CTN Test Report
91-003

CALS TEST NETWORK

NTB-ID-TM-12-91-04

CALS EXPO 90
CAD DATA TRANSFER DEMONSTRATION

March 8, 1991

DTRC

Prepared by
Navy CTN Test Bed
David Taylor Research Center
Bethesda, MD 20084-5000

AQC 96-08-2215

☐ ____________ copies are being forwarded. Indicate whether Statement A, B, C, D, E, F, or X applies.

☒ DISTRIBUTION STATEMENT A:
APPROVED FOR PUBLIC RELEASE: DISTRIBUTION IS UNLIMITED

☐ DISTRIBUTION STATEMENT B:
DISTRIBUTION AUTHORIZED TO U.S. GOVERNMENT AGENCIES ONLY; (Indicate Reason and Date). OTHER REQUESTS FOR THIS DOCUMENT SHALL BE REFERRED TO (Indicate Controlling DoD Office).

☐ DISTRIBUTION STATEMENT C:
DISTRIBUTION AUTHORIZED TO U.S. GOVERNMENT AGENCIES AND THEIR CONTRACTORS; (Indicate Reason and Date). OTHER REQUESTS FOR THIS DOCUMENT SHALL BE REFERRED TO (Indicate Controlling DoD Office).

☐ DISTRIBUTION STATEMENT D:
DISTRIBUTION AUTHORIZED TO DoD AND U.S. DoD CONTRACTORS ONLY; (Indicate Reason and Date). OTHER REQUESTS SHALL BE REFERRED TO (Indicate Controlling DoD Office).

☐ DISTRIBUTION STATEMENT E:
DISTRIBUTION AUTHORIZED TO DoD COMPONENTS ONLY; (Indicate Reason and Date). OTHER REQUESTS SHALL BE REFERRED TO (Indicate Controlling DoD Office).

☐ DISTRIBUTION STATEMENT F:
FURTHER DISSEMINATION ONLY AS DIRECTED BY (Indicate Controlling DoD Office and Date) or HIGHER DoD AUTHORITY.

☐ DISTRIBUTION STATEMENT X:
DISTRIBUTION AUTHORIZED TO U.S. GOVERNMENT AGENCIES AND PRIVATE INDIVIDUALS OR ENTERPRISES ELIGIBLE TO OBTAIN EXPORT-CONTROLLED TECHNICAL DATA IN ACCORDANCE WITH DoD DIRECTIVE 5230.25, WITHHOLDING OF UNCLASSIFIED TECHNICAL DATA FROM PUBLIC DISCLOSURE, 6 Nov 1984 (Indicate date of determination). CONTROLLING DoD OFFICE IS (Indicate Controlling DoD Office).

☐ This document was previously forwarded to DTIC on ____________ (date) and the AD number is __________________.

☐ In accordance with provisions of DoD instructions, the document requested is not supplied because:

☐ It will be published at a later date. (Enter approximate date, if known).

☐ Other. (Give Reason)

DoD Directive 5230.24, "Distribution Statements on Technical Documents," 18 Mar 87, contains seven distribution statements, as described briefly above. Technical Documents must be assigned distribution statements.

Shirley Stephens
Print or Type Name

Per telecon with Shirley Stephens 8/20/96
Authorized Signature/Date

DSN 787-3085
Telephone Number

CTN Test Report
91-003

NTB-ID- TM-12-91-04

CALS EXPO 90 CAD DATA TRANSFER DEMONSTRATION

March 8, 1991

Navy DTRC Contact
Ben Kassel
(301) 227-1355
email kassel@dtrc.dt.navy.mil

CTNO Contact
Melvin S. Lammers
(513) 257-3085
e-mail lammers@logdis1.hq.aflc.af.mil

DTRC

Prepared by
Navy CTN Test Bed
David Taylor Research Center
Bethesda, MD 20084-5000

David Taylor Research Center
Bethesda, Maryland 20084-5000

DTRC/TM-12-91-04 Mar 1991

Systems Department
Technical Memorandum

CTN Report 91-003

CALS EXPO 90
CAD DATA TRANSFER DEMONSTRATION

by

Ben Kassel

Approved for Public Release;
Distribution Unlimited

Preface

I acknowledge the following organizations for their assistance in the preparation of this report. Without their participation this demonstration would not have been possible:

IBM
INTERGRAPH
MARTIN MARIETTA ENERGY SYSTEMS AT OAK RIDGE
COMPUTERVISION
SUN MICROSYSTEMS
NAVAL ORDNANCE STATION LOUISVILLE
NAVAL AIR DEPOT JACKSONVILLE
ARMY CALS LAB
AIR FORCE CALS LAB
DAVID TAYLOR RESEARCH CENTER
NAVAL SEA COMBAT SYSTEMS ENGINEERING STATION
IGES DATA ANALYSIS

This report does not endorse any product, process, or company.

Executive Summary

The DoD Computer-aided Acquisition and Logistics Support (CALS) Test Network (CTN) is conducting tests of the military standard for the Automated Interchange of Technical Information, MIL-STD-1840 and its companion suite of military specifications. The CTN is a DoD sponsored confederation of voluntary participants from industry and government, managed by the Office of the Secretary of Defense (OSD) CALS office with technical staff at Air Force Logistics Command (AFLC) and Lawrence Livermore National Laboratory (LLNL). The objective of CTN tests is to demonstrate and evaluate the interchange and functional use of digital technical information between industry and government using the CALS standards.

This test was a demonstration of the transfer of CAD data between dissimilar systems. It was conducted at the CALS Expo in Dallas TX, December 3-6, 1990.

The objective of the demonstration was to test the exchange of CAD data in an uncontrolled environment using commercially available translators.

None of the CTN Reference Materials were used to perform this demonstration. Instructions for the creation and transfer of the CAD models were purposely vague and limited guidance was provided to the modeler. The exact format of the neutral file was left to its creator.

Overall the results were as expected from experience in the transfer of data in the production environment, and with the evaluation of CTN testing. Data was received in various formats and the IGES files contained different types of information including MIL-D-28000 subsets.

On the basis of the demonstration it is recommended that:

1) CAD vendors require more incentive than is given presently to implement MIL-D-28000 translators and MIL-STD-1840 tape utilities.
2) MIL-STD-1840 should be expanded to include different forms of media including 3 1/2" floppy disk drive, 1/4" streaming cartridge, 8mm cartridge, and optical disk. The format should depend upon the context of the transfer.

3) MIL-D-28000 subsets require further constraints[1] such as those provided by Application Protocols.

4) Additional Application Protocols (subsets) are required to transfer design and manufacturing data, including solid geometry.

5) Technical direction must be given to all participants in a data exchange program to ensure the exchanged data is useable.

1 Any new issue discovered during this demonstration will be addressed through the usual MIL-D-28000 revision. Modifications and comments for MIL-D-28000 should be submitted using standard form DD 1426 which can be found on the last page of the specification.

1 Introduction

The Navy node of the CTN at the David Taylor Research Center (DTRC) conducted a demonstration of data transfer using IGES. The CTN was interested in performing this demonstration to assess the implementation of MIL-STD-1840 at the users level using commercially available off the shelf technology. Participants in the demonstration were representative of various government and industry activities. Many different IGES preprocessors were used to create the IGES files, but only one postprocessor was used to create the assembly. This simulates the environment in which an integrator obtains pieces from many suppliers.

2 Overview of the Demonstration

This was a demonstration of data transfer in the design and documentation of a Laser Doppler Velocimeter (LDV) probe. Product specifications were developed for the design and manufacture of each component. Each participant was given a different component to model. The detail design was then transferred to the system integrator to develop the product model and perform configuration management. A single assembly was selected for this demonstration to simplify the modeling and system integration requirements. These components were designed using different CAD systems at different organizations. The native CAD system was allowed to use any construction technique including wireframe, surface, and solid geometry. Upon completing the design the CAD database was translated to IGES. Therefore, each component was translated to IGES using the commercial preprocessor delivered with the CAD system used to create the component. The IGES file may contain any legal entity, however this data transfer program required the complete geometric wireframe definition be included. Each IGES file was postprocessed and used to create a single component on the receiving CAD system. The geometry was reviewed and then used

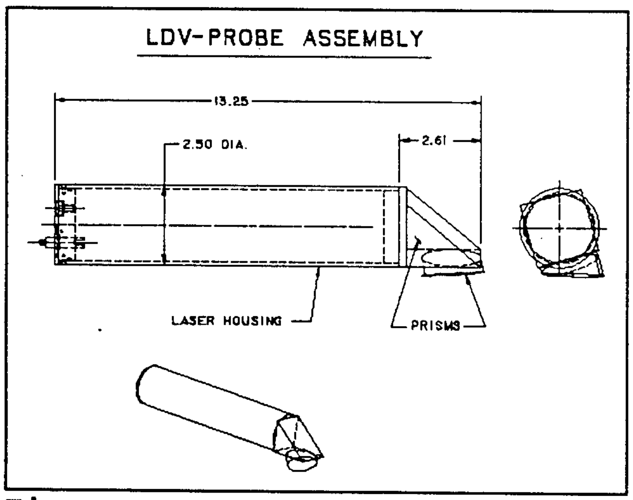

Figure 1 - LDV-PROBE ASSEMBLY

to generate the solid model in the proper orientation required for the assembly. The only requirement of the transfer was that a wireframe representation of the component be included in the IGES file.

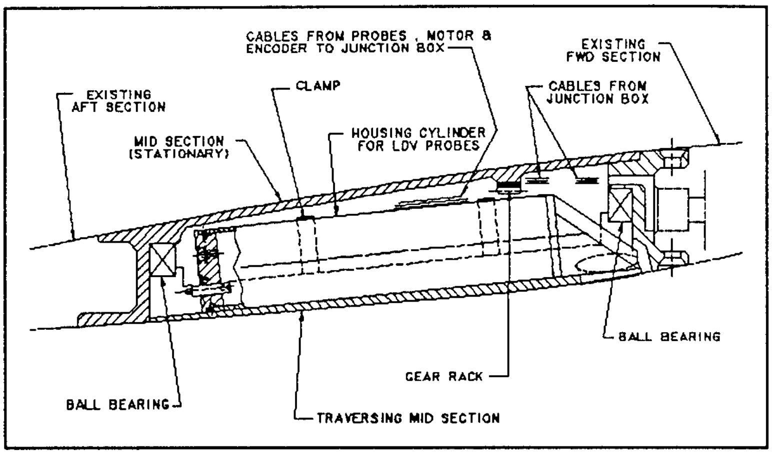

Figure 2 - LDV-PROBE INSTALLATION DIAGRAM

It was desirable to deliver the IGES data in the format described in MIL-STD-1840, however this was not a requirement. The purpose of the demonstration was to simulate the actual data transfer practices currently used by industry. Most of the commercial CAD packages do not include MIL-D-28000 capabilities. This is to be expected for many reasons, including the immaturity of the standard and the current state of incentives for the CAD vendor.

In addition to the transfer of CAD data, graphics are required for technical publications. Technical illustrations (figure 1 and 2) were created from the product model. These illustrations were a combination of the product model and annotation entities such as cross hatch, text, and dimensions. The graphics display was then converted directly to CCITT group IV to be inserted into this document.

3 Test Data and Procedures

3.1 Test Data

The data used for this demonstration was provided by DTRC. It was representative of the type of data used in the design and manufacture of small mechanical piece parts. The data was provided on engineering drawings (figure 3 and 4). Each participant in the demonstration only received the data required to model a single component in the assembly.

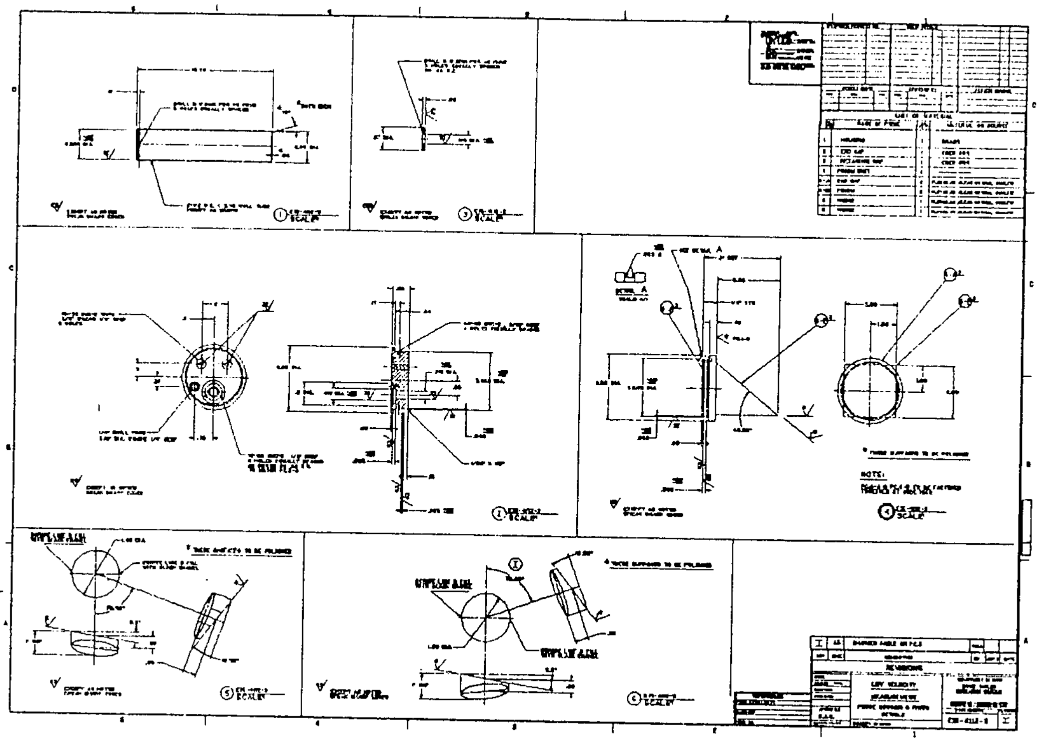

Figure 3 - Detail Drawing of LDV Probe Housing

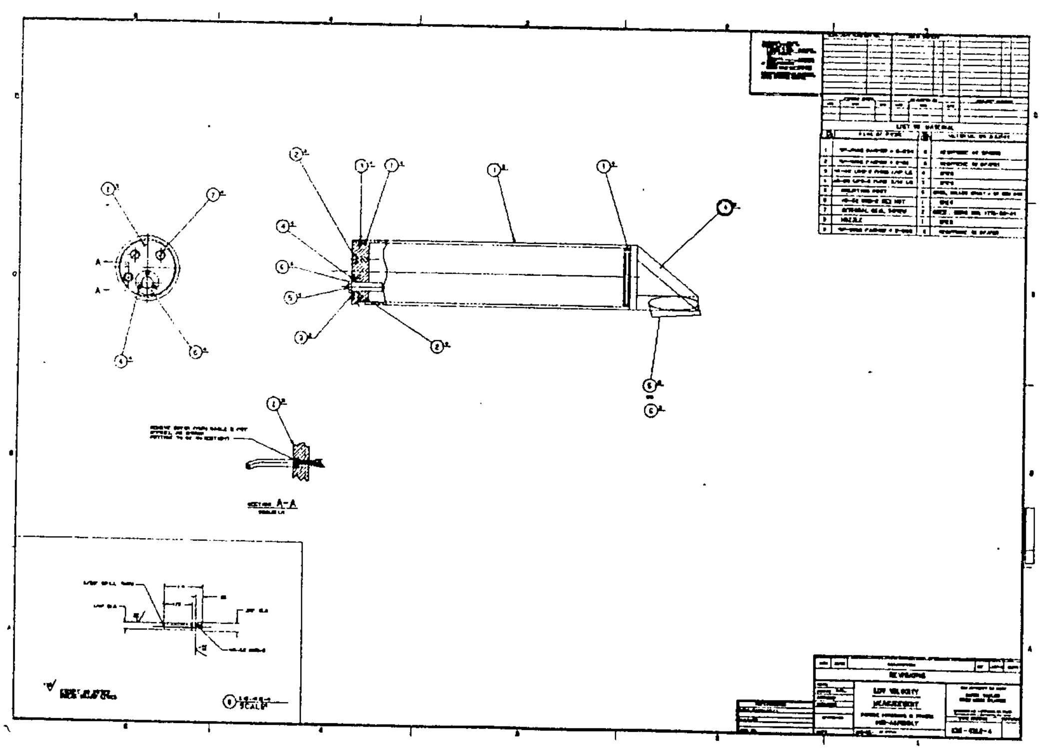

Figure 4 - Probe Assembly and Nozzle Detail Drawing

3.2 Test Procedures

The following procedures were used for the demonstration:

1. DTRC provided design documentation to each participant. The data was sufficient to create a model using any 3-D CAD system.

2. Each participant created a CAD model of a specific component. An optional drawing incorporating the 3-D model was created by some participants.

3. The CAD model was preprocessed into the IGES format. MIL-D-28000 Class II or Class IV data was requested but not mandatory for this demonstration.

4. Any legal entity was permitted in the IGES file, but was required to contain a wireframe or surface representation of the component.

5. The IGES file was delivered to DTRC for postprocessing.

6. The media was analyzed to determine its format.

7. The IGES data was analyzed for conformance to MIL-D-28000.

8. The IGES file was postprocessed using Computervision CADDS 4X on a Sun Microsystems SPARCstation 1.

9. A solid model of selected components was developed from the postprocessed IGES files.

4 Test Results

4.1 Transmission Envelope

Data was received in various formats on various media. In all cases the data was useable but required some interpretation in order to determine its format. Data was received in the following formats:

1) 5 1/4" low density floppy disk; DOS format
2) 1/4" cartridge; tar format
3) 9 track tape; tar format
4) 9 track tape; MIL-STD-1840 format
5) 9 track tape; 80 bytes/rec, 10 rec/block, ASCII format
6) 9 track tape; VAX/VMS format
7) 3 1/2" floppy disk; tar format
8) 802.3 Local Area Network; File Transfer Protocol

4.1.1 Physical Media

The submission of the CAD data on various media and formats is an indication that simpler and more common methods are used than those specified in MIL-STD-1840. In some cases the headers on the file were hand coded. This indicates the need for a wide distribution of MIL-STD-1840 tape tools. It also demonstrates a lack of tape tools being provided by the CAD vendors, or an unwillingness of the CAD user to use these tools. Numerous requests were made by demonstration participants to be permitted to submit the data using the UNIX tape archive (tar) format.

4.1.2 Data Format

IGES files were received in varying conditions. Three of the participants attempted to deliver MIL-D-28000 Class II data using the physical format described in MIL-STD-1840. Some of the participants provided MIL-D-28000 Class II data without using the headers described in MIL-STD-1840. Some of the participants supplied data using standard IGES.

4.2 Processing IGES/MIL-D-28000 data

IGES data was pre-processed at various sites and sent to DTRC for post-processing. In addition the tapes and files were analyzed to determine the format of the data and the physical media.

4.2.1 General Comments on Pre-processing

Pre-processing was performed on many systems. Instructions from DTRC for pre-processing were purposely vague and therefore it is difficult to perform a direct comparison. This was done in order to encourage the use of procedures and techniques used at the activity to transfer data in the normal production environment. The intent of the demonstration was not to provide a direct comparison of pre-processors or procedures at the individual sites. Instead, it provided an indication of the state of commercial software and procedures used at the working level.

4.2.2 General Comments on Post-processing

All of the IGES files were post-processed using the same CAD system. This was done in order to simulate the transfer of data from several sources to a single NAVY CAD I (CAEDOS)[2] site. The following exceptions should be noted. Due to the logistics problems of installing a CAEDOS system at CALS Expo 90, CADDS 4X version 5 on a SUN SPARCstation was used. There are some differences between the IGES translator used for the demo and the CAEDOS version, however the CAD software is similar and the resulting databases are transportable.

5 Analysis of Physical Media

Each file was analyzed to determine its format. Two of the participants attempted to provide the data in MIL-STD-1840 format. Media received in MIL-STD-1840 format was analyzed using TAPETOOL. The results of the analysis is available upon request.

---

[2] CAEDOS is the Computer Aided Engineering and Documentation System. It was originally intended for the NAVY laboratories and was later expanded to include any NAVY activity. 405 Computervision Designer V, and Designer V-X seats were provided via this contract.

6 Analysis of IGES files

Each IGES file was analyzed for conformance to MIL-D-28000. Only two of the participants claimed to have provided data in MIL-D-28000 Class II format. The remaining files, although not claiming to conform to MIL-D-28000 were close, and could conform with minimal modifications.

6.1 Tube (Piece 1 sheet 3)

The system used to design this component combines geometry and graphics with the intelligence required to define the feature. The CAD system is also used to annotate the design, provide textual data required to convey non-geometric data, such as dimensions, feature control symbols, and notes. Many different techniques are used by CAD systems to perform this task. In this case the dimensions, crosshatching, notes, etc., are placed into the 3-D model on a different layer from the geometry. The annotation was oriented such that it was visible in the view in which it appeared. The post processed file is shown in figure 5.

6.2 End Cap (Piece 2 sheet 3)

The CAD system used to create this piece implemented MIL-D-28000 by taking all of the geometry and annotation and flattening it out, using IGES drawing space. This implementation also included the 3-D geometry in model space. The 3-D model was present in the IGES file, but the only visible graphics were those required to create the drawing. The designer of this component claimed conformance to MIL-D-28000 Class II. The post processed file is shown in figure 6.

6.3 Retaining Cap (Piece 3 sheet 3)

This component was created using a novel approach. The guidance drawing for the component to be constructed was scanned. The resulting raster image was converted to MIL-D-28000 Class I. Although this was not exactly what was intended for the demonstration, it is a good example of the data which can be received if not specified properly. The post processed file is shown in figure 7.

6.4 Prism Unit (Piece 4 sheet 3)

This component was modeled in 3-D space using wireframe geometry. There were no drawings or any type of annotation received with the component. The designer of this component claimed conformance to MIL-D-28000 Class II. The post processed file is shown in figure 8.

6.5 Wedge (Piece 5 sheet 3)

This component was modeled in 3-D space using surface geometry. There were no drawings or any type of annotation received with the component. The post processed file is shown in figure 9.

6.6 Wedge (Piece 6 sheet 3)

This component was modeled in 3-D space using wireframe geometry. There were no drawings or any type of annotation received with the component. The post processed file is shown in figure 10.

6.7 Nozzle (Piece 7 sheet 4)

This component was modeled in 3-D space using wireframe and surface geometry. There were no drawings or any type of annotation received with the component. The post processed file is shown in figure 11.

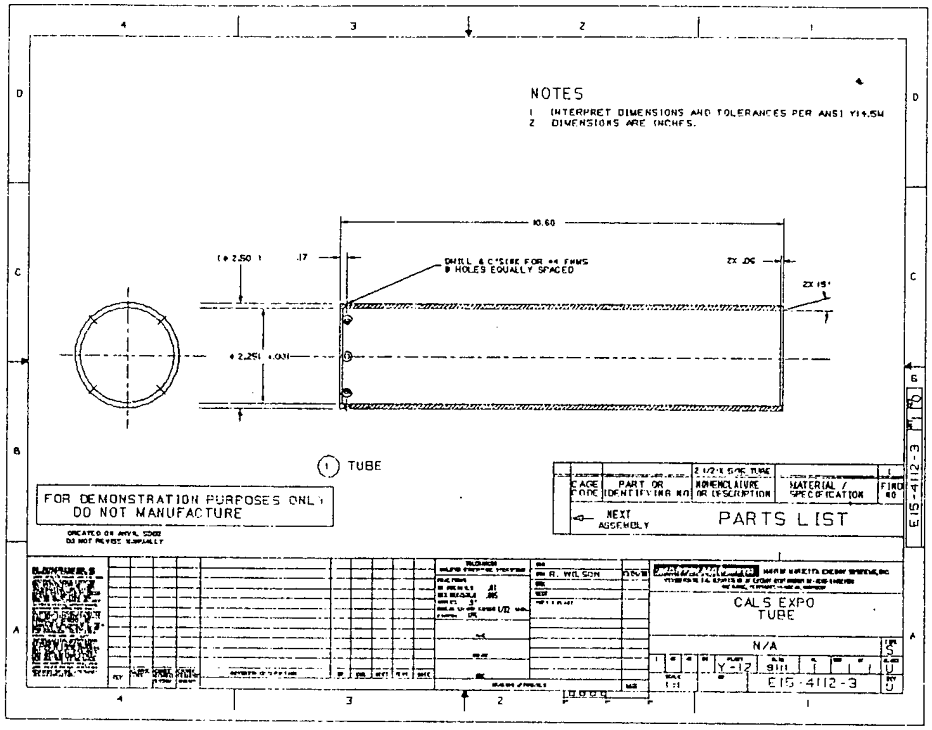

Figure 5 - Tube (Piece 1 Sheet 3)

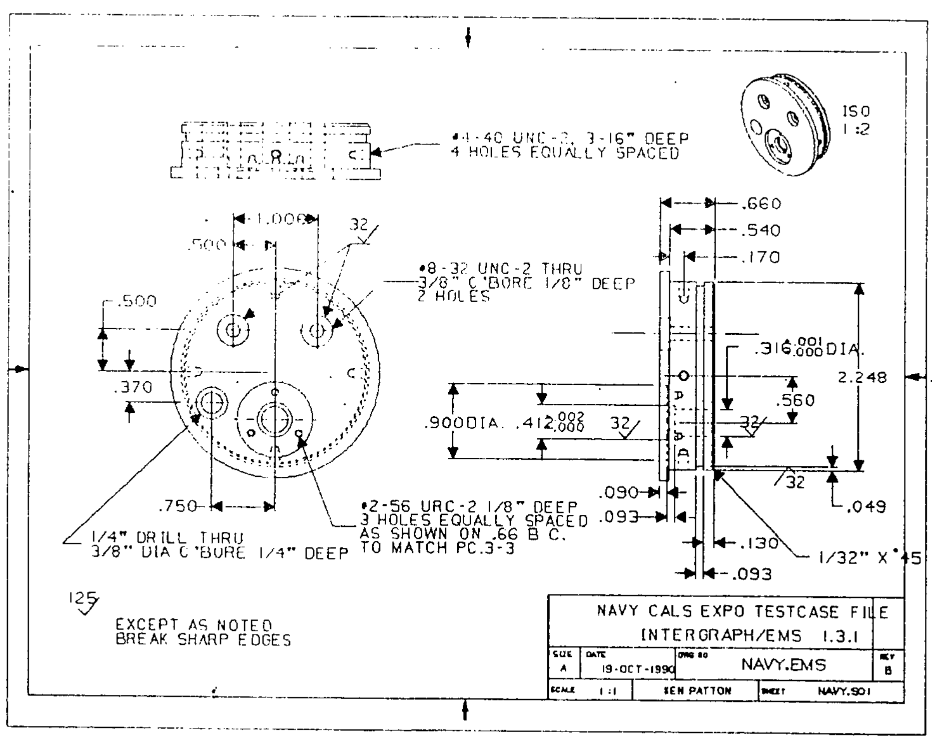

Figure 6 - End Cap (Piece 2 Sheet 3)

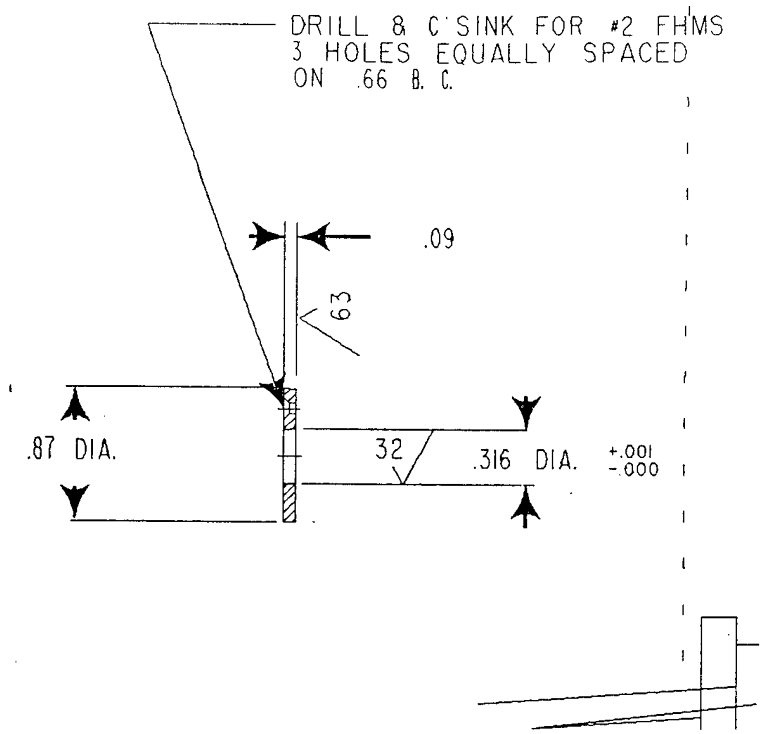

Figure 7 - Retaining Cap (Piece 3 Sheet 3)

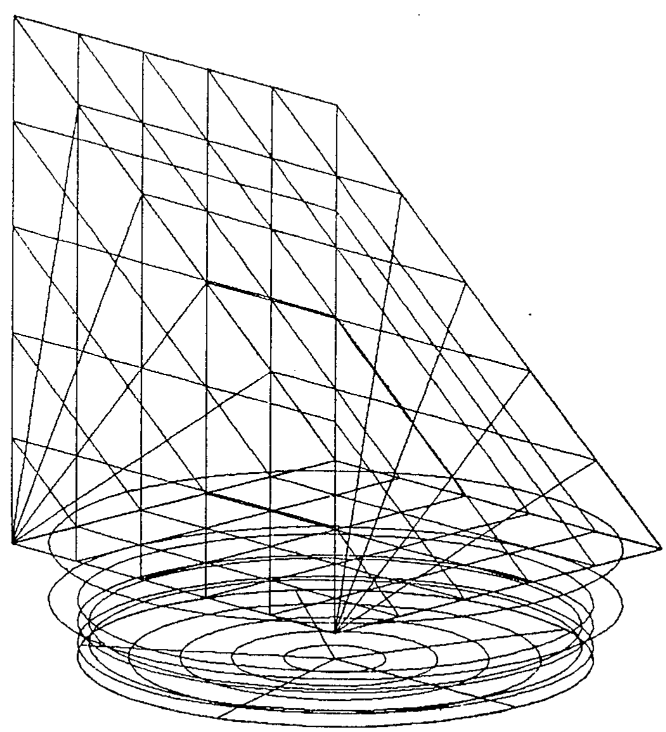

Figure 8 - Prism Unit (Piece 4 Sheet 3)

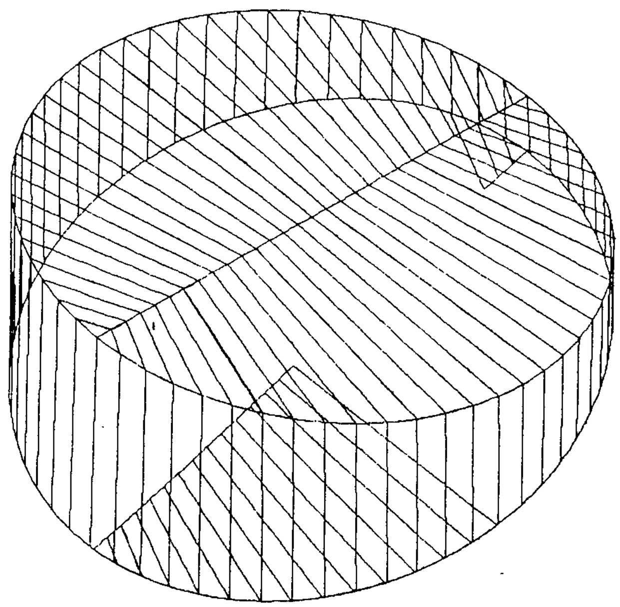

Figure 9 - Wedge (Piece 3) Sheet 3)

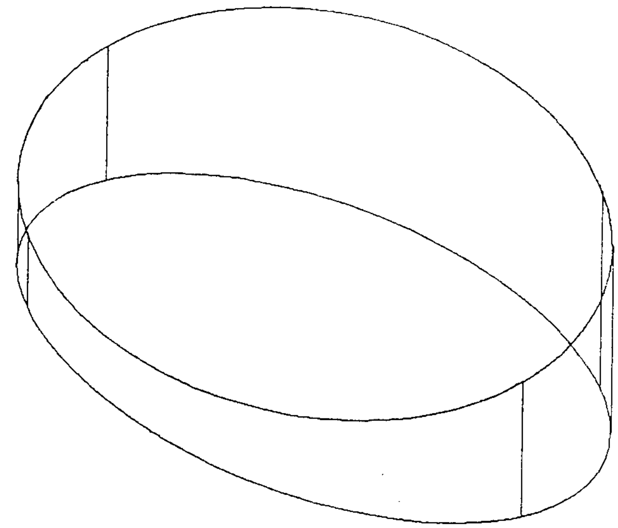

Figure 10 - Wedge (Piece 6 Sheet 3)

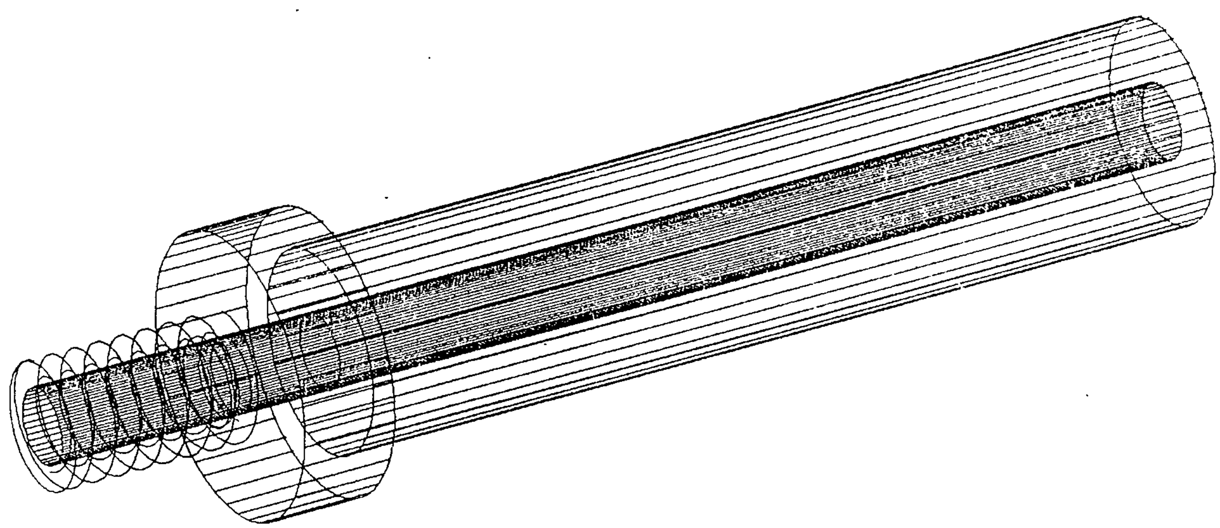

Figure 11 - Nozzle (Piece 7 Sheet 4)

7 Conclusions and Recommendations

7.1 Lessons Learned

MIL-STD-1840 is not well known at the user level. In some cases where it is used, it is an undesirable alternative to other formats, predominantly tar.

MIL-STD-1840 tape tools must receive wider distribution. The most effective way for the tools to be accepted would be for the CAD vendors to provide them using a familiar user interface.

MIL-D-28000 must be expanded to allow for the transfer of product model geometry.

The subsets in MIL-D-28000 require further constraints. Multiple IGES entities can be used to represent the same CAD constructs. This causes different MIL-D-28000 files to be created which represent the same idea. The migration from subsets to application protocols should alleviate this problem.

The participants in a data exchange program must be aware of the idiosyncracies of the translators, CAD software and procedures implemented at the sending and receiving sites.

7.2 Conclusions

Organizations are using IGES for many applications. The actual exchange of information is more complex than the transfer of data. The requirements and scope of the data transfer program must be determined in advance. At this stage in the development of MIL-D-28000, a working knowledge of the specification and the CAD systems is required to ensure a successful data transfer.