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LOGISTICS SUPPORT ANALYSIS AUTOMATION CONCEPTS

FINAL DRAFT

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EXECUTIVE SUMMARY

The Air Force CALS program was established to improve weapon system reliability and maintainability and to reduce the cost of acquisition and support. A major objective of CALS is to improve the flow of technical information by introducing automated systems that will manage digitized technical information. Using a Modular Planning Process (MPP) methodology, this report analyzes the Logistics Support Analysis (LSA) process by examining the environment, studying the opportunities and planning the direction. The scope of the report focuses on the Acquisition phases of the weapons system life cycle. A subsequent planning study, called Operational Support, will examine LSA and related data in the Operations and Support (O&S) phase of the weapons system life cycle. At the conclusion of the Operational Support study, a comprehensive set of automation recommendations in a system concept plan will be developed for the life cycle.

Section 2 of the report describes the LSA Future Environment. Factors influencing the future Air Force LSA environment are identified and described. This is done for the recent environment, near term future, and long term future. Factors addressed include changes to MIL–STD–1388, a growing Air Force reliance on modifications, and technology developments. There are trends which indicate the integration of the LSA process with industry design processes. Similarly, trends indicate further integration of the LSA data with Air Force logistics processes and systems in the production and O&S phases of the life cycle.

Section 3 of the report describes findings, recommendations and strategies. Major recommendations are summarized below.

EARLY DESIGN INFLUENCE

The Air Force needs to provide logistics guidance to initiate a new weapon system or equipment item by providing information based on past experience with similar systems. Findings show that logistics data is either not readily available to designers or is only available in diverse paper formats. This hinders effective consideration of logistics requirements in the early portion of the life cycle and results in additional time and expense to assemble information into usable formats. The report recommends that automated access to logistics support information should be readily available to guide new acquisition programs and major modifications during the Pre–concept and Concept Exploration phases.

LSA MANAGEMENT AND REVIEWS

In the area of LSA management and reviews, findings show that timeliness, accuracy and currency, ease of use, and adequate use of technology are lacking. The findings identify a requirement for the Systems Program Office (SPO) to have on-line access to the contractor's automated LSA/LSAR system and related systems. This enables the Air Force to be proactive rather than reactive in LSAR reviews; to have timely access to accurate information; and

to have complete information (such as access to both engineering drawings and trade study data in addition to the LSAR). This on–line access to the contractor's LSA/LSAR system enables the Air Force to make use of the latest advanced technology.

INITIALIZATION

LSA data is valuable in initializing AFLC support systems. The findings identify a critical period at the end of Full Scale Development (FSD) and the beginning of Production when the LSA process is usually concluded. New data developed from testing and early operations are not fed back to the LSAR. The impact of a change to one or more support areas cannot be assessed since LSAR is no longer updated. The Air Force needs to maintain the discipline of the LSA process by keeping the LSAR up-to-date, at least through a significant portion of the Production phase, as determined by the SPO, user and ALC. This practice will allow the Air Force to alter support processes when engineering change proposals are submitted and other changes take place that impact system support. This will provide an on–going capability to assess support changes with an integrated view of all ILS elements, since the LSAR will still be a source of current information. This approach is consistent with MIL–STD–1388 which continues the LSA process through the production phase.

MAINTENANCE

Use and maintenance of LSA and related data also occurs during the O&S phase of the weapon system life cycle, particularly in performing LSA on modifications. O&S is not within the original scope of the study; however, continued study of logistics support data in this phase of the weapons system life cycle is recommended to provide a comprehensive analysis of automation opportunities for digital management of LSA and related data. The results of the study of the O&S phase will then be combined with the results from this study of LSA in the Acquisition phases to create a system concept plan for LSA and related data over the entire life cycle.

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SECTION 1: INTRODUCTION

This document presents the findings, recommendations, and strategies developed by the LSA planning study and establishes the basis for the Operational Support study. This section describes the background, scope, objectives, and methodology for the LSA study and the organization of the document.

1.1 BACKGROUND

In conjunction with the Department of Defense–wide Computer–aided Acquisition and Logistics Support (CALS) program, the Air Force CALS program was established to improve weapon system reliability and maintainability and to reduce the cost of acquisition and support. A major objective of CALS is to improve the flow of technical information by introducing automated techniques to improve the delivery and use of large quantities of digitized technical information. Upon achieving automation, CALS will significantly reduce the amount of paper and labor necessary to receive, store, use, and disseminate these technical data.

In October 1985, an Air Force Program Management Directive (PMD) established a CALS Management Integration Office (MIO) at HQ AFSC to coordinate the CALS program. The PMD identified the following tasks to accomplish the CALS objectives:

- Plan to integrate all existing Automated Technical Information (ATI) projects with a standard information systems framework; determine the full range of CALS objectives and management concepts; and plan large–scale demonstrations and implementation of CALS technology for a weapon system acquisition program;
- Ensure that data system structures are consistent and comply with Air Force guidelines;
- Perform a cost analysis for replacing present technical information management methods with automated methods; and
- Prepare and maintain an ATI and CALS Program Management Plan (PMP) that addresses program integration and consolidation of CALS schedules and incorporates improved automated technical information capabilities.

The Air Force CALS MIO is responsible for planning, developing, and implementing the CALS initiatives and has contracted with the Transportation Systems Center (TSC) of the Department of Transportation (DOT) to provide systems engineering support. As part of the CALS planning initiative, TSC developed and implemented the Modular Planning Process (MPP), an information engineering systems approach designed to:

- Focus on technical plans that will not be outdated before implementation;
- Incorporate existing/ongoing Air Force systems and projects;

- Meet the information distribution requirements of the user community; and
- Interface with a variety of organizations responsible for weapon systems acquisition and logistics support.

The MPP is divided into three phases: examine the current environment, study the opportunities, and plan the direction. FIGURE 1-1 illustrates the breakdown of each phase. Using the framework of the MPP, TSC has written a series of reports for the Management Integration Office (MIO) that analyze the Logistics Support Analysis (LSA) process, its functions, and the LSA Records (LSAR). These reports and the MPP phases they address are identified by an uppercase letter in FIGURE 1-1. The LSA Automation Strategies report is based on the findings of the earlier reports written for the MIO, and addresses the Review and Modify Alternatives component of the third phase of the MPP. Remaining sections of the modular planning process will be addressed in a related planning effort called Operational Support.

1.2 SCOPE

This report examines logistics support information which includes the LSAR, other LSA outputs (e.g., use studies and trade–off analyses) and related information.

The scope of this study is limited to the following phases of the weapons system life cycle:

- Concept Exploration (CE),
- Demonstration and Validation (D/V),
- Full Scale Development (FSD), and
- Production (Prod).

These phases are shown in FIGURE 1–2.

Since this report focuses on the Acquisition phase of the life cycle through FSD and on initial production activities, an analysis of the role of LSA and related data in the Production and O&S phases is necessary to complete the automation planning. Much of the data needed to effectively influence the early design should come from maintained logistics support data (including lessons learned) collected from earlier programs. In addition the data and integrated processes developed in Acquisition have implications for O&S. A subsequent module will examine logistics support information and its uses in the O&S phase of the weapon system life cycle. At the conclusion of the O&S module, a comprehensive set of automation recommendations or a system concept plan will be developed.

1.3 OBJECTIVES

The purpose of this report is to present automation concepts developed by the LSA module and establish the direction for a module that will study logistics support information in O&S. The result of this combined study will be a set of automation recommendations for Air Force

EXAMINE THE ENVIRONMENT

Initiate the Process

Perform Initial Assessment
- Create Preliminary Description of Environment
- Identify Organizational Expectations
- Establish Priorities

Develop Specific Procedures
- Establish Management Plan
- Identify Advisory Group
- Prepare Project Plans

Conduct Structured Analysis

A Describe Current Environment
- Create Functional Model
- Identify Major Data Elements
- Describe the Organizational Infrastructure
- Identify Major Information Flow Parameters

B Assess Transitional Projects
- Identify Objectives
- Describe Functions and Data
- Identify Technologies
- Identify Infrastructure Affected

STUDY THE OPPORTUNITIES

Assess Technology

Identify Existing Technologies
- Review Current Environment
- *B* *Review Ongoing Projects*
- *C* *Identify Existing Technologies*

Research Future Technology Opportunities
- Select Technology Areas
- Consult with Technology Experts
- *D* *Examine Similar Applications*
- *E F* *Review Development Trends*

Establish Technology Alternatives
- Quantify Directions
- *D* *Specification of Implementation Issues*
- Examine Benefits and Costs

Project Future Requirements

Forecast Requirements
- Review Applicable Scenarios
- Conduct Discussions with MAJCOMs
- *E* *Forecast Process Changes*
- Assess Infrastructure Constraints

Examine Feasible Alternatives
- Determine Feasibility Issues
- *E* *Review Industry Trends*

Define Future State

Describe Future Environment
- Define the Impact of Tecnology on Current State
- Define Projected Organizational Responsibilities
- Define Relevant Interface Requirements

Create Functional Model
- Develop a Description of Future State
- Identify Projected Major Information Flow Parameters

PLAN THE DIRECTION

Formulate Alternatives

G Assess Critical Issues
- *Examine Objectives*
- *Identify Technologies*
- *Review Organizational Issues*

H Propose Initial Alternatives
- *Select Future Requirements*
- *Identify Technologies*
- *Structure Proposals*

Review and Modify Alternatives
- Review Criteria
- Identify Relationships with Transitional Projects
- Define Policies and Organizations Involved

Develop Consensus

Review Progress with Advisory Group
- Identify Discussion Topics and Priorities
- Evaluate Current Environment
- Establish Objectives
- Provide Access to Information

Develop Common Understanding
- Review Future Requirements
- Evaluate Recommended Solutions
- Examine Feasibility Issues

Expand Advocacy Network
- Identify Implementation Agencies
- Select Appropriate Forums
- Communicate the Plans

Prepare Implementation Plan

Define Activity Descriptions
- Establish Implementation Guidelines
- Establish Evaluation Criteria
- Develop Implementation Procedures

Develop Organization Plan
- Confirm Major Milestones
- Establish Transition Plan
- Identify Organizational Responsibilities

Establish Constituency
- Gain Management Acceptance of Plan
- Obtain a Commitment for Execution

Create Documentation
- Establish Goals
- Define Resource Requirements
- Recommend Technologies
- Define Organizational Impact
- Establish Financial Parameters

KEY TO LSA REPORTS AND THE MPP PHASES THEY ADDRESS:

A LSA Current Environment Report
B An Assessment of Two Systems as Candidates for an Air Force LSAR System
C Current Data Base Technology Assessment
D Assessment of Potential Use of LSAR Data by LMS Systems
E An Assessment of the NBS Information Resource Dictionary (IRD) Standard
F Emerging Data Management Technologies Assessment
[shaded box] LSA Automation Concepts Report

FIGURE 1-1. MODULAR PLANNING PROCESS OVERVIEW creation, management, and use of LSA related data, beginning at the earliest stages of the weapon system life cycle (Pre-Concept), through the Acquisition phase and transition into the O&S phase. The plan will be integrated with other modular planning efforts taking advantage of proposed organizational structures for the flow of information, common standards, hardware, and software.

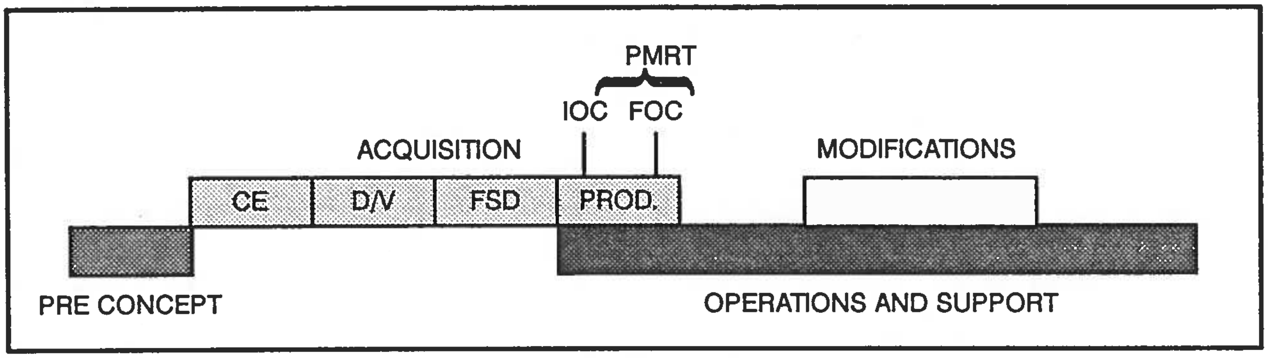

FIGURE 1-2. WEAPONS SYSTEM LIFE CYCLE

1.4 METHODOLOGY

In addition to the modular planning process and its reports referenced in FIGURE 1-1, TSC reviewed Air Force acquisition, mission, and organization regulations relating to LSA. Site visits and interviews were conducted at Air Force organizations involved in current acquisitions and at a number of contractor facilities. Information on management, analysis, transfer, verification, and use of LSA data was collected at several professional meetings including those of the National Security Industry Association (NSIA), the Government/Industry LSA Conference, the LSA Implementation Working Group, and the LSA Automation Working Group.

1.5 DOCUMENT ORGANIZATION

Section 2 describes the future LSA environment. Findings, recommendations and strategies are presented in Section 3 and conclusions to the report are in Section 4.

SECTION 2: LSA ENVIRONMENT

This section documents Air Force and Department of Defense (DoD) environmental factors influencing the recent and future Air Force LSA environment during a fifteen year time frame from 1984 to 1998. These factors fall into two categories: institutional influences and technological influences. These influences are an input to the development of LSA automation concepts. The fifteen year time frame is broken down into the following five year intervals:

Recent Influences: 1984–1988

Near–Term Influences: 1989–1993

Long–Term Influences: 1994–1998.

2.1 RECENT INFLUENCES 1984–1988

Air Force institutional and technological influences affecting the LSA environment between 1984 and 1988 are described below.

2.1.1 Air Force Factors

Institutional influences include MIL-STD-1388 changes, Materiel Readiness Support Activity (MRSA) validation, contractor's systems, Unified Data Base (UDB), Acquisition Review Group (ARG) findings, and cost effectiveness of the LSA process.

MIL–STD–1388 CHANGES

Several changes to the regulation MIL–STD–1388 governing LSA, occurred between 1984 and 1988. MIL–STD–1388–1A superseded MIL–STD–1388–1, and MIL–STD–1388–2A superseded MIL–STD–1388–2 and MIL–STD–1552A. In addition, MIL–STD–1388–2A Notice 1 was released in 1986 and Notice 2 in 1987. These changes gradually improved the usefulness of the LSA process and addressed LSAR data and LSA process shortcomings. However, these frequent changes also made it difficult for the process to become institutionalized and understood; they made it difficult to build automated support to comply with the regulation.

MATERIEL READINESS SUPPORT ACTIVITY (MRSA) ROLE

The U.S. Army Materiel Readiness Support Activity (MRSA) has specified an LSA process and a format for receipt of LSA data in MIL–STD–1388. In addition, it now validates LSAR systems that comply with that format. This facilitates automation of LSAR functions and ensures that DoD can obtain the data digitally, regardless of which vendor's LSAR system is used.

Validated LSAR ADP systems are classified by MRSA as Type I, II, or III. Type I systems are front–end data entry and edit systems. They feed data into MRSA's Joint Service ADP system to create the LSAR master files and generate LSAR reports. Type II systems perform Type I functions and create the LSAR master files. They rely on the Joint Service ADP system to generate the LSAR reports. Type III systems perform Type II functions and also generate the LSAR reports.

CONTRACTOR'S SYSTEMS TO SUPPORT LSA

Several contractors (e.g., Northrop and Lockheed) have built their own LSAR systems to support Air Force and DoD acquisitions. In many cases, these systems contain more than LSA data; they may be an automated ILS system with LSA capabilities. Contractor's systems reflect technological developments, making use of relational databases and working toward integrating related systems.

UNIFIED DATABASE (UDB).

The UDB system is a recent Air Force–built computer system for receiving, storing, and manipulating LSAR data. It uses a network database management system to produce flexible responses to ad hoc queries. However, UDB is costly to modify for the frequent changes in MIL–STD–1388, due to its use of a network database. Further investment in UDB will be limited; ALCs may use UDB at their option.

ACQUISITION REVIEW GROUP (ARG)

The 1982 ARG Report, initiated by the Deputy Chief of Staff for Logistics and Engineering, General Leo Marquez, identified the deficiencies in the current LSA process and the need to improve performance. ARG recommendations cover several areas including standards, training and education, and automation. The report recommends the increased use of automated tools in the LSA process. An Air Force Implementation Working Group is monitoring the implementation status of the twenty–five ARG tasks.

COST–EFFECTIVENESS OF THE LSA PROCESS

LSA has the potential to be a cost–effective process if it is well managed and given management priority. By designing a system for efficient operations and supportability right at the beginning of the weapons system life cycle, the LSA process typically achieves significant benefits in the operations and support phase for both readiness and cost of support.

A 1985 case study on the effectiveness of LSA on the Single Channel Ground and Airborne Radio System (SINCGARS), determined that the LSA cost was $2.1 million and the benefits were $65 million. However, the authors acknowledged that most of the benefits resulted from changing the custom–built power source to a standard, common battery and that this change might have occurred without LSA[1] .

A basic issue in defining the cost effectiveness of the LSA process is to identify specific changes in the weapon system design that occurred as a result of LSA, quantify the benefit of

[1] Cost Effectiveness Study of LSA: SINCGARS, USAMC, Materiel Readiness Support Activity, MRSA CES 85–01, June 1985.

those design changes, and compare them to the cost of performing LSA. There are also benefits to be gained from a well defined set of logistics support resources for the weapon system or equipment items. Examples of logistics support resources would be the earlier fielding of a system and more efficient logisitics processes. Based on the fact that LSA can influence a design early in the life cycle, and based on meetings with numerous Air Force acquisition personnel, the conclusion is that LSA is indeed a cost–effective process.

2.1.2 Technology Factors

Current technological influences include computer-aided logistics, database technologies, and miscellaneous technologies.

COMPUTER–AIDED LOGISTICS

A few leading defense contractors have interfaced their CAD/CAM systems with automated and integrated LSA capabilities. This enables the design process to be integrated with supportability considerations. One example of integrated LSA technology is the ability to produce a three–dimensional color model of a weapon showing, in color codes, the mean time between failure of various weapon components and their location in the weapon.

DATABASE TECHNOLOGY

In the field of automation technology, Data Base Management Systems (DBMS) have enabled complex Management Information Systems (MIS) to be implemented. The DBMS handles complex file structures that store information on an organization rather than information on a specific application. In addition the DBMS provides quick access to the data with safeguards to support multiple user on-line access. During the 1984 to 1988 time frame, the relational model has emerged as the preferred DBMS model, due to its flexibility for ad hoc queries and reports, and its ease of modification, which supports frequent changes in MIL–STD–1388.

MISCELLANEOUS

Other technology influences are as follows:

- Minicomputers are being used to support functions such as engineering.
- Chip technology is increasing computer speeds and processing capacities.
- Magnetic storage is increasing by an order of magnitude in capacity and speed.
- Personal computers are being developed as processing tools.
- Graphics capabilities are increasing in display devices
- Trends toward connectivity of computers are developing

2.1.3 Summary

MIL–STD–1388 is gradually being implemented within the Air Force. There exists today a large number of weapon systems and equipment items that were built prior to MIL–

STD–1388. Therefore, it will take time before the 1388 process is fully institutionalized. The LSA process continues to be viewed as a valuable process because of the benefits it can achieve in establishing a supportable design and defining required logistics support resources for O&S functions. The LSA process and MIL–STD–1388 continue to receive a great deal of high level interest and visibility from DoD and industry because of their importance to the supportability of systems.

During 1984 through 1988, most of the improvements to the LSA process recommended by the ARG report have been addressed. The remainder are planned for completion by the end of 1989.

2.2 NEAR TERM INFLUENCES 1989–1993

Air Force institutional and technological influences affecting the LSA environment between 1989 and 1993 are described below.

2.2.1 Air Force Factors

Near term Air Force influences include: reliance on modifications, tighter budgets, and the LMS modernization program.

GROWING RELIANCE ON MODIFICATIONS

The number of major new weapon systems that the Air Force builds is declining every decade. For example, during the 1940s and 1950s, the Air Force developed at least six new fighter systems per decade. During the 1960s and 1970s, two new systems were acquired in quantity; the F–4 and F–111 in the 1960s, and the F–15 and F–16 in the 1970s. Current budget plans indicate that only one new fighter will be developed in the 1980s and 1990s; the Advanced Tactical Fighter (ATF). The cost to build new systems has grown so large that the Air Force is relying more and more on modifications to existing systems to remain current with technology.[2]

Regulations (AFLC 57–21 and a proposed AFR 800–xx) require that LSA be performed on Class IV and V modifications, a practice that has yet to be institutionalized. The managing ALC organization is responsible for performing LSA on modifications. There is reluctance to use LSA on modifications where no LSA was performed during the original acquisition. As this problem is resolved, there will be a growing role for LSA data throughout the life cycle of a system. Also, there will be a growing need for LSA practitioners within AFLC to assure effective implementation of LSA on modifications.

IMPACT OF TIGHTER BUDGET ERA ON LSA

DoD is now in a period of constrained financial resources. According to General Alfred Hansen, "As defense budgets increased in the early 1980s, the pressure to change outdated

2 "Modernization through Modification", General Richard D. Smith, USAF. *Air Force Magazine*, October 1987, p. 64.

mind–sets was reduced. At the time, we could better accept trading off R&M in our weapon systems for other performance characteristics. We could simply deal with the inherent limitations of unreliable systems by throwing money at the problem and buying our way out . . . Today, however, as resources become more constrained, they will be less available to support unreliable systems".[3] Since LSA is one of the first ways that Reliability and Maintainability (R&M) is incorporated into a weapon system design, the more constrained budget environment may give LSA a larger role earlier in the design and modifications to new weapon systems. This could result in the development of more supportable weapon systems and eventually in the reduction of life cycle costs.

Similarly the Air Force's Reliability and Maintainability 2000 Program seeks to place R&M on an equal footing with traditional management priorities of delivering a new weapon system within cost, schedule, and performance constraints. Since LSA is one vehicle for incorporating R&M into design, it should be given more priority by SPO managers.

AFLC LOGISTICS MANAGEMENT SYSTEMS (LMS) MODERNIZATION PROGRAM

AFLC has undertaken a major program to modernize its computer systems. The goal of the modernization effort is to solve data processing problems in four AFLC core functions; requirements development, acquisition, storage, and distribution. New systems will be linked by two major communications systems, partially alleviating a common problem of having many small scope systems with no link to other systems.

Planning for the LSA process and the LSAR databases must take into consideration the LMS Modernization Program. LSAR data will feed information to one or more of these systems.

2.2.2 Technology Factors

Near term technology influences include MRSA developments, object-oriented DBMSs, computer-aided logistics, and miscellaneous technologies.

MODIFIED MIL–STD–1388–2A.

MRSA plans additional changes to MIL–STD–1388–2A through two revisions: MIL–STD–1388–2B and a companion effort given an interim name of 1388–3B. These changes will allow the LSA process to capture additional, improved data elements and to produce more useful output. MRSA will change the standard from today's 80 column card format for the LSAR to a relational database format and reduce the number of standard output reports through consolidation.

MRSA'S RELATIONAL SYSTEM

MRSA will develop relational tables using DBMS software with MIL–STD–1388–2B that will be made available to all the services. While the cost is apparently low, the system will require

[3] "Reliability and Maintainability (R&M): Key to Combat Strength". *Air Force Magazine*, Winter 1988, p.5

significant planning and infrastructure investment if the Air Force decides to make the MRSA system operational within its environment. MRSA will only provide software to those organizations requesting it. Installation, training, hardware, communications capabilities, and system management capabilities will be the responsibility of the Air Force or its contractors if the MRSA software is accepted for use.

OBJECT–ORIENTED DATA BASE MANAGEMENT SYSTEMS

Object–oriented DBMSs are an emerging technology that manage objects rather than data. Systems using object–oriented technology will be able to manage graphics, pages, data elements, and other objects, and will be able to perform such operations as rotating. This will increase the productivity of application developers and improve the data manipulation capabilities of end users. This will have potential benefit for the LSA process because of the need to refer to both text and graphics in the LSA process. This new technology is now entering the marketplace. Several more years of development are required before it is a mature technology, offering a stable, well–supported product to large organizations.

COMPUTER–AIDED LOGISTICS

Computer–aided logistics capabilities have been developed by all major defense contractors, providing closer integration of supportability analysis with design processes. Contractors can now meet LSA requirements through automated integration of computer–aided logistics with CAD/CAM. This expedites the LSA process in the contractor's arena and provides opportunities to improve Air Force reviews of LSA outputs.

OTHER TECHNOLOGY

Other technology influences are as follows:

- Microcomputers and microcomputer networks will increase in popularity.
- Optical disks will mature and challenge magnetic media as the storage medium for computers.
- Standards such as the Product Data Exchange Standard (PDES) will be developed to improve facilitating the exchange of drawings and text. PDES has recently expanded its scope to include logistics data.

2.2.3 Summary

MIL–STD–1388 will be modified during the 1989 through 1993 time frame. As a result, effective use of relational database technology for LSA functions will become available. As the number of modification programs increase, the use of the LSA process on major modifications will increase during this period.

LSA will continue to be viewed as a useful process. Supportability will continue to be emphasized as equally important as cost, schedule, and performance factors on systems.

With most of the LMS Modernization Systems reaching full operational capability, there is a greater opportunity to interface LSAR data with LMS data. The LSAR could automatically initiate logistics activities by populating LMS databases with initial logistics parameters involving provisioning, support equipment, training, etc.

2.3 LONG TERM INFLUENCES 1993–1998

Possible Air Force institutional and technological influences affecting the LSA environment between 1993 and 1998 are described below.

2.3.1 Air Force Factors

Possible long term Air Force influences are as follows:

- Military Standards will be updated to incorporate space logistics.
- Defense Data Network will increase in capability to 1.54 mb/sec.
- Remaining LMS projects will be completed.

2.3.2 Technology Factors

Possible long term technological influences are as follows:

- Object–oriented DBMSs will be mature.
- PDES will be defined and initial implementations will be demonstrated.
- Rudimentary heterogeneous distribution capabilities will enter the marketplace.
- Workstations will replace microcomputers and dumb terminals.
- International Standards Organization (ISO) seven level architecture will become standard for communications interfacing.
- Parallel processors will increase computer capabilities.

Given these trends, the LSA process can be expected to become more integrated with design processes. Industry will have fully integrated their ILS process and systems with CAD/CAM/CIM processes and systems. Automated tools will have expedited LSAR reviews by Air Force personnel, making them more effective.

The Air Force should see an increased dependence on workstations (rather than terminals) as a tool to develop and manage information and access and exchange data and graphics. Workstations with their own processing capability will be the terminal nodes of a network that will connect the user to other users, to databases of information within the Air Force, and to commercial databases maintained for online research. Electronic mail and electronic bulletin boards will lead to new ways of reviewing and commenting on information. Most draft versions of documents will remain in a digital electronic form for easier distribution and review.

Computers have long had the potential to perform repetitious, time-consuming tasks with greater accuracy than can be done manually. Expert systems will extend this capability to tasks that require judgment. As a branch of artificial intelligence, expert systems give the computer rudimentary analysis and decision–making capability. Expert systems will be developed to evaluate proposals and review data. This will allow Air Force personnel to focus on other tasks.

2.4 CONCLUSION

This section documents both Air Force institutional trends and technology trends impacting LSA. It shows that the LSA process is supported by several institutional influences and that the process could benefit from technology developments. The Air Force can maximize the use of technology in its future LSA processes, but is often constrained by the institutional influences affecting the LSA process. There are trends that clearly indicate the integration of the LSA process with industry design processes. Similar trends point to further integration of the LSA data with Air Force logistics processes and systems in the production and O&S phases of the life cycle. In the next section, LSA automation approaches are defined in terms of findings, recommendations, and strategies.

SECTION 3: FINDINGS

LSA is divided into two parts; the process and the data. In the early phases of Acquisition the Air Force has the role of facilitating the design by giving guidance for the LSA process to the contractor via the contract. As the weapon system design is developed, the Air Force and the contractor use the LSA process to influence the design for supportability considerations, review the design of the support systems, and review the estimation of support resources. All involved Air Force Commands participate in a series of LSA reviews that examine the LSA process and the resulting LSAR.

At the end of FSD, system designs should be complete and the LSAR database should have been fully developed. Data from the LSAR is used to initialize the Air Force depot and base logistics management systems. In the course of Program Management Responsibility Transfer (PMRT), logistics support information data is delivered to the Air Force support organizations (the responsible Air Logistics Center – ALC).

This section discusses Early Design Influence (3.1), Manage/Review (3.2), Initialize (3.3), and Maintain (3.4). Each of these subsections is broken down into Finding, Recommendation, and Strategy; these sections propose ways in which the Air Force could use automation to improve the flow of information.

3.1 EARLY DESIGN INFLUENCE

3.1.1 Finding

During Pre–Concept and Concept Exploration, there is a requirement to factor in logistics considerations into major design decisions. Access to logistics support data during this time period is either not readily available or is not automated. This hinders the use of logistics support information to influence the development of concepts and designs. With the initiation of a Statement of Need (SON), AFR 57–1 requires that logistics considerations be addressed, including reliability and maintainability factors. The logistics data required in early design should include high-level predicted and actual data from similar systems, as well as logistics lessons learned from earlier acquisition programs and from the operation of deployed systems.

The difficulty in accessing logistics support information results in additional costs and lost opportunities to influence design. Later changes to a design become more expensive as the life cycle progresses. Historical data indicates that seventy percent of life cycle costs are locked in by design decisions made prior to Milestone I[5]. Other costs are incurred developing data in usable formats. Opportunities to use logistics experience data in trade–off analyses and use studies are lost.

[5] DSMC Systems Engineering Management Guide, p. 17-2, December 1986

3.1.2 Recommendation

The Air Force should provide readily available and automated access to high–level, predicted and actual logistics support information from existing weapon systems (and major equipment items) as an input to Pre–Concept and Concept Exploration activities. This would improve the definition of support requirements to be met by a new weapon system, major equipment item, or major modification. By providing access to logistics support information, the overall requirements for the proposed system could more readily include logistics support factors. This would contribute to meeting the R&M 2000 goal of giving supportability the same priority as cost, schedule, and performance considerations.

The data should be readily available to Air Force and contractor design personnel in an automated manner.

3.1.3 Strategy

The strategy is to generate the majority of predicted and actual logistics data for early life cycle activities from several systems in the Logistics Management System (LMS) Modernization Program. Since the decisions before Milestone I are major design decisions, most of the required information is high level data on overall reliability and maintainability of a weapon system. Terminals or workstations that provide access to systems like the Reliability and Maintainability Information System (REMIS) for headquarters major commands, the relevant Products Division, and Air Staff could accomplish this recommendation. Automated lessons learned databases should also be readily accessible.

3.2 MANAGE/REVIEW

3.2.1 Finding

The current LSA review process lacks timeliness, accuracy and currency, ease of use, and adequate use of technology.

TIMELINESS

The LSA process should be initiated early in the life cycle so that design influence is feasible. If the process is started too late, the design may proceed before an LSA team is in place to review designs for supportability considerations.

Typically, the development and approval of logistics support information lags behind the requirements for its use. This is due to untimely entry of LSA data into the LSAR. The time required to review and accept LSA data during the Acquisition process can result in delays in ILS planning. This affects the efficiency and effectiveness of support equipment reviews, provisioning reviews, and other ILS processes.

ACCURACY AND CURRENCY

Data delivered for reviews is often out–of–date and inaccurate. By the time a review takes place, the data delivered to the Air Force are at least thirty days old. The manual compilation and distribution of paper reports is time consuming and labor intensive. The result is often a review that does not reflect the current configuration or state of the design. This decreases the value of the review and increases the need for further reviews to examine updated information.

Separate and uncoordinated reviews are often held to address data supporting different ILS elements (for example, provisioning and support equipment). Delays in the feedback of decisions from one review, combined with the long lead times to develop data for subsequent reviews, can result in conflicting decisions and decisions based on inaccurate data. This problem is further complicated by the use of multiple keys to access and update data. Often the same data elements are stored in different records and accessed using different indices. This leads to the element being updated in one record and not in another.

In addition, the review process often requires data that are not stored in the LSAR, such as drawings, and supporting reports such as use studies, and trade–off analyses. Consequently, the LSAR is not a complete source of information for LSAR reviews; this results in reviews either being delayed while necessary information is collected, or proceeding with incomplete information.

The tailoring process is another aspect of this issue. Tailoring is the process of selecting those portions of MIL–STD–1388 that will be placed on contract for a particular acquisition program. The LSA process must be tailored for each program. Many programs do not tailor the LSA process sufficiently. This results in additional costs for the development, and delivery of duplicate data or data that has no value to the program. Conversely, if tailoring is not performed with the requirements of the end user in mind, insufficient data to support the system may be purchased. The net result is an increase in time and money for support over the life of the weapon system.

The LSAR is often viewed in the Air Force as an unreliable source of information. This is partly due to the fact that there is little accountability for changing data in the LSAR. The LSAR most often does not include information on who authored the data, or when and why the data was created or changed.

EASE OF USE

There is a need to access data to answer questions relating to the specific needs of an acquisition program. Flexibility to format the data to respond to ad hoc queries is lacking. Currently, this process consists of manually aggregating data from several reports. This is a time–consuming, costly and error prone way to access needed data. The problem exists primarily because the current delivery standard for data is paper reports, often containing several hundred pages of data, in a fixed format.

USE OF TECHNOLOGY

The SPO is responsible for the acquisition of the weapon system; this includes contractor progress reviews and management decisions. Consequently, the SPO needs access to the best available information to solve the various acquisition issues. The LSA community faces several impediments in adopting new automation technologies that could simplify the process.

For instance, relational technology is only gradually being introduced into MIL–STD–1388. In addition, only a few major contractors have integrated their LSA system with CAD/CAM systems to analyze a design for supportability considerations.

3.2.2 Recommendations

3.2.2.1 Large Programs

For large acquisition programs, the Air Force should require on-line access to a contractor's LSA system and related systems in the Acquisition phase of the life cycle. This will result in timely, accurate, and current LSA data that will enable the Air Force to take a proactive role in LSAR reviews. Reviews will be more timely and cost–effective. Personnel will be better prepared for reviews and fewer on–site reviews will be necessary. The C–17 is a working example of this approach. The infrastructure for future LSA programs is depicted in FIGURE 3-1.

Each organization that needs access to the information is connected directly to the contractor's automated system. The SPO maintains control over data that has been submitted for review and data that has been approved as a result of prior review. The contractor controls the working data in the database.

RATIONALE

The above recommendations are based on the following rationale:

The time taken to receive, distribute, and review LSAR data and to manage LSA is reduced through on-line access to a contractor's system. The contractor would provide the terminals or workstations to all Air Force users including the SPO, ALC, and Using Command. Comments from organizations are input through terminals (or workstations) and reviewed electronically. This would cut down the need for face–to–face reviews, which are time consuming to schedule and costly in terms of travel.

Contractors can provide a relational (or eventually an object–oriented) database system for compiling data and reports and for storing the data. This process is faster than manually compiling the review information and would improve accuracy and currency. It would also help to ensure that all reviewers were looking at the same version of the data containing the latest available information about the design.

A relational database system provides ad hoc query capability with a minimum of user computer knowledge. With this capability the reviewers could manipulate data electronically. Automated review capabilities could be built into the data base system to perform many of the labor–intensive consistency checks that are required today. This would allow the reviewer to focus on the information he/she is responsible for. Ease of use would also encourage additional analyses of the data, which would lead to better reviews.

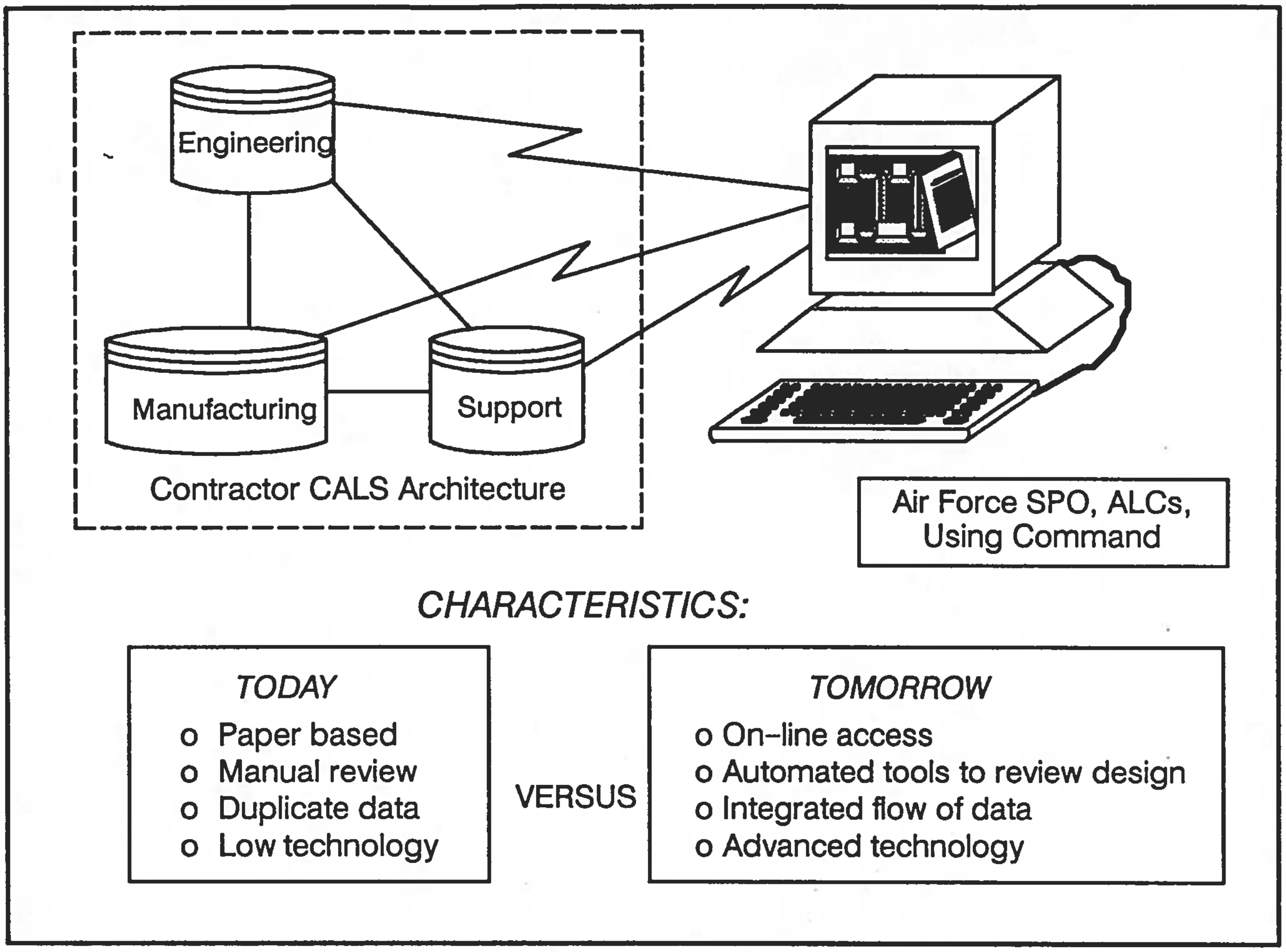

FIGURE 3-1. INFRASTRUCTURE FOR FUTURE LSA PROGRAMS

In the long-term, the Air Force will be able to migrate with technology enhancements through contractor-supplied systems. Contractors can often apply the latest technology more quickly than government computer systems, which are modernized through competitive procurement cycles. Use of modern technology would make user access to drawings and related data easier through on-line techniques. Expert systems could improve the efficiency and effectiveness of the tailoring process. New database techniques would allow data types such as drawings and reports to be stored in a database and displayed with LSAR data on high resolution workstations. New review tools could assess the design supportability and the logistics resources estimated. Having all the data in a single source, would assist users in understanding design information.

This recommendation avoids the cost of developing and maintaining an Air Force, acquisition-phase LSAR system that would have to meet the needs of a wide range of programs. It would also eliminate the need to exchange data between systems.

3.2.2.2 Small Programs

For small acquisition programs, it may not be cost–effective to contract for on-line access to contractor systems. In these cases, there is a need to continue to plan for in–house Air Force system(s) so that LSA data can be digitally received and reviewed.

3.2.3 Strategy

3.2.3.1 Large Programs

To ensure that the information available from a contractor's system can be accessed by the Air Force, contract language must include requirements that the contractor provide the necessary access to its automated system. The contractor system should provide standard formats as well as ad hoc reporting capabilities. Access to the contractor's system must include access to all data needed for reviews. In most cases this will require the use of graphic workstations that can integrate and display drawings and data. Both MIL–HDBK–59 (the DoD CALS Program Implementation Guide) and some recent weapon system programs have developed contract language to meet this need. A new or revised specification describing Air Force functional requirements for an LSAR system may also be needed to describe specific capabilities such as global updating.

Control of the data is essential to maintain the integrity of the reviews. The Air Force SPO must be the approving authority for the data with control and authority over users, including the contractor, to effectively manage the review process. FIGURE 3-2 illustrates the alternative methods of physically controlling data during an LSAR review. In the contractor–direct method, the SPO approves a snapshot of the database to be reviewed by all involved Air Force commands, including the SPO. Each command is then able to directly read the SPO–approved data. In the SPO–based method, the SPO physically receives the data from the contractor and has a computer infrastructure in place to provide access to other Air Force commands. In both cases, the SPO has a role in assuring that all reviewers are reviewing the same LSAR data.

Delivery of data in standard format is necessary to ensure that acquisition data can be used again. There are several situations where this is the case: modifications to the weapon system, spares procurement, production restarts, and mission changes all require analyses that would benefit from easy access to logistics support data developed during prior acquisitions.

3.2.3.2 Small Programs

Acquisition organizations will need to monitor the availability of commercial and government–supplied systems to determine those which best meet their management and review needs. Interchange between acquisition organizations will provide the latest available alternatives and experience. The status of MRSA's plans for MIL–STD–1388 and automated support provided by MRSA will be another factor.

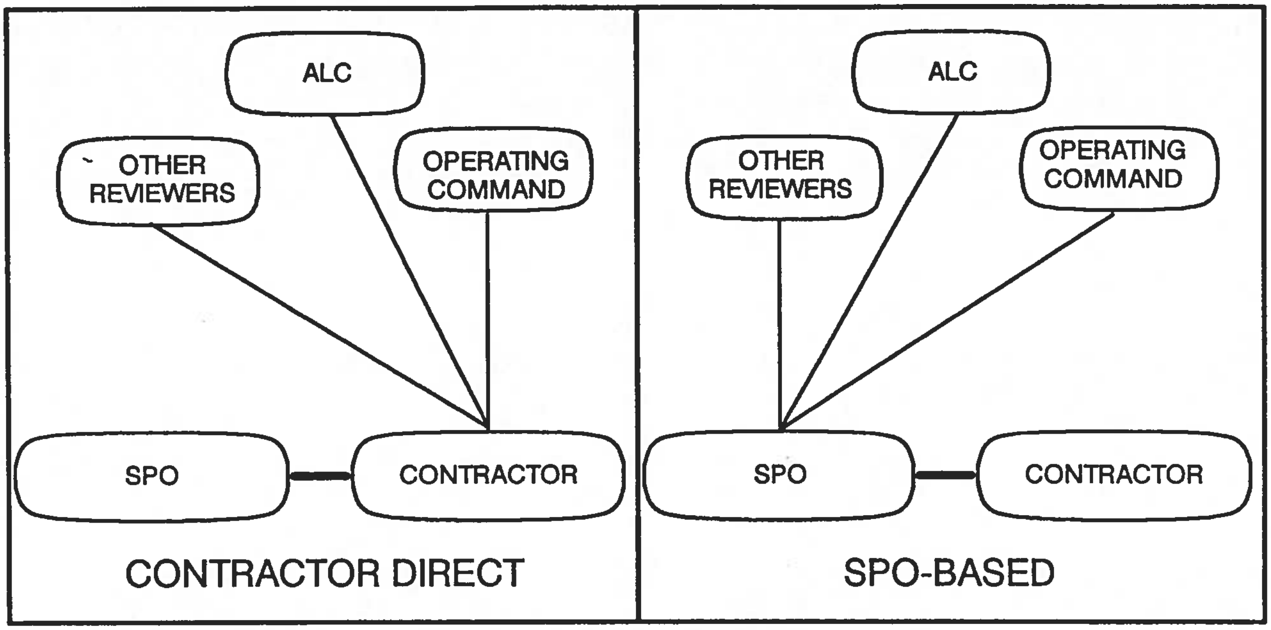

FIGURE 3-2. DATA REVIEW METHODS

3.3 INITIALIZE

3.3.1 Finding

The LSAR is developed in detail through the Full Scale Development (FSD) phase. The LSA process is designed to integrate the information and assess the impact of one logistic support area on another. For instance, facilities and support equipment requirements have been developed using data pertaining to hazardous materials used in provisioned items. Similarly, provisioning and support equipment data rely on predictions of Mean Time Between Repair (MTBR) and Mean Time To Repair (MTTR). By the end of FSD, the weapon system design has been baselined and the LSAR is complete, down to the lowest replaceable unit. Data from the LSAR are delivered to the respective supporting organizations who use the data to initialize the AFLC support systems.

There is a critical period in Acquisition, between the end of the Full Scale Development phase and the beginning of the Production phase, where the LSA process concludes in practice. The LSAR should, in the beginning of this Production phase, receive data from testing and operation of early production units for comparison with the predicted data. This data often does not return to the LSAR. The support areas that receive the data to initialize their systems from the LSAR often rely on other sources of information. Provisioning and support equipment changes may modify the LSAR values, but the changes are not entered into the LSAR changes. By keeping the LSAR current, the Air Force can avoid recreating data and expedite depot activation.

After initialization of the support systems, the operation of the system begins. During this period, the design for the system undergoes a number of changes. Engineering Change Proposals (ECP's) are developed, based on the results of early operations. The supportability issues of ECPs are not as systematically reviewed as the original designs. No information is fed back to the LSAR where the LSA process should be used to integrate these changes and update the support elements. The result is that the LSA process is not effective throughout production; the LSAR loses its value as a tool for integrating the support areas; changes to ILS elements are not made to reflect ECPs and test and evaluation results.

3.3.2 Recommendation

The Air Force needs to continue to impose the discipline of the LSA process on the support elements by keeping the LSAR updated at least through a major portion of the production phase or until PMRT. This will encourage continued use of the LSAR as a reliable source of logistics support information for ILS processes and their related systems.

Proposed changes should be fed into the LSA process during the production phase. Reports from the LSA process would define the impact of proposed changes using data from all the support areas. These reports could be used by the Configuration Control Board to approve changes. Once the contractor updates the LSAR, the same mechanisms that initialized the support systems can issue updates.

3.3.3 Strategy

The Air Force should require that the contractor keep the LSAR up–to–date through the production phase. The LSA process should continue to function under the direction of the SPO. The cost of this recommendation should be outweighed by the benefits from maintaining the discipline of the LSA process on ILS elements. Delivery of contractor LSAR data to the Air Force will be needed at points near the end of FSD and during production in order to initialize and update AFLC systems.

3.4 MAINTAIN

3.4.1 Finding

Opportunities to use LSA or related data and the discipline of the LSA process should be examined for use in the O&S phases. This involves analyzing organizations that participate in the logistics support information process that are directly responsible for the system support. This includes the performance of supportability assessments (LSA Task 500) during O&S.

3.4.2 Recommendation

To ensure that the recommendations for the future development of automated systems to support logistics support information are complete, it is necessary to examine the potential for using the LSA process and its data during O&S phase functions. This should be done using a modular planning process that would 1) examine the current flow of LSA data into O&S systems, 2) study the planned and existing systems involved in that flow, and 3) define automation recommendations.

3.4.3 Strategy

The Operational Support module to study this area has begun. The results of this study will be combined with the findings of the LSA module to develop automation recommendations for logistics support data that will cover both the Acquisition and O&S phases of the system life cycle.

SECTION 4: CONCLUSION

This report summarizes the future state concepts developed during the LSA planning study. It describes current and future trends that will be influencing the Air Force LSA environment and presents automation findings, recommendations, and strategies. These will be combined with the results of the Operational Support study into a consolidated set of automation recommendations for logistics support information. Major recommendations are summarized below:

- The Air Force should provide readily available and automated access to high–level, predicted and actual logistics support information from existing systems as input to Pre–Concept and Concept Exploration activities. By providing access to logistics support information, the overall requirements of the proposed system could more readily include supportability factors. Access to data should include automated lessons learned databases. The data should be readily available to Air Force and contractor design personnel in an automated manner.
- For large acquisition programs, the Air Force should require on-line access to a contractor's LSA system and related systems during the Acquisition phase of the life cycle. This will provide the Air Force with timely, accurate, and current LSA data, enabling the Air Force to take a proactive role in LSAR reviews. It will also give the Air Force more complete data for performing LSAR reviews because related engineering drawings, tradeoff studies, and other pertinent information will be more readily available. Reviews will be more timely and cost–effective. Personnel will be better prepared for reviews and fewer on–site reviews will be necessary.
- For small acquisition programs, it may not be cost effective to contract for on-line access to contractor systems. For small programs, there is a need to continue to plan for in–house Air Force systems to receive LSA information so that it can be digitally received and reviewed.
- Air Force SPOs should maintain the discipline of the LSA process and require that contractors keep the LSAR data current through the production phase of the life cycle. The supportability issues of ECPs, test & evaluation results, and other production phase activities can be subject to the rigors of the LSA process just as the original designs were. Changes to ILS elements could then be made to reflect production phase activities. As a result, the LSA process and the LSAR would provide value as tools for integrating the support areas during the production phase. The data would continue to be useful for such AFLC functions as provisioning, support equipment, and reliability and maintainability data.
- To ensure that the recommendations for the future development of automated systems to support logistics support information are com-

plete, it is necessary to examine the potential for using LSA and related data in O&S phase functions. This should be done using a modular planning process that would examine the current flow of LSA data into O&S systems, study the planned and existing systems involved in that flow, and define automation recommendations.