Altair

Innovation Intelligence®

GPU TECHNOLOGY CONFERENCE

Product Innovation Using Private & Public Cloud

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VP of Strategy & Business Development, Altair Engineering }

Agenda

- **Who is Altair?**

- **Altair NVIDIA Collaboration**

- **Product Innovation using Private and Public Clouds**

  - Infinite Exploration

    - "Going beyond Nominal Simulations"

- **Data Movement**

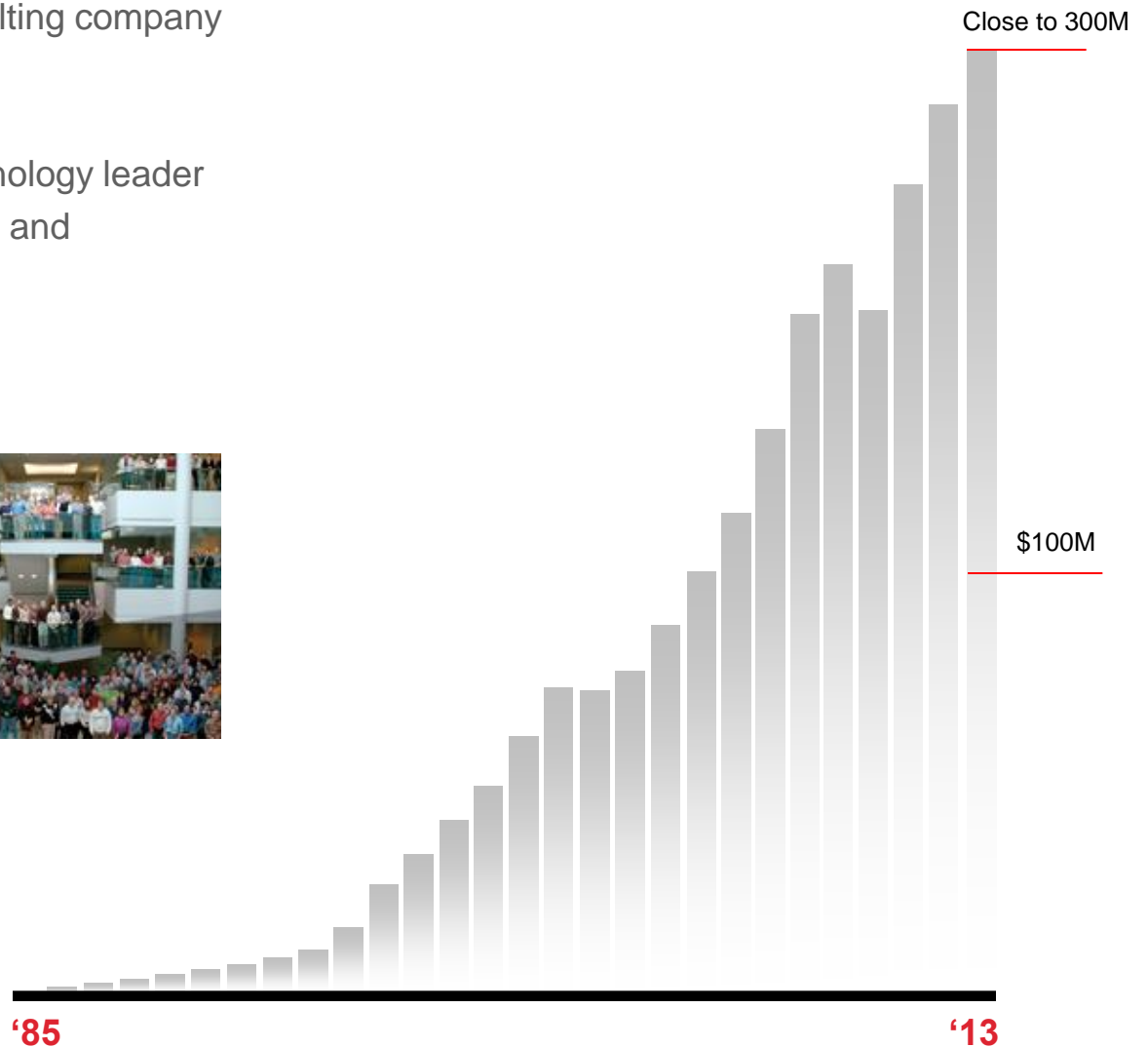- **Why is Remote Visualization Critical for HPC on the Cloud?**

Altair Overview

Founded ...

In 1985 as a product design consulting company

Today ...

A global software, services & technology leader
with over 45 offices in 21 countries and
5,000+ customers worldwide

Close to 300M

$100M

'85   '13

Altair Overview

HyperWorks
Engineering Simulation
and Optimization Software

ProductDesign Solutions
Product Innovation and
Development Consulting

solidThinking
Simulation-driven Industrial
and Concept Design Software

Enterprise Solutions
Cloud-based Business and Engineering
Analytics Software and Consulting

PBS Works
High Performance Computing
Software and Consulting

Staffing Solutions
Technical Staffing and
On-premise Consulting

Example of Altair's Advanced Simulation Solutions

Integrated solvers platform with best-in-class scalability, quality, robustness. Solutions include structural (**OptiStruct** and **RADIOSS**), CFD (**AcuSolve**), and multi-body dynamics (**MotionSolve**) analysis. Altair's solvers are **optimization-ready** and can be coupled for **Smart Multiphysics** analysis.
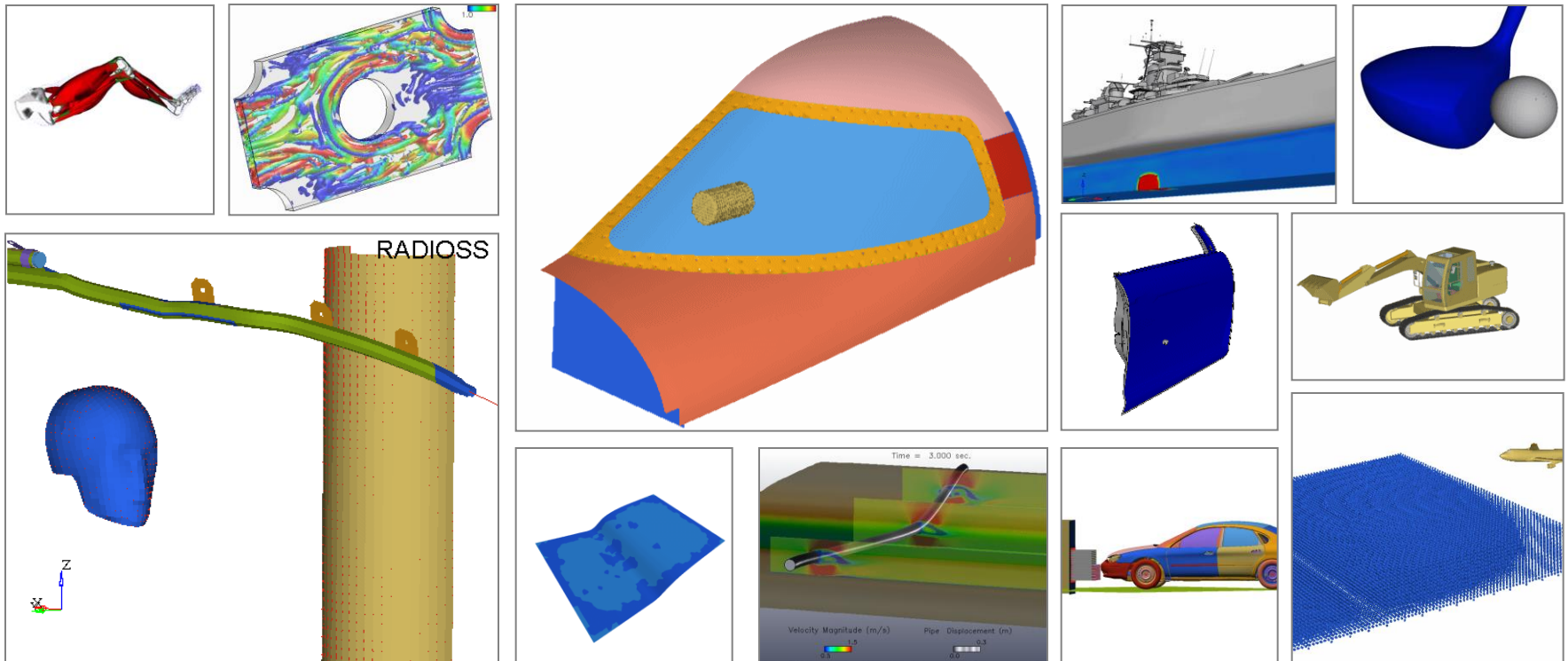
Why Altair?

Altair is the only company that…

Makes HPC Tools

PBS Works™

Develops HPC Apps

HyperWorks®

and uses HPC Apps!

ProductDesign

**500 Altair engineers worldwide
use HPC every day for
real-world modeling
& simulation**

Altair – NVIDIA Cooperation

Visualization (Remote & Desktop)
- HyperMesh
- HyperView
- HyperStudy
- Inspire
- SolidThinking

Application Solvers
- Radioss (Structural – Crash)
- Acusolve (CFD)
- Optistruct (Optimization)

HPC / Graphical Resource Management
- PBSProfessional Workload Management
  - Improved Reliability
  - Mixed Environments

Licensing
- HWU Solver Licensing Modification to encourage GPU Usage
- 1 GPU is treated as 1 Core

Why Cloud?
How do we Define it?

Altair's Definition:

Easy access and use of high performance computational

and domain specific resources On-Demand

So it is…

Access to One Big Computer

(the "Big Computer" being a hardware and software engineered solution)

Components Required for Infinite CAE Exploration
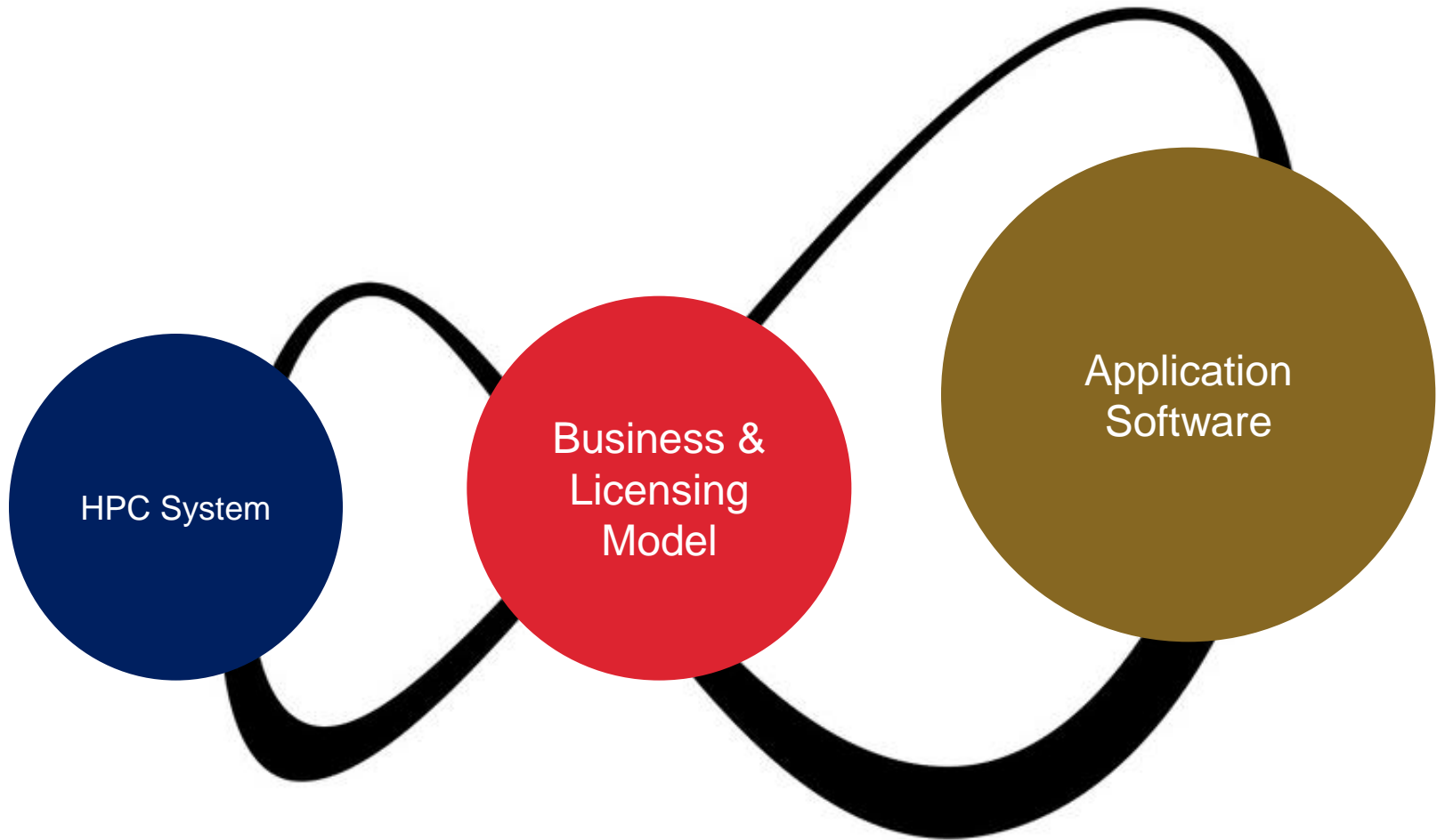
Altair Cloud Offerings: Your Cloud Your Way!

△ Altair

Remote Visualization powered by NVIDIA

Access to: HyperWorks on the Cloud

Private Cloud Appliance

HyperWorks Unlimited

On-premises, **CAE private cloud** appliance, unlimited use of HyperWorks

Simulation Cloud Suite

Comprehensive software suite for simulation life cycle management

HyperWorks On-Demand

Off-premises, **CAE public cloud** appliance using existing HyperWorks & PBS Works

Public Cloud

Powered by: PBS Works Suite

Typical CAE Results Size for CRASH & CFD Analysis

$\triangle$ Altair

	File Size	Download Times in **Hours** for SINGLE Simulation RUN	
		10 Mbps (Connection)	50 Mbps (Connection)
Crash Medium	10 Gb	2.5	0.5
Crash Large	50 Gb	11	2
CFD Medium	100 Gb	23	4
CFD Large	4 Tb	936	168

1. The times are assuming 0% loss
2. Download time is a Big Deterrent for running large CAE jobs on the cloud!

Data Movement Problem in Large CAE Studies

On Premises Cloud

Off Premises Cloud
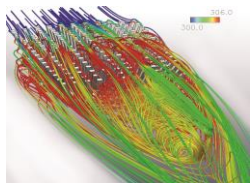
Product Innovation Process
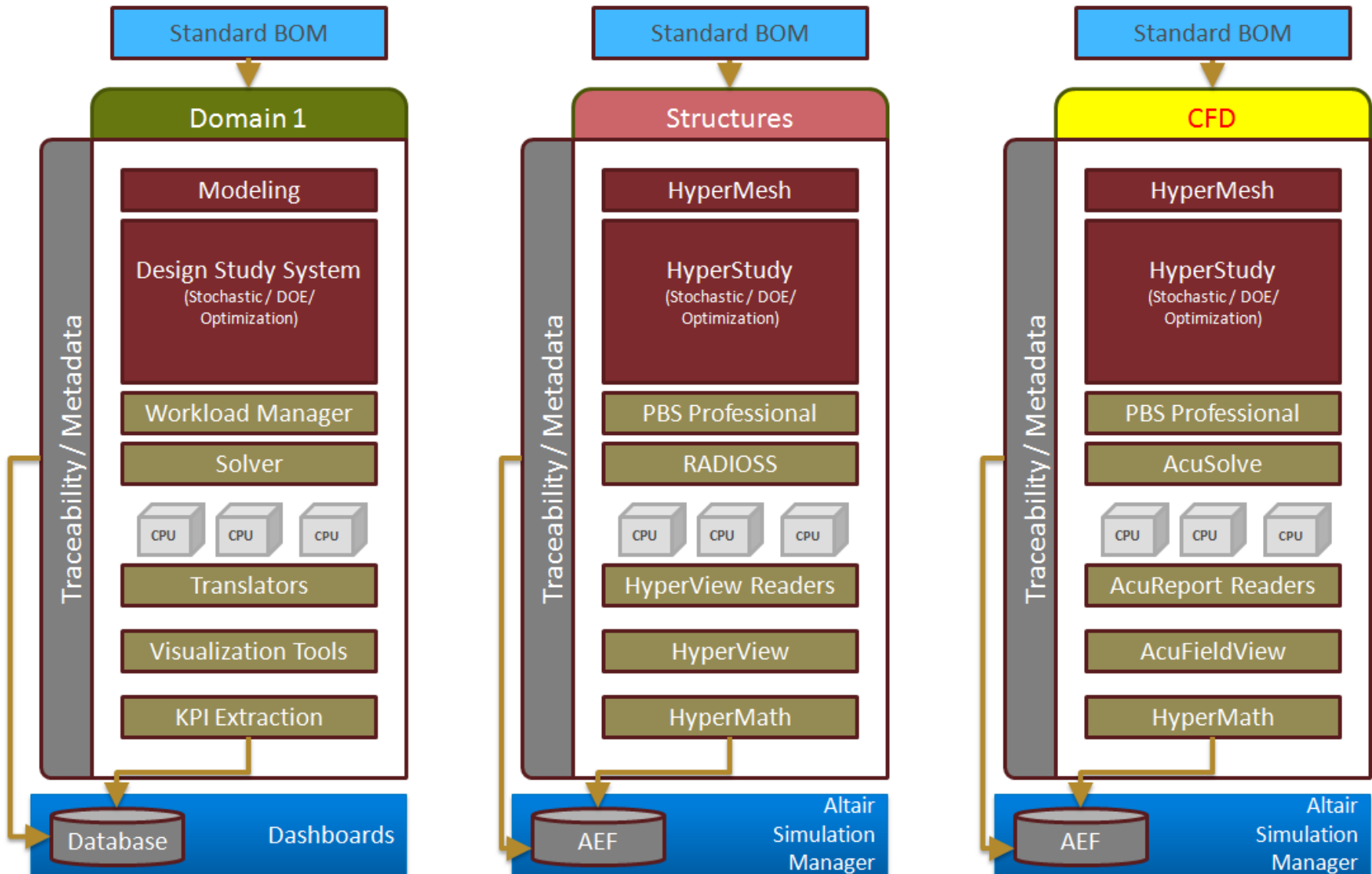
Cloud Maturation Path for CAE △ Altair

Standard BOM

Domain 1

Traceability / Metadata

Modeling

Design Study System
(Stochastic / DOE/
Optimization)

Workload Manager

Solver

CPU   CPU   CPU

Translators

Visualization Tools

KPI Extraction

Database

Dashboards

Simulation Data Management

Remote Visualization

Application Software & Workload Management
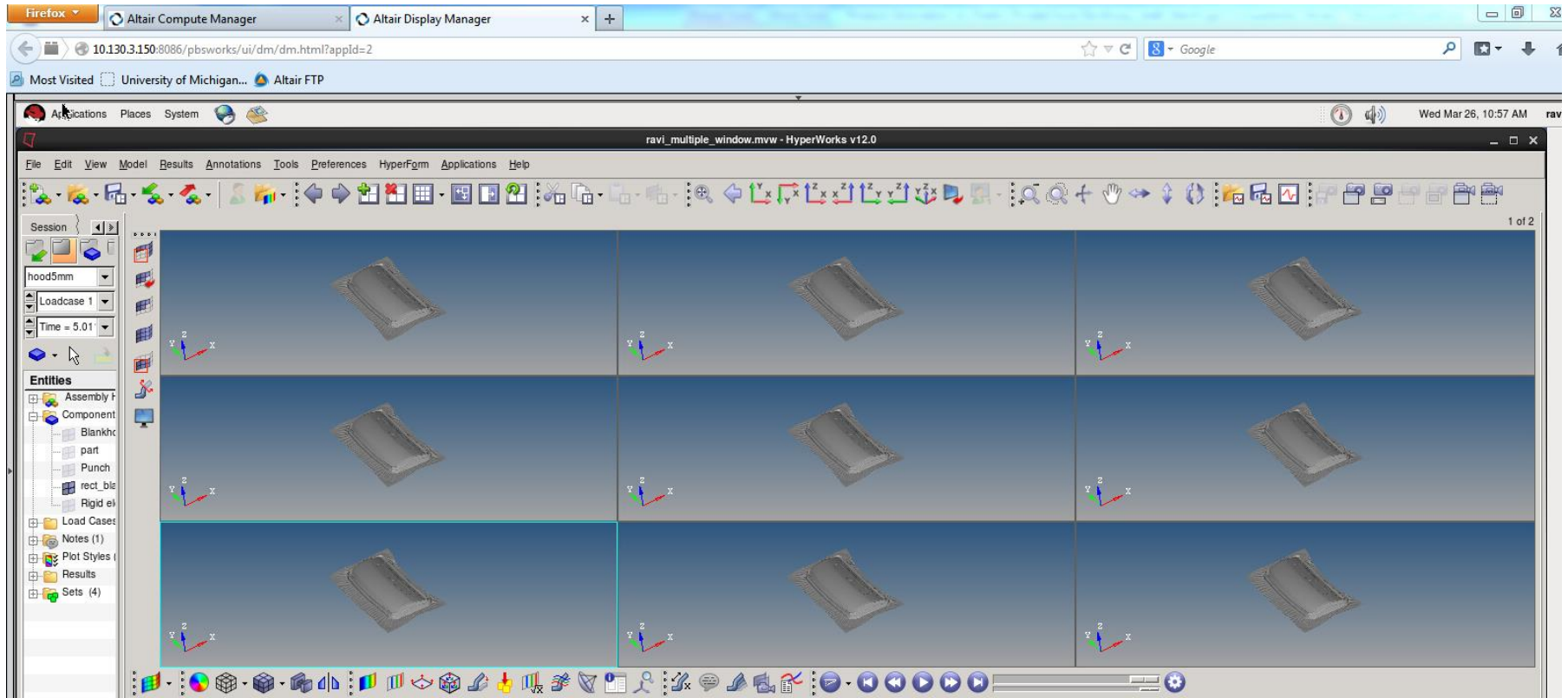
CPU Cycles
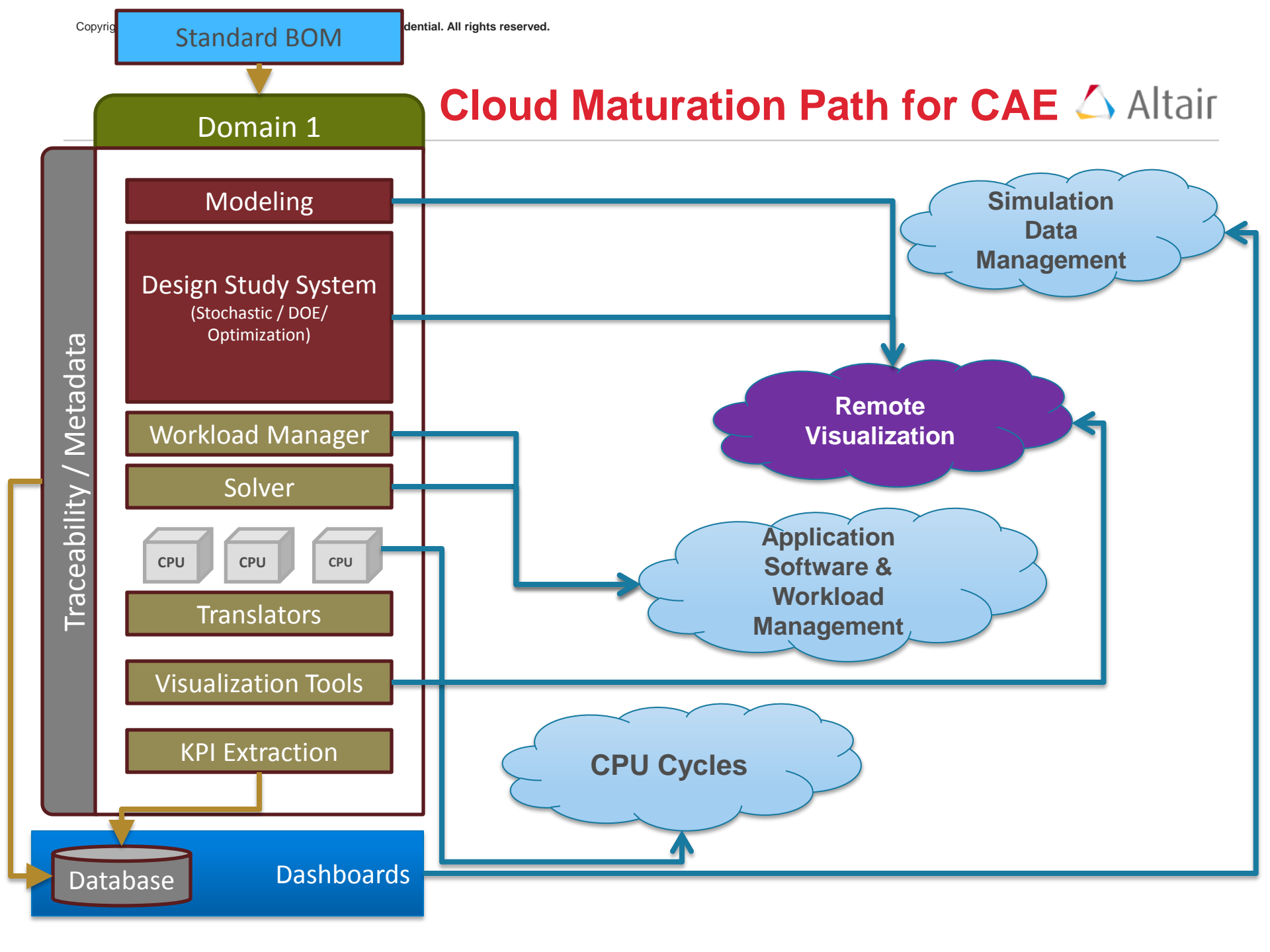
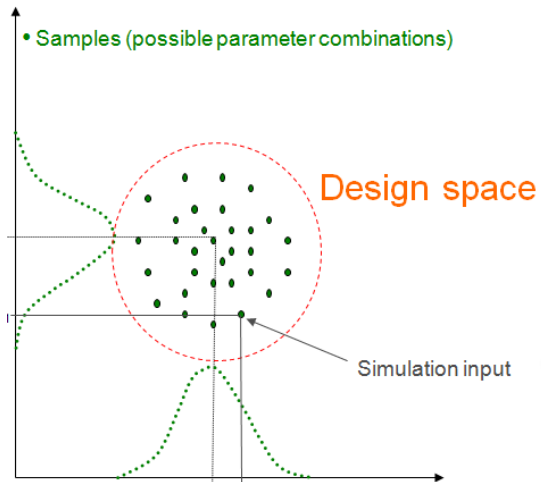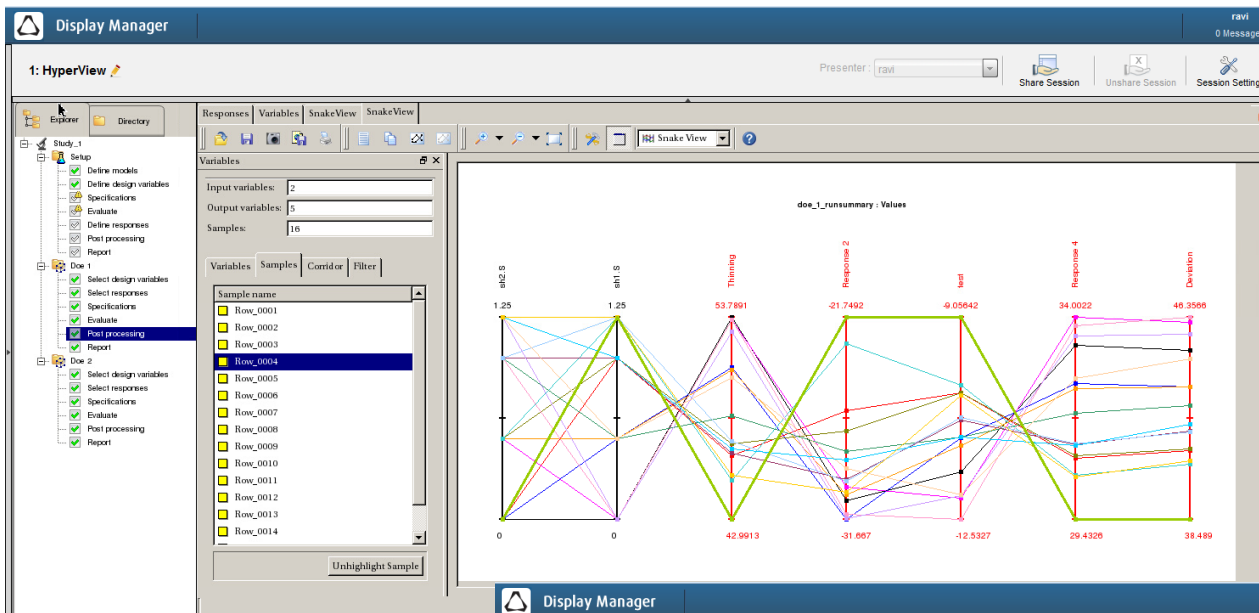# Product Innovation- Sheet Metal Forming - Example 1

Model info: hood5mm
Result: /home/ravi/Hood/approaches/doe_1/run__00001/m_1/hood5mm.h3d
Loadcase 1 : Time = 0.0000e+00
Frame 1
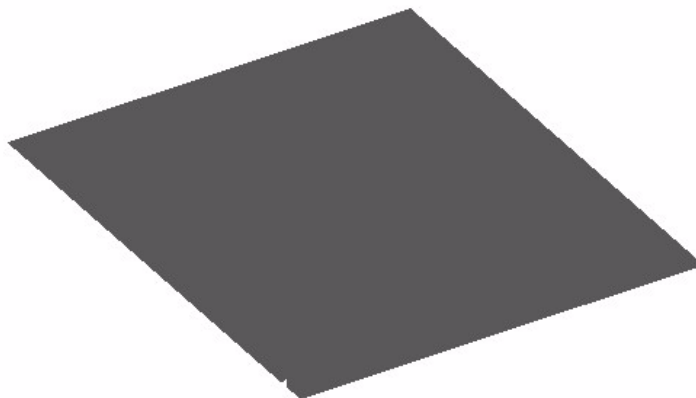
Contour Plot
%Thinning(Scalar value, Mid)
- 5.379E+01
- 4.419E+01
- 3.460E+01
- 2.501E+01
- 1.541E+01
- 5.818E+00
- -3.776E+00
- -1.337E+01
- -2.296E+01
- -3.256E+01
- No result
Max = 5.379E+01
SHELL 100125089
Min = -3.256E+01
SHELL 100125254

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Product Innovation- Sheet Metal Forming - Example 1

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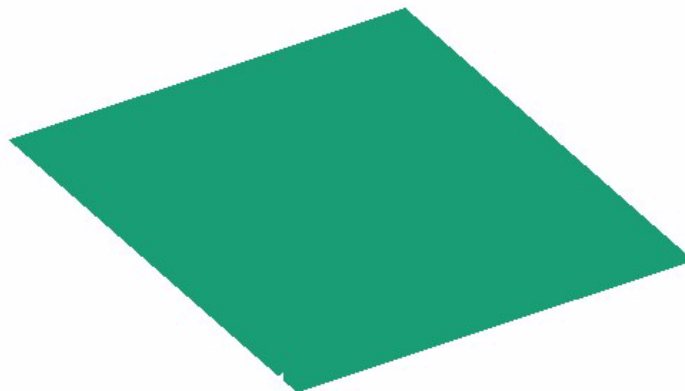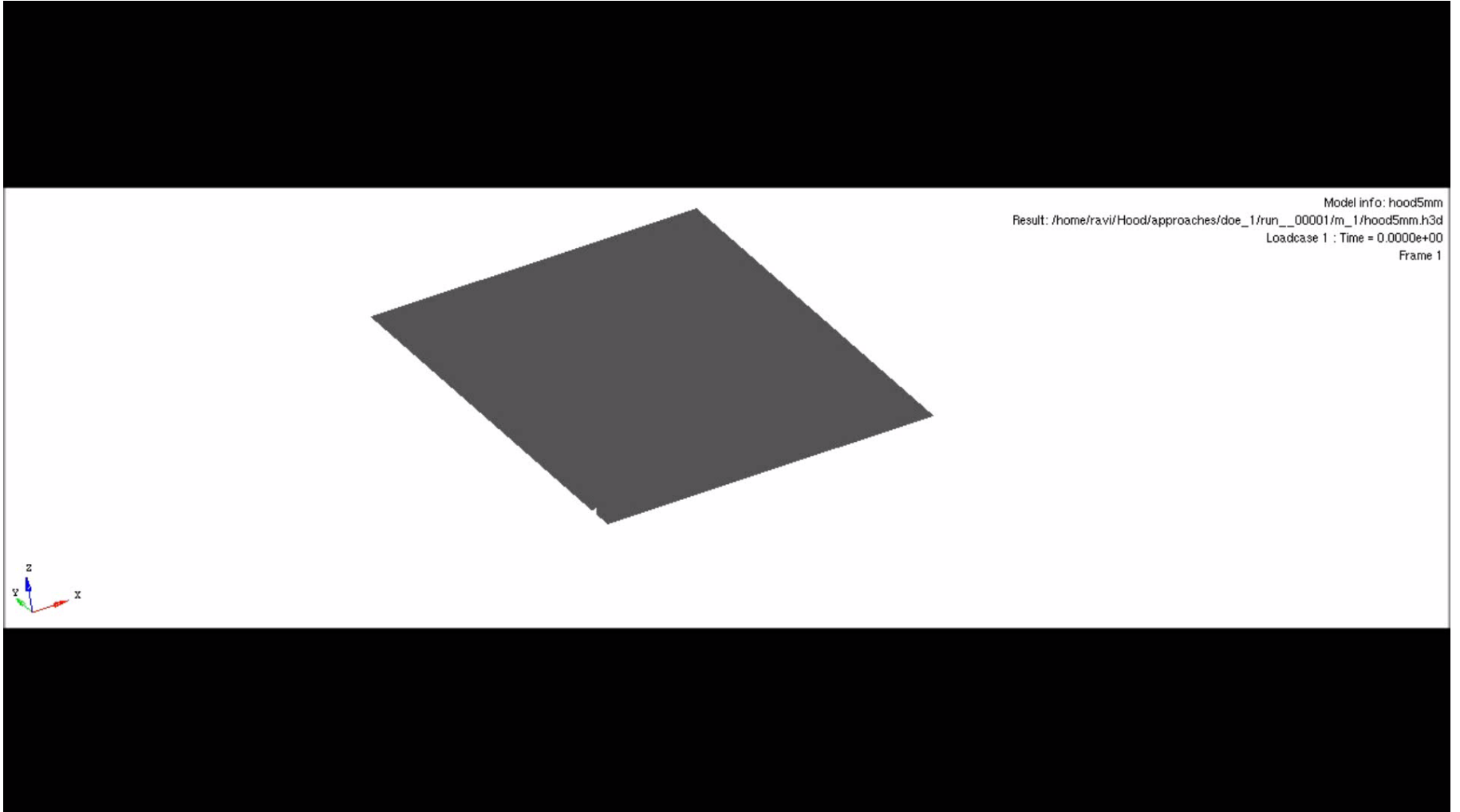
Product Innovation- Sheet Metal Forming - Example 1
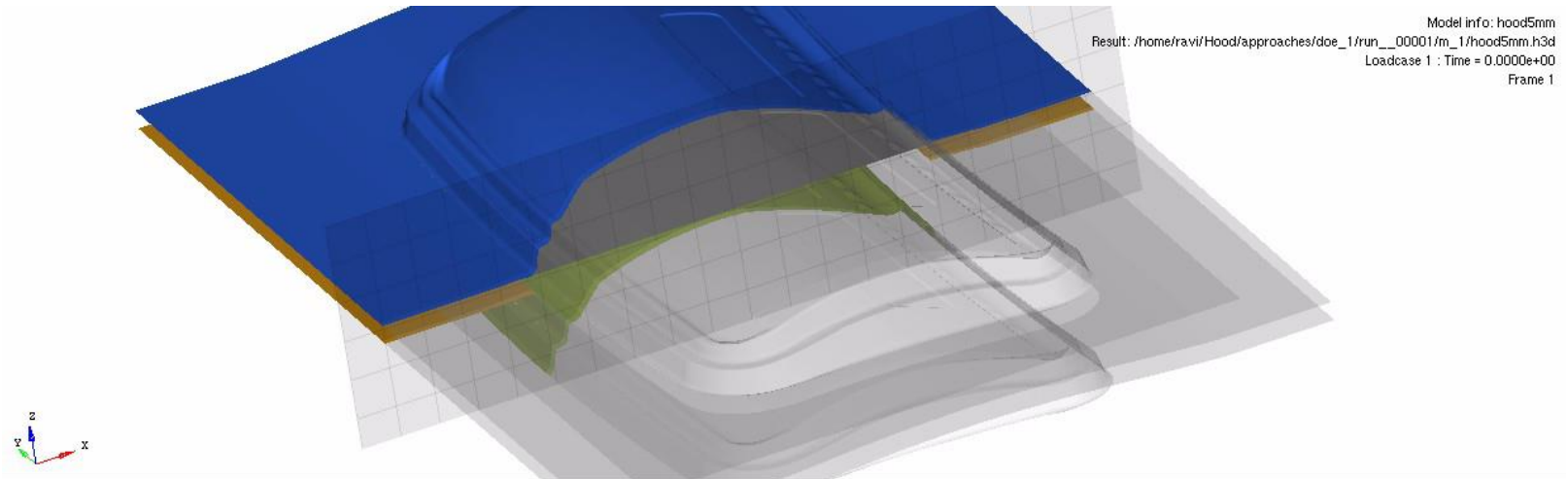
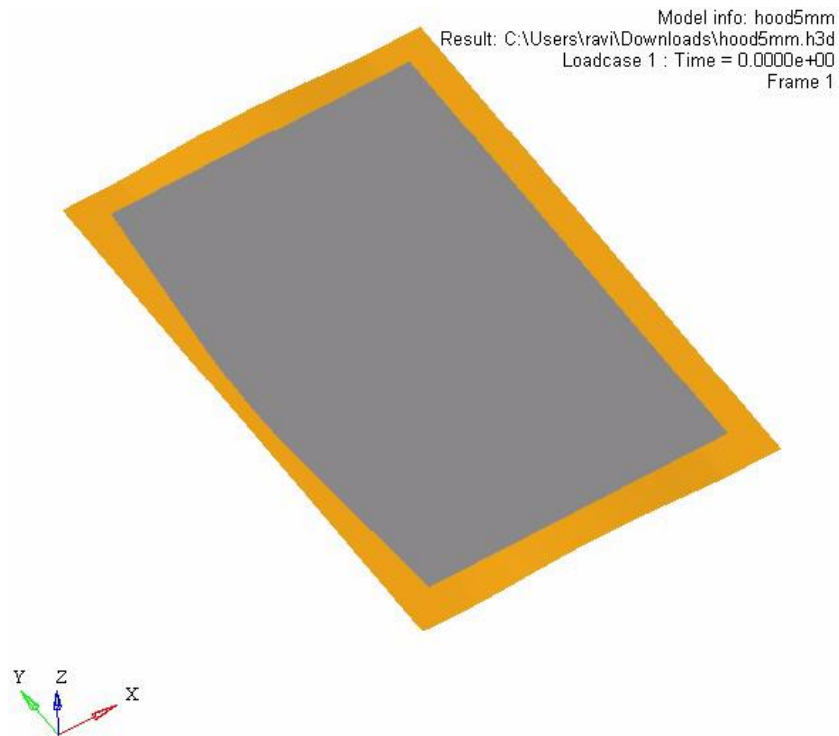# Product Innovation- Sheet Metal Forming - Example 1
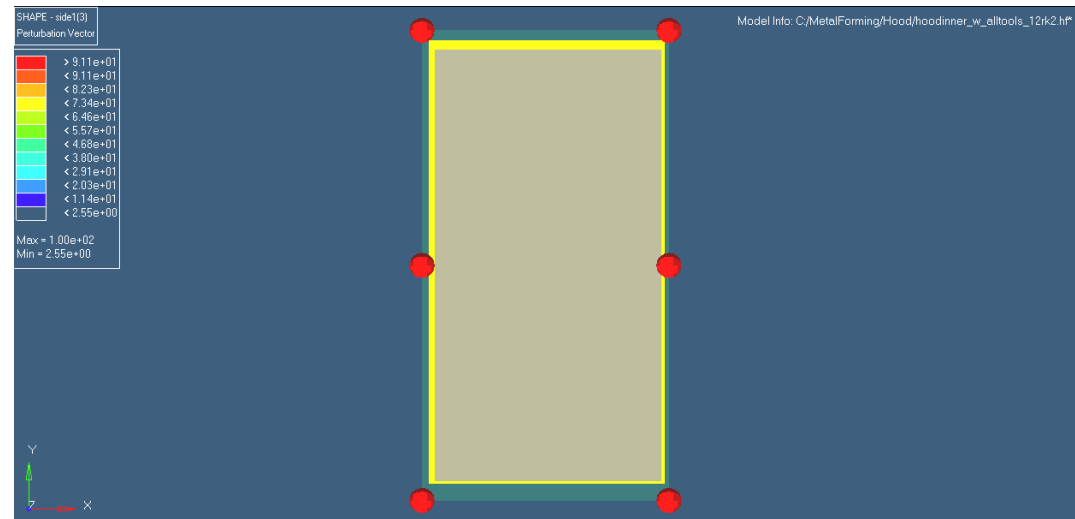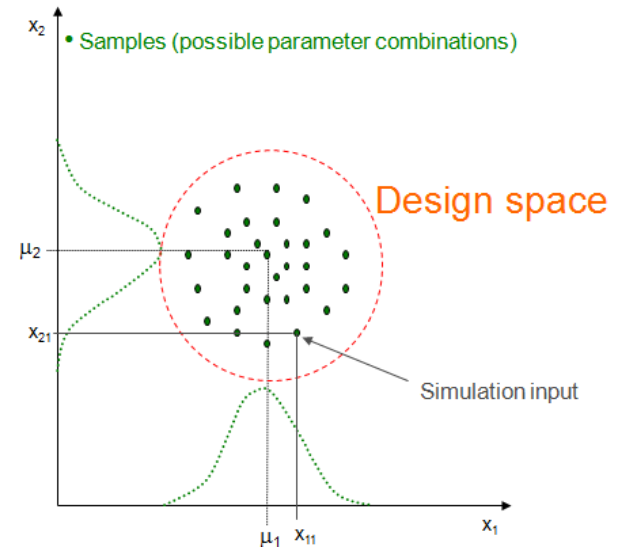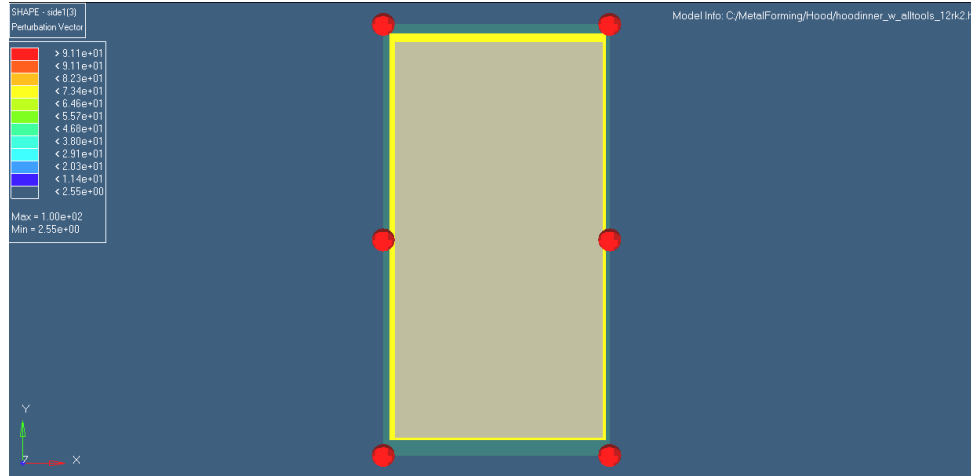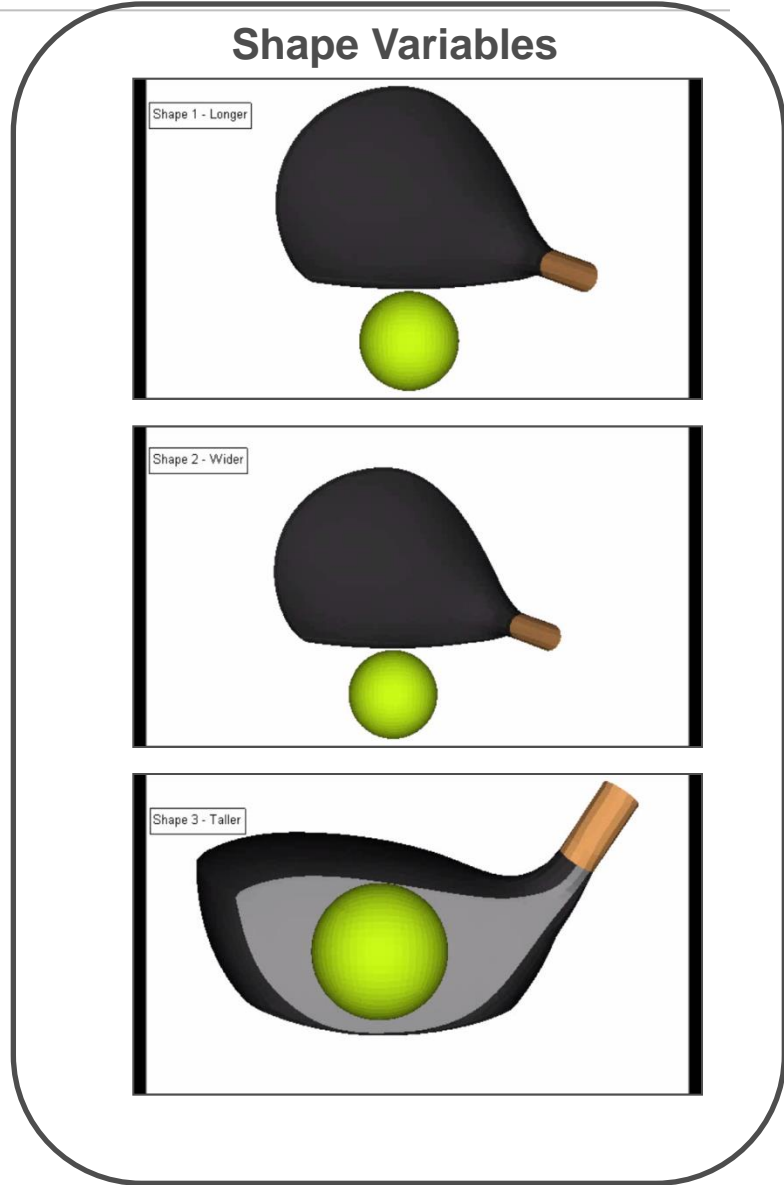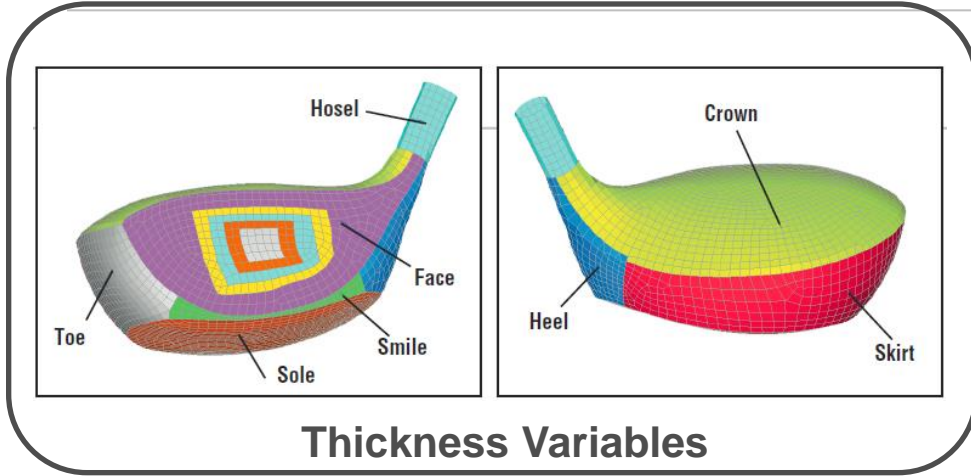
Large Exploration - Example

Infinite Exploration - Example

△ Altair

doe_3_runsummary : Values

longer	wider	taller	COR	Average_P~
0.75	0.726562	0.731482	0.975786	248513
-0.735	-0.738281	-0.743827	0.234354	72261.3

Variables   Response

• Samples (possible parameter combinations)

Design space

Simulation input
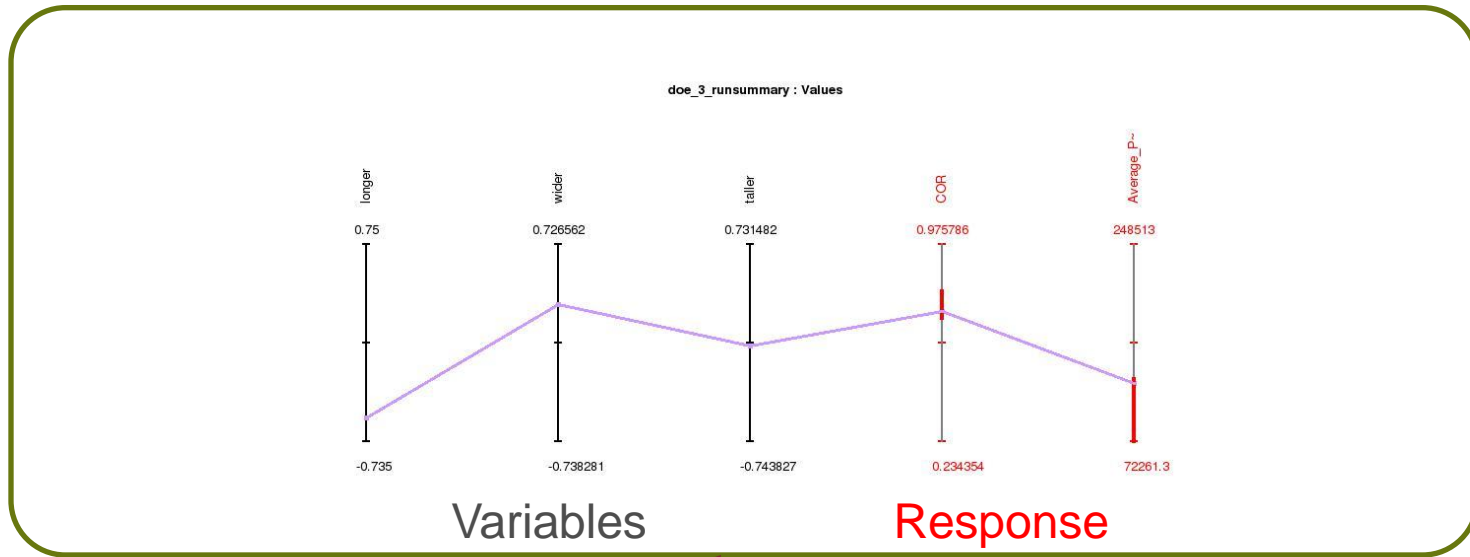
Product Innovation- Sheet Metal Forming - Example 1
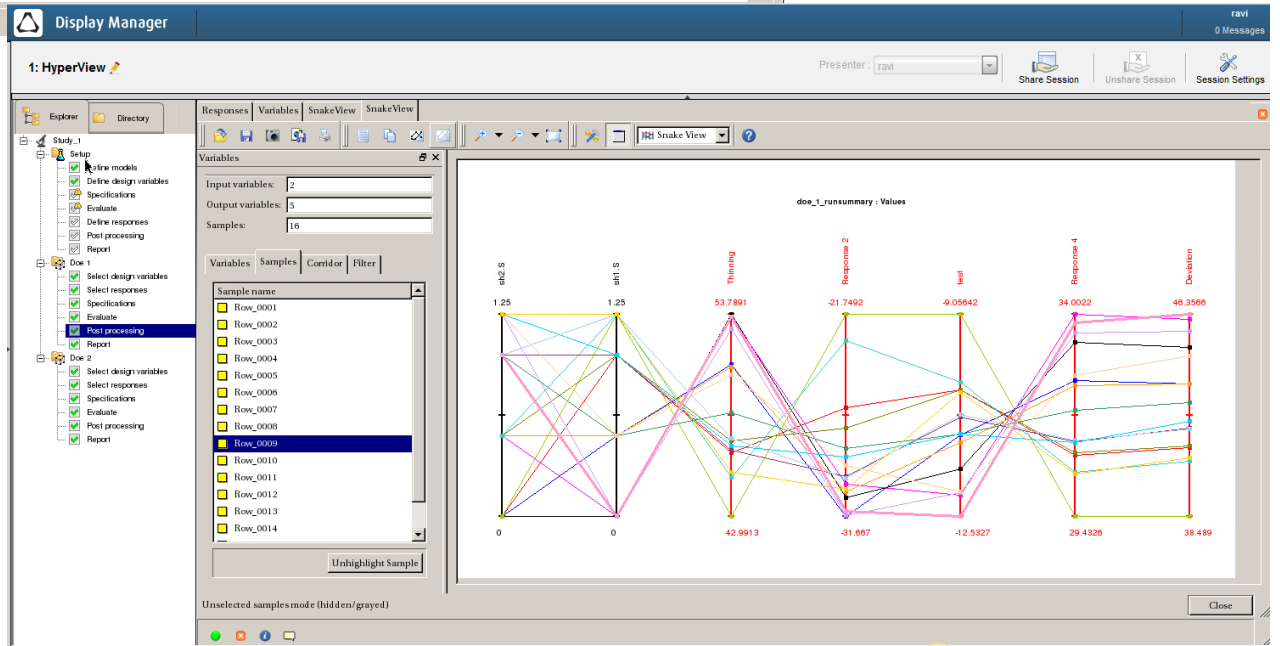
Best and Worst Case in the Runs!

Model info: hood5mm
Result: C:\Users\ravi\Downloads\hood5mm.h3d
Loadcase 1 : Time = 0.0000e+00
Frame 1

Model info: hood5mm
Result: C:\Users\ravi\Downloads\hood5mm(1).h3d
Loadcase 1 : Time = 0.0000e+00
Frame 1
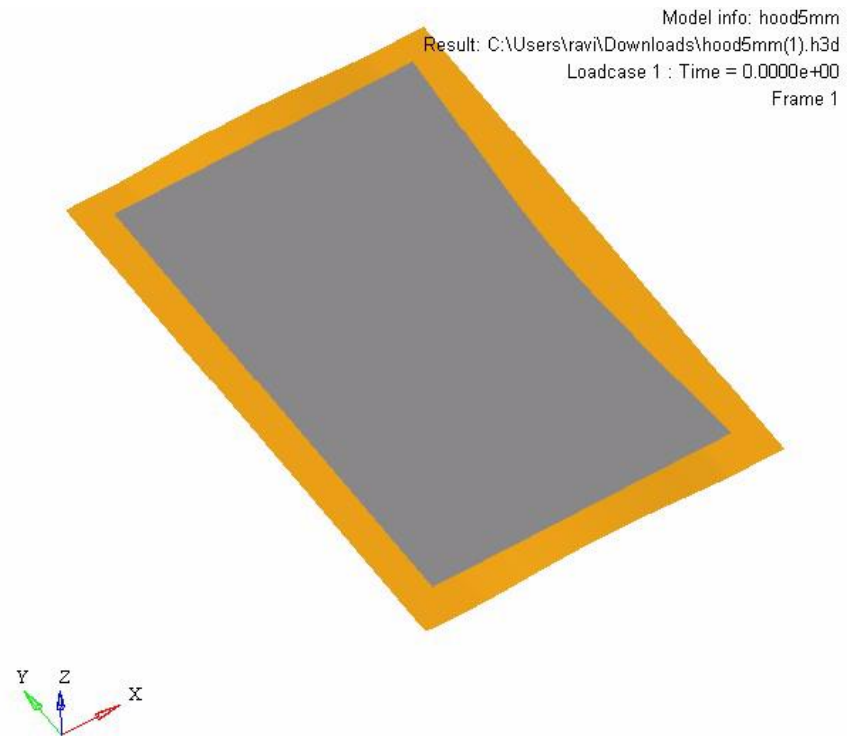
Product Innovation- Golf Club- Example 2

Thickness Variables

Shape Variables

Model Source: 4Mase, T. et al (2003)

Infinite Exploration - Example

- Samples (possible parameter combinations)

Design space

Simulation input

x_2

x_1

μ_2

x_{21}

μ_1 x_{11}

Shape 1 - Longer

Shape 2 - Wider
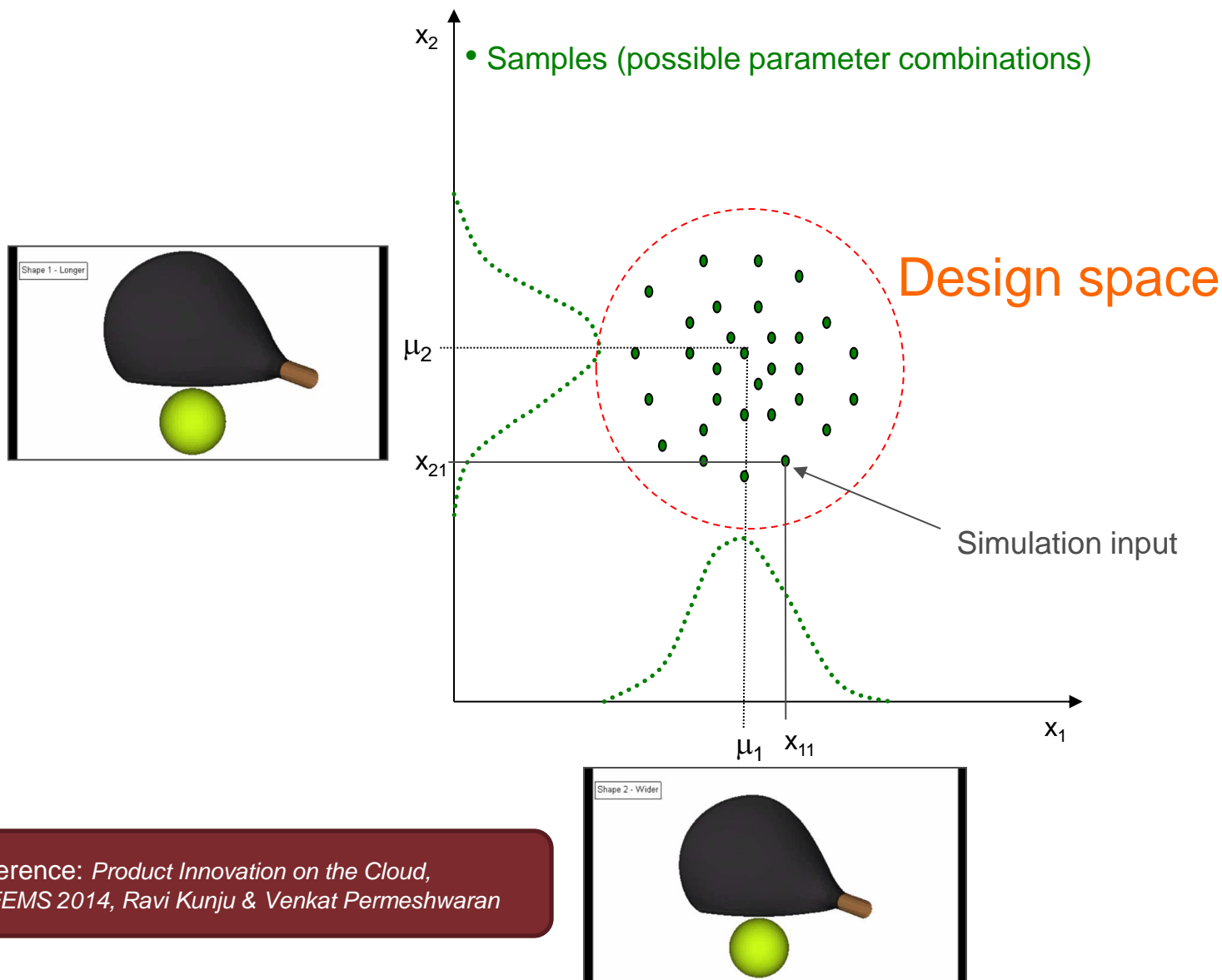
Reference: *Product Innovation on the Cloud, NAFEMS 2014, Ravi Kunju & Venkat Permeshwaran*

Infinite Exploration - Example

doe_3_runsummary : Values

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Variables   Response

- Samples (possible parameter combinations)

Design space

Simulation input

Infinite Exploration - Example

Variables   Response

- Samples (possible parameter combinations)

Design space

Simulation input

Infinite Exploration - Example

Results from Large DOE Run on the Cloud

Defining a Filter

Isolating the best Possible Run from the Spread

Video Comparing Nominal vs. Zeroed in Design
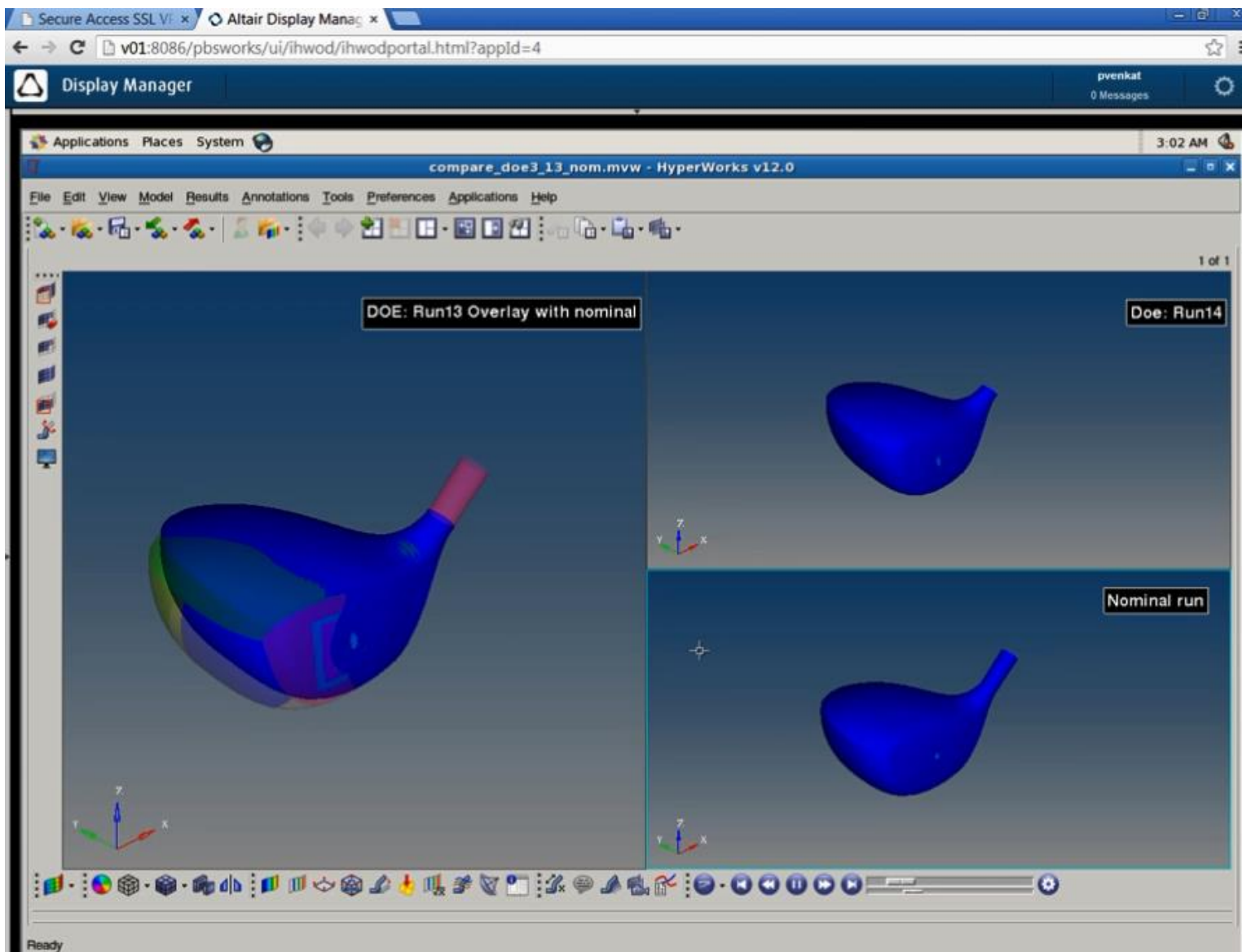
Time Savings Running on the Cloud

Altair

Comparison of solution times between workstation and HPC infrastructure	Details
Run time for 1 RADIOSS simulation (average for a workstation, dual core m/c)	90 sec
Number of sequential jobs	100
Total amount of time for 100 sequential runs (average for a workstation)	9000 sec
Number of compute nodes used on the HPTC infrastructure	10
Run time for 10 RADIOSS simulations (average, each job using 8 cores per run)	13 sec
Total elapsed time for total 100 runs (Estimate)	130 sec
Elapsed time savings	8870
Percentage Gain	98.6%
Adjustment for Data Latency	12%
Total Estimate Gain	86.7%

Note:

1. Your workstation is fully engaged in interactive applications

Typical CAE Results for CRASH & CFD Analysis

△ Altair

100 Runs DOE or Stochastic Run	File Size	Downl... ...urs for ...ation RUN	50 Mbps (Connection)
Crash Medium	10 Gb	2.5	0.5
Crash Large	50 Gb	11	2
CFD Medium	100 Gb	23	4
CFD Large	4 Tb	936	168

All times will be 100 times!

1. The times are assuming 0% loss
2. Running DOE or Stochastic Simulation increases the result sizes further
3. Download time is a Big Deterrent for running large CAE jobs on the cloud!
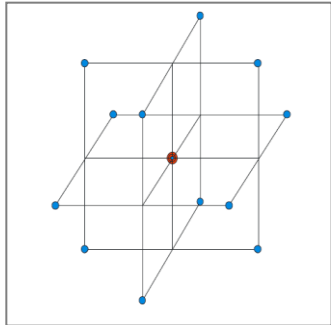
Design Study and Infinite Exploration on the Cloud
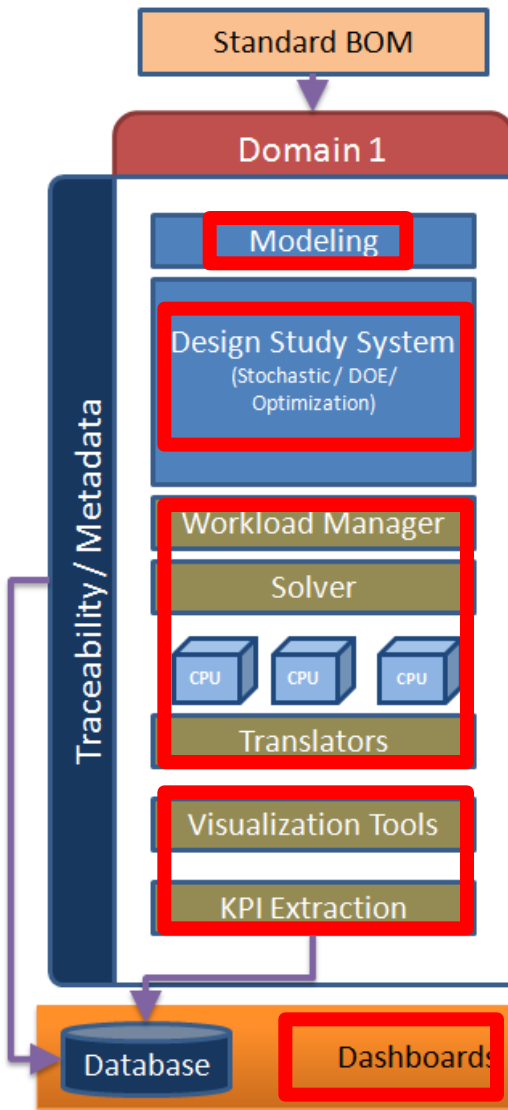
NVIDIA Kepler & Quadro Cards
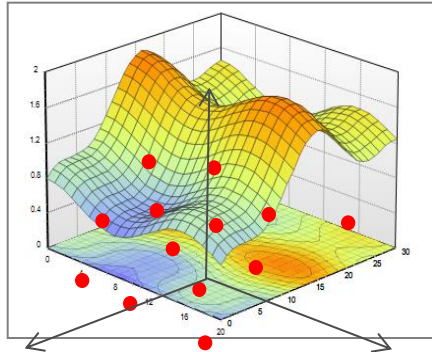
Going Beyond

Step 1

Creating an experimental design

- Factorial designs
- Plackett-Burman
- Box-Behnken
- Central-Composite
- Latin HyperCube
- Hammersley
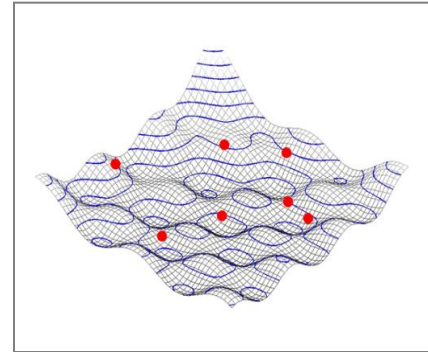- User defined
- External Matrix

Step 2

Build the surrogate model

- Least square
- Moving least square
- HyperKriging

Step 3

Optimize based on surrogate model

- Genetic Algorithm
- Sequential Quadratic Programming
- Adaptive Response Surface
- Method of Feasible Directions
- Sequential Optimization and Reliability Assessment
- Multi-Objective Genetic Algorithm
- Gradient-Based Method for Multi Objective Optimization
- External optimizers

Stochastic study based on surrogate model
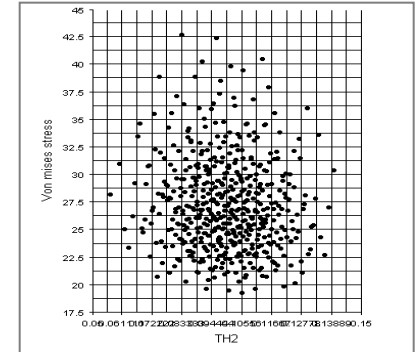
- Random
- Latin HyperCube
- Hammersley

Observations: Running Simulations on the Cloud

- **No Software Client installed locally**
  - All Access even to interactive software through Web Browser using Altair Display Manager

- **No necessity to run jobs locally**
  - All jobs were submitted to the cloud through Compute Manager

- **No need to transfer Data to the local machines**
  - Use of **NVIDIA Graphics Cards on the server** for remote visualization

- **Fully Optimized Utilization of Hardware Resources**
  - Fully Integrated Web Job Submission through Compute Manager

Conclusions

Cloud based HPC allow;

- Massive Scalability of Hardware and Software Resources instantly

- Running large spectrum of simulation design exploration on the cloud

- Performing entire Simulation Lifecycle from anywhere using a simple web browser is possible with right technology stack

- Remote Visualization with Graphic Technology from NVIDIA can be efficiently utilized for accelerated interpretation of simulation data for rapid product innovation

For More Information

- **Contact**
    - Rajagopalan.Varadarjan@altair.com
    - Ravi Kunju
        - ravi@altair.com

- **Visit Us Online**
    - www.altair.com
    - www.altair.com/cloud
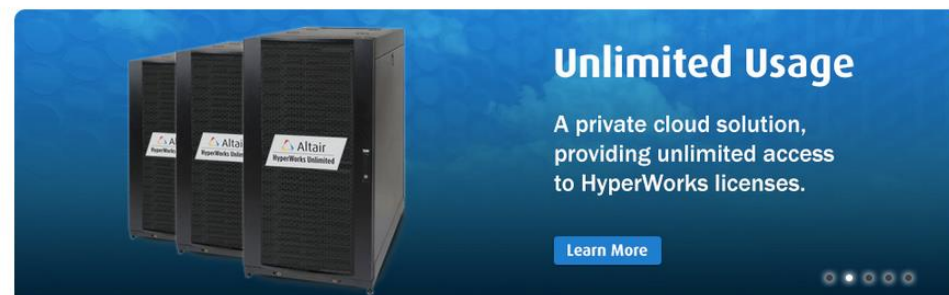
Thank You!