Democratizing CAE at AAM
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Agenda

• AAM Introduction
• Virtual Development in Automotive Industry
• Need for Simulation Democratization
• Initiatives to Democratize CAE
• Enablers and Opportunities
• Summary
North America Driveline Trends

US LV Sales - Upside Potential/Downside Risk

- **Upside Potential**
- **Baseline Forecast**
- **Downside Risk**

<table>
<thead>
<tr>
<th>Year</th>
<th>Upside Potential</th>
<th>Baseline Forecast</th>
<th>Downside Risk</th>
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<td>2014</td>
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<td>2016</td>
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<td>2018</td>
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<td>2020</td>
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- **Upside**: Fuel, Boomers, Prices, Replacement Rate, Interest Rates
- **Downside**: Fuel, Prices, Debt, Income, Regulations, Interest Rates
- **Unknown**: Millennials, Sharing, Urban Mobility

Source: LMC Automotive
About AAM

AAM is a tier one global automotive supplier of driveline and drivetrain systems and related components for light trucks, SUVs, passenger cars, crossover vehicles and commercial vehicles.

Our intense focus on engineering and manufacturing allows us to build value for our customers through quality, technology leadership and operational excellence.

- ESTABLISHED: 1994
- WORLD HEADQUARTERS: DETROIT, MI
- CUSTOMERS: >100 WORLDWIDE
- LOCATIONS: >35 FACILITIES IN 13 COUNTRIES
  - Brazil
  - China
  - Germany
  - India
  - Japan
  - Luxembourg
  - Mexico
  - Poland
  - Scotland
  - South Korea
  - Sweden
  - Thailand
  - United States
Due to extreme compression in development time:

- Hardware results often not available or incomplete prior to next design freeze!
- Entire organization, all the way from Design Engineer to Chief Engineers have to rely on Simulation!
- Extremely important to have Simulation Governance to improve reliability, repeatability of simulation results and reduce errors and uncertainty
Simulation Data Exchange & Deliverables

OEMs

Customer

New Technology & Architecture Integration

Mass, Cost and Quality Management

DFMEA & PFMEA

Tier 1s

Tier 2s & Tier 3s

Project Management and Communication

Invention and Balancing Attributes

Creativity & Resources
CAE Evolution in Automotive Industry

2017
- Multi-Physics
- System Level Optimization
- Co-Simulation
- Hybrids & eDrives

2018
- Virtual Factory Optimization
- New Energy & Materials

2019
- Virtual Product Development
- Democratized CAE
- Stochastic CAE

2020
- 5 day Concept to Production Cycle
- Instant Performance Dashboards

Best in Class CAE Leadership
Extent of Democratization

- High Performance Computing
- Databases, Automation & Standardization
- Simplified CAE Tools & Standard Procedures
- Web Application Based Tools
- Train & Deploy next Generation Tools
Considerations for Democratization of CAE

• What are the drivers for Democratization?
• What makes CAE capable of deploying across enterprise?
• What tools and processes are being deployed?
• What are the opportunities and challenges?
• How is this perceived and accepted by non-CAE organizations?
• Is it only an “Early screening” objective?
Workload Outstrips Demand all the Time

Typical CAE Workload

Workload Demand

Outside Help

Headcount
8 Initiatives to improve Democratization

1. Simplify tools
2. Create and validate databases for loads, materials, common components etc.
3. Find niche areas to deploy CAE tools outside CAE departments
4. Forward deployment of simulation
5. Automation of multi-discipline simulation
6. Standardization, including reporting
7. Train non-CAE users in using simulation tools and interpreting results
8. Grow CAE experts still needed in key areas
Simplify CAE Tools

- Maturity of CAE within an Organization
  - Right Skill Sets
  - Resource allocation
  - IT support
- Simulation Process documented in PLM
- Define clear requirements for CAE models and results
- Establish clear workflow between CAD, CAE and Product Engineers
- Template based CAE models
- Reuse of CAE data, models, loads, results etc.
- **Leadership: Motivate, Support & Train CAE Engineers**
Host in PLM:

- Standard Bearings
- Bearing data required for CAE
- Fasteners, including performance data
- Seals – static and dynamic seals
- CAE Reports
- Genetic CAE Models with boundary conditions
- Loads for designing standard components and subsystems
- Material databases needed for CAE
- Technical specifications
- Lessons learned
- Design Standards and KBE
- Others
CAE Tools Deployment

Integrated Stochastic System Optimization

- Casting
- NVH
- Gears & Bearings
- Controls & Software
- Structure
- Multi-Body
- Assembly Simulation
- Mechatronics
- CFD/Thermal

Virtual Factory
Manufacturing/Assembly etc.
Process Modeling

Complexity

Democratize

CAE Experts

- Casting Solidification
- Simple NVH
- Gear FEA
- Simple Structure & Optimization
- Fastener Analysis
- Bearing Sizing

6/11/2014
AAM Confidential
Look for Opportunities to Spread CAE

Vehicle Dynamics → Dyno Simulation → Loads Prediction

.Subsystem Design → Co-simulation → Optimized Design
Forward Deployment of Analyses

- Enable Designers/Designing Engineers create “first time capable” designs
  - Topology Optimization using simple
  - Simple FEA tools to analyze structural performance
  - Manufacturing Process evaluation
  - Morph CAD geometry quickly
  - Templates to flag deviations from best practices
  - Integrated in PLM systems
    - Stop “Bad Designs” before getting out to detailed analyses
Embed Automation of Multi-Disciplinary Optimization in Design Process

- Engine Assembly
- Transmission Assembly
- Transfer Cases, RDMs & PTUs
- Prop shafts & Bearings
- Brackets & Mount Systems

- Packaging
- Shape & Topological Optimization
- Durability
- Driveline Kinematics
- Non-linear Contact Analysis
- Driveline NVH
- Thermal & Fluid Flow Analysis

Optimization
Consistent and Automated Reporting

• Reports are automatically generated by using customized tools
  • Data is organized per pre-determined process
  • All parameters used in model are documented and managed in database
  • Key Results are automatically plotted and overlaid
  • Standard views and values to enable easy comparison
Simulation Engineer needs to understand the physical system, loads, boundary conditions and usage – in advance

Simulation Engineer needs to explain results and put simulation results in the context of Physical Test

Empower and expand the role of non-CAE Engineers!
Enablers for Democratization

- Simplify tools
- Deploy more “Architecture CAE” small DoF tools
- Knowledge Capture & reuse
- Clear and efficient data flow between departments and organizations
- Apply early and consistently
- Find “analytically oriented” associates
- Share knowledge
- Seek support from Senior Leadership and entire Organization
- Reward non-CAE employees doing simulation
Knowledge Capture using Knowledge Management Tools

Digitizing Knowledge in the Automotive Industry

Document Centric → Convert → Assessment Centric

K-PAC (Knowledge Packets)

Different User Experiences

Library Model

Current Design

Appraisal Model (Assessment)

Design Standard
Data Flow Between Departments

CAE in Each Department & Expert input → System Level Analysis by CAE Experts → Reduced CAE Effort

Durability → Thermal → NVH → Assembly
Who can do CAE?

• Designers
• Designing Engineers
• Application or Design Release Engineers
• Test & Validation Engineers
• Manufacturing Engineers
• Program Management?
Summary

- The capability and capacity for CAE continues to improve at all levels
- The nature of product development is changing, analytical expertise within all departments in an organization is a must
- Companies have started learning to effectively leverage their enterprise wide simulation capability and potential
- While CAE experts are needed, Simulation at all parts of organization is required
- Thoughts on how to deploy Enterprise CAE at a Tier 1 has been described
Thank you!
“Democratization of Simulation” in an Automotive Supplier

The term “democratization of simulation” has achieved significant popularity recently and carries a certain message of encapsulation and forward deployment of computer simulation to allow it to be used by a larger share of the engineering community. While CAE specialists have a role to play in analytical validation, business needs are dictating usage of simulation by all parts of engineering to drive cost down in a compressed product development cycle. This suggests the potential for many advantages, including more interaction between design and analysis and the execution of analytical DOE early in development cycle. However the implementation of this democratization requires far more than encapsulation and automation through a thin client environment. It also requires clear definition of the important elements of simulation and synthesis in product creation, their preferred sequence and flow, clear identification of data models, seamless integration of tools to control the process. The organizational boundaries, resource constraints and varied analytical approaches have to be overcome to create an efficient multi-physics simulation process. This paper will provide insights into the ongoing development of these processes within a Tier 1 automotive driveline supplier.