STEP and Intelligent Product Data Management

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Key Acronyms and Definitions

Some STEP Application Protocols:
- AP 203: “Configuration-Controlled 3D Design” (MCAD)
- AP 209: “Composite and Metallic Analysis and Related Design” (CAE)
- AP 210: “Electronic Assembly, Interconnect., and Packaging Design” (ECAD)

Without PDM, CAx Models are “Islands”

Current COTS PDM: Association, not Integration

“Intelligent PDM” (IPDM)

Plug-and-Play IPDM (with CORBA / OMG PDM Enablers Interfaces)

Product Master Model Evolution Over the Life Cycle

Benefits of a STEP-based IPDM Service

The NASA STEP Testbed IPDM Pilot

For more info: STEP/OMG URL’s!
Key Acronyms and Definitions

- **CAx**: CAD/CAM/CAE, etc.
  - Engineering software for the modeling of a product in any life cycle phase. E.g.: Mechanical Computer-Aided Design (MCAD), Electrical Computer-Aided Design (ECAD), Manufacturing (CAM), Analysis/Simulation (CAE), etc.

- **PDM**: Product Data Management
  - Systematic maintenance, storage, tracking, and access to all information about a product throughout its lifecycle, including concepts, plans, documents, specifications, drawings, engineering and analysis models, manufacturing process information, testing information, etc. Configuration Management (CM) is a subset of PDM.
STEP AP 203: Configuration Controlled 3D Designs of Mechanical Parts and Assemblies

Configuration Management
- Authorization
- Control (Version/Revision)
- Effectivity
- Release Status
- Security Classification
- Supplier

Geometric Shapes
- Advanced BREP Solids
- Faceted BREP Solids
- Manifold Surfaces with Topology
- Wireframe with Topology
- Surfaces and Wireframe without Topology

Product Structure
- Assemblies
- Bill of Materials
- Part
- Substitute Part
- Alternate Part

Specifications
- Surface Finish
- Material
- Design
- Process
- CAD Filename
STEP AP 209: Composite & Metallic Analysis & Related Design

Analysis Discipline Product Definitions
- Finite Element Analysis
  - Model (Nodes, Elements, Properties,...)
  - Controls (Loads, Boundary Constraints,...)
  - Results (Displacements, Stresses,...)
- Analysis Report

Design Discipline Product Definition
- Shape Representations
- Assemblies

Configuration Control, Approvals
- Part, product definitions.
- Finite element analysis model, controls, and results

Information Shared Between Analysis & Design
- 3D Shape Representations
- Composite Constituents
- Material Specifications & Properties
- Part Definitions

Composite Constituents
- Ply Boundaries, Surfaces
- Laminate Stacking Tables
- Reinforcement Orientation

Material Specifications & Properties
- Composites
- Homogeneous (metals)

3D Shape Representation
- AP202/203 Commonality Plus
- Composite Specific 3D Shapes
  - Advanced B-Representation
  - Faceted B-Representation
  - Manifold Surfaces With Topology
  - Wireframes & Surface without Topology
  - Wireframe Geometry with Topology
  - Composite Constituent Shape Representation
STEP AP 210: Electronic Assembly, Interconnect, and Packaging Design

Physical
- Component Placement
- Bare Board Geometry
- Layout items
- Layers non-planar, conductive & non-conductive
- Material product

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

Product Structure/Connectivity
- Functional
- Packaged

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

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

Requirements
- Design
- Allocation
- Constraints
- Interface

Technology
- Fabrication Design Rules
- Product Design Rules
Without PDM, CAx Models are “Islands”
Models Are Isolated Within Disciplines

Mechanical (MCAD)  
Item X  
Item Y
  
Analysis (CAE)  
Item X  
Item Y
  
Electronic (ECAD)  
Item X  
Item Y
  
Systems Engineering  
Item X  
Item Y

Tools

Discipline-Specific Model Databases
Current Product Data Management (PDM): Models Can Be *Associated* But Not *Integrated*
“Intelligent PDM” (IPDM): Master Models Integrate Discipline Models

- Mechanical (MCAD)
- Analysis (CAE)
- Electronic (ECAD)
- Systems Engineering

Tools

Models (Discipline Views)

STEP AP's

NASA STEP Testbed

Integrated Master Models

Discipline View Mappings

Spacecraft X Master Model

Instrument Y Master Model
Plug-and-Play IPDM: CORBA PDM Enablers Object Interfaces

- Mechanical (MCAD)
- Analysis (CAE)
- Electronic (ECAD)
- Systems Engineering
- CORBA-Enabled Tool

- AP 203
- AP 209
- AP 210
- AP 233
- Instrument Y Object

Discipline Model Mappings
Integrated Master Models

Spacecraft X Master Model
Instrument Y Master Model

NASA STEP Testbed
The Product Master Model Evolution: Population of Model Contents Over the Mission Life Cycle

**Pre-Phase A**
- Integrated Mission Proposal
  - Mission Parameters
  - Requirements
  - Functional Model
  - Preliminary Components

**Phase A/B**
- Prototyping and Analysis
  - Mission Parameters
  - Requirements
  - Functional Design
  - Behavioral Model
  - Physical Model

**Phase C/D**
- Detailed Design, Build, and Test
  - Mission Parameters
  - Requirements
  - Functional Design
  - Behavioral Design
  - Interface Control Docs
  - Physical Design/Arch.
Benefits of a STEP-based IPDM Service

- Exchange of models among CAx tools from different vendors
- Exchange of models between CAx tools from different disciplines (electrical/mechanical/analysis/simulation)
- Cross-discipline model integrity (common information is shared), enabling a robust Systems Engineering view
- Tracking of all mission/model parameters throughout the life cycle
- Standard library format for product model/design re-use
- Standard, STEP-based PDM format for NASA/contractor data sharing
  - Avoids requiring contractors to buy the same tools (expensive for the contract; additional learning curve)
  - Major OEM’s are using STEP in this way
Objective:
- To provide a plug-and-play service for the management, integration, and synthesis of multi-disciplinary product models for heterogeneous tools and applications

Implementation:
- **Expresso** will provide the “model integration and view synthesis” engine (integrating application-specific models into the Product Master Model and synthesizing other application-specific view models out of the Product Master Model)
- **EXPRESS-X** mappings will define the transformations between the **STEP AP** data (application-specific models created by tools) and the STEP-based **Product Master Model**
- **OMG PDM Enablers and CAD Services** interfaces will be implemented using CORBA and Python to provide plug-and-play access for tools and applications
For More Info:  STEP/OMG URL’s!

- **Expresso** *(free download)* -- [http://step.nasa.gov/testbed#expresso](http://step.nasa.gov/testbed#expresso)
  - *Note:* available as source (lisp) or binaries for Windows or Linux.
- **STEP On A Page** *(a capsule summary and current status of STEP)* -- [http://pdesinc.aticorp.org/step_on_a_page.ppt](http://pdesinc.aticorp.org/step_on_a_page.ppt)
- **PDES, Inc.**: a government-industry consortium implementing STEP -- [http://pdesinc.scra.org](http://pdesinc.scra.org)
- **USPRO** *(U.S. Product Data Association)*, distributor for STEP documents -- [http://www.uspro.org](http://www.uspro.org)
- **NASA STEP Central**: the main NASA site for STEP information -- [http://step.nasa.gov](http://step.nasa.gov)
- **The NASA STEP Testbed**: STEP/OMG infrastructure pilot project -- [http://step.nasa.gov/testbed](http://step.nasa.gov/testbed)
- **The OMG Manufacturing Domain Task Force (MfgDTF)**: PDM Enablers, etc. -- [http://www.omg.org/homepages/mfg](http://www.omg.org/homepages/mfg)