

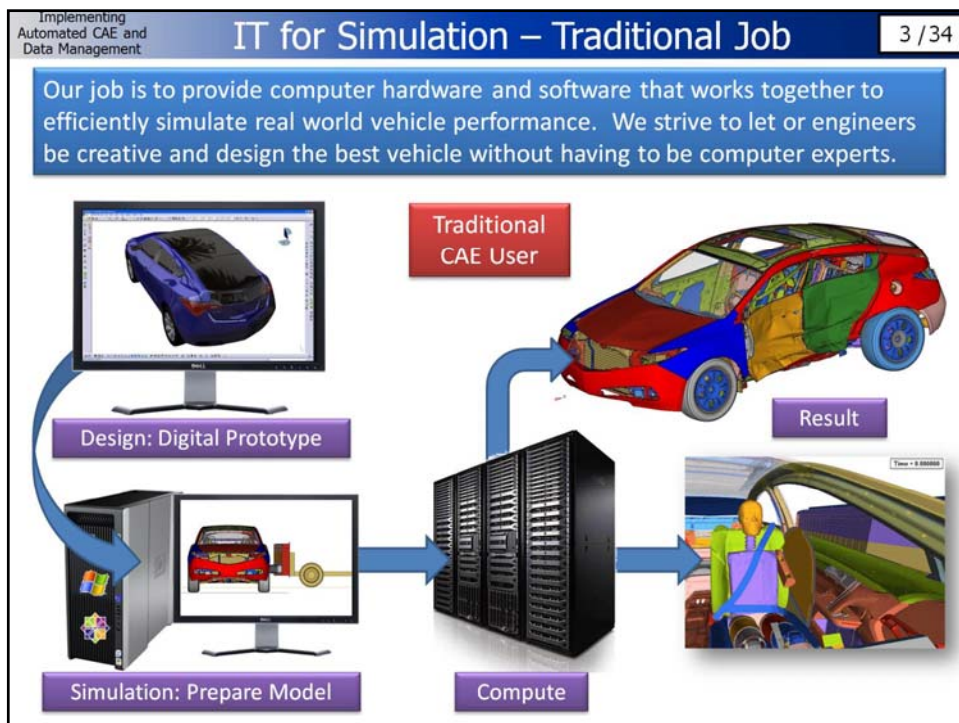
Implementing Automated CAE and Data Management	Agenda	1 / 34
<ul style="list-style-type: none">• Background about Honda R&D Americas• IT for Simulation• The Journey• 2 Examples<ul style="list-style-type: none">– Design CAE – HVAC Duct– CAE Expert – Roof Crush• Concerns & What's Next		

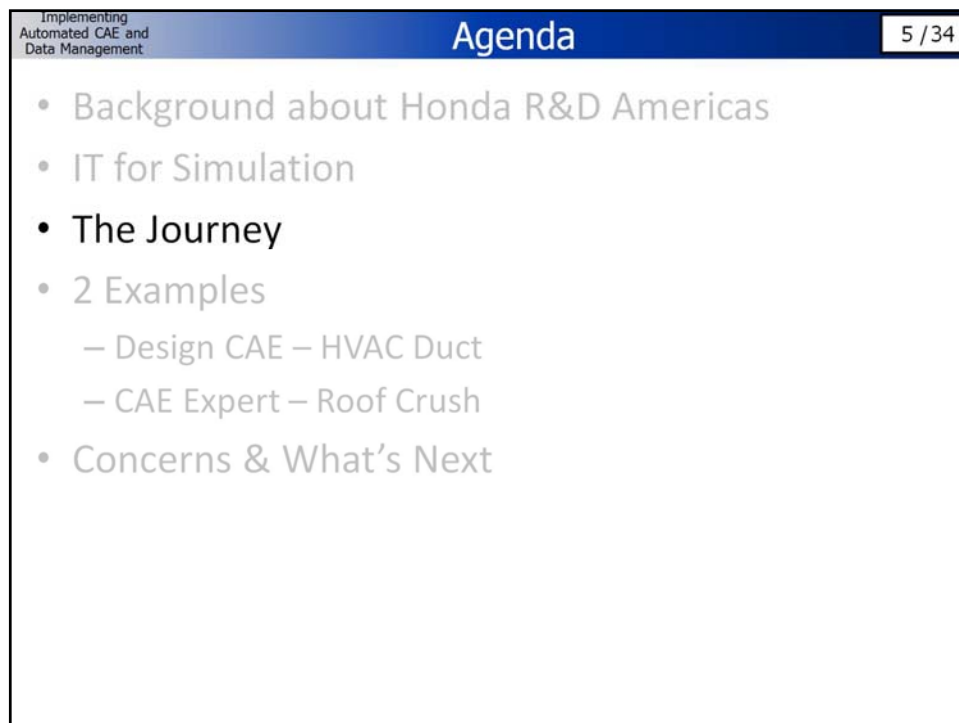
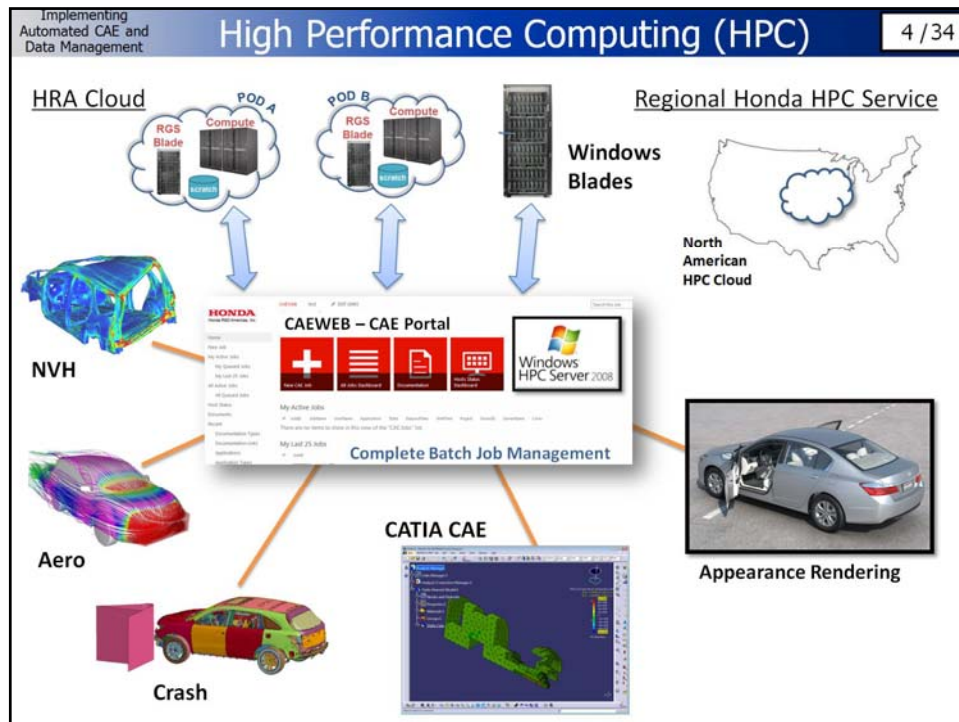
Implementing Automated CAE and Data Management

Agenda

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- Background about Honda R&D Americas
- **IT for Simulation**
- The Journey
- 2 Examples
 - Design CAE – HVAC Duct
 - CAE Expert – Roof Crush
- Concerns & What's Next



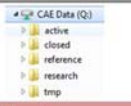




Implementing Automated CAE and Data Management

Honda R&D Americas – Phase 1

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Phase 1	Phase 2	Phase 3	Future
<p>Honda R&D – Ohio</p> <ul style="list-style-type: none"> ➤ Frame and Chassis Development ➤ Pilot, Element & Ridgeline 	<ul style="list-style-type: none"> • Honda R&D Americas is still small • Maturing frame and chassis development • CAE community is small and expert driven 		
<p>◆ CAD / PLM</p> <p>CATIA V4 VPM NAVI</p>	<ul style="list-style-type: none"> • Implementing the start of PLM • First Digital Prototype Model (DPM) capability is implemented with CATIA V4 		
<p>◆ CAE Automation</p>  <p>White Body Builder</p>	<ul style="list-style-type: none"> • First CAE Automation attempt. Build the safety CAE body in white model from CATIA data with HyperMesh for batch meshing and welding. 		
<p>◆ CAE Data Mgmt</p>  <p>Network Drive (Windows & Linux)</p>	<ul style="list-style-type: none"> • Focus is on expert CAE (NV, crash, durability), batch meshing and expanding HPC resources • Modeling methods are growing rapidly 		


Emerging need is to reduce model creation time and effort.

Implementing Automated CAE and Data Management

Automation and Data Mgmt Starts

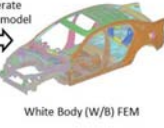
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- Growing need for safety simulation provides an opportunity
 - Crash simulation provides a good return on CAE investment, but demands high quality, detailed vehicle structural finite element model
 - Developed a software application with Altair to automate the body in white



WBB
Mesh & Assembly

Generate FEM model



White Body (W/B) FEM

- BOM interface included part selection, material, thickness, and mesh quality settings
- System auto extracted CAD, meshed parts and welded sub-assemblies

- Body in white tool was not successfully implemented. 3 Reasons.
 1. **Batch mesh quality was not acceptable** – software vendors have improved
 2. **It didn't work reliably** – CAD data quality was inconsistent (what is final shape, which direction is thickness, where are spot welds)
 3. **The users didn't want it** – our current process is fine, we don't need it

This failure identified the gaps for a successful tool in the future

Implementing Automated CAE and Data Management

What Do the Users Want?

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This is a critical question for success of a new system or tool




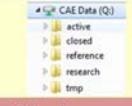
- Expert Engineers want good information and good data
 - Information => part #, material, thickness, weld location
 - Data => quality 3D surface or solid definition
 - We can start here. This is required for automation also.
- Expert Engineers want flexibility / freedom to find the right answer
 - They won't just accept the answer some automated tool gives them
 - Flexibility often means manual adjustment – a new method, a new way
 - Freedom may mean a new design concept that wasn't "programmed in"
 - We need to use industry standard Pre-Post software applications
- Expert Engineers want efficiency
 - Many write their own script to automate a specific task or process
 - Shared use of scripts requires modeling standards – even for experts
 - We need a semi-automated tool. Automate the repetitive, non-thinking

Honda needed the expert CAE users to lead the next step

Implementing Automated CAE and Data Management

Honda R&D Americas – Phase 2

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Phase 1	Phase 2	Phase 3	Future
<p>Honda R&D – Ohio</p> 	<p>➢ Vehicle technology research expands</p> <p>➢ MDX, Pilot & ZDX</p>	<p>• Honda R&D Americas is growing both in manpower and responsibility</p> <p>• CAE capacity and capability is increasing</p>	
<p>◆ CAD / PLM</p>  <p>CATIA V5</p> <p>Body DPM Standards</p> <p>CATIA V4 VPM NAVI</p>	<p>• CATIA V5 modeling capability and standardization provide the structure for automation</p>		
<p>◆ CAE Automation</p>  <p>Build all crash modes</p> <p>Simultaneous Simulation Process (SSP)</p>	<p>• SSP is a semi-automated, DPM driven process that quickly builds multiple crash models</p>		
<p>◆ CAE Data Mgmt</p>  <p>Network Drive (Windows & Linux)</p>	<p>• High speed, project organized network storage meets the need</p>		

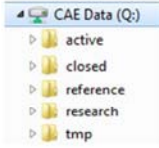
Efficiency and capability are good, but can they scale with increasing demand?

Implementing Automated CAE and Data Management

No Data Management for CAE?

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- Network file system does provide data management



Directory Structure

- Linux: /cae/data/active/project/event/group
- Windows: \\am\hrao\cae\active\project\event\group

- where projects = current vehicle development project codes
- where events = select development stages
- where group = appropriate groups

- Simulation Data Management Suites are available
 - Investigated MSC's SimManager, Altair's Data Manager & Simulia's SLM
 - They provided CAD to Simulation report capability, but required significant customization and commitment to implement.
 - SLM was newer to the market and offered a different option, an smaller scale approach focused on configuration instead of customization.
 - However, software and implementation was costly for all and the CAE experts perceived these tools as a loss of flexibility and slow down

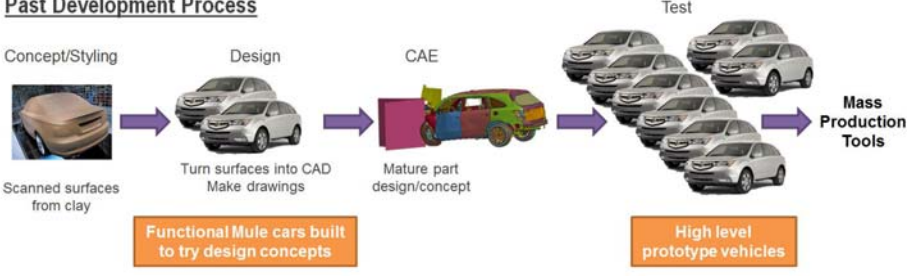
Honda is not ready to deploy CAE Data Management

Implementing Automated CAE and Data Management

Vehicle Development Is Changing

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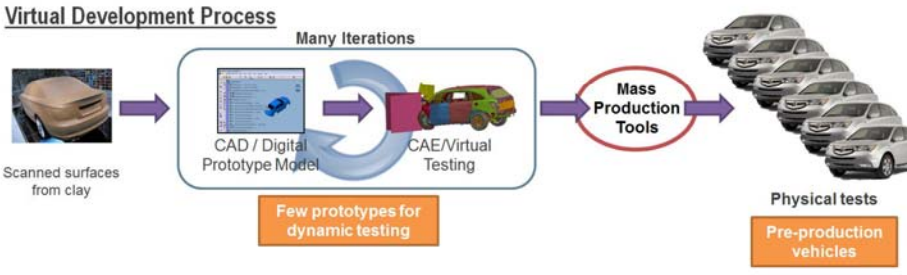
Past Development Process



Functional Mule cars built to try design concepts

High level prototype vehicles

Virtual Development Process

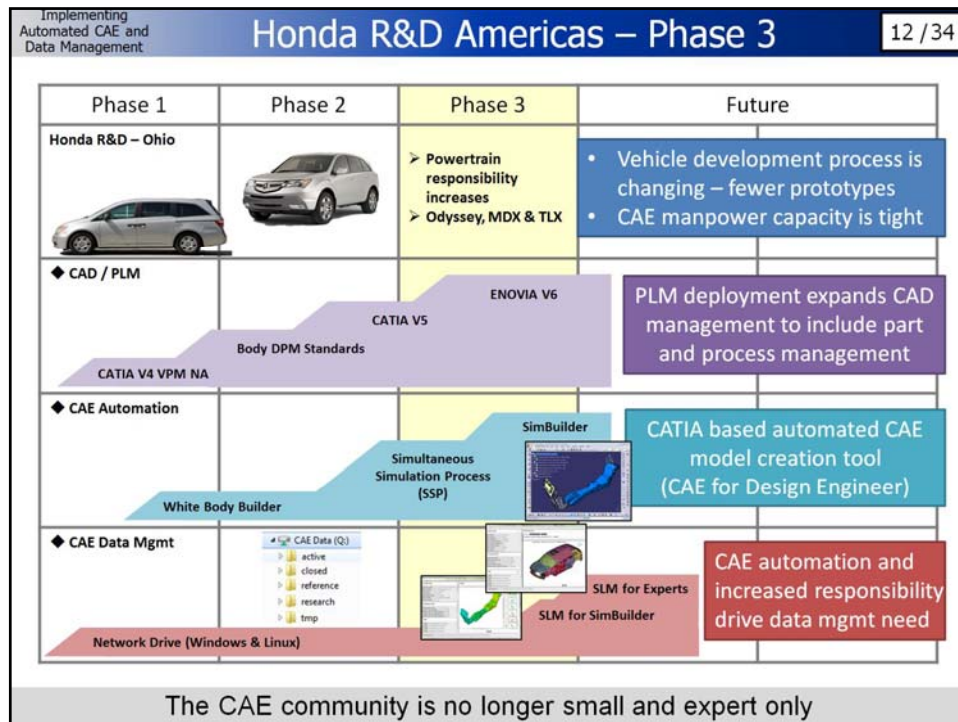


Many Iterations

Few prototypes for dynamic testing

Physical tests
Pre-production vehicles

Success is based on confidence of predictive CAE methods



Implementing Automated CAE and Data Management

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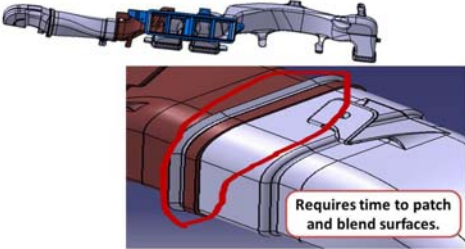

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Implementing Automated CAE and Data Management

Design CAE Example – HVAC Duct

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- Problem
 - Current method had **trouble meshing part assemblies** and had limited solver capacity (license cost & workstation calculation).
 - The **interactive process** was time consuming and occupied the CATIA license. It also didn't provide any automated reporting or data management.

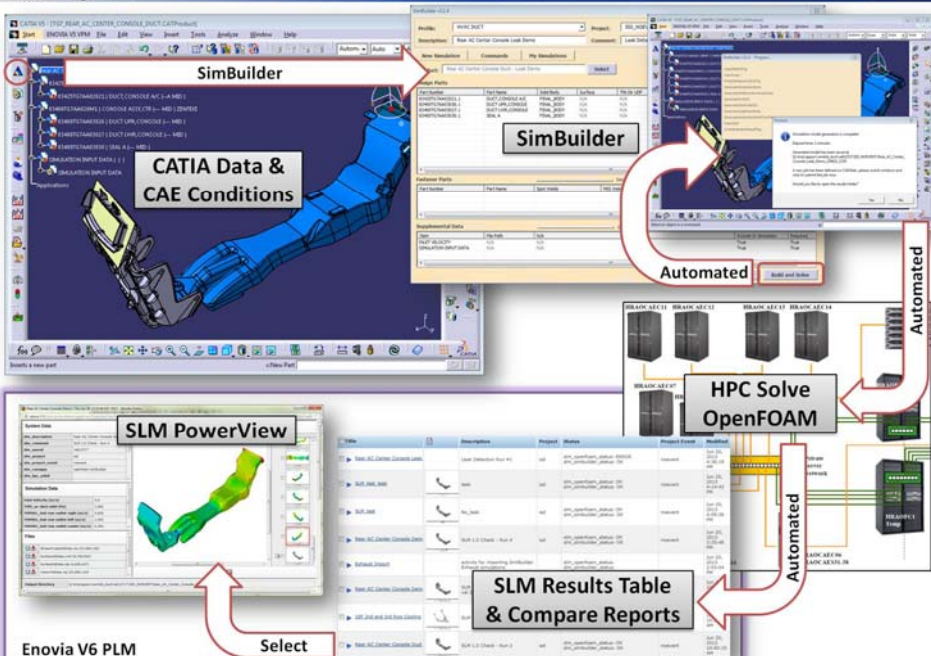



- Goal
 - Develop an automated HVAC Duct system simulation tool that eliminates meshing issues, improves solve time and accuracy, automates reporting and provides simulation data management.
 - The tool interface should be based in or work with CATIA.

Implementing Automated CAE and Data Management

HVAC Duct Solution Overview

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The diagram illustrates the automated workflow for HVAC duct simulation. It starts with **CATIA Data & CAE Conditions** being processed by **SimBuilder**. The output is then sent to **HPC Solve OpenFOAM** for automated solving. The results are visualized in **SLM PowerView** and summarized in an **SLM Results Table & Compare Reports**. The entire process is managed within the **Enovia V6 PLM** environment.

Implementing Automated CAE and Data Management

SimBuilder Description

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- General purpose, automated CATIA CAE model builder
- Common interface for all simulation types => profiles
- A Profile is a specific set of rules and commands to build and perform a predefined simulation
 - Profile = config + library command + custom command
 - Examples: Joint strength, panel rigidity, HVAC duct airflow, etc
- Contains a library of standard CAE model building functions that are executed as needed by each profile.
- Leverages Honda standards such as DPM properties, connection definitions & batch job processing

Structural

CFD

NVH & Acoustics

↓ Profiles

Implementing Automated CAE and Data Management

SimBuilder – HVAC Specifics

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Required

- PRODUCT
- PARTS ()
- SIMULATION INPUT DATA ()
 - xy plane
 - yz plane
 - xz plane
 - Working supports
 - PartBody
- INSIDE PT
- INLET SURFACE
- OUTLET SURFACES
- SECTION PTS - PATH 1
- SECTION PTS - PATH 2
- SECTION PTS - PATH 3
- SECTION PTS - PATH 4
- SECTION PTS - PATH 5
- SECTION PTS - PATH 6
- SECTION PTS - PATH 7
- SECTION PTS - PATH 8
- SECTION PTS - PATH 9
- SECTION PTS - PATH 10
- REFERENCE LINES AND CAMERA
- REFERENCE SURFACES

Required

Duct geometry: surface or solid

Required

INSIDE PT: Define fluid domain to solve

Optional

INLET SURFACE: Define inlet boundary

OUTLET SURFACE: Define outlet boundary

Optional

CUSTOM CAMERAS

If you setup custom cameras in CATIA, those same views will be generated in the post processed result images. This allows you to get a detailed look at specific concern areas.

Camera in CATIA → Generated Image

Optional

REFERENCE SURFACE: Define surface to draw contour

Implementing Automated CAE and Data Management

OpenFOAM – Mesh & Solve

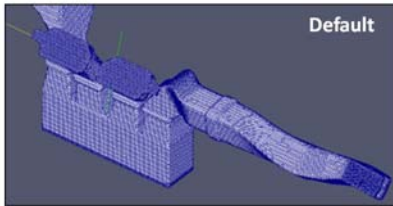
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Mesh and Solver Settings

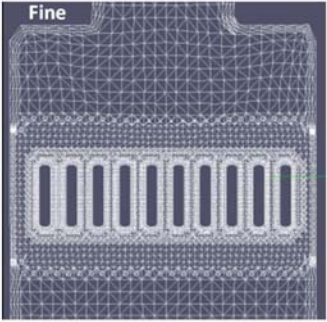
- Discretization Scheme: 2nd Order
- Turbulence Model: SST K- ω
- Boundary layer: 3 prism layers
- Cell Length: see chart (Cartesian snapped Cell)
- Number of iteration: 1,500
- Number of cpu: 128 parallel

==> Calc. with 530,000 cells takes about 9 minutes

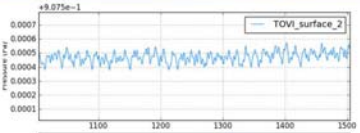
Distance from wall (mm)	Default (mm)	Fine Part (mm)	In/outlet Boundary (mm)
< 10	3.125	0.390 - 1.563	1.563
< 50		3.125	
< 100	6.25	6.25	
< 200	12.5		
Boundary layer	0.3mm	N/A	

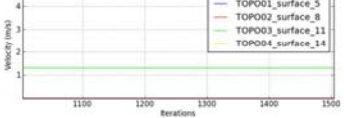


Default



Fine





Implementing Automated CAE and Data Management

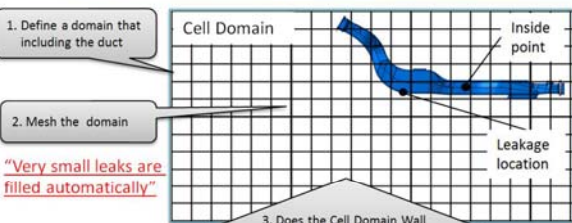
OpenFOAM – Leak Detection

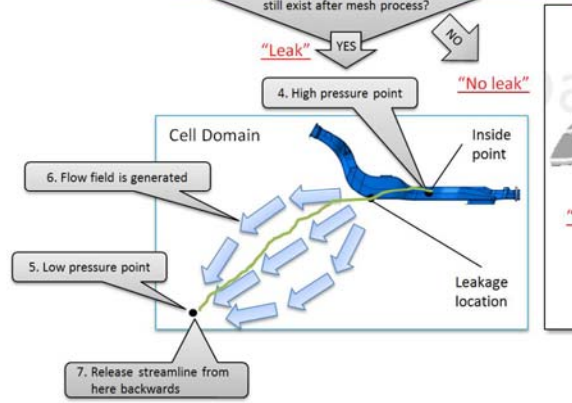
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1. Define a domain that including the duct
2. Mesh the domain
3. Does the Cell Domain Wall still exist after mesh process?
 - YES: "Leak"
 - NO: "No leak"
4. High pressure point
5. Low pressure point
6. Flow field is generated
7. Release streamline from here backwards

The top concern for an internal CFD simulation with batch mesh is leak control or an unsealed domain.

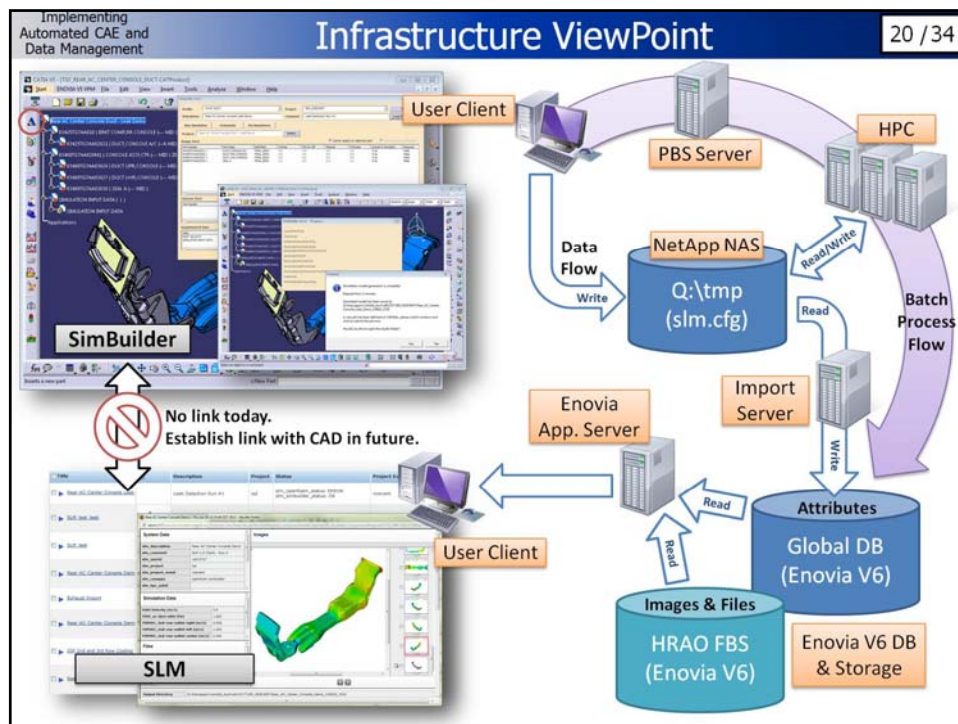
This was the root cause of the part assembly meshing troubles of the previous tool.







"Leak Located"





Implementing Automated CAE and Data Management

CAE Expert Example – Roof Crush

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- **Problem**
 - Engineers often run several design ideas at the same time and then manually check the results interactively one-by-one.
 - New engineers rely on experienced associates to answer questions about previous developments and to find old data.

- **Goal**
 - Automatically create initial results (animations, pictures, graphs, key values) that focus the engineer on the most promising designs for in-depth analysis.
 - Categorize, track and retain previous development results and knowhow to bring new engineers up to speed quickly and minimize impact to experienced associates.

Implementing Automated CAE and Data Management

Roof Crush Solution Overview

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Model Geometry & CAE Conditions

ANSA

Job Submission

HPC Solve

SLM PowerView

SLM Results Table

Select

Solve and Report

Automated

Search Results	Job Name	Job Details	Application
MEI_RoofCrush_001	MEI_RoofCrush_001	Roof Crush sample for QA testing	Idyna
MEI_RoofCrush_002	MEI_RoofCrush_002	Roof Crush sample for QA testing	Idyna

Implementing Automated CAE and Data Management

Job Submission is Our Chance

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CAEWeb is the portal for High Performance Computing (HPC) resources, services and knowledge

- Required for engineers to submit CAE jobs for calculation.
- Provides system level information that can be used to automate activities for the CAE users
- Latest version gather additional information to allow automation of reports and SLM data import.

New Required Information

CAEWeb CAE Team Site

NEW CAE Job

User-name * dturk
 Password * *****
 Domain * safety
 Sub-Domain * component
 Verification * roof_crush
 Purpose * baseline
 Project & Stage * kkt_s1
 Vehicle Spec * sunroof
 Job Name * MEI_RoofCrush
 Job Details * Roof Crush sample for QA testing
 Application * Idyna
 Version * 971_MFP_SF_R7_076365
 Input File * \\nam.dh.honda.com\hrc\cae\mg\id\971...
 Additional Files *
 Wall Time * 16:00:00
 Required CPU Cores * 256

Advanced Application Options

Post-Processing Applications

Submit Job Generate QScript File Create PS Script Create Python Script Clear Cache

Implementing Automated CAE and Data Management

SLM Features - Search

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- Integrated with core Honda R&D Americas Enovia PLM system
- Access from My Desk + Scenario Definition + Simulation Activity Search
- Standard SLM interface configured to show attributes important to Honda

Search Refinement

Case Sensitive Limit to 100 results

Type: Simulation Activity

Name: []

Originated: Mar 6, 2014

Modified: []

Title: []

Description: []

Project: []

Project Event: []

Owner: []

Search Results

Description	Verification	Comments	Project	Project Event	Status	Judgement	Owner	Originated	Ms
L_F2_cm1a_022	side	Roof Crush example for QA testing			slm_jedyna_status: OK	Turk, Dan		Apr 5, 2014 2:40:09 PM	
slm_examples	side	side overlap test example			it slm_jedyna_status: OK	sample		Apr 5, 2014 2:34:39 PM	
08_ZWD_MASTE	rear_odt	Rear ODB example for QA testing			slm_jedyna_status: OK	Turk, Dan		Apr 5, 2014 2:33:42 PM	
MES_Master_RoofCrush	roof_crush	Roof Crush example for QA testing			slm_jedyna_status: OK	Turk, Dan		Apr 5, 2014 2:33:39 PM	
slm	side	test side example			it slm_jedyna_status: OK	sample		Apr 5, 2014 2:18:19 PM	
MES_RoofCrush	roof_crush	Roof Crush sample for QA testing			slm_jedyna_status: OK	Turk, Dan		Apr 5, 2014 2:15:19 PM	

Callouts:

- Initial Sort (most recent)
- Select for Powerview
- Easy Filter Result Table
- Select Header to Sort By
- Customize Your Search

Implementing Automated CAE and Data Management

SLM Features - Powerview

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System Data

slm_userid	Turk, Dan
slm_domain	safety
slm_subdomain	component
slm_caeweb_template	roof_crush
slm_caeweb_templatever	1.0
slm_caeweb_version	2.3.0
slm_purpose	baseline
slm_project	
slm_revision	001

Simulation Data

Vehicle Mass [kg]: []

IIHS Target (4.4x) [N]: []

Max Force [N]: []

Max Displacement [mm]: []

Displacement at Target Load [mm]: []

Files

- 01_Baseline_report.pptx (232,421)
- FullModelReport.csv (1,889,007)
- HE_R_dynamore_out.txt (1,567)
- MES_R_metapos_out.txt (37,991)
- MES_RoofCr_sim_out.txt (294)

CAE Powerview

Images Referenced Files Lifecycle 29

Simulation Activity "MES_RoofCrush" rev -: Images

0-01_Baseline : IIHS Roof Crush Barrier : ORIGINAL STATE

Callouts:

- Update Judgement
- Other Main Windows Ref Files: Include files Lifecycle: Control Lifecycle State
- Available Images
- Key Data (searchable)
- Upload a File
- Watermark (removed by Lifecycle change)
- Path to Complete Results
- Safety Simulation ANSA Report and other files

Implementing Automated CAE and Data Management

SLM Features – Compare Results

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- Select two simulations and click on Compare Results
- June 2014 release supports 10 items

The screenshot displays the SLM Compare Report interface. On the left, there is a 'Search Refinement' panel with filters for 'Case Sensitive' (Limit to 100 results), 'Simulation Activity', and 'Originated' (Mar 6, 2014) and 'Modified' dates. The main table shows simulation results with columns for 'Description', 'Verification', and 'Comments'. Two rows are highlighted in blue, and red boxes with arrows point to 'Click' and 'Parameters' buttons above the table, and 'Check Box' labels pointing to checkboxes in the Description column. A detailed parameter comparison table is visible on the right side of the interface.

Implementing Automated CAE and Data Management

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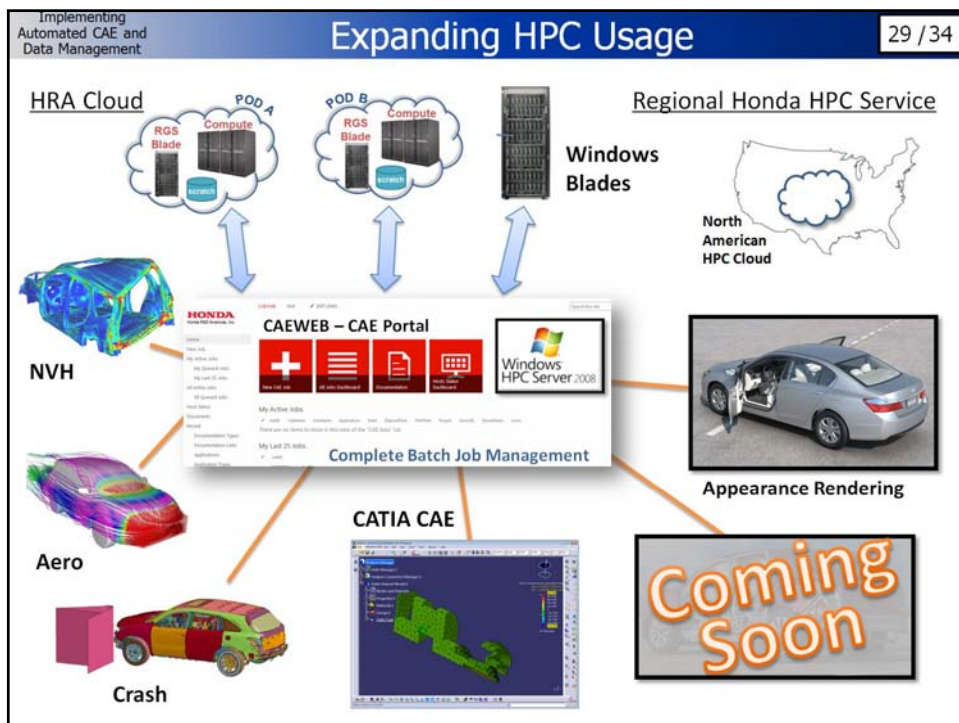
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Implementing Automated CAE and Data Management

Concerns & What's Next

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- The success of CAE automation and data management is fragile
 - Some automation tools are regularly used and applied to development, but other have been developed but not used
 - Need to understand why some tools fail
 - Enhance and expand the scope and capabilities of what works
 - Data management is optional from the simulation engineer's perspective
 - CAE automation is required to get results, but the ultimate value of data management is not realized until the next development – delayed benefit
 - Until then, focus on “What can we do for you” and “Capturing the data.”
 - Management support will be required to ensure successful growth
- Promote, Listen, Improve, Repeat
- Keep watch of both technology and industry – you might think of the next great thing



Implementing Automated CAE and Data Management

IT for Simulation – New Consideration

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Our goal to provide computer hardware and software that works together to efficiently simulate real world vehicle performance does not change. But finding new ways to apply existing technologies to simulation, can have a big impact.

Design: Digital Prototype

Simulation: Prepare Model

Compute

Life Like Result

Non - Traditional CAE User

Thank You