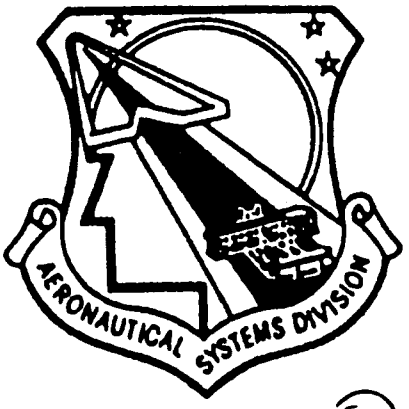

ASD-TR-91-5011

SIMULATOR DATA INTEGRITY PROGRAM; PROCESS STANDARD DEVELOPMENT

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April 5, 1991

Final Report for 5 December 1988 - 5 April 1991

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Training Systems/Systems Program Office
Aeronautical Systems Division
Air Force Systems Command
Wright-Patterson Air Force Base, Ohio 45433-6503

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This report is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

Lt John S. Nehir

James D Basinger

Project Engineer
Training Sys/Sys Development Office

FOR THE COMMANDER

MICHAEL E. UECKER, Lt Col, USAF
Director for Advanced Programs
Training Systems System Program Office

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The Simulator Integrity Program is a component of the overall Air Force initiatives to improve the quality, performance, scheduling and supportability of Aircrew Training Equipment. This program focuses on the quality, timeliness, currency, and maintenance of the technical information (source data) generated in the weapon system organizations and used in the training equipment development and support organizations.

In accordance with the Statement of Work for the Simulator Data Integrity Program this report documents the methodology, findings, accomplishments, conclusions and recommendations associated with the development, review, and introduction of the principal product of this effort, Military Standard - Aircrew Training Equipment Source Data Process Standard MIL-STD-XXXX, October, 1990.

A general description of the overall effort is provided in Appendix 1, "Bridging The Information Gap".

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FOREWORD

This document frequently makes reference to the contents and application of a draft military standard which is the principle topic of this report. Although it is not essential, it is recommended that the reader who is not familiar with the Simulator Data Integrity Program obtain a copy of MILITARY STANDARD: AIRCREW TRAINING EQUIPMENT SOURCE DATA PROCESS STANDARD, MIL-STD-XXXX, OCTOBER 1990.

At the time of this writing MIL-STD-XXXX is under review within the Air Force. Requests for copies should be directed to: 2nd Lt. John Nehr, Simulator Data Integrity Program Program Manager, ASD/YWB WRIGHT-PATTERSON AIR FORCE BASE, OH 45433-6503. TELEPHONE: DIRECT DIAL 513-255-7177, AUTOVON 785-57177.

SUMMARY

The Simulator Data Integrity Program is a component of the overall Air Force initiatives to improve the quality, performance, schedules and supportability of Aircrew Training Equipment. This program focuses on the quality, timeliness, currency, and maintenance of the technical information (source data) generated in the weapon system organizations and used in the training equipment development and support organizations. The principle product of this program is the Military Standard: Aircrew Training Equipment Source-data Process Standard (DRAFT) MIL-STD-XXXX, October 1990.

This document is the Final Report describing the development of MIL-STD-XXXX during the time period from January, 1989 through March, 1991. The objective of this report is to generally describe the program activities, findings, conclusions and recommendations associated with the development of MIL-STD-XXXX. This standard is the product of collaboration with the Weapon System contractors, Training Equipment contractors, Air Force and other government organizations that participated in the Industry/Service Working Group (I/SWG) activities. The standard was developed using the classic approach of baselining the definitive end-user requirements upon which a systems engineering process model was structured. The integrated requirements and the process model went through several progressive changes as a result of field surveys and subsequent reviews by the Air Force and the I/SWG.

The adopted version of MIL-STD-XXXX is intended to be tailored for application in the RFP(s) for the Major Weapon Systems and the associated Aircrew Training Equipment. The standard delineates the requirements for a systems engineering approach to developing and maintaining source data products at the Weapon System and Training device levels. The Weapon System contractors will generally initiate the processes by the progressive development of training-oriented source data products that are configured to the emerging Weapon System and the emerging Air Crew Training System. The processes include Requirements Analyses, Product Development, Verification, Integration, Configuration Management, Certification, Validation, Repositories, Reporting, Interface Control and Database Management.

Similar processes are implemented by the Training Equipment contractors for the development, design, test, and Contractor Logistics Support (CLS) of the fielded training equipment. Associated with this effort is the requirement for the Life-cycle support of the source data products by all contractors. A key objective of this initiative is to minimize the time required to acquire source data needed to support modifications of the training devices.

The principal conclusions of this report are:

- **VALIDATION OF PREVIOUS RESEARCH**
  This effort has served to re-affirm and expand the original findings, conclusions, and recommendations of the 1988 Simulator Data Integrity Study (ref ASD-TR-88-5024).

- **MIL-STD-XXXX IS A VIABLE APPROACH**
  The implementation of the Military Standard: Aircrew Training Equipment Source Data Process Standard, MIL-STD-XXXX; will significantly improve the quality, concurrency and timeliness of Aircrew Training Equipment.

- **TRAINING EXPERTISE UP-FRONT**
  The Weapon System contractors, will find it necessary to apply training oriented expertise to the development of the source data products used by the training equipment developers.

- **A HANDBOOK IS NEEDED**
  The initial application of MIL-STD-XXXX to any given combination of emerging Weapon Systems or Aircrew Training Equipment requires the use of a companion reference document (Handbook) that provides guidance in the identification of Source Data Requirements.

- **MIL-STD-XXXX ENVIRONMENTS**
  The effectiveness of MIL-STD-XXXX will be greatly enhanced in the environment where either or both Concurrent Engineering (CE) and Computer-aided Acquisition and Logistics Support (CALS) requirements are invoked.

The principal recommendations of this report are:

- **IMPLEMENTATION OF MIL-STD-XXXX**
  It is recommended that the implementation of MIL-STD-XXXX focus on the objective of integrating the requirements of the Simulator Data Integrity Program within the Systems Engineering Master Schedule (SEMS) applied to major weapon system acquisitions.

- **MIL-STD-XXXX APPLIED TO TRAINING SYSTEMS**
  It is recommended that the next revision of MIL-STD-XXXX address the requirements for source data products needed in all areas of Aircrew and Maintenance Training Systems.

- **EXPLOITING THE CALS INITIATIVES**
  It is recommended that the application of MIL-STD-XXXX be structured to take full advantage of the information management, database requirements and capabilities associated with the CALS initiatives.

- **JOINT SERVICE ADAPTATION OF MIL-STD-XXXX**
  It is recommended that MIL-STD-XXXX be reviewed and revised as required for use by the U.S. Navy, and the U.S. Army as a joint Military Standard, or a DOD Standard.

- **COLLABORATION WITH THE FLIGHT TEST AGENCIES**
  It is recommended that the appropriate flight test agencies provide expertise and support in the development, verification and validation of training-critical MIL-STD-XXXX Source Data products.

A generalized description of the Simulator Data Integrity Program is provided in Appendix 1, "Bridging the Information Gap", a paper presented at the 1989 I/ITEC conference proceedings.

INTRODUCTION:

The Simulator Data Integrity Program is a Systems Engineering approach to the development and maintenance of the technical information (source data) needed for the development, design, construction, integration, testing, maintenance, modification, concurrency, and life-cycle support of U. S. Air Force, Aircrew Training Simulators and associated training equipment. The objectives of this program is to reduce flight simulator development schedules and life cycle costs.

This program is the outflow of the Simulator Data Integrity Study, completed in 1988, which identified the fundamental problems associated with the quality, timeliness, adequacy, integrity, interoperability, concurrency, and management of the source data provided by the Weapon System organizations and used by the Training Equipment and Training System developers and operators. The final report of that effort, ASD-TR-88-5024, Simulator Data Integrity Study, April 1988, Shaw, J.J. and Gibino, D. J. (DTIC AD# B-131 809) documents the technical and non-technical aspects of these problems. The principle recommendations of the study focused on the requirement for quality-based systems engineering processes for both the weapon system contractors and the simulation equipment developers and users.

The purpose of this program is to establish uniform practices that will ensure the quality, timeliness, effectiveness, and supportability of the various technical information obtained from the weapon system community and used by the training equipment developers and operators. The scope of effort is to identify and define the process requirements leading to the development of a military standard that will achieve the program objectives. Associated with this effort is the collaboration between industry and the Air Force in the form of an Industry/Service Working Group (I/SWG) to provide feedback and develop consensus for the process standard.

This report documents the methodology, findings, accomplishments, conclusions, and recommendations associated with the development, review, and introduction of the Military Standard - Aircrew Training Equipment Source Data Process Standard, MIL-STD-XXXX October, 1990.

The structure of this report is based on the task requirements of the Statement Of Work, Project Plan, and the completed effort. The report provides an overview of the salient activities in the four program phases. It also provides insight into the areas of difficulty and the recommendations for further consideration. A comprehensive description of the program is provided in Appendix 1, "Bridging the Information Gap", a paper presented at the 1989 Interservice/Industry Training Equipment Conference.

METHODOLOGY:

The development of the Aircrew Training Equipment Source Data Process Standard is based on classic Research and Development methods. The overall approach was predicated on a detailed requirements definition that established the baseline criteria for the process standard. In parallel with the development of the standard was the formative reviews by both government and industry organizations. The structured project functional flow is illustrated in Figure 1 and described below:

Phase A - Project Planning:
Those activities associated with the coordination and preparation of the project plan.

Phase B - Requirements/Definition:
During this phase the overall requirements for the source data processes were identified, analyzed and integrated into a systems engineering oriented process model that established the process flow, relationships and interfaces.

The research activities associated with the identification of requirements was accomplished through the use of data searches, mail surveys and field surveys. The field surveys involved interviews with 10 Weapon System Contractors, 8 Training System Contractors, 4 USAF Using Commands, 9 USAF Aeronautical Systems Division organizations, 3 USAF Flight Test Center organizations, Air Force Logistics Command, U.S. Navy Training System Center, 2 Commercial Aircraft Manufacturers, FAA, and others. It is estimated that approximately 155 individuals participated in the field surveys and interviews.

The data reduction and integration was accomplished progressively and in parallel to develop the frame of reference for the Requirements Taxonomy and the Process Model. This model evolved through a series of reviews and adjustments to accommodate diverse areas of interest. The final version of the model is illustrated in Figure 2. The integrated requirements were documented in the Requirements Taxonomy provided at the completion of Phase B.

> *(NOTE: The Requirements Taxonomy is no longer current due to the subsequent activities in Phases C and D that introduced new, and/or revised requirements and methods.)*

Phase C - Develop Standard:
This phase consisted of two parallel efforts - preparation of the military standard and the Industry/Service Working Group (I/SWG) review of the military standard.

The preparation and authoring of the preliminary version of the military standard was based on the approved Requirements Taxonomy and the Process Model completed in the preceding phase and further revised in this phase. This version of the standard was reviewed and coordinated with the Air Force prior to release to the I/SWG, who participated in a series of reviews providing input on the functionality, substance, language and implementation of the standard.

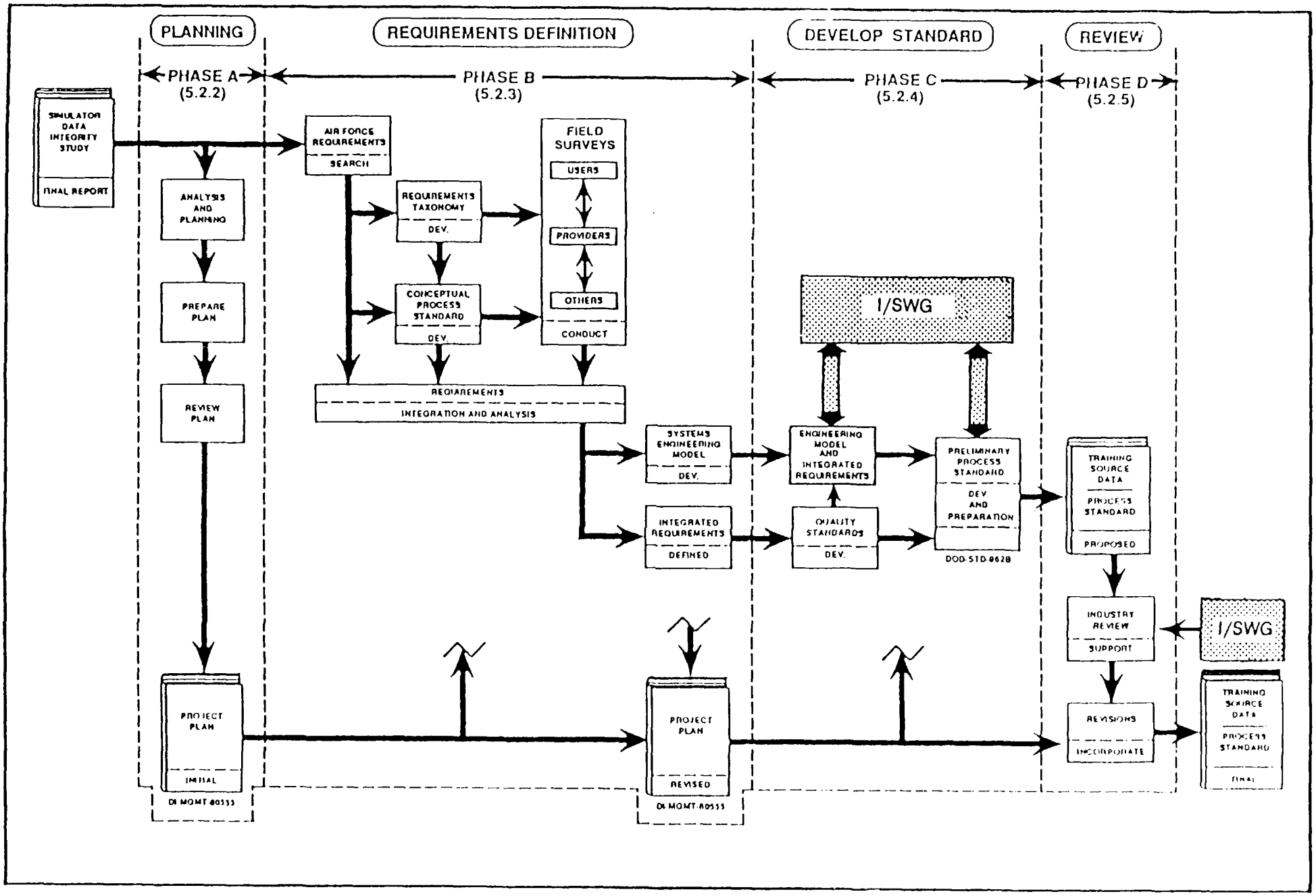
The I/SWG effort was directed at obtaining the perspectives and consensus of the various interest groups to the basic concept of the processes under consideration for incorporation into the standard. Accordingly, we solicited and obtained substantial verbal and written input from the I/SWG representatives. This input was analyzed and reviewed with the Air Force prior to integration into the process standard. A synopsis of the overall response of the I/SWG is included in the Results section of this report.

The final version of the proposed draft Military Standard, MIL-STD-XXXX Aircrew Training Equipment Source Data Process Standard, dated October 1990, incorporated the coordinated composite requirements of the I/SWG and the Air Force organizations that would be responsible for the implementation of the standard. This document was formally delivered to the Air Force on October 4, 1990.

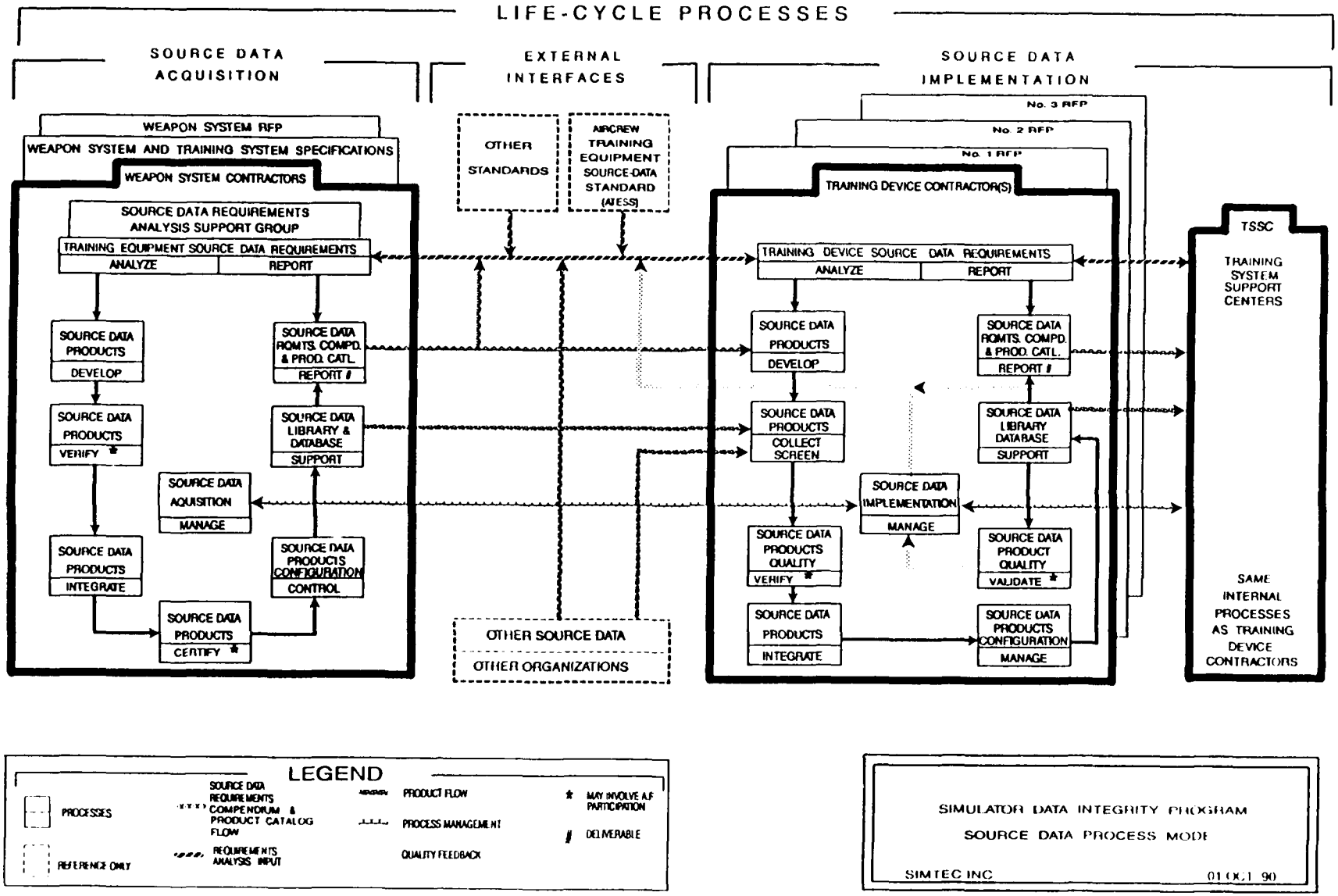
Phase D - Industry Review:
The final phase of the effort to develop the process standard was originally intended to provide a broad-based industry review in the form of an Industry/Government Workshop. The Workshop would provide the means of indoctrination and familiarization to the Weapon System and Training System/Training Equipment communities as well as a forum to develop further improvements in MIL-STD-XXXX and the overall Simulator Data Integrity Program.

> *(NOTE: The planning for this phase was changed to facilitate an additional Air Force initiative to develop a Military Handbook as a companion document to the MIL-STD-XXXX. Accordingly, it was decided to defer the broad-based industry review until the Handbook is sufficiently developed.)*

This approach was found to be very effective in that the overall development of the process standard was a collaboration between diverse interest groups. It was essential to obtain and exchange insights into needs and concerns of the Weapon System organizations and the other organizations that are critically dependent on the source data generated in the Weapon System community.



Project Planning Functional Flow
Figure 1.



Source Data Process Model
Figure 2.

RESULTS:

The results of this effort is divided into two areas:

- o Completion of the Military Standard: MIL-STD-XXXX.
- o Completion of the I/SWG Activities.

MILITARY STANDARD - COMPLETION

The principal results of this effort are incorporated in the draft Military Standard: Aircrew Training Equipment Source-Data Process Standard, MIL-STD-XXXX, October 1990. It contains the products of the fact finding, investigations, analyses, reviews, I/SWG feedback and other associated activities that contribute to the substance of the process standard. At the time of this writing, the October, 1990 Draft version of MIL-STD-XXXX is under review within the Air Force, as a preliminary step leading to the formal adoption and release of the Military Standard in the USAF MIL-PRIME program.

I/SWG ACTIVITIES - COMPLETION

The secondary results of this effort was the completion of the I/SWG related activities over a period of two years. Table No.2 summarizes the I/SWG representation during this effort.

The initial I/SWG activities involved series of field surveys and interviews with both Industry and Government organizations to identify the source data process requirements. Thirty eight (38) organizations and approximately 155 individuals participated in that activity.

The second set of activities was directed at a series of three (3) I/SWG meetings held in Manassas, Virginia in April, June and August, 1990. These meetings provided valuable information from the perspective(s) of the diverse interest groups involved with the development and maintenance of source data. Generally, the information was in the form of verbal and written input from both Industry and Government representatives. The inputs were processed and reviewed by the Air Force for integration into MIL-STD-XXXX. The objectives of the individual meetings and the total I/SWG effort were achieved. The following is a synopsis of the three meetings and associated activities based on the meeting minutes and other documentation generated and delivered during that time period:

A. PRELIMINARY I/SWG ACTIVITIES:

The preliminary activities associated with the planning, preparation, solicitation and other management activities were initiated in January 1990. The principle elements of this activity are:

1. The overall planning and coordination of the I/SWG effort.
2. The preparation of the I/SWG Charter and Frame of Reference.

3. The preparation of the draft USAF letter to Industry that announced the formation of the I/SWG and invited industry participation. The letter was signed by the ASD Commander Lt. Gen. Loh, and distributed on 5 March, 1990 to the I/SWG.

4. The liaison with Industry organizations to determine their interest and to designate the I/SWG representative(s).

B. I/SWG MEETINGS:

1. The following tasks were completed for each of the three meetings:
   - o preparation and coordination of all meeting materials,
   - o technical support to the Air Force during the meetings,
   - o provisioning of meeting facilities and equipment, and
   - o miscellaneous administrative support services.

2. I/SWG Meeting No. 1 - (17-19, April 1990) Attendance: 60 people representing 37 organizations. This meeting served to indoctrinate the I/SWG to the overall program, familiarization with the source-data systems engineering model and to review the process standard requirements taxonomy. During this meeting 88 written inputs were received. The first I/SWG meeting minutes (18 May, 1990) documents the results of the meeting.

3. I/SWG Meeting No. 2 - (12-14, June 1990) Attendance: 43 people representing 34 organizations. This meeting was directed at the initial review of the draft process standard, which included a walk-through of the interim draft document. Each element of the standard was presented and discussed as appropriate. During this meeting 126 input forms were received, and reviewed by the Air Force. The meeting minutes (11 July, 1990) documents the proceedings.

4. I/SWG Meeting No. 3 - (14-16, August 1990) Attendance: 34 people representing 24 organizations. This meeting addressed the revised draft process standard and the implementation of the Simulatory Data Integrity Program. A second walk-through of the revised draft process standard was completed. The approach to the implementation of the process standard was discussed in considerable detail. During this meeting 36 input forms were received and reviewed by the Air Force. The meeting minutes (20 Sept. 1990) documents the proceedings of this meeting.

5. The information obtained during the I/SWG meetings was reviewed in detail by SIMTEC and the Air Force to determine the requirements for changes to the process standard. It should be noted that the majority input focused on implementation and cost issues as opposed to the content of the process standard.

ORGANIZATIONS	SURVEYS	MEETING	MAIL LIST
INDUSTRY ORGANIZATIONS			
WEAPON SYSTEM PRIME CONTRACTORS			
MAJOR WEAPON SYSTEM CONTRACTORS:			
Boeing Defense and Space Group			
- Military Airplane Division	x	x	x
Douglas Aircraft Company	x	x	x
General Dynamics Corporation			
- Ft. Worth Division	x	x	x
Lockheed Aeronautical Systems Company		x	x
McDonnell Aircraft Company	x	x	x
Northrop Corporation			
- Aircraft Division	x	x	x
Rockwell International			
- North American Aircraft Operations			x
PROPULSION SYSTEM CONTRACTORS:			
GE Aircraft Engines Engineering Division	x	x	x
Pratt & Whitney Group			
- Government Engines Business		x	x
AVIONICS SYSTEM CONTRACTORS:			
Honeywell Defense Avionics Systems			x
IBM System Integration Division	x	x	x
Martin-Marietta Electronics and Missiles Group	x	x	x
Unisys Defense Systems			x
Westinghouse Electric Corporation			
- Electronics Systems Group	x		x
OTHER CONTRACTORS:			
Kohlman Systems Research, Inc.		x	x
Systems Control Technology (SCT)		x	x
TRAINING SYSTEMS PRIME CONTRACTORS			
TRAINING EQUIPMENT CONTRACTORS:			
AAI Corporation	x	x	x
Boeing Aerospace & Electronics	x	x	x
Burtek			x
CAE Electronics LTD.	x	x	x
CAE-Link Corporation			
- Flight Simulation Division	x	x	x
ECC International Corp.		x	x
Flight Safety International, Inc.	x	x	x
General Electric Company			
- Simulation & Control System Dept.		x	x
Hughes Training and Support Systems Group	x	x	x
Loral Defense Systems-Akron	x	x	x
McDonnell Douglas Training Corp.	x	x	x
Quintron Corporation		x	x
Reflectone, Inc.	x		x
OTHER INDUSTRY ORGANIZATIONS:			
Boeing Commercial Airplane Group	x	x	x
Grumman Electronics System Division		x	x

INDUSTRY/GOVERNMENT WORKING GROUP (I/SWG) PARTICIPATION

Table 1

ORGANIZATIONS	SURVEYS	MEETING	MAIL LIST
GOVERNMENT ORGANIZATIONS			
UNITED STATES AIR FORCE:			
AERONAUTICAL SYSTEMS DIVISION (ASO)			
C-17 System Program Office (ASD/YC)		x	x
Advanced Tactical Fighter Program Office (ASD/YF)		x	x
Engineering (ASD/EN)	x	x	x
Training System-System Program Office (ASD/YW)	x	x	x
AIR FORCE LOGISTICS COMMAND (AFLC):			
Hill AFB Ogden, UT (AFLC 00-ALC/MMI)	x	x	x
AIR FORCE SYSTEMS COMMAND (AFSC):			
Air Force Flight Test Center, Edwards AFB, CA	x	x	x
HEADQUARTERS USAF (XOOTW)	x	x	x
TRAINING COMMAND (HQ. ATC)	x		
MATERIAL AIR COMMAND (HQ. MAC/DOT)	x	x	x
STRATEGIC AIR COMMAND (HQ. SAC/X0R)	x	x	x
TACTICAL AIR COMMAND (TAWC/TNT)	x	x	x
AIR NATIONAL GUARD (NGB/XOPM)		x	x
U.S. NAVY			
Naval Training Systems Center	x	x	x
OTHER GOVERNMENT AGENCIES:			
Federal Aviation Administration (FAA)	x	x	x

INDUSTRY/GOVERNMENT WORKING GROUP (I/SWG) PARTICIPATION

Table 1 Continued

FINDINGS:

The salient findings of this effort are:

FINDING No. 1 - I/SWG CONSENSUS

There is a consensus within the organizations that participated in this effort, (see Table No. 1) that the Simulator Data Integrity Program and the fundamental requirements of MIL-STD-XXXX will yield significant improvements in the quality, effectiveness, concurrency, validation, and life-cycle costs of Aircrew Training Equipment.

FINDING No. 2 - INITIAL BENEFITS - PERFORMANCE AND SCHEDULE IMPROVEMENTS

The initial benefits of implementing MIL-STD-XXXX will be evident in two areas: the quality of the end-products and the effectiveness of the training equipment test program. The quality of the training equipment will be improved in direct proportion to the quality of the design information provided to the equipment designers. Likewise, the effectiveness and efficiency of the training equipment test program will be improved as a result of the quality and credibility of the test information provided to support the test and evaluatin processes. The combined effect of these two improvements will be increased training equipment performance and a reduced program schedule.

FINDING No. 3 - LONG-TERM BENEFITS - TRAINING EQUIPMENT CONCURRENCY

The long term benefits of the use of MIL-STD-XXXX is the life-cycle availability of high quality source data products that are maintained concurrently with the configurations of both the Weapon System and Aircrew Training System. The principal pay-off is the reduction in both cost and schedule of training equipment modifications and upgrades.

FINDING No. 4 - TIME RELATIONSHIPS - START EARLY!

The effectiveness and efficiency of the Simulator Data Integrity Program will increase in direct proportion to the timeliness of implementing MIL-STD-XXXX. There are critical windows of opportunity that typically occur only once in each Weapon System program, that must be exploited to yield cost-effective Training Simulation Design and Verification Data. The emerging weapon system programs responding to MIL-STD-XXXX starting at, or before, Milestone One will be able to take advantage of the windows of opportunity such as:

- o Human Factors Engineering Studies
- o Mission and Task Analyses
- o Research and Design (R&D) Simulations
  - Propulsion System Design
  - Wind Tunnel Studies
  - Vulnerability Simulations
  - Other Analyses
- o Test and Evaluation Master Plan (TEMP)
- o Training System
  - Analysis and Design
  - Development
  - Evaluation

- o Weapon System Design
  - Engineering Development Simulations
  - Flight Control System Design
  - Aerodynamic Design
  - Avionics Design
  - Failure Mode Analyses
- o Weapon System Testing (DT&E/IOT&E)
- o Weapon System Modification/Update Programs

Although the processes delineated in MIL-STD-XXXX are intended to be applied to emerging weapon systems, it is anticipated that (with appropriate tailoring) significant benefits can be realized in mature weapon systems undergoing major modifications and upgrades, provided that the effort is initiated at the earliest possible point in time.

FINDING No. 5 - SUPPLEMENTARY GUIDANCE

The identification of the requirements for source data is the most critical process within MIL-STD-XXXX. The Weapon System contractors and the Training Equipment contractors represented in the I/SWG strongly recommended that supplemental guidance in the form of a Military Handbook should be in place as a companion document to MIL-STD-XXXX. The purpose of the handbook is to provide a reference resource to aid the weapon system and training equipment contractors in the preliminary identification of the source data needed for various training devices. The handbook should identify the essential characteristics of source data based on generic applications. Appropriate technical details should be included to permit the weapon system engineers to translate the generic characteristics to weapon system specific characteristics. The secondary application of the handbook is to permit the weapon system contractors to estimate the tasking, resources and schedules associated with the development and life cycle support of source data products.

FINDING No. 6 - WEAPON SYSTEM CONTRACTORS - TRAINING SMART:

For the effective implementation of MIL-STD-XXXX by the Weapon System contractors (primes and subcontractors alike), it is apparent that they should apply training simulation oriented expertise and other simulation resources for the development and maintenance of the source data products. These training oriented resources are essential for the translation of training functionality into quality based source data products. Typically these skills and resources must be applied concurrently within the mainstream of the development and testing of the major weapon system and it's components. This is a new role for the Weapon System contractors that have parallels in the design, manufacture and support of commercial airliners.

FINDING No. 7 - AIR FORCE IMPLEMENTATION OF MIL-STD-XXXX

MIL-STD-XXXX was developed in a frame work of functional requirements focused on the technical objectives as opposed to the contractual and acquisition requirements. As the program evolved the implementation issues began to take form. During the I/SWG meetings there was considerable discussion by the various interest groups (military and industry) as to how to implement the standard. These discussions covered a wide range of implications, including: accountability, risk management, reporting, advocacy, costs, transfer of responsibility, delivery and acceptance of source data products, and other related factors. It was determined by the Air Force that a comprehensive implementation plan is needed to effectively apply MIL-STD-XXXX in any given Weapon System/Training System acquisition.

FINDING No. 8 - COMMONALITY CONSIDERATIONS

There is strong evidence suggesting that the concepts of the MIL-STD-XXXX applied to other areas of training will also yield significant improvements. This was further emphasized by the I/SWG in their recommendations that the process standard should be expanded to include other areas of Aircrew Training and Aircraft Maintenance Training. For example, in the case of Maintenance Training Equipment, there is a high level of commonality with the source data required for Aircrew Training Equipment. Other potential applications include:

- o Aircrew Training:
  - Curriculum
  - Courseware
  - Computer Aided Instruction (CAI)
  - Training Materials
- o Maintenance Training:
  - Curriculum
  - Courseware
  - Computer Aided Instruction (CAI)
  - Training Materials
- o Preparation of technical and operations manuals.
- o Logistics Support Analyses.

FINDING No. 9 - ANTICIPATED PROBLEMS - WEAPON SYSTEM ORGANIZATIONS

The application of MIL-STD-XXXX in the weapon system community requires appropriate management control to ensure effectiveness in the Systems Engineering of the total weapon system. Typically, there are numerous requirements for various "data" that ultimately compete for resources in the prime and subcontractors engineering groups. The development of the MIL-STD-XXXX Source Data Products requires the use of the engineering resources from the various engineering organizations that are in the mainstream of the weapon system development. As established in the Commercial Airline environment, the traditional practices of relegating Training Simulator Data to the ancillary support groups such as Ground Support Equipment, or Logistics Support, will not provide adequate results. Therefore, the challenge to the weapon system contractors and sub-contractors is to provide the necessary management initiatives and program priorities that will yield the short and long term benefits of the SDIP.

FINDING No. 10 - ANTICIPATED PROBLEMS - TRAINING ORGANIZATIONS

The application of MIL-STD-XXXX by the Training Equipment contractors and sub-contractors will require special attention in the areas of Source Data Product: Development, Verification, Configuration Management and Validation processes. The requirements for these processes must be integrated into the training equipment Systems Engineering disciplines to ensure that the source data products are maintained current with respect to multiple allocated baselines. The primary baseline is the specific training equipment design criteria. The secondary baselines are the configuration(s) of the Weapon System and the configuration(s) of the associated Aircrew Training System.

As in the case of the Weapon System Contractors (above), the Training Equipment Contractor and sub-contractors will have to break from tradition and initiate management and engineering practices to maintain the integrity of the source data, from the beginning of the development effort to the final delivery of the training equipment with it's complement of source data products. In addition, the Contract Logistics Support (CLS) organization will be responsible for the life cycle continuation of the processes.

FINDING No. 11 - ANTICIPATED PROBLEMS - ACQUISITION ORGANIZATIONS

The overall requirements of MIL-STD-XXXX are based upon the current Air Force acquisition strategies which includes the objective for the contractors to accept full responsibility for the deliverable products. This approach obligates the contractors to the development and the evaluation of the source data products prior to the implementation of the products in the development and evaluation of the Aircrew Training Equipment. The problems associated with this approach is the potential weaknesses in quality assurance of the source data products. This is best illustrated in the case where the government chooses to have the training equipment developed under a separate contract, i.e. not under the prime weapon system contract. In this case, the source data products would pass from one prime contractor to another with limited formal acceptance evaluation by the Government. In some instances this approach will have minimal risk; however, in some of the more critical areas of training simulation the risks are substantial.

FINDING No. 12 - COMPUTER-AIDED ACQUISITION AND LOGISTICS SUPPORT (CALS)

In those Major Weapon System programs that are designated as CALS candidates, the source data products produced under MIL-STD-XXXX will be compatible with the requirements of the DOD Computer-Aided Acquisition and Logistics Support initiatives (Reference MIL-HDBK-59). Accordingly, the Weapon System and Training Equipment Contractors performing under the CALS program will be required to incorporate the source data products into the Contractors Integrated Technical Information System (CITIS) for direct access to those with a need to know. This includes the capability to transfer the source-data products via digital media to the users. This capability will greatly enhance the effectiveness of the overall process requirements of MIL-STD-XXXX.

CONCLUSIONS:

The fundamental conclusions of this effort are:

CONCLUSION No. 1 - VALIDATION OF PREVIOUS RESEARCH

This program has served to revalidate and expand the original findings, conclusions, and recommendations of the 1988 Simulator Data Integrity Study (ref XXX).

The members of the I/SWG and other participants in this program have confirmed that the problems identified in the original study have impacted programs and environments not previously investigated. For example, in the original study we did not have sufficient information to draw any conclusions with respect to the situation where the prime Weapon System Contractor is also responsible for the Aircrew Training System. As a result of the current effort it has been determined that the previously identified data problems are being experienced in those programs where the provider of source data is also the user. In some instances the magnitude of the problems were as similar in scope as the original findings. In one instance, this "in-house" problem caused significant program delays. In another instance, once the "in-house" problem was identified, it took considerable time to bridge the gap between the weapon system engineering groups and the training system/training equipment developer.

CONCLUSION No. 2 - MIL-STD-XXXX IS A VIABLE SOLUTION

The application of the Military Standard: Aircrew Training Equipment Source Data Process Standard, MIL-STD-XXXX, will significantly improve the quality, concurrency and timeliness of Aircrew Training Equipment.

There is a consensus of the I/SWG and other interested groups that the early application of the MIL-STD-XXXX in the emerging weapon systems, or major updates, will yield both short and long term benefits to the contractors and the Air Force. These benefits will be realized in the development, design, evaluation, modification, operation and support of aircrew training equipment. The application of this standard is characterized as an 85% solution to the traditional problems of source data.

In three instances, major weapon system contractors have stated that they will initiate the principal elements of this program in advance of the formal requirement. In another instance the Air Force Logistic Command has indicated that they are considering the application of the standard to an F-16 block modification.

The concurrency of Aircrew Training Equipment will be significantly improved by the timely availability of quality source data products that will represent the evolving configurations of both the weapon system and the training systems. In some instances, the I/SWG has indicated that 50% of the delays associated with simulator modifications are attributed to the lack of required source data.

CONCLUSION No. 3 - TRAINING EXPERTISE UP-FRONT

The Weapon System contractors, will find it necessary to apply training oriented expertise to the development of the source data products used by the training equipment developers.

The requirements of MIL-STD-XXXX focus on the quality and functionality of the source data products used in the design and performance of Aircrew Training Equipment. The development of these products requires expertise within the weapon system organizations that can translate

the requirements for training equipment into acceptable source data products. The training oriented expertise would typically include training technologists, Instructional System Developers, Training Simulation Engineers, and other subject matter experts familiar with the Air Force operating command training methodologies. This expertise would be involved in the following processes required in MIL-STD-XXXX:

- o Source-Data Requirements Analyses
- o Source-Data Product Development
- o Source-Data Product Validation
- o Source-Data Product Verification
- o Source-Data Product Management

CONCLUSION No. 4 - A HANDBOOK IS NEEDED

The initial application of MIL-STD-XXXX to any given combination of emerging Weapon Systems or Aircrew Training Equipment requires the use of a companion reference document (handbook) that provides guidance in the Source-Data Requirements Analysis processes.

Both the Weapon System organizations and the Aircrew Training Equipment organizations involved in the initial phases of development requires a supplementary resource or reference document that identifies, defines, and generally describes a generic set of source data requirements. The Handbook delineates typical requirements in sufficient detail to permit the users to address the detail requirements for a specific application. The Handbook serves as a tool or aid in these functional areas:

- o The initial proposal effort the Weapon System and Training Equipment contractors of the scope of effort and resources needed to develop the source data products.
- o The initial Source-Data Analyses Processes in accordance with MIL-STD-XXXX paragraph 5.1.1 and 5.2.1.

(NOTE: At the time of this writing, the Air Force has issued a contract to SIM-TEC Inc. to develop the Military Handbook: Aircrew Training Equipment Source-Data Requirements, (Draft) MIL-HDBK-ATESR.)

CONCLUSION No. 5 - MIL-STD-XXXX ENVIRONMENTS

The effectiveness of MIL-STD-XXXX will be greatly enhanced in the environment where either or both Concurrent Engineering (CE) and Computer-aided Acquisition and Logistics Support (CALS) requirements are invoked.

The requirements of MIL-STD-XXXX are predicated on the principles of Systems Engineering applied to the development and maintenance of Source Data Products concurrently with the development of the Weapon System and the associated Training Equipment. Therefore, as the Weapon System development progresses the Training System requirements will evolve in parallel with the Training Equipment Source DAta Products. When this process is started sufficiently early in the weapon system program, the optimum level of effectiveness and efficiency is realized.

Sustaining this process in the out years will maximize the return on investment through concurrency of the training equipment with respect to the changing configurations of the weapon system and the training system.

The application of MIL-STD-XXXX in those weapon systems programs that are subject to the CALS requirements will escalate the short and long term benefits of the effort. The fundamental advantages of CALS complements the overall source-data processes, by the use of integrated data bases and digital transfer of the data products. In the CALS environment both the acquisition and implementation of source data is more cost effective and requires significantly less management control.

RECOMMENDATIONS:

The principal recommendations are:

RECOMMENDATION No. 1 - IMPLEMENTATION OF MIL-STD-XXXX

It is recommended that the implementation of MIL-STD-XXXX focus on the objective of integrating the Source Data Acquisition Process requirements within the Systems Engineering Master Schedule (SEMS) applied to major weapon system acquisitions.

The quality of training programs is critically dependent on the timeliness and quality of the information obtained from the weapon system organizations for use in the training environment. Experience has shown that when the weapon system contractor(s) are properly motivated, under the right conditions, they will provide effective source data. The processes invoked in MIL-STD-XXXX are aligned with the principles of Systems Engineering, and the frame work of the SEMS. Accordingly, when MIL-STD-XXXX is invoked in the SEMS in the earliest phases of a weapon system acquisition the maximum benefits will be achieved.

RECOMMENDATIONS No. 2 - MIL-STD-XXXX APPLIED TO TRAINING SYSTEMS

It is recommended that the next revision of MIL-STD-XXXX should encompass the overall requirements of source-data products needed in all areas of Aircrew and Maintenance Training Systems.

The current version of MIL-STD-XXXX focuses on the requirements of source data to support the development of Aircrew Training Equipment. As identified by the I/SWG and others, the issues and impact of inadequate low quality source data have serious consequences in other areas of USAF Aircrew and Maintenance Training Systems. Major shortfalls in Instructional System Development, Curriculum Training Materials, Instructional Delivery and other training system components are attributed to deficiencies in: source data availability, quality and timeliness. Within these areas and disciplines there is a high level of commonality of source data requirements.

(NOTE: This recommendation was given serious consideration by the Air Force, and in principle was accepted. Due to various constraints at that time the recommendation was deferred for future reconsideration.)

RECOMMENDATION No. 3 - EXPLOITING THE CALS INITIATIVES

It is recommended that the application of MIL-STD-XXXX be structured to take full advantage of the information management and database requirements and capabilities associated with the CALS initiatives.

Contractors responding to the requirements of MIL-STD-XXXX will by necessity propose to implement the program in various databases. The DOD CALS initiatives provide an engineering and data management environment for the overall weapon system, of which the requirements of MIL-STD-XXXX is a very small component. The integrated capabilities of the CALS initiatives will serve to reduce the cost of: development, configuration management, accountability, data management, data ownership and interface management associated of the source data products.

RECOMMENDATION No. 4 - JOINT SERVICE ADOPTION OF MIL-STD-XXXX

It is recommended that MIL-STD-XXXX be reviewed and revised as required for use by the U.S. Navy and the U.S. Army as a joint Military Standard or a DOD Standard.

The adoption of MIL-STD-XXXX for use by the Navy and the Army is an essential step in establishing the acceptability, influence and credibility of a uniform standard. It is clearly mutual advantage to all services to ensure that this standard will meet their unique requirements and to conform to the DOD standardization programs. For example it would be both cost-effective and practical to invoke a USAF/Navy MIL-STD-XXXX in the emerging acquisition of the Joint Primary Aircraft Training System (JPATS).

RECOMMENDATION No. 5 - COLLABORATION WITH THE FLIGHT TEST AGENCIES

It is recommended that the appropriate flight test agencies provide expertise and support in the development, verification and validation of training-critical MIL-STD-XXXX Source Data Products.

The MIL-STD-XXXX processes for the development, verification and validation of Source Data Products are accomplished solely by the developing contractors and monitored by the Air Force. This general approach is considered sufficient in some areas, but marginal in areas that are performance-sensitive for training objectives, and the acceptance testing of the training equipment. The use of the internal resources of the Flight, Avionics, Propulsion and other Test Agencies to evaluate the source data products will significantly improve the quality of the source data products and simultaneously reduce the attendant risks. This approach is effectively used by the Navy in the areas of Aerodynamics, Flight Controls, and Handling Qualities through the use of aircraft flight test resources from the Naval Aircraft Test Center, Patuxent River, MD. Similar approaches are used in the Commercial Airline environment.

It should be further noted that the collaboration with the flight test centers is mutually beneficial in that they have a vested interest in obtaining quality source data products for their flight test simulation facilities. Based on previous investigations it was determined that there is approximately an 80% commonality of requirements for source data from the weapon system contractors for training simulation and flight test simulation purposes.

APPENDIX

Bridging the Information Gap

This paper is copied from the 1989 Interservice/Industry Training Equipment Conference (I/ITEC)

BRIDGING THE INFORMATION GAP

A MAJOR IMPROVEMENT IN AIRCREW TRAINING SYSTEMS

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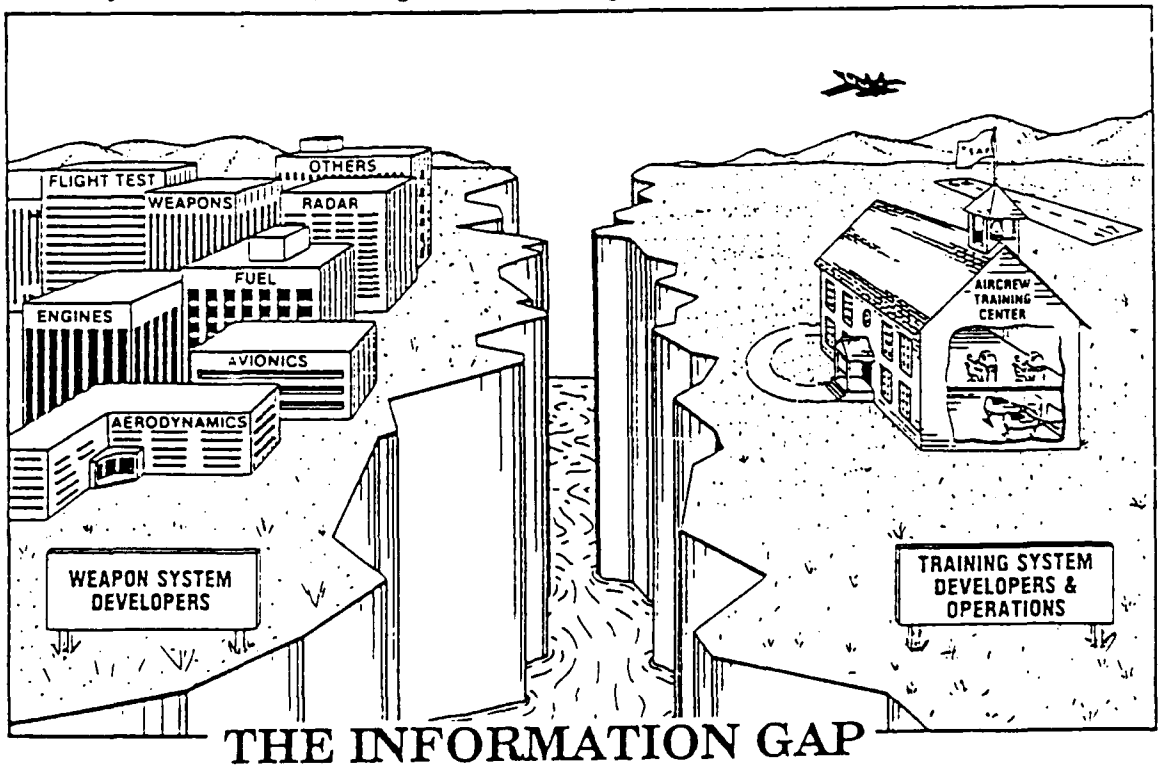
ABSTRACT

The design, test, and operation of aircrew training systems and aircrew training devices rely heavily upon source information describing the weapon system. In the last 10 years the size of weapon system source information has exploded into millions of pieces of information; however management approaches for acquiring and implementing the source information are virtually unchanged in 30 years. These traditional approaches contain little or no quality standards, are severely inadequate in today's environment, and cannot meet future training needs. Major program problems stemming from these inadequacies include: extended development time, lack of training program concurrency with the weapon system, substandard technical quality, higher program costs, and reduced supportability.

This paper presents an innovative approach to dealing with the source information issue. The Simulator Data Integrity Program, after documenting existing inadequacies in a 1988 research report, is proceeding with the development of a source information process standard. This process standard abandons the traditional approach of treating source information as an elusive by-product and instead treats it as an integrated life-cycle process. When fully implemented, this new approach will change the way the Air Force, the weapon system contractors, and the training system contractors do business. It will remove risk from training system programs by putting the weapon system source information which drives training system design and testing on a much more stable and predictable basis. This, in turn, will yield benefits in schedule, cost, and technical performance.

This first paper to industry presents the background of the ongoing Simulator Data Integrity Program, the present status of the program, future program objectives and the challenges to both industry and Government, to bridge the information gap.



THE INFORMATION GAP

INTRODUCTION

The Information Gap

The development and operation of aircrew training systems and equipment is critically dependent on the weapon system resources for training-oriented information (source data) describing the functionality, operating characteristics, environments, man-machine interfaces, etc. Typically, the training system developer/operator will solicit source data from the weapon system resources, who respond with available data that was generated for purposes other than the training of operator's.

mainstream of weapon system development. The information gap has serious consequences: extensive delays, inordinate costs and protracted compromises in training quality.

Due to deficiencies in source data, traditionally, the training system developers find it necessary to empirically create and/or enhance an estimated 30% of the source data required for recent weapon system trainers. In some cases the weapon system contractor could not provide the appropriate source data because the requirement was not known at the time the weapon system was being developed.

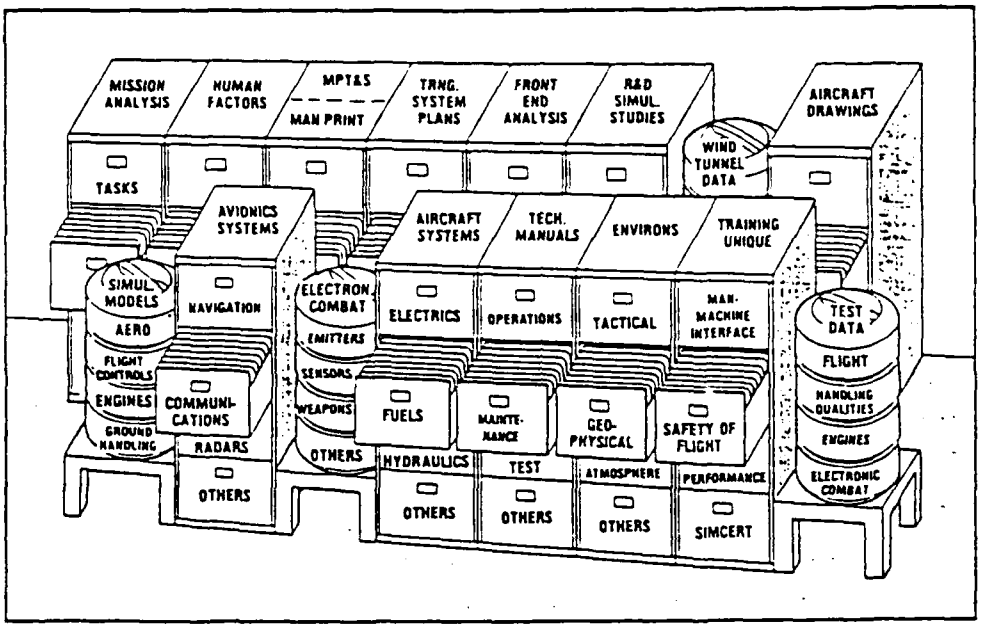


Figure 1. Typical Information Sources Required for Training

In the case of the USAF aircrew training programs, to provide proficient: pilots, navigators, engineers, electronic warfare operators, refuelers, mission planners, etc. for tomorrow's weapon systems, the training system developers and operators are confronted with escalating requirements for source data. In addition to the weapon system technology drivers, is the expanding role of aircrew training systems, to encompass cockpit resource management, team training, mission rehearsal/planning, combat training and other training. These initiatives invoke requirements for improved quality and timeliness of source data, in addition to source data not identified previously.

Unfortunately, the recent and past performance in the acquisition and implementation of source data has been substantially short of the needs. This deficiency is characterized as the *information gap* between the weapon system contractors and the training system developers/operators.

The information gap is not new, in fact it has been a constraint in the military world for as long as training has been relegated to organizations outside of the

What Kind of Information?

The source data required by the training system developer/operator from the weapon system resources varies as a function of the training program objectives. If the training system includes unsophisticated training devices, the requirements for data will be substantially less than the source data required to support a sophisticated multi-media capability. Tomorrow's training programs will require source data that is more uniquely oriented to behavioral objectives, man-machine interfaces, complex environments, team-training and combat training than is currently used in today's aircrew training.

Figure 1 illustrates some examples of source data generally required in today's training systems. This

The Information Gap has serious consequences: extensive delays, inordinate costs, and protracted compromises in training quality.

figure does not convey what, in fact, is available or applied. In some cases, this type of data is produced by the weapon system contractors as part of the overall weapon system contractual data requirements. In other cases, the data may be *available* but not formally produced for any contract requirement. Still other data requires very specific requirements definition and training-oriented development to meet the needs of the users.

Where and When is the Information Produced?

The weapon system organizations that generate source data and the timing of that activity are essential to the effectiveness, integrity, and supportability of the information base required for training programs.

The origins of source data are typically the prime weapon system contractors, and the various subcontractors for engines, avionics, aircraft subsystems, electronic combat, etc. Additionally there are the various organizations that integrate, test and modify the weapon system. The overall quality of source data is a function of the effort by the weapon system developers to provide information that is accurate, consistent, complete, and appropriate to the need. If high-fidelity simulation is a training system requirement, then the engineering groups within the contracting organizations must provide definitive models, data, and associated information to facilitate the development and support of the training capability.

> **The challenges...are not constrained by technology, but are instead rooted in the management approach...to establishing cost-effective uniform practices...**

In the case of emerging weapon systems, the timeliness of source data to facilitate training system development is the critical path for deploying the required training capability to support weapon system readiness. This situation is compounded by the unique window of opportunity for the development, generation, integration, and validation of source data that is inextricably embedded in the weapon system schedule.

Management Role

This paper provides an overview of the long-term problems associated with shortfalls in source data. The deficiencies in both acquisition and implementation of source data in the current and emerging situation are examined and the proposed solutions are presented. The challenges to the industry and the Government are not constrained by technology, but are instead rooted in the management approach to establishing a framework that will motivate the weapon system contractors, training system contractors, and the training system operators to establish cost-effective uniform practices for bridging the information gap.

BACKGROUND

Traditional Management Approaches

During the last 10 to 15 years, the potential capability of aircrew training systems and equipment has increased dramatically with advancements in training technologies and simulation capabilities. Unfortunately, in many cases, this potential is not being fully realized. The principle shortfalls are attributed to deficiencies in quality, timeliness, and integrity of the source data needed for the design and support of training devices. The acquisition of training system/equipment source data has been frequently imposed upon the weapon systems contractors through the use of various Data Item Descriptions (DIDs). For example, DI-T-30717 *Simulator Design, Data Requirements (May 1977)*, generally identifies generic data in broad (not specific) terms and is regarded as a tailorable "*shopping list*" from which selections are made in an attempt to define the training system data requirements. Source data acquisition for emerging weapon systems is typically initiated by the Air Force in prime weapon system acquisition contracts. This may be in the form of a commitment to establish associate contracts with *yet to be identified training system contractors*, or alternatively, the data requirements DID's are applied to the contract during the Demonstration/Validation (DEM/VAL) phase of weapon system procurement. Training device manufacturers are usually not under contract until 1 to 3 years after the weapon system DEM/VAL Request for Proposal (RFP) has been released.

Today, the training system/equipment developers are responsible for the quality and timeliness of source data that was most likely identified before they were selected. They must identify additional requirements and develop their liaisons and contractual agreements with various weapon systems contractors[1] in hopes of obtaining the additional information. In this scenario, the weapon system contractors may have completed their design and development processes and be well into DEM/VAL activities by the time the training system developer initiates his request for training system specific source data. In the case of the existing weapon system, the weapon system contractor will have long since fulfilled any obligation incurred by the original development processes, making the overall effort too difficult, very costly, and much less effective.

Problems - Cause and Effect

Mainstream emphasis in training systems development is characteristically aimed at fielding a

1. The number of subcontractors in current and emerging weapon system programs ranges from 12 to 35.

system or device that matches the current or emerging weapon system, as opposed to providing continuous (long-term/life-cycle) support to account for upgrades to the weapon system or changes in missions and employment tactics affecting training requirements.

The prevailing situation has led to a number of quality problems impacting the effectiveness of training system/equipment development and life-cycle operation.

Weapon systems contractors are not, typically, training oriented in their approach to establishing criteria for source data. Training functionality is largely overlooked because there are no definitive requirements, or guidance for the contractor to address training objectives. This is usually compounded by an inadequate training requirements definition during program front-end analysis. Another contributing factor is the belief that the optimal training system configuration mirrors the weapon system, in the mistaken conclusion that the aircraft is the ideal learning tool. Consequently, the weapon system contractor is inclined to supply whatever information is most readily available, and not necessarily the data best suited to meeting training objectives.

The *shopping list* approach of the DID traps both the weapon system and training system houses. The source data supplied, and accepted, to meet contract requirements are, in most cases, information that most closely relates to the DID items, as opposed to data determined to be the most effective for training purposes. In this manner, both sides fulfill their contractual obligations, but the quality of the source data is not realized.

Low-quality, inadequate, and late source data has led to frustration in the related engineering processes and fostered the growth of practices based upon heuristic approaches, reverse engineering, and empirically derived design data. These approaches are admirable in intent and, given the scope of the effort, truly amazing in accomplishment; however, they lack the technical credibility and supportability required for an effective source data package. In general, these methods have not proved capable of producing training systems/equipment adaptive to current demands for high quality and concurrency.

Air Force Research

Increasingly complex weapon systems, and correspondingly higher expectations for training system performance are compelling the Air Force to seek solutions to the expanding source data shortfalls obstructing the development of training tools essential for modern mission success. A series of initiatives targeted toward achieving total quality acquisition of training assets and life-cycle operation were established to identify weaknesses and promote improvements. One of these initiatives was the Simulator Data Integrity Study, which had the following goals:

- Improve training equipment performance,
- Reduce training equipment development time,
- Reduce life-cycle costs,
- Provide timely updates (concurrency),
- Reduce update costs,
- Exploit commonality in the use of source data, and
- Reduce contractor bidding costs.

The objectives of the study were to examine the difficulties experienced in obtaining comprehensive and timely source data, and to propose changes to assure that source data requirements are satisfied. The research focused primarily on the source data required in the development of Weapon Systems Trainers and Operational Flight Trainers for emerging fixed-wing tactical and transport aircraft.

The study added an exclamation point to the Air Force's perceptions of the problems. The quality of source data evidenced major deficiencies especially in microprocessor/software intensive systems: Avionics, Electronic Warfare, Flight Controls, and Aerodynamics. The source information acquisition and implementation processes suffered serious shortfalls due, in part, to poor requirements definition, lack of relevance to training needs, and lack of quality standards. These, and other factors, combined to cause the following consequences:

- Delayed startup of simulation and training programs.
- Extended government and contractor test programs.
- Limited training effectiveness.
- Inordinate life-cycle costs.
- Excessive bidding risks and program costs.
- Unsound simulator engineering practices.

The study also highlighted some areas of successful source data practices such as the Air Force F-16 Block Update Program, commercial airline and FAA-Advanced Simulation Programs, and the Naval Air Test Center (See Reference 2). They all demonstrate a capability for effective source data development and integration practices proving that quality source information can be achieved.

Research Recommendations

The conclusions led to the study's recommendations for establishing a uniform process standard that sets out guidelines for the weapon systems and training systems contractors in the acquisition, implementation, and support of source data.

The keys to this recommendation are the management initiatives taken to define training source data requirements, ensure that correct data is generated and quality controlled to meet those requirements, and to guarantee that the information remains current.

DEVELOPING THE SOLUTION

Current Program

The principle recommendation of the Simulator Data Integrity Study to, *develop process standards for the acquisition and implementation of source data*, is the basis for the current program, and has this target objective:

Establish, implement, and sustain cost-effective uniform practices that will ensure the overall quality of source data used in the development, deployment, and life-cycle support of aircrew training systems and associated equipment.

To reach this objective, the program is based on a structured approach that encompasses a *Requirements Definition Phase*, a *Process Standard Preparation Phase*, and the *Industry Review Phase*. Each of these phases will be supported by joint industry/USAF working groups. The Requirements Definition Phase will be completed in the 1st half of 1990. The Process Standard Preparation Phase is scheduled for completion in the 3rd quarter of 1990, followed by the Industry Review Phase.

A Systems Engineering Management Approach

The findings in the original study establish that the weaknesses in the acquisition and implementation of source data are attributed to methodology not technology. The current Air Force practices, which are based on traditional methods, have evolved from approaches used for over 30 years. The evolution of these methods is seriously lagging behind today's needs and existing technologies. When considering the implications of the emerging technologies and the corresponding training requirements for the 1990's, the consequences and imperatives are all too clear.

Preliminary analysis of the projected requirements for the acquisition and implementation of source data in the 1990's indicates the need for a systems engineering approach that meets this criteria:

- A weapon system-level capability for a training-oriented source data requirements analysis that starts with inputs developed in the concept definition phase of the emerging weapon system, and continues through the life cycle of the weapon system.

- A weapon system-level capability to develop, generate, integrate, and validate source data products conforming to the requirements identified in the aforementioned requirements analysis.

- A weapon system-level capability for configuration management, quality control, repository, distribution, and interface management of source data products, to be used in various training applications. This capability shall be structured to support multiple training systems throughout the life cycle of the weapon system.

- A training system-/training equipment-level capability for source data requirements analysis, collection, and validation of the source data products obtained from the weapon system-level data base (repository). This capability is transferred to the operators and support organizations after deployment of the training assets. These organizations will continue to use the basic processes established in the development of the training system.

- A training system-/training equipment-level capability for integration, configuration management, quality assurance, verification, and life-cycle support of source data products.

- A capability within the Air Force Test Centers for the validation and verification of the functionality of source data products acquired by the weapon system contractors and implemented by the training system/training equipment contractors/operators. In addition the test centers will provide supplementary source data and related expertise.

- A tightly coupled interface between all elements in the overall system that ensures these source data characteristics:

- Quality	- Accountability
- Timeliness	- Commonality
- Concurrency	- Effectiveness
- Supportability	- Efficiency
- Traceability	- Integrity

Based on this fundamental criteria applied to a variety of weapon systems (trainer, fighter, bomber

transport, etc.) and varieties of training systems/training equipment, training developers/ operators. It is apparent that industry-adopted, uniform practices are essential.

Development of Source Data Processes

The initial effort is the determination of requirements for the processes necessary to translate functional needs into cost-effective practices.

Acquisition Processes

The proposed general processes for the acquisition of source data products (Figure 2) include requirements analysis, product definition, development, validation, integration, configuration management, data base (repository) management, product catalog, product currency, quality management, and working group host. The weapon system contractor will initiate these processes as part of the demonstration/ validation program activities, and continue throughout the life cycle of the weapon system. The origins of source data requirements are rooted in the planning, concept definitions; Manpower, Personnel Training and Safety, (MPT&S); and front-end analysis that precedes the weapon system Demonstration/ Validation phases. These processes shall address the diverse requirements for source data to support a variety of training applications and multiple training systems.

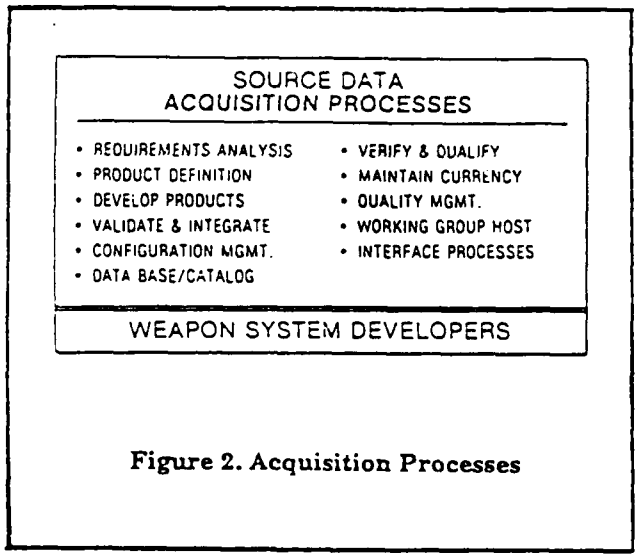


Figure 2. Acquisition Processes

Implementation Processes

Likewise, the processes for the implementation of source data products will be established for the training system/equipment developers (Figure 3), and operators. It should be noted, that the overall approach accommodates the potential for multiple applications of source data in various combinations of training systems and/or training equipment,

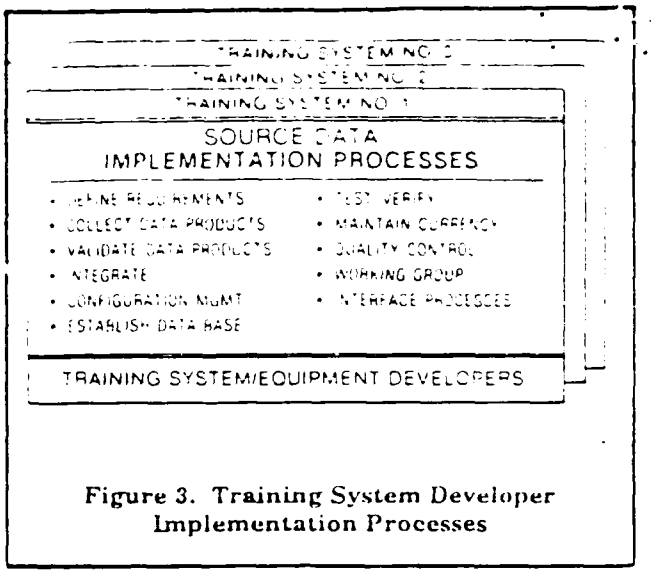


Figure 3. Training System Developer Implementation Processes

throughout the life cycle of the weapon system. The implementation processes for the developer and operators are essentially the same, except for the scale or volume of source data products after the training systems are deployed. These processes will encompass requirements definition, source data collection, validation of source data products, integration, configuration management, data base management, testing and verification, currency management, quality control, and working group participation (Figure 4). The operator/user will typically assign the implementation activities to the logistics support components (depots, AFLC, TSSC, etc.)

The operator's implementation of source data is driven by two primary requirements.

- Concurrency to the Weapon System
- Concurrency to the Training System

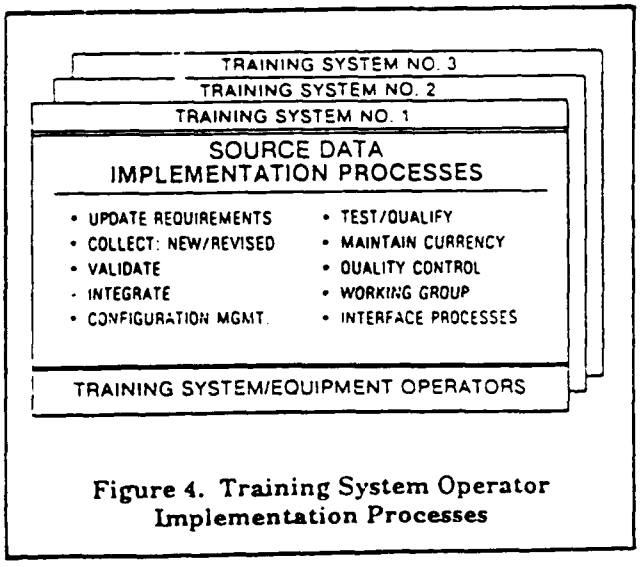


Figure 4. Training System Operator Implementation Processes

Source Data Process Requirements

Generally, the role of the cognizant U.S. Air Force agencies is to establish the requirements (Figure 5) and ensure the functionality of the overall processes. The Air Force flight test centers shall provide various levels of validation and verification of the source data products, and in addition they shall be a supplementary resource for source data products.

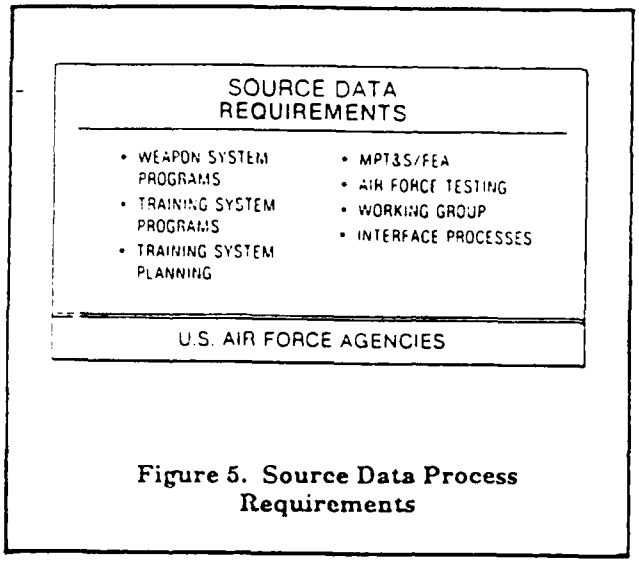


Figure 5. Source Data Process Requirements

Interface Processes

The definitive requirements for interface processes between weapon system developers/operators and the Air Force agencies have not been determined at this time. Obviously, the interactions between the users and providers of source data will be the most demanding and potentially most critical. The emerging DoD initiatives for Computer-aided Acquisition and Logistics System (CALS) shall be an integral part of the information exchange, and interface processes. Figure 6 is a conceptual overview of the broad-based functional requirements for processes to acquire and implement source data products.

COSTS/BENEFITS

The fully integrated processes for the acquisition and implementation of source data will require up-front costs and yield short- and long-term benefits, accruing significant life-cycle savings.

In the case of emerging weapon systems, the initial costs are associated with the detailed source data requirements analysis, and the development of the source data products integral to the mainstream of the weapon system program. The cost effectiveness of these efforts will be determined by the planning, the integration of qualified resources, and the overall

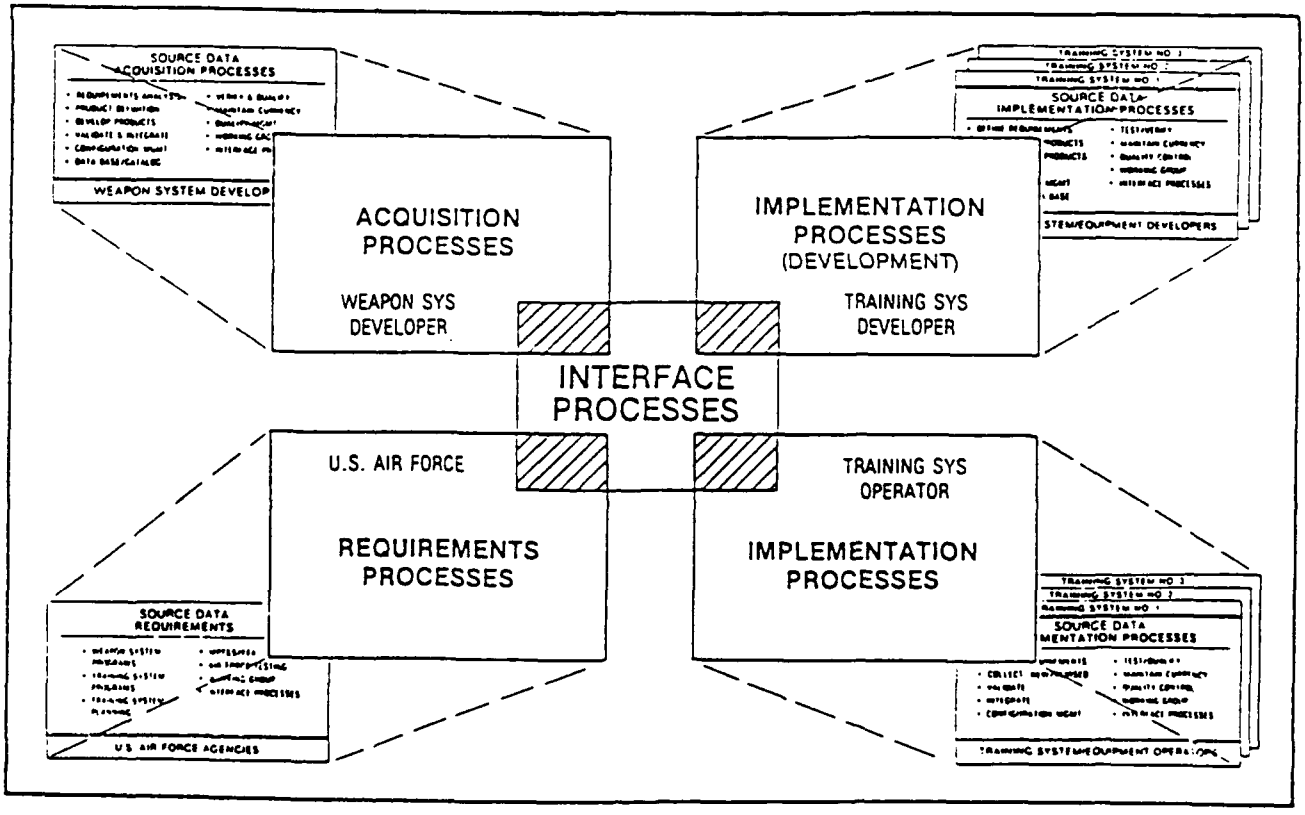


Figure 6. Interface Processes

quality control of the processes. The recurring costs associated with the day-to-day support of the data base, repository, and user's interface will be a function of demand during the weapon system full-scale development and the level of weapon system modifications. After the weapon system initial operational capability milestone, the level of activity will be driven by both weapon system and training system changes.

The benefits of this capability are shared by the weapon system contractors, the training system contractors, and the training system users. The following is a summary of the direct benefits:

- Reduction in bidding risks associated with the training system procurement due to availability of definitive source data to support program development.
- Cost and schedule reductions attributed to significant decreases in engineering effort associated with the establishment of design criteria.
- Cost and schedule reductions attributed to significant decreases in the overall test and evaluation of the training equipment.
- Concurrency improvements resulting from improved response times for weapon system source information.
- Increased operational effectiveness attributed to the overall quality of source data used to develop and operate training systems.
- Increased supportability attributed to the overall integrity, accountability, and compatibility of source data for the long-term needs of training system performance.
- Increased efficiencies attributed to commonality of source data used in multiple applications within and external to the training system. Integral to this benefit are the savings accrued in the case of 2nd, and 3rd generation training systems and training equipment to support the basic weapon system and its derivatives, used by various Air Force commands and other services.

THE MANAGEMENT CHALLENGE

The quality of source available data plays a crucial role in management's ability to develop successful training systems on time and within budget. The severe quality problems which exist due to shortfalls in the acquisition and implementation of source information have been documented in the Training System SPO's "Simulator Data Integrity Study Final Report" (Reference No.1). Current practices of going back to *fix* the data following contract award for weapon system full-scale development invariably result in added aircrew training system program costs and lost schedule time.

Management action is the key to eliminating quality information deficits resulting in cost and schedule overruns and inferior training system development. The challenges to correct this debilitating data problem lie in the ability and motivation of the Government, the training system industry, and the weapon system manufacturers to work together toward a solution. Here are the challenges:

- *Understanding the Problem* - The direct correlation between poor weapon system source information and poorly performing training systems must be understood and acknowledged by the industry.
- *Assuming Responsibility* - The Government, the training system industry, and the weapon system contractors must each acknowledge their respective responsibilities. A sincere effort on the part of all three is required for success.
- *Avoiding Inappropriate Solutions* - Acquiring source information of higher quality is a complex technical and management issue. It cannot be solved through quick fixes or by simply shifting contractual responsibility without first providing a technical foundation.
- *Cooperation* - Cooperation between the three parties involved is essential for success. The challenge to management is to ensure that a positive *"can-do"* atmosphere exists, and to provide the appropriate resources to achieve success.

The challenge to our industry...is to recognize that improvements in training, program concurrency, cost, and technical performance will accrue from this effort.

SUMMARY

In summary, the Simulator Data Integrity Program has, through documented industry surveys, established that ineffective practices for source information acquisition and implementation are adversely impacting the quality of aircrew training systems and training devices. These deficiencies are being attacked through the development of a source data process standard which accommodates technology projections and promotes a solution for the 1990's and beyond.

The source data process standard offers these improvements to the training industry:

- A tailorable working tool clearly defining the management and technical processes to be applied during the acquisition and implementation of source data.
- Processes providing for quality and uniformity among the multiple suppliers of data which support a single training system.
- A standard that yields source data products with excellent integrity, quality, and supportability characteristics.

The challenge to our industry, to Government, to the weapon system contractors and to the training system developers and operators, is to recognize that improvements in training, program concurrency, cost, and technical performance will accrue from this effort. We are challenged to make a major quality improvement in training systems, and by working sincerely and cooperatively together our goal of bridging the information gap can be achieved.

REFERENCES

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