Previous Section

8.0 -- ISO 10303 Standards STEP/PDES

8.1 -- Purpose

STEP (Standard for the Exchange of Product model data) is the unofficial name for the ISO 10303 standards which are being developed by the International Organization for Standardization (ISO). STEP is formally called the "Industrial Automation Systems and Integration -- Product Data Representation and Exchange Standard". In the United States, STEP is known as PDES which stands for "Product Data Exchange using STEP". PDES is the U.S. organizational activity that supports the development and implementation of STEP.

STEP is an international standard which is being designed to give a complete computer-interpretable representation of product data in a neutral format throughout the complete product life-cycle (design, engineering analysis, manufacture, support and maintenance, and disposal). This representation makes it suitable not only for file exchange but also as a basis for implementation, sharing, and archiving product databases. STEP is an extremely broad specification, including virtually every data item required to develop, analyze, manufacture, document, and support products ranging from mechanical products to electronic products to large structures such as ships and buildings, etc.

The STEP standards are fundamental to the Continuous Acquisition and Life-cycle Support (CALS) effort. CALS encompasses an architecture for Contractor integrated Technical Information Services (CITIS) which requires an Defense Shared Data Warehouse (DSDW). The STEP shared data environment will provide the kernel of the DSDW and will support information access for prime contractors, sub-contractors, and the DoD.

8.2 -- Typical Application

A typical application of product data in the form of a STEP file is shown in the following figure:

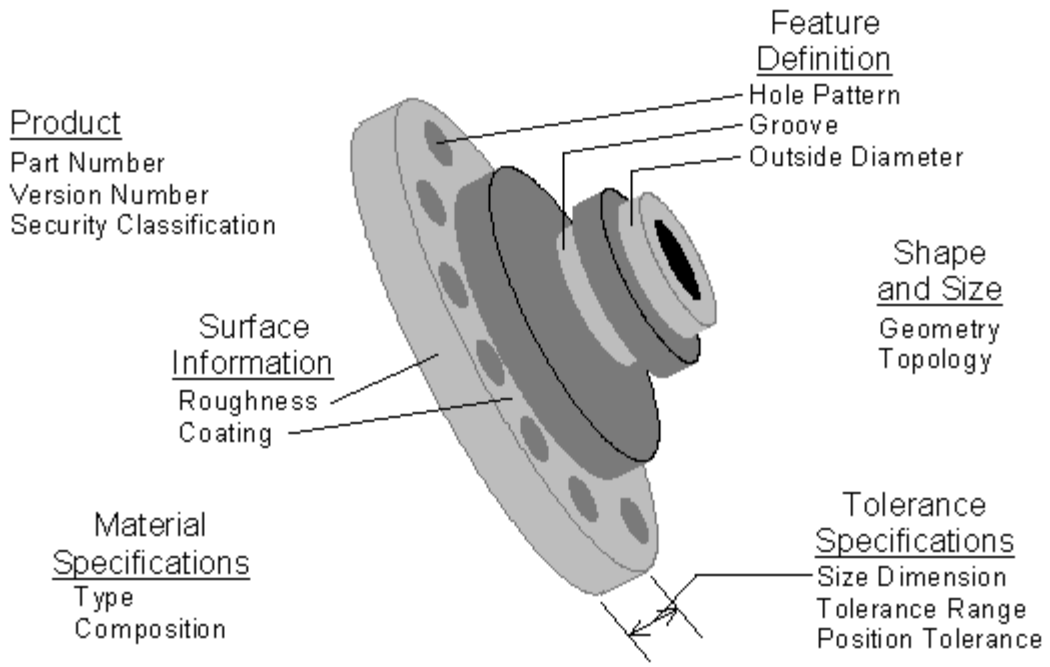

Figure 10-2 -- Example of a STEP data file.

8.3 -- Architecture of the Standard

8.3.1 -- STEP Parts

STEP is organized as a series of Parts which are divided into six logical groups. Each of these groups is called a Class. Each Class has a unique function in STEP. Within each Class, documentation for each Part is being developed. STEP is being published as a set of inter-related standards, each of which falls into one of the six Classes in the following figure.

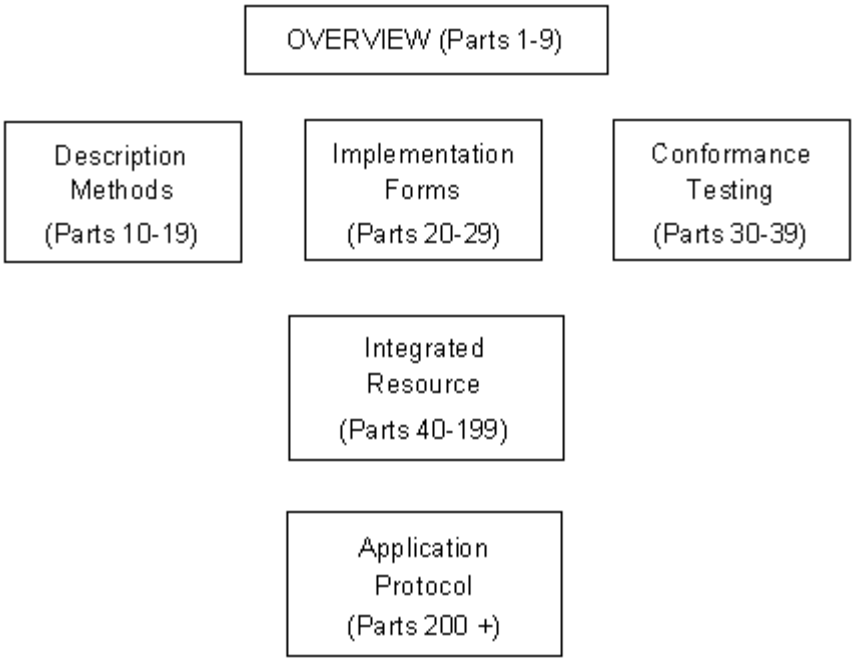

Figure 10-3 -- STEP Parts.

8.4 -- Status and Planned Extensions

8.4.1 -- STEP Initial Release

The initial STEP release in 1994 establishes a foundation for subsequent releases of STEP. This initial release of STEP includes the following Parts:

Part	1	- Overview and Fundamental Principles
Part	11	- EXPRESS Language Reference Manual
Part	21	- Clear Text Encoding of the Exchange Structure
Part	31	- Conformance Testing Methodology
Part	41	- Fundamentals Product Description and Support
Part	42	- Geometric and Topological Representation
Part	43	- Representation Structures
Part	44	- Product Structure Configuration
Part	46	- Visual Presentation
Part	101	- Drafting
Part	201	- Explicit Drafting
Part	203	- Configuration Controlled Design

8.4.2 -- STEP Subsequent Releases

Subsequent STEP releases will provide added functionality and extend the capabilities of the Parts in the initial Release. The schedule for these STEP subsequent releases has not been determined. The following Parts are currently being developed.

Part 22 - STEP Data Access Interface (SDAI)
Part 32 - Test Laboratory Requirements
Part 33 - Structure and Use of Abstract Test Suites
Part 34 - Abstract Test Methods
Part 45 - Materials Products
Part 47 - Shape Tolerances
Part 48 - Form Features
Part 104 - Finite Element Analysis
Part 105 - Kinematics
Part 202 - Associative Drafting
Part 204 - Mechanical Design Using Boundary Representation
Part 205 - Mechanical Design Using Surface Representation
Part 206 - Mechanical Design Using Wireframe Representation
Part 207 - Sheet Metal Die Planning and Design
Part 208 - Life Cycle Product Change Process
Part 209 - Design Through Analysis of Composite & Metallic Structures
Part 210 - Electronic Printed Circuit Assembly: Design and Manufacture
Part 211 - Electronic Printed Circuit Assembly: Test, Integrated Diagnostics and Remanufacture
Part 212 - Electrotechnical Plants
Part 213 - NC Process Plans for Machined Parts
Part 214 - Core Data for Automotive Mechanical Design
Part 215 - Ship Arrangements
Part 216 - Ship Molded Forms
Part 217 - Ship Piping Systems
Part 218 - Ship Structures
Part 219 - Dimensional inspection Process Planning

8.5 -- Implementation Issues

The initial release of DIS STEP is available for implementation. The emphasis on software applications is currently focused on creating Application Protocols (APs) which are focused on high value industrial processes.

8.5.1 -- Implementation of APs

APs are the implementable parts of STEP. Many APs are in the planning or development stages. Guidelines (Ref.2) for the development of APs are documented and are available through the U.S. Product Data Association. To date, AP 202, "Associate Drafting", and AP 203, "Configuration Controlled Design", have been approved as ISO standards. AP 210, "Electronic Printed Circuit Assembly: Design and Manufacture", is currently a preliminary ISO standard that will go to DIS for review in January 1997, with official release as an ISO standard anticipated in June 1997.

When an AP is proposed for development, approval is required from the IGES/PDES Organization (IPO). The AP proposal requires a precise definition of scope and a detailed plan for development. The

development of the AP proceeds in accordance with the STEP guidelines. The draft AP is reviewed and balloted through the international standards process.

8.5.2 -- Software Tools

There is a growing recognition of the need for software tools to facilitate the STEP standards development, application software implementation, and testing process.

- Software tools can be catalogued in four major groupings.
- Standards development tools: Parsers, compilers, editors, schema generators, etc.
- STEP data exchange tools: Software to generate and interpret STEP physical files and databases, etc.
- Data management tools: STEP data access interfaces and database management software, etc.
- End User Tools: Translators, etc.

8.5.3 -- Implementation Levels

STEP provides a wide variety of levels for system implementation. Implementation levels are particular ways of storing, exchanging or accessing information which are distinguished by the degree of data sharing. Those levels may include the following:

- **Exchange File** -- Product data is exchanged between computer systems or applications using STEP exchange files which are defined in STEP Part 21. The structure of the exchange file is derived from the conceptual data model's EXPRESS definition. It is expected that the early use of STEP will involve using exchange files to move data between systems.
- **Database** -- Product data is stored and accessed in databases based on various database architectures (such as relational or object-oriented) This database level will allow application developers to create, manipulate, and share STEP data, based on standard data models and system interfaces. Applications use a standard query language such as SQL or standard interfaces such as the STEP Data Access Interface (SDAI) defined in Part 22.
- **Data Access** -- Product data can be accessed independently of the storage method used.

8.5.4 -- Testing

The STEP testing activities are categorized as follows:

- **Standards testing:** addresses the quality of the evolving STEP specification itself. These validation efforts provide assurance that the methods employed by STEP will indeed work, and that the standard provides a means to meet the functionality that it claims to support.
- **Component testing:** This is the preliminary testing conducted by the STEP software

implementor to verify that the application software addresses both the basic requirements imposed for compliance with the standard and the users' functionality requirements.

- **Conformance testing:** evaluates a software product with respect to the specifications provided in a Part of a STEP standard and tests for the presence of these characteristics required by the standard itself. STEP includes the specifications for Conformance testing as a requirement built into many Parts of the standard.

- **Acceptance testing:** concerned with the user's specific requirements. It tests a software product against a set of requirements defined by the users of that software product. This type of testing may include performance, user interfaces and inter-operability with other systems.

Current efforts are primarily focused on developing methods for Conformance and Standards testing. Component and Acceptance testing activities have just gotten underway within the vendor and user communities.

8.5.5 -- IGES to PDES Migration

The initial Graphics Exchange Specification (IGES) is an ANSI standard which provides a neutral data format for exchanging mechanical product data. IGES was not originally intended to capture extensive product information for the entire product life-cycle. With the planned release of IGES version 6.0 in early 1998, IGES application development will stop and IGES will be gradually replaced with STEP. Strategies for migrating from IGES to PDES are being proposed by and discussed within U.S. standards development bodies.

8.6 -- Extent and Maturity of User and Vendor Support

Tools for modeling and developing specialized applications in STEP have been available, primarily in standards development and research activities, since the mid-1980's. As the technology has gained momentum, commercial suppliers' efforts are being focused on providing more tools for software developers and implementors.

Recently, several STEP toolkits have been introduced commercially. These tools provide needed resources for the developers and implementors and they should accelerate development of applications. There is a growing recognition of the need for software tools to facilitate development and testing processes. This should lead to additional tool development for these activities.

As of September 1996, at least 24 vendors had either released or were working on STEP Vendor translators to support AP 203. Each translator provides different levels of conformance, with the Catia and Unigraphics translators providing the most comprehensive capabilities. These two translators meet all six AP 203 conformance classes and were released in late 1995.

8.7 -- Additional Documentation

- DIS 10303 (STEP) Standards, initial Release, May 1993

- Mark Palmer and Mitch Gilbert, "Guidelines for the Development and Approval of STEP Application Protocols", WG5/P5 Working Draft, 7 January 1993

- TC184/SC4 "Reference Manual" (Draft), October 1992

- "Product Baseline Activities", National Initiative for Product Data Exchange, Release 1, October 1992.

9.0 -- Hypermedia/Time-Based Structuring Language -- HYTIME (ISO/IEC Draft International Standard 10744)

9.1 -- Purpose

The Hypermedia/Time-based Structuring Language (HyTime) is a standard language for representing the logical structure of documents with requirements for space and time based coordinates and addressing. HyTime is based on SGML (ISO 8879), and uses the grammatical and syntactical conventions of SGML. HyTime provides the capability to package information objects using a standardized markup language whose structure will enable non-sequential access, querying, version control, and long-term maintenance despite system evolution or migration.

By using the SGML/HyTime standards, the application designer can create system independent files that are transferable and interoperable across dissimilar computer applications. HyTime provides architectural forms for the definition of SGML element classes in SGML Document Type Definitions (DTD). HyTime does not provide a DTD, as such, but instead, constitutes a meta-DTD from which conforming application DTDs can be created.

Users of HyTime-compliant systems can incorporate active references within documents and to external on-line documents. HyTime can reference documents in multiple notation languages, e.g., IGES, VHDL, ODA, etc. HyTime location addressing includes the capability to reference read-only documents, which is crucial to incorporating legacy data.

HyTime is designed for modular application. Features of the language which are not needed for an application need not be supported. Depending on which features are supported, HyTime provides:

- **Location addressing:** a standard way of encoding a system-neutral address of any information object or any part of an information object within or external to any given document. Addressing may be by name, position, or semantic property.

- **Hyperlinking:** models for hyperlink classes independent of the number of objects linked to, and the context of the link.

- **Scheduling:** synchronization and alignment of information objects relative to one another. Information objects are positioned within events on the spatio-temporal axes of a Finite Coordinate Space (FCS).

- **Object Modification:** Object modification is scheduled by HyTime but must be applied by

application-specific functions. This enables the scheduling of rendering instructions in other notations, e.g., PostScript.

- **Event Projection:** Events may be scheduled and projected onto alternative finite coordinate systems and scaled accordingly.

- **Parsability:** HyTime documents are parsable by SGML applications; parsing checks for correct SGML grammar and syntax as well as conformance of the instance to the DTD.

HyTime is not now a CALS standard. It is perceived as a potential standard supporting future interactive, electronic, hypertext and multimedia CALS applications.

9.2 -- Typical Applications

The HyTime language can be directly applied to hypertext (documents that enable multiple access paths) and multimedia applications. These include the design and encoding of information for Interactive Electronic Technical Manuals and Portable Maintenance Aids (IETM/PMA), on-line review of existing documents both in and not in neutral formats, and the creation of large interoperable hyperdocument libraries or design data bases.

HyTime has potential applications in the areas of project management, enterprise process design, discrete event simulation, and music. The DoD is using HyTime and SGML as the basis for its Metafile for Interactive Documents (MID) initiative. MID is a common interchange structure that takes neutral data from varying authoring systems and structures it for display on dissimilar presentation systems. MID is intended to allow all databases of weapons system technical information to be compatible with all IETM delivery systems. MID also may be merged with the draft Standard Multimedia Scripting Language (SMSL) standard as an ISO standard. For more information on MID, see paragraph 13.0 or the MID WWW site at:

<http://navycals.dt.navy.mil/mid/>

9.3 -- Status and Planned Extensions

The newest and most significant addition to the HyTime published standard is the HyQ query language. It was added to provide an alternative user interface (sanctioned by ISO) not only to HyTime and SGML documents but non-SGML documents as well by using HyTime features. Some of the recent technical changes to the published standard impact the Content Data Model which must be revised accordingly.

9.4 -- Implementation Issues

Non-HyTime notations used in scaling factors cannot be executed by a HyTime system. Such notations might include the potential for asynchronous interrupts by a user.

9.5 -- Extent and Nature of User and Vendor Support

Prominent work being done with the HyTime standard includes:

- The Tri-Service working group developing specifications for an Interactive Electronic Technical Manual (IETM),
- Use of the HyTime hyperlinking architectural forms in the Content Data Model of the Integrated Maintenance Information System of the US Air Force,
- Work by the MHEG committee to demonstrate the inclusion of compressed video in a HyTime-compliant document,
- The use of the Document Style Semantics and Specification Language (DSSSL) to provide processing semantics for HyTime-compliant applications, and
- The DoD's MID initiative.

A Special Interest Group (SIG) was created to support the hypermedia community. The SGML SIGHyper (SGML User's Group Special Interest Group on Hypertext and Multimedia) maintains an active membership comprised of some of the world's leading authorities in the hypermedia field, and publishes a newsletter containing articles on the use of HyTime.

The Davenport Group in their Draft Advisory Standard, 30 January 1992, has adapted a subset of HyTime architectural forms as the basis for On-line and Printed Technical Documents (MANPAGES) usually supplied by UNIX vendors to customers. It will allow vendors to bundle documents from a variety of publishers and to give the customers access to these documents via one or more independently defined interfaces.

9.6 -- Additional Documentation

- SGML SIGHyper Newsletter; Vol. 1 No. 1; October, 1991, c/o TechnoTeacher Inc., 1810 High Road, Tallahassee, FL 32303.
- 8879 Information Processing Standards -- Text and Office Systems -- Standard Generalized Markup Language (SGML).
- "Hypermedia Standards: HyTime and MHEG", Brian Markey, Digital Equipment Corporation. From the Proceedings of the CALS Expo '91 sponsored by the CALS/CE Industry Steering Group.
- "Interactive Processing of Information Objects", Paula Angerstein, Computer Task Group. From the proceedings of the CALS Expo '91 sponsored by the CALS/CE Industry Steering Group.
- "The Tri-Service Interactive Electronic Technical Specification", Eric L. Jorgensen, Department of the Navy. From a presentation given by Eric Jorgensen at the CALS Expo '91 sponsored by the CALS/CE Industry Steering Group.
- "Integrated Maintenance Information System (IMIS) Content Data Model (CDM)", Bryan K

Caporlette, Armstrong Laboratory Logistics Research Division. From the proceedings of the CALS Expo '91 sponsored by the CALS/CE Industry Steering Group.

- "The 'HyTime' Hypermedia/Time-based Document Structuring Language Steven R. Newcomb, Neill A. Kipp, and Victoria T. Newcomb. Communications of the ACM, November 199l/Vol.34, No. ll.

- "Standard Music Description Language (SMDL)", Charles F. Goldfarb. Committee Draft International Standard ISO/IEC CD 10743, April l 1991.

- "HyTime: A Standard for Structured Hypermedia Interchange", Charles F. Goldfarb. CALS Journal, Summer 1992, Vol. 1, No. 2.

- World Wide Web page http://www.techno.com/TechnoTeacher

10.0 -- EDIF (Electronic Design Interchange Format)

10.1 -- Purpose

The Electronic Design Interchange Format (EDIF) standard (ANSI/EIA 548) is a file format and product description for electrical/electronic application data files. EDIF is a language used to interchange design data between CAD systems. Such CAD systems are often referred to as Electronic CAD (ECAD) Systems or Electronic Design Automation (EDA) Systems. The language is a data format designed to be written and read by computer programs which are constituent parts of EDA systems or tools. The language is a standard under the auspices of the Electronic Industries Association (EIA), a US based industry association responsible for a number of electronics-related standards. EDIF Version 3 0 0 has also become an IEC standard; IEC 1690.

EDIF is a neutral electronic design interchange data format. With the use of EDIF only one version of a design library must be written, and only one translator -- to a neutral format -- is required. EDIF was designed to address all concerns shared by the electronic design community, including simulation models, schematics, and Integrated Circuit (IC) layouts.

A major advantage of EDIF over many CAD formats is that EDIF may be used to exchange only the amount of data necessary and agreed upon. Thus, a netlist might be defined in EDIF and sent to an IC foundry. The IC foundry might return an EDIF file describing the resulting IC layout. The users are not obligated to interchange schematic information or behavioral information if not desired.

Traditional IC layout exchange standards (including IGES) describe geometric data, but they do not specify the connectivity between components. EDIF provides an option for describing the connectivity as an integral part of the MaskLayout View.

10.2 -- Typical Applications

Integrated Circuit (IC) vendors use EDIF to exchange IC mask data. In addition, EDIF is used for product representation. There are some users of EDIF for Printed Circuit Board (PCB) library and layout archive

and transfer.

Many EDIF users plan to use VHSIC Hardware Description Language (VHDL) for system architectural descriptions, while proposing to convert the VHDL gate level descriptions into EDIF. This conversion creates a link from the higher-level descriptions to the lower, more physical, descriptions. In fact, some think that EDIF, through its Behavioral View (which describes system behavior), can be used to transform models written in a hardware description language such as VHDL, into an equivalent description in another language.

10.3 -- Status and Planned Extensions

EDIF Version 3 5 0

Version 3 5 0 was released as an review/prototype document in December 1994. EDIF Version 3 5 0's new PCB Layout extension allows EDIF users to transfer descriptions of PCB layouts alongside descriptions of associated schematic and netlist information. The PCB Layout data will be limited mostly to physical descriptions, with a small number of design and technology rules. Use of a common information model as used in EDIF Version 3 0 0 is also incorporated into EDIF Version 3 5 0. The interim standard was released for review and so that trial implementations can be evaluated before EDIF Version 4 0 0 is released.

EDIF Version 4 0 0

EDIF Version 4 0 0 is currently out for ballot (as EDIF Version 3 9 9). Subject to a successful ballot this will be accepted as the new standard, EDIF Version 4 0 0, later this year.

There is a strong need to transport PCB/MCM layout from one CAD system to another or to manufacturing. EDIF was created for this very purpose. EDIF Version 4 0 0 covers many more technology and design rules, to deal with Multi-Chip Modules descriptions and to allow the transfer of documentation associated with physical layouts (e.g., assembly drawings, drilling drawings and other mechanical drawings).

EDIF Version 4 0 0 (3 9 9) extends the interim Version 3 5 0 Standard in three important areas:

- **Technology Rules**
  - manufacturing rules
  - assembly rules
- **MCM Capabilities**
  - chip-first technologies
  - chip-last technologies
    - tape automated bonding (TAB)
    - wire bonding
    - flip chip
- **Manufacturing Drawings**
  - annotated PCB/PCA data
  - used in the manufacturing process

10.4 -- Extent and Nature of User and Vendor Support

EDIF, the world's most widely used electronic design interchange format, is an essential part of the Electronic Industries Association's (EIA) service to the electronics industry. Since its inception ten years ago, EDIF has become a vital part of the Electronic Design Automation (EDA) industry, with more than 100 companies and universities along with countless end-users around the globe using this standard to share design information efficiently.

The USA EDIF Users' Group was formed to review proposals, air problems and make suggestions. User groups can now be found in Europe, Japan, Russia and the United States. All of these groups organize annual conferences to present papers on common user issues and take advantage of tutorials and workshops on the latest EDIF modifications.

The EDIF standard is being mapped to PDES/STEP. The PDES/STEP activity is developing PDES Application Protocols for Electronics that include a teaming of the CAD Framework Initiative (CFI), EDIF, and PDES, to facilitate CAD integration through product data. An integrated CAD shared Product Database will be formed. The EDIF responsibilities to this effort are:

- Definition of broad electronic user information requirements
- Mapping of information requirements to EDIF syntax
- Extension of EDIF syntax to support information requirements
- User demonstrations

CFI will be defining, designing, and prototyping a framework for CAD integration, while PDES, Inc. will be defining broad mechanical user information requirements, and refining electronic user information requirements for specific domains (e.g., PCA/PCB). These will subsequently be mapped to STEP.

The Navy's RAMP program is providing a translator that converts the schematic information from EDIF format into an MIL-STD-l840 conforming RAMP fileset. EDIF is used to carry not only the circuit schematic, but also the electrical functionality for passive components (such as resistors, inductors, and capacitors).

10.5 -- Additional Documentation

- CALS Report, Vol 2, No. 8, August 1989.

- CALS Report, Vol 4, No. 8, August 1991.

- "CALS Architecture Study", Report to the Joint Logistics Commanders and Office of the Secretary of Defense CALS and EDT Office, Volume 1: Report, June 30, 1991.

- "An Overview of Electronic Data Interchange Standards", SME Technical Paper MS89-178, Standards of CIM Conference, February 21-23, 1989.

- Dashman, Eric H., "AVHDL-to-EDIF Translator", The Fourth EDIF User Group Workshop Digest of Technical Papers, EDIF User Group, 2222 South Dobson Road, Building 5, Mesa,

AZ 85202, 1988.

- Gilman Alfred S., "Using VHDL and EDIF in Concert", The Fourth EDIF User Group Workshop Digest of Technical Papers, EDIF User Group, 2222 South Dobson Road, Building 5, Mesa, AZ 85202, 1988.

- Shahdad Moe, "An Interface Between VHDL and EDIF", Proceedings of the 24th ACM/IEEE Design Automation Conference, 1987, pp 472-478.

- Grout Steve, Martin Marietta Corporation, "Lessons Learned, Developing STEP Electronic Applications", CALS Expo '92.

- Sneed James, "Conversion of Technical Data for Printed Wiring Assemblies into CALS MIL-STD-1840 Standard Digital Data", CALS Expo '92.

- "Harmonizing CALS Product Data Description Standards: An Evaluation Report by the EIA Ad Hoc CALS Study Group".

- EDIF Standard EIA -- 548.

- Introduction to EDIF (EIA/EDIF-1).

- EDIF Connectivity.

- EDIF Application Guide -- for Schematics Transfer.

- EDIF Schematic User Guide (EIA/EDIF-2).

Copies of these references may be ordered from the Electronic Industries Association, 2001 Pennsylvania Ave., N.W., Washington, DC 0006 (Mark V. Rosenker, EIA Engineering Department 202/457-4900)

Next Section