AP 210
Capabilities for Modular Electronics
December 5, 1997
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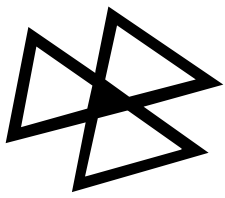*John G. DeLoof:* SCRA

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Handout 4b.1

■ PDES, Inc.

■ Naval Supply Systems Command RAMP Program Office

■ Rockwell International, Avionics & Communications Division

■ Boeing Defense & Space Group

■ Hughes Aircraft Company

■ NIST

■ Domain is Design of Electronic Assemblies, their Interconnection and Packaging

■ Scope is the "As-Required" & "As-Designed" Product Information

– Design "In Process"

– Design "Release"

■ Sharing Partners:

– Design / Analysis

– Manufacturing / Analysis

■ Sharing Across Several Levels of Supply Base

AP210 Development Summary

- ■ ISO 10303-210 is currently in DIS document development
- ■ Next Milestones
  - – Conduct CD Document Ballot Resolution Workshop
  - – Complete DIS Document Qualification
  - – Initiate Development of Abstract Test Suites
  - – Restart NWI220 Development
  - – DIS Document Ballot Process
  - – FDIS Document Ballot Process
  - – Register IS

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AP210: Electronic Assembly, Interconnect and Packaging Design

Product Structure/ Connectivity
- Functional
- Packaged

Part
- Functionality
- Analysis Support
- Shape 2D, 3D
- Package
- Material Product
- Properties

Physical
- Component Placement
- Bare Board Design
- Layout templates
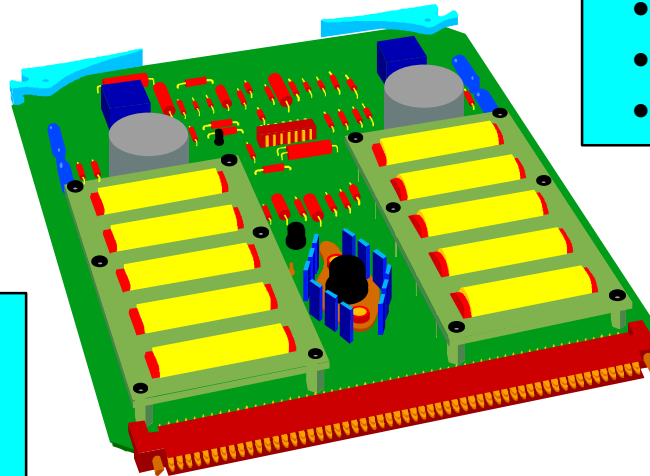- Layers non-planar, conductive & non-conductive
- Material product

Configuration Mgmt
- Identification
- Authority
- Effectivity
- Control
- Requirement Traceability
- Analytical Model
- Document References

Geometry
- Geometrically Bounded 2-D
- Wireframe with Topology
- Surfaces
- Advanced BREP Solids
- Constructive Solid Geometry

Requirements
- Design
- Allocation
- Constraints
- Interface
- Rules

Design Control
- Geometric Dimensioning and Tolerancing

Technology
- Fabrication Design Rules
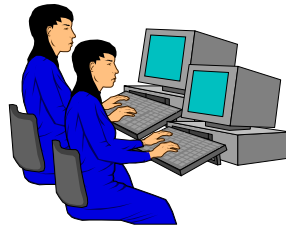- Product Design Rules

Requirements

Product Designer
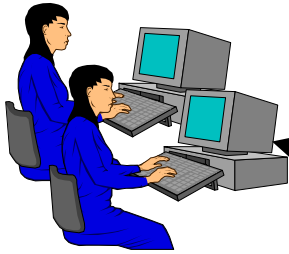
Package Data
Supplier

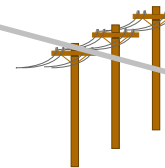Analysis Model
Supplier

Corporate Data
Validation Process

Assembly
Vendor

Device
Supplier

**Known Good
Data**

Fabrication
Vendor

Industrial (User) Requirements

- Replace legacy hybrid (drawing & computer based) systems & processes.

- Integrate Design Engineering, Manufacturing Engineering, and Production Data.

- Configuration Management Data for "Virtual Enterprise" between Part Vendors (Functional and Interconnect), Designer, Assembler, and Customer.

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- Integrate Systems Engineering /EE / ME / Analysis
  - Library and Product Data.
  - Replace GIF pictures With Computer Sensible Data Sheets in Web Based Publishing
  - 3D and 2D Views of Parts, Interfaces.
  - Individual Shape Representations tailored to Analysis Purposes .
 - Functional Data
    - Schematics & Schematic symbols
    - Models

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- Maintain Requirements as Design Progresses Instead of Replacing Requirements with Final Design, e.g., Keep a Copy of "As Required Board Outline".

- Be Technology Independent to Maximum Extent Possible
  - Standard Should NOT be Obsolete when Implemented.
  - Useful for Microwave / Photonic Designs

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- Support hierarchical product design; enclosure, black box, module, pca, mcm, ball grid array, pcb, parts, cabling.

- Compatible with EDIF (desired), VHDL, MHDL, etc.

- Allow Users to Replace IGES, Gerber, IEC 1182-1 (IPC), GDS-II.
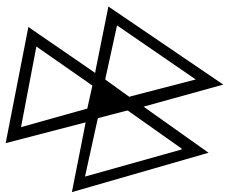
Requirements Capability

Requirements
- Design
- Allocation
- Constraints
- Interface
- Rules

■ Supports System Engineering Methodology Throughout Standard, ie., allocation.

■ Model partially based on Kuziak's work at U of I.

■ Requirements can be Extracted from Specifications and may be Assigned to Almost any Design Aspect for purposes of design reuse, constraints, or interface control.

■ Some Design aspects Serve as Explicit Requirements for Other Design Aspects (e.g., Connectivity for Layout)

■ Implements organization standard design rules for assembly and layout.

Product Structure and Connectivity

Product Structure/Connectivity
- Functional
- Packaged

- Hierarchical Models include: Functional, Physical, Requirements, Rules, Assembly, PCB, Parts, and Materials

- Functional Model: Folded Hierarchical Netlist, Flattened Netlist, Flattened Netlist With Routing Constraints

- Network Listing Capability: Generic, Multi-level, or Multi-discipline

Product Structure and Connectivity

■ Signal Based Characterization of Functional Unit:

- – Signal Data Type Definition
- – Allowed Signal Categories (e.g., ATLAS)
- – Uses External Definition Capability

Product Structure/

- Functional
- Packaged

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- Schematics: Will Use Schematics Module from AP 212

- Schematics Symbol: Will Use Schematics Symbol Module from Ap 212

- Pin Mapping: Included in AP 210

**Product Structure/
Connectivity**
- Functional
- Packaged

Technology Capability

Technology
- Fabrication Design Rules
- Product Design Rules

- **Generic Assembly and Interconnect Data Model**
  - Through hole, SMT, fine-line, MCM's, molded parts, etc.

- **Design for Manufacture: Technology Capability and Constraints**
  - Example: Explicitly State Relationship Between Land Shape Requirements and Interconnect Fabrication Technology Data.
    - » Material Identification & Composition (e.g., IPC -xxxx)
    - » Interconnect Fabricator Process Capability
    - » Package Terminal Characteristics
    - » Substrate to Terminal Joint Characaterization

- **Product Design Rule Constraints**

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Physical Model Capability

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Physical
- Component Placement
- Bare Board Design
- Layout Templates
- Layers non-planar, conductive & non-conductive
- Material product

- Assembly Component Placement

- Topologically Explicit Model of the Layout "Metal"

- Functional Conductivity Characterization of Layout "Metal" in Electrical, Optical, Thermal Domains.

- Lumped, Distributed, Thermal Terminals

- Geometric Context for Supporting Mapping Between Circuit, S Parameter, Full-3D Electrical Models

- Material Description, Composition, and Assembly

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Physical
- Component Placement
- Bare Board Design
- Layout Templates
- Layers non-planar, conductive & non-conductive
- Material product

- "Define Once, Reuse Many Times" Applied to All Layout Items.

- Design Intent Preserved for Complex Layouts (Multiple Conflicting Planes and Signal Lines)

- Easy to Extract Bare Board Test Data

- Material Definitions As Simple or As Complex As Desired

- Classify Holes, Line Widths for Tolerances

- Multiple Assemblies for Same Interconnect

- Multiple Interconnects in the Same Assembly

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Physical
- Component Placement
- Bare Board Design
- Layout Templates
- Layers non-planar, conductive & non-conductive
- Material product

■ Assembly and Interconnect Model Applies to Panelization As Well As End Product Design. Step and Repeat, Coupons, Flash; All Handled.

    ■ An Assembly Panel Is an Assembly

    ■ A Fab Panel Is a PCB

■ AP 203 Readers Can Read an AP 210 Exchange File So Manufacturing Assembly Can Use AP 203 Viewers
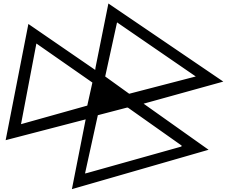
Physical Design Control

Design Control
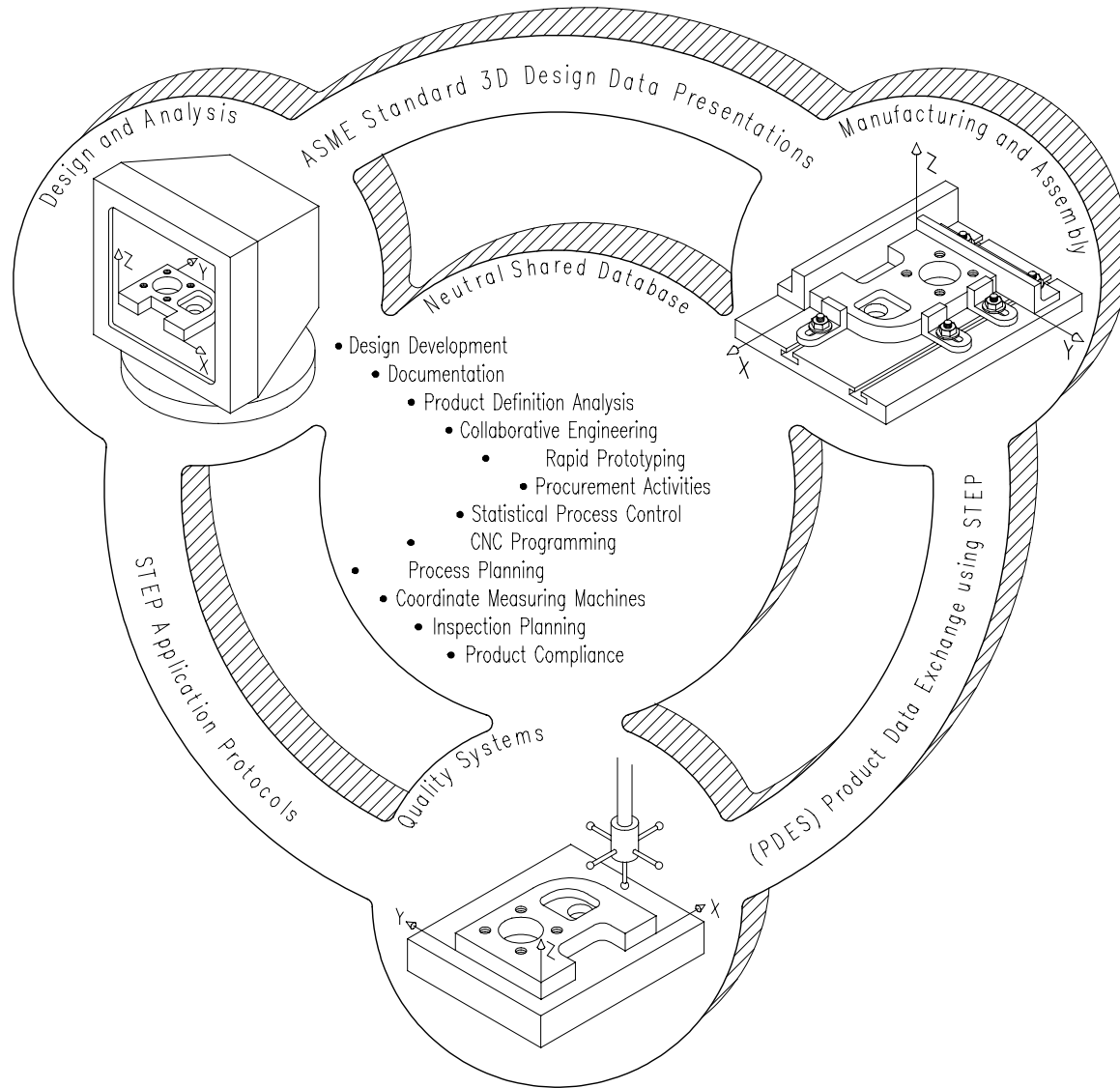- Geometric Dimensioning and Tolerancing

■ Industrial Benefit

– Groundwork for Significantly Improving Cycle Time

– Basis for Rule-Based GD&T engines in CAD/CAM

■ Methodolody

– Application-to-application exchange (e.g., between CAD/CAM and Coordinate Measurement Machines.) Without Human Interpretation

– Explicitly Based on the ASME Y14.5M and ISO 1101 Standards for Drawing Based Exchange of GD&T Data.

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- Design Development
  - Documentation
    - Product Definition Analysis
      - Collaborative Engineering
        - Rapid Prototyping
          - Procurement Activities
      - Statistical Process Control
      - CNC Programming
  - Process Planning
  - Coordinate Measuring Machines
    - Inspection Planning
      - Product Compliance

Design and Analysis

ASME Standard 3D Design Data Presentations

Manufacturing and Assembly

Neutral Shared Database

STEP Application Protocols

Quality Systems

(PDES) Product Data Exchange using STEP

Part Model Capability

Part
- Functionality
- Termination
- Shape 2D, 3D
- Single Level Decomposition
- Material Product
- Characteristics

■ Information structures often found in "library"

   – Tightly Coupled Simulation Models and Product Definition Data

   – Defined Parameter Types

   – Defined Port Names and Types

   – Models Instantiated by Explicit Assignment of Product Definition Data to Parameters and Ports
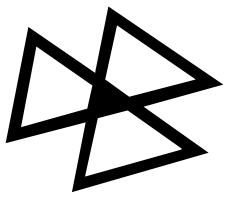
Part Model Capability (cont-d)

Part
- Functionality
- Termination
- Shape 2D, 3D
- Single Level Decomposition
- Material Product
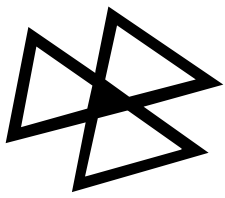- Characteristics

■ Extend Industry Standard Package Definition from Drawings to Direct Digital Application, E.G., JEDEC MO-156, Issue A

■ Implements Programmable "Make From" Parts

■ Multi-level Multi-Discipline Part Shape Representation

   – Environment

   – Purpose

   – Material Condition

Geometry Capabilities

- Explicit compatibility with IPC and EDIF and Gerber

- Geometry Models based on AP 203 and others (not all geometry from AP 203 used).

- Moves electronic product representation into 3D technology

- Parametric Curves (tapers, etc.) to support microwave

Geometry
- Geometrically Bounded 2-D Wireframe with Topology
- Surfaces
- Advanced BREP Solids
- Constructive Solid Geometry

Configuration and Design Management Capabilities

■ Conventional Design Control for In-Process and Released Data

■ Include Simulation Models

■ Associate Different Design Discipline Models with Same Product Definition

■ Net Change Capability:

    – Add, Delete, Change Properties

    – Applies to Any Sensible Design Object (Constrained by Rules in Data Model)

    – Allow Direct Correlation Between Change on Drawing and Design Database Change

Configuration Mgmt
- Identification
- Authority
- Effectivity
- Control
- Requirement Traceability
- Analytical Model
- Document References
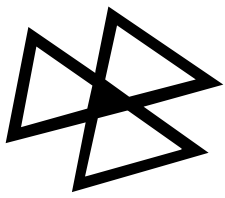
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■ **Externally Defined Data types**
Reference Authoritative Documents

– IEC 1182-1 1988 (Land Shapes, Land Patterns)

– JEDEC MO-156, Issue A, Date APR 1994

– Externally Defined Data Types Provide Technology Independence.

AP210/AP203 Statistics

|	AP203	AP210
■ ARM Entities	44	747
■ AIM Entities	45	537
■ Assertions	37	1101
■ Units of Functionality	14	76
■ Conformance Classes	6	24

AP210 Implementations

- PreAmp Application Framework Uses CD
- BD&SG Durability Analysis Uses CD
- RASSP Manufacturing Interface (MI)Uses DIS-WD1
- RASSP MI Will Update to DIS
- TIGER Program Uses DIS-WD1
- RAMP Manufacturing Interface Will use DIS
- PDES INC. Electromechanical Pilot Project Will use DIS
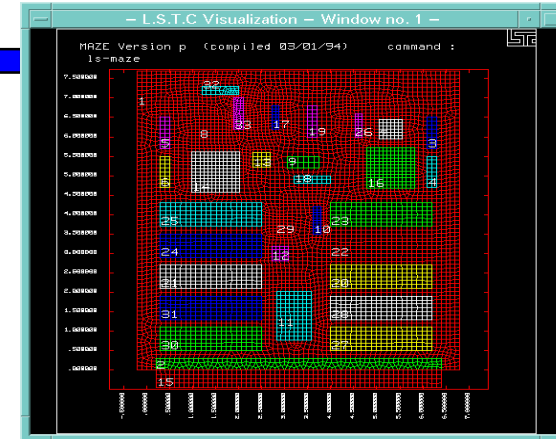- Member Companies will use DIS

Electromechanical Pilot

```
                    ECAD →  □  →  □  →  □  →  □  →  Circuit Board
                     ↕      ↕     ↕     ↕     ↕        Assembly
Requirements                                              ↓
              STEP Data for Exchange  AP 210         Quality
                     ↕      ↕     ↕     ↕     ↕        Product
                    MCAD →  □  →  □  →  □  →  □  →      ↑
                                                     Product
                                                     Package
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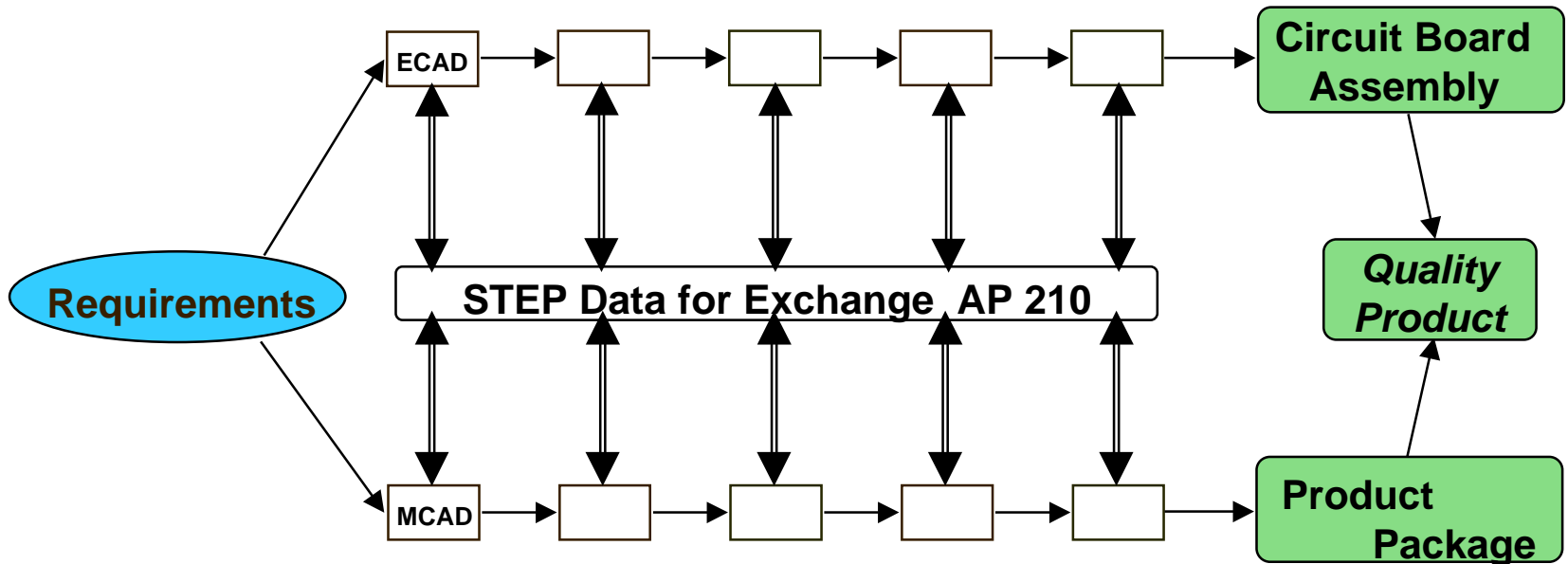
The EM Pilot uses AP210 to integrate electronic and mechanical design processes
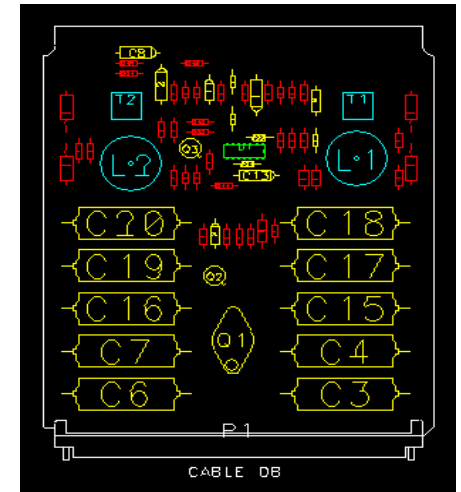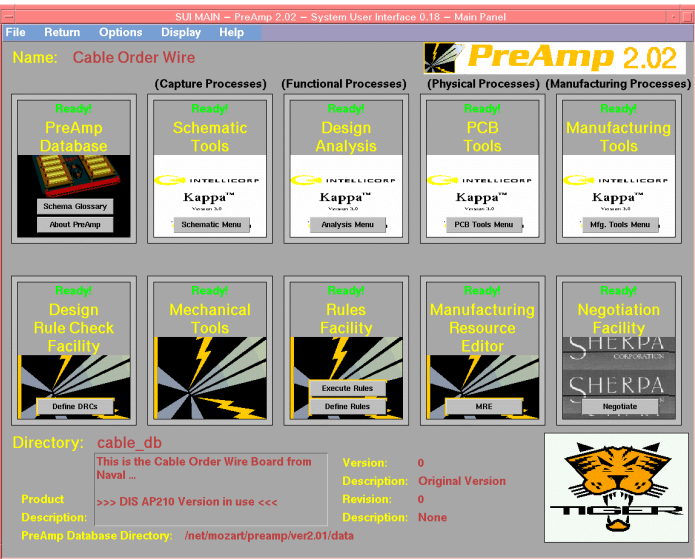
Boeing AP210 Research

Design

Producibility

Mentor
To
AP210
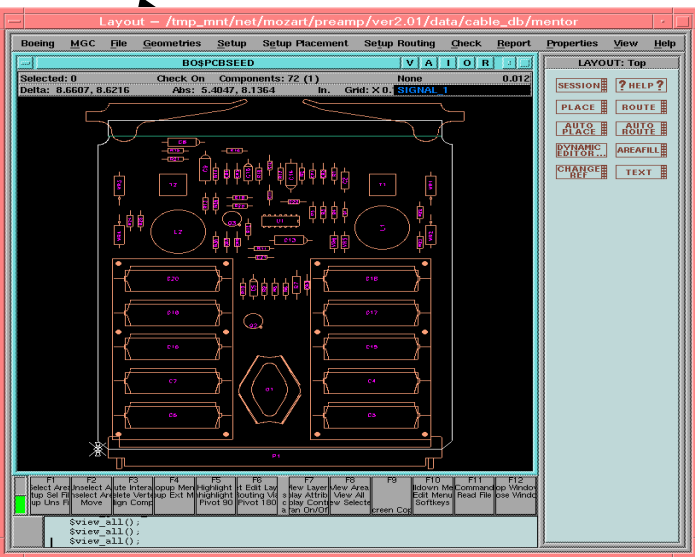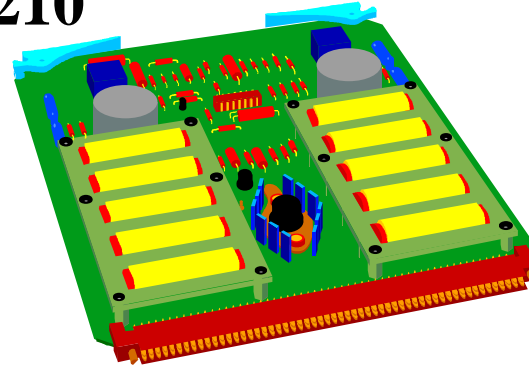
AP210

AP210
To
PreAmp/TIGER

AP210
To
Maze

AP210
To
GenCad

Analysis

Manufacturing

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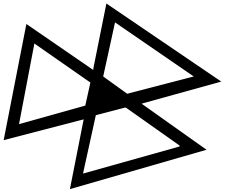
■ Support Virtual Enterprise

- – Design View and Usage View

- – Exchange (Add, Change, Delete) Instance Data Information

- – Robust external definition model

- – Concurrently Exchange: Configuration Management, Design Management, Document, Specification, Behavior as Required Properties (Requirements), as Planned Properties, Rules, Functional, Layout, Assembly, GD&T, Process Technology, Material, Layer Stackup Models.
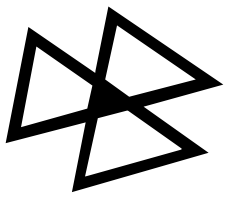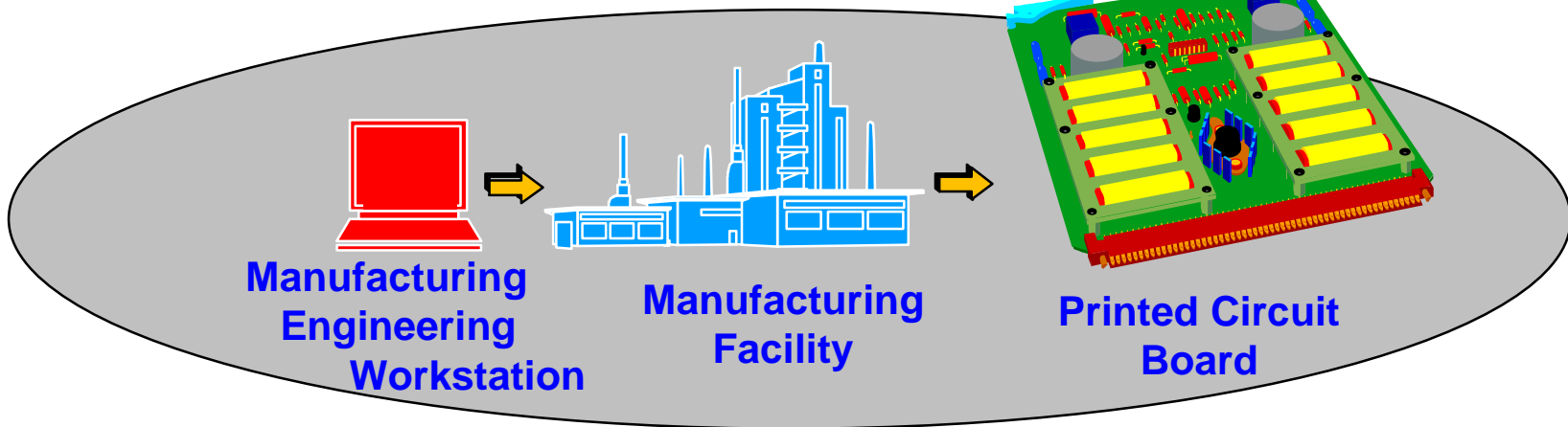
NWI220: PCA Process Planning

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PROCESS/FACTORY CHARACTERIZATION
- PCB Fabrication
- PCA Assembly
- Variability Characteristics

PRODUCT DESIGN

Manufacturing Engineering Workstation

Manufacturing Facility

Printed Circuit Board

PLANNING CHARACTERIZATION
- PCB/PCA Planning Data
- Plan Structure and Org
- Operations and Steps Measurement
- Work Measurement Standards

MANUFACTURING SPECIFIC PRODUCT INFORMATION
- 2D Panel Layout Geometry
- Process Tolerance
- Material, Consumable & Deliverable
- Process Design

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■ Functional Model

    – Functional Specification

    – Explicit Test Bench Definition

– Reuse of Folded Hierarchy Network Listing Definition

– Tightly Couple Package Definition and Functional Definition

– Black Box and White Box Model of "Part".

» Assembly, End-user Environment

» Fatigue, thermal, vibration, static load

» Analysis purpose