Dr. Ulrich Fox, Ralf Fachbach

Ford Motor Company
CAE PLM Solution and integration with CAE Pre-Processor Software

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Introduction
Drivers for CAE PLM @ Ford

• Efficiency
  – CAE Model Build effort
  – CAE Model Quality and Reliability
  – Process Automation

• ONE FORD
  – Global CAE Process
  – Global Sharing of Data and Work
Ford C3P System

Digital Pre Assembly (DPA)

Theme Development

Plant / Assembly

Service

Package Development

Product Engineering

Digital Product / Process

CADQOS

CATIA V5

CATIA V5

Teamcenter / AVBOM

Functional Simulation

Virtual Build

Supplier Integration

Product / Process Simulation
Ford C3P Sites

- Dearborn, Michigan, USA
- Merkenich, Germany
- Dunton, England
- Cuautitlan, Mexico
- Camacari, Brazil
- Chennai, India
- Gothenburg, Sweden
- Shanghai, China
- Hiroshima, Japan
- Broadmeadows, Australia

- 7,600 Teamcenter
- 5,100 CAD
- 14,500 Digital Buck
- 310+ Supplier Connects
CAE PLM History

1997: Deployed Metaphase for „CAE PIM“
  – CAE Model storage assigned to Product data
2000: CAE Model Build and Management with I-DEAS/TDM
  – CAE Model creation based on CAD authoring tool
2004: Teamcenter Deployment for CAE PIM
  – CAE Data management as first Teamcenter Deployment worldwide
2006: Teamcenter CAE Customization
  – CAE Process Automation
  – Pre-Processor Integration
2008: TCSim Project
   - Teamcenter for Simulation (TCSim) Selected as Strategic CAE Data Management Tool
   - Developed Solution for CAE Model Build Management

April 2010: Deployed TCSim for CAE PIM
   - OOTB CAE Data Management Solution

Jan 2011: CAE PLM Strategy workshop
   - Defined set of global CAE PLM Principles (e.g. on sync. & mapping w/ product structure, knowledge capture, etc)
Development

Ford EU Tactical Solution
= Local Customization

Ford Global Strategic Solution
= Teamcenter Simulation

C3P NG TS2.0
C3P NG TS1.2
C3P NG TS1.0
C3P NG 3.x
C3P Classic

2001
2002
2003
2004
2005
2006
2007
2008
2009
2010

TC 2007.1 UA
TC 2005 UA
Devpt. K/O
Scope
TCSim Project Scope (2008-2010)

Simulation Process

Phase 1

- Product Configuration
- Pre-Processing
- Structure Mapping

Phases 2+

- CAE Marking
- Collect Sub-Assemblies
- Component Meshing
- Build CAE Sub-Assembly

- Collect Connections
- Build CAE Assemblies
- Populate Eng. Properties

- Solve
- Job Submission
- Job Control

- Post-Processing
- Test Correlation

- Correlation
- Standard Results
- Secondary Results
CAE PLM Development Scope (2011-2014)
Architecture
Data Model – “EBOM embedded in CAE str/”

Product Structure

CAE Structure

CAE Structure, Composite View
Data Model – “CAE embedded in EBOM”

Product Structure

CAE Structure, Composite View
Data Model – Classification

• Classification is used to create and maintain a structured library based on CAE specific classification attributes
• Classification of CAE Data makes required data easier to find and retrieve

• Search the classification hierarchy based on different criteria to find the CAE data you need
• View data associated with your CAE item in the viewers. (jt, text, etc)
• Control complexity of growing CAE Library
Tool Architecture

**Server/Client**

- Teamcenter for Simulation
  - Create/Maintain Structure
  - Change mgmt.
  - Notification
  - Manage EPs
  - Maintain/Document Data Sets
  - Work Packaging
  - Share Data
  - ...

**Client „TCSim tool set“**

- tc_inspector
  - Customer specific utilities
  - Advanced functionality
  - Fix Minor Bugs

**tc_xyz / Preproc.**

- CAE Pre-Processor
- Read Structure
- Read Data sets
- Start Processes
- Modify Data Sets
- Modify EPs

**D/B Common w/ PDM**

- PLM XML

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Interface Format

- Siemens PLM XML Format Selected
  - Versatile Format
  - Configurable via „Transfer Modes“
  - Provides Image of the Selected Structure
    - Structure & Metadata
    - Paths of Included Data Sets
    - Copies of the Files Attached to Data Sets in Native Format
CAE Pre-Processor Integration
Pre-Processor Integration – Crash Vehicle Assy

- Modular library
- Generic Models
- Manage mcf's
- Module selection
- Model content
- Instances
- Module Positions
- PLM XML

- Modify mcf's
- Realize connections
- Modify Meshes
- Position Modules
- Quality Checks
- Numbering
- Mass Trimming / Balancing
- Loadcase Setup
- Output Request
- Final Deck
Pre-Processor Integration Modes

- Full Data (Metadata+Bulk)
  - Geometry / No FE Model
  - FE Model / No Geometry
  - Geometry & FE Model
- Separate Bulk / Metadata
  - Metadata / No Bulk data
  - …
- „Parallel“ Build
  - Incremental Packages
  - …

→ Develop more sophisticated integration (based on API’s)
Summary & Outlook
Summary & Outlook

• Efficient, global CAE PLM implementation in place
  Key success factors:
  – Business driven development approach
  – Full integration with PDM solution, small extra IT effort
  – Use Out of the box, uncustomized solutions where possible
  – CAE s/w integration provides user efficiency gain of initial solution
  – Ground up scoping, implementing CAE model build solution first and growing to wider process steps gradually

• 2011-2014 Extension Proposals
  – Analysis management, process automation
  – CAE / Test integration
  – Generic mapping of CAE and product data
  – Business process integration
Thank You
Backup Material
Data Model

CAD data for consumption by CAE, for CAE model build and analysis.

A theoretical example of the CAE PLM data model for a CAE model item assembly that has been generated from a Design Solution based CAD item assembly is shown below.
Use Cases

1. Body-in-Prime CAE model build
   – Batch meshing CAD data (including Catia V5/JT CAD conversion, automated mid-surfacing)
   – Automated assigning of CAE engineering properties to CAE parts (PID, part thickness, part material, MID etc)
   – Automated creation of CAE connections via Master Connection File

2. CAE Module Management
   – Store, maintain and share CAE System Modules

3. Vehicle CAE Model Build
   – Automated assembly of CAE Modules, incl. connections
Use Case #1 (details)

1. Create/Clone/Update CAE Structure
2. Populate EP’s
3. Export & Send PLMXML Pkg
4. Create & Debug mcf
5. Mesh & Assemble
6. Create Connections
7. Freeze & Share Model
Pre-Processor Integration – Model Build

- Export CAE structure from Teamcenter via PLM XML Export
- Launch Pre-Processor integration and import CAE structure PLM XML Package
- Perform automated Data Preparation Steps (e.g. Translation, positioning, instancing, mid-surfacing, structuring, ...)
- Export CAE PLM XML package from Pre-Processor, containing CAE model data
- Import CAE PLM XML package into associative CAE structure in Teamcenter
Experiences

• Rollout successful w/o show stopper issues
  – Memory limitations unveiled
  – Remote data transfer issues
  – Dependency from PDM tree integrity

• 8 x Performance increase of key steps compared to previous Teamcenter CAE PIM solution
  – Initial „Overhead“ for CAE Data Management of BIW CAE model is close to 0
  – Overhead is more than offset by downstream benefits

• Technology still evolving
  – Configuration (Data Model, Key PLM Behaviors) is stable
  – TCSim “Tool Set” improving, 2 releases / month since April
  – Improvements realized in Teamcenter 8.3 and planned for Teamcenter 9 and beyond