Caterpillar “Virtual Product Development” & HPC
Oct 13 – DOE Simulation Summit

Sri Srinath
Agenda

- Company Overview
- Caterpillar “Virtual Product Development” Goals
- Technologies / Applications
Who We Are

- A Fortune 50 global enterprise
- 2009 sales and revenues of $32.4B
- Global team of more than 225,000 Caterpillar and Cat Dealer employees
- Nearly 500 locations in 50 countries (manufacturing, marketing, logistics, service, R&D and dealer locations)
- Products at work in more than 180 countries around the world
Integrity, Excellence, Teamwork, Commitment

- More than 93,000 employees
- Over 50% based outside U.S.
- Guided by *Our Values in Action*, Caterpillar’s Worldwide Code of Conduct
What We Do

World’s largest manufacturer of construction and mining equipment

A machine for every job

Virtual Product Development

Caterpillar Confidential: Green
What We Do

World’s largest manufacturer of construction and mining equipment
What We Do

A leader in diesel and natural gas engines and industrial gas turbines

Power for an energetic world
What We Do

Support for customer needs

Financing

Logistics

Remanufacturing and Rebuilding
“Our future is built on the work we do today. Losing our focus on technology and innovation is not an option. We can either lead in this area or watch as others pass us by. **We choose to lead.**”

Jim Owens
Caterpillar Chairman & CEO
We are Investing Heavily in R&D

<table>
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<tr>
<th>Year</th>
<th>R&amp;D Expense</th>
<th>% of S/R</th>
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<tbody>
<tr>
<td>2004</td>
<td>$928M</td>
<td>3.1</td>
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<tr>
<td>2005</td>
<td>$1,084</td>
<td>3.0</td>
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<tr>
<td>2006</td>
<td>$1,347</td>
<td>3.2</td>
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<tr>
<td>2007</td>
<td>$1,404M</td>
<td>3.1</td>
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<tr>
<td>2008</td>
<td>$1,728M</td>
<td>3.4</td>
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<tr>
<td>2009</td>
<td>$1,421M</td>
<td>4.4</td>
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Our future depends on successful product development!

Nearly $6 million invested in R&D each working day in 2009
Diverse Modeling & Simulation Applications

- **Engine Systems**
  - Cycle simulation
  - Valve trains
  - Crankshafts
  - Aftertreatment

- **Cooling Systems**
  - Radiators
  - ATAAC
  - Fans
  - A/C
  - Parasitics

- **Drivelines**
  - Transmissions
  - Clutches
  - Final drives
  - Wheels & Tires
  - Gear dynamics

- **Controls & Electronics**
  - Component & full vehicle simulation
  - Algorithm development
  - User programming
  - Co-simulation

- **Fluid Systems**
  - Fuel
  - Hydraulic
  - Lube
  - Brake
  - Steering

- **Linkages & Structures**
  - 2D & 3D rigid bodies
  - Flexible body dynamics

- **Full Machine**
  - Performance

- **Cooling Systems**
  - Radiators
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- **Full Machine**
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Product Development Timeline

Drive Discovery Early in Design Process

Modeling & Simulation

Cost to fix problem
Time to fix problem

$1

$10 - $100

$1000

Concept
Design
Build
Test
Validation
Production

Virtual Product Development
Caterpillar Confidential: Green