A Global PLM strategy in Ford Motor Company

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Overview

- A Global product strategy relies on a global PLM strategy
- A global PLM strategy is enabled by interoperability
- Interoperability must be achieved at all levels:
  
  **Level-1**
  Data & Tools Interoperability across core design and engineering activities
  - Product Definition (Geometry)
  - PMI & Metadata
  - Analysis and Attributes
  - PDM-Enabled

  **Level-2**
  Interoperability across PLM Processes and Components
  - PDM
  - BOM
  - MFG Systems and Processes
  - Requirements & Assumptions

  **Level-3**
  Interoperability across global vehicle programs
  - Global Platform
  - Global Commodities
  - Global Release & Change Management
  - Enabled by Standard Information Model
Interoperability – Level 1
Product Creation Core Tools

• CAD Interoperability
  – Working with geometry in one CAD tool with reference geometry from another CAD tool

• PDM Interoperability
  – Product Data is shared and exchanged between multiple purpose product data management centers.

• Visualization-based Interoperability
  – Product Data Pipeline
  – Data sharing and collaboration across multiple design and engineering disciplines using efficient product data representation.
C3PNG Levels of CAD Interoperability

1. Geometry and Topology
2. Assembly Hierarchy
3. CAD metadata (PMI, annotation, Weld, layers & groups)
4. Interface to ancillary products (CAx, EESE, etc.)
5. Design-in-Context – Tessellation, Precise, On-Demand
6. Associativity support (change notification)
7. PDM driven data exchange, PMI independent of CAD tool
8. CAD History Tree, Design Intent, geometry supporting info
9. Common user interface, common data model

Primary Target

Next: Re-mastering

Level 1 2 3 4 5 6 7 8 9

• Increasing Levels of complexity
Product Creation Systems
A Global PDM - Teamcenter Centric

Integrated CAD/CAM/CAE/PIM and Visualization Platform

- Over 16,000 Users
- Over 100 Vehicle Programs
- 74 Data Distribution Servers

Digital Product Structure

IDEAS  CATIA V4 / V5

Teamcenter Engineering with Multi -Site

Integrated Clash Management

Digital Factory (EMS)

Distributed Digital Vehicle

PDV  Issue Management

Over 10,000 Users
74 Data Distribution Servers
Over 100 Vehicle Programs

Integrated CAD/CAM/CAE/PIM and Visualization Platform
**JT-Based Interoperability: Multi-CAD Design in Context**

**Benefits:**
- Multi-CAD / Single PDM Environment
- JT Generation via Engineering Translation Services
- JT Read Capabilities in CATIA V5 and IDEAS
- Seamless Integration. No manual translation/exchange is necessary

**History:**
- Began Development in 2001
- Initial Production in 2003
- Currently Deployed World-wide
JT Pipeline

JT Enabled Interoperability across core PD tools

PD/KBE
- PDV
- PDV
- Jack
- Tce
- D Buck
- VVT

Indirect PDV

Services
- ToolDraw
- ToolDraw
- Adobe Illustr
- PDV
- 3dsMax
- AutoTrol
- TCViTransCables
- TCVi
- VisJack
- VSP

Mfg
- TCM
- eMS
- Jack
- FIDES
- PartViewer
- EMS Planner

PTO
- CAE Mashing
- TessOnDemand
- ePDFx
- PTO Buck

Corp Design
- ICIDO
- Opticore
- Bunkspeed
Global CAE Strategy

- BOA – Bill of Analysis
- Clear link between CAD and CAE

Teamcenter Based Integration

BOM → CAD Component → CAE Component → CAE Model → CAE Results
Achieving Geometric Compatibility
Requires Aligned BOM, CAD and DPA Processes

BOM Authoring
- Single Bill of Material with a Defined Maturity and Freeze Cadence

CAD Authoring / Config
- Configured CAD Data Aligned to BOM
  - Production End Item Based Design Solutions
  - Collaboration Structure for Layouts and Studies
  - Manufacturing Structures aligned to BOP

Zone Layout / Digital Validation
- Management and Delivery of Geometric Compatibility
  - Cascade System and Comp Design Requirements
  - Validates Digital Control Models
  - Manages Geometric Issues and Resolution
Digital Pre-Assembly
Geometric Verification, Compliance to Standards

DPA 0
- Function
  - Dynamic displacement
  - Movement
  - Heat
  - Clearances
  - Variation
  DPA Owner: Block Leaders

DPA 1
- Static Nominal Taisen
  - Clearances
  - Positional correctness
  - Interface completeness
  DPA Owner: Block Leaders

DPA 2
- Craftsmanship
  - Design Appearance
  - Margins/Flushness
  - Grains/Gloss
  DPA Owner: Craftsmanship

DPA 3
- Tolerance
  - VSA Focus studies agreed by Design, Program & VO
  DPA Owner: Craftsmanship

DPA 4
- Service
  - Removal
  - Access
  - Damageability
  DPA Owner: FCSD

DPA 5
- Mfg/Assembly
  - Formability
  - Assembly Process
  - Plant Floor Ergonomics
  DPA Owner: VO & SBU ME

DPA 6
- Package/Ergo
  - Ingress/egress
  - Reach
  - Vision
  - Accessibility
  - Spatial Relationships
  DPA Owner: Basic Design Package

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**Requirements - Verification**

- Functional Specifications
  - Material
  - Key Life
  - Component

- Nominal Taisen Specifications
  - Component System & interface requirements.

- Craftsmanship Specifications
  - Exterior
  - Interior
  - Under Hood

- Appearance Tolerance
  - Acceptance Criteria for Component Variation

- Service Specification
  - Component Mfg Standards
  - Control specs
  - DFA Req

- Mfg/Assembly
  - Component Mfg Standards
  - Control specs
  - DFA Req

- Package/Ergo
  - Component Ergo Req
  - Component Package Standards
Fully Integrated Digital Prototyping Environment

- **Teamcenter 2007**
- **Rich Client**
  - IDEAS
  - CATIA V5
- **Thin Client**
  - TC Vis
  - Clash Mgmt
- **BOM Authoring**
- **AVBOM**
- **ICM - Integrated Clash Management**
- **Issue Management**
  - Req. Mgmt
  - Integrated Reporting
- **Mfg Rich Client**
- **FIDES**

- **Digital Prototyping**
Significant impact on the Results

Launch Issues Reduction

- On-going, year over year reduction in Manufacturing issues – 5 years running
- Overall 80% reduction in issues at the first physical build

Continuous improvement in digital pre-assembly process yields ongoing reduction of launch issues.
Interoperability Level-2
Current Ford PLM Environment

Digital Product Development
(Product / Process / Resource)

Complexity Management
Commonality and Reuse Management
Advanced Production Bill of Material
Engineering & Marketing Integration (PDL)
Program Definition & Cost / Weight / Management
Digital Definition (Templates)
Full Vehicle & Powertrain

Configured, Extracted & Distributed Digital Vehicle
Digital Factory / Digital Service
Integrated Digital Mock-up & Clash Management

Geometric Requirements Validation
CAE & Digital Pre Assembly

Ford Proprietary
• Multi-Site data sharing established across all sites
• Each site can exchange data with any other site
• Consolidation effort is currently under way
Sharing information across all PLM systems and tools

**Business Systems**

- Issue MGR
- WERS
- AIMS
- MPNR
- Parts Lib
- CCAS
- AVBOM

**Electrical Domain**

- Model Based Design (TeamCenter UA)
- Virtual Verification (HiL Validation)
- Communication (Vector)

**Product Creation Systems**

- Functional Definitions
  - User Interface
  - Workflow manager

**Digital Pre Assembly (DPA)**

- Digital Product / Process Structure
- Digital BOM / BOP

**Theme Development**

- Service

**Package Development**

- Product Engineering

**Plant / Assembly**

- Product / Process Simulation

**Functional Simulation**

- Supplier Integration

**Virtual Build**

- Catia V5

- CADQOS
Systems Engineering Framework
Integrating CAD/CAE and VSEM

Holistic Cross – Domain Requirements Management
Aligning functional requirements systematically across software, electronics, mechanical

1. Holistic Req. Mgt. Solution
   Manage Requirements and Validations in context of vehicle / functional structure

2. Mechatronics Architecture (applied to VSEM)
   supporting requirements, parameters, calibration, test, etc.

3. Holistic Req. Mgt. Solution
   Manage Requirements and Validations in context of vehicle / functional structure

4. CAE Data Management
   CAE/Req./Test Data Mgt.

5. C3P / VSEM Convergence

VSEM 2010 Project

SetK / eFDVS Requirements Mgt.

C3P – PD/Mfg.

C3P - CAE

Ford Proprietary
VSEM Infrastructure: Information Architecture

PLM Product Development Data Backbone
Vehicle, Features, CAE, SW - part, HW - part….

Electrical Domain Design information
(Sand box level)

Model Based Design

Virtual Verification
HiL Validation

TeamCenter UA
- User Interface
- Workflow manager

Requirement Management

Communication

Functional Definitions

Global Enterprise information
Electrical domain information
Local information in point tools
Defined Exchange formats

- Leveraging standard data exchange formats
- Minimize the number of E/E development tools
- Leverage existing Corporate infrastructure
- Global data replication supporting LCC development
- Allow best-in-class design tool usage
Interoperability – Level 3
Business Transformation

Old Way

Program Centric

New Way

Global Platforms

Global Commodities

Differentiated Top Hats
"If you look at C1, it's almost a microcosm of what we're trying to do in the enterprise as a whole,
"Having a very strong and capable platform - and on top of that you put very unique products that are unique not just in how they look but are very consistent with the individual brand DNA." - Derrick Kuzak
**Key Business Drivers Summary**

**Key Business Drivers:**

- **Capability**
  - Provide an integrated Process/Methods/Tools Solution set with improved capabilities versus today
  - Improve Vertical integration *within* Brands
  - Required to provide BIC capability for Product Creation (Time to Market, Efficiency, Quality)

- **Commonality**
  - Enable product commonality cross brand (Platform, Commodities, etc.)
  - Improve Horizontal integration *across* Brands
  - Required to support increased cross brand technology sharing (e.g. CD3s, C1, EU-CD, B2e, etc.)
Global Product Creation Hierarchy of Enablers

Business Priorities

- Reduce Cost
- Increase Profitability

Key Business Strategies

- Distributed Engineering (LPEA, Commodities, PTO)
- Cross-brand Manufacturing
- Cross-brand Purchasing
- Platform Consolidation & Part Commonality

Major Process/Data/IT Enablers*

- GPDS and common Processes
- C3P-NG
- Single Product Definition
- Common BOM (Eng, Purch, and Manuf)*
- Transparent part number structure

Other Key enablers include: Engineering & Manufacturing Standards, Systems Library

Proposed Framework for prioritizing Process/Methods/IT Enablers
Release Management
Current Capabilities

- **Automated processes exist mostly within given toolsets and functions**
  - CAD Change Management Workflows (TeamCenter Engineering)
  - Worldwide Engineering Release System (Home-grown)

- **Hybrid Solutions exist at key functional or organizational touch-points within the Product Lifecycle**
  - CAD & Engineering (CAD / BOM Reconciliation)
  - Engineering & Purchasing (Part / Supplier Sourcing)

- **Non-Automated workflow processes tend to be found at soft-points within our processes.**
  - Time based triggers (BOM Scrub to meet milestones)
  - Less Formal Approval Required (Early Vehicle Program Changes)

- **Wide variation in CAD release methods cross functions**
  - Powertrain, Chassis, Body and across Vehicle/PT Development Centers

- **Overall loss of business efficiency due to:**
  - Variation in methods on global programs - vehicle teams follow different process based upon localized methods
  - Audit-based process adds unnecessary time and complexity to release/change process, and false sense of integrity of release/change event
Back office environment is hidden from users

Metrics produced directly from the process

Users interact with a single process
- Removes complexity
- Users don’t have to know the whole process

Process is mapped and codified:
- Scaleable
- Captures intellectual property

Strategic Workflow Direction

Business Process Metrics & Reports

Engineering
- Manufacturing
- CAD Designer

Purchasing
- PPM

CPE
Objective:

• Deliver streamlined global Process for P-Release and Change Management built upon the principle of ensuring BOM and supporting virtual data accurate and validated prior to P-Release and all production changes by:
  – Use of common global process across all functions and supporting global supplier business environment: eliminates process variation across CBG and/or Engineering Functions.
  – Bundling virtual data into a single Teamcenter object to support virtual review, validation and signoff in Teamcenter: eliminates data re-entry, elimination of CAD information in WERS, eliminates use of review and signoff functionality in PPM Audit.
  – Providing pre-validation tools to ensure that all of the data in the virtual environment supporting the release/change is aligned to the BOM (production drawings/CCTM, in-context DPA validation): eliminates need for PPM Audit validation checks.
Example: New Global Purchasing Strategy

- Global supply base - “Aligned Business Framework”
- Reduce key supplier base 50%,
  - Mutual profitability and improving quality
  - Two or three global suppliers per commodity
    - Regional suppliers on an exception basis
- Develop “Commodity Business Plan”
  - 100+ sets of components
  - Reduce complexity and what is the
  - Migration plan with suppliers
  - Technology
  - Manufacturing footprint
New Global Purchasing Strategy
New Information and Interfaces

Component Group 1 Strategy
Component Group 2 Strategy
Component Group 100 Strategy
Vehicle Program 1
Bill of Material 1
Global Sourcing Area 1
Global Sourcing Area 2
Global Sourcing Area 200
ABF Supplier 1
ABF Supplier 2
ABF Supplier 200
New Global Purchasing Strategy →
New Information and Interfaces

Component Group 1 Strategy
Component Group 2 Strategy
Component Group 100 Strategy

Vehicle Program 1
Bill of Material 1
Global Sourcing Area 1
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ABF Supplier 1
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New Global Purchasing Strategy ➔
New Information and Interfaces

- Component Group 1 Strategy
- Component Group 2 Strategy
- Component Group 100 Strategy

Vehicle Program 1 ➔ Bill of Material 1

- Global Sourcing Area 1
- Global Sourcing Area 2
- Global Sourcing Area 200

- ABF Supplier 1
- ABF Supplier 2
- ABF Supplier 200
New Global Purchasing Strategy
New Information and Interfaces

- Component Group 1 Strategy
- Component Group 2 Strategy
- Component Group 100 Strategy
- Vehicle Program 1
- Bill of Material 1
- Global Sourcing Area 1
- Global Sourcing Area 2
- Global Sourcing Area 200
- ABF Supplier 1
- ABF Supplier 2
- ABF Supplier 200
New Global Purchasing Strategy

New Information and Interfaces
To deliver the collaboration required for Ford’s global transformation information needs to have the same meaning to all stakeholders globally. Information needs to comply with documented and accessible standards.
Information Standards for the Industrial Backbone: Driving Efficiencies and Integration

Defining the information landscape required to deliver EPIC and OneFord

Creating robust global information standards for the industrial backbone

Working with “left hand side” organizations to deploy standards – PAF example

Working with Global Platform Programs and Process Owners to leverage standardized information to deliver GPDS efficiencies and cross-functional integration

Results: increased business satisfaction from IT delivery, defragmentation of IT landscape

Business Results:

Manufacturing Engineering: Without PAF we can’t contain the requirements of a global Manufacturing Engineering process

Digital Innovation: PAF based reporting drives CAD-BOM alignment, and the CAD structure

Attributes (NVH): It’s going to greatly improve the process for engineers, enable identifying issues early, and constantly staying on the status of the CAD

Global Material Cost: Detailed BOM comparisons that took weeks can be done in minutes, it’s a major enabler for us

Program Management: prior solutions addressed multiple symptoms, they never provided a platform the business can cross functionally converge, I feel [with PAF] we now have the critical mass
Thank You