2011 ANSYS Seminar:
Designing better Hybrid Electric Vehicles with Numerical Simulation

Stephen Smith
UK Automotive Team
Seminar Overview

• Component & System level with HEV’s
• Electrochemistry & Electro-thermal interaction in battery packs
• Electric Machine design
• Design, optimisation of a system
• Thermal & vibration system simulation
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Simulation Driven Product Development

Digitally simulate performance across all physics of complete systems, in their real-world environments

- Concept Development
- Evaluate New Ideas
- Feasibility Assessment
- Assess Designs
- Final Design
- Engineer Manufacture

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Business Drivers

- **Top business pressures driving product design improvement:**

- **Biggest hurdles for product design:**

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![Graph showing business drivers and biggest hurdles]

- **Customer demand for lower cost products**: 50%
- **Shortened product development schedules**: 45%
- **Competitive pressures to differentiate with better quality/reliability**: 26%
- **Need for greater innovation for new market opportunities**: 22%
- **Competitive pressures to differentiate with smarter/feature rich products**: 16%

- **Problems/errors found too late**: 47%
- **Making trade-off for cost, performance, and quality**: 41%
- **Frequent design changes**: 36%
- **Predicting product behavior in a real world environment**: 28%
- **Workforce reductions/lack of technical experts**: 24%
Best-in-Class Companies
Good Practices

- Strategies to improve product design:

  - Analyze product behavior earlier: 56%
  - Implement a 'get it right the first time' strategy: 39%
  - Promote collaboration between analysis experts / design engineers: 38%
  - Evaluate more design iterations in the concept/design stage: 43%
  - Define best practices for assessing product behavior: 36%
  - Reduce number of unique parts in product: 34%

Work with Digital Prototyping
Only 22% of Best-in-Class companies perform multiphysics modeling.
Simulation Intensity

When Simulation is Used?

- Occasionally, 1-3 times during the design process: 28% Best-in-Class, 16% All Others
- Systematically, regular intervals throughout design process: 49% Best-in-Class, 48% All Others

This is the biggest difference between Best-in-Class companies and all others!

Slides describing the main results available

PDF copy of the report available to share with your contact (Report value: $400)
• In 100 years the fan has not evolved much
• Dyson – Reinventing the fan
  – Evaluated over 10 designs per day.
  – Improved performance 250% over original design.
“ANSYS FLUENT helps with the quality of the final product, because we have such confidence in the accuracy of the results. We can design parts and get them to the car confident that those parts will work on track. We don’t have to spend as much time correlating with wind tunnel results…”

— Steve Nevey of Red Bull Racing
Simulation Driven Product Development:™

Digitally simulate performance across all physics of complete systems, in their real-world environments

- Innovative and higher-quality products
- Dramatic time-to-market improvement
- Minimize development, warranty and liability costs
Global Simulation Leader

Only software company focused solely on simulation with 40 years of simulation software experience

• Approx. 1,600 employees / 60+ sales offices on 3 continents
  • Network of sales channel partners in 40+ countries
  • 21 major development centers on 3 continents

2009 & 2010 Target % of revenue spending on R&D: ≈ 15%

34,000 Total Customers
Including 97 of the top 100 Industrial Companies on the FORTUNE Global 500

315,000 Commercial Seats
290,000 University Seats
200 Channel Partners
160 Industry Partners
Our Strategy: Pervasive Simulation

- Simulate the Entire Product
- Democratize Simulation
- Span the Product Development Cycle
- Unified Simulation System
Simulate the Entire Product

- Capture the complexity of real-world environments
- Multiphysics for “smart” products
- Scale from the nano-level to large global systems
Simulate the Entire Product
Democratize Simulation

- Ease of use – without compromising capability or accuracy
- Enable convergence and collaboration
- Enable a broader range of usage
Span the Product Development Cycle

- **Better:** Earlier insight drives innovation; More alternatives
- **Faster:** Fewer problems to resolve makes quicker cycles
- **Cheaper:** Early detection saves cost

### ANSYS
- Simulation Driven Product Development

### Development Phase
- Concept Design
- Detail Design
- Prototyping
- Evaluation
- Production Ramp-Up
- Full Production

### Resolution Cost per Problem
- Development Phase $[p]$:
  - Concept Design: $1 \times$
  - Detail Design: $10 \times$
  - Prototyping: $100 \times$
  - Evaluation: $1000 \times$
  - Production Ramp-Up: $20000+ \times$

### Design Change Cost
- Traditional Analysis and CAD
- Conventional Design, Build, Test
- Simulation Driven Design Change Cost

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Unified Simulation System

- **ANSYS Workbench™ Framework**
  - Multiple disciplines
  - Seamless integration
  - Common Interaction
  - Flexible Workflow

- **Modern computing**
  - Broadscale Parametric Evaluation
  - High Performance Computing (HPC)
  - Harnessing “The Cloud”

- **Key Benefits:**
  - Rapid cycles
  - Solve more complex problems
  - Unerring accuracy
Shaping the Future of Simulation

- CFD solver integration (FLUENT + CFX)
- Refined Nonlinear Mechanical
- Full-wave Electromagnetic Simulation
Shaping the Future of Simulation

- User-Defined, Intelligent/Intuitive Meshing
- Process Automation
- Robust Design

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Shaping the Future of Simulation

- Collaborative Analysis of Results
- Intuitive Simulation Applications
- Workgroup Simulation Environment
ANSYS Workbench

- Automates Data Transfer Steps
- Captures Personalized Processes
- Encompass the Validation Activities
- Extends Optimization Influence
- Reduces Cost of Ownership
Shaping the Future of Simulation

Common Applications And External Interfaces Will Leverage The Unifying Capabilities Of The Workbench Platform
Applications will be unified to streamline workflows
# Smart Simulation

## Performance Change over Last 2 Years

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<th>Best-in-Class</th>
<th>Industry Average</th>
<th>Laggards</th>
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<tr>
<td></td>
<td>3% Decrease</td>
<td>7% Increase</td>
<td>11% Increase</td>
</tr>
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<td>Change in Warranty Costs</td>
<td>7% Decrease</td>
<td>1% Decrease</td>
<td>6% Increase</td>
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<td>Change in Number of Physical Prototypes</td>
<td>3% Decrease</td>
<td>No Change</td>
<td>7% Increase</td>
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<tr>
<td>Change in Number of Change Orders after Design Release</td>
<td>4% Decrease</td>
<td>3% Increase</td>
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Source: Aberdeen Group, Cost Saving Strategies for Engineering: Using Simulation to Make Better Decisions

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Continual Validation

• Current Plans Base on Global Customer Input
• Future Validation and Modifications Through:
  – These User Group Meetings
  – Your Feedback to Technical Support and Sales
  – Advisory Council Meetings
  – Individual Customer Meetings
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