REPORT OF THE JOINT INDUSTRY - DoD TASK FORCE ON COMPUTER AIDED LOGISTIC SUPPORT (CALS)

Volume I: Summary

Frederick R. Riddell
Richard A. Gunkel
George Beiser
Siegfried Goldstein
Bruce Lepisto
Editors

June 1985

Prepared for
Assistant Secretary of Defense
Manpower, Installations and Logistics

IDA
INSTITUTE FOR DEFENSE ANALYSES
1801 N. Beauregard Street, Alexandria, Virginia 22311

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

AD-A161777

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED

1b. RESTRICTIVE MARKINGS

2a. SECURITY CLASSIFICATION AUTHORITY

2b. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A

3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited

4. PERFORMING ORGANIZATION REPORT NUMBER(S) IDA Report R-285

5. MONITORING ORGANIZATION REPORT NUMBER(S)

6a. NAME OF PERFORMING ORGANIZATION Institute for Defense Analyses

6b. OFFICE SYMBOL (If applicable)

7a. NAME OF MONITORING ORGANIZATION OUSDRE (DoD IDA Management Office)

6c. ADDRESS (City, State, and ZIP Code)
1801 N. Beauregard Street
Alexandria, VA 22311

7b. ADDRESS (City, State, and ZIP Code)
1801 N. Beauregard Street
Alexandria, VA 22311

8a. NAME OF FUNDING/SPONSORING ORGANIZATION Assistant Secretary of Defense Manpower, Installations and Logistics

8b. OFFICE SYMBOL (If applicable)

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER MDA 903 84 C 0031

8c. ADDRESS (City, State, and ZIP Code)
The Pentagon
Washington, D.C. 20301

10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.
		T-3-192	

11. TITLE (Include Security Classification)
REPORT OF THE JOINT INDUSTRY - DOD TASK FORCE ON COMPUTER AIDED LOGISTIC SUPPORT (CALS) - Volume I - Summary

12. PERSONAL AUTHOR(S)
Frederick R. Riddell, Richard A. Gunkel, George Beiser, Siegfried Goldstein, Bruce Lepisto, Editors

13a. TYPE OF REPORT FINAL

13b. TIME COVERED FROM ______ TO ______

14. DATE OF REPORT (Year, Month, Day) 1985 June

15. PAGE COUNT 179

16. SUPPLEMENTARY NOTATION

17. COSATI CODES

FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Automated Technical Information
Digital Logistics Data, Weapon System Support Data, Automated Support Data, Computer-Aided Logistics Technical Manuals, Engineering Support Data, Maintenance and Supply Data, Training Manuals, Operation Manuals

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

In April 1984 the Institute for Defense Analyses was directed by OSD to assemble a task force of senior industry and government people to address the problems faced by DoD in attaining an integrated computer-aided logistics support system. The task force was given a charter to "develop a strategy and a recommended master plan for computer-aided
(continued)

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT
☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS

21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED

22a. NAME OF RESPONSIBLE INDIVIDUAL

22b. TELEPHONE (Include Area Code)

22c. OFFICE SYMBOL

DD FORM 1473, 84 MAR 1 JAN 73

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Item #19 (continued)

logistic support." The task force was formed and held an intensive series of meetings during the last half of 1984 during which this report was prepared.

Volume I of the report gives a summary of the task force deliberations and lays out a recommended strategy and master plan that would, in five years, have in place all the elements needed for a complete computer-aided logistics support (CALS) system based on electronic data transfer. Volumes II, III, IV and V of the report were prepared by the subgroups on Policy and Legal Constraints, Architecture, Information Requirements, and Technical Issues that were formed to examine different aspects of implementing a CALS system. These volumes contain detailed information that supports the recommendations made in the Summary, Volume I.

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Accession For	
NTIS GRA&I	X
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

June 1985

QUALITY INSPECTED 3

INSTITUTE FOR DEFENSE ANALYSES

Contract MDA 903 84 C 0031
Task T-3-192

PREFACE

This report was prepared by the Institute for Defense Analyses (IDA) for the Office of the Secretary of Defense, Manpower, Reserve Affairs and Logistics Under Contract Number MDA 903 84 C 0031, Task Order T-3-192, "R&D Support to Improve Force Readiness."

The issuance of the report answers the specific task to "...assemble a group of both industry and government personnel...experienced in...computer-aided technologies for automation of support procedures in order to examine issues...include(ing) the subcontractor level, inventory management techniques, etc. At present these issues are being addressed individually without apparent consideration of their interaction in meeting the total DoD objective...to evolve a general plan for automated support of DoD operating systems which addresses the problems of interaction between the different systems now in use or evolving, and the various approaches being taken by DoD to address its readiness problems."

REPORT OF AD HOC GROUP ON COMPUTER AIDED LOGISTIC SUPPORT (CALS)

VOLUME I. SUMMARY REPORT

CONTENTS

Additional Volumes in this Report:

Volume II: Report of the Policy/Legal Constraints Subgroup

Volume III: Report of the Architecture Subgroup

Volume IV: Report of the Information Requirements Subgroup

Volume V: Report of the Technical Issues Subgroup

EXECUTIVE SUMMARY

1. The Task Force Charter

In April 1984 Under-Secretary of Defense DeLauer and Assistant Secretary of Defense Korb issued a memorandum[1] which tasked the Institute for Defense Analyses (IDA) to assemble a task force of senior industry and government logisticians to address the problems faced by DoD in applying new and emerging computer technology to improve the logistics support process. The task force was given a charter to "develop a strategy and a recommended master plan for computer-aided logistic support." The task force was formed and held an intensive series of meetings throughout the last half of 1984, during which this report was prepared.

The DeLauer/Korb instruction was generated by a perception in OSD that there was an important opportunity to co-ordinate the rapidly expanding automation of support functions in the Services and the Defense Logistics Agency with the efforts in segments of the defense industry to achieve "near-paperless" design, engineering, manufacturing and logistics planning operations. Through integration of automated reliability and maintainability analysis into initial computer aided design, better supportable weapon systems can be designed and manufactured. There are also enormous potential benefits in logistics efficiency if the product definition and technical data which manufacturers generate in digital form could flow to all users in the support system without the hard-copy paper links that are now used to transmit information. The CALS task force confirmed these perceptions, and developed program objectives and a strategy to take advantage of this opportunity.

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[1] Reproduced as Figure 1-1 below.

2. CALS Program Objectives

Working in cooperation with the defense industry, other government agencies, and professional and industrial associations, the Department of Defense should take immediate, positive action making use of current and emerging computer technology to:

- Design more supportable weapon systems
- Transition from paper-based to digital logistics and technical information.
- Routinely acquire and distribute logistics and technical information in digital form for new weapon systems.

These objectives cannot be achieved immediately. But by following a strategy of near-term, mid-term and long-term actions, DoD can within five years have in place a program for receipt and distribution of logistics products in digital form for all major weapon systems entering production. By taking immediate action at the DoD-level to define and adopt a complete set of data exchange standards, and to develop overall architectural guidelines for automation of technical information throughout the Military Departments, DoD can establish the unified interface requirements which will enable industry to accelerate its own automation initiatives. The Military Services already have programs in being that represent important building blocks in this effort; these programs should be strengthened and extended. Service implementation plans should be developed to integrate these individual building blocks into a complete network for digital distribution, processing, and use of the logistics information delivered by industry.

In parallel with these actions to automate the development and distribution of logistic support products, DoD and industry should both take aggressive action to better use computer technology to improve weapon system supportability by integrating reliability and maintainability (R&M) analysis into the initial design process. This is also a central thrust of logistics support analysis (LSA), and a CALS program will provide improved tools for accomplishing LSA objectives. Industry has the principal responsibility for incorporating these automated analysis tools into its computer aided design and engineering (CAD/CAE) processes. However, DoD must provide the design requirements and contract incentives needed to guide industry efforts. R&D and IR&D priority must be given to meeting this objective.

The strategy recommended by the CALS Task Force provides a phased program of individual initiatives designed to support achieving these CALS objectives. By fully and formally committing DoD to these objectives, and the strategy for accomplishing them, the OSD sponsors of this study can inaugurate significant and far reaching improvements in the acquisition and logistics management of future defense programs.

3. Recommended Strategy and Implementation Management

The Task Force recommends that a DoD policy be established that will both direct and encourage the integration of existing "islands of automation" and facilitate the transition of logistics processes within DoD and industry from paper-based to digital mode in an orderly way. The policy should stress the need for each DoD component to develop a phased plan for:

- Demonstrations and incentives to integrate R&M into CAE/CAD, and to automate supportability design analysis.
- Adoption of DoD-wide interfacing standards and neutral data formats.
- Instituting pilot programs to integrate selected logistics functions into segments of a CALS system, while concurrently requiring that weapon program new starts plan to utilize digital support data.
- Establishing DoD-wide coordination toward a planned CALS architecture.

For each of these thrusts a plan of action was developed and is presented below.

To implement the planned actions, a management office should be established in each Service and in DLA with responsibility, authority, and resources for coordination of all four thrust areas. While each DoD component should develop a CALS implementation plan that best meets its individual requirements, development of a unified, DoD-wide interface with industry is also needed. There are various options for effecting the necessary overall coordination among the Services and DLA. The Task Force felt that, at the least, a DoD Steering Group should be established at the senior Service level with members from OSD, the Services, and other DoD agencies. This group should be charged with (1) maintaining communication between the individual management offices in each Service and in DLA, (2) maintaining a continuing dialog with industry regarding CALS plans and programs, (3) overseeing the establishment of interfacing standards and neutral data formats, and (4) evolving an overall CALS architecture. An alternative supported by a portion of the Task Force was an OSD program office with a full-time staff and the funding authority needed to provide more centralized control and direction of the CALS program.

4. Recommended Plan of Action

a. Plan for Thrust 1 - Integration of Automated R&M and Supportability Analysis into Design

Findings

- Reliability, maintainability, and supportability (RM&S) analyses are not part of the engineering design mainstream.
- Technology for integrating RM&S into computer-aided design exists.

Recommended Actions

• Formalize inter-Service coordination through a Memorandum of Agreement	Immediately
• Develop new RM&S Tools	On-going
• Publish plan to expand applications through incentives, contract requirements, R&D	September 1985
• Publish catalog of RM&S tools	June 1986
• Establish Centers of Excellence for demonstration of integrated supportability design analysis	January 1986 to January 1989

b. Plan for Thrust 2 - Interfacing Standards and Neutral Data Formats

Findings

- Interim standards are available, and are already being adopted.
- Near-term and long-term DoD goals do not exist.
- Current DoD policies do not support minimum needs for DoD-wide standards.

Recommend Actions

• Establish DoD plan and schedule	Immediately
• Interfacing standards	
- Policy on specific interim standards	July 1985
- Adopt specific product definition standard	Summer 1986
• Data Standards	
- Publish information management and access standard	December 1985
- Publish initial CALS data element dictionary	January 1986
- Publish expanded CALS data element dictionary	January 1987

c. Plan for Thrust 3 - Pilot/Demonstration Programs

Findings

- Integration of functions introduces need for procedural changes, retraining and reassignment of personnel.
- Pilot programs are needed to demonstrate the benefits of CALS initiatives in an operational environment, and to obtain user feedback for future system design.

Recommended Actions

• Initiate pilot programs to integrate on-going Service programs and demonstrate:	January 1986 to January 1989
- Digital delivery and use of engineering data	

- Automated authoring and updating of technical documentation
- Interactive training and maintenance aids
- Automated LSA data and LSA reports

● Each Service designate a "lead the force" *acquisition program to demonstrate use* of digital data from the acquisition cycle through to field use.	1985 to 1995+

- DoD should coordinate these pilot programs to demonstrate functional use of the specified interfacing standards and neutral data formats.
- All weapons program new starts should plan to utilize digital support data to the maximum extent possible.

d. **Plan for Thrust 4 - DoD-Wide Coordination Toward a Planned CALS *Architecture***

Findings

- Integration of automated functions requires a plan and management coordination.
- DoD-wide architectural guidelines do not exist.

Recommended Actions

● Issue DoD planning guidelines	Immediately
● Services and DLA publish phased system development plan	December 1985
● Services and DLA publish initial CALS architecture	March 1986
● DoD-wide coordination	June 1986
● Pilot/demonstration programs (see thrust 3)	January 1986 to January 1989

5. **Consolidated Schedule**

Figure ES-1 gives a consolidated schedule for the thrusts detailed above. In combination, this strategy will provide at the end of five years all the tools and demonstrated "building blocks" needed to initiate a fully integrated Computer Aided Logistic Support program for all major and less-than-major systems entering production.

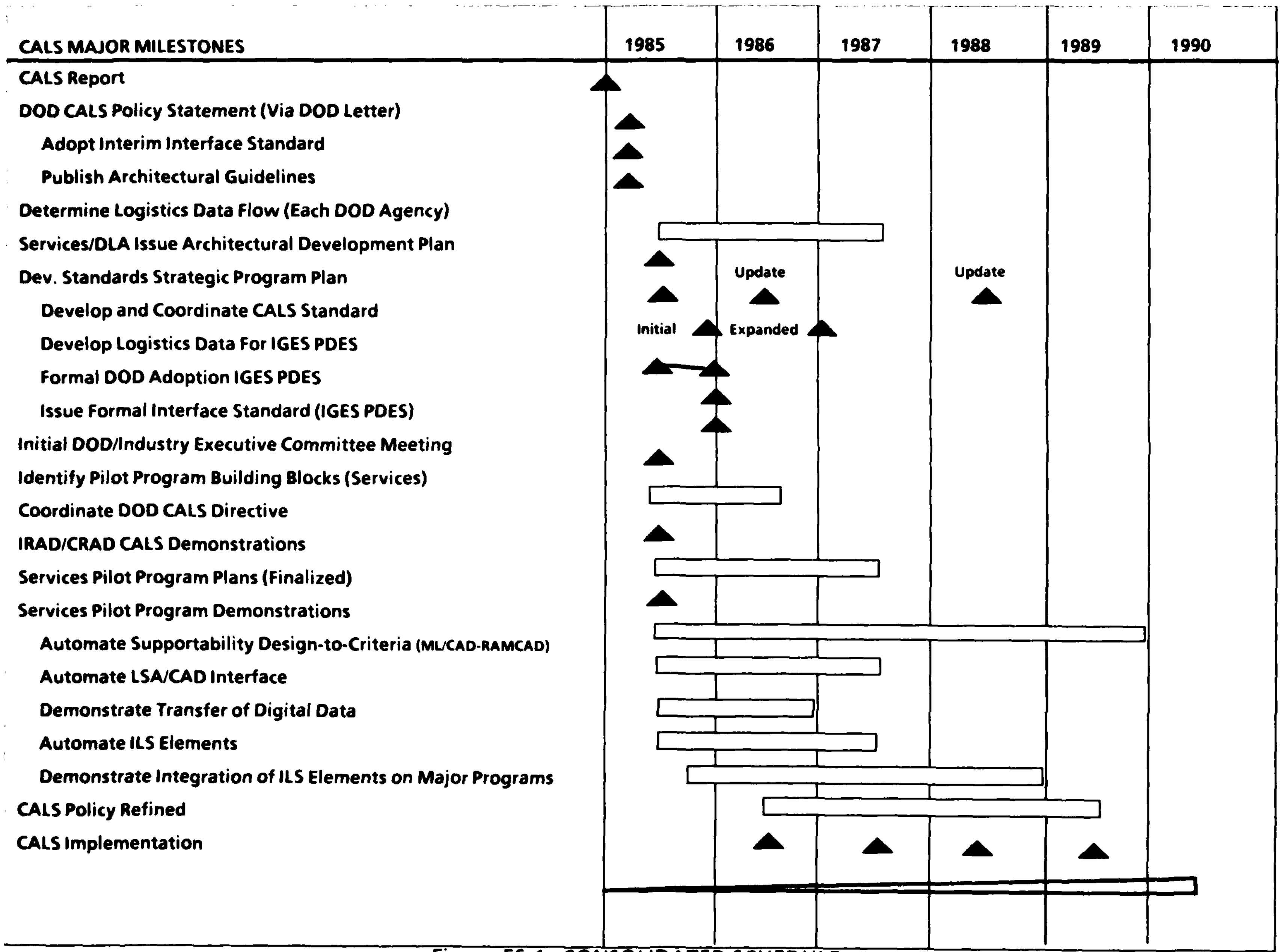


Figure ES-1. CONSOLIDATED SCHEDULE

GLOSSARY

AFEMMIS	Air Force Equipment Management Information System
AFIMS	Air Force Information Management System
AFIMMSS	Air Force Information Maintenance Manufacturing Support System
AFLC/LFSMS	Air Force Logistics Command Program/Logistic Force Structure Management System (i.e., SCDS, RD, WSMIS, ETADS, PMIS, CDMS)
AIMT	Artificial Intelligence-Based Maintenance Tutor
ALADIN	Air Base Local Area Digital Network
AMC	Army Materiel Command
AMIS	Automated Maintenance Information System
AMS	Automated Maintenance System (C-5 aircraft)
APPS	Automated Printing and Publishing System
APT	Automatic Programming of Tools
ASIMS/OPNET	Air Staff Information Management System/Operational Support
Assured Log Comm	Logistic Force Structure Management System
ATE/BITE	Automated Test Equipment/Built In Test Equipment
ATMS	Automated Technical Manual System
ATOS	Automated Technical Order System
AVMI	Automated Video Maintenance Information System
BIT/BITE	Built In Test/Built In Test Equipment
CAC	Combat Analysis Capability
CAD	Computer Aided Design
CAD/CAM	Computer Aided Design/Computer Aided Manufacturing
CAE	Computer Aided Engineering
CAEDOS	Computer Aided Engineering and Documentation System
CALS	Computer Aided Logistic Support
CAM	Computer Aided Manufacturing

CAMS	Core Automated Maintenance System
CAPP	Computer Aided Production Planning
CAT	Computer Aided Testing
CCSS	Commodity Command Standard System
CDMS	Contract Data Management System
CDRL	Comtract Data Requirements List
CDS	Centralized Data System (F-16 Avionics)
CIRS	Combat Information Retrieval System
CITS	Central Integrated Test System (B-1B)
CLAMP	Closed Loop Aeronautical Materials Program
CMS	Combat Maintenance System
CORE	
CSAS	Configuration Status Accounting System
DARMIS	Data Requirements Management Information System
DBMS	Data Base Management System
DDN	Defense Data Network
DED	Data Element Dictionary
DID	Data Item Description
DIDS	Defense Integrated Data System
DIF	Document Interchange Format
DLA	Defense Logistic Agency
DLSC	Defense Logistics Service Center
DMS	Deployed Maintenance System
DSREDS	Digital Storage and Retrieval of Engineering Data System
DSS	Deployed Supply System
EDASRES	Engineering Drawings Automated Storage & Retrieval Systems
EDCARS	Engineering Data Computer Assisted Retrieval System
EDMICS	Engineering Data Management Information Control System
EDS	Engine Diagnostic System
EEMT	Electronic Equipment Maintenance Training System
EIDS	Electronic Information Delivery System
EMDB	Equipment Maintenance Data Base
ETADS	Enhanced Transportation Automated Data System
FEEDER	MIDAS Follow-on

FIND	Fault Isolation by Nodal Dependence Troubleshooting System
Flexible Inter-Connect	Mini Computer System Program for Network Data Switching
GENCODEtm	Generalized Coding, Trademark of Graphics Communications Association (GCA)
GIDEP/AGED	Govt./Industry Data Exchange Program/Advisory Group on Electronic Devices
GIMADS	Generic Integrated Maintenance Diagnostic System
GKS	Graphics Kernel System
GPAMS	General Purpose Automated Maintenance System
GPS	Ground Processing System
ICAD	Integrated Computer Aided Design
ICAE	Integrated Computer Aided Engineering
ICAM	Integrated Computer Aided Manufacturing
ICASE	Integrated Computer Aided Sustaining Engineering
ICP	Inventory Control Point
IDAS	Integrated Design Automation System
IDD	Information Delivery Device
IDEF	Integrated Computer Aided Manufacturing Definition Language
IDSS	Integrated Design Support System
IGES	Initial Graphics Exchange Specification
IGPS	Intelligent Gateway Processing System
ILS	Integrated Logistic Support
IMIS	Integrated Maintenance Information System
IRAM	Improved Repairable Asset Management Program
ISITE	Integrated Selt-Instructive Test Equipment
LAN	Local Area Network
LC/IS	Logistic Communications/Information Systems
LDC	Logistics Data Communications
LEIDS	Logistic Electronic Information Delivery System
LFSMS	Logistics Forces Structure Management System
LIMISS	Logistics Information Management Support System
LOG-C^3I	Logistics Command, Control, Communications and Intelligence
LOGMARS	Automated Marking and Reading Symbols Program

LOGMOD	Fault Isolation Aid
LOGNET	Logistic System Information Network
LORA	Level of Repair Analysis
LRU	Line Replaceable Unit
LSA	Logistic Support Analysis
LSAR	Logistic Support Analysis Record
ManTec	Manufacturing Technology
MARDIS	Modern Army Research and Development Information System
MEIDS	Militarized Electronic Information Delivery System
MICAP	Mission Capability
MIDAS	Maintenance Information Data Automation System
MLCAD	Maintenance and Logistic Factors in CAD
MMICS	Maintenance Management Information Control System
MODAS	Maintenance and Operational Data Access System
M-SPECS	Modular Specification System for Technical Manual Contract Requirements (TMCRS)
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
NAPLPS	North American Presentation Level Protocol Syntax
NAPS	Navy Automated Publication System
NARFS	Navy Air Rework Facility System - Depot Level OAS
NAVIS	Navy Automated Video Information System
NBBS-AMRF	National Bureau of Standards - Automated Manufacturing Research Facility
NEDDSARS	Naval Engineering Drawings Digital Storage and Repository System
NICADMM	Navy Integrated Computer Aided Design, Manufacturing and Maintenance
NOMAD	Navy Onboard Maintenance Aiding Device
NPODS	Navy Print-on-Demand System (Part of NAPS for MIL SPEC & STPS)
NPPS	Navy Printing and Publishing System
NSDSA	Naval Sea Data Support Activity
NTDS&R	Navy Technical Documents, Storage & Retrieval
NTIPS	Navy Technical Information Presentation System

O&S	Operations and Support
OAS	Office Automation System (Part of ICP/SPCC)
ORA	Optimum Repair Analysis
Pacer Acquire	Mfg. Umbrella-Computer Technology/Architecture
PCASS	DLA Parts Control Automated Support System
PCP	DoD Parts Control Program
PDES	Product Definition Exchange Standard
PEAM	Personal Electronic Aid for Maintenance
PEP/BOSS	Paperless Environment Project/Buy our Spares Smarter or Procurement Document Automated System
PHIGS	Programmer's Hierarchial Interactive Graphics Standard
PIPPS	Publication Information Processing & Printing System
PIXIE	Portable Maintenance-Aid Device
PM	Program Manager
PMIG	Programmer's Minimal Interface to Graphics
PMIS	Production Management Information System
PMR	Provisioning Master Record
RAMS	Repairable Assets Management System
RDB	Requirements Data Bank
RIP	Readiness Improvement Program
RM&S	Reliability, Maintainability and Supportability
ROLAIDS	Reconfigurable On-Line ATE Information Distribution System
SCDS	Stock Control and Distribution System
SEASTARS	Satellite Engineering Assisted - Shipboard Test and Repair System
SGML	Standard Generalized Markup Language
SNAPS	Shipboard Nontactical Automated Processing System For configuration status accounting (CSA) in weapon system file (WSF) downloads
SOW	Statement of Work
SPCC	Spare Parts Control Center (Part of PEP/BOSS)
SP/LAN	Supply Point/Local Area Network
SPLICE	Stock Point Logistics Integrated Communications Environment
SPRINT	Sperry Interactive Graphic Maintenance Trainer
SREM	Software Requirements Evaluation Methodology
STARS	Shipboard Test and Repair System

STARS	Software Technology for Adaptable, Reliable Systems
STEPS	Ship Technical Publications System
TD/CMS	Technical Data/Configuration Management System
TDM	Technical Data Management
TDMS	Technical Data Management System
TDSS	Technical Data Storage System
TI	Technical Information (Usually DODD 5200.20 Revised)
TIAC	Technical Information Analysis Center
TICCIT	Time-Shared Interactive Computer Controlled Information Television
TIDER	TI Deficiency Report
TIDS	TRIDENT Integrated Data System
TIPPS	Total In-House Publication Production System (McDonnell Aircraft)
TIMS	Technical Information Management System
TM	Technical Manual
TMMP	Technical Manual Management Program
3M	Maintenance and Material Management System
TMSS	Technical Manuals Specifications and Standards
TPAS	Technical Publications Automated System (General Dynamics)
TRC/TOD	Technical Repair Central/Technical Order Distribution
TTO/ITO	Tailored Technical Orders/Integrated Technical Orders
UDBAL	Unified Data Base for Acquisition Logistics
VDI(CGI)	Virtual Device Interface (Computer Graphics Interface)
VDM(CGM)	Virtual Device Metafile (Computer Graphics Metafile)
VHSIC/IDAS	Very High Speed Integrated Circuits/Integrated Design Automation System
VIMAD	Voice Interactive Maintenance Aiding Device
WAN	Wide Area Network
WSMIS	Weapon System Management Information System
WYSIWYG	What You See Is What You Get
ZOG/VINSON	Automated, Computerized, Operational Management System Aboard the USS Carl Vinson (CVN 70) Since 3/83

Chapter I

POTENTIAL FOR ADVANCES IN COMPUTER AIDED LOGISTIC SUPPORT

A. OPPORTUNITY, BACKGROUND, PROBLEMS

1. Opportunity

Industry is moving rapidly to adopt computer-aided techniques wherever there are payoffs in reduced labor or improved performance. This effort extends from early design through to field support functions and includes both technical and management data. While this process has been underway for many years, particularly at the larger companies, recently it has accelerated markedly due to proven benefits and reduced costs of computer hardware and software.

Overlying this process are the rapid advances being made in computer and communications technology. These advances present automation opportunities that didn't exist only a few years ago, and make it necessary for organizations to constantly reassess their implementation plans. For example, the new, powerful workstations that are appearing on the market make it possible to unload mainframes and increase the availability of computing power throughout the design and manufacturing environment. This new hardware is being accompanied by new software, such as that which gives the design engineer powerful tools for performing reliability and maintainability analysis on new military hardware.

Industry is currently in the process of trying to organize the piecemeal development of individually automated functions into integrated company-wide systems. This is a non-trivial problem not only because of the technical problems of hardware/software interfaces and of controlling large distributed data bases, but also because frequently there are accompanying organizational changes that are needed.

Similar piecemeal application of computer-aided technologies in the logistics area are underway in DoD, but the evolution toward integrated systems is not as rapid as in industry. The major opportunity that presents itself now is for DoD to integrate its internal processes for automated distribution and usage of logistics products, as well as ensuring they will interface with industry for weapon support functions. This is a far more complex problem than that facing each company in setting up a company-wide compatible system. DoD must interact with hundreds of suppliers and support a huge variety of products in the field. The time to initiate this effort, however, must be now, and the potential payoffs are so large that a concentrated, continuing effort is warranted.

Integration of the "islands of automation" that have evolved in both industry and government presents both technical and management problems. A major technical problem is that of creating "standards" or translators to effect communication among the wide variety of hardware and software systems in use. On the management side, there comes a time when it is valuable to starting exerting corporate-level control over application projects to ensure that the potential benefits from interfacing independent functions and using common data to reduce errors and save time can be realized. Industry is recognizing this need more and more widely, and is setting up corporate-level groups to establish a management strategy for evolving toward "near paperless" operations.

These government and industry initiatives to expand the application of computer technology are proceeding in parallel with increasing emphasis on programs to improve the logistics supportability of new weapon systems. Supportability must be designed into new systems, and support processes must be optimized throughout the operational life of the system. These are central themes of Integrated Logistic Support (ILS) planning and Logistic Support Analysis (LSA). Computer technology promises - and has already demonstrated - powerful new tools for satisfying ILS and LSA program objectives. Taking advantage of these tools should be given high priority within both DoD and industry.

This is the environment in which Under Secretary DeLauer and Assistant Secretary Korb issued an implementing memo entitled "DoD Strategy for Development of an Integrated Computer Aided Logistic Support Capability" (see Figure 1-1), which initiated this study. The memo chartered a joint DoD-Industry ad hoc group under the auspices of the Institute for Defense Analyses to "develop a strategy and recommended master plan for Computer Aided Logistic Support. This plan will identify our objectives, the major steps to accomplish them, and recommend responsibilities for implementation."

2. Background

Logistic support is a data intensive operation and all government agencies involved in this area have large investments in automated data systems. Major initiatives are underway throughout DoD to apply new hardware and software technology to make existing systems more effective and efficient. Upgrading these systems is also supported by a large ongoing system development effort. The scope of this effort is given in Appendix B, which lists and categorizes dozens of development programs aimed at improving Automated Technical Information (ATI) capabilities in the Services and in the Defense Logistics Agency (DLA). A major deficiency in this overall massive effort is that only a very small fraction is aimed at integrating functional " islands of automation" that exist, or are being created, throughout DoD. The handful of programs that are beginning to address integration problems are described in the following paragraphs.

The Technical Information Management System (TIMS) program by AMC is a beginning Army ATI effort. The TIMS program will develop an overall architecture needed to automate and store (in a readily retrievable form) technical information relating to training, maintenance, operations and configuration management for Army weapon systems, using the latest proven commercial technology. The TIMS effort will integrate a number of independent ATI projects that will focus on the CAD/CAM interface with engineering drawings, digital storage and retrieval of engineering data, a technical data/configuration management system, interfaces with both the provisioning master record (PMR) and the logistics support analysis record (LSAR), publication automation and electronic information delivery.

OFFICE OF THE SECRETARY OF DEFE

WASHINGTON DC 20301

1 6 APR 1984

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (IL&FM)
ASSISTANT SECRETARY OF THE ARMY (RD&A)
ASSISTANT SECRETARY OF THE NAVY (RE&S)
ASSISTANT SECRETARY OF THE NAVY (S&L)
ASSISTANT SECRETARY OF THE AIR FORCE (RD&L)

SUBJECT: DoD Strategy for Development of An Integrated Computer Aided Logistic Support Capability

The very rapid evolution of Computer Aided Engineering, Design, and Manufacturing coupled with digital information systems has given rise to an opportunity for major advances in generation, integration, and use of logistic technical information.

The name "Computer Aided Logistic Support" has been proposed for these functions. The objective would be to largely automate weapon system support planning processes and data access to be fully integrated with Computer Aided Design, and Manufacturing. To develop this capability, we must rethink our DoD and industry processes. We must address standards, requirements, funding, contracting, and technical problem areas.

Therefore, we are chartering a joint DoD-industry ad hoc group under the auspices of the Institute for Defense Analyses to develop a strategy and recommended master plan for "Computer Aided Logistic Support." This plan will identify our objectives, the major steps to accomplish them, and recommended responsibilities for implementation. We would like each Service to appoint a representative and to provide him with direct access to the Service activities involved. IDA will arrange for industry representation and interaction with current industry task forces such as that chartered by NSIA. The duration of the task force will be 6 months. At the completion, we will arrange for briefings to senior Service and DoD personnel. The DoD focal point is Russell R. Shorey, OASD(MI&L), his alternate will be Mr. Joseph D. Arcieri. Please provide him with the names of your representatives within two weeks.

Larry Korb
Lawrence J. Korb
Assistant Secretary of Defense
(Manpower, Installations
and Logistics)

Richard D. DeLauer
Richard D. DeLauer
Under Secretary of Defense
(Research and Engineering)

Figure 1-1

Under the Navy ATI System Architecture project, a baseline study of the Navy technical information environment is planned to identify and analyze problem areas and deficiencies, and to determine ATI requirements. Current and emerging ATI technologies will be assessed to develop concepts and technical approaches for resolving the identified problem areas and correcting deficiencies. A top down architectural design will then be developed for a Navy-wide ATI system which is capable of supporting a wide variety of ashore and afloat units.

The goal of Air Force programs for automation of technical information is to move the Air Force to a point where it has the capability to accept, store and retrieve technical information (TI) and graphics in digital form. TI is defined as CAD, CAM, CAE data, engineering drawings and specifications, and technical orders. Six primary areas of effort have been defined, one of which is to develop an architectural strategy. A layered architecture will be developed that will include the Air Force Information Management System (AFIMS) architecture developed by AF/SI and the Logistics Information Management System (LIMSS) architecture developed by AF/LEY. The AFMIS architecture will provide the logical framework for defining information system policies, standards, and guidelines for the development of integrated information processing and transfer technologies. The LIMSS program will define logistic system architecture standards and a C^3 infrastructure that will allow logistic applications for multiple users which are network compatible.

In DLA, acquisition is underway for interim automated storage and retrieval equipment to fully automate technical data drawing repositories for storage and reproduction of Aperture Cards at four centers. This program includes follow-up planning for the capability to accept and distribute digital drawing data. A study is planned to assess the need for enhanced item intelligence for data contained in the Defense Logistics Services Center (DLSC) Defense Integrated Data System (DIDS) Inventory for preliminary design support. Modernization of the existing Parts Control Automated Support System (PCASS) supporting the DoD Spare Parts Program (DoDI 4120.19) is also planned.

3. Scope of CALS

Computer Aided Logistic Support is a strategy for application of existing and emerging computer technology to improve the productivity and quality of logistic support by:

1. Actively influencing the design process to produce more supportable weapon systems.
2. Automating the development, delivery, and maintenance of logistic support products.

The objectives of CALS are to use automation technology to design more supportable weapon systems; transition from paper-based to digital logistics and technical information; and routinely acquire and distribute that information in digital form for new weapon systems. CALS would span the entire program life cycle, beginning with the pre-concept phase and progressing through product disposal. Ultimately, it would be implemented across all weapon systems and all military services. In Chapter II the concept of a complete CALS architecture is described.

The structure of CALS in the acquisition process is shown in Figure 1-2. To incorporate supportability enhancements into the initial design concept of a weapon system, the logistics data base needs to be linked to the product definition process (CAD), providing the basis for influencing the design, automating logistics support analysis (LSA), and making logistics simulation assessments. This would allow R&M analysis of design alternatives at all stages of the design. Given more "real time" availability of the results of logistic analyses, there would be opportunities for evaluation of alternative support concepts for multiple design options. The data elements required for the LSA process including support requirements would reside in an ILS data base. The ILS requirements resulting from the LSA process would be available to develop the support resources through a series of computerized output modules.

This integrated CALS system structure not only provides the tools to design improved supportability into the new weapon system, it also provides the information base to automate the creation of logistics support products, and the digital delivery of logistics and technical information from the defense

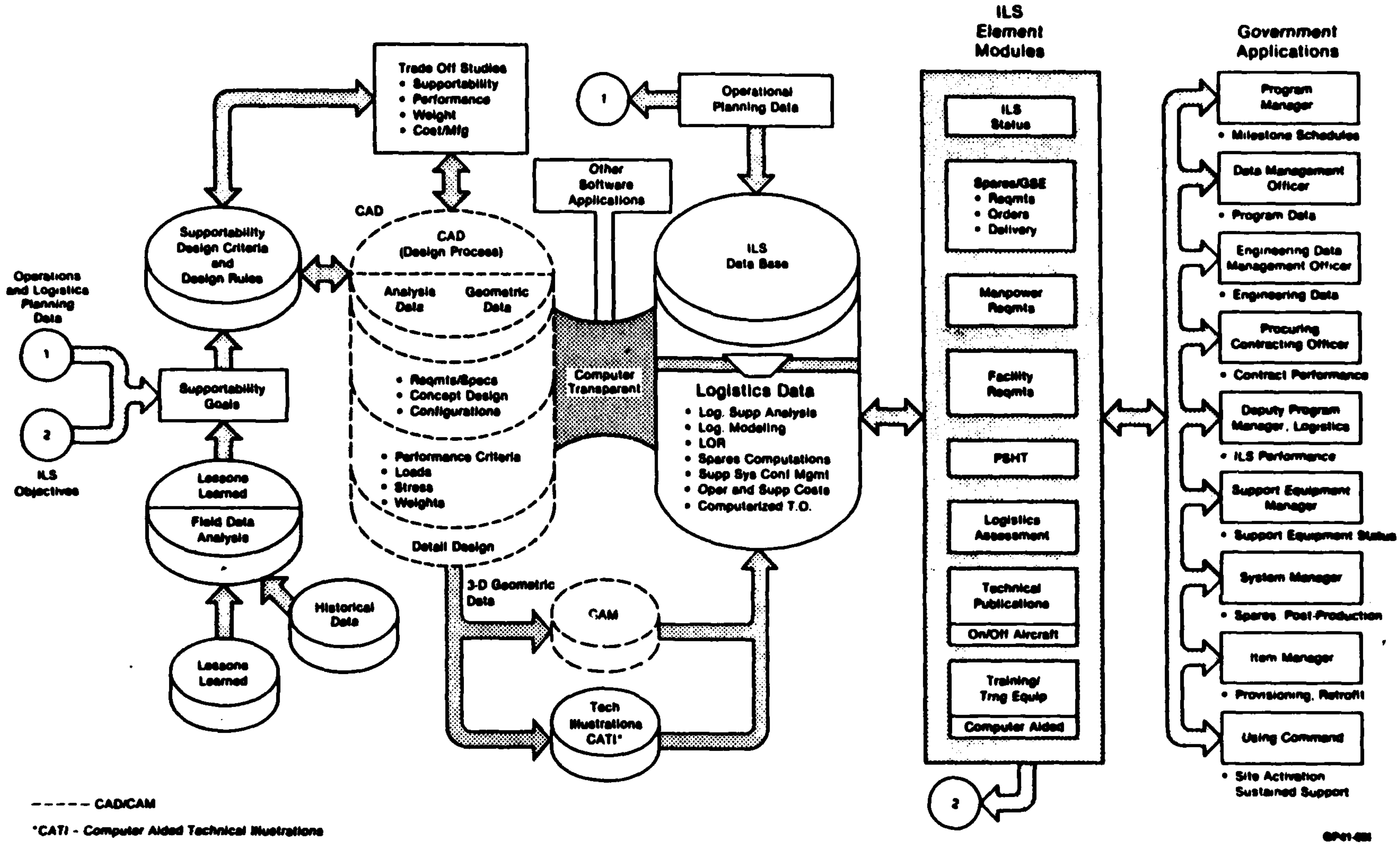


Figure 1-2. COMPUTER AIDED LOGISTIC SUPPORT IN THE ACQUISITION PROCESS

contractor into DoD's infrastructure of logistics and operational users. Creating logistics products is a data intensive function, and is already recognized as a fertile ground for automation. Industry has already done a great deal to apply computer technology to this process, although there remain many opportunities to further automate. The biggest payoffs lie in integrating those individual functions that have already been automated: for example, passing CAD geometry data digitally to an automated authoring system workstation, where it can be used for graphic illustration of technical manuals, whose text has been built from LSA task analyses transmitted digitally from the ILS data base.

These steps toward integrating individual automated functions within the contractor's plant represent in microcosm the third major element of a complete CALS program. The greatest benefit of automating the creation of logistics support products and information arises when that information is distributed in digital form from the contractor who created it, into the government infrastructure of functional users who store, process, and update the information. Digital exchange of data requires attention to system architecture planning, the application of standards for data formatting and communication, and functional utility of the digital data. The difficulty of designing and implementing either a corporate-wide integrated system, or the much more complex distribution network needed within the government, offers correspondingly greater benefits. Logistics information will be more accurate, more timely, and more effective in supporting military operations, as well as less costly. Data can be either physically delivered to the requiring government activity, or maintained in place at the contractor facility, depending on program needs and relative costs. Functional users of logistics data will not need to be concerned how or where their data is stored because they will have immediate access to it via a sophisticated network of intelligent gateways, wide area communications, and distributed data bases.

These ILS data bases would contain data elements as agreed to by the government and contractor and could be electronically transmitted/called up to user viewing screens. This would provide the Government with significantly enhanced logistics support capabilities throughout the operational life of the weapon system. Technical information required for spare parts provisioning, modification efforts, maintenance, training, and configuration management would be current and accessible. Maintenance of data files could be assumed by Government agencies, as required, with no loss of essential data and without the expense of recreating a weapon system file.

While Figure 1-2, Computer-Aided Logistics Support, illustrates the large scope of CALS, it in fact understates that scope, since CALS is shown there during the weapon system acquisition process in some detail, but the operational logistics system needed to support the weapon system over its life cycle of 20 to 30 years is not shown in comparable detail. The CALS study has focused on the use of computer technology within the acquisition process, because it is here that the government must take immediate action to lay the foundation through which the ultimate payoffs of the CALS program, as outlined above, will be secured.

Figure 1-2 highlights some important aspects of CALS:

A. Automation in design, manufacturing, logistics and support functions (shown as rectangles in the figure) is underway and will continue at an accelerated pace. Similar explosive expansion is occurring in the data bases (shown as cylinders in the figure) supporting this automation.

B. Current direction of this automation is a hodge-podge of differing implementations, often of nearly identical functions, subject to individual industry and government organizational requirements and concerns, and the pressures from hardware and software marketeers to procure theirs as the "best" solution.

C. Industry will continue automation for reasons of productivity, quality and competitiveness as measured by return-on-investment. Government will continue automation for similar reasons although competitiveness is supplanted by force readiness and sustainability.

D. The government pays for nearly all such automation: in the government via line items in the federal budget; in industry via direct charges to weapon system contracts, or indirect charges via corporate investment.

B. PROPOSED DOD OBJECTIVES

1. Opportunities of a CALS Program

Specific opportunities that appear to be attainable through CALS applications discussed above are to:

- Apply automated supportability analysis to achieve design influences through CAD/CAM, and thus make large R&M gains in future weapons programs.
- Reduce the overhead costs associated with manual logistic processes and thus reduce weapon flyaway costs.
- Increase the effectiveness and lead time of logistic planning by eliminating error prone manual processes.
- Enhance the effectiveness of procurement and configuration controls through integration of drawings, CAD, CAM, LSA and other data.
- Ensure continued availability of complete, validated technical data, drawings, etc. for follow-on support, spares reprocurement, post production support.
- Improve the accuracy and reduce the cost of the data to interface with the operational training and maintenance systems.

2. CALS Program Objectives and Requirements

The CALS Task Force structured a set of objectives for a CALS program that would take best advantage of these opportunities. A CALS program implemented by both government and industry should use existing and emerging automation technology to:

- Design more supportable weapon systems.
- Transition weapon system logistics and technical support throughout the system's life cycle from paper-based to digital, near paperless mode.
- Routinely create, distribute, and use logistics and technical information for new weapon systems in digital form.

The Task Force concluded that by taking action now, a CALS program could be set in motion that would allow this third objective - digital logistics support for new weapon systems - to be achieved within five years. Specifically, the committee concluded that the phased strategy developed in the remainder of this report would provide the basis for DoD to make a formal commitment now that by 1990 all new major and less-than-major weapon systems and equipment entering production would have operational programs to create, distribute, and use logistics and technical information in digital form.

Achieving this objective, and the no less important objectives of designing more supportable weapon systems and transitioning DoD logistics support to a near paperless environment, will require cooperative action by DoD as a whole, the individual Military Departments and Agencies, and defense contractors. Each DoD component must develop a plan for CALS program implementation that best meets its individual requirements. However, these programs must be coordinated in such a fashion that DoD establishes a unified interface with industry for digital data exchange, as well as an internally integrated CALS system architecture. Industry must be prepared to join with DoD in planning this unified interface, and in making the significant resource investments that a CALS program presupposes. DoD's role in encouraging and facilitating industry support for CALS will involve defining contract arrangements and investment incentives, as well as specifications and standards, data interface requirements, and source selection criteria.

3. Problems Facing DoD in Implementing a CALS Strategy

A fundamental DoD problem has been lack of widespread recognition of the need for implementing a CALS strategy now. One view is that the wide scope and diversity of logistics support system needs make it inadvisable to try to address the overall problem. In this view, it is better to let the piecemeal solutions evolve freely and later tie them together. Undoubtedly this is what will happen if the current course is maintained.

The disorganized, seemingly random development of "islands of automation" has distinct benefits:

a) Each functional element can automate at a pace and in a manner that optimizes its specific needs.

b) Incremental automation can capitalize on the latest hardware and software available at that point in time and, with foresight, can plan for upgrades.

c) The resulting number of solutions is not infinite: witness the small number (14) of major viable computer-aided drafting systems, and the relatively small number of successful personal computers.

d) While mass production is supposed to lower costs, healthy competition in our capitalist economy can have even greater impact.

e) Any attempt to "standardize" the automation process will inevitably cause endless, frustrating discussion of the details of what and how to standardize. This is particularly true among the Services and even among logistics elements within a Service, as well as within the defense industry. There is little incentive to scrap the considerable sunk investment or to alter automation plans already in motion.

However, industry experience would indicate that automation payoffs are attained more quickly if an overall strategy and planning effort is established early in the game. An example is the early establishment of interfacing rules, so that the gains to be made in accuracy and speed from use of common data bases can be attained more quickly. The interface areas (shown shaded in Figure 1-2) portray the scope of this problem, and are the single facet of an overall government/industry CALS architecture that is not only susceptible to standardization but must be standardized in order to realize maximum benefit from automation.

An analogy can be drawn between CALS system interface requirements and the recent mandate that all automated machine tool, robotics and CAD/CAM suppliers to General Motors must comply with the Manufacturing Automation Protocol (MAP). Presumably GM has enough economic clout to pull this off and set a de facto industry standard without significant encroachment into the specifics of each supplier's products. In the same way DoD can successfully mandate a set of defense industry interface standards for digital data delivery that allow automation to continue apace, provided that the scope of CALS needs and interface requirements are satisfied. There are four aspects to this problem which should be addressed in a CALS strategy:

1) Avoid dictating specifics of automation tactics within the Services and industry. Automation will proceed anyway as advancing technology affords the means to automate. A common communication medium will further encourage automation.

2) Eliminate the communication barriers, or at least provide a common basis to accommodate those barriers. This must be accomplished in two parts: (1) define a broad spectrum of data elements to be used by every CALS participant (normally a participant will require only a subset of the total), and (2) define universal formats for the exchange of data. Both must be evolutionary in nature to accommodate changes, new requirements, and new technology.

3) Develop physical media and protocols for the transfer of data. This should include telecommunications networks based on expansion/extension of existing/evolving government and commercial networks, as well as more prosaic magnetic tapes, disks and even hardcopy (for existing drawings, printouts, manuals, and where automation lags or is not cost effective).

4) Require conformance to CALS specifications and standards by all industry and government participants in any aspect of logistics matters beginning with design and development. The requirement should encompass the foregoing format and interface standards as well as performance requirements (such as response times, reliability, availability, security/integrity, archival permanence, disaster recovery/backup) for the delivery-on-demand of all contractual data to properly authenticated requestors.

4. CALS Strategy

The sponsors of the CALS study requested a strategy and master plan for these actions. The committee that was formed for this purpose concluded that the CALS strategy should focus on four primary areas where existing DoD initiatives fell short of meeting the needs of a comprehensive CALS program.

In summary, what appears to be needed are means to attack the following problems:

- Lack of contract incentives and requirements for integrating automated R&M and supportability analysis into initial weapon system design.
- Lack of interfacing rules and/or standards that would allow rapid intercommunication between diverse systems.
- Lack of an agreed-upon conceptual architecture encompassing a DoD-wide system.

- Lack of priority and funding for pilot/demonstration programs which would advance the overall strategy most effectively.

C. APPROACH TAKEN

A core group was formed, consisting of fourteen senior industry and government committee members, each of whom designated an alternate to provide continuity. Five subgroups were created with the committee members serving as chairmen, vice-chairmen or in integration roles in each subgroup. The subgroups were made up of about 50 liaison and support members.[1] Seven monthly two-day meetings were conducted, at which both individual subgroup meetings and overall group meetings were held. Some subgroups held additional meetings for special purposes.

The objectives of each subgroup were as follows:

a. Architecture Subgroup

To describe the architectural framework of a CALS system (including technical, operations and support, and management data) that would allow DoD to make full use of contractor-generated digital data both for the near-term (the next 5 years) and for the longer term (10 to 15 years); and to recommend implementation plans. Coordinate results with inputs from the Information Requirements, Technical Issues, and Policy/Legal Constraints Subgroups.

b. Information Requirements Subgroup

To define generic government and industry data requirements by identifying data users and applications, types of data available and required, and capabilities existing and needed. Three types of data--technical, management and operations/support--were to be considered.

c. Technical Issues Subgroup

To identify and describe the technologies, both existing and under development, which are relevant to the CALS data requirements and

[1] A complete list of participants with their subgroup affiliations, is provided in Apendix A.

architecture developed by other subgroups; as well as the technical and engineering considerations (particularly including standardization for data exchange/transfer) on which emphasis should be placed to satisfy these data requirements and architecture.

d. Policy and Legal Constraints Subgroup

To identify DoD and industry policies and existing planning standards (e.g., MIL-STD 1388-2A), identify relevant laws (e.g., PL 96-511, Paper Work Reduction Act) and, relevant regulations (e.g., DAR and FAR) which facilitate or constrain pursuit of the CALS strategy. The results should be cross-checked with potential policy and legal issues evolving from the other subgroups in order to identify recommended changes necessary to facilitate the CALS strategy.

e. Demonstration Projects Subgroup

To develop a program of pilot projects to demonstrate the benefits of CALS initiatives in an operational environment, thereby securing active user participation in the evolutionary development of a CALS system architecture. These pilot projects should focus on high payoff, high leverage functions that build upon existing Service initiatives wherever appropriate, as well as applying new technologies, standards, and procedures for automating weapon system development and support.

2. Organization of Report

Each of the subgroups initially identified issues to be addressed and then assigned these to members for short written reports. These papers form the basis of reports by each subgroup which are presented in Volumes II, III, IV and V of this report. In this Volume I of the report, a summary of the group analyses and recommendations is presented as follows. Chapter II presents a "Target System" which is an initial definition of a conceptual architecture for CALS. It is recognized that much more effort is needed to properly define an architecture and keep it updated as technologies and functions change. Nevertheless, an initial concept was needed to provide focus for the group effort. Chapter II was prepared largely by the Architecture Subgroup.

Chapter III, "Issues and Problems to be Overcome," is a summary of the issues identified by each subgroup and discussed in detail in the subgroup reports. Chapter IV provides the final collective recommendations of the group, based on the subgroup reports which are individually summarized in Appendix C.

Chapter II

TARGET SYSTEM

A. DESCRIPTION OF THE TARGET SYSTEM CONCEPT

There was general agreement in the Group that a Computer-Aided Logistic Support (CALS) Target System Concept, which described the characteristics of an integrated "CALS system," should be constructed. The Architecture Subgroup undertook this task and this chapter is a summary of their work, which is described in more detail in Volume III. Even a brief review of this chapter shows that a complete DoD/Industry CALS system requires a large and continuing effort which should be undertaken in phases, based on DoD priorities. Nevertheless, the CALS Target System Concept provides a needed framework for assessing current strategy, within which an orderly evolution to the desired CALS capability can be planned.

1. <u>Necessary Attributes</u>

It is important to re-emphasize that CALS is a program and a strategy for achieving better use of automation technology in weapon system development and support. The CALS Group is not recommending the creation of a single, monolithic "CALS system." This chapter describes what a CALS system should look like, not what the CALS system should be. Each of the CALS study subgroups identified key attributes which the CALS Target System should possess. The following is a consolidation which represents the views of the group as a whole:

- CALS must operate with the most up-to-date (near real time) information possible.

- CALS should be user transparent in terms of data type, data location and type of computer.
- CALS should provide weapon system design criteria (requirements) based on analysis of shortfalls in current capability, lessons learned, field experience and comparability analysis. A major objective is to achieve dramatic R,M&S improvements through the ability to directly influence the design.
- CALS must have provisions to supply data to, and provide data from, logistics models and O&S cost models.
- CALS should be able to draw data directly from the CAE/Product Definition data base. This may require specialized processing in order to be directly useful as inputs to CALS. One key example is the graphical representation of the component, which in many cases will be a three dimensional solid model. Tools must be developed which can quickly and efficiently translate this automated design geometry to, for example, technical order and training graphic formats.
- A key target of CALS is to reduce the cost of data by reducing manual, labor intensive, repetitive data entry and the repetitive processes inherent in current methods and procedures used to develop components of the logistics system.
- Another CALS target is to improve the accuracy, timeliness and availability of Service operational data.
- The implementation of CALS must be done so as to minimize the cost and resource impact upon industry. Since much of industry is already investing heavily in CAD/CAE/CAM, the recommended approach is through the adoption of neutral interface standards.
- Procedural controls and management responsibility must be established to verify/qualify and maintain records on the standards and the translators.

2. *Target System Overview*

The intent of the architectural concept presented here is to provide a functional description of the many capabilities that are needed in an integrated CALS system. The CALS Target System will utilize computer techniques to perform the following major tasks:

a. Interact with the design and design modification processes to ensure major improvements in reliability, maintainability and supportability

b. Provide the accurate, timely and complete information necessary for support planning and the acquisition of support resources

c. Facilitate the effective management of provisioning and supply

d. Provide training, technical information and remote assistance to the technician

e. Provide and support new operation and maintenance aids for the next generation of weapon systems

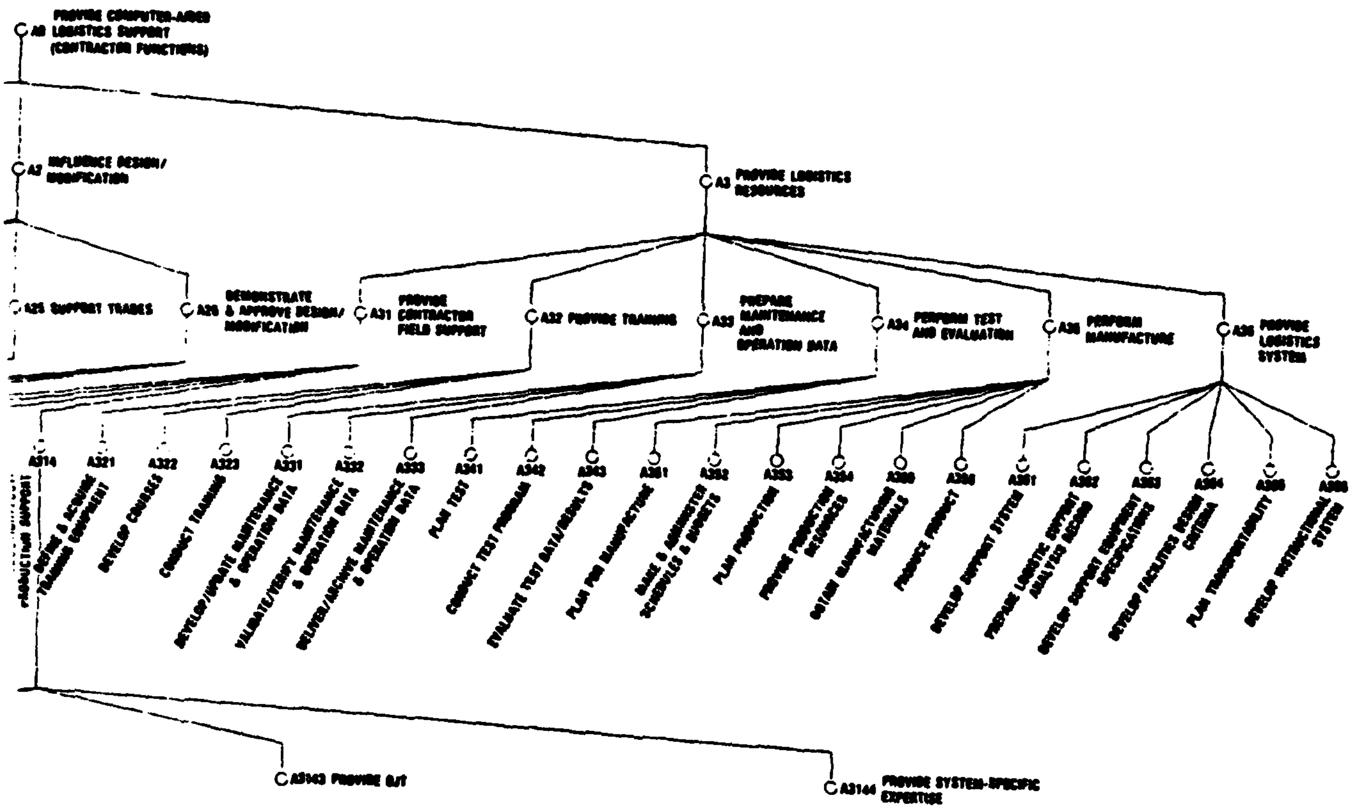
f. Provide integrated diagnostics and computer programs for built-in-test and automatic support equipment

g. Provide automatic data collection and field feedback

h. Facilitate the Services' utilization of these improvements

Figures II-1 and 2 depict the major functions comprising the CALS Target System for the systems of a contractor and Military Service respectively. The overall interrelation of the functions are little different than a "text book" ILS program. Nor should they be, since an ideal logistic support system, whether manual or computerized, should provide for a properly designed weapon system, adequately supported, with a field feedback system in place. Today, an ideal, total logistic support system does not yet exist for two major reasons: (1) support-related analyses and feedback to the weapon system's design process takes so long as to be virtually ineffective, and (2) the cost of many of the analytical and data preparation tasks is so high that they are usually reduced in scope as a cost saving measure. This erodes the support planning and resource acquisition process, and jeopardizes readiness and supportability of the weapon system.

The CALS Target System will interact directly with the design process, taking advantage of computerized design techniques as well as computerized support-related analytical and design optimizing techniques. This process provides that support-related design attributes (reliability, maintainability, testability, etc., as detailed in sections that follow) are addressed at the same time an item is being designed, rather than after-the-fact. Data preparation,



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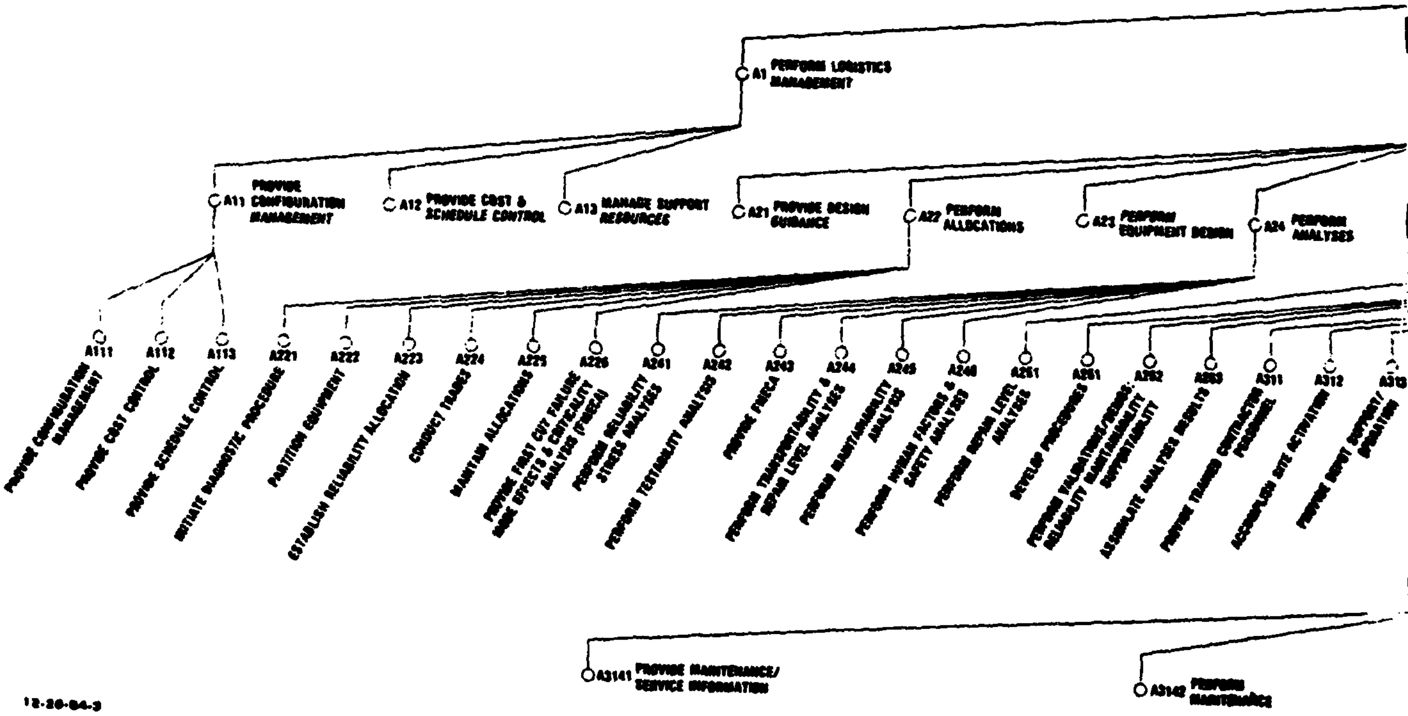

Figure II-1. CONTRACTOR FUNCTIONS

1 of 2

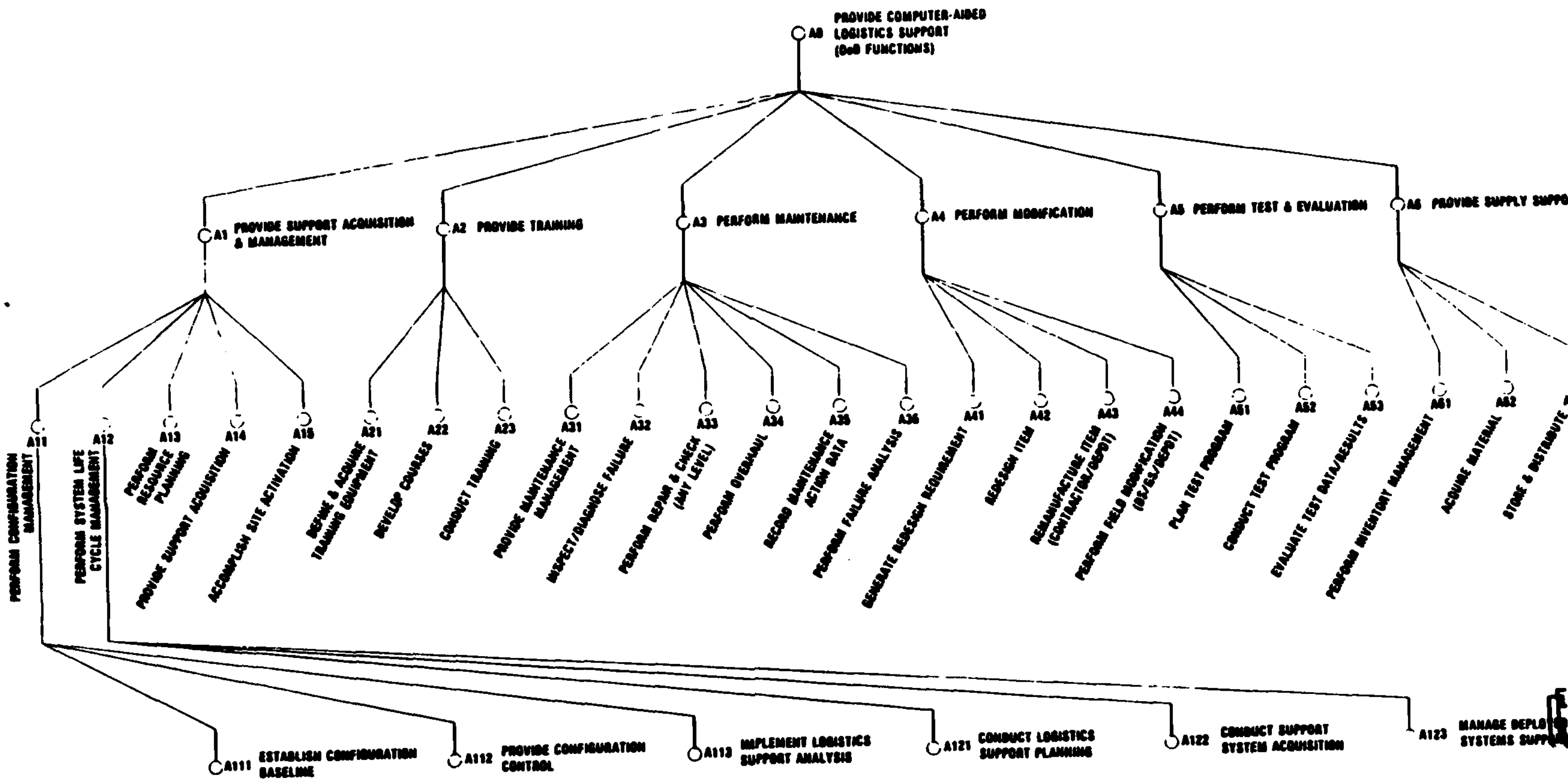

Figure II-2. DOD FUNCTIONS

or better, design information preparation, is also automated, thereby reducing costs to a minimum, and providing all the information that is required virtually in parallel with the design process-accurately, completely and configuration controlled.

Once the weapon system's design has been optimized by elements of the CALS Target System, the design information will be interrogated by other computerized system elements to create the Logistic Support Analyses Record (LSAR) for support planning and support resource acquisition planning. Preparation of technical data which may be required, such as maintenance instructions, will be accomplished from the design information utilizing automated authoring systems; alternately, a direct link to the maintainer will be established to enable him to interrogate design and support information remotely to guide him through the maintenance tasks.

Spares acquisition documentation, as well as digitized reprocurement information, will also be prepared automatically from the digital design information repository, stored on a future contemporary medium (such as optical disk).

To optimize the Services' tasks of supporting the weapon system, advantage will be taken of computerized techniques as well as the digitized design information. Training programs will no longer be as lengthy and complex, with attendant retention problems. Instead they will concentrate on training personnel to use computerized maintenance aids and automated testing/troubleshooting devices. The training itself will utilize the latest in computerized teaching devices. Besides weapon system design features, computer optimization will be applied to maintenance tasks (via modeling of maintenance scenarios resulting from defined battle scenarios for example) to define the tasks to be performed at each level. Utilization of accurate, configuration-controlled design information for the automated preparation and validation of test and fault isolation procedures, will ensure proper testing and error free repairs.

The technician's time-consuming corrective action reporting system will be replaced with user friendly, interactive terminals. These in turn will interact with programs that will assimilate, analyze and feed back information to the designer, as well as to the design guide data banks, such that desired design growth can be accomplished, and facts about the weapon system can be utilized for future designs.

Volume III, Report of the Architecture Subgroup, contains further details of the Target System. That report is arranged by the major functions depicted on Figures II-1 and II-2. Each function is expanded into a more detailed IDEF diagram which depicts the information flow between subfunctions. Their controls, feedbacks and, where appropriate, techniques, are also depicted on the diagrams and discussed in the accompanying text.

B. POTENTIAL BENEFITS FROM THE TARGET SYSTEM

The following paragraphs provide capsule descriptions of the current status of elements of the logistic support process together with an assessment of benefits to be derived if the target system were implemented.

1. Interaction with the Design or Design Modification Process

a. Current Status

Presently most design guidance is provided manually via indoctrinations and hard copy guides prepared by the Reliability, Maintainability and Supportability engineers as part of the Logistics Support Analysis (LSA) process. Inputs are generally limited to what is contained in the specification and the "illities" engineers' own experience, with little or no tradeoff between performance-related and support-related design features. This is due to the lack of time and analytical techniques that specifically address the design process.

The design process itself is evolving to employ computer techniques to assist the designer in defining the product (CAE,CAD), to create the drawings (CAD), and to provide machine tool information (CAM). This process is being continuously enhanced in such a manner that the design programs could directly interact, or provide and accept information from performance-related analytical programs.

Presently, support-related design analyses techniques are performed without such interaction, though many use separate, stand-alone computerized techniques. There are analytical techniques available today to perform many of the analyses required by Reliability, Maintainability, and

Supportability (see Volume II, Table 2-8). However, the analytical techniques employed today are performed in series with a design, so that design modifications due to feedback become costly or cause schedule slippages by requiring changes in actual drawings or items that have already entered the manufacturing process.

Reliability analyses in particular are performed with stand-alone modules of computerized techniques, which are available either off-the-shelf or are developed in-house. Some of these are already interactive with related reliability/maintainability analyses, such as the FMECA. Software is available either to perform these analyses on relatively complex equipment. Except perhaps for small companies, very few reliability analyses are performed manually today.

Testability analyses are performed by both manual and automated techniques. Manual techniques are used where a sufficient library of components is not available to perform these techniques automatically, or where the specifications are sufficiently liberal that a simple checklist such as may be found in MIL-STD-2076 would suffice. Very powerful analytical techniques exist today. These require inputs in the form of the schematic and the range of input test stimuli. The programs that analyze performance also require the desired/specified transfer characteristics of the circuit in order to assess the item's capability to perform its function. Present testability analyses can provide test programs of limited complexity for automated test equipment. Automated instructions for maintenance procedures are not yet possible, however.

Information regarding test nodes and ambiguities resulting from a diagnostic procedure are normally provided in hard copy for review by a senior level engineer. The task usually involves technical tradeoffs concerning the division by nodes, mechanical in nature as concerns the amount of circuitry that can be placed within the module being designed, cause/effect analysis from Optimum Repair Level Analysis (ORLA), and separately prepared testability analyses. These tasks are performed manually, with computerized techniques assisting in the mathematics of the tradeoffs, such as ORLA.

The current analytical techniques employ performance and design information derived from drawings, performance specifications, timing diagrams, interconnection diagrams, etc. Inputs are also provided by manual techniques, with little or no interaction between computer programs possible, due to a lack of standardization of digital information format and transfer techniques. Manual techniques are also used in cases where subjective analyses and mock-ups are utilized, such as human factors and safety analyses.

Data transfer to other users including LSAR, technical manuals and spares is usually performed manually.

b. <u>Target Principles and Characteristics</u>

The Target System will interact with Computer Aided Engineering/Computer Aided Design (CAE/CAD) systems by providing design guidance from an automated library of design rules, on-line design analyses, and automated feedback during the design and development process of an item of equipment.

This task translates the Reliability, Maintainability and Supportability (R,M&S) requirements of an equipment item into terms that can be related, first to the designer in terms of guides, and then to the CAE/CAD computer in terms of design rules for qualitative and quantitative rule checking. Quantitative R,M&S apportionments will also be provided from trade-off optimization programs to establish design targets in terms of figures of merit, as well as to provide a library of information for use by the design analysis programs. This process results in the information necessary to design the equipment with proper consideration of logistics factors.

The Target System will provide for completely interactive design guidance, analyses and feedback, as well as for automatic tradeoff and optimization among reliability, maintainability, supportability, mechanical/electrical packaging/modularization, performance, weight, volume, and cost. Tradeoff analyses will also model readiness and sustainability, as well as the effects on transportability. The latter will be modeled so as to interact with the modularization of the equipment being designed, which in turn would interact with provisioning costs, stocking levels, and warehousing considerations.

Once partitioned, MTBF will be mechanically allocated to the module being designed. This narrows the selection of preferred parts and/or material to be used in the design of the module. Prescreening will result in a recommended parts list which can then be transfered to the product definition bill of material automatically, as well as provided in text processor format for use in final parts lists and LSAR inputs. MTTR will also be allocated to the module during partitioning, which separates task times into testing tasks, remove and replace tasks, and repair tasks.

As part of the design process, the Target System will automatically perform the necessary analyses to evaluate the design against specified requirements. The following are typical:

a. Circuit analysis will be performed to determine testability commensurate with performance attributes, test capabilities resident in the circuit, and planned field/depot test facilities. The detailed analyses will also provide information for automatic test point placement. These testability analysis programs will develop the checkout, fault isolation, and alignment procedures, as well as procedures to be used by built-in-test routines, support equipment, and technical manuals.

b. The Target System will also perform the Failure Modes, Effects and Criticality Analyses (FMECA) of the item being designed, and the item's next higher level of assembly. It will test the equipment partitioning to assess the effect and propagation of functional failures, and identify problems in performance degradation, fault detection and fault isolation. It will also identify critical failures and parts.

c. Maintainability Analyses of a design will be automatically prepared utilizing inputs from the reliability analyses, testability analyses, test procedures, optimum repair analyses, FMECA, and design information (in terms of the assembly, cabling, assembly process, components and component placements, fasteners, nomenclatures, and reference designators).

d. A human factor analysis will automatically analyze the design from the standpoint of work access and other anthropomorphic considerations. Together with the Maintainability Analyses, it will determine the task, skill, and training requirements of the maintainer and operator.

e. To serve in the determination of Source, Maintenance and Recoverability (SMR) codes, as well as in tradeoff studies, Optimum Repair Level Analysis (ORLA) will be performed to ascertain the most economical maintenance level of the item in question. The Target System will provide for automatic input to the model, as well as operational interaction with the other models used in tradeoff analyses.

c. **Benefits**

The Target System's utilization of computerized techniques that are interactive with the design process, as well as with each other, will provide the following major benefits as compared to present techniques:

(1). Realistic Tradeoffs. Viable, implementable tradeoffs between performance characteristics affecting mission capability (including weight and volume), readiness, reliability and maintainability, cost and schedule will be possible to assess the influence of these critical attributes on performance, supportability and life cycle costs, as well as to optimize among them.

(2). Automatic Optimization. Interactive design analyses will enable the performance of the above optimization automatically during the CAE/CAD process. This will help preclude costly changes, schedule slips, and most of the current "test-analyze-and-fix" way of doing business, because all this will take place prior to producing drawings, or digital design information.

(3). Design Rule Preparation. The automatic reduction of actual field data into Lessons Learned will provide for the comparison system required by DoDD 5000.39 for specification preparation and general design application guidance.

(4). Realistic Supportability Requirements. The tradeoff and optimization process, coupled with design rule application and allocation programs, will provide for establishment of reliability, maintainability, and testability requirements tailored to the weapon system's planned utilization and support scenarios. Requirements will also consider contemporary component and material reliability, use of redundancies, and computer techniques for self healing and work-around procedures. The resultant requirements will not only be implementable but will also be translated to design features to ensure compliance.

(5). Accurate and Timely Analyses. The many reliability, maintainability and testability analysis models will be standardized, validated for accuracy, and approved for use in terms of how they address existing (manual), or yet to be developed, government specified, and industry accepted techniques. Automatic interaction (or as a minimum interim measure, parallel manual interaction) with the design process will enable the CAE/CAD systems engineer or designer to rectify problems and optimize the design attributes, as previously described. Circuit analyses will provide performance data at the item's input and output boundaries, as well as performance signatures at the test points used in the development of fault detection/isolation techniques and support resource planning. This will occur in parallel, rather than in series, with the design process.

Automatic interaction between the various analyses described in Volume III, Table 2-8 will preclude transcription errors, omissions, and mixups between configurations of equipment analyzed. The interaction will also provide the audit trail required by MIL-STD-1388-1A.

(6). Automated Design Review. The utilization of approved analytical techniques and digital storage of the results will permit remote design evaluation and approval. This can be as simple as remote review of the results and certification that the appropriate analyses were used, and have approved the item analyzed. This will provide a more meaningful and cost effective review process than is presently available.

(7). Integrated Diagnostics and Reliability Centered Maintenance. The automatic modeling of complex maintenance scenarios will provide for the development of tradeoff factors for Integrated Diagnostics as well as for Reliability Centered Maintenance, which when applied to support planning will result in a truly cost effective and efficient support system.

(8). Elimination of Data Items. Classic, manually produced data items will be replaced by predetermined or ad-hoc queries of the LSAR and/or an ILS data bank containing all the necessary supportability information. These information sources will be accessed (with proper security in place) by authorized personnel, via terminals, for their particular CALS application. This will save the major portion of data preparation costs, which presently represent a significant portion of acquisition cost. The technique will also eliminate transcription errors and data item rejections, and provide the most timely, accurate information possible.

2. Provide Training Products

a. Current Status

Training equipment is presently defined off-line by individuals knowledgeable in the methodologies and required results of training for the systems in question. They manually develop the plans, determining hardware, software, and procedures; manually prepare specifications; and manually issue purchase requisitions for training aids.

Currently, a system's training course is planned and written after the design is completed, and usually after the hardware is built. Research and development for providing automated training development and computerized interaction with design analyses have begun on a small scale. Actual hardware is used to help design the course by exercising its performance capabilities, and by sampling maintenance tasks using "safe" faults and simulated repair situations. Computer based trainers for classroom and field training in operation and maintenance are in use. However, programs for these machines are prepared independently from design performance testing and maintenance evaluation information.

b. Target Principles and Characteristics

The Target System will provide a substantial increase in the amount and quality of weapon system built-in training through on-line interaction with training experts during the design process, to define the training methodology. This will result in definition of the training aids and course-ware needed to support the training process. Automated optimization will determine which portion of the training requirements will be met using on-line interactive programs, built into the weapon system.

Designed-in training programs will provide on-site field training for equipment use and maintenance. Because more simulation of equipment operation and failures will be possible using integral computerized techniques, the resultant training will provide superior instructions which can also be randomly accessed to assist in an actual repair situation. The course-ware developed for other than interactive training will be employed in technician training programs, and the preparation of checkout and fault isolation procedures. All of the manuals, design analysis, and other training aids will be available to the student in digitized format for use in computerized maintenance aiding devices. This will allow the material to be evaluated using CAE technology and rapidly updated.

c. <u>Benefits</u>

The CAE/CAD/CALS data base, including LSAR for the weapon system, will be an information source for designing the training hardware and software. This will ensure full compatibility of the training program and its related training aids with the appropriate design configuration. The early availability of weapon system design information will provide considerably more time for development and acquisition of training products.

Optimization between training products and weapon system built in training will reduce training program costs and improve maintenance. Classroom training costs will also be improved by utilizing computerized teaching aids. Focused, on-the-spot field training would save a significant amount of maintenance time by eliminating searching of technical manuals, learning fundamental principles of operation, and trying to reinvent solutions to known problems.

3. <u>Provide Test, Evaluation and Feedback</u>

a. <u>Current Status</u>

Test and evaluation on the part of the contractor presently employ the classic quality assurance, techniques acceptance tests and demonstrations. Plans and procedures are prepared manually, except where automatic test equipment is employed. For the latter, techniques exist for the automatic preparation of test procedures for electronic equipment of limited complexity.

The Services conduct test and evaluations utilizing manual techniques and hard copy operation and maintenance instructions. Data collection and feedback systems are manual, and are largely inadequate for analyzing and identifying underlying causes of maintenance and reliability problems.

b. <u>Target Principles and Characteristics</u>

The interactive design analyses described in Subsection 1 will automatically provide test, evaluation, and feedback well ahead of actual quality assurance and acceptance testing, which classically are the first formal design validation techniques. These analytical techniques, though no substitute for actual hardware testing, will exercise the design on the system/equipment level to determine if any system-related software/hardware interface problems exist. The analytical techniques will also "stress" the design against the system requirements. Shortcomings will be identified by the computer and corrective actions will be recommended or automatically implemented, depending upon authorities given the interactive programs. The results may also be used to develop the most probable work-arounds and self-healing techniques for inclusion in the weapon system's software/firmware.

The deliverables normally required by a contract include a complete set of test plans and procedures. These will be generated by the computer using the inherent knowledge created while designing and modifying the equipment /system. The appropriate formats for the plans and procedures will reside on the computer and, when initiated, be prepared and available for review. This review will be performed initially by the contractor and then transmitted computer-to-computer to the developing agency for review. Once approved, the developing agency will transmit its comments back to the contractor via the computer link.

The computer prepared test procedures for automatic testing, modified by the interaction of the stress analyses, will be utilized to prepare the quality and acceptance test procedures. If automatic test equipment is to be utilized, its programing will also be prepared by the computer, utilizing artificial intelligence techniques. In this manner, a computer programmed for testing will simulate all of the proper signals required to exercise the equipment during these tests. Test results will be recorded and analyzed automatically, and test data, feedback data and malfunction reports will be prepared by the computer in digital and/or hard copy form.

The same information and techniques will serve for the Services' tests and evaluations, and for preparation of associated documentation.

c. Benefits

Design-interactive automatic test and evaluation techniques will provide significant risk reduction for entering quality assurance tests and/or demonstrations, acceptance testing, and field testing. Equipment will have a far better chance of passing the tests, precluding contractual problems and potential redesign. Test results will also project actual operational capability more accurately, since the systems will have undergone appropriate stress analyses and testing using thorough, computer-prepared test procedures to assess compliance with all specified requirements in the most probable operating situations.

Benefits will also be derived from timely, properly structured performance and malfunction feedback systems. Support planning can be adjusted as rapidly as information is placed into the data base.

4. Preparation of Operation and Maintenance Instructions and Data

a. Current Status

At present, operation and maintenance instructions and related information are prepared by writers from source material such as drawings, performance specifications and test data. Parts listings for illustrated parts breakdowns are created from bills of material on an assembly drawing; maintenance tasks are prepared independently from maintenance analyses to prescribe disassembly order. There is little, if any, interfacing with reliability, maintainability or logistic support analyses processes.

Actual rendering of the printed material employs contemporary automated text processing techniques. Delivered material, however, still consists of plate negatives and printed hard copy. Changes are bundled into convenient annual or other periodic update cycles. They usually consist of change pages to be manually inserted into the existing material, and are consequently inconvenient and not timely.

The accuracy, utility, and adequacy of technical content describing equipment performance or maintenance actions are limited by virtue of preparation techniques and cost.

b. <u>Target Principles and Characteristics</u>

The Target System will have automated capability to prepare hard copy operation and maintenance instructions together with associated data, such as parts lists, torque values, etc. These items will be prepared by computer aided authoring systems, coupled with automated publications production and electronic delivery/distribution systems. Source material will be obtained directly from the design information prepared by the CAE/CAD computers.

The Target System will also be capable of structured, interactive, electronic delivery of information. This will enable the technician to utilize terminals, or other forms of on-line communication, to obtain interactive instructions and attendant data. The interaction can be tailored to provide appropriately screened information for all levels of experience and skills, as well as specific equipment configurations. Repair parts will be identified automatically, as will the closest source for these parts. This will be derived from automatic interrogation of the logistics data base, constructed in turn via the automated LSAR process. Substitute parts and work-around procedures will also be available, as appropriate, from the same data base.

c. <u>Benefits</u>

The computer aided authoring systems' direct utilization of design information will provide the most accurate information possible for the preparation of instructions and maintenance data. Similarly, updates will be accomplished easily, and pace will be kept with design changes. Besides cost savings that result from reducing the efforts of technical writers and the rework identified during validation/verification, this material will reduce operating and maintenance errors. Immediate availability of design information will also provide for greatly reduced preparation time, thereby enabling hands-on validation of the instructions during factory assembly, test, and inspection of the equipment. This will flush out errors, and eliminate the cost of providing separate material for the shop floor.

Electronic data delivery systems will eliminate the costly and time consuming process of plate negative preparation, printing, and distribution. They will also provide for more successful repairs with lowered skill requirements and reduced classroom training requirements.

5. Other Operation and Maintenance Aids

a. Current Status

Instruction and aids for operating and maintaining military systems have been constrained by specifications to use of paper media, as well as a rigid, fixed format. Built-in-test, though widely specified and used, has been reported to be incomplete or inaccurate for fault detection and isolation in many instances. Automatic test equipment and its programming have suffered similar complaints. Investigations attribute these problems to the common limitation of manual techniques in designing these aids, as well as inadequate optimization of their utilization. Research to improve analysis, optimization, and integration of diagnostic techniques and levels of performance has begun, but total implementation will require other features of the Target System to be in place.

b. Target Principles and Characteristics

The next generation of weapon systems will feature extensive use of micro electronics in avionics, control systems, and built-in sensing and monitoring of equipment condition. This will be made possible using CAE/CAD/CALS techniques. Even mechanical systems (such as aircraft flight control surfaces) will be controlled and configured by computers as necessary. The architecture of these selfprogramming systems will involve basic components (e.g., a power supply) that are automatically reconfigured into different subsystems as needed to perform multiple functions during a mission, and to work around failed components. A new maintenance decision possibility is thereby added, namely, whether to fix a malfunctioning system or let it continue to operate in a degraded mode. Decision factors will be provided by the system's computer.

based on design and performance information derived from the analytical data base prepared during the design process, and from field feedback.

The conditions under which maintenance will be performed in the future will also be more severe. Battle 2000 Service concepts envision high mobility and repair on the run, with few forward fixed bases. CAE/CAD/CALS-designed test equipment will be miniaturized (using VHSIC technology) and highly mobile, taking maximum advantage of integrated diagnostic design tradeoff results which optimize test facilities between prime and support equipment for front-line repair. Procedures for battle damage repair, not normally modeled for maintenance tasks due to the unpredictability of such damage, will be a necessity for survival, even in austere and remote areas. This will require access to more extensive engineering data than normally provided in technical orders. Detailed design information downloaded from a remote host computer will provide the technician with battle damage assessment capabilities as well as repair, patching, or work-around procedures. High density local storage will suffice when communications cannot be established with a remote host system.

c. Benefits

Automation will provide additional tools which will make maintenance management much more efficient and effective. Opportunities include the availability of on-condition data from the weapon system, access to historical data to detect trends, use of computers to analyze the effectiveness of processes and procedures, resource status, tracking, optimal job sequencing, and positive equipment configuration control. The interface with the supply system can provide for automatic parts ordering, status determination, and better decisions on cannibalization and transfer to higher maintenance levels.

Design-related anthropomorphic maintenance modeling presents the opportunity for modeling battle damage situations. The models can then be used to assess battle damage through interactive communications with whatever skill level technician is available at the repair site. Artificial intelligence programs will also guide the repair. The technique is a potential, highly cost effective force multiplier in an actual battle situation.

6. Manage the Provisioning and Supply Processes

a. Current Status

Presently, semi-automatic techniques are employed for required record keeping and inventory management. Configuration management is provided only through updates to illustrated parts breakdowns, with no automatic upgrading of spares inventories. Nor are SMR codes subject to updating based on maintenance experience, because analyses of the data from field feedback systems are primarily tedious, manual processes, with the computer only assisting in sorting and preparing summary reports. As a consequence, the supply system is slow to respond and cannot take advantage of optimum buys and spares deployment.

b. Target Principles and Characteristics

The digital format of the Target System's logistics data base will provide rapid and accurate record keeping of inventory levels and configurations down to the replacement part level's "used on" information. Adjustments to stockage levels and redistribution of stock points can be instantly calculated from the automatic field feedback system. The information will be used for reprocurement, and to adjust spares levels and SMR codes based on repair experience. Automated ordering and price assessing systems will also be in place to cut lead times and provide assurance of economical buys.

c. Benefits

Automation of the provisioning and supply process will effect substantial cost savings by optimizing stockage levels to stockpile location and depletion rates. Cross indexing to other identical (form, fit and function) material, determination of temporary substitute parts for emergency use, etc. Automated changes in SMR codes to reflect experience will also reduce resupply costs. Automated auditing of spares consumption, learning curves, and non-recurring costs prior to procurement will more accurately forecast the need for spares provisioning.

Digital facility and product design information will minimize storage space requirements, and enable rapid updating and configuration control of this information. High quality reproduction directly from the original digital information will provide highly legible, accurate hard copy, data where necessary, unlike the present second or third generation, illegible microfilm's material. And the digital manufacturing data package will thoroughly document the design for remanufacture via CAM.

7. Interaction with Field Modifications

a. Current Status

The primary generators of redesign requirements are field or test program feedback, which identifying deficiencies in performance and the need for performance upgrades via field modification. At present, the analysis and feedback process employs manual techniques. The redesign process (contractor or Service) depends on an original technical data package, manufacturing information, technical specifications, and the redesign requirement (i.e. a problem report or change specification). The redesign itself may use the same CAE/CAD techniques used for the original design, if any, but configuration management and updating of attendant analyses and data are performed manually.

b. Target Principles and Characteristics

The Target System will provide the same interaction for contractor performed modifications as for the original design and development process. Requirements for modification will be based on performance changes and/or an automated deficiency reporting system. That system will employ automated analyses of field maintenance data.

Field modifications performed by the Services, on the other hand, will be supported by the repository of design and performance information collected during design and testing of the equipment. Access to this information, as well as direct communication with the designer, will be provided through the same remote communications facilities used for the field repairs.

c. Benefits

The remotely accessible repository of design, performance, and failure information will reduce the cost of modification by eliminating research and reverse engineering. Automation of the reporting systems for the modification process will reduce paperwork and accelerate the process. The reporting system will also provide for more accurate and timely tracking of approved modifications, and total weapon system costs.

8. Perform Logistics Planning and Support Analysis

a. Current Status

Presently, logistics planning and acquisition of support resources is performed manually from classic, standard data items. The LSAR has been employed as a data collection system and has recently been updated to address computer processing techniques. Many of the analytical techniques and output reports have also been automated. However, they are not yet used to replace the standard data items. Some of these data items, such as spares documentation, test programs, and FMECAs have been separately automated for cost reduction. However, these do not use the LSAR data base. Instead they derive information manually from raw design information such as schematics and assembly drawing.

Maintenance task analyses and related analyses are performed manually for input to the LSAR and, in some cases, for preparation of source material for technical manuals.

Assignment of SMR codes, though available from Optimum Repair Level Analyses (ORLAs), is still a manual task at provisioning conferences. Provisioning itself is essentially a manual task, with larger weapon systems employing limited computer techniques. The Services utilize computerized ordering systems, and have started to utilize computers for value assessment.

There is a general lack of cohesiveness, integration of information, and overall management of the details of the logistics process.

b. Target Principles, Characteristics and Benefits

In addition to the design and data structure described in Subsection 1.c and elsewhere, the many standard planning documents (reliability, maintainability, ILS plans, etc.), and technical reports (prediction reports, LCC reports, FMECA reports, etc.) will be accessible via terminals, from the design and analyses data bases. This would provide cost savings and succinct planning information.

Outputs of the maintainability models will interact with dependent programs, such as repair level analyses, life cycle cost analyses, transportability analyses, test program generation, technical manual repair procedures, maintenance task analyses, manpower and skill analyses, spares and repair parts identification, SMR coding and support equipment analyses. These will provide direct input to the LSA process or similar support resource planning analyses. This will save the major portion of preparation costs, eliminate transcription errors, preclude data item rejections, and provide timely, accurate information.

Benefits can be derived from having complete and up-to-date information on all aspects of a system's support. accessible to all parties with legitimate needs. This will expedite access to equipment maintenance schedules, status of spare parts inventories, and the distribution network. Repair records for a given piece of equipment can be easily obtained and updated to reflect local maintenance actions. The flow of spare parts can be more closely monitored, and potential bottlenecks can be avoided or minimized.

System diagnostics, technical data, and hardware/software updates can be integrated and better managed. Realtime availability of the latest diagnostic and troubleshooting information will reduce dependance upon the talent, skill and experience of the maintenance personnel.

Chapter III
ISSUES AND PROBLEMS TO BE OVERCOME

Considerable industry and government attention has been focused on integration of automated business systems. However, relatively less effort, has been applied to the integration of computer-aided engineering systems or to the design of systems to acquire, manage, and communicate graphical, alphanumeric, and textual data in various combinations. Research and development work has been performed on generic data base management technology, but this technology has not been exploited on a broad level for the development and deployment of major weapon systems.

There are a number of in-place and emerging logistic information systems at both contractor and government facilities. These technical support systems are generally hierarchical in nature, are transaction driven, and usually operate in a batch environment. Data reside in a heterogeneous computer environment and are generally difficult or impossible to exchange among dissimilar computer systems. Current emphasis by both the government and industry is in development of organization-driven rather than data-driven automation systems. In the development of a weapon system, the traditional technical support data bases that are passed on to the contracting agency are engineering drawings, specifications, and technical orders for maintenance support. The remaining technical data bases that reside with the contractor are also significant. These data bases are controlled by design, analysis support organizations, and are not maintained as official released data.

The objective of the CALS task force was to develop a strategy and a plan for accelerating the evolution from this current environment to an integrated CALS system. Specific problems and issues that surfaced in the early subgroup meetings and that were addressed in their individual reports are discussed in the following paragraphs.

A. INTERFACING STANDARDS AND NEUTRAL FORMATS

1. Policies

- Existing DoD policies do not support a minimum set of standards for acquiring and transfering electronic information from industry to government users. (Policy/Legal Subgroup)

2. Format Standards

- There are evolving formatting standards for graphics and text data that permit exchanges between incompatible hardware/software systems. These are gradually gaining industry acceptance. DoD should define its role and level of participation in the development of such standards (Technical Issues Subgroup).

3. CALS Data Standards

- A standardized set of data elements for electronic information within the weapon system acquisition process does not exist. (Policy/Legal Subgroup)
- Necessary revisions to current CALS-related data standards (e.g. MIL-STD-1388-2A etc.) to accomodate digital CALS data efficiently must be defined (Information Requirements Subgroup).
- A universal numbering system (e.g. as in the Air Force FINDER proposal) or other form of data referencing structure may need to be adopted to facilitate on-line distribution and access to CALS data (Information Requirements Subgroup).

4. Telecommunication Standards

- DoD policy issued 10 March 1983 requires all DoD data processing systems to use the Defense Data Network (DDN) for long-haul and area communication. This network may not be able to handle the projected volume of CALS data. (Policy,/Legal, and Technical Issues Subgroups)

B. DESIGN INFLUENCING ISSUES

1. Policies

- Policies do not encourage use of computer-aided techniques to improve integration of logistics considerations in the early stages of design. (Policy/Legal Subgroup)

2. Design for Supportability

- Current design procedures do not emphasize supportability considerations early in the design. In general supportability is analyzed after the design is firmed up when major changes are difficult to make. There is a need to develop the design influence algorithms and the analytic software to bring support considerations into the early design. (Technical Issues Subgroup)

C. ARCHITECTURE ISSUES

1. Generic CALS Data/Information Model

- A generic model of CALS is needed to relate and time phase the many proposed issues and recommendations, including those not yet identified. The model must be structured so it will apply to defense systems over their entire life cycle. Such a model will strongly influence the architecture of the CALS as it evolves. (All Subgroups)

2. CALS System Structure

- Near term and long term goals to achieve interoperability and interchangeability of electronic information do not exist. (Policy/Legal, and Architecture Subgroups)

3. Partitioning of CALS System

- In developing a CALS concept it is important to decide whether the supporting data system is to be partitioned by data, by function, and/or by process. The partitioned "subsystems" can then be developed independently using standardized interfaces and data elements. (Architecture Subgroup)

4. Tri-Service System

- There are many common characteristics of a CALS system among the three Services. Conversely there are Service-specific needs that define unique characteristics. These diverse needs must be integrated into a tri-Service system (Architecture Subgroup).

D. SHARED DATA BASE ISSUES

1. Responsibilities for Data

- Proprietary data rights and acquisition of computer software is a CAD/CAM issue that will impact CALS, especially if we visualize CALS access to contractor CAD/CAM files. (Policy/Legal Subgroup)
- Government access to CAD/CAM/ILS files vice data delivered as part of the acquisition process is a significant policy issue (Policy/Legal Subgroup).

2. Access Control and Integrity

- Access control to a supplier's data base is a major management problem. Today, a typical data base owner (i.e. the prospective CALS supplier) has a list of authorized users with appropriate identification codes and passwords. In the CALS environment, any user with a need-to-know should have access. But the worldwide list of such users for a major weapon system (field commanders and maintainers, program managers, supply managers, prime and associate contractors, suppliers, vendors) could number in the thousands and change daily. Keeping each data supplier current with such a list of users, and enforcing confidentiality both data and access controls on every user, appears to be a security problem of unprecedented dimensions. (Technical Issues Subgroup)

3. Data Product Specifications

- A CALS strategy for digital data delivery must specifty what data would be required, how that data relates to current data delivery requirements, and how is the transition from current paper data to digital data delivery is to be made (Information Requirements Subgroup).

4. <u>Archiving of Data</u>

- Currently, support data are archived in the form of paper drawings, tables and text. Digital receipt creates technical concerns about how is it to be stored, what media should be used and how will it be protected (Technical Issues Subgroup.)

5. <u>Relationship to Existing Data Bases</u>

- Certain elements of a CALS system have already been converted to digital form both by industry and by government agencies. Evolution of a CALS program must address not only the paper to digital transition, but also the integration of these previously automated segments (Technical Issues, and Architecture Subgroups).

E. TRAINING/TECHNICAL ORDER AUTOMATION ISSUES

1. <u>Coordination</u>

- There are many ongoing efforts in industry and in government to automate technical orders, training information and other support products. In general these are aimed at automating the production of paper documentation. There is a need to better co-ordinate these efforts and provide for the delivery and use of digital data. (Architecture, and Policy/Legal Subgroups)

2. <u>Data Bases</u>

- Preparation of training material, technical orders and other support products could be done with greater accuracy and at less cost if the automated systems were tied directly into the CAD/CAM-Product Definition data base. (Policy/Legal, and Technical Issues Subgroups)

F. OTHER ISSUES

1. <u>Pilot Programs</u>

- Pilot programs, operating in the user community, will be needed to surface and solve problems related to retraining and reassignment of personnel as well as to demonstrate the benefits of a new approach. Without such pilot programs, elements of the CALS system will be slow in reaching general acceptance by users. (Pilot/Demonstration Projects Subgroup)

2. Technology Advances

There is a continuing need to adjust any concerted CALS program to changes in technology. Of particular interest to CALS in the software area is the evolution of expert systems; of interest in hardware is the development of high density disk storage devices. (Technical Issues Subgroup)

Chapter IV

CALS GROUP FINDINGS AND RECOMMENDATIONS

A. CONSOLIDATION OF SUBGROUP RECOMMENDATIONS

1. Approach Taken

One major problem faced by the CALS subgroups was the significant amount of interaction and functional overlap that occurred despite efforts to partition each subgroup's work to preclude unnecessary duplication of effort. Many of the topics and issues that are here integrated into a single, overall strategy, such as standards for data exchange were addressed from a functional perspective by all five subgroups. It is apparent from the individual subgroup report summaries given in Appendix C that there is considerable commonality in their recommendations. As a result, membership of each subgroup was structured to provide an integration role for selected CALS Group members, who drew upon the individual subgroup reports to assemble the collective findings and recommendations presented in this chapter. Chapter One presented the general environment in industry and government, the opportunities and potential benefits available to DoD, and the objectives of a CALS program. These emerged during the early meetings of the CALS study, and were progressively refined thereafter. This chapter presents the strategy and plan of action that was developed to achieve those objectives. The CALS Group concluded that by pursuing the individual recommendations making up each of the four central thrusts of the CALS strategy, DoD-with industry cooperation and support-can successfully capitalize on current and emerging computer technology to:

- Design more supportable weapon systems
- Transition DoD operations and weapon system support from paper-based to digital logistics and technical information.

- Routinely acquire and distribute logistics and technical information in digital form for new weapon systems.

To implement the strategy that follows, and achieve these objectives, DoD must implement a CALS management process that recognizes the requirement for both a centrally coordinated framework for the total CALS program, and individual initiatives that best meet the needs of each Military Department and Agency. These issues are also addressed in this chapter of the report.

2. CALS Strategy and Management Actions

The consolidated findings and recommendations of the CALS subgroups were assembled into four strategic thrusts. From the viewpoint of the whole group, these can be categorized as follows:

- Recommendations for increasing the influence of weapon support requirements in the early stage of design, including:
  - Programs to speed development of computerized RM&S tools
  - Incentives for industry to integrate computerized RM&S tools into CAD/CAE systems
- Recommendations for establishing DoD-wide interfacing standards and neutral data formats, so that diverse hardware/software systems can share digital information. From the point of view of data handling three issues are involved:
  - Data transparency
  - Data definition
  - Data communication
- Recommendations for pilot programs directed at the integrated use of digital data to support high payoff functional applications. These include:
  - The automation of technical manuals, and training and maintenance aids using common digital data bases.
  - Automated delivery, storage, and use of engineering drawings and product definition data
  - Integrated digital support systems for provisioning, reprocurement, and logistics support analysis.

- Recommendations for establishing DoD-wide coordination toward a planned CALS architecture. Specific needs are:
  - A phased program which would define and prioritize a "building block" approach to CALS implementation
  - An architecture and an information flow model to structure on-going actions and new technology developments.

Each of these four strategic thrusts is addressed in detail in the chapter sections that follow. A concluding section provides recommendations for management action to implement these strategic thrusts. Collectively, these recommendations respond to the CALS study charter's requirement to develop a plan which will "identify our objectives, the major steps to accomplish them, and recommended responsibilities for implementation."

B. INFLUENCING DESIGN FOR WEAPON SUPPORTABILITY

1. Findings

The rapidly growing application of Computer-Aided Design (CAD) and Computer-Aided Engineering (CAE) in American industry creates the opportunity to significantly improve the ability of defense contractors to design for weapon system Reliability, (R), Maintainability (M) and Logistic Supportability (S). U.S. defense contractors are among the leaders in the use of CAD/CAE. However, it was agreed that the use of this capability to address reliability, maintainability, and logistic supportability is still in its infancy. The technology necessary to automate RM&S techniques, and to integrate them into the CAD/CAE process, exists and is waiting to be exploited. While there are isolated activities that are adapting RM&S techniques to CAD/CAE, these are primarily IR&D programs, or programs to automate manual procedures, and are not yet part of the engineering design and analysis mainstream. Actions by DoD are needed both to demonstrate the capability and document the benefits of integrating RM&S analysis into computer-aided engineering and design systems, and to encourage industry to use these techniques routinely.

Thus there are two major elements to be considered in a DoD plan of action: (1) programs to speed the development of a full set of RM&S[1] design tools for CAD/CAE systems (these should include demonstration projects incorporated in the actual design process at contractor's facilities, as well as sponsored development of integrated RM&S tools in selected product areas), and (2) incentives during the acquisition process for contractors to integrate automated RM&S design tools into the mainstream of CAD/CAE engineering analysis and design.

a. **Programs to Speed Development of a Full Set of RM&S Tools**

1. **Demonstration Programs**

There are some DoD-sponsored demonstration projects already underway to promote RM&S tool development. For example, the AF MLCAD effort has two demonstration projects, one focusing on thermal analysis and accessibility in the redesign of a GLCM power unit, and the other a testability redesign effort on a portion of the F-16 weapons pylon. The first of these has already proved its value in demonstrating rapid redesign capability. A proliferation of such demonstrations is needed to cover the wide range of products and the associated diverse CAD/CAE systems utilized by DoD contractors.

2. **Integration of RM&S Tools**

The potential to create a "RAMCAD design work station" is a powerful opportunity to address the central issue of integrating RM&S requirements into design decision making. Development of such a work station would serve several purposes:

- Demonstrate the ability to integrate RM&S design requirements in a timely way.

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[1]DoD Directive 5000.39 defines "supportability" as a generic term to include all aspects of support requirments. This definition is not yet widely recognized however, and the term RM&S has been used here for clearer communication.

- Stimulate the vendor community to provide integrated RAMCAD systems, and the user community to utilize such systems
- Provide a tool for evolving improved design specifications.
- Provide a means for independently validating designs.

Logistics R&D and IR&D funds should be targeted toward a variety of RM&S tool development opportunities. The tool development effort will be a continuing process, involving upgrades and enhancements to accommodate new technology, as well as new techniques and applications. All potential avenues for tool development must be addressed. It may be necessary for DoD to sponsor and/or develop some tools initially. One approach would be to sponsor a program by a consortium of universities and industry to spur new developments in this area. At the same time avenues should be explored to encourage private development by weapon system contractors, CAD/CAE vendors, and software houses. The most opportune and promising of these vehicles should be promoted as Centers of Excellence, with a full program to develop, demonstrate, publicize, and export a complete spectrum of integrated supportability design analysis tools. A "white paper" defining CAD/CAE applications for different product lines is one way to build industry support.

b. Incentives to Use RM&S Tools

Historical experience indicates that application of RM&S tools will not occur spontaneously - at least not on a broad basis. It appears therefore, that a program of incentives must be developed. In some situations, large, immediate payoffs will accrue and little incentive (other than not prohibiting or unwittingly penalizing the application of these RM&S tools) will be required. In other situations, appropriate incentives will be needed to offset intangible or long-term returns.

Incentives must be provided for program offices as well as contractors. Initially, there may be a need for Service "consulting teams" to assist program managers in writing SOWs, assessing proposals, and reviewing results. In addition, there are documented cases where some of the time and money associated with testing, fabrication, and mockups has been saved through application of automated RM&S techniques. The potential savings are large and this area should be investigated more fully.

2. **Recommendation**

To implement these findings, the following actions are recommended:

- The Air Force should continue their MLCAD project through AFHRL/LR, and should be named as DoD lead Service, supported by full participation of other Services and DoD agencies. This cooperation is already underway through a RAMCAD subpanel of the JLC. However, the lead Service designation should be formalized and coordinated funding allocated.

- The initial task of the Services under Air Force leadership should be development of a full program plan based on the findings outlined above. This task should be completed by September 1985.

- An analysis of the application of automated RM&S techniques to diferent products should be accomplished to define and publicize state-of-the-art techniques and benefits.

INFLUENCING WEAPON SYSTEM DESIGN

Designation of Air Force as Lead Service and formalize interservice coordination through a memorandum of agreement	IMMEDIATELY
Publish Program to Expand Applications - Inventory of available tools - Proposals for Demonstration Projects - Increased funding required - Incentives and R&D priorities	SEPTEMBER 1985
Publish proposals for contract requirements and source selection criteria	SEPTEMBER 1985
Begin implementing Incentives Program,	FALL 1985
Publish Catalog of RM&S Tools	June 1986

Demonstration Projects of Individual Tools/Techniques	JAN 1986-JAN 1987
Establish Centers of Excellence for demonstration of integrated supportability design analysis	JAN 1986-JAN 1989
New RM&S Tool Development	Continuing

The following milestone plan illustrates how a RAMCAD integration demonstration can be completed in three years. A single agency should be identified to manage the effort, and provided with sufficient resources to accomplish the task. This agency would define the project, accelerating existing Service efforts as a baseline "jumping off" point, and identifying an appropriate demonstration vehicle. By leveraging efforts currently underway, the proposed RAMCAD demonstration can reduce the technical risk, and speed realization of the benefits from the high levels of system reliability, maintainability, and availability which will be routinely achieved when RAMCAD is implemented throughout industry design practices.

Milestones

• Identify Implementation Agency	Fourth Quarter FY85
• Identify Demonstration Vehicle	First Quarter FY86
• Identify Functions/Analyses to be Automated	Second Quarter FY86
• Adaptation/Automation/Integration of Models	Second Quarter FY87
• Demonstrate integrated RAMCAD tools for the Demonstration Vehicle	Third Quarter FY87-Second Quarter FY89

To secure the greatest return on investment, multiple projects should be initiated, each applying the same concepts and milestones to examine appropriate automated RM&S applications for different product categories (e.g., airframe, vehicle, missile electronics, avionics).

C. INTERFACING STANDARDS AND NEUTRAL DATA FORMATS

1. Findings

The CALS Group charter calls for establishment of a framework that would allow DoD to make full use of digital data created by defense contractors and shared among a wide spectrum of functional users. A fundamental problem is that the digital data systems being used now are largely unique to each contractor. This "piecemeal" application of automation technology is a fact of life and will continue. Any effort to standardize these contractor systems would be counter-productive, particularly since the whole automation process is taking place amid rapidly evolving technology. The approach that is urgently needed is to start establishing or adopting a set of standards and neutral data exchange formats which will permit these diverse software/hardware systems to be successfully interfaced.

There was universal agreement within the CALS Group on this point - reflected in the strong recommendations made by each CALS subgroup (see Appendix C). There is an immediate need for DoD to establish interim interfacing standards, while over the long term DoD must continue to work with and actively support U.S. industrial and international groups to develop more universal standards. Interim standards are available for DoD use, and they are already being adopted and contractually applied by both government and industry. DMSSO acceptance notices have been published for both IGES and GenCode (SGML), and both are being contractually required for new Army/Air Force automated authoring and drawing repository systems. The Navy has made a broad commitment to IGES for ship acquisition programs. However, current DoD policies do not support the minimum requirements of both government and industry for a complete family of DoD-wide standards, through which the Military Departments and Agencies can present a single face to the defense industry. Neither near-term nor long-term DoD goals for digital data exchange have been established.

The issues can be partitioned in several ways, depending on the perspective taken. The CALS Group agreed to treat these issues from the "data" viewpoint, and defined three areas of concern:

- Data Transparency - How can data generated in diverse hardware/software systems be universally accessed?
- Data Definition - What data elements should be included in a notional CALS data base?

- Data Communication - What networks or other media and protocols are needed for transferring CALS data?

The recommendations which follow propose some immediate actions. In addition, through the Defense Materiel Specifications and Standards Office (DMSSO), responsibility should be assigned for development of a comprehensive long term standards development plan which involves close DoD co-ordination with various industry and government groups.

2. Recommendations

a. Data Transparency

No matter what the digital system in which it is generated, or what logistics products are being developed, CALS information can be classified into three types: textual, graphical, and mathematical. To develop the needed interface standards for such information, DoD should:

- Participate in the continued development and implementation of the Initial Graphics Exchange Specification (IGES) for engineering drawings, 3-D wireframe part models, and 3-D surface part models.
- Participate in the development, implementation and testing of the IGES Product Definition Exchange Specification (PDES) for solid part models, full part definition and support of advanced manufacturing planning systems.
- Participate in the continued development and implementation of the SGML standard for text processing and the GKS standard for graphics data within an applications program.
- Support the development of procedures, software, hardware, and training materials necessary to provide the required interface between IGES and SGML, and to process and exchange mathematical data and relationships in a manner in which they can be used in a quantitative way.
- Participate in the development and demonstration of a full range of standards which support and supplement the standards discussed above. These include, but may not be limited to, CORE for three dimensional graphics, VDI (CGI) and VDM (CGM) for

device independence, NAPLPS for text and graphics communication, and PHIGS as a "next generation" graphics language. These and other standards must be developed and integrated into the CALS effort in a cohesive manner.

- Establish a framework for development and validation by CALS participants of translators between their unique data system implementations and the standards adopted for CALS. Then, publish a plan to provide for configuration control, validation and certification of both standards and translators, and archiving of data and programs using the standards and neutral interfaces. Test methodologies should be developed and translators demonstrated to check compliance, and to assure data integrity in the exchange process as well as in archiving of data.
- Participate in implementation of transition plans for continued data and text entry with existing format-only, what you see is what you get (WYSIWYG), word-processing machines (e.g., the DIF standard and currently installed word processing systems) utilizing implicit coding and code minimization techniques to facilitate routine indirect entry of SGML codes.

To start this process, specific actions and milestone dates are proposed as follows. The schedule is required to meet the needs of the pilot/demonstration programs (see Section D of this chapter for recommendations as to implementation procedures):

Actions/Standards	Dates/Time Period
• Publish a DoD plan and schedule to develop and implement CALS data exchange standards	IMMEDIATELY
• Formal DoD adoption by policy statement of the following standards - The Standard Generalized Markup Language (SGML) for text processing - The Graphics Kernel System (GKS) for two dimensional graphics - The Initial Graphics Exchange Specification (IGES), Version 3.0, as an interim standard for product definition	JULY 1985

• Publish procedures for certification of standards compliance, procedures and test data for validation of translators, and procedures for IGES/SGML/GKS interfaces for integration of product definition, text, and graphics data	SUMMER 1985
• Refinement and initial application of procedures for certification, validation and interfacing; incorporation of necessary enhancements, including logistics data, in IGES PDES and in GenCode/SGML application procedures.	SUMMER 1985-JAN 1986
• Formal DoD adoption of IGES PDES for digitized product definition	JUN 1986-SEPT 1986
• Service demonstration of typical inte grated applications (such as digitized drawing transfer and automated authoring); development and application of procedures and test data for IGES PDES translator validation; incorporation of electronic and electrical applications into PDES.	JAN 1986-JAN 1988

The implementation of the above actions should be under a designated lead Service with DoD oversight, with the full participation of the other Services, DoD agencies and industry, and with the National Bureau of Standards (NBS) providing the government/industry technical interface.

Specific proposals for product definition and other standards for consideration by NBS and industry should be developed under ongoing Service pilot programs (ref Section D below). These efforts should be fully supported by multi-Service funding.

These interim steps are crucial for establishing a well defined starting point for government use of digital data in a manner allowing industry to focus their effort toward orderly growth in automation.

b. **Data Definition**

Problems of end-to-end data exchange cannot be resolved without consideration of the data base structures of both sender and receiver. There are also questions as to the most effective techniques for archiving digital data. To allow effective integration and control of government data acquisition, effectively automate current manual processes, and reduce current redundancies in creation, access, and delivery of weapon support documentation, it is essential that a standard dictionary of CALS data elements be developed. The existing DoD program for logistics data element standardization (LOGDESMAP), while useful, falls short of requirements in this area. However, DoD has successfully undertaken a major logistics data element standardization initiative through publication of MIL-STD-1388-2A, covering LSAR requirements. MIL-STD-1388-2A's Data Element Dictionary establishes joint Service and industry agreement on the definition and format of over five hundred key LSA, R&M, and provisioning data elements. By expanding this approach to data element standardization, and coupling it with development and demonstration of data base management systems and neutral query languages to utilize this standard data regardless of its original or storage media, DoD and industry can make weapon system logistics and technical information more accessible to functional users throughout the logistics infrastructure. DoD should:

- Support the expansion of the MIL-STD-1388-2A data element dictionary to broader areas of coverage.
- Initiate an evolutionary process designed to develop and implement, within the context of CALS standards and translators, a data element cross reference capability that provides the capabilities desired in the Air Force proposal for a "Universal Numbering System." See Vol. IV Appendix C. there is a need to be able to easily track, extract and manipulate data pertaining to a specific component across many functional (i.e., maintenance, supply, cost accounting, logistics support analyses) data bases and systems. It is not clear, however, that one "Universal Number" that would have to be carried intact (and updated when changes occur) across all data bases and data systems is the only answer. Exploitation of modern data structure techniques and indirect addressing approaches could lead to a less cumbersome and possibly more feasible solution.
- Develop and publish a document providing an architecture for information transmission management and access control, using language standards, neutral data exchange formats, and communication protocols for access/delivery of CALS data. This top

level specification, or "umbrella" standard, should include performance requirements addressing the issues of reliability, availability, maintainability, security, integrity, transaction response times, arrival performance and disaster recovery. It should also reference/invoke subsidiary standards such as MIL-STD-1388-1A/2A, through which CALS data requirements are identified and defined.

- Undertake a complete review of Military Standards and Data Item Descriptions to provide for acquisition of logistics and technical information in digital rather than hard-copy format. This review should first address the areas of highest potential payoffs, such as engineering drawings, technical manuals, and logistic support analysis documentation. Defense contractors who are not yet in a position to deliver digital data should not be forced to do so, but digital delivery should be clearly defined as the preferred, cost effective mode for satisfying government data acquisition requirements.

The following actions are proposed (concurrent with the actions for developing interfacing standards):

Actions/Standards	Dates/Time Period
• Announce a DoD Schedule for coordination and publication of new/revised DoD Standards and DIDs	IMMEDIATELY
• Publication of Information Management and Access Architecture Standard	DECEMBER 1985
• Publication of Initial CALS Data Element Dictionary expanding the MIL-STD-1388-2A base line to incorporate requirements from Supply Support, Support Equipment, Technical Data (Process Automation), Transportability, Packaging; revision of all associated DIDs	JAN 1986
• Implementation of multi-source, multi-user standard data elements, including Service demonstrations of on-line digital delivery	JAN 1986-JAN 1987

- Publication of expanded CALS Data Element Dictionary incorporating Reliability, Technical Data (Product Automation), Maintainability, and Manpower and Training Data Elements. — JAN 1987

c. <u>Data Communication</u>

The problems of networking protocols, distributed data base management, access and security, etc. in communicating between data systems are not unique to CALS. However, in addition to problems such as data element cross referencing, there are some significant CALS technology issues that need to be addressed. These include: increased traffic volume on military networks; alternate communication methods for delivery of data which are not needed in real-time; optimum partitioning of distributed and redundant data bases; data base update and control procedures; and communication protocol bridging, especially between military and industrial applications.

To address these problems, DoD should:

- Quantify projected logistics data transmission volumes, storage volumes, and traffic management requirements which the CALS architecture will impose on the Defense Data Network (DDN).
- Develop time-phased requirements for the expansion of DDN capacity and bandwidth to accommodate projected CALS traffic, and for extension of DDN geographically. (Under current DDN policy, such requirements and associated funding are provided by the Services according to need.)
- Develop, demonstrate, and implement a policy, plan, and standards for interconnection of DDN with commercial networks to further extend CALS communication to contractors and vendors having no DDN access.
- Sponsor demonstration programs to resolve technical issues and to select from competing approaches/concepts.

Technical issues should be resolved and implementing or corrective actions initiated through studies and demonstration projects conducted between July 1985 and July 1986. Based on the results of those studies and demonstrations, CALS electronic data transmission requirements should be incorporated into Service demonstrations of data transparency and on-line delivery conducted during Jan 1986 - Jan 1987, as described in the previous two sections.

D. PILOT AND DEMONSTRATION PROGRAMS

1. Findings

It is important to recognize that in implementing CALS there will be technical system integration problems, problems in demonstrating benefits of CALS initiatives in an operational environment, and problems related to retraining and reassignment of personnel. Defining and implementing a viable CALS system design architecture (see Section E of this chapter) requires the active involvement of functional users, exercising system alternatives in an operational mode. These design and implementation problems point up the need for pilot programs, operating in the user community, to surface and solve these problems as well as to demonstrate the benefits of these new techniques. Without such pilot programs, elements of the CALS system will be slow reaching general acceptance by users, and may provide inadequate or even counterproductive strategic solutions.

If a single new weapon system were used as the primary pilot program for sequential implementation of all CALS program elements, then it would be a decade or more before major elements of a CALS system would be demonstrated. What is needed to shorten this time-scale is a "building block" approach which will concurrently demonstrate the application and value of separate segments of a CALS system. With such an approach, it is realistic to expect that the major elements of a complete CALS system can be shaken down through pilot programs in the next five years. Concurrently, each Service should designate one or more specific new systems as "lead-the-force" demonstrations of a more complete CALS system.

Any recommendations for pilot programs must reocgnize that within the Army, Navy, Air Force, and Defense Logistics Agency there are numerous such programs already underway. (See Appendix B). Some of these are testbeds for CALS-related concepts or new technologies. Others represent major Service-wide, or Agency-wide commitments to upgrade the existing DoD infrastructure for logistics and technical information processing. These programs are being managed by individual program offices, major commands, and various laboratories. Newly created offices in two the Military Departments to manage and coordinate Automated Technical Information programs still lack the resources and the scope to integrate these programs fully. Exchange of information concerning progress (failures and/or successes) is primarily taking place through an informal network of telephone calls between program offices or at trade shows and symposia. As the various offices work towards the implementation of their programs, there is no consistency in their approach which would permit later integration of the demonstrated capabilities into an operating CALS system. There is a fundamental need to co-ordinate these activities. A fully integrated system to receive, store, process, and distribute logistics and technical information should build upon successful Service/Agency programs as primary nodes in overall CALS system architecture.

2. <u>Recommendations</u>

a. <u>Pilot Programs in Acquiring Digital Support Data</u>

There are three major types of support data that are provided to DoD by industry.

- Engineering and configuration data - in the form of engineering drawings and related documentation.
- Maintenance and operating data - in the form of technical manuals and training procedures.
- Logistic support data in the form of LSARs, provisioning data, etc.

It is recommended that concurrent pilot programs that provide active functional user support be established in each of these areas in order to:

(1) Obtain user input from an operational environment to define an effective CALS system architecture, building from existing Service/Agency program nodes toward the target system in Chapter Two.

(2) Address technical issues and demonstrate the value of the interfacing and neutral format data standards established for DoD (see Section B above).

(3) Co-ordinate and, as necessary, expand the scope of ongoing Service and Agency programs for utilizing digital support data.

(4) Establish contractual and legal interfaces with industry on the control and use of digital support data.

The uniform objectives of the three concurrent programs should be as follows:

> To develop and demonstrate on a variety of weapon systems and with a variety of contractor data bases, the ability of government agencies to contract for, accept, validate, and store digital weapon support data, and to deliver it to government users on demand in any required media.

The Service co-ordination offices should develop pilot programs with this objective for each of the three types of support data described above. These programs may be extensions of ongoing programs such as DSREDS, EDCARS, ATOS, NTIPS, etc. Whether established as extensions of, or separate from such programs, these existing Service initiatives should be recognized as major nodes (building blocks) of an evolutionary CALS system structure. A co-ordinated plan should be produced by each Service office and inter-service co-ordination should be effected during CY 1985. The programs should be planned for completion by the end of 1988 at the latest.

b. <u>Pilot Programs in Operations Logistics</u>

Parallel pilot programs should be initiated within the operational logistics community to utilize the digital support data prescribed above. These can run concurrently with the data acquisition programs by judicious selection of programs where digital support data are already available, or even by creating digitized data from current hard copy.

Plans for such programs should be prepared by the Service co-ordinating office on the same schedule as for the data acquisition programs, and the latest completion date should also be the end of 1988.

c. Vertical Integration Programs

In addition to the above "horizontal" development of CALS program building blocks, each Service should designate a "lead the force" weapons program to accept and utilize all categories of digital data from contractors. the objective would be to demonstrate "vertical" integration of CALS elements by the complete support of a major system using digital data from the acquisition cycle through to field operations.

The CALS co-ordination offices in each Service should scope such a program and co-ordinate its progress with the other "horizontal" pilot programs described above. Ongoing programs such as the B-1 program in the Air Force and the F-18 program in the Navy could be candidates for this vertical integration role, or new programs such as the Air Force Small ICBM or the Navy SSN-21 could be selected. Such vertical integration programs need not be as constrained by the evolution of comprehensive standards and the schedules of the horizontal programs. They must, however, not be developed in isolation. The completion dates of such programs will extend well beyond the five years allowed for the horizontal programs. This is not significant, however, since they are pilot programs for the integrated use of digital support data. They must be carefully phased however so that they can be updated to accommodate changing standards and new technology.

These "lead the force" programs should be viewed as the models for development of a comprehensive CALS system architecture that spans all weapons programs. However, planning to apply the concepts and objectives of CALS should not be delayed until all the Lessons Learned are in from either the horizontal or the vertical integration pilot programs. Within the next five years, basic CALS policies should be in place and effectively institutionalized, horizontal pilot programs in both acquisition and operational logistics should be completed, and the "lead the force" programs recommended above should be well underway. Thus, it is both feasible and realistic to target 1990 as a "CALS implementation" date. But getting there demands that action begin immediately to do more than just demonstrate CALS concepts. All new weapon systems and equipment that will enter production beginning in 1990 should start now to plan for creation, access/delivery, and use of logistics and technical information in digital form. Concurrently planning to apply CAD/CAE-integrated supportability design analysis to new weapons programs from the outset of the development process can make all the objectives of a complete CALS program successful within a five year time span.

E. DOD-WIDE COORDINATION TOWARD A PLANNED CALS ARCHITECTURE

1. Findings

The DoD logistics management process is among the most data-intensive enterprises in existence, and only significant investment in the application of information processing technology has allowed operational logistics to succeed as a management process. The CALS Group has focused on the emergence of information processing technology as a meaningful tool in acquisition logistics, without forgetting functional users in the operational logistics community are the ultimate beneficiaries of that technology.

Specifically, improvements are needed in the structured process through which information processing technology is applied to both acquisition and operational logistics management. Improvements are particularly needed in areas that are of major concern to CALS. Most system design and architectural planning for the use of computer technology within DoD has focused on the use of quantitative data within the DoD infrastructure. Relatively less attention has been given either to computer interfaces with industry, or to automation of traditionally paper-based information such as drawings and manuals (whose source also lies in industry). A top-level coordinating function must operate more effectively within OSD, each Service, and the other DoD components to implement and proliferate the recommendations offered elsewhere in this chapter. (The management structure through which such a coordinating function would operate is addressed in Section F of this chapter.) This coordinating function must be supported with both the resources and the tools to focus on efficient digital information exchange among the creators and the users of logistics and technical information.

Current individual and collective Service efforts to develop roadmaps for the evolution of Automated Technical Information, a CALS architecture, and logistic information models are necessary and imperative, but not sufficient. DoD-wide architectural guidelines do not exist, but are critically required for the objectives of the CALS program to be achieved. While recognizing that the Military Departments and Agencies must tailor a generic CALS program to meet individual operational requirements, it is imperative that a single, DoD-wide face be presented to a defense industry that must deal simultaneously with all Services and Agencies. What is ultimately needed is a detailed examination of the complete flow of logistic information as a guide for the CALS coordinating function. This information flow model, updated as both technology and user demands change, can provide both a target structure for the application of information processing technology by industry and DoD, and an analytical tool for most efficiently implementing the digital data exchange capabilities which the CALS study recommends. In developing this model, its proponents must co-ordinate the separate (and equally legitimate) interests of: industry and government; research and development originators of CALS data, and operational logistics users of the data; information resource management (IRM) and functional communities; OSD and the DoD components.

2. Recommendations

To develop the CALS architecture and information flow model, DoD-wide architectural guidelines must first be established. Then, a program plan must be published identifying and prioritizing the functional areas to be addressed, and the milestones to met. The work of the Architecture Subgroup, through its IDEF process models, (described in Volume III) is recommended as a starting point.

The resulting architectural model should be used to support the research needs identified in other CALS recommendations, such as data traffic and storage volumes, tradeoffs between data access and delivery, efficient networking and data base structures, peacetime and wartime flows, and security restrictions. This requires an accelerated development process for the model in order to meet the established targets for those research activities. The CALS architecture must be translated into new or revised Military Standards, such as those recommended in Section B of this chapter addressing

CALS Standards and Neutral Formats. Existing Service logistic data automation enhancement plans should be reviewed to ensure that operational logistic data systems within each DoD component are evolving in a manner consistent with the intent and objectives of the CALS architecture. A program of incentives and increased funding should be established to complement policy initiatives which expedite the application of standard neutral formats and common data element definitions for digital data exchange throughout the acquisition and operational logistics community.

Milestones	Target Date
• DoD publish Architecture Guidelines	IMMEDIATELY
• Services and DLA publish CALS Architecture Development Plan and Initiate Development	DECEMBER 1985
• Services and DLA publish initial CALS architecture and recommend changes to policy, Military Standards, and data automation enhancement plans; identify necessary incentives and priorities	MARCH 1986
• DoD-wide co-ordination and update and review with industry	JUNE 1986
• All agencies refine initial CALS architecture through research, demonstration programs, etc; expand CALS architecture.	JAN 1986-JAN 1989

F. MANAGEMENT ACTIONS

1. Findings

In each of the categories of recommendations presented above there is an expressed need for co-ordination among government agencies, and between industry and government. In some areas, e.g., standards and neutral formats, and design influencing for RM&S, the group has recommended that a lead Service be designated and given the responsibility of co-ordinating actions with other Services. In other areas, e.g., pilot programs, and developing a CALS system architecture, it appeared that a top level co-ordinating function was needed together with focal points for co-ordination within each of the

Services. As computer-aided technologies are applied to individual elements of the logistic system, "islands of automation" are created. If the substantial benefits to be gained from an integrated CALS system are to be realized, then it is essential that means be found to plan the interfaces between these islands.

There are a number of options as to how co-ordination can be effected. These range from designating specific organizations with the resources and authority to get the job done, to establishing information exchange groups which rely on interactive discussions and pursuasion for action. Which option is most appropriate for the particular situation may depend on factors outside the scope of this study. The CALS group therefore decided to present options for implementing the recommended management actions.

2. <u>Recommendation</u>

a. <u>Policy</u>

It is recommended that OSD issue an immediate policy statement adopting a strategy to accelerate development of a CALS system. The elements of the strategy are:

- To develop means and incentives for industry to integrate automated weapon support ability analysis into the CAD/CAE process, as recommended in Section B above.
- To adopt interim interfacing and neutral format standards at once, followed by the development of more complete standards, as recommended in Section C above.
- To institute pilot programs in the user community with the objective of integrating "islands of technology" into segments of a CALS system, as recommended in Section D above.
- To establish DoD-wide coordination toward a planned CALS architecture, based on DoD architecture guidelines and Service architectural plans. as recommended in Section E above.

b. <u>Options for Implementation</u>

Each of the following paragraphs outlines one approach to managing the implementation of a comprehensive CALS program. All participants in the study agreed that, even with the strong DoD policy commitment described above, "business as usual" would not be adequate for this purpose. The implementation alternatives each provide a different degree of centralized control, but they also each offer other advantages and disadvantages which made them attractive to different segments of the diverse group who participated in the CALS study.

1. Lead Service

One option for implementing the CALS strategy is to have each Service designate a central point for each of the four basic thrusts of the strategy. Thus each Service could have as many as four separate offices, each responsible for one element of the strategy. OSD would then designate a lead Service for each element to effect inter-service co-ordination. OSD oversight would be by the customary budget review process.

2. Service Co-ordination Offices

Another option is to have each Service designate a CALS co-ordination office responsible for all elements of the strategy within its own Service. Overall co-ordination would be effected by a joint OSD - Service - Industry technical advisory group which would meet two or three times a year with the Service co-ordination offices to exchange information and provide guidance. There are two variations of this option:

- Each Service office would function in a coordinating role only, with responsibility for integration and Service-centralized planning, but with limited resources and execution authority.
- Each Service office would provide a true management function, vice more restrictive program coordination. The CALS program management office would be given the authority, the responsibility, and the resources necessary to ensure program success.

3. DoD Steering Group

A third option is to establish Service program management offices as recommended in option 2, but provide stronger DoD-wide co-ordination by appointing a DoD Steering Group at the Senior Service level with members from OSD, from each Service, and from other appropriate DoD agencies. This group would meet regularly and have planning and program approval authority over the actions taken to implement the CALS strategy. In addition to co-ordinating the Service programs, this group would be charged with maintaining regular contact with industry and with other government agencies.

4. <u>DoD Joint Program Office</u>

Another option is to establish a Joint Program Office with full time staff and funding authority to implement the strategy. This would integrate the Service co-ordination offices on a day-to-day basis; with all the responsibilities cited in options 2 and 3 above, and also provide a continuous vehicle for interaction with industry.

5. <u>CALS Implementation Office</u>

Still another option is to assign authority and resources for implementing the strategy to a separate CALS office at OSD level. This would place the whole co-ordinatin function for DoD in one office.

c. <u>Co-ordination of Service CALS Programs</u>

Early realization of the tremendous potential payoff to DoD of a complete CALS program is directly related to the extent to which the development of individual elements of CALS can be co-ordinated and integrated. The options presented above are in order of increasingly effective integration and centralized control. The group feels that any co-ordination effort less than the third option presented above (i.e., establishing CALS management offices in each Service and appointing a DoD Steering Group with planning and program approval authority) would be inadequate.

DoD should direct each Service to create a permanent CALS Management Office as its official focal point for co-ordination of all programs establilshed to implement the CALS Study recommendations. This office will also serve as the interface with other government offices. In addition, the Services should meet at a minimum of four times per year to exchange information on progress and program activities.

Specific objectives of this CALS Management office are to:

(a) Manage the definition, development, and implementation of Service/Agency programs to achieve the objectives of all four thrusts of the CALS strategy.

(b) Install a discipline in digital logistics support techniques developed by program offices.

(c) Provide continuous coordination with other Srvices.

(d) Provide a central point for coordination and interface with industry.

DoD should direct the establishment of these offices at the conclusion of the present CALS effort, and should schedule the first inter-service meeting in the summer of 1985. These meetings should include representatives from industry, the National Bureau of Standards and other government agencies.

It is also recommended that a permanent DoD/Industry CALS executive coordination committee be established. This organization would meet as frequently as needed to provide overall direction for the activities of the Services' coordination offices. Industry representatives should actively participate with DoD in defining a CALS program structure that best satisfies their common objectives. Industry representatives should also be involved in an ongoing dialogue with Service CALS management offices about current and future activities. The CALS steering committee should be established at the conclusion of the present CALS effort and the first meeting scheduled for mid summer 1985.

APPENDIX A

PARTICIPANTS IN THE COMPUTER-AIDED LOGISTIC SUPPORT STUDY

APPENDIX A
PARTICIPANTS IN THE COMPUTER-AIDED LOGISTIC SUPPORT STUDY

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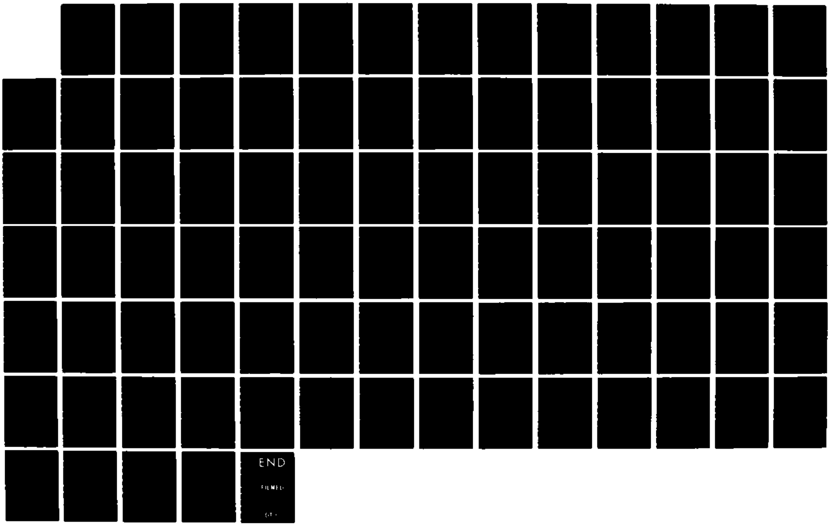

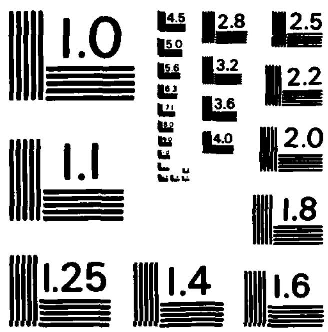

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APPENDIX B

OVERVIEW OF ONGOING SERVICE PROGRAMS IN AUTOMATED TECHNICAL INFORMATION SYSTEMS (ATIS)

Appendix B

OVERVIEW OF ONGOING SERVICE PROGRAMS IN AUTOMATED TECHNICAL INFORMATION SYSTEMS (ATIS)

1. **Summary of ATIS Programs/Projects**

a. **Status of Army ATI Programs**

The Technical Information Management System (TIMS) program by AMC is a major Army ATI integration effort. It is a proposal to automate and store (in a readily retrievable form) technical information relating to training, maintenance, operations and configuration management for Army weapon systems by using the latest proven commercial technology. The TIMS effort will be supported by a number of independent ATI projects that will focus on the CAD/CAM interface with engineering drawings, digital storage and retrieval of engineering data, a technical data/configuration management system, redesign of both the provisioning master record (PMR) and internal processing of the logistics support analysis record (LSAR), publication automation, and electronic information delivery.

The following are brief summaries of some of the above Army initiatives in the ATI area:

Digital Storage and Retrieval of Engineering Data (DSREDS) is an ongoing joint Army/Air Force effort, the Air Force counterpart being designated the Engineering Data Computer Assisted Retrieval System (EDCARS). Another similar project, the Data Requirements Management Information System (DARMIS) is designed to automate the retrieval of technical data requirements tailored to specific contractual needs.

Since TIMS must provide an interface with the supply, logistics, maintenance and procurement functional processes, a redesign of both the PMR and LSAR processing is underway to provide required ATI support to the Direct Support Unit Standard Supply System (DS4), the Standard Army

Maintenance System (SAMS) and the Commodity Command Standard System (CCSS).

Integration/management of all ATI within the TIMS program context will be accomplished by a Technical Data/Configuration Management System (TD/CMS), which will directly interface with automatic publication systems such as the Automated Printing and Publication System (APPS), the Automated Technical Manual System (ATMS), and UPDATE which is a new publishing process that can produce high-speed revisions in a throw-away format. It is anticipated that the inputs of the tri-Service effort on Technical Manuals Specifications and Standards (TMSS) can be incorporated into these automated publication projects.

The ability to deliver electronic information will proceed from the basic Electronic Information Display System (EIDS) that will provide a self-paced, total job training package, refresher training, individualized or on-the-job training to all soliders to the Militarized Electronic Information Delivery System (MEIDS), and to the Logistics Electronic Information Delivery System (LEIDS). MEIDS, being developed for the maintenance community, will deliver technical documentation to combat, combat support and combat service support units; while LEIDS, in parallel development for the remainder of the logistics community, is being configured to accomplish logistic type functions such as requisition and inventory in both tactical and non-tactical locations. MEIDS and LEIDS will be mutually compatible with EIDS and their development will parallel EIDS in order to minimize development and engineering lists.

The last area of the Army's ATI effort directs new technology and strategies to the problem of delivering technical information to the maintainer, whether in the field or in garrison, in ways that will facilitate its usage. The Personal Electronic Aid for Maintenance (PEAM) is a joint Army/Navy project for the development of a "job aid" which would improve the productivity of the organizational level maintenance technician by enhancing the quality management and delivery of required technical information. The Navy's designation for PEAM is the Automatic Maintenance Information System (AMIS). Another developmental effort in this same area is the Artificial Intelligence-Based Maintenance Trainer (AIMT).

b. <u>Status of Navy ATI Programs</u>

The Navy is proceeding with programs that will provide for definition, acquisition and generation, and distribution of automated technical information (ATI).

Under the ATI System Architecture project, a baseline study of the Navy technical information environment is planned to identify and analyze problem areas and deficiencies, and to determine ATI requirements. Current and emerging ATI technologies are to be assessed to develop concepts and technical approaches to resolve the identified problem areas and correct deficiencies. A top down architectural design will then be developed for a Navy-wide ATI system which is capable of supporting a wide variety of ashore and afloat units.

The impact on the defined ATIS architecture of on-going Naval programs in configuration control, such as the Ships Technical Publications System (STEPS) and the Naval Engineering Drawings Digital Automated Repository System (NEDDARS), which provide the references and/or technical publications pertaining to ships, systems or equipment and their related engineering drawings to the active fleet, shore support activities and shipyards, will be investigated and integrated within the ATIS design architecture.

A demand printing system, designated the Navy Automated Publishing System (NAPS), is to be established at the Naval Publications and Forms Center for test and evaluation. In conjunction with the NAPS program, a prototype operation for an automated electronic composition system, the Navy Technical Information Presentation System (NTIPS), will be established. Similarly, a management information system (MIS) will be developed by the Navy Publications & Printing Division Office that will be integrated with the printing resources of NAPS.

Some of the networking problems of ATIS are being addressed by the Navy in its Configuration Status Accounting System (CSAS), which supports maintenance planning by utilizing the more accurate configuration accounting system contained in the weapon system file (WSF) of the Shipboard Nontactical Automated Processing System (SNAPS). Another Navy thrust in this area is the Repairable Assets Management System (RAMS). This is an implementation of LOGMARS to upgrade the repairable assets process through increased electronic interfaces, with feedback to the Navy's Maintenance and Material Management System (3M) for automation of repairables transaction and status accounting. In order to alleviate the shortage of telecommunication facilities available at stock point locations within the network area, the Stock Point/Local Area Network (SP/LAN) program will develop the local area networking architectual plan and install a prototype state of the art system at the Naval Supply Center, Oakland, California for test and evaluation.

The broad networking aspects of ATIS are being examined through the Logistics System Information Network (LOGNET) program. This effort will procure and install test bed equipment in specific Naval organizational activities for selected applications, to develop, test, and evaluate a Navy-wide information network concept for on-line access to the broad range of logistic data bases required to support fleet and shore supply and maintenance operations.

To date, a network integration program needed for the development of the large distributed data base management system envisioned by the ATIS architecture has not been defined.

The Navy has designated a Program Manager for the automation of technical information. PML-550 is the Program Manager designation assigned to the Naval Supply Systems Command. A full system test of the automation of TI to replace paper technical manuals is scheduled for FY-85. Specifically, side-by-side paper vs. automated system tests are planned for the F-14A at NAS Miramar and the AN/SPA-25D Radar repeater at San Diego. Program plans for the automation of drawing repositories and a print-on demand system also will be developed in 1985.

c. <u>Status of Air Force ATI Programs</u>

The Air Force goal in programs/projects for the automation of technical information is to move the Air Force to a point where it has the capability to accept, store, and retrieve technical information (TI) and graphics in digital form. TI is defined as CAD, CAM, CAE data, engineering drawings and specifications, and technical orders.

Following are the Air Force programs/projects related to the indicated areas of effort:

1. Automated Technical Order/Technical Data
2. Technical Information Display Devices
3. Tailored Technical Order
4. Coded Maintenance Data
5. Integrated Technical Order/Technical Data/Diagnostics
5. Architecture Strategy.

Area One effort is being accomplished by two key programs. The first, the Automated Technical Order System (ATOS), is an AFLC program that is designed to automate the production of technical orders from information in a digital format. The second, the Engineering Drawing Computer-Aided Retrieval System (EDCARS), is also an AFLC program being developed jointly with the Army's Digital Storage and Retrieval Engineering Data System (DSREDS) program to store and provide engineering drawings in a digital form. With the successful completion of the ATOS and EDCARS programs, the Air Force will have attained the capability to handle and store technical information in digital form. Parallel efforts have been undertaken by AFFDL to utilize ATOS/EDCARS capability for acquisition and storage of three dimensional CAD/CAM product definition data for eventual incorporation in the Integrated Design Support System (IDSS) being developed for the B1 program. The AFML will also benefit from the ATOS/EDCARS program through the integrated computer aided manufacturing (ICAM) program.

In Area Two, Technical Information Display Devices, efforts are focused on the transfer of data from paper to the electronic display medium for flightline use. AFHRL is developing the equipment that will permit the technician to interface with equipment on board the aircraft, and/or at the maintenance workstation, and provide for more efficient performance of maintenance tasks. As part of the Integrated Maintenance Information System (IMIS), AFHRL is developing technical data storage/displays/computers that will provide the technician with an interface to technical orders, integrated diagnostics maintenance management data and his own progressive training program.

While Area Two looks at how to display technical information, the programs in Area Three look at how the displayed information can best be provided to allow the maintainer to perform his task. The projected use of less specialized technicians with varying skill levels performing an increasing range of maintenance tasks requires variation in the technical content of the maintenance data. The Tailored Technical Order program, also being pursued by the AFHRL, will develop a interactive set of instructions which will allow a senior technician to proceed rapidly, while a less experienced technician could request basic steps or more detail when necessary. Inputs into this program will be from the ATOS and the Generic Integrated Maintenance Diagnostics (GIMADS) program.

Less specialized technicians using a wider range of technical orders impose a requirement that the coding, numbering, and structuring of technical data be consistent. Area Four programs, using the Maintenance Integrated Data Access System (MIDAS), will provide for digital cross referencing of work unit codes, technical orders, and engineering drawings across the functional areas of aircraft, missile, space and support systems. This will allow technicians to readily transition from one weapon system to another or between functional areas.

Area Five will consolidate the efforts of Areas One, Three and Four under AFLC's Equipment Maintenance Information System (AFEMMIS) project. AFEMMIS architecture will combine the Core Automated Maintenance System (CAMS) and the Equipment Maintenance Data Base at the unit level with the diagnostic information gathered by the Generic Integrated Maintenance Diagnostics (GIMADS) program. GIMADS integrates the built-in test/fault isolation test systems data, automatic test equipment data, technical order data, and on-board weapon system maintenance data for higher utilization of weapon system assets. Successful accomplishment of this area will improve the Air Forces' ability to help weapon systems be combat ready in peace, and to sustain them in war.

The architectual strategy for implementing the Air Force ATI program efforts will be provided for in Area Six. A layered architecture will be developed that will include the Air Force Information Management System (AFIMS) architecture developed by AF/SI and the Logistics Information Management System (LIMSS) architecture developed by AF/LEY. The AFMIS architecture will provide the logical framework for defining information system policies, standards, and guidelines for development of integrated information processing and transfer technologies. The LIMSS program will define logistic system architecture standards and a C^3 infrastructure that will allow logistic applications to multiple users which are network compatible.

d. <u>Status of DLA ATI Programs</u>

Acquisition is underway for interim automated storage and retrieval equipment to fully automate technical data drawing repositories for Aperture Cards at four centers. This program includes follow-up planning for the capability to accept and distribute digital drawing data.

A study is planned to assess the need for enhanced item intelligence of data contained in the Defense Logistics Services Center (DLSC) Defense Integrated Data System (DIDS) Inventory for preliminary design support. There is also a planned modernization of the existing Parts Control Automated Support System (PCASS) supporting the DoD Spare Parts Program (DoDI 4120.19).

2. <u>Tabulation of ATI Programs/Projects</u>

Service and DLA ATI efforts have been summarized in Figure B-1 as a number of selected common ATI "user" activities viz. parts manufacture, maintenance systems, automated technical information systems and other functional users. All of these "user" activities are present to some degree in the ATI programs/projects in being within all three Services. The degree/specific areas in which this is being accomplished across the Services can be seen in Table B-1 through B-5 which catalogues the programs/projects that relate ATI "user" activities to common generic elements within a "user" activity. Table B-6 presents the ATI activity within DLA.

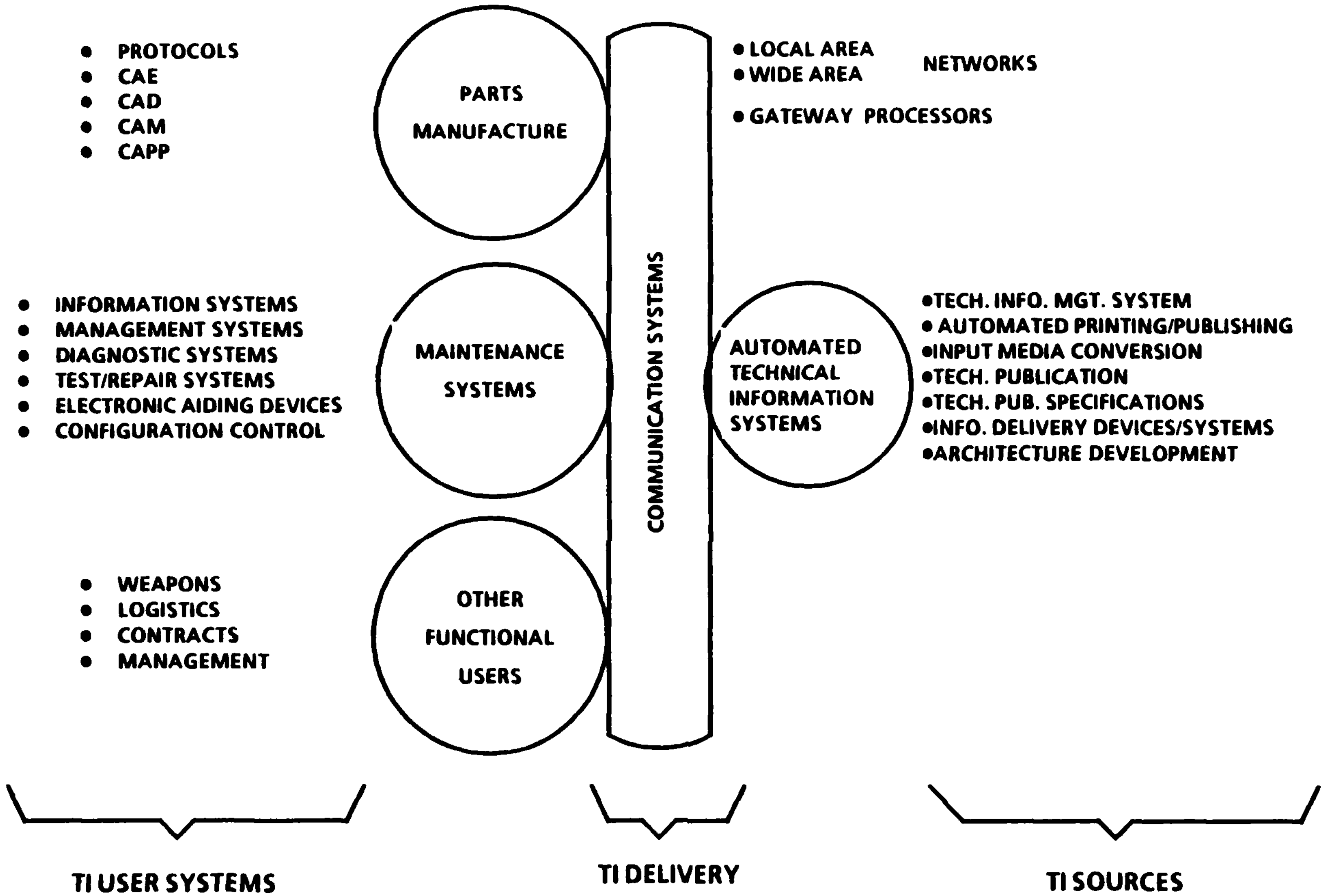


Figure B-1. (U) CURRENT SERVICE ATIS ACTIVITIES

Table B-1. AUTOMATED TECHNICAL INFORMATION (ATI) SYSTEM ACTIVITIES

ELEMENTS	ARMY	NAVY	AIR FORCE
Guidance Program	TIMS[1]	NTIPP[1] TMMP[1]	
Tech. Info. System	TIMS[3] MARDIS[1]	NTIPS[2] TIDS[1]	ATOS[2]
Automated Printing/Publishing System	APPS[3]	NAPS[2]	PIPPS[3] TIPPS[1] TPAS[1]
Technical Manual Publishing System	UPDATE[1] ATMS[3]	STEPS[1]	
Engineering Drawings on Aperture Cards	DSREDS[3]	NEDDSARS[3]	(?)[1]
Digitized Aperture Cards	DSREDS[3]	EDMICS[1]	
Digitized Engineering Drawings	DSREDS[3]	EDMICS[1]	EDCARS[2]
Technical Manual Specifications	TMSS[1]	TMSS[1] M-SPECS[1]	TMSS[1] TTO/ITO[2]
Information Delivery Systems	EIDS[2] MEIDS[2] LEIDS[2]	NAVIS[1]	
Information Management (i.e., TI) Systems	TIMS[3] TIAC[1] GIDEP/AGED[1] CCSS[1]	ZOG/VINSON[1] SNAPS[1]	AFIMS[3] ASIMS[1]
Architecture	Logistics[2]	ATI[2]	AFIMS[1] LIMSS[2] ATI Integration[2]

Note: (?) In existence or planned but project/program acronym unknown.

[1]On-going Project/Program.

[2]Project/Program in Log R&D Program Plan.

[3]Anticipated Project/Program.

TABLE B-2. MAINTENANCE SYSTEM ACTIVITIES

ELEMENTS	ARMY	NAVY	AIR FORCE
Maintenance Information Management Systems		RAMS[2] 3M[1]	MMICS[1] AFEMMIS[3]
Coded Marking for Maintenance		LOGMARS[1]	MIDAS[2] (FEEDER[3])
Automated Maintenance Systems			AMS (C-5)[1] CDS (F-16)[1] CMS[3] CAMS[3] EMDB[2] GPAMS[3]
Configurational Status	CCSS[1]	TD/CMS[1] CSAS[2] SNAPS[1]	
Maintenance Aiding Devices	PEAM[2] PIXIE[1]	AMIS[2] PIXIE[1] NOMAD[1] VIMAD[1]	(?)[2] PIXIE[1] (F/L Device)[2] (A/C Device)[2] (Shop Device)[2]
Maintenance Training Devices	AIMT[2]	NOMAD(TICCIT)[1]	
Diagnostic Systems		ROLAIDS[3] LOGMOD/FIND[1]	EDS[1] GIMADS/CITS[1]
Test and/or Repair Systems/Equipment	ISITE[1]	ISITE[1] ROLAIDS[3] STARS[1] SEASTARS[1]	ISITE[1] CAT[1]
Maintenance Information System	CCSS[1]		IMIS[3] AFIMMSS[3] MODAS[1]

Note: (?) In existence or planned but project/program acronym unknown.

[1]On-going Project/Program.

[2]Project/Program in Log R&D Program Plan.

[3]Anticipated Project/Program.

Table B-3. PARTS MMANUFACTURE ACTIVITIES

ELEMENTS	ARMY	NAVY	AIR FORCE
Digitizing Protocol		IGES[1]	APT[1] IDEF[1]
CAE		CAEDOS[3]	ICASE[3]
CAD			MANTEC[1] IDAS[1] IDSS[2] ICAD[1] MLCAD[3]
CAM			ICAM[1] NBS-AMRF[1] AFIMMSS[3]
CAPP			ICAM[1]

[1]On-going Project/Program.

[2]Project/Program in Log R&D Program Plan.

[3]Anticipated Project/Program.

Table B-4. COMMUNICATION ACTIVITIES

ELEMENTS	ARMY	NAVY	AIR FORCE
WAN		AUTODIN II[1]	AUTODIN/DDN[1] (DDNII)[3] ASIMS/OPNET[3] ALADIN[3]
LAN (Logistics)		SPLICE[1] LDC[1] LOGNET[2] SP/LAN[2]	DDN/LOGNET[2]
LAN (Test and Repair)		SEASTARS[1]	
LAN/WAN/(Test and Repair)		SEASTARS[1]	
Gateway Processing			1 GPS[3]

[1]On-going Project/Program.
[2]Project/Program in Log R&D Program Plan.
[3]Anticipated Project/Program.

Table B-5. OTHER FUNCTIONAL USER ACTIVITIES

ELEMENTS	ARMY	NAVY	AIR FORCE
Management Systems	DARMIS[3]	ZOG/VINSON[1] CCSS[1]	AFLC/LFSMS[3]* LIMSS[2] (LOG C3I)[3]

*Includes: SCDS, RDB, WSMIS, ETADS, PMIS, CDMS.

[1]On-going Project/Program.
[2]Project/Program in Log R&D Program Plan.
[3]Anticipated Project/Program.

Table B-6. DEFENSE LOGISTICS AGENCY ATI ACTIVITIES

ELEMENTS	DLA	SIMILAR SERVICE EFFORTS		
		ARMY	NAVY	AIR FORCE
Engineering Drawings on Apperature Cards	EDASRES[1]	DSREDS[3]	NEDDSARS[3]	(?)
Digitized Aperture Cards	EDASRES[3]	DSREDS[3]	EDMICS[1]	
Digitized Engineering Drawings	EDASRES[3]	DSREDS[3]	DSREDS[3]	EDCARS[2]
Parts Control	PCASS[1]	CCSS[1]	SPCC[1] ICP/OAS[1]	
Design Support/Parts ID/Logistics	DIDS[1]	LEIDS[2] MEIDS[2] CCSS[1]	LOGMARS[1]	IDSS[1] MIDAS[2]

Note: (?) In existence or planned but project/program acronym unknown.

[1]On-going Project/Program.

[2]Project/Program in Log R&D Program Plan.

[3]Anticipated Project/Program.

The Service and DLA programs/projects reported in the above tables for the "user" activities are reported as acronyms (defined in the Glossary) and have been annotated by a superscript as an ongoing project, a Log R&D program, or as an anticipated ATI effort.

3. Service and DLA Roadmaps and Schedules

Service efforts to accelerate the transition from paper to electronic systems through their Log R&D programs are presented (where available) as a program scenario, a roadmap, an implementation schedule and a program element identification.

a. Army ATI Scenario

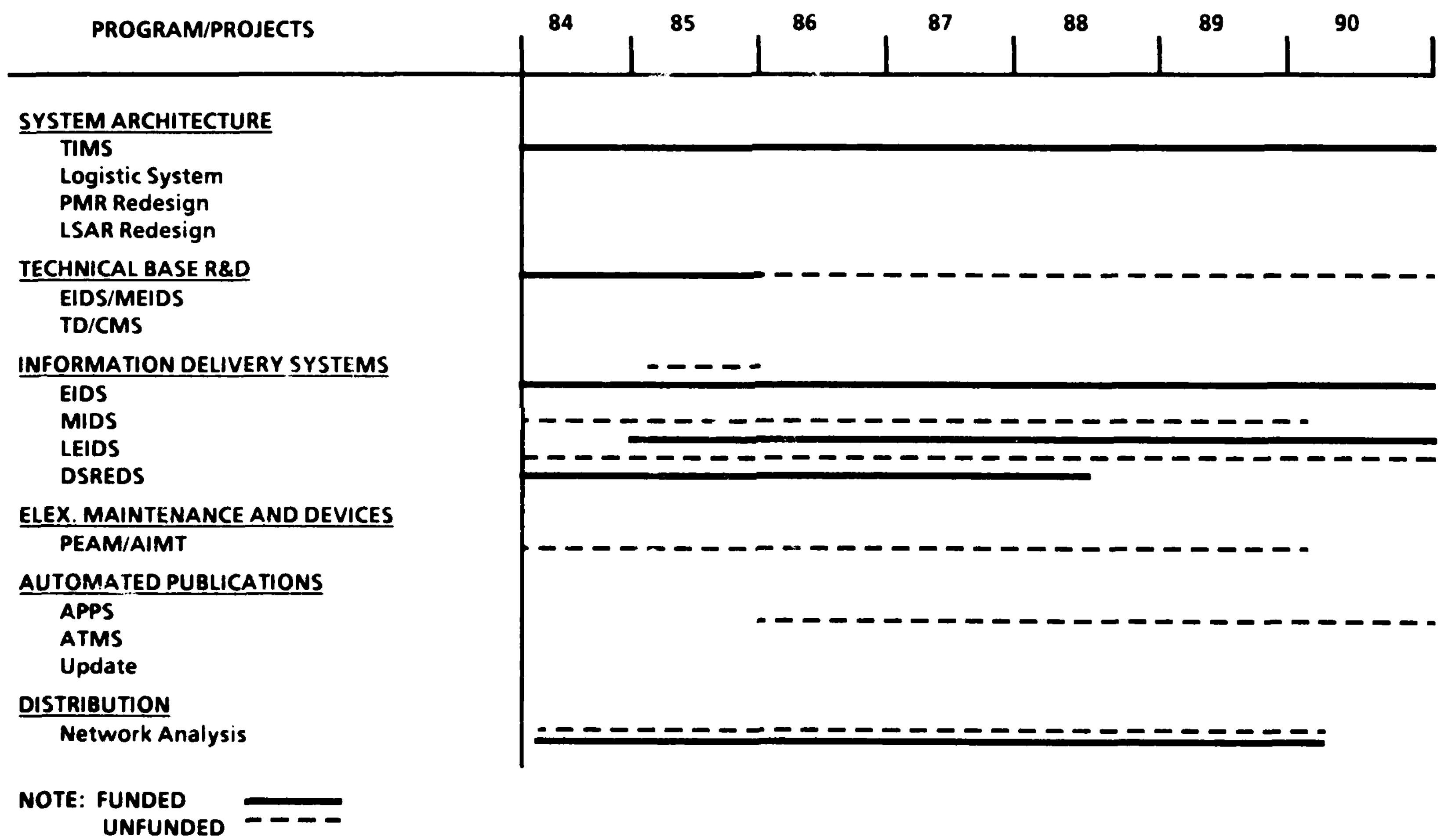
The Army's goal is to establish an interconnected automated system to manage technical information from source to user. It is an attempt to automate and store in a form readily retrievable (and yet to be determined) all technical information relating to training, maintenance, operations, and configuration management for Army weapons systems by using the latest proven commercial technology.

A review of Mission Area Analyses (MAA) has revealed the existence of technical information management deficiencies in the combat service support (CSS), communications, command and control (C^2), and special operations areas.

Current Army maintenance organizations must repair a bewildering variety of equipment. As more complex systems are fielded, the problem becomes increasingly more difficult. A typical weapon system in the 1980s has a documentation burden of at least four times that of a system fielded in the 1940s (~9K vs. 36K of documentation). Clearly, the present system of using hard copy technical manuals is unsatisfactory due to the number of changes, the difficulty of updating them, and the overriding fact that most soldiers lack the reading level skill to utilize the manuals; average reading grade levels are at about 8th grade, whereas the average manual's reading grade level spans an interval from 10th to 12th grade.

Over the past 7 years the Army has made a deliberate attempt to bring together technical manual (TM) development and training. The goal was to

ASSUMED ARMY SEVEN YEAR SCHEDULE FOR ATI



provide a cost effective program for maintenance and operation of new systems by providing a TM that would support training as well as performance. Data indicate that while this approach supports training, the large volume of pages it generates, along with the preparation time required, is not cost-effective. Some reduction in volume is possible through early involvement by trainers in adjusting the level of detail actually required and the proper formats for TM data presentation. Cost and time improvements can be made by improvements in the Integrated Logistic Support (ILS) process. In the long run it would appear that information technology which uses the media transfer appeal of TV and video gaming would be a promising avenue of approach; this is one approach being investigated in PEAM.

ASSUMED* ARMY ATI PROGRAM ELEMENT IDENTIFICATION

PROGRAM	PE NO.	PROJECT NO.	TASK NO.
System Architecture:			
Logistic System	62719	AT40	CO
	62746	A094	QO & YO
	63313	D087	03
Technical Base R&D:			
EIDS/MEIDS	62746	A094	
Information Delivery Systems:			
EIDS	63723	D335	1
MEIDS	63723	D335	2
LEIDS	63723	D335	3
DSREDS			
Electronic Maintenance Aid Devices:			
PEAM/AIMT	63744		
Automated Publications:			
APPS	65803	731	
	65803	761	
Distribution:			
Network Analysis	65803	720	
	65803	728	

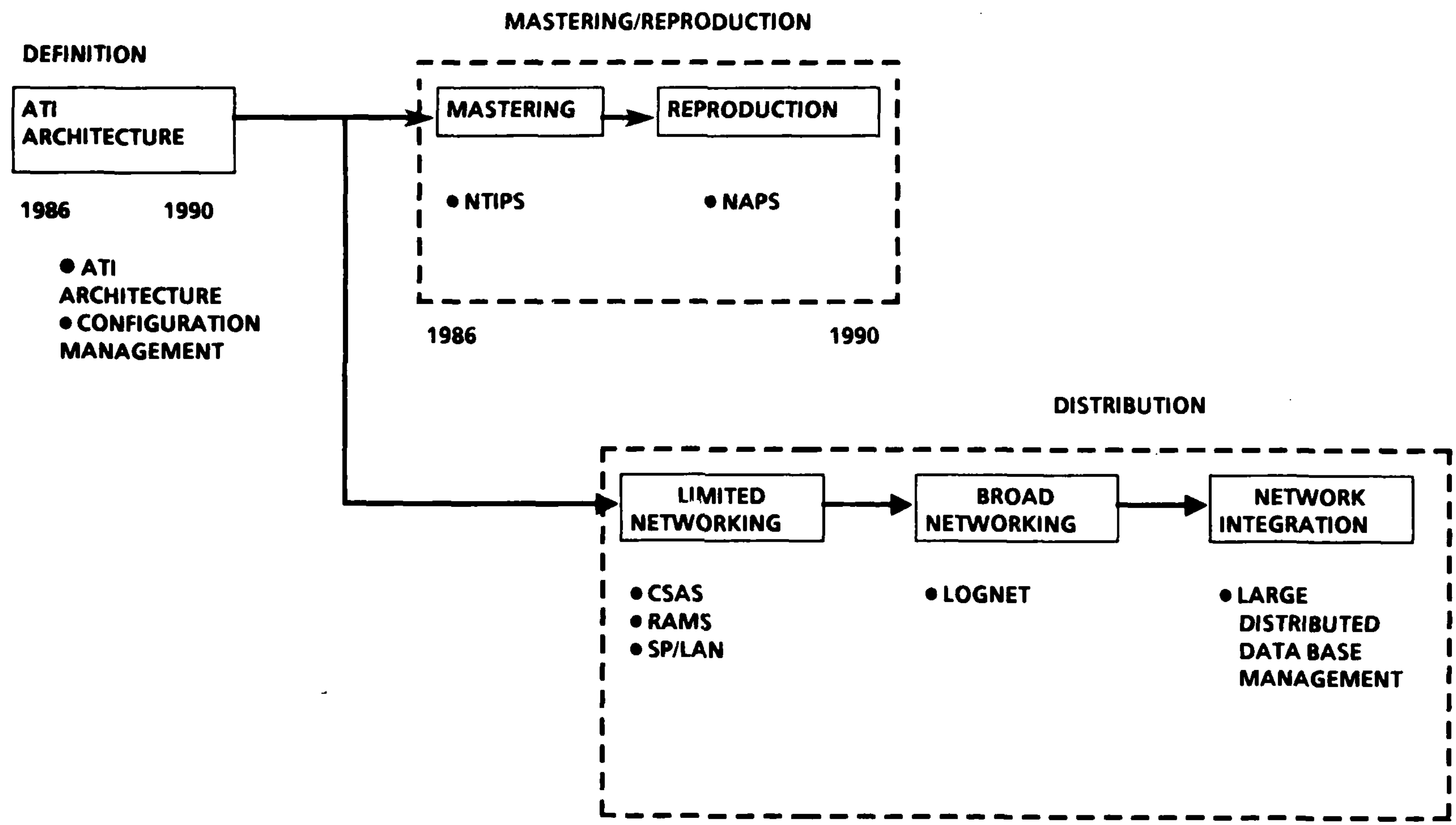
*From Log R&D Program Plan, 1983 RD-5 Exhibit.

b. <u>Navy ATI Scenario</u>

The Navy's objective is to accelerate the transition to electronic TI systems, reducing the cost of TI generation, data entry, reproduction and distribution while controlling ATI system proliferation. This approach should enhance the Navy's readiness through increased availability of current and accurate TI. The Navy feels that this can be accomplished by implementing ATI systems that provide for every aspect of the Naval weapons systems acquisition cycle (i.e., requirements definition, system design, manufacture deployment, operational support and configuration management). In addition, an integrated logistic TI system must provide support to the design and manufacturing phases of the acquisition cycle.

Functional subsystems already exist within the Navy that cover each phase of the acquistion cycle. These need to be integrated by consolidating their current or developing electronic data bases into a large distributed data base via dedicated network communication/distribution facilities, so that needed data can be accessed at the level of need by authorized control.

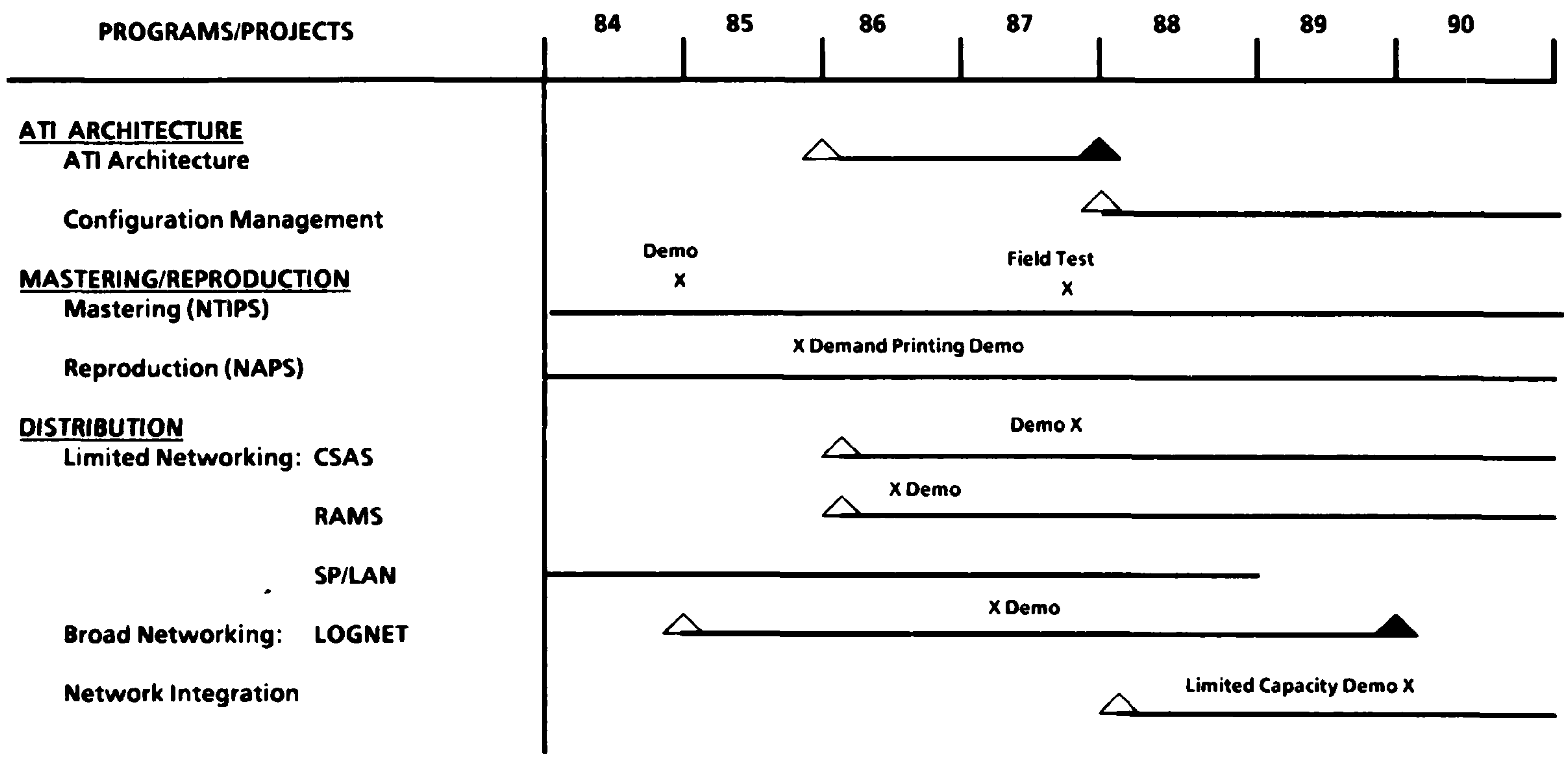
NAVY AUTOMATION OF TECHNICAL INFORMATION ROADMAP



NAVY ATI ROADMAP DETAILS

	ARCHITECTURE	MASTERING	REPRODUCTION	LIMITED NETWORKING	BROAD NETWORKING	NETWORK INTEGRATION
TECHNICAL OBJECTIVE	• Create structure for "Paperless" TI environment	• Reduce technical information to digital format for storage on magnetic/optical media	• Develop multi-media TI delivery capabilities	• Develop networks for distribution of TI in specific functional areas	• Develop multi-functional global network capability	• Develop data base management techniques for very large distributed data bases
PRESENT METHOD	• Hard copy masters of TI text & graphics • Central stock points for publications	• Hard copy source documents	• Hard copy printed material	• Hard copy printed materials and reports	• Hard copy reports and documents	• Separate data base systems with manual/semi-automatic interfaces
TECHNICAL APPROACH	• Develop top-down architecture for storing/handling technical information in digital form	• Develop methods for transcribing existing documents to digital format • Create authoring systems for generating new technical information	• Determine user needs • Establish hardware/software requirements • Demonstrate prototype reproduction on demand system	• Design/adapt data bases • Develop communication software • Define terminal requirements • Implement demonstration project	• Extend limited network capability	• Define data base hierarchy • Establish processing and communications protocols • Demonstrate restricted capacity system
BENEFITS	• Coherent structure for technical information with ability to transfer information by electrical/electronic means	• Reduced storage requirements • Greater responsiveness • More current documentation	• Simplified update capability • Reduced printing/publication costs	• More efficient transfer of TI • Reduced delays • Reduced shipping/handling costs	• Timeliness of logistic information • Improved support	• Com· lete integration of TI data base • Elimination of manual transfer of data between networks

NAVY SEVEN YEAR SCHEDULE FOR ATI



NAVY ATI PROGRAM ELEMENT IDENTIFICATION*

PROGRAM	PE NO.	PROJECT NO.	TASK NO.
<u>ATI Architecture</u>:			
ATI Architecture			
Configuration Management			
<u>Mastering/Reproduction</u>:			
(NTIPS)	63727	W 1032-PN	
NAPS	63727	T-1805	
	62760		
<u>Distribution</u>:			
CSAS			
RAMS			
SP/LAN	62760		
LOGNET	63727	T-1806	
Network Integration			

*From Log R&D Program Plan, Navy, and NSIA Presentations.

c. <u>Air Force ATI Scenario</u>

The end goal/objective of Air Force programs and projects for automation of technical information is to move the Air Force to the point where it has the capability to accept, store, and retrieve technical information (TI) and graphics in digital form. Technical information is defined as CAD, CAM, CAE data, technical drawings and specifications, and technical orders.

The following are current programs/projects related to the areas of automation of technical information by the Air Force:

(1) The Automated Technical Order System (ATOS) is designed to accept and store the technical order (TO) information from the contractor in a digital form on nine track magnetic tape. This is then used to print the technical orders on paper. A prototype digital TO installation has been tested at Ogden ALC for F-16 technical orders. Having proven successful, the system will be expanded to include the remaining Air Logistic Centers (ALCs). The system of distributing the TO to users in digital format is being planned by the Technical Repair Center/Technical Order Distribution (TRC/TOD) Group.

The Engineering Drawing Computer Aided Retrieval System (EDCARS) is designed to accept and store engineering drawings in digital form. It is being developed jointly with the Army's Digital Storage and Retrieval Engineering Data System (DSREDS) program. This will eventually be integrated with the ATOS system into a 3-D CAD/CAM capability for digital data management in the Integrated Design Support System (IDSS).

With the successful completion of the ATOS and EDCARS programs, the Air Force will have obtained the capability to accept and store technical information in digital form.

(2) Equipment will be developed for use by the technician on the flight line which interfaces with on-board aircraft equipment to allow the technician to do maintenance tasks more efficiently. An interface between these display devices and a mass storage unit will integrate ATOS into the maintenance process.

(3) A Tailored Technical Order (TTO) is an interactive set of instructions, which will allow for variation of the technical content of

maintenance data from individual to individual. This is necessary because the Air Force is moving toward an era of less specialized technicians with varying skill levels. The TTO will allow a senior technician to proceed with maintenance tasks with only basic data, while a less experienced technician could request additional details as necessary. The main source of information is ATOS, which will be integrated with diagnostic capabilities and presented by technical information display devices.

(4) The Maintenance Information Data Access System (MIDAS) is a structured reference system based on Air Transport Association Standard 100, which provides a functional correlation between work unit codes, technical orders, and engineering drawings. This is necessary to minimize confusion when less specialized technicians are being required to use a wider range of technical orders in performance of maintenance tasks. Cross referencing of the work unit codes, technical orders, and drawings will correlate the information by functional areas, and assist personnel to transition across weapon systems.

(5) The Generic Integrated Maintenance Diagnostics System (GIMADS) is a program to integrate diagnostics, built-in-test (BIT) functions, and technical orders so that the Air Force can improve fault isolation on equipment during maintenance. GIMADS interfaces with ATOS, TTO, EDCARS, and MIDAS to allow for higher utilization of weapon system assets.

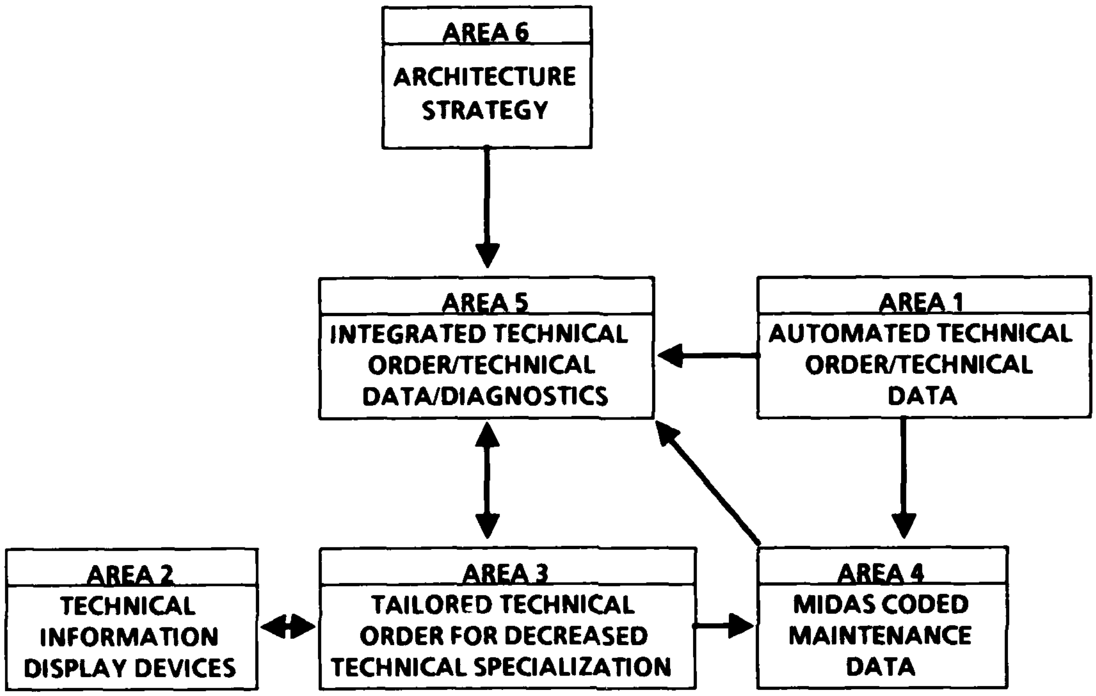
(6) The architectural strategy for implementing ATI will provide a structured approach to ensure that the ATI system evolves in a coherent and cohesive manner. A layered architecture is being pursued that includes the Air Force Information Management System (AFIMS) and the Logistics Information Management Support System (LIMSS) architecture.

AFIMS will provide a logical framework for defining information system policies, standards, and guidelines for development of integrated information processing and transfer technologies. AFIMS architecture is based on the open system interconnection reference model which provides increased vendor independence, interoperability and user access to a wider range of authorized resources. Internetworking of information systems will be supported by DDN and Air Force LANs.

The LIMSS program will define logistic systems architecture standards and a logistics C^3 infrastructure that will be fully compatible with multiple user networks. Once the architecture has been articulated, the ATI system design will be integrated to achieve the desired state of information flow.

Other system efforts include: The Integrated Computer Aided Manufacturing (ICAM) program, which will focus on sheet metal manufacturing work for aircraft, and the Integrated Maintenance Information System (IMIS) which will develop the capability of a maintenance technician to interface with a weapon system at the job site.

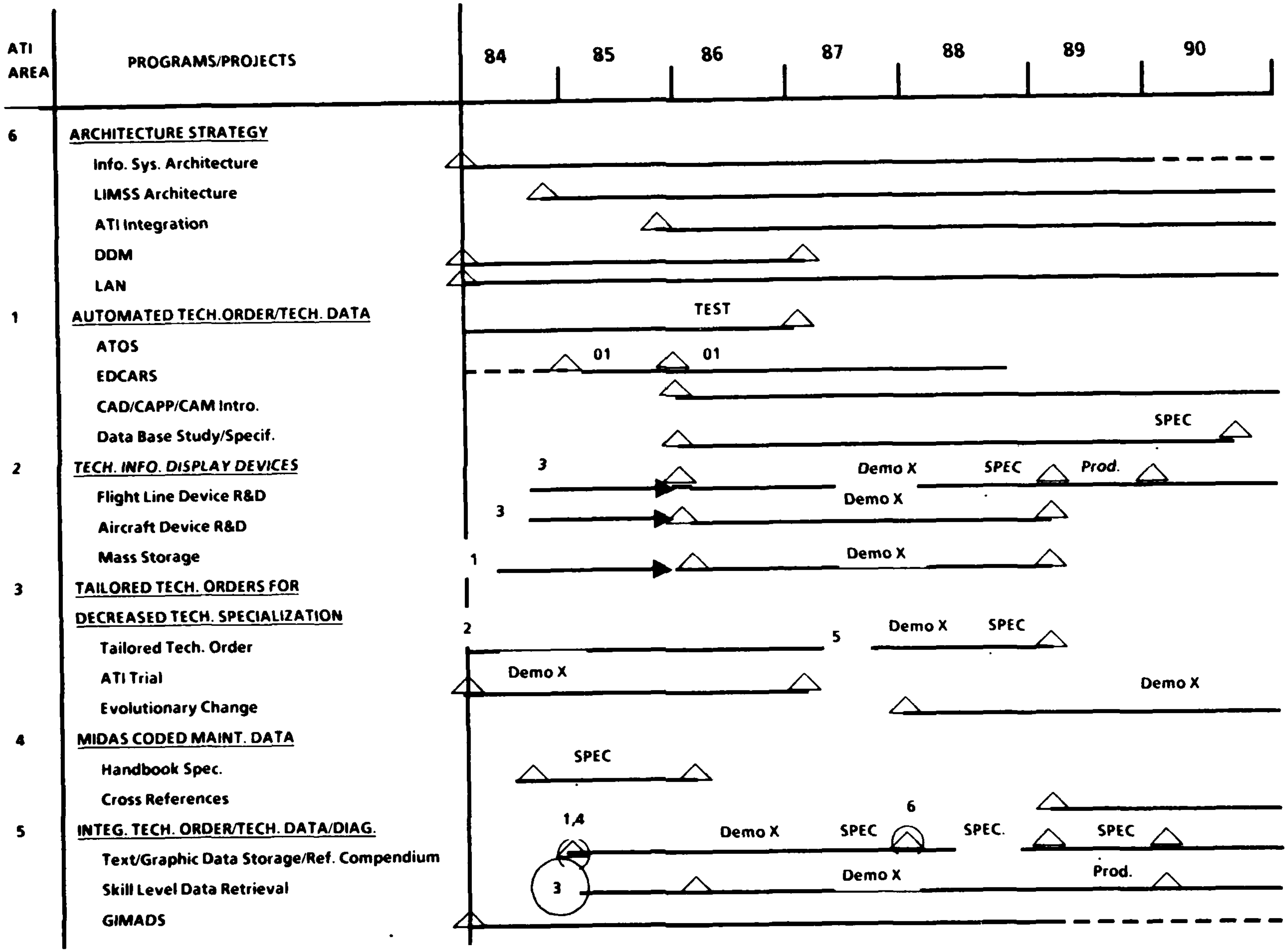
AIR FORCE ATI AREAS--ROADMAP FLOW/DEPENDENCY



AIR FORCE ATIS ROADMAP AREAS:

(1) Automated Technical Order/Technical Data
(2) Technical Information Display Devices
(3) Tailored Technical Order for Decreased Technical Specialization
(4) MIDAS Coded Maintenance Data
(5) Integrated Technical Order/Technical Data/Diagnostics
(6) Architecture Strategy

AIR FORCE SEVEN YEAR SCHEDULE FOR ATI



AIR FORCE ATI PROGRAM ELEMENT IDENTIFICATION*

PROGRAM	PE NO.	PROJECT NO.	TASK NO.
Architecture Strategy:			
Info. System Architecture			
LIMSS Architecture	64740	2983	
ATI Integration			
DDN	DoD Funds		
LAN	DoD Funds		
Automated Tech. Order/Tech. Data:			
ATOS	ALC Funds		
EDCARS	ALC Funds		
CAD/CAPP/CAM Intro.	62205		
	63106	2940	
Data Base Study/Specif.			
Tech. Info. Display Devices:			
Flight Line Device R&D	62205	1710	
	63751	2362	
Aircraft Device R&D	62205	1710	
	63751	2362	
Mass Storage			
Tailored Tech. Orders for Decreased Technical Specialization:			
TTO	63751	2362	
ATI Trial			
Evolutionary Changes			
MIDAS Coded Maintenance Data:			
Handbook Specifications	O&MN Funds		
Cross References	O&MN Funds		
Integrated Tech. Orders/Tech. Data/Diagnostics:			
Text/Graphics Data Storage			
Cross Reference Compendium			
Skill Level Data Retrieval	62205	1710	
GIMADS	64708		
"Other" Identified Elements:			
IDSS	63106	2940	
MLCAD	62205		
	63106	2940	
IMIS	63106	2950	
UDBAL	63106	2744	
PIPPS	65872	3008	

*From Log R&D Program Plan, AF Presentations 1983 RD-5 Exhibit.

d. <u>DLA ATI Scenario</u>

The goal of DLA programs for automation of technical information is to acquire the capability to receive, store and distribute technical information and graphics in digital form. Such information is generated from CAD, CAM, and CAE technology, including technical drawings, standards and specifications.

The following existing programs are considered the most viable for enhancement in support of the ongoing Service/Agency and Industry ATI programs.

The Engineering Drawing Automated Storage and Retrieval Systems (EDASRES) will be implemented at four DLA technical data repositories to store engineering drawings received in aperture cards or paper from the Services/Agencies and Industry. Paper drawings are currently filmed and mounted on 35 mm aperture cards for storage. The evolution toward digitization using EDASRES will occur through a phased transition. The first phase will require DLA to fully automate retrieval and reproduction of existing aperture cards and paper drawings. The second phase will provide a capability for accepting digital drawings and data from the Services/Agencies. The existing stored aperture cards will only be scanned and digitized as needed.

The Defense Logistics Services Center (DLSC) Federal Catalog System provides a common language that allows the Military Services and Government Agencies and their respective contractors to search DLSC files by reference/part number for the current Stock Numbers or National Item Identification Number for the applicable referent/part numbers and related management data. Currently, a major portion of DLSC's resources are applied toward the operation of the Defense Integrated Data System (DIDS). DIDS represents the culmination of over twenty years of evolutionary growth of the Federal Catalog Program and its amalgamation with other programs of the Department of Defense. This data bank consolidates a major portion of the information common to logistics systems of the Military Services, civil agencies, and friendly governments in a single file. There are some 5 million items contained in the cataloging program with some 140 primary government logistics users of item intelligence and over 55,000 industry suppliers registered. Under the CALS umbrella it is envisioned that DLSC's logistics data contained in the Federal Catalog Program can be utilized and enhanced to improve characterization of existing product definition for preliminary design support.

The DOD Parts Control Program (PCP) is intended to conserve resources and to reduce life cycle costs through improved equipment reliability by: (a) reducing the variety of parts entering the supply system; (b) promoting the application of established or multi-use items of known performance; (c) applying techniques to assist in the identification and selection of parts that will enhance inter- and intradepartmental system commonality, interchangeability, reliability, maintainability, and standardization. The existing DLA Parts Control Automated Support System (PCASS) presently supports the PCP in preliminary design requirements.

3. Summary of Service ATI Demonstrations

Potential demonstrations of ATI elements as derived from program/project descriptions and/or presentations and funding documents are summarized for the Services.

POTENTIAL DEMONSTRATION* OF ATI ELEMENTS

REFERENCE SOURCE	ARMY	NAVY	AIR FORCE
Log R&D Program Plan	PEAM EIDS (4)	NIPS NAPS (4) SP/LAN LOGNET	MAINT. AIDS (3) DISTR. ARCH. UDBAL (3) IDSS MLCAD
Service Presentations, RD-5 Exhibits NSIA Info.	TIAC GIDEP/AGED APPS UPDATE	ATIS ARCH. ZOG/VINSON CSAS (3) RAMS (8) NEDDARS (3)	ATOS EDCARS IMIS (3) LIMSS PIPPS

Note: *Includes Pilots, Prototypes, Test Beds, Advance Develop. Items and Demonstrations. (N) indicates number of demonstrations possible if more than one.

Appendix C
SUBGROUP RECOMMENDATIONS

Appendix C

SUBGROUP RECOMMENDATIONS

This appendix presents the actions proposed by each subgroup as necessary to solve the issues and problems identified in Chapter III. Each subgroup was asked to consider three categories of recommended actions: (1) management actions regarding policy and organizational issues, (2) proposed pilot programs aimed at proving out elements of a CALS system in the user environment, and (3) proposed programs to demonstrate specific technology developments of interest to CALS.

The following summaries are presented by subgroup and are extracted from the individual subgroup reports presented in Volumes II, III, IV and V of this report.

A. POLICY AND LEGAL CONSTRAINTS SUBGROUP RECOMMENDATIONS

1. General Policy Recommendations

a. DoD policy should establish digital data transfer as the preferred method for acquiring engineering drawings, technical manuals, and other weapon system acquisition support data.

b. DoD should require the use of existing and emerging industry standards (such as IGES, SGML, GKS, VDI, VDM, PHIGS and NAPLPS) for accomplishing such digital data transfer wherever possible.

c. DoD policy to actively promote development of digital data systems should be strengthened through revision of DoD Instruction 5000.19 policy for management and control of information requirements.

d. A joint industry/government team should be tasked to prepare a CALS standard.

e. CALS policy should encourage pilot program demonstrations during IR&D/CR&D technology development.

f. CALS policy should recognize the acceptance of alternate delivery media.

2. <u>Standardization Strategy</u>

It is recommended that a Strategic Program Plan be prepared by the Defense Materiel Specifications and Standards Office (DMSSO) to identify standardization opportunities and provide a detailed roadmap to develop standards needed for long range support of CALS initiatives especially in the areas of data bases, data elements, communications, graphics and textual standards. The Program Plan for digitized information should identify ways and means to promote DoD's participation and support of efforts by voluntary standards organizations such as American National Standards Institute (ANSI) and International Standardization Organization (ISO).

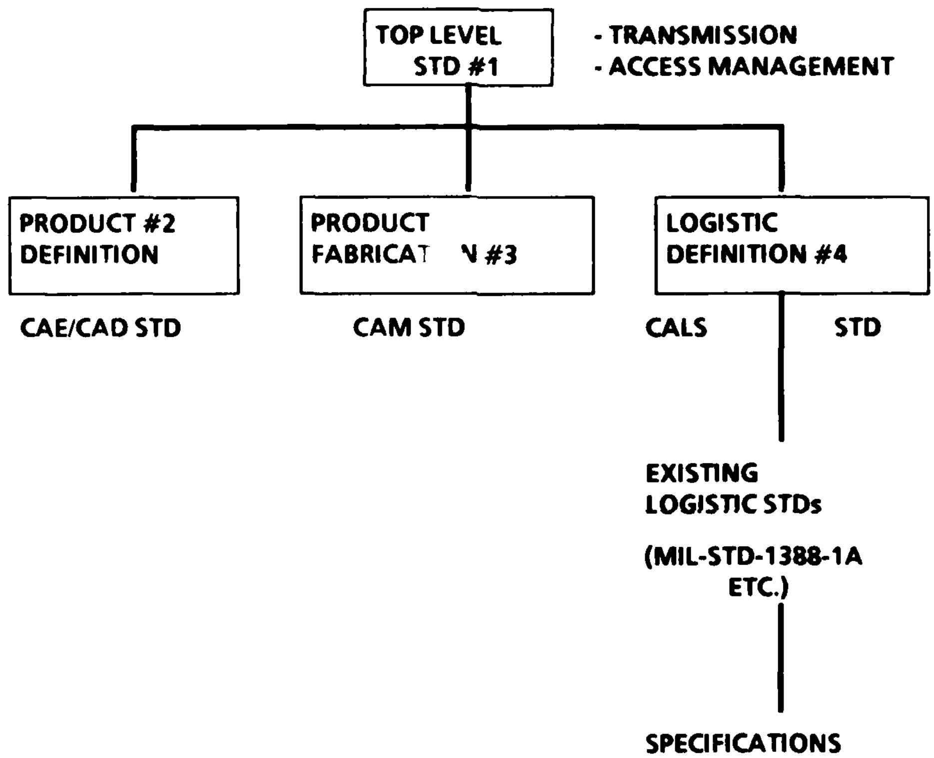
3. <u>Top Level Interface Standard</u>

A high level standard for handling the exchange of electronic information and data such as ANSI's IGES and ANSI's proposed SGML should be considered for adoption by DoD to enforce future interchangeability and transportability of digitized information between Services, agencies, and contractors. Issues to address are:

1. Integration of various information program requirements and identification of major data repositories that can manage and maintain digitized data for each of the Services. This should include digitized information for ILS support as well as digitized data for product definition data (CAE/CAD engineering data), manufacturing data (CAM) and procurement data.
2. Formal validation requirements and facilities for validating translators (compilers) need to be established to ensure transportability (interface) of the various data elements and permit communication between the participants (industry and government agencies as well as between CAE/CAD/CAM and CALS).
3. The CAD/CAM and CALS standards are subset standards which relate to top level interface standards for information transmission

and access management (graphics and text). The general relationship of data base standards to the top level standard is illustrated below.

CALS MIL-STD RELATIONSHIP



4. CALS DoD MIL-Standard

a. General Discussion

Developing a comprehensive set of standard data element definitions for commonly used logistics parameters is a major challenge. Many programs exist or are under development today for automating technical information. An output of CALS is the integration of these programs to enhance the computer-aided operations. In order to implement efficiently this multi-weapon system, multi-service concept, standards are needed to define common data elements and data requirements in each ILS element ares. Logistics support analysis (LSA) and the logistics support analysis record (LSAR) provide a model for the development of a CALS standard defining data elements and data requirements. MIL-STD-1388-1A identifies the LSA tasks to be accomplished during weapon system acquisition. LSA documentation records the results of performing those tasks. Data produced as a part of that LSA documentation are delivered by the performing activity in accordance with data element definitions, data item descriptions, and reports contained in MIL-STD-1388-2A which describes LSAR requirements. Neither standard specifies how the performing activity should accomplish the LSA tasks, or which LSAR data the requiring activity should specify to meet weapon support needs. MIL-STD-1388-2A has also taken the first (albeit incomplete) step in creating a central data element dictionary supporting the data requirement of the acquisition logistics and engineering (reliability and maintainability) communities. It not only supports logistics support analysis, but also the provisioning technical data requirements of the provisioning community. To achieve the objectives of a CALS standard applicable to all ILS disciplines, data elements for other logistic support activities must be added, i.e., training, technical publications, etc. In order to accomplish this task, functional specialty groups in the DoD acquisition arena must participate and cooperate in the development of a single CALS standard. Task and functional requirements of those individual specialty groups should continue to be identified by task-oriented standards such as MIL-STD-1388-1A. Data element definitions, data item descriptions, and report formats should be consolidated into a single source. A DoD directive (similar to DODD 5000.39, perhaps) or policy statement should require the establishment of a CALS standard that would act as an index and dictionary for the data required during logistic development and acquisition phases including post-production. An evolutionary approach to development of this CALS standard, beginning with the foundation laid by MIL-STD-1388-2A, will facilitate progressive application to ongoing (existing) programs, and permit early application to new weapon system acquisitions.

b. Approach to CALS Standard Development

The approach to the development of a CALS standard must recognize six basic criteria, that is:

(1) Existing logistic tasks identified in present logistic MIL-STDs (i.e., MIL-STD-1388-1A, etc.) and specifications are to be retained.

(2) Existing logistic data requirements and DIDs will be reviewed to eliminate present data element duplication and inconsistency.

(3) The CALS standard will reduce and consolidate the number of present logistic DIDs.

(4) The CALS standard will reference current logistic MIL-STDs which should be retained.

(5) The CALS standard would encourage tailoring for each program application.

(6) The CALS standard would be the primary contract instrument for identifying logistic information requirements.

5. Graphics Standard

DoD should consider specifying IGES as the standard for delivery of engineering drawings and product definition data.

The Naval Sea System Command has issued two policy instructions that require the use of the Initial Graphics Exchange Specification (IGES) for this purpose. These policy instructions could be tailored by DoD to provide graphics standards for all military Services.

(a) The first is NAVSEA Instruction 5230.8, "Transferring Technical Data Among Navy and Contractors' CAD/CAM Systems" dated 23 August 1984. This instruction requires that IGES Version 2.0 be used in exchanging product definition data among participating CAD/CAM systems except for work under the cognizance of the Deputy Commander for Nuclear Propulsion, NAVSEA 08. The instruction also requires that:

- IGES Version 2.0 will be invoked in all new contracts involving transfer of CAD/CAM technical data to and from NAVSEA.
- All offices, shore activities and detachments under the command of COMNAVSEA shall ensure that all solicitations, proposals and contracts for new construction, conversion modification,

modernization and overhaul of naval ships, weapons development and engineering, design services and other new NAVSEA acquisitions incorporate IGES format whenever technical data are to be transferred between CAD/CAM systems. (Backfit of existing acquisitions programs is encouraged where cost effective and feasible.)

(b) The second policy instruction is NAVSEA Instruction 9085.3, "Policy for Selected Record Drawings for Ship Acquisitions, " dated 18 September 1984. This instruction requires that the shipbuilder deliver, with each ship, a master for each drawing for each ship. The master drawing shall be in two formats:

- Photo - Lithographic plastic, and
- Digitized Initial Graphics Exchange Specification compatible format.

The Deputy Commander for Nuclear Propulsion (SEA 08) is also exempt from this requirement as long as the intent of the instruction is achieved.

6. Recommended Implementation Policy

a. Development Plan

To begin the implementation process, DoD should issue a policy for fostering CALS (NAVSEAINST 5230.8, for example). This policy must tie together on-going and planned DoD logistics support efforts and create an integrated roadmap for CALS development, demonstration and phased implementation. In general, what appears to be needed are means to attack the following problems:

(1) Lack of an agreed-upon conceptual architecture encompassing a DoD-wide system.

(2) Lack of interfacing rules and/or standards that would allow rapid intercommunication between diverse systems.

(3) Lack of priority and funding for pilot/demonstration programs which would advance the overall strategy most effectively.

b. <u>Recommended CALS Schedule</u> (Refer to Figure IV-1)

CALS implementation should be a progressive process beginning with specified pilot programs. Pilot programs would demonstrate conceptual feasibility and could be used to examine and adjust, when necessary, the overall implementation strategy. This building block approach would permit systematic progress reviews and serve to identify system changes needed to assure reasonable success in subsequent implementation phases. Evaluation of pilot programs would identify required policy refinements and lead to a final DoD guidance to all Services.

7. <u>Logistic Support Contract Analysis</u>

Logistic support contract requirements imposed on four typical aerospace programs were analyzed to determine if changes to current contracting procedures are required to implement a support program in a total electronic environment. The findings of the contract analysis are summarized as follows:

(a) The CDRL DD Form 1423 can be utilized to revise the delivery media from paper to electronic form.

(b) A technique must be established to define customer reviews, controllable audits, and acceptance for computerized data.

(c) Computer data control methods must be established to control working data, proposed data, approved data, and archival storage.

(d) No standard exists which defines electronic transmission media.

(e) The training/publications community must revise current methods to develop and conduct support service.

B. ARCHITECTURE SUBGROUP RECOMMENDATIONS

1. <u>Major Concerns</u>

The recommendations contained in this section represent the major concerns of the architecture subgroup in making CALS a reality.

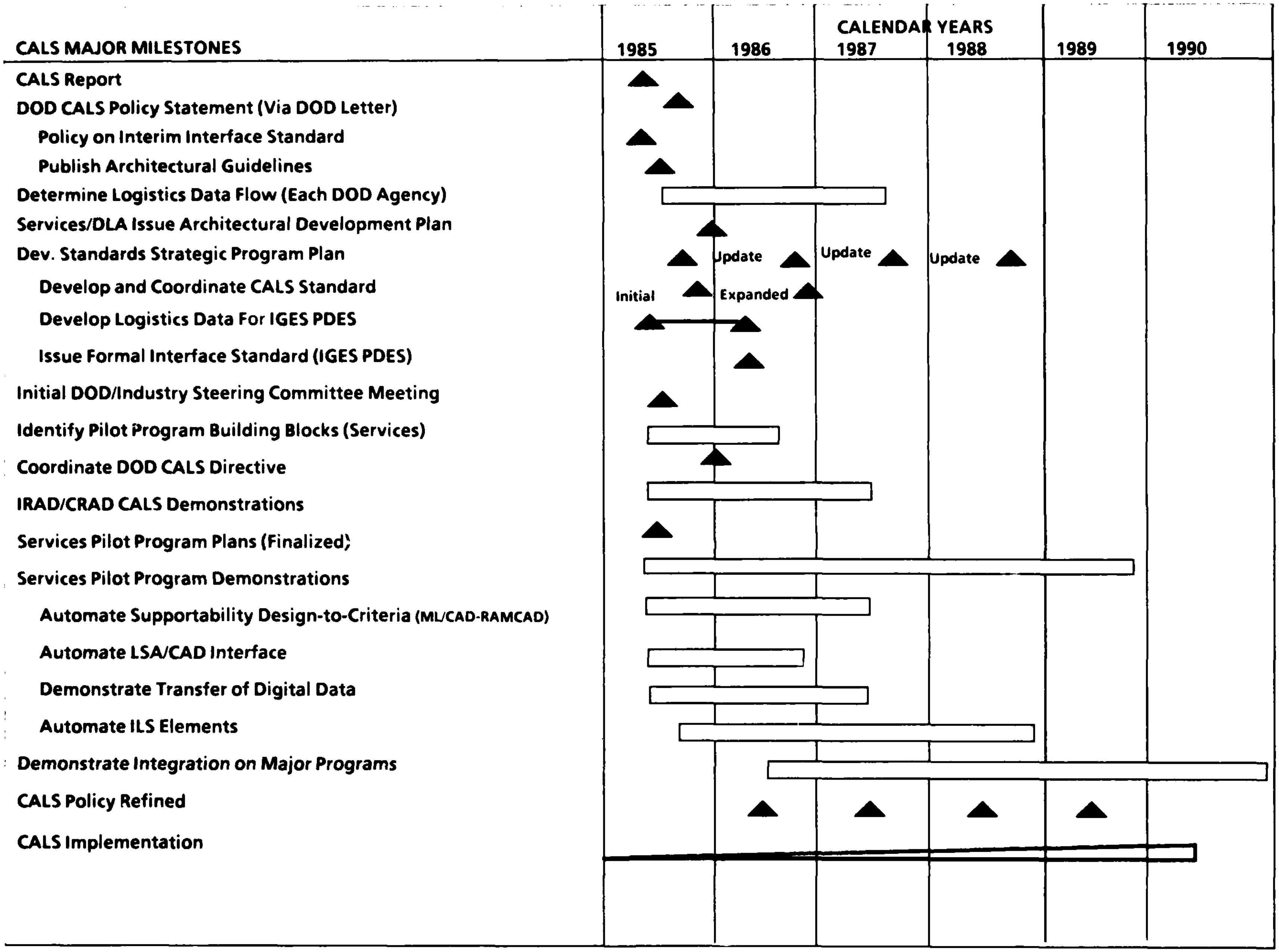


Figure IV-1. CONSOLIDATED SCHEDULE

a. <u>Logistics Data Item Consolidation Techniques</u>

A task should be initiated to develop the capability of producing the full range of logistics data items (DIDs) from the LSAR data base and to demonstrate the feasibility of data in digital formats normally delivered in hard-copy DID formats. Specific steps for this task are given in Volume III, Architectural Subgroup Report. This task should be started as soon as possible, preferably in 1985, and should be chartered at the DoD level.

b. <u>Outputs of CALS Demonstration Efforts</u>

All CALS demonstration efforts should result in capabilities that can be embodied in appropriate standards and data item descriptions for implementation throughout DoD. Each demonstration effort should result in drafts of the standards and DIDs that are appropriate to it's activities.

c. <u>Demonstrate the Digital Delivery of Technical Publications</u>

Technology is available to provide multi-service electronic delivery formats for technical publications. Integration of publications requirements with LSAR, provisioning technical documentation and integration of the data with CAE/CAD should be accomplished to minimize the number of interfaces and consequent translating techniques that industry and DoD must maintain for delivery of the data. Development of multi-service electronic delivery formats will reduce the number of translators and delivery formats required by both industry and the Service. This activity will also be a precurser for delivery of publications data via interactive maintenance aids.

d. <u>Development of Configuration Control Strategy for Electronic Data Systems</u>

CALS should be structured to allow simple tracking of logistic configuration management data by electronic systems. The development of engineering and CAD/CAM systems will include methods of controlling and documenting equipment configuration. CALS must be structured to utilize this configuration data and be expanded to track and control the configuration of logistics data and support resources to match these to the operational and maintenance hardware/software.

e. <u>Development of Incentives for Both Industry and DoD to Move Forward With CALS</u>

Both industry and DoD (government agencies) need solid reasons for adopting the changes that will be required to take full advantage of CALS. Its adoption, though doubtlessly very beneficial in the long-run, will be costly, inconvenient and resented by some whose way of doing business will be upset. Specific considerations and recommendations are given in Volume III, Architecture Subgroup Report.

f. <u>Charter a DoD/Services Group that will be Responsible to Develop and Implement Common Data Delivery Formats for all Services</u>

To reduce the number (type) of data delivery formats required by the Services, a DoD/Services Group should be chartered to review their demonstration projects and implement common data delivery formats for all Services wherever possible.

In addition, an intra-Service coordination committee should be established, and a chairman and key personnel appointed to perform the following tasks:

- Interact with the other Services, DLA and industry to form an oversight/coordinating committee, and appoint representatives to that committee.
- Define specific plans to implement the pilot demonstration programs as they relate to each Service.
- Prepare a CALS data/information flow chart tailored to each Service's needs.
- Take an inventory of the digital data transfer techniques already in place.
- Participate in DoD-wide establishment of interfacing standards and neutral formats to facilitate exchange of digital data.

g. <u>Development of an Education Program to Facilitate Implementation Plans</u>

The DoD/Services and DLA should implement an education program to provide people involved in CALS with knowledge of computer systems software and standards. Technology is progressing very rapidly in the computer sciences and must be understood by planners, managers, implementers and operators to build and keep CALS viable and current with technology.

h. **Assign Responsibility for Continuation of Architecture Development Begun by Architecture Subgroup Using IDEF Techniques**

The overall CALS architecture in the report has only been developed to the higher function levels. The architecture needs to be further defined to the levels of detail required by developers and users. The assignment of responsibility to expand the detail of IDEF diagrams for this purpose is recommended.

2. **Recommended Pilot/Demonstration Programs**

a. Digital Delivery of Technical Publications

Objective: Develop and demonstrate a tri-Service capability to contractually specify and accept delivery of contractor developed technical publications in a digital format.

b. Interactive Diagnostic and Maintenance Aids

Objective: Demonstrate a capability to design the prime hardware and maintenance aiding diagnostics as an integrated, interactive system. Present digital maintenance instructions/diagnostics to the technician utilizing a user-friendly, portable display. Show the resulting improvement in maintenance of complex electronic equipment in the field.

c. Reliability and Maintainability in Computer Aided Design (RAMCAD) Demonstration

Objective: Demonstrate and document the benefits of integrating R&M analysis into Computer Aided Engineering and Design Systems.

d. Interactive LSAR Input

Objective: Develop and demonstrate a capability to input data automatically to the LSAR. This demonstration will extract data from the CAD engineering data base and other automated systems and load it directly into the LSAR.

e. Automation of Classic Logistic Data Item

Objective: The demonstration will employ computerized techniques to prepare a classic logistic data item (i.e. Support Equipment Recommendation Summary) directly from an LSAR data base in its presently specified format. This will bridge the gap between near term and future data acceptance, while at the same time demonstrate that all duplication of effort between LSAR and the additional data items that are duplicative, but yet are still required by data users, can be eliminated.

f. Computer Aided Specification/RFP Preparation

Objective: Demonstrate that reliability, maintainability and supportability equipment design attributes can be developed as part of a specification's performance requirements by computer interaction with, and prompting of, the authors. The specification would, as part of an RFP, be sufficiently specific that the appropriate design features would be provided by the designer, taking advantage of the competitive leverage during the proposal phase.

g. Integration of Demonstration Projects

Objective: Demonstrate the ability of the above pilot or prototype systems to interact and communicate so that all logistic functions can be accomplished with standard operating protocols and procedures.

C. INFORMATION REQUIREMENTS SUBGROUP RECOMMENDATIONS

1. Findings/Conclusions

a. Contractor's Perspectives

(1) Although there are differences in the degree of automation currently achieved within industry, most Primes are moving rapidly toward automating processes to deliver data to the government.

(2) Industry assessments claim a current capability to deliver digital data that the Military Services are not prepared to accept.

(3) Automation of information handling will provide for across-the-board productivity and quality improvements.

(4) Legal and policy issues are minimal and are not considered an impediment.

b. **Data Structure**

(1) Even though transition to digitized data bases is occuring, the prevailing mentality of information management remains in the paper medium.

(2) Information systems need to be data driven rather than organization or application driven.

(3) Logistics data can be expected to transition from information-oriented (the "what") to knowledge-oriented (the "how") as the capability of capturing knowledge in the design and manufacturing data base of a weapons system increases.

c. **Universal Numbering System**

(1) Recent efforts in information automation have been driven by functional demands that have evolved into a series of "functional foxholes" with little cross-feed capability.

(2) User needs at all levels require rapid and effective routes into and out of data stored in the various data bases.

(3) Because of the investment, existing functional systems will not be scrapped; hence there is a need for a universal numbering system or data dictionary to bridge the "foxholes".

(4) Any universal system developed must preserve the integrity of existing data and must be user friendly as defined by the functional user.

d. **LSAR Data Interface**

(1) While duplication/redundancy exists in all functional areas, the most significant areas of duplication occur among areas of reliability (MIL-STD-1529A) maintainability (MIL-STD-470) and support equipment (MIL-STD-2097) with respect to LSAR data requirements (MIL-STD-1388-2A).

(2) Automation opportunities center around functionally oriented data bases that would contain weapon system data and serve as baseline data.

e. Military Standards Relationships

Analysis of data relationships between the 76 MIL-STDs which generate significant data reporting requirements is an area that needs to be addressed. Such a study is beyond the scope of the current effort.

2. Recommendations

The recommendations of the Information Requirements Subgroup are focused in two areas: the elimination of duplicate data requirements and their attendant military specifications; and the establishment of standardized informational needs by the Department of Defense. To accomplish these end results, both short and long term actions are required. It must be stressed that these actions are not sequential actions, but parallel actions which require coordination to assure a viable product.

a. Short Term Actions:

(1) Identify the interface between the LSAR and potential standard neutral formats (e.g., IGES, GKS, and GENCODE). The action should be based upon IGES 2.1 to be released in December 85. Initial evaluation should be completed by July 1985 (Army lead).

(2) Representatives of the logistic community should participate in the design/evolution of the neutral formats to assure that logistic informational needs are satisfied. This will be an ongoing task that should be initiated immediately (OSD lead).

(3) Eliminate current data duplication between the LSAR and these MIL-STDs currently referenced by MIL-STD-1388-2A (e.g., MIL-STD-1629 (FMECA) and MIL-STD-2073 [preservation and packaging]). This includes the exploitation of automation opportunities to streamline the data delivery process. In addition this action will require the elimination and consolidation of current military standards. This should not be construed as a thrust to reorganize functions within the DoD, but to provide a single recognized vehicle by which to present needed information. This overall effort will require up to four years to complete. Volume IV, Report of the Information Requirements Subgroup, contains the actual actions required, their priority, and proposed completion times (OSD lead).

b. Long Term Actions:

(1) Expand the short term action of a(3) above to encompass those MIL-STDs associated with the referenced standards. This will utilize the MIL-STD relationship identified in Volume IV. Whereas action a(3) will minimize the addition of data elements to the LSAR, this action could result in significant changes to the LSAR data system (OSD lead).

(2) Establish the standard information needs of the Department of Defense. This includes establishment of: (a) a universal numbering (or equivalent) system to maintain an audit trail of information as it relates to itself and the hardware, (b) a DoD data element dictionary (or standard of specification) which identifies data nomenclature, definitions, field length/type, and identifier.

D. TECHNICAL ISSUES SUBGROUP RECOMMENDATIONS

1. Findings

The following items summarize the findings of the subgroup:

1. Standards efforts are needed on -
   a. Identifying the overall architectural structure for CALS -- especially to allow integrated work to proceed at distributed locations.
   b. Identifying a set of standards for CALS architecture.
   c. Adopting (early) a set of interface standards.
   d. Reviewing the present FINDER efforts on terms and headings, which requires more attention and possible redirection.
2. Graphic representation effort requires attention on at least three levels -
   a. Digitizing present 2D drawings.
   b. Converting present 2D drawings to digital 3D representation.
   c. Full digital structuring of 3D models.
3. Action is required relative to projected use of the DDN--especially to develop -

a. A time-phased plan that will show the extent and the impact of CALS requirements on the DDN and the means of accommodating these requirements.

b. A policy that allows contractors early access to the DDN.

c. A recognition of the likely need for contractor--and possible DoD--to use alternate commercial facilities and the means of accommodating this need.

2. General Recommendations

The subgroup strongly recommends the following four programs[1], which include demonstration and validation, in the belief that substantial progress in any of these areas would be a major factor in achieving key CALs objectives.

a. Creating a General Logistic Information Model. This model should indicate the times and points of logistic interaction with design and manufacturing in carrying out a generic plan for weapon system development and support--from the preconcept (or even the requirement/proposal stage) to product disposition. Consideration should extend to logistic products, available logistic data, formats, modes of communication and interaction and a definition of the logistic features that are desired in the product design. The Logistic Information Model should be evolved by continual interaction with the logistics community and should include the dynamic characteristics of the logistic process.

[1]See the Technical Issues Subgroup Report, Volume V of the supporting report series for details on these programs.

b. <u>Developing Design Influence Algorithms</u>. These algorithms should provide definitions and a scale for measuring and prioritizing the various supportability elements (maintainability, reliability, testability, human factors and other logistic objectives), both among themselves and relative to nonlogistic features of the product. Particularly, these algorithms must be available and be applied during the early stages of 1) an initial design, 2) an engineering change, 3) product modernization, or 4) item remanufacture. Any intent to review a proposed design for its logistic impact after its first design review will be too late to be effective.

c. <u>Developing a Logistic Work Station</u>. The logistic work stations will be expected to support logistic interests in such areas as maintainability, reliability, testability and human factors (i.e. the elements of supportability) in the same way that a computer-aided design (CAD) computer supports the designer in the areas of aerodynamics, hydrodynamics, structures, hydraulics, electronics and kinematics (i.e. the elements of performance). The logistic work station is expected to be capable of manipulating textural, graphic and numerical data to achieve early influence on design decisions. Such a work station will have both generic software and its own specialized logistic software which will, among other things, apply algorithms for tradeoff analyses and employ complex logistic rules checking to ensure a supportable design.

d. <u>Developing a Kernel Logistic System</u>. The kernel logistic system combines the logistics information model, the design influence algorithms and the logistics workstation into a basic integrated system which includes all the needed auxiliaries and peripherals. It will use the logistic work station and its algorithms with the necessary logistic data bases (preferred parts; lessons learned during previous design, manufacturing and support; cost driving modes and levels; and dictionaries) along with program management considerations and priorities to achieve an integrated basic operational logistic system. It must incorporate CALS standards and be compatible with general CALS requirements and other interacting processes. It also must be compatible with CALS and related CAD/CAM systems at both the terminal and the system level to ensure an adequate design influence and must be interactive on a real time or a near real time basis. This logistic kernel concept can be expanded either by replication or by expansion to meet the needs for broader interfacing with its design and manufacturing system counterparts. This program will incorporate the basic elements of items "a", "b", and "c" above.

3. Technical Issues

This section provides several technical issues (items) along with the subgroup's comments. These items require a further critical review to ensure an adequate assessment.

Item 1. Total Versus Limited Data Needs

Digitizing the total data requirements of DoD and possibly those of its prime contractors, as seen by its suppliers, would be complex, costly and of marginal utility -- as well as probably beyond the present state-of-the-art.

Comment Total digital data systems for defense logistics are well off into the future when they will have greater utility. Adequate attention should be given to a near term logistic system and its data requirements -- not as an alternate but as an essential element in the evolution of the *total system*. Past experience with large systems shows a tendency to over collect data, overdesign products, underestimate support requirements, underdevelop CAM and overcontrol the various functions. This experience calls for better and more detailed analysis of what is needed to design and support a product.

Item 2. Loss of Proprietary Data Rights

Contractors fear that an integrated CAD/CAE/CAM/CALS data system will result in loss of their proprietary data rights.

Comment The ten commonly identified separate ILS elements and the presently separate CAD/CAE/CAM/CALS automation efforts provide a hierarchical basis for relieving corporate fears over loss of data rights while setting in motion the development of a strong CALS. Technical concepts are available that will allow the development of appropriate CALS access control procedures. The very critical associated CALS data management architecture needs to be developed, prototyped, and tested.

Note: Items 1 and 2 discuss the technology for allowing data access but avoiding unauthorized modification or actual loss of data. The policy issue of proprietary rights of access to data is addressed separately by the Policy and Legal Constraints Subgroup and reported above.

Item 3. Generic Standards for CALS

Military standards are slow to develop and difficult to implement. However, lack of standards for data interchange poses a serious threat to the evolution of CALS programs.

Comment Standards are essential to a successful CALS. In particular, standards for data interchange between heterogeneous computer systems --- for example, standards for data formats, communication, and data bases--are required.

Many of the required standards are in the early development phase, while some are more complete. Complete standards should be adopted where applicable, standards which are near completion should be pushed, and preferred practices or interim specifications prepared where standards are lacking. These efforts should be directed through existing standards bodies to increase CALS leverage. The recommended evolution of CALS standards, as well as the choice of wide-interest (if not yet universal) standards, should serve to forecast the future to all prospective CALS participants. As the demand for CALS-compliant capability increases, the competitive market will respond with products at reasonable cost. Standards are an end product. Earlier, they are proposals for "unification" of protocols, formats and procedures. Many benefits of standards can be achieved by preparing and calling out 1) preferred practices, 2) prestandards, or 3) interim standards. These documents are relatively effective. They also can be developed rapidly and they are less costly.

Item 4. Specific Standards for CALS

An integrated CALS System must have internal standards, such as standard names, descriptors, and procedures. These should be common across the Department of Defense.

Comment A naming standard is underway to develop a list of approved class words, key words, and modifiers --- in other words, a classification and coding of data for an orderly dictionary to support the IDS System. The prestandard terms in current use can be a problem, but many powerful techniques such as relational data base management schemes provide at least a partial solution to this problem.

In order for typical military personnel to easily use and understand the output from automated logistics systems, a good information dictionary is needed. Such a dictionary should identify symbols, set the meaning of these symbols, describe the relations between such symbols, and show the constraints on the use of those symbols.

Currently available dictionaries are inadequate in these basic concepts and are incomplete in their functions. Recent work in information modelling theory provides a basis for the design of an appropriate general information dictionary, but extensive development effort is needed to produce an appropriate CALS information dictionary.

Note: The customary reticence of commercial enterprise to accept standards can be turned toward enthusiastic user participation by the discipline of reporting early and continuously the status of each standard and by presenting an equally careful statement of its intended use and by emphasizing the advantages to all that results from its use in CALS work.

Item 5. Design Decision Support

A total information concept is necessary to ensure support of a weapon system for decades after it has been designed, showing the design assumptions and decision rationale so that subsequent changes do not reinsert the very features that were eliminated from consideration during the original design.

Comment Detailed records of design decisions appear to be very desirable -- especially for the selected design and for the thoroughly analyzed alternative (rejected) design features. However, annotated log entries on the selected design and on the more important rejected features may be adequate if the log provides adequate guidelines for reconstructing the basis for the original decision.

Item 6. Embedded Processors and CALS

Developments in computer-aided technologies make possible the use of embedded processors as sources of essential logistic data.

Comment The rapid development and expanded use of embedded processors is a valuable aid to anticipating logistic needs and to impressing these needs on the conceptual design of a weapon system. Properly considered, these computers offer a welcome potential for more complete, more accurate and more timely logistics data gathering, reduction and use.

Item 7. CALS During Surge

CALS must be more flexible than is suggested by its present strong focus on a seemingly idealized early attainment of its ambitious technical and organizational goals.

Comment Some logistic -related computer aided technologies were "given some consideration" during recent surge (limited mobilization) studies. CALS issues must be strengthened and set forth more convincingly in order to get more serious consideration during such surge studies. A proven CALS capability can be a valuable decision-aiding tool during future exercises.

Item 8. Digitizing of Drawings

The problems of working with both conventional and a variety of digitized (CAD) drawings in the same product program suggests the need for large scale conversion of present drawings to digital format and their accommodation to other automated requirements.

Comment Current technology and engineering practice defines each part on an engineering drawing medium that was designed solely for human interpretation. Future requirements are for this part definition to be captured electronically for ease of communication, for archival integrity and for interpretation by computer.

Digital scanning of existing drawings allows the drawing to be electronically stored and transmitted over communication channels and reproduced at the other end. Current scanners, data compression techniques, laser storage systems, and laser printers provide most of the necessary technical tools required to effectively utilize digitized drawings.

Present part models are expressed as 2D wireframe, 3D wireframe and 3D surface geometric models. Each of these representations is incomplete in terms of the total information content needed for analysis or for automated manufacturing planning. Solids models are seen to be the approach to give the required "completeness" to the product definition.

CALS must recognize this diversity, accommodate the technological trends and plan for the effective utilization of these various forms of data models. New technology developments should be supported and related standards activity encouraged. Validation techniques should be created to check the integrity of data received by DoD in any of these forms.

Recognizing there will be a variety in the forms for digital representation of product model data, the CALS program should encourage the creation of translators to change the part model from one particular digital form to another form.

In the order of sophistication, completeness and complexity these forms are:

Digitally Scanned Drawing
2D Wireframe Model
3D Wireframe Model
Surfaced Model
Solids Model

Translators to convert a more sophisticated model to a lesser sophisticated model will be relatively easy to develop. Far more difficult is the reverse. However, these translators will be far more valuable to DoD over the life span of the archive data files because they will enable an easy transition to new technology process tools for logistics support. Example translators might include either 2D or 3D wireframe model creation from a scanned engineering drawing.

3. Future Developments

All of the Subgroup's fields of interest -- including their related issues -- are candidates for future implementation as artificial intelligence-based or expert/knowledge-based systems. The lack of needed knowledge or technology should not delay logistics developments leading toward knowledge-based systems so long as the possible later transition from data-based to knowledge-based system operation is given appropriate early attention.

E. DEMONSTRATION PROJECTS SUBCOMMITTEE RECOMMENDATIONS

1. Pilot Programs

a. Findings

Industry's use of CAD, CAM and CAE graphics and design analysis is exploding. Industry is rapidly digitizing their logistics support systems. They are creating data bases and establishing company-peculiar protocols for the creation and storage of data. Industry is also developing numerous systems for the internal storage and handling of logistics data.

Unfortunately, there are no universal standards nor is the government prepared to accept many types of these data in digital format. Government is well aware of the problem and is expending significant funds to demonstrate technical feasibility of specific techniques. The end result of the government sponsored research is the creation of "islands of technology" which demonstrates that government is able to handle specific information in specific cases. A listing of the major programs currently being pursued by Army, Navy and Air Force are contained in Appendix B. The Services have R&D or development programs to allow receipt of digitized drawings, digitized tech orders, and digitized provisioning data, and to receive many other forms of digital data. Unfortunately, as of this date, no program exists to do what may be called "vertical integration"; that is, the assembly of these various digital techniques into one program office and the combining of all of this information to improve system supportability. The objective of a vertical integration program would be to utilize, on an interactive basis, the wealth of digital information available in contractors plants in order to improve and modernize the logistics processes and readiness of our new weapon system.

b. <u>Recommendations</u>

Vertical Integration Program - It is our recommendation that each Service be directed to designate an existing program office which will become its "lead the force" program office to accept and utilize all types of digital data from contractors. This program office's funding should be augmented and the various digital data "islands of technology" should be brought together within one program office and, if appropriate, on one data base, with standards being established between the contractor and the government so that data exchange and interaction in digital format can be accomplished. All possible areas should be included (i.e., drawings, tech orders, training materials, maintenance, test equipment information, etc.). The program contractor should be required to create this information digitally and to make it available to the program office digitally. The program office in turn would develop new techniques to handle this information which will hopefully result in improved logistics support. One end product for all three Services should be to establish DoD procedures for:

(1) Transfer of text

(2) Transfer of data

(3) Establishing Government Data Bases

The ultimate goals of a vertical integration program should be to demonstrate that an integrated system will work and to evaluate the benefits of utilizing digital logistic data in a functioning program office.

Suggested milestones for implementation of the tasks outlined above are:

<u>Second Quarter 1985</u>

1. Program office selected
2. RFP released for the generation of DIDS and a SOW covering the receipt of engineering drawings.

<u>Fourth Quarter 1985</u>

1. Receipt of information specified
2. Approve and release of RFP covering government receipt of digital drawings.

<u>Third Quarter 1986</u>

Demonstration of program office capabilitiy to receive digital drawings and utilize them to improve the logistics process.

Similar schedules should be developed for government receipt of technical documentation, maintenance aids, etc. These technologies should be brought on-line as funding and engineering capabilities make them feasible.

2. Service Co-ordination

a. Findings

It was the concensus of the group that within the Army, Navy and Air Force many digital technology demonstrations are occuring. They are being managed by individual program offices, major commands and various laboratories. Exchange of information concerning progress (failures and/or successes) is primarily taking place through an informal network of telephone calls between program offices or at trade shows and symposia. As the various offices work towards the implementation of their programs there is no consistency in the protocols or standards that industry is being asked to interface with.

b. Recommendations

1. It is recommended that DoD direct each Service to create a permanent CALS Coordination Office as its official spokesman for the creation of digital standards and protocols. This office will serve as the permanent interface on digital standards with other government offices. The Services will meet at a minimum of four times per year to exchange information on progress of their vertical integration programs and on other digital development programs within the Services which are utilizing improved information processing technologies.

2. These offices will be the "TARGET" for industry to observe when they are creating digital standards and protocols within their own companies. Additionally, these offices will be responsible for determining how the government uses digital data delivered by defense contractors.. The offices will:

(a) Demonstrate laboratory technologies

(b) Implement various standards adopted by government users, industry associations and national/international standards organizations.

(c) Install a discipline in digital logistic support techniques developed by program offices.

(d) Provide continuous coordination with other Services.

(e) Encourage continued horizontal programs to advance technologies.

3. DoD should direct the establishment of these offices at the conclusion of the present CALS effort and should schedule the first inter-Service meeting in the spring of 1985. These meetings should include representatives from DLA and the National Bureau of Standards.

3. Government/Industry Co-ordination

a. Findings

(1) The CALS study has proven valuable to both industry and the government. It has provided a unique forum for the exchange of information on the digital explosion. It has been the forum in which the expression of frustration by industry and government concerning the lack of standards and protocols can be expressed. The concensus might be that the various government agencies need some discipline in this area and that industry seeks a standard "TARGET" to aim it in the development of their internal systems so that they would be capable of interfacing with the ultimate government systems.

(2) Similarly, it has been the forum to demonstrate the benefits that can be provided by the National Bureau of Standards and by DMSSO. The digital data problem is simply too large for any one organization to cope with. It covers too many disciplines and permeates the roles and missions of most organizations. National guidance is needed.

b. Recommendations

(1) It is recommended that a permanent DoD/Industry CALS executive coordination committee be established. This organization would meet semi-annually and review the activities of the Services' coordination offices. Industry would be provided an opportunity to review the standards being placed on contract by the government with other contractors and to comment on their impact. They could provide suggestions to the coordination offices and discuss future activities.

(2) This semi-annual meeting could be conducted by DoD or one of its contractors. It would be held in a neutral environment with the development of new digital logistics techniques as its primary objective.

(3) This office should be established at the conclusion of the present CALS effort and the first meeting scheduled for mid summer 1985.

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IDA Report R-285

REPORT OF THE JOINT INDUSTRY-DoD TASK FORCE ON COMPUTER-AIDED LOGISTIC SUPPORT (CALS)

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