Democratizing CAE at AAM

NAFEMS Conference

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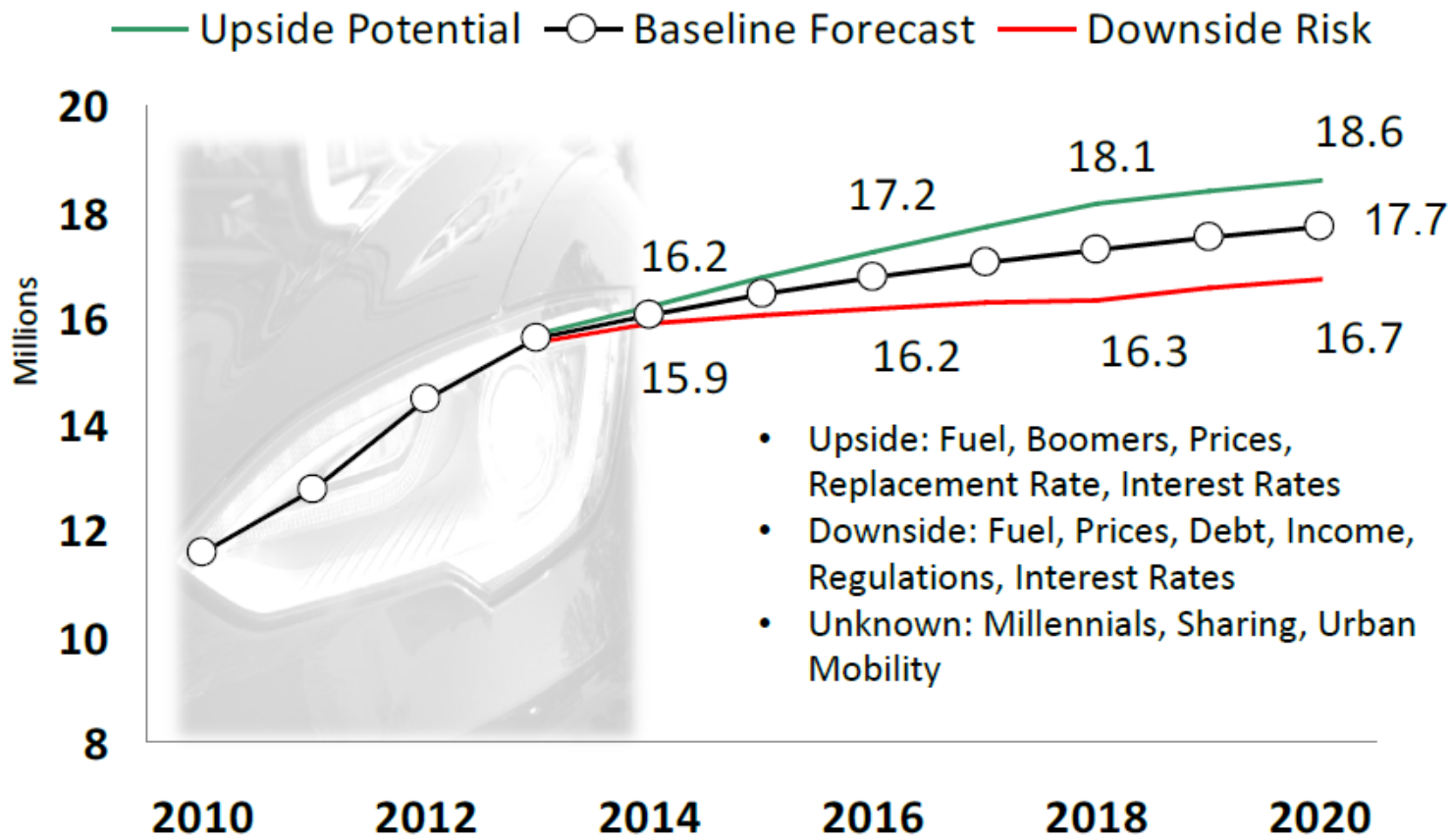
Agenda

- 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



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.**

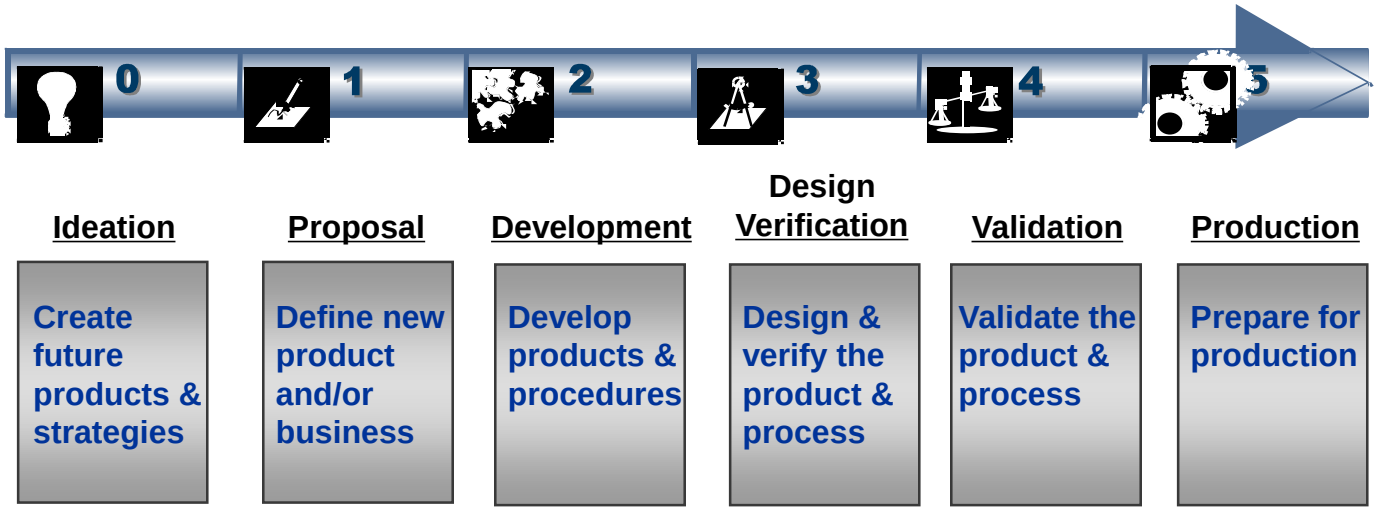
Our intense focus on **engineering** and **manufacturing** allows us to build value for our customers through **quality**, **technology leadership** and **operational excellence**.

- ESTABLISHED: **1994**
- WORLD HEADQUARTERS: **DETROIT, MI**
- CUSTOMERS: **>100 WORLDWIDE**
- LOCATIONS: **>35 FACILITES IN 13 COUNTRIES**

  - Brazil
  - China
  - Germany
  - India
  - Japan
  - Luxembourg
  - Mexico
  - Poland
  - Scotland
  - Scotland
  - South Korea
  - Sweden
  - Thailand
  - United States

Virtual Development in Automotive Industry

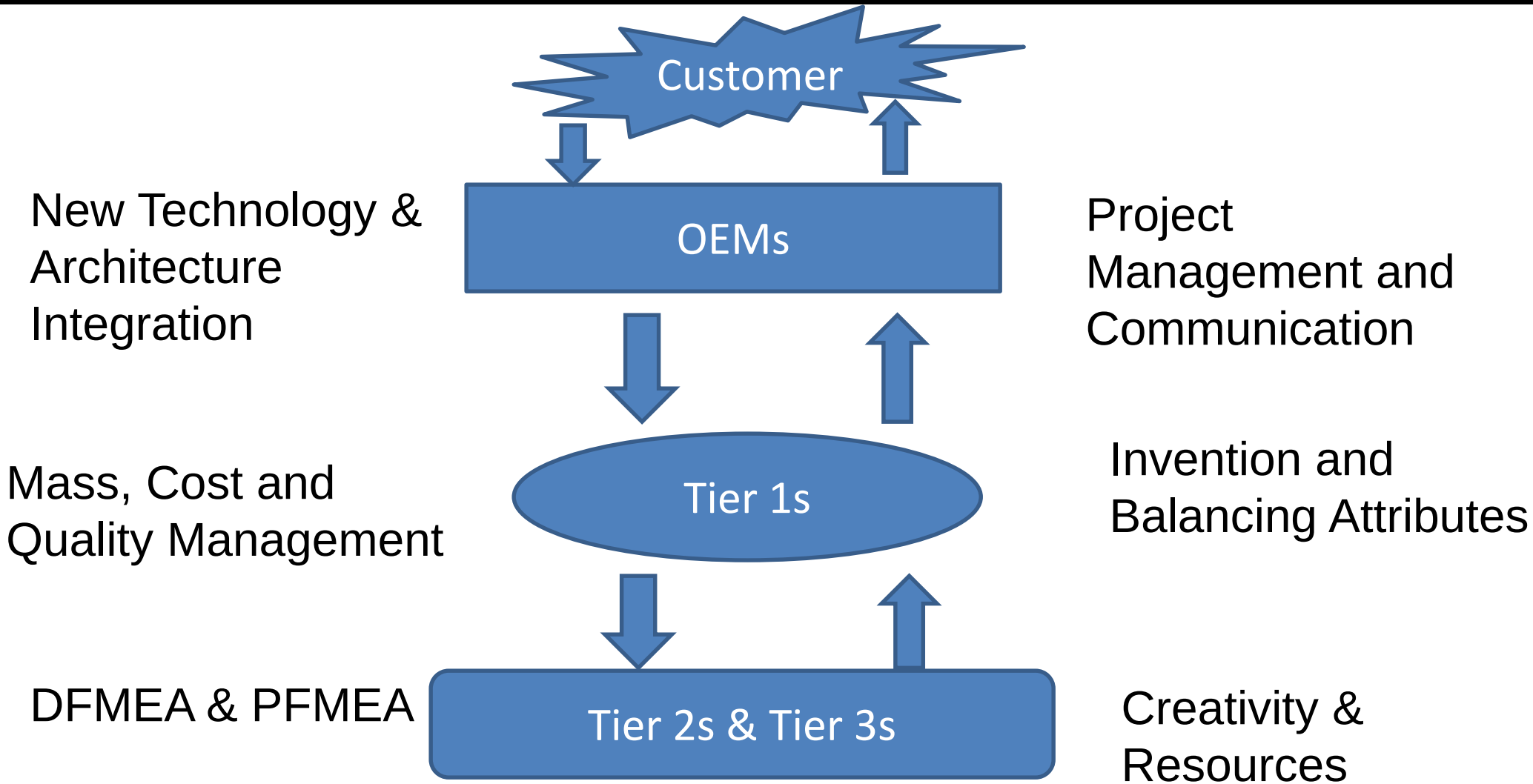
Product and Process Development & Launch



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



CAE Evolution in Automotive Industry

CAE Technology

2017

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

2018

Virtual Factory
Optimization
New Energy &
Materials

2019

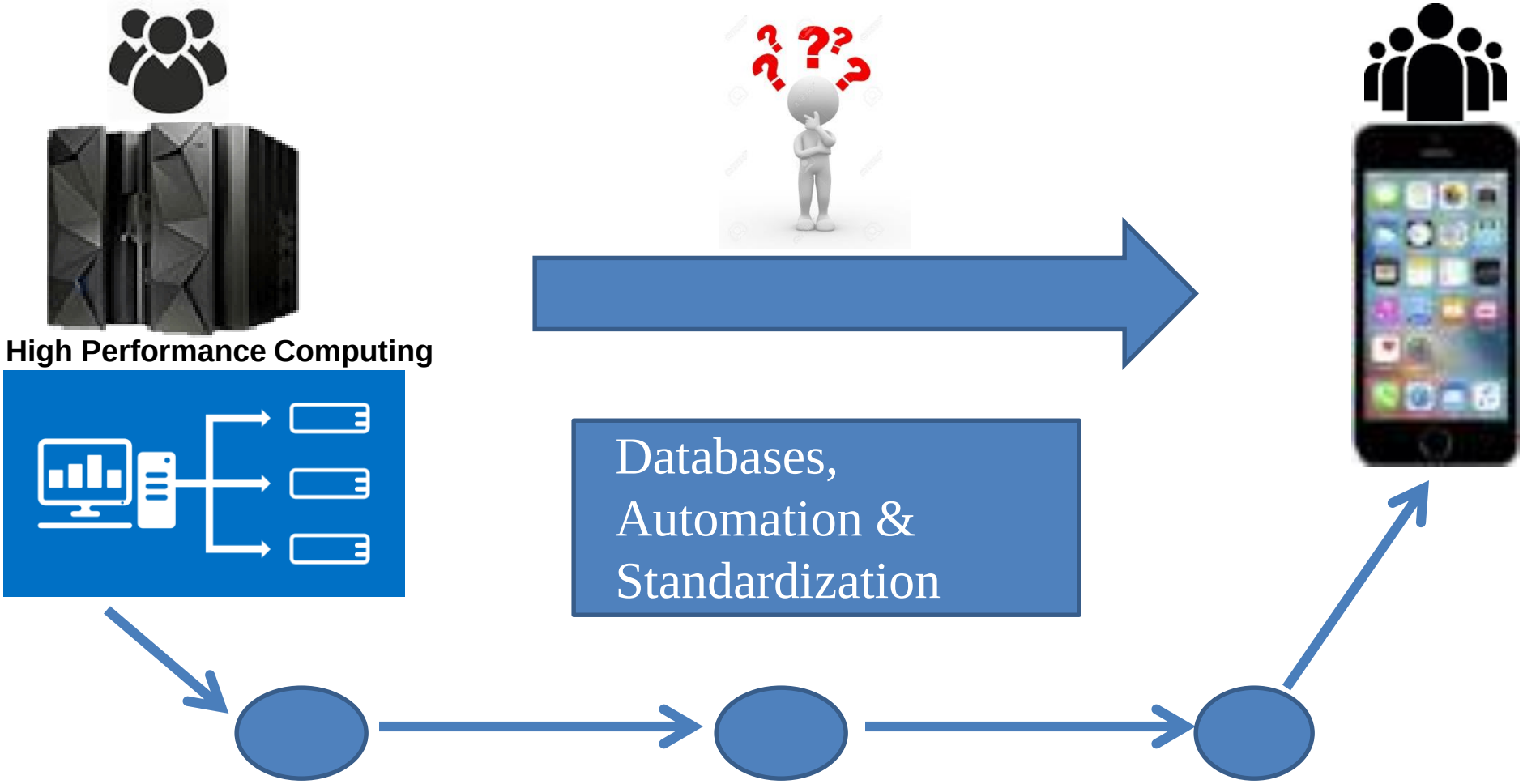
Virtual Product
Development
Democratized CAE
Stochastic CAE

2020

5 day Concept to
Production Cycle
Instant Performance
Dashboards

Best in Class CAE Leadership

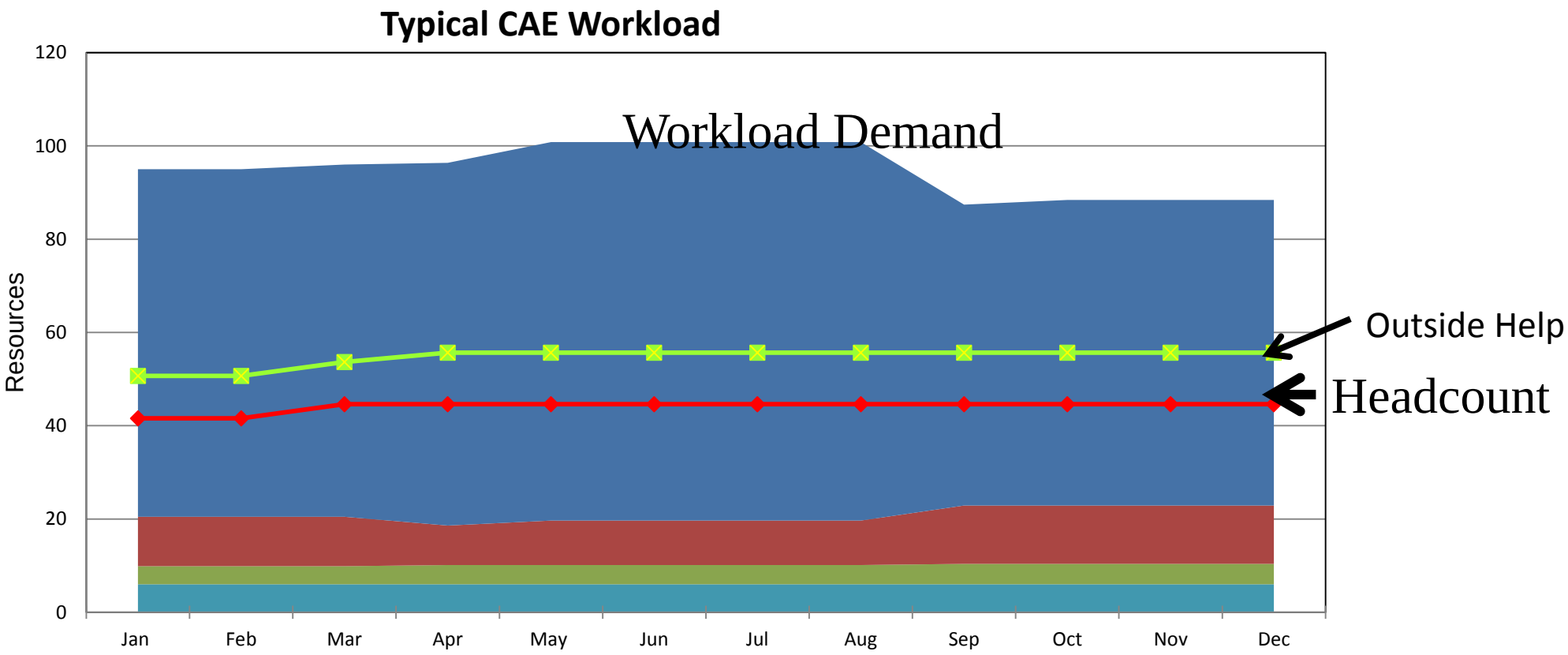
Extent of Democratization



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



Initiatives towards Democratization

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

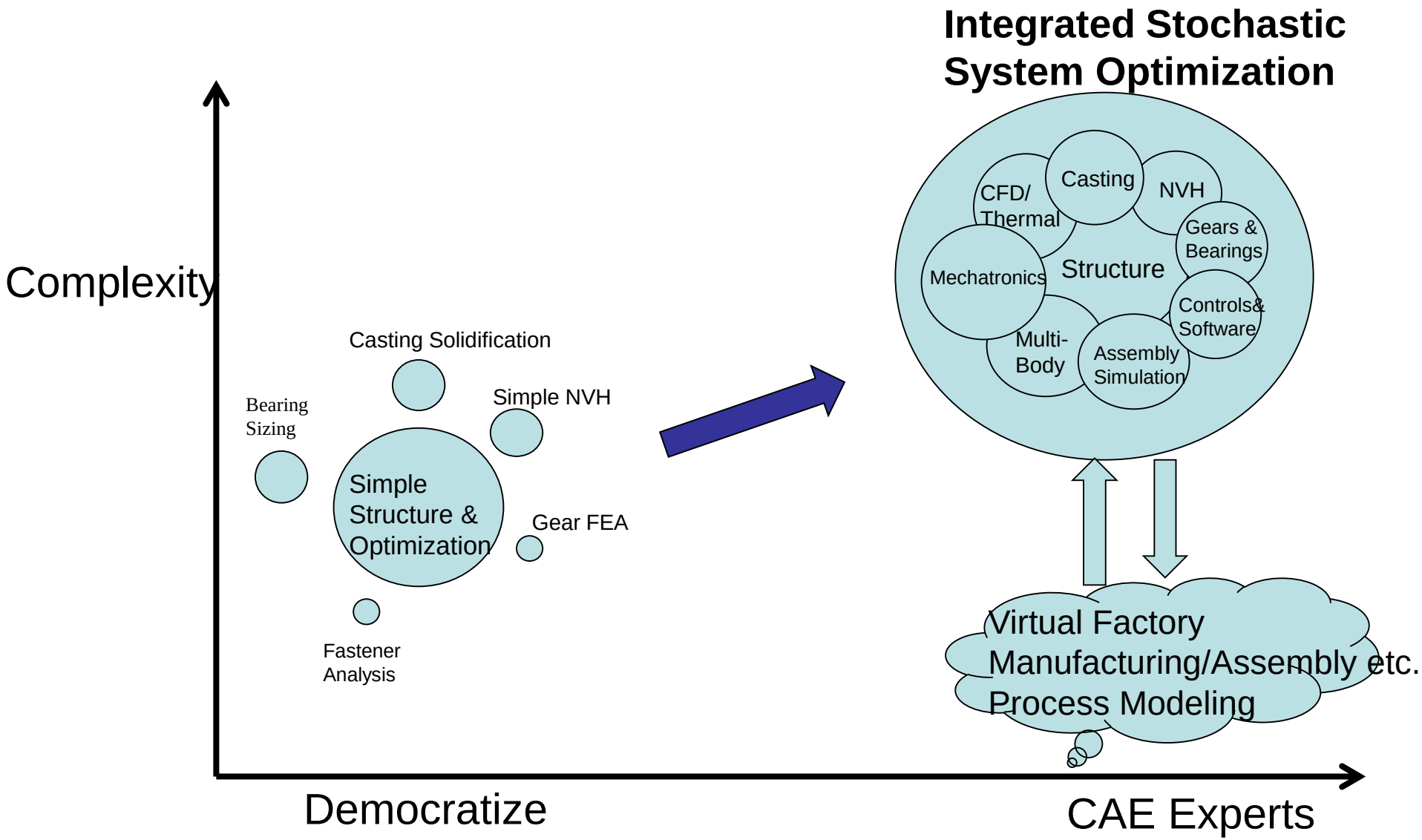
- Maturity of CAE within an Organization
  - Right Skill Sets
  - Resource allocation
  - IT support
- Simulation Process documented in PLM
- Define clear requirements for CAE models and results
- Establish clear workflow between CAD, CAE and Product Engineers
- Template based CAE models
- Reuse of CAE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

Databases for Common Components

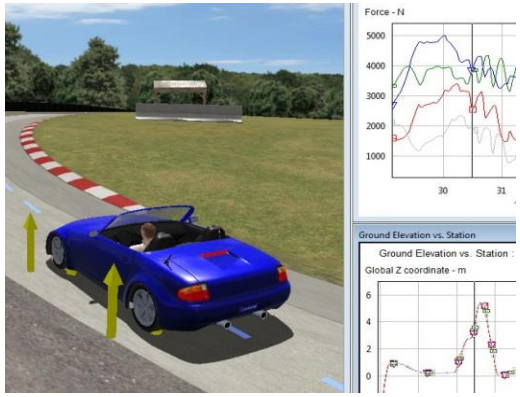
Host in PLM:

- 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

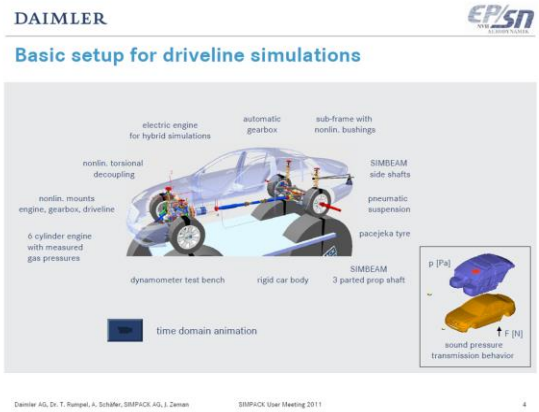
CAE Tools Deployment



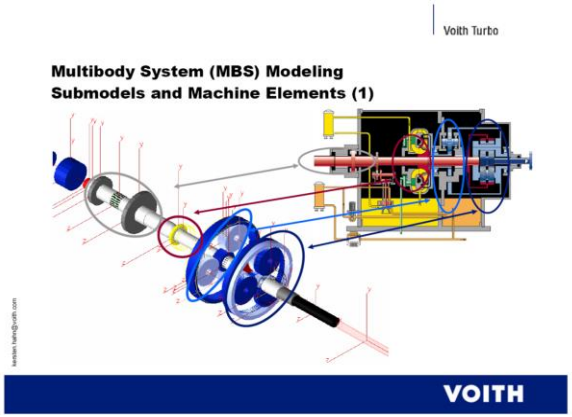
Look for Opportunities to Spread CAE



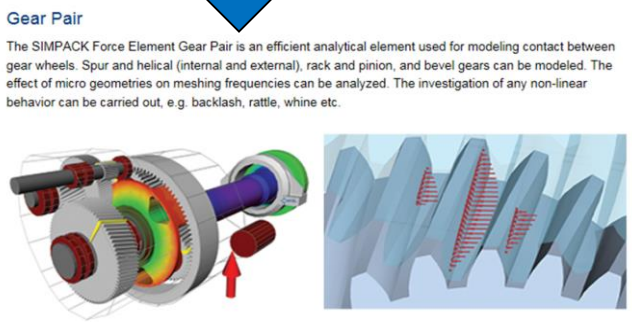
Vehicle Dynamics



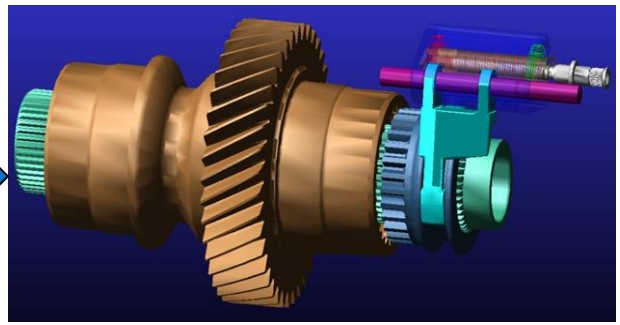
Dyno Simulation



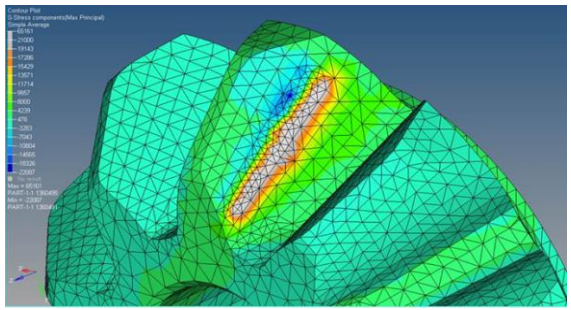
Loads Prediction



Subsystem Design

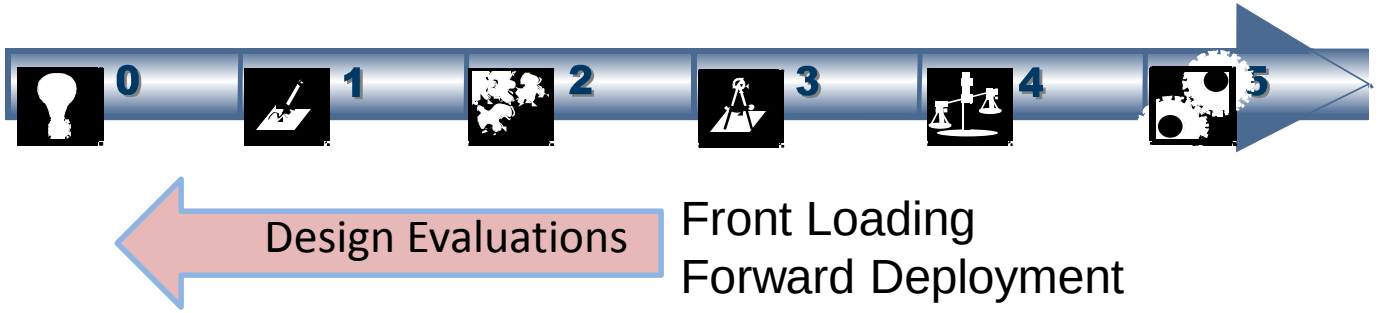


Co-simulation



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

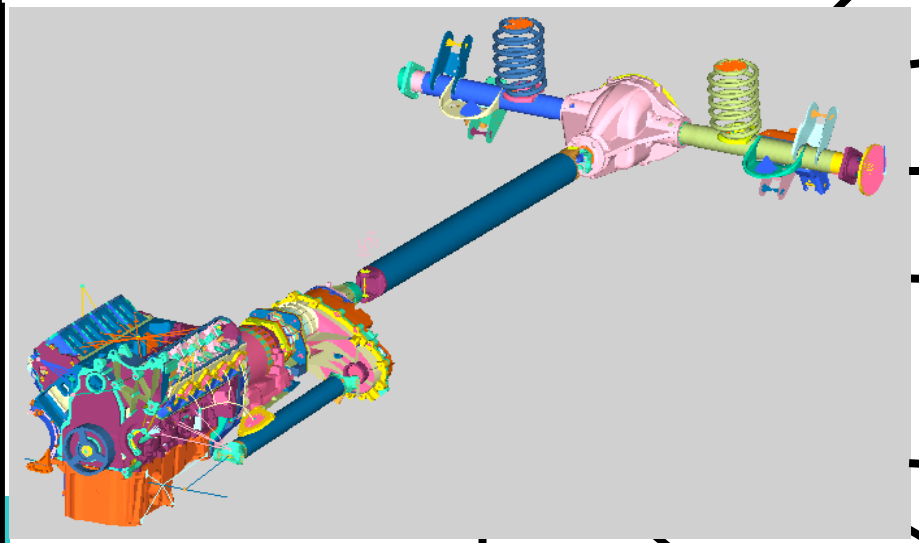
Engine Assembly

Transmission Assembly

Transfer Cases, RDMs & PTUs

Prop shafts & Bearings

Brackets & Mount Systems



Packaging

Shape & Topological Optimization

Durability

Driveline Kinematics

Non-linear Contact Analysis

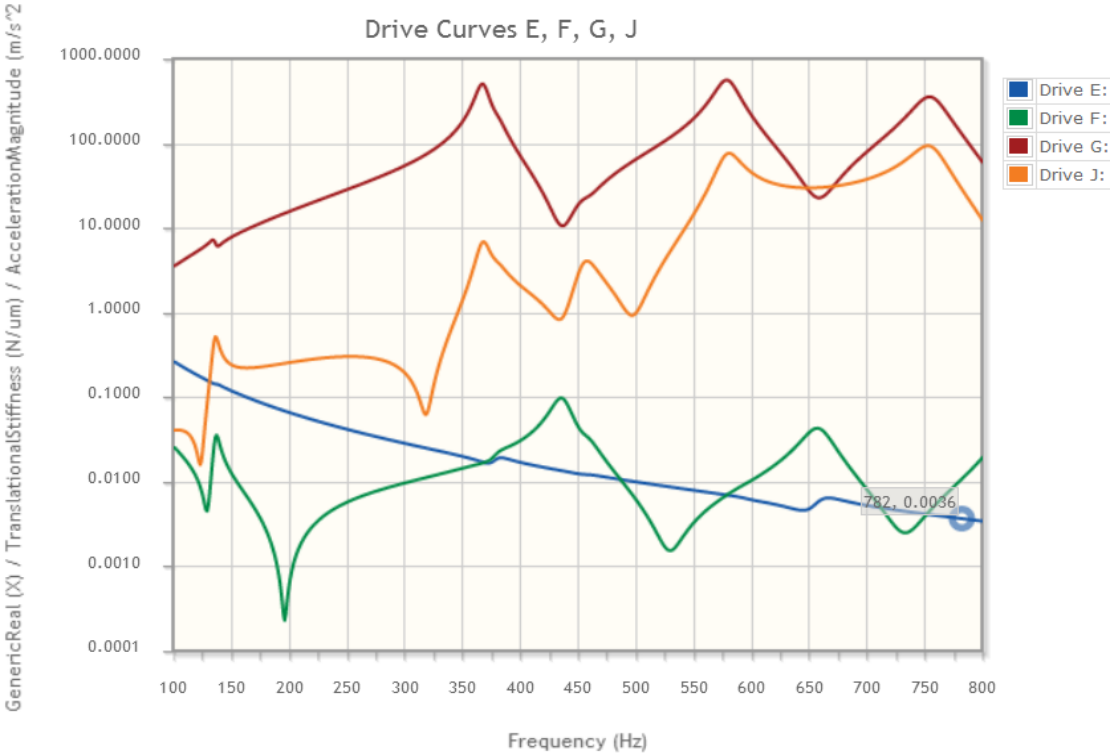
Driveline NVH

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

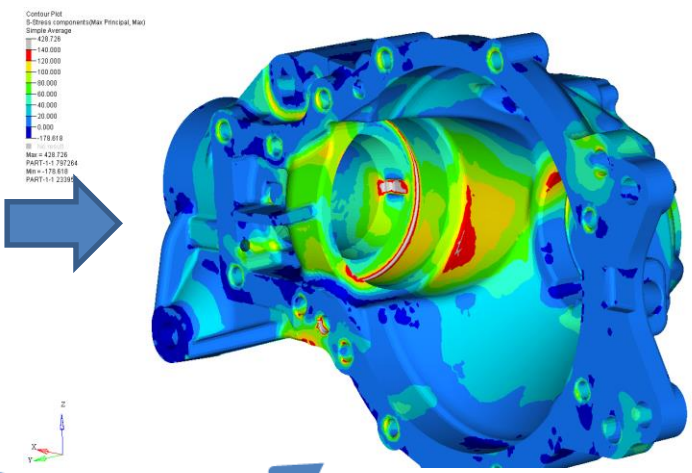


Train non-CAE Engineers

ROAD

LAB

MATH



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!

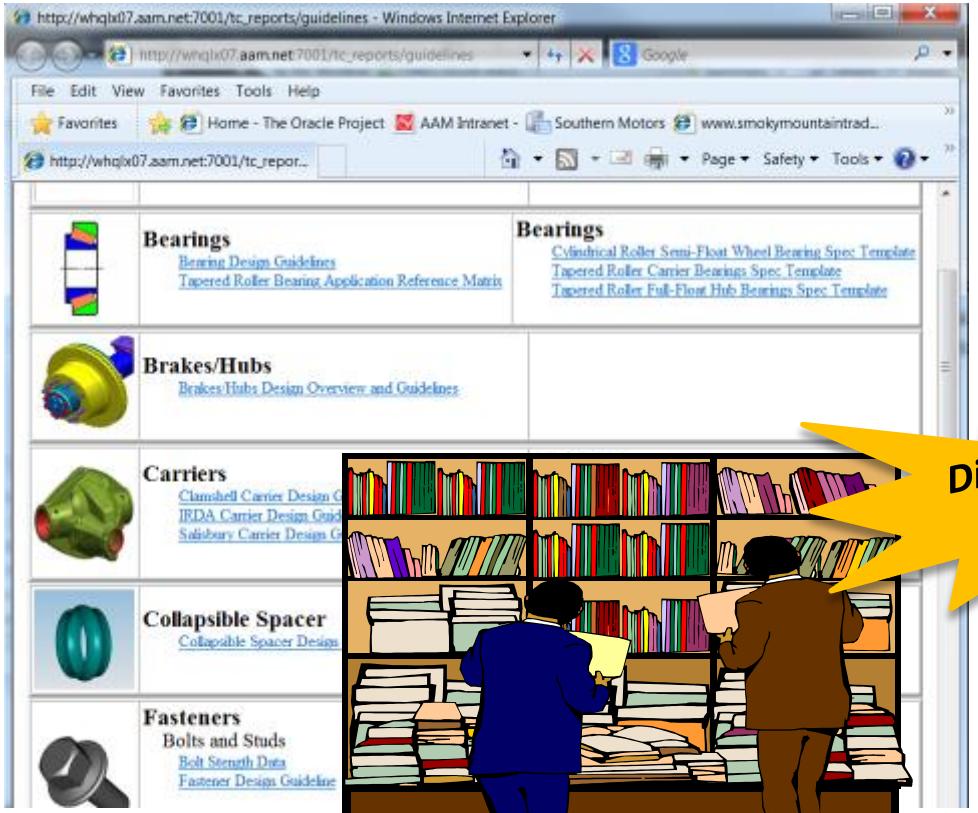
Enablers for Democratization

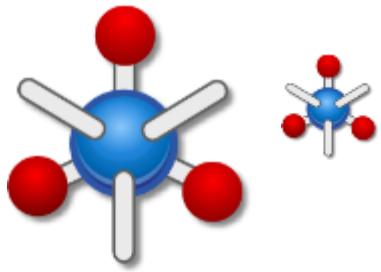
- Simplify tools
- Deploy more “Architecture CAE” small DoF tools
- Knowledge Capture & reuse
- Clear and efficient data flow between departments and organizations
- Apply early and consistently
- Find “analytically oriented” associates
- Share knowledge
- Seek support from Senior Leadership and entire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

Knowledge Capture using Knowledge Management Tools

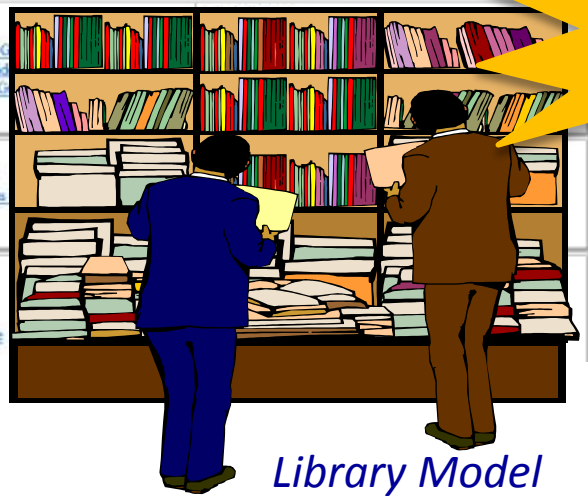
Digitizing Knowledge in the Automotive Industry

Document Centric → **Convert** → **Assessment Centric**





K-PAC **(Knowledge Packets)**

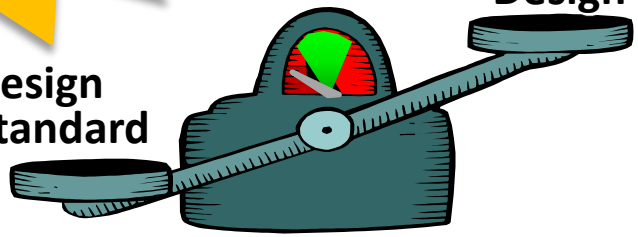


Library Model

Different User Experiences

Current Design

Design Standard



Appraisal Model (**Assessment**)

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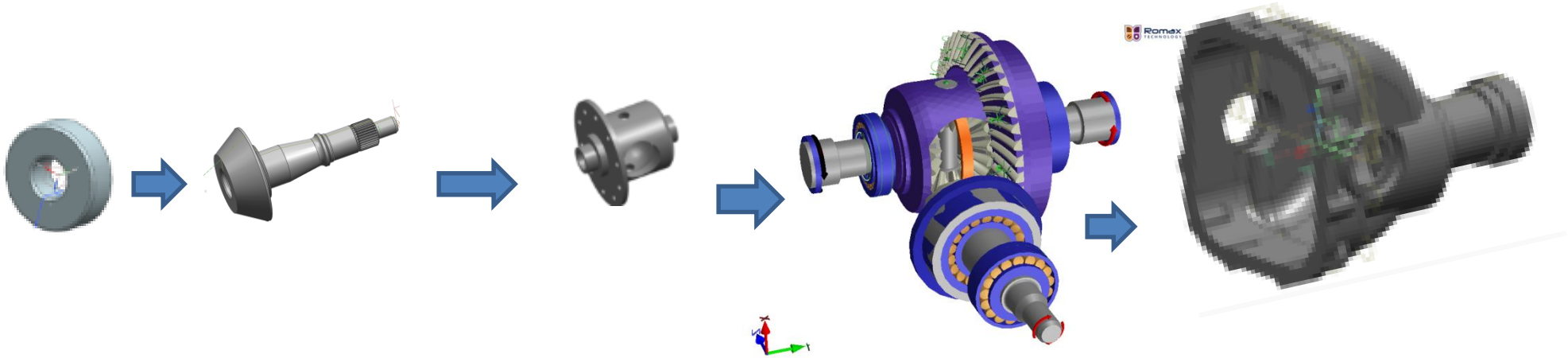
Data Flow Between Departments



Durability

Thermal

NVH

Assembly

CAE in Each Department & Expert input

Reduced CAE Effort

System Level Analysis by CAE Experts

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!

Delivering POWER®

June 6-9 NAFEMS Paper

"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.