

Virtual Product Development



# ***Caterpillar “Virtual Product Development” & HPC***

***Oct 13 – DOE Simulation Summit***

***Sri Srinath***

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# Agenda

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- ❑ *Company Overview*
- ❑ *Caterpillar “Virtual Product Development” Goals*
- ❑ *Technologies / Applications*

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# 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

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# Team Caterpillar

## 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



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# What We Do

World's largest manufacturer of construction and mining equipment



A machine for every job



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# What We Do

World's largest manufacturer of construction and mining equipment



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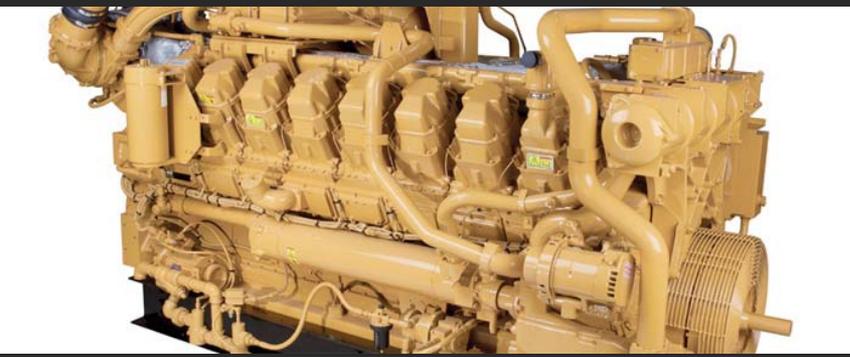
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# What We Do

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



Power for an energetic world

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# What We Do

## Support for customer needs



Financing



Logistics



Remanufacturing  
and Rebuilding

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# Commitment From the Top

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“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

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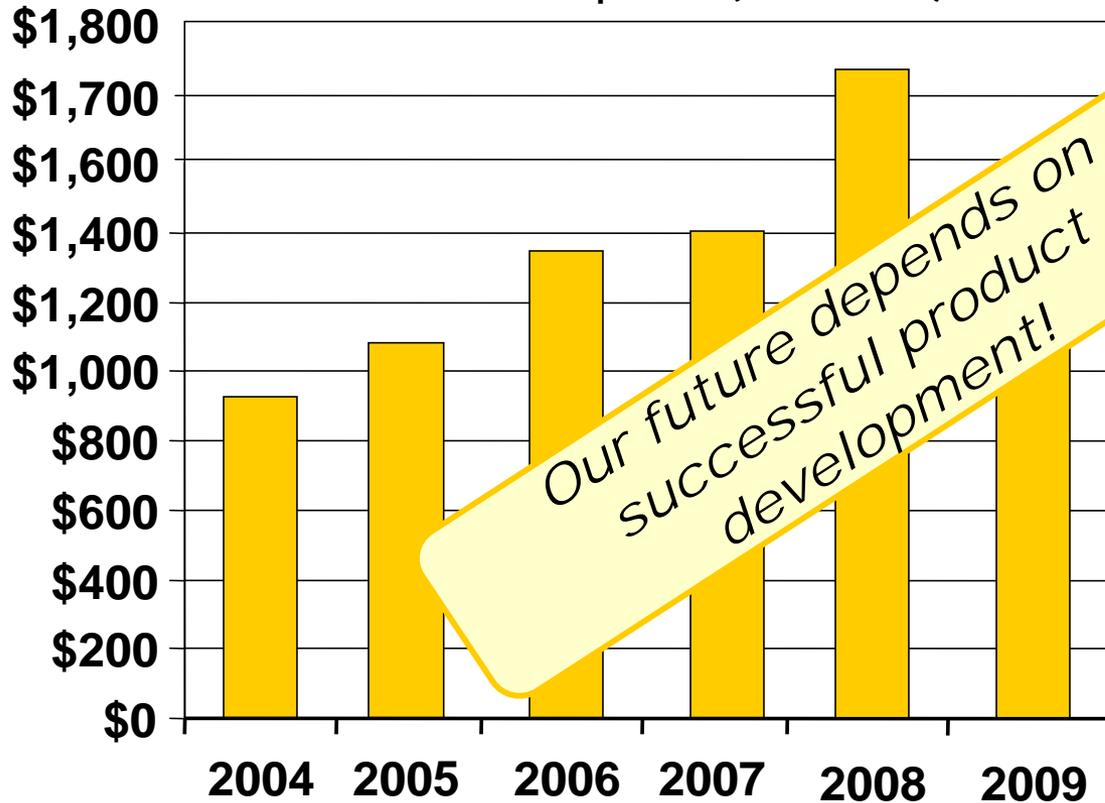
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# We are Investing Heavily in R&D

■ Research & Development (in millions)



Our future depends on successful product development!

Nearly \$6 million invested in R&D each working day in 2009

Year	R&D Expense	% of S/R
2004	\$928M	3.1
2005	\$1,084	3.0
2006	\$1,347	3.2
2007	\$1,404M	3.1
2008	\$1,728M	3.4
2009	\$1,421M	4.4

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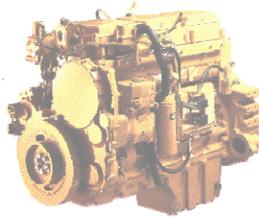


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# Diverse Modeling & Simulation Applications

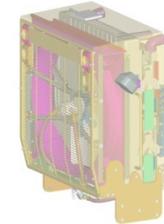
## Engine Systems

- Cycle simulation
- Valve trains
- Crankshafts
- Aftertreatment



## Cooling Systems

- Radiators
- ATAAC
- Fans
- A/C
- Parasitics



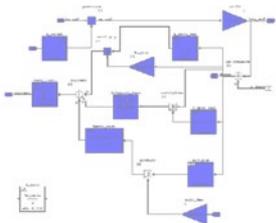
## Full Machine

- Performance



## Controls

- Component simulation
- Algorithm
- User program
- Co-simulation

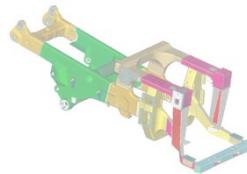


## Fluid Systems

- Fuel
- Hydraulic
- Lube
- Brake
- Steering

## Linkages & Structures

- 2D & 3D rigid bodies
- Flexible body dynamics



## Drivelines

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



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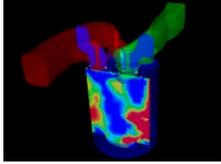
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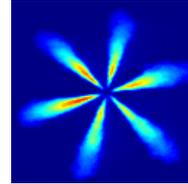
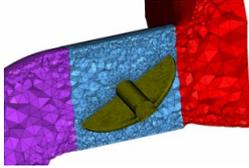
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# Micro-structure to complete System

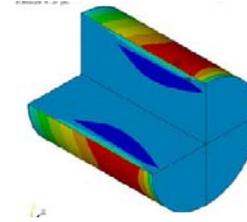
## Diverse Modeling Applications & Tools



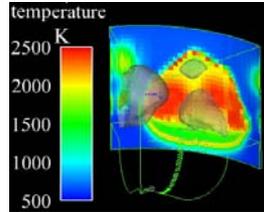
Flow Simulation



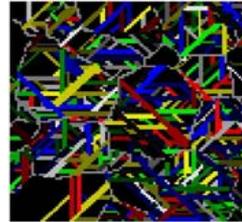
Combustion System Simulation



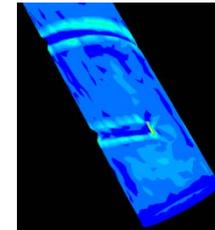
Diesel Particulate Filter (DPF) Simulation



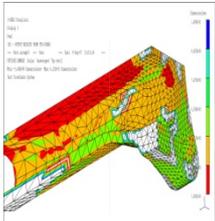
Carbon Deposit Simulation



Microstructure Evolution During Heat Treating



Acid Condensation Simulation



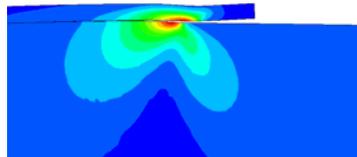
Thermal Fatigue Life Prediction



Multibody Dynamics



Earth / Machine Interaction



Crack Propagation Simulation

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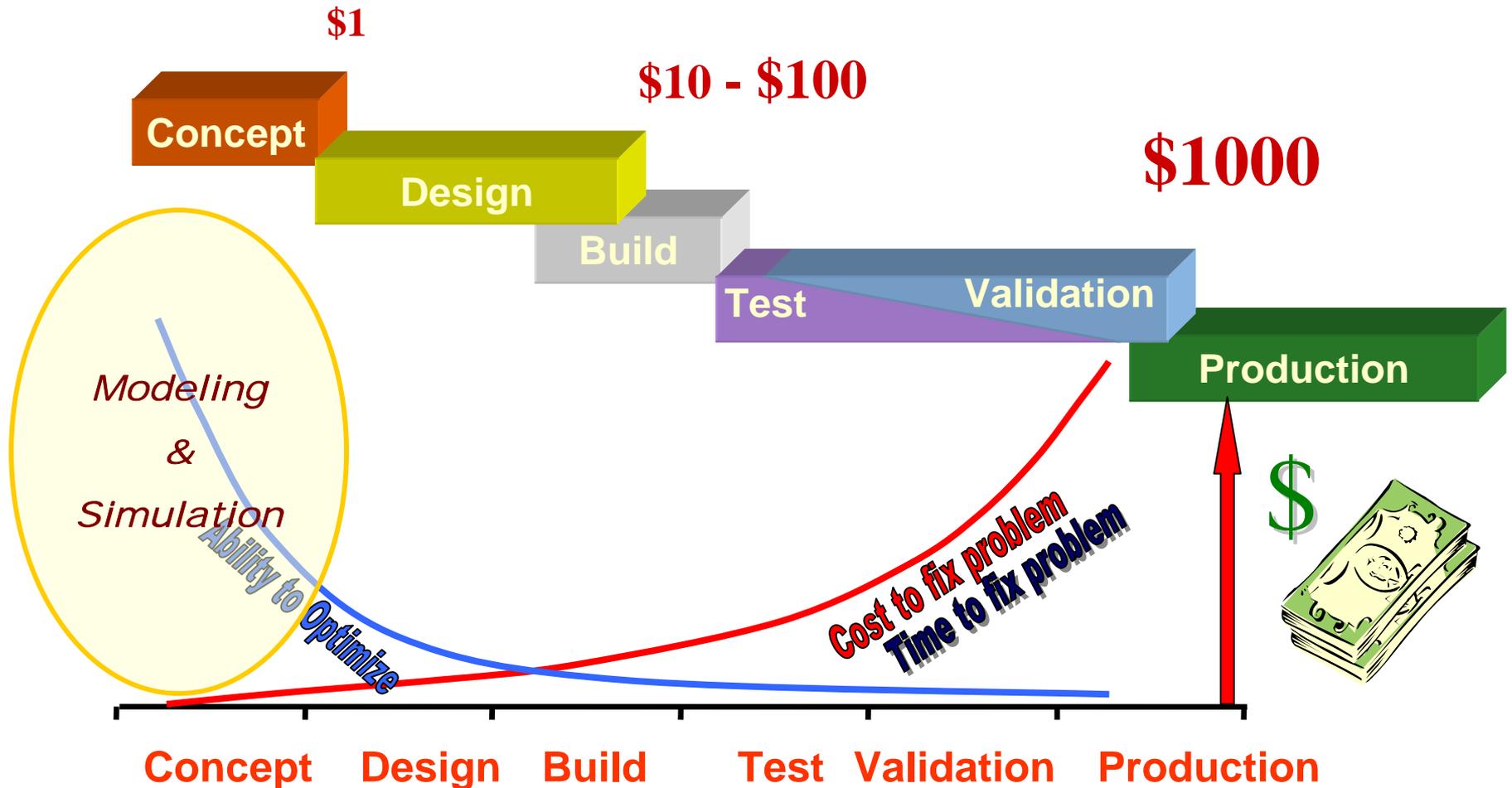
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# Product Development Timeline

**Drive Discovery Early in Design Process**



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