Industry and ManTech Interaction Success

David Baum
Common PDM MBE Solution Architect
Dec. 5, 2011
Industry and ManTech Interaction Success

Raytheon Corporation
Hardware Engineering
Common Product Data Management (PDM)
Model Based Enterprise (MBE) Solution Architect
David Baum
Dec. 5, 2011
Agenda

- Who we are and what we make at Raytheon
- Our EDS & IPDS Support Standards of Excellence across multiple Businesses
- Our Common PDM Information System
- Raytheon’s MBE
- Use Case Standards for MBD models.
- ManTech Projects & their value to Raytheon
Who We Are

- A technology and innovation leader specializing in defense, homeland security and other government markets throughout the world
- 2010 net sales: $25 billion
- 72,000 employees worldwide
- Headquarters: Waltham, Mass.
Our Strategy

- Focus on key strategic pursuits, Technology and Mission Assurance to sustain and grow our position in our four core defense markets:
  - Sensing: Expand beyond traditional RF/EO to new growth focus areas, including multi-mission areas.
  - Effects: Leverage kinetic energy-based expertise into EW, directed energy and cyber markets.
  - C3I: Broaden market presence in communications, C2, networking and knowledge management.
  - Mission Support: Expand beyond product support, engineering services and training.

- Leverage our domain knowledge in all markets, including Homeland Security and Cybersecurity.

- Expand international business by building on our relationships and deep market expertise.

- Continue to be a Customer Focused company based on performance, relationships and solutions.

A technology-driven growth strategy
What We Make

Core Market: Sensing
Technologies that acquire data and create accurate, reliable information for effective battlespace decisions.

Core Market: C3I (Command, Control, Communications and Intelligence)
Integrated real-time systems that optimize operational planning and execution.

Core Market: Effects
Technologies that achieve specific military actions or outcomes — from striking targets to disabling hostile information systems.

Core Market: Mission Support
Total life-cycle solutions that ensure performance, no matter the mission, no matter the platform.

Systems and solutions to ensure flawless performance.
Common Design Controls and Practices

- Common Product Data Management (PDM) Workflows
- Engineering Documentation Standards (EDS)
- IPDS Best Practices for MBE in Process Asset Library (PAL)

72,000 employees; 2010 net sales: $25 billion
National Defense Industry Association Position
High Level MBE Benefits

- Reduce time to acquisition of first article for systems and solutions
  - More complete evaluation of the trade space
  - Earlier risk identification and mitigation
  - Concurrent and collaborative engineering
  - Design reuse
  - Accelerated development

- Reduce the time to implement planned and foreseen changes in systems
  - Design reuse
  - Rapidly evaluate changing threats and explore trade space

- Enhance Reliability
  - Earlier and continuous requirements and system verification
  - Identify and resolve errors/issues/fewer post-fielding issues

- Enhance Interoperability
  - Inclusion of the operating environment and external interfaces in system models
  - Early and continuous interface and interoperability verification

Reference:
Final Report MBE Subcommittee
Jeff Bergenthal (Subcommittee Lead)
NDIA Systems Engineering Division
M&S Committee, February 2011
DoD TRL & MRL Requirements by Life Cycle Phase

Raytheon IPDS Gates =>

Pre-Material Solution Analysis

Material Solution Analysis

Technology Development

Engineering & Manufacturing Development

Production & Deployment

Predefined TRL & MRL Levels must be met at Program Milestones

Terms:

TRL – Technology Readiness Level
MRL – Manufacturing Readiness Level

Acquisition Milestone Decision Authority (MDA) Approvals:

- Tech Dev Strategy ready to guide Tech Dev phase
- Readiness to start Integrated System Design (E&MD phase)
- Readiness to enter Production

Raytheon MBE focus 2011
Complexity & Functions requires System Decomposition

- **Model Based Definition (MBD) – 2011**
  - Enterprise MBD Specification completed in 2010
  - MCAD Models that are Qualified for defined Life Cycle Use Cases (Standards)
  - New visualization tools (ProductView)

- **Model Based Manufacturing (MBM) – 2012**
  - Global supplier communication and support of product IP
  - MCAD Models transitioned from “As Designed” to “As Planned”
  - Derivatives from MCAD models used for process plans.

- **Model Based Systems Engineering (MBSE) – 2013**
  - Virtual verifications at the core of these capabilities
  - Requirement allocations & derivations
  - “As Verified” status linked to PDM

- **Model Based Life Cycle Support**
  - Reuse of MBD for technical manuals

Model Based Enterprise Framework is Common PDM
Common PDM MBD Capability
Use Case Requirements

- **Authoring** – defining all the features, annotations, and attributes required of a model for its defined use cases.
- **Checking** – verifying that all Hardware Development Plan (HDP) specified “use cases”, and modeling standards are met for model integrity before formal release to PDM.
- **Design Review** – verifying that the model is complete for form, fit, and function.
- **Concurrent Engineering** – inputs (analysis, annotation, feature changes, etc.) to the design model from functional SME’s determined to be critical to the part/assembly.
- **Configuration Management** – identification of all correct attribute data for formal control.
- **Manufacturing Process Flow**
  - First Article Inspection – Identification of critical features/dimensions in model
  - Assembly Aids – extraction of parts list; geometry for assembly aids/work instructions
  - CNC Programming – geometry and tolerances needed to drive CNC programming
- **Supplier Review** – distribution of a formally controlled model with all information needed for review of HDP planned “use cases”.
- **Technical Manuals** – similar to Assembly Aids with identification of replaceable assemblies.

Use Cases Keep Model Development in Scope
Exploring Solutions For Improved Interoperability

Customer / Supplier Interoperability During Collaborative Design (CSI)

- Solution addressing AFRL BAA: 08-08-PKM
  - Air Force Research Laboratory
  - Defense Manufacturing Science & Technology (MS&T)
  - High Performance Manufacturing: Model Based Enterprise
CSI Overview

POC: Steven Turek
937.904.4957
steven.turek@wpafb.af.mil
Contractor: ATI

DoD Problem:
Lack of defined data exchange format requirements between suppliers and customers generate significant hidden costs for weapons systems

Approach:
• Capture, validate and test “data-contract” requirements by assessing the requirements, evaluating the highest priority requirements, and developing prototype solutions for the most critical requirements
• Using the DEXcenter, ITI will develop CSI modules, to include contract mapping tools, and software libraries
• Conduct a demonstration to highlight the savings achieved through automation and develop a commercialization plan

Warfighter Benefits:
Reduced costs and higher quality data. Improvements in business practices will be seen in:
• Less cost to deliver products to the warfighter by eliminating non-value added data manipulation tasks and elimination in errors introduced in the manual manipulation of the data
• Less time for new capabilities to reach the warfighter because of streamlined processes through the supply chain during early product development phases
• Cost savings are estimated to be over $35 million per major program

"DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited. Case Number 88ABW-2011-5822."
Vision

A flexible, configurable, standards based system which automates common tasks associated with Customer Supplier Interoperability

- Easily / quickly configurable to handle different contract requirements
- Leverages existing ITI technologies (DEXcenter, PDElib, CADscript, CADfix, CADIQ, etc)
- Supports typical requirements like:
  - Model preparation
    - Removing / adding / hiding data
    - Organization
    - Coordinate systems
    - Renaming
    - Abstraction / simplification
    - Adding IP / ITAR notes
  - Translation
    - Neutral standards (STEP, IGES)
    - CAD Native formats
    - Visualization
  - Validation
    - Geometry, topology, PMI
  - Delivery
    - Encrypted
    - IP protection
    - ITAR controls
    - Direct (https web, sftp) or via PLM
  - Tracking / auditing

"DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited. Case Number 88ABW-2011-5822."
Accelerating MBE deployment – CSI contract addendums

Benefits

- Potentially enables a more efficient transition from drawing to model-based definition
- May provide an alternate path to translation of featured models

Honeywell

Draw-to-PMI (MBD Generator)
Automation to merge associative 2D GD&T into the model and produce associative 3D PMI

Rockwell Collins

Critical Problem Resolution (CPR) Process
Detects and resolves model issues in design for manufacturability

Lockheed Martin

3D PMI Translation
Translation of associative 3D models and 3D PMI between dissimilar CAD environments

Rockwell Collins

3D ECO Documentation
Document model changes in a 3D format that greatly improves communication in the MBE

Benefits

- Eliminate un-producible features – better quality model
  - Identify potential problems; collaboratively resolve with supply chain
  - Reduce rework or scrap due to design escapes
  - Eliminate model ambiguity that otherwise drives design revision
  - Improve model translation success and designer productivity

- Eliminates need for drawing-based documentation of design change
- Improves designer productivity (reduces time) in model/drawing revision
- Improves quality; model is explicit master; fully represents/documents change
- Necessary step toward full model based design (eliminating drawing)

- Support MBE approach - maintain the digital thread
- Streamlines design to manufacturing process within supply chain
- Increased product quality due to higher confidence in data handoff
- Reduce scrap due to conversion/interpretation issues
- Reduce cycle time through automation of conversion & validation

15

"DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited. Case Number 88ABW-2011-5822."
Addendum 1 to Statement of Work

Customer/Supplier Interoperability during Collaborative Design (CSI)

Task 3.1 - 3D Mode Comparison and Validation for ECOs: The contractor shall develop a prototype solution that integrates 3D Modeling Comparison and Validation for ECOs with the existing CSI platforms. The 3D ECO Documentation capability will document differences in 3D Model Based Designs after a revision or change is made in the model. That changed model could then be compared to the original model and all differences would be reported in a 3D viewing format with annotations sufficient to highlight each change and permit the user to graphically manipulate the model.

Piloting CADIQ model comparison capability, with Pro/E models, to identify model changes during change management process.

Use Case Applications:
- MBD Authoring
- MBD Checking
- Configuration Management
- Concurrent Engineering
Task 3.2 - Migration to Model-Based Definition (MBD) with PMI: The contractor shall develop a prototype solution that enables the Mitigation to a Model-Based Definition (MBD) with PMI for existing CSI platforms. This capability will automatically interpret dimensions, tolerances, symbols and notes on the 2D drawing along with associated features/geometry so that PMI can automatically populate the 3D model space with all necessary associations, eliminating the need for a 2D drawing.

Established a Raytheon Standard MBD Schema, with start parts and PDM attributes, for use with tools that enable Model-Based Definition”.

Use Case Applications:
- MBD Authoring Standards
- MBD Checking Standards
**Task 3.3 - PMI Conversion Process Enhancements:** The contractor shall develop a prototype solution that demonstrates PMI conversion capabilities to enable the translation of PMI data in one CAD system (source system) to a second CAD system (target system). The PMI conversion capability will track the dimensions, text, tolerances and symbols along with the associated features/geometry of the source system as the translation of the underlying features/geometry are processed and associated with the appropriate features/geometry in the target system.

Raytheon is working with its industry partners, PTC and ITI, to validate conversions of CAD file formats.

**Use Case Applications:**
- Configuration Management
- Supplier Review
- Technical Manuals
**ManTech Projects Leveraged**

**Task 3.4 - Critical Problem Resolution for Manufacturing:** The contractor shall develop a prototype solution that demonstrates a critical problem resolution (CPR) process to remedy manufacturing modeling issues early in the design process. The CPR process should identify critical manufacturing problems and their corresponding resolutions, and integrate with the existing CSI platform. The results of this continuous analysis should be fed into the configuration files for quality tools that can be used to validate engineering models prior to engineering release and manufacturing.

Raytheon is developing MBD model qualifications & workflows that are prioritized by modeling defect causes.

**Use Case Applications:**
- Design Review
- Concurrent Engineering
- First Article Inspection
- Assembly Aids
- CNC Programming
- Supplier Review