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#### 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



#### ONE TEAM

People working together as a lean, global enterprise for automotive leadership, as measured by:

Customer, Employee, Dealer, Investor, Supplier, Union/Council, and Community Satisfaction

#### ONE PLAN

- Aggressively restructure to operate profitably at the current demand and changing model mix
- Accelerate development of new products our customers want and value
- Finance our plan and improve our balance sheet
- · Work together effectively as one team

#### ONE GOAL

An exciting viable Ford delivering profitable growth for all





Feel the difference



# **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

-	My Teamcenter - Teamcenter 2007						
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# **CAE PLM History cont.**

#### 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

Product 🚯 Model 🏢 Analysis					
BOM Line	Rev Description	Item	🔹 😻 Attachments 😕 Referencers 🕅	Variants 🔀 Composite	
MRK0410376/1-D5-C346-010103-0000001 (view)	Safety - ROOF 5DR FOE FA	CAEModel	Line	Туре	
MRK0410377/1-DIC346A50202-00001 (view)	Safety - PANEL ROOF Safety - PNL FRT RF OTR	CAEModel CAEModel	MRK0410376/1-DS-C346-010103-00 CAEModelRevision		

#### Jan 2011: CAE PLM Strategy workshop

 Defined set of global CAE PLM Principles (e.g. on sync. & mapping w/ product structure, knowledge capture, etc)









### **TCSim Project Scope (2008-2010)**



Phase 1

Phases 2+



#### CAE PLM Development Scope (2011-2014)





# Architecture



#### Data Model – "EBOM embedded in CAE str/"

#### **Product Structure**



- GO3M51-R107A64-A CHNK2/4-MBR FRT FLØCS +
- MRK0495007/1-GO3M51-R5C364-C
  - 🗄 🔗 GO3M51-R5C364-C/8-SPCR SUB FR 🕅 NG MRK0494863/1-AV61-2L456-A-INS-01
- Durability SPCR SUB FR MTNG

Durability - BRKT BRK LN FRT LH

AV61-2L456-A-INS-01/2-BRKT BRK LN FR H



DIC1W520720-00026/1-NUT M06 WELD HEX FLNG 0

W520720-S/2-NUT M06 WELD HEX FLNG 08 DIC1W706507-00001/1-BLT M10X25.0 WLD PIL 8 (vie

6507-S/3-BLT M10x25.0 WLD PIL 8

+

F.

/520720-S/2-NUT M06 WELD HEX FLNG 08 DIC1W520720-00027/2-NUT M06 WELD HEX FLNG 0

#### Data Model – "CAE embedded in EBOM"

#### **Product Structure**





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#### **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

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- 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



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### **Tool Architecture**

Server/Client Client "TCSim tool set" **Teamcenter** tc\_inspector to utilities to ansa to defau tc\_inspector for Simulation Create/Maintain Structure Change mgmt. Notification Manage EPs tc\_xyz / Preproc. Customer specific utilities Maintain/Document Data Sets Advanced functionality Work Packaging Fix Minor Bugs CAE Pre-Processor Share Data Read Structure • . . . Read Data sets Start Processes Modify Data Sets Modify EPs PLM XML D/B Common w/ PDM

#### **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

Package

PLM XML

SDK

Read



Ford

# **CAE Pre-Processor Integration**



# Pre-Processor Integration – Crash Vehicle Assy

CAE SE - Teamcenter 20	107 			
🖗 Back - 🎯 - CAE SE (	watsonm (watsonm) - CAE Engineering/Team Analyst [3	MC-517071703])		
	Getting Started My Teamcenter CAE SE X			
Enter Item ID to Sear 🛃 💌	Product 🗄 Model 🏢 Analysis			
uick Links Customize 🔺	BOM Line	Rev Description	Discipline	
Home >>	001752/A;1-BV61-A045830-A-INS-01	NVH - SUPT CNSL PNL RR	NVH	
My Saved Searches >>	001754/A;1-FDRBV61A112K76A01	NVH - PLATE FRT SEAT MNTG RR INR RH	NVH	
😵 My Links 🛛 🚿	001756/A;1-FDRBV61A112K77A01	NVH - REINF FLOOT	NVH	
	001729/A;1-GC3M51-R11140-A	NVH - P**	NVH NVH	
Inen Items	001741/A;1-FDR8V415104A95A01	* <b>1</b> 04	NVH	
perioditis	001744/A;1-FDR8V41510254^~ 001747/A;1-FDR8V41~	anter	NVH NVH	
	001750/A:1		NVH	
		TRT SEAT MTG FRT	NVH	
	1001761 1 COV	BRKT FRT SEAT MTG FRT	NVH	
	001761	NVH - BRKT FRT SEAT MTG FRT NVH - MBR FRT FLR CROSS CNTR	NVH	
listory 🔺	001726/A	NVH - PLATE FRT SEAT MOUNTING RH	NVH	
#9 002204/A;1-002135 002138/1:1-C346 BIP Under	001726/A;1-GO3M51-R617K65-A	NVH - PLATE FRT SEAT MOUNTING RH	NVH	
002135/1;1-C346 BIP Under	001760/A;1-FDRG03M51R10878801	NVH - MEMBER FRT FLR CROSS OTR FRT NVH - MEMBER FRT FLR CROSS OTR FRT	NVH Niel	
C346-BIP-Underbody/1;1-FD	001719/A;1-GO3M51-R111K36-A (view)	NVH - REINF FRT FLR PNL AT TUNNEL	NUMAS	
Getting Started				
• Mod	ular library			
· Con	aria Madal	_ F	PLM XM	
• Gen	enc model	5		
• Man	age mcf's			
		1011		
<ul> <li>Module selection</li> </ul>		on		
Model content				
Instances				



Modify mcf's

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- Realize connections
- Modify Meshes
- Position Modules

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- Quality Checks
- Numbering
- Mass Trimming / Balancing
- Loadcase Setup
- Output Request
- Final Deck



Module Positions

### **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

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- Incremental Packages
- → Develop more sophisticated integration (based on API's)



🞐 PLM XML Import 🛛 🔀			
2			
Teamcenter	Importing Object: D:\temp\003118_A;1-003094.xml		
	Transfer Mode Name: incremental_import		
STEP	View Log File:		
PLMXML			
	OK Apply Cancel		



# **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**



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# **Backup Material**



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# **Use Cases**



### **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)

- Create/Clone/Update 1. **CAE** Structure
- Populate EP's 2.
- 3. Export & Send PLMXML Pkg
- Create & Debug mcf 4.
- Mesh & Assemble 5.
- **Create Connections** 6
- 7. Freeze & Share Model



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#### **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



### **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

