



Altair

Innovation Intelligence®

Product Innovation Using Private & Public Cloud

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GPU TECHNOLOGY
CONFERENCE

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

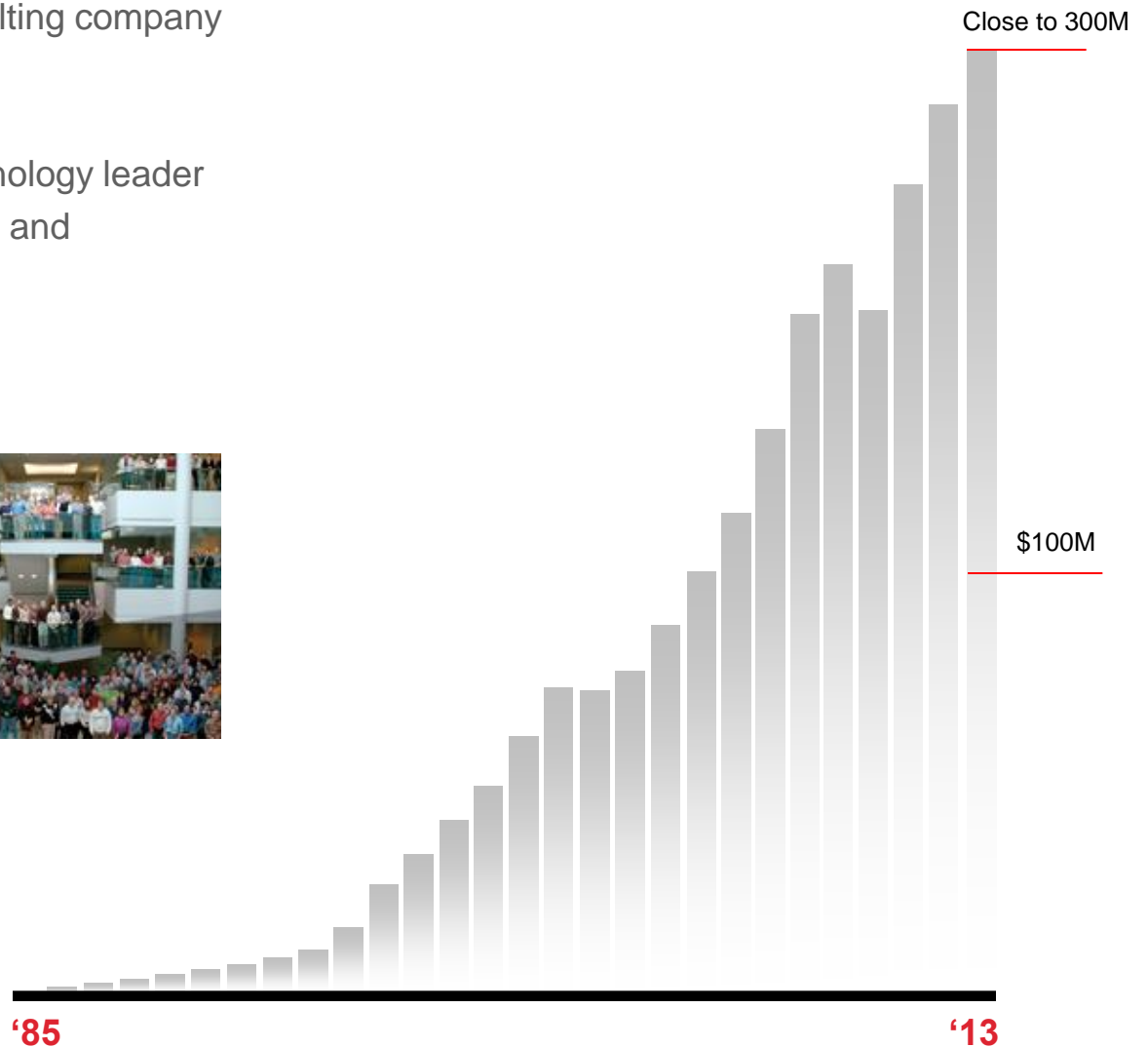


Founded ...

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



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



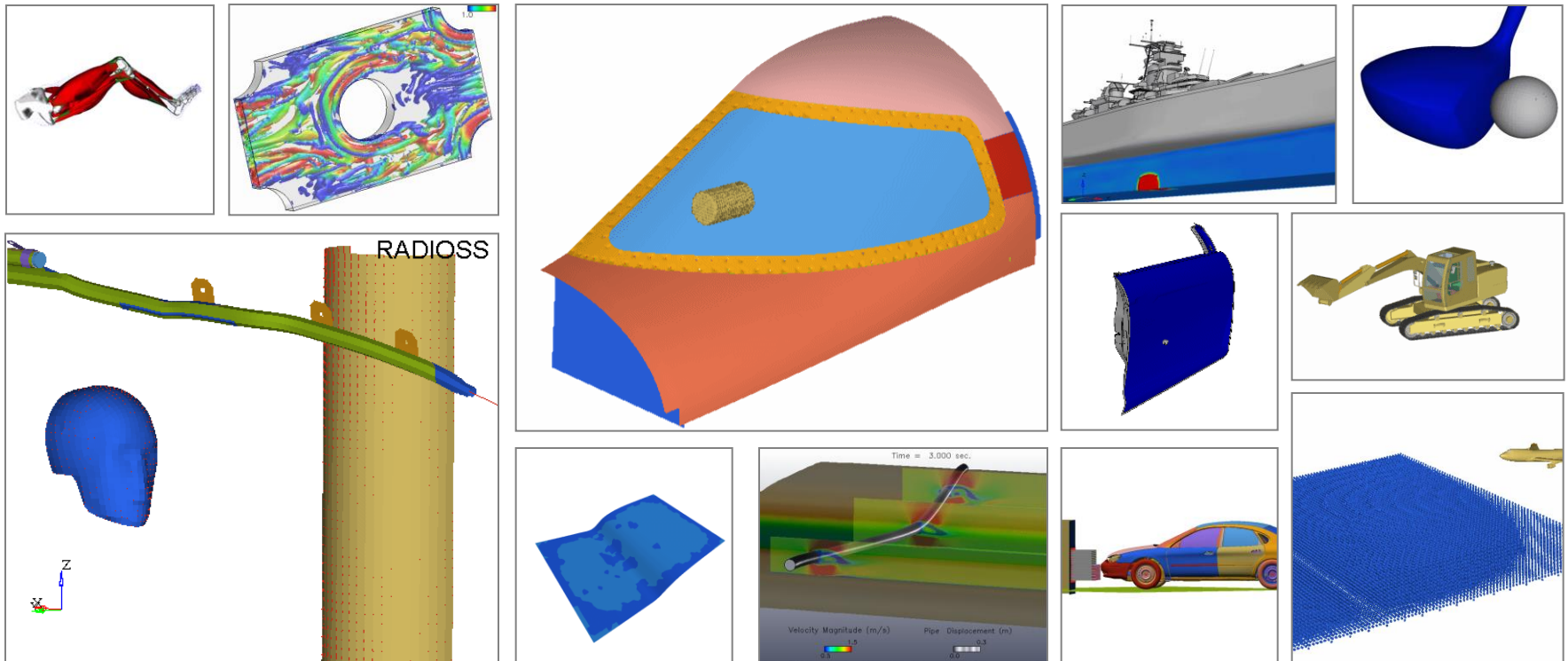
Staffing Solutions

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:

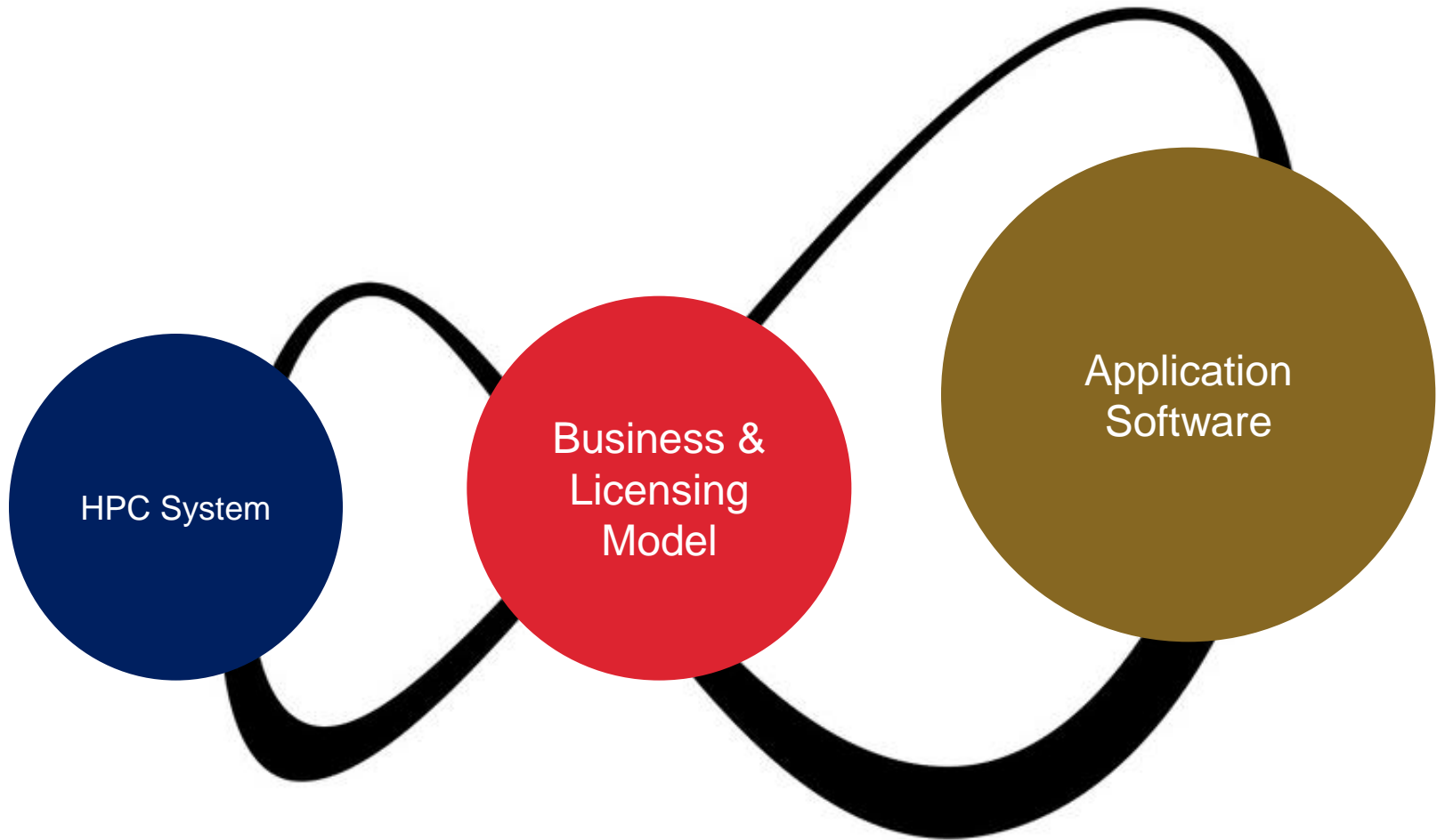
**Easy access and use of high performance computational
and domain specific resources On-Demand**

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!



Remote Visualization powered by NVIDIA

Access to: HyperWorks on the Cloud

HyperWorks
Unlimited



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

Private Cloud Appliance

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



Download Times in Hours for SINGLE Simulation RUN			
	File Size	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

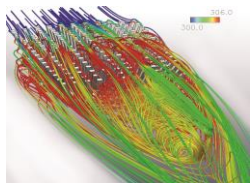
1. The times are assuming 0% loss
2. Download time is a Big Deterrent for running large CAE jobs on the cloud!

Data Movement Problem in Large CAE Studies

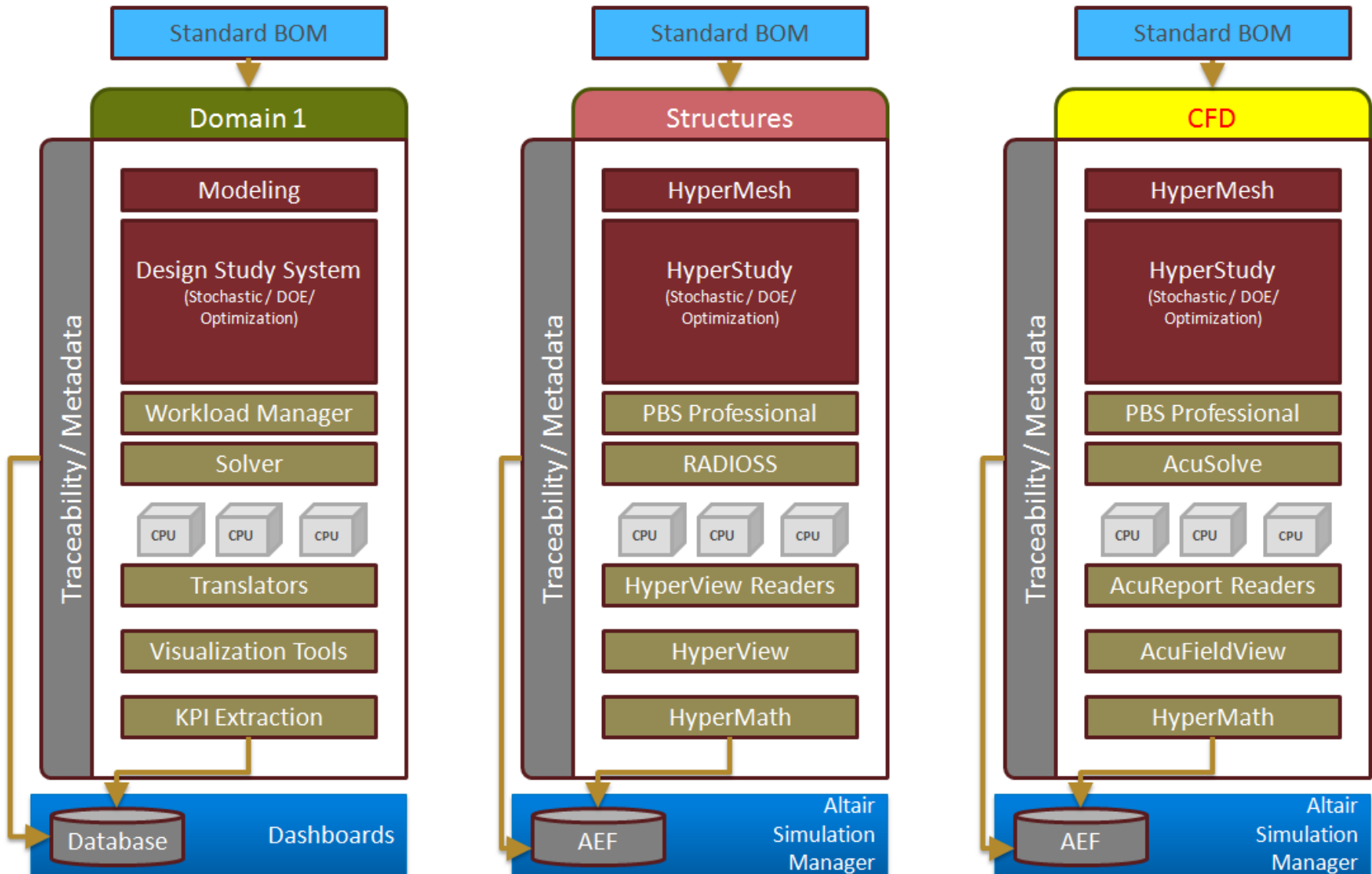


On Premises Cloud

Off Premises Cloud



Product Innovation Process



Standard BOM

Cloud Maturation Path for CAE Altair

Domain 1

Modeling

Design Study System
(Stochastic / DOE/
Optimization)

Workload Manager

Solver

CPU

CPU

CPU

Translators

Visualization Tools

KPI Extraction

Traceability / Metadata

Simulation
Data
Management

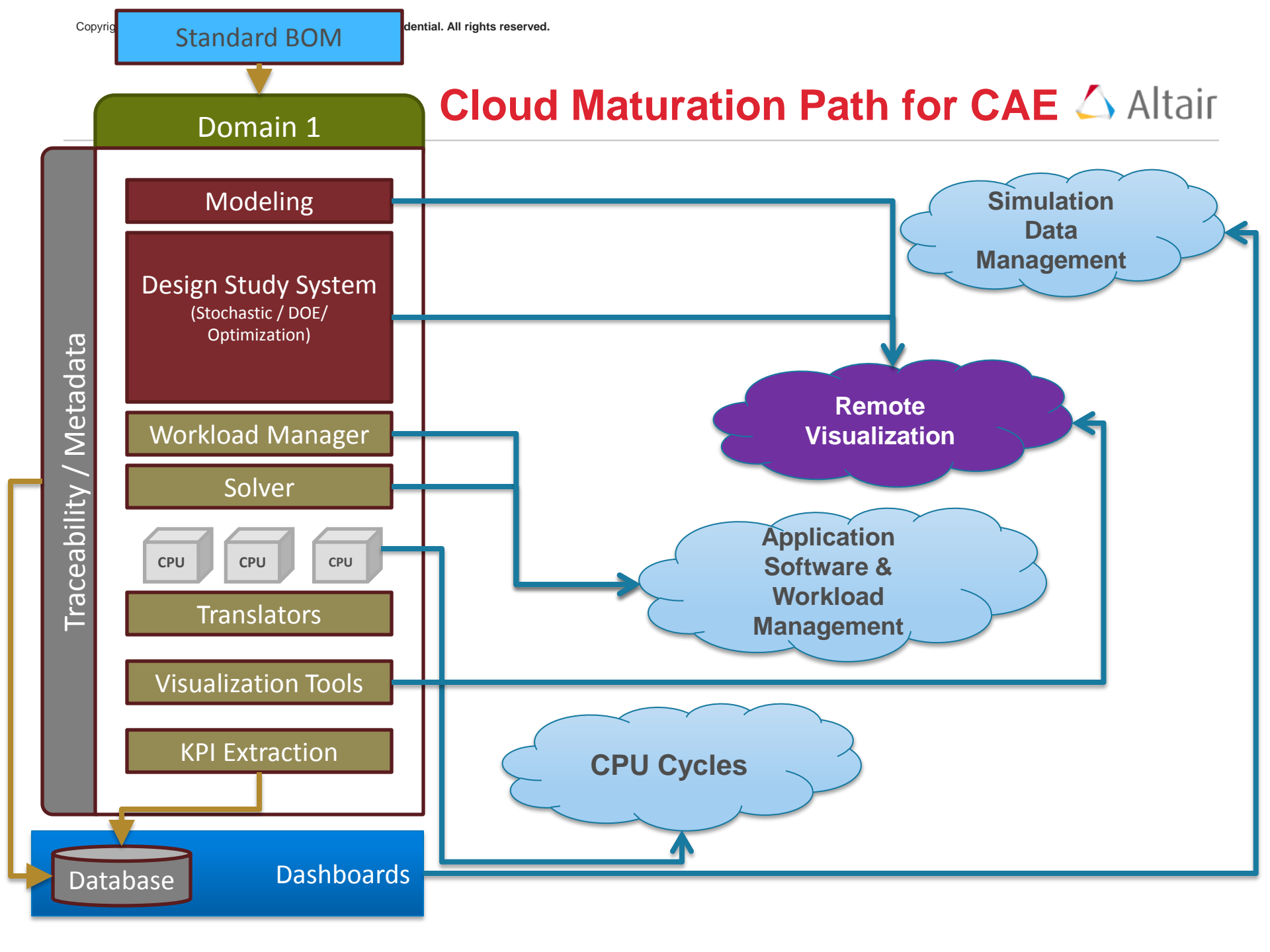
Remote
Visualization

Application
Software &
Workload
Management

CPU Cycles

Database

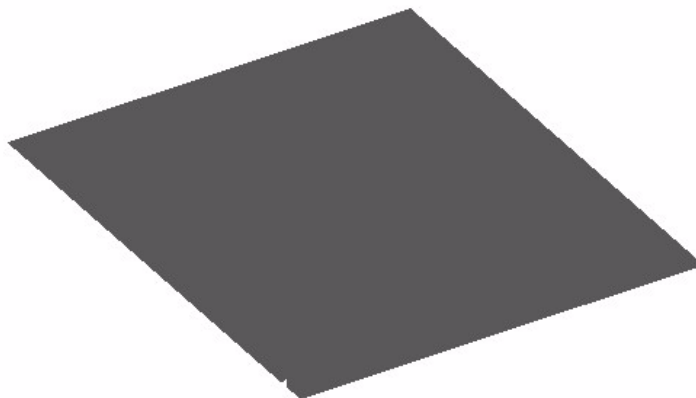
Dashboards



Product Innovation- Sheet Metal Forming - Example 1



Model info: hood5mm
Result: /home/ravi/Hood/approaches/dae_1/run__00001/m_1/hood5mm.h3d
Loadcase 1 : Time = 0.0000e+00
Frame 1

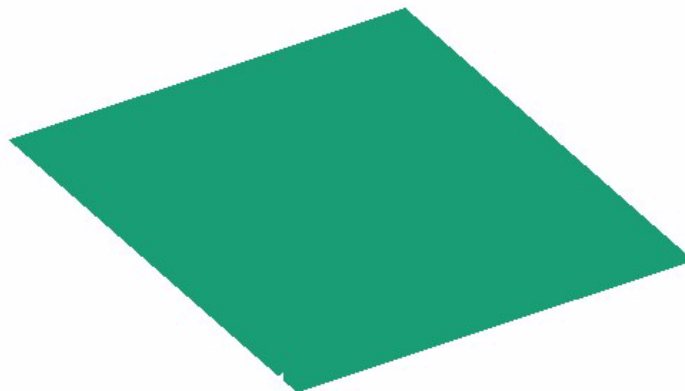


Contour Plot
%Thinning(Scalar value, Mid)

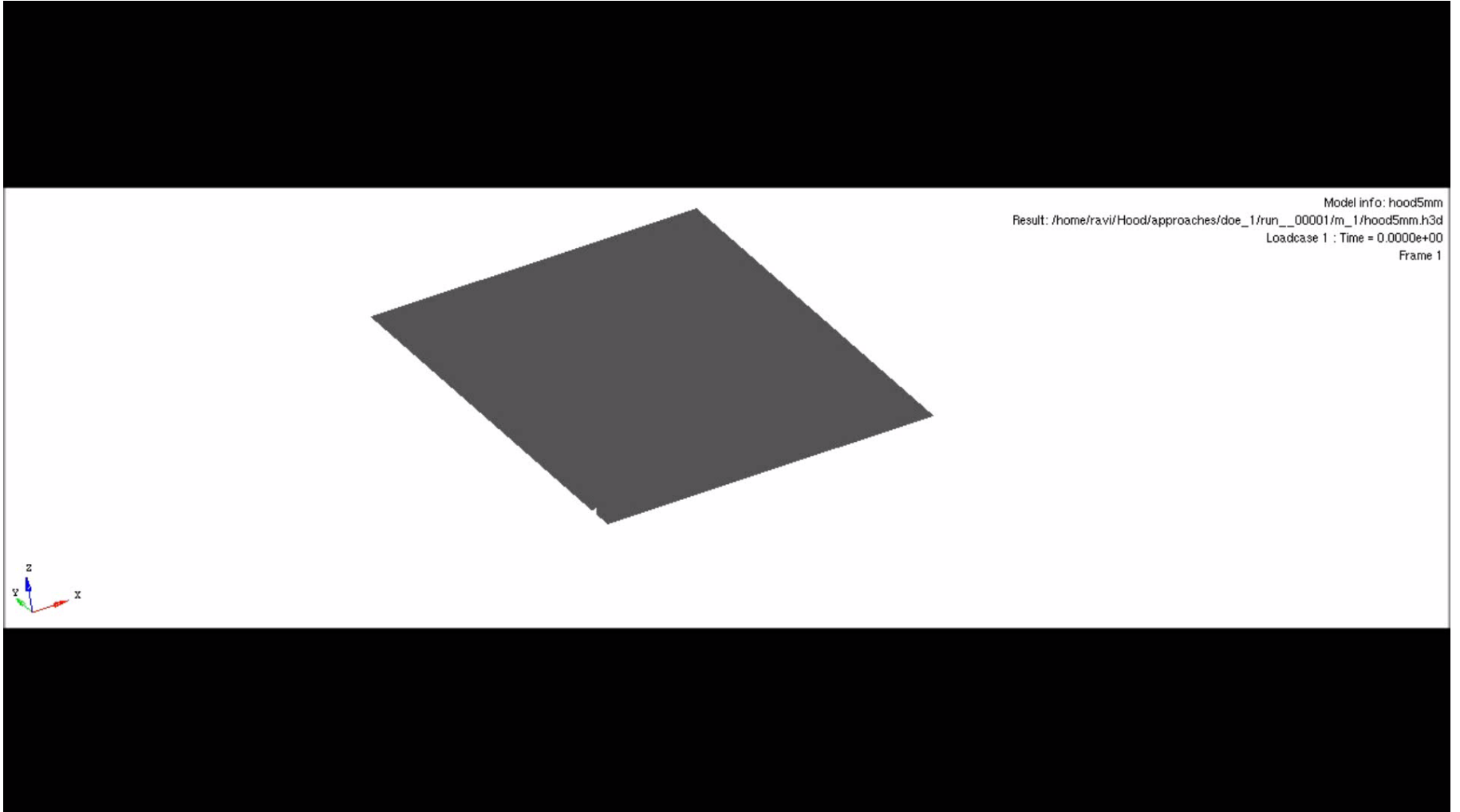
5.379E+01
4.419E+01
3.460E+01
2.501E+01
1.541E+01
5.818E+00
-3.776E+00
-1.337E+01
-2.296E+01
-3.256E+01
No result

MAX = 5.379E+01
SHELL 100125089
MIN = -3.256E+01
SHELL 100125254

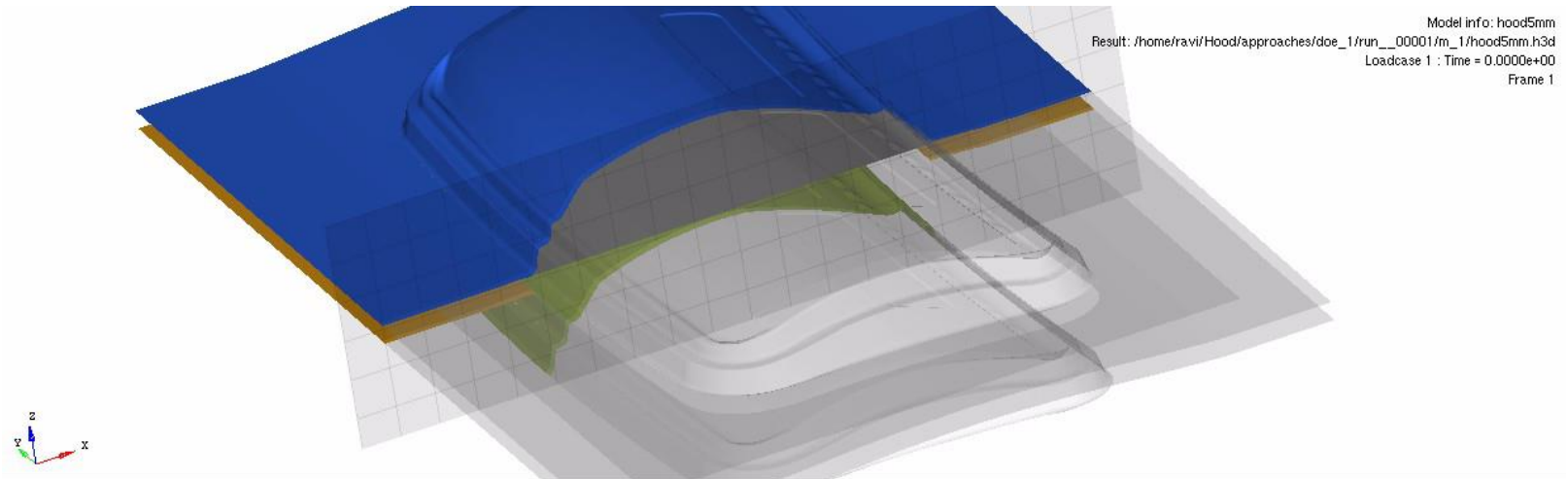
Model info: hood5mm
Result: /home/ravi/Hood/approaches/dae_1/run__00001/m_1/hood5mm.h3d
Loadcase 1 : Time = 0.0000e+00
Frame 1



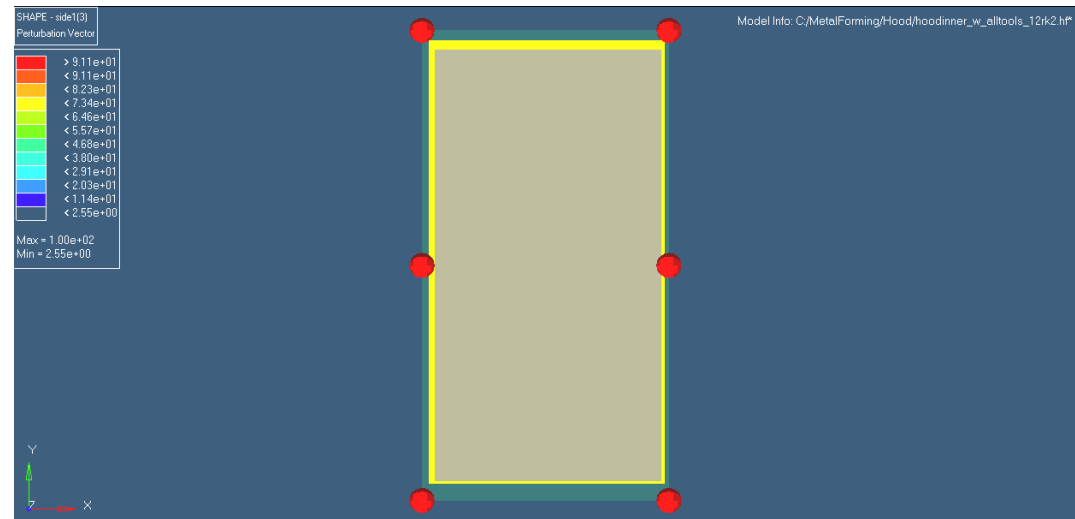
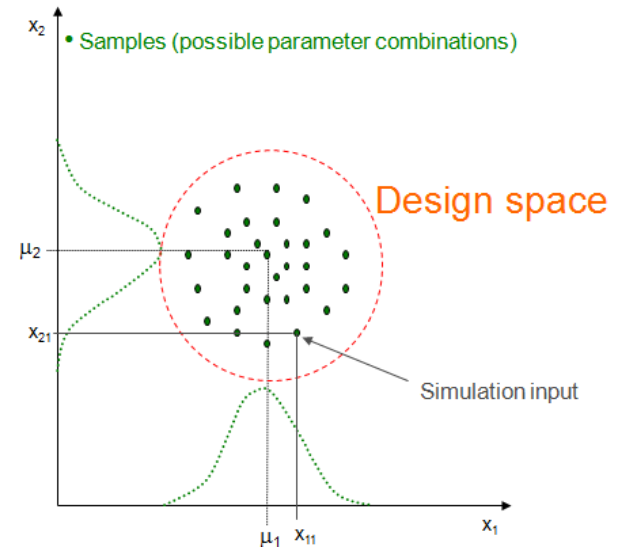
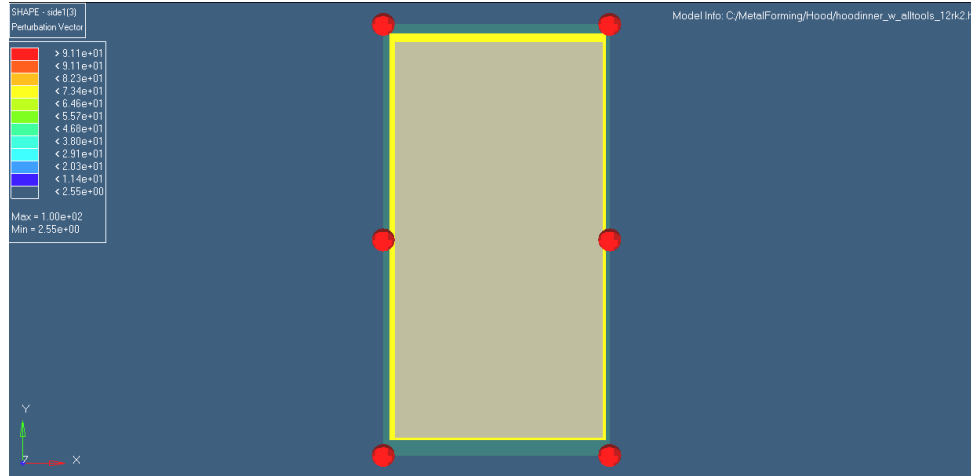
Product Innovation- Sheet Metal Forming - Example 1



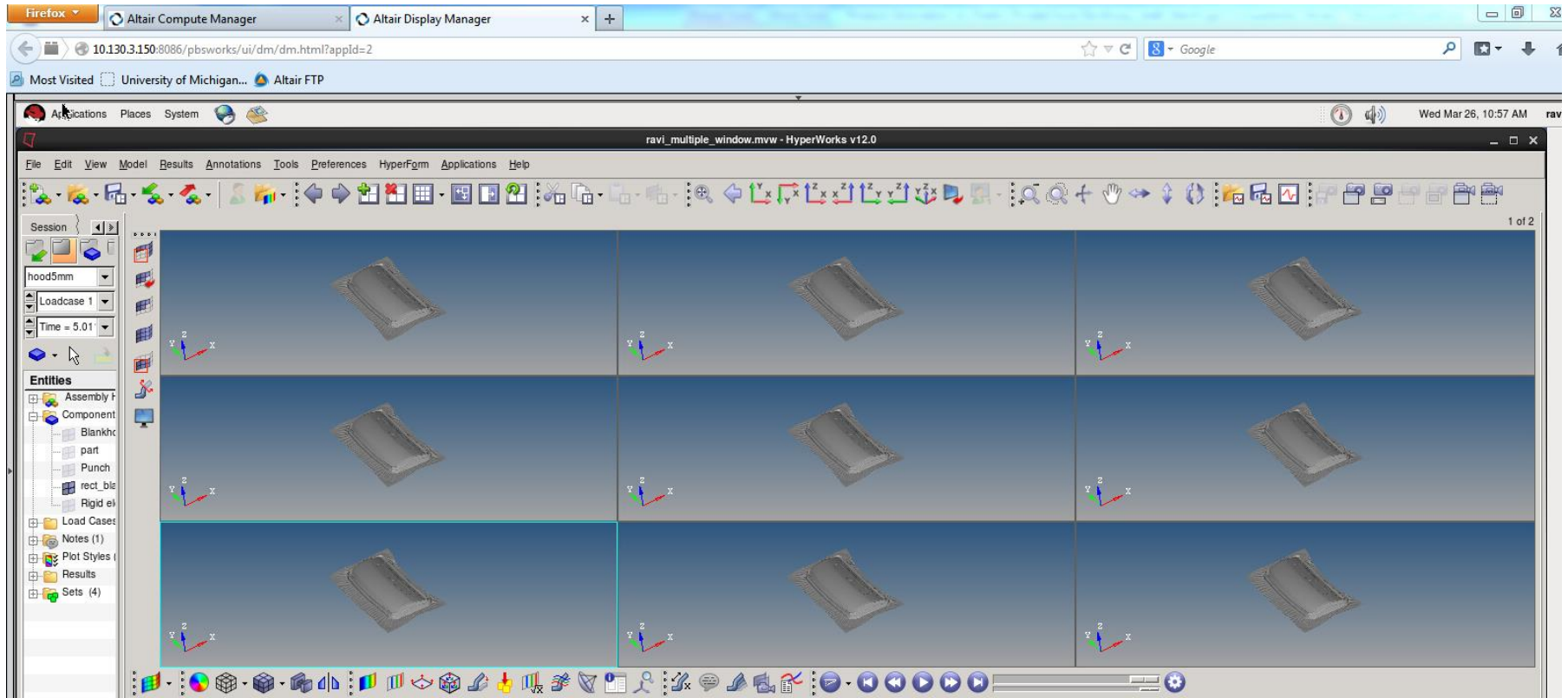
Product Innovation- Sheet Metal Forming - Example 1



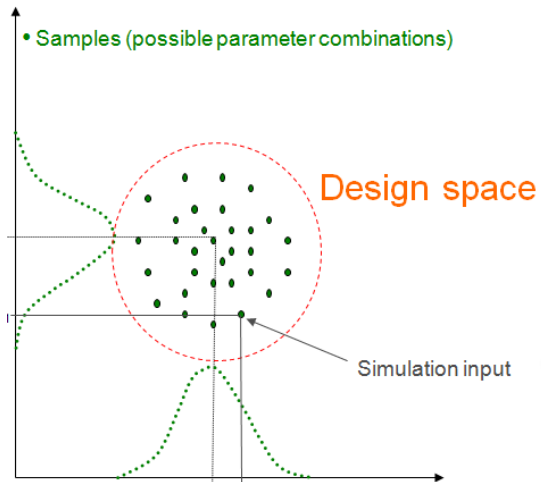
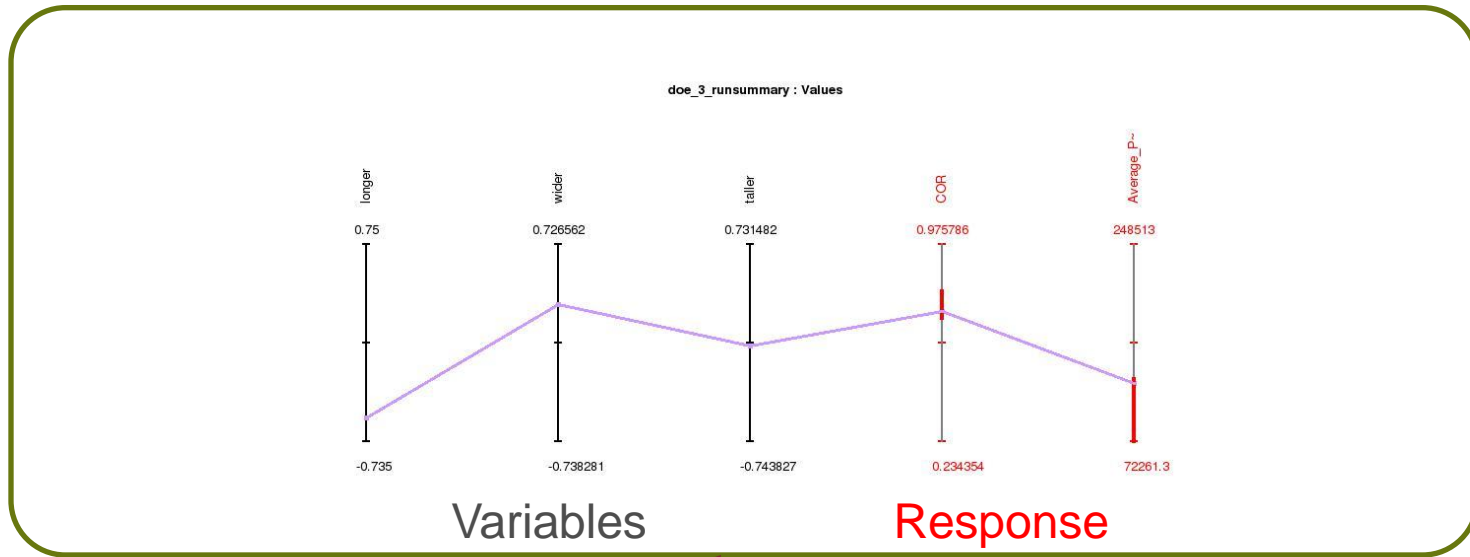
Product Innovation- Sheet Metal Forming - Example 1



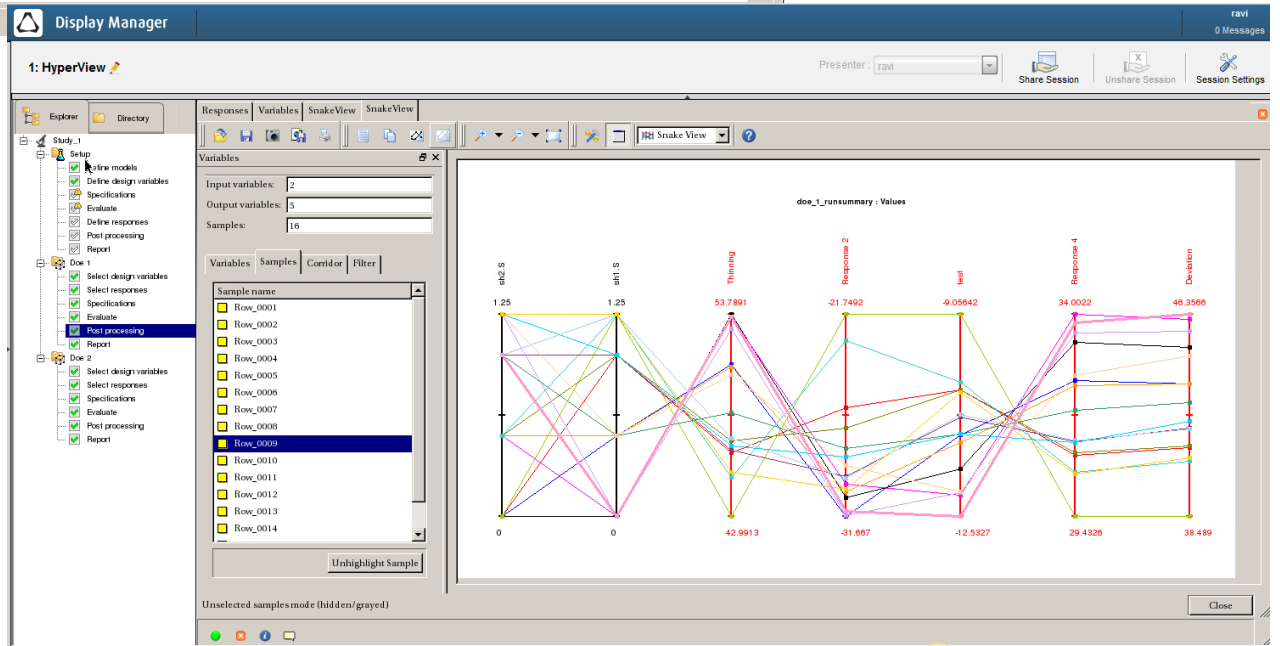
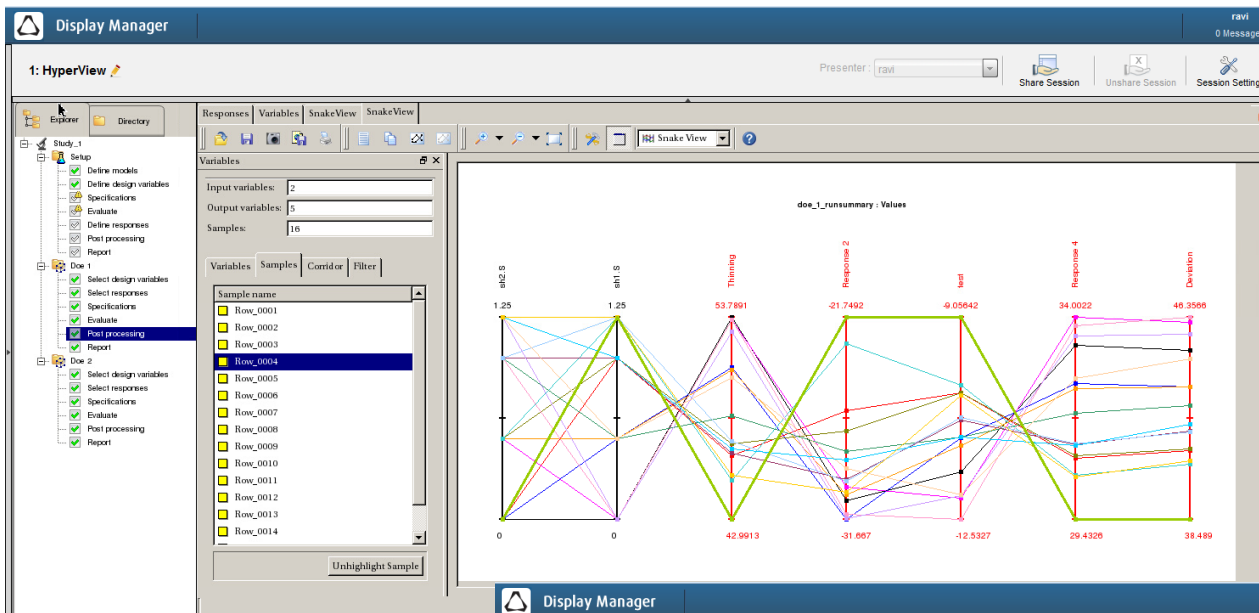
Large Exploration - Example



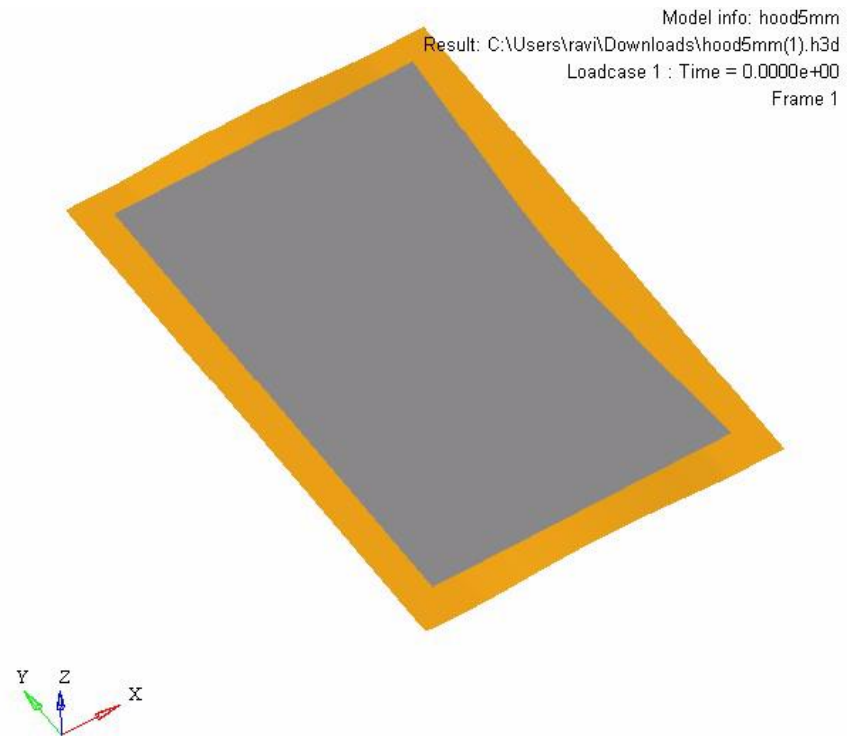
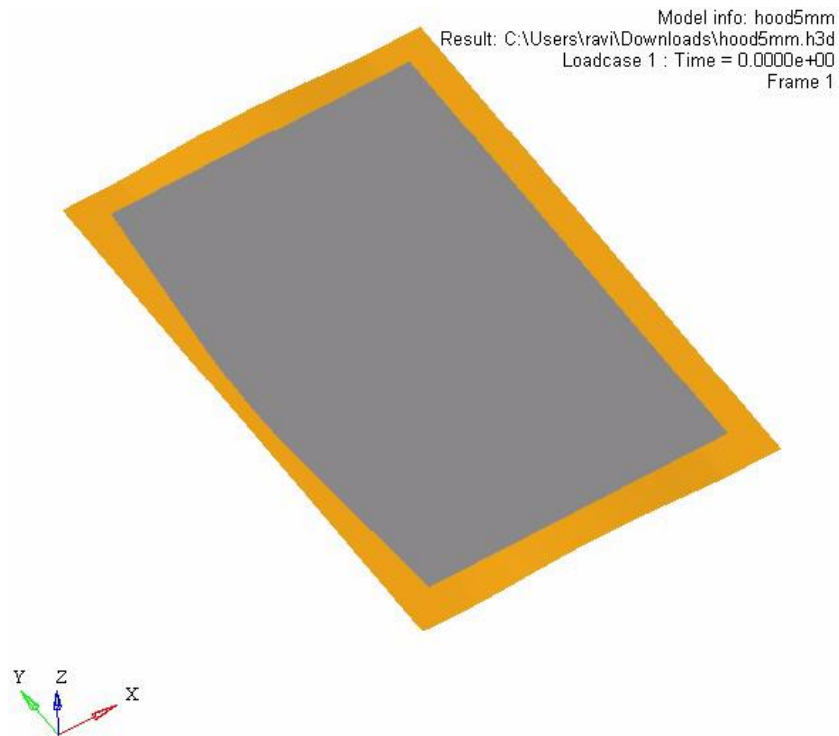
Infinite Exploration - Example



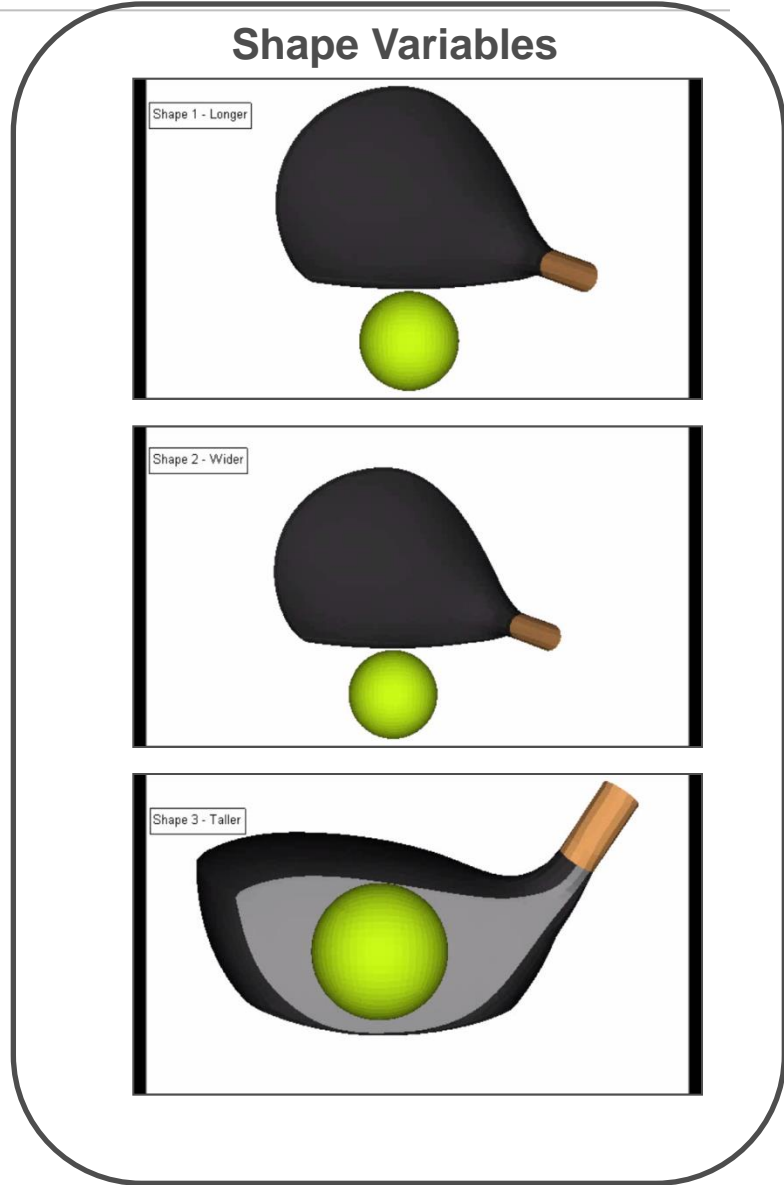
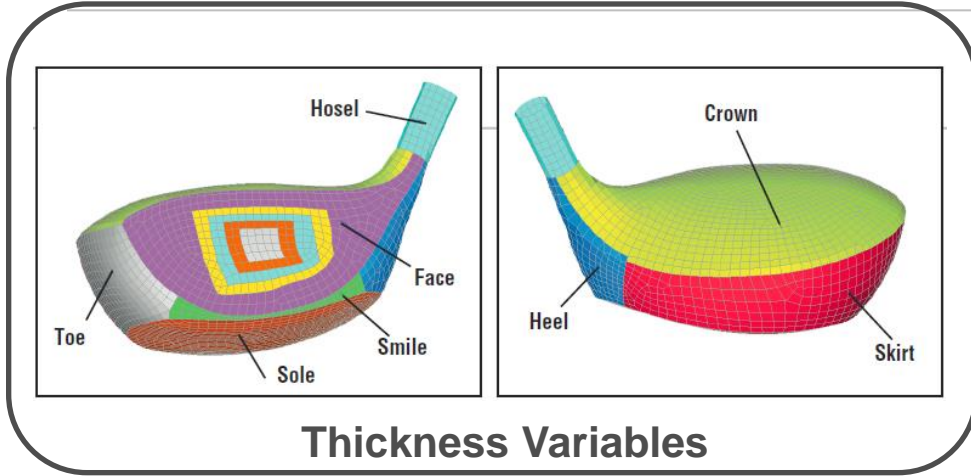
Product Innovation- Sheet Metal Forming - Example 1



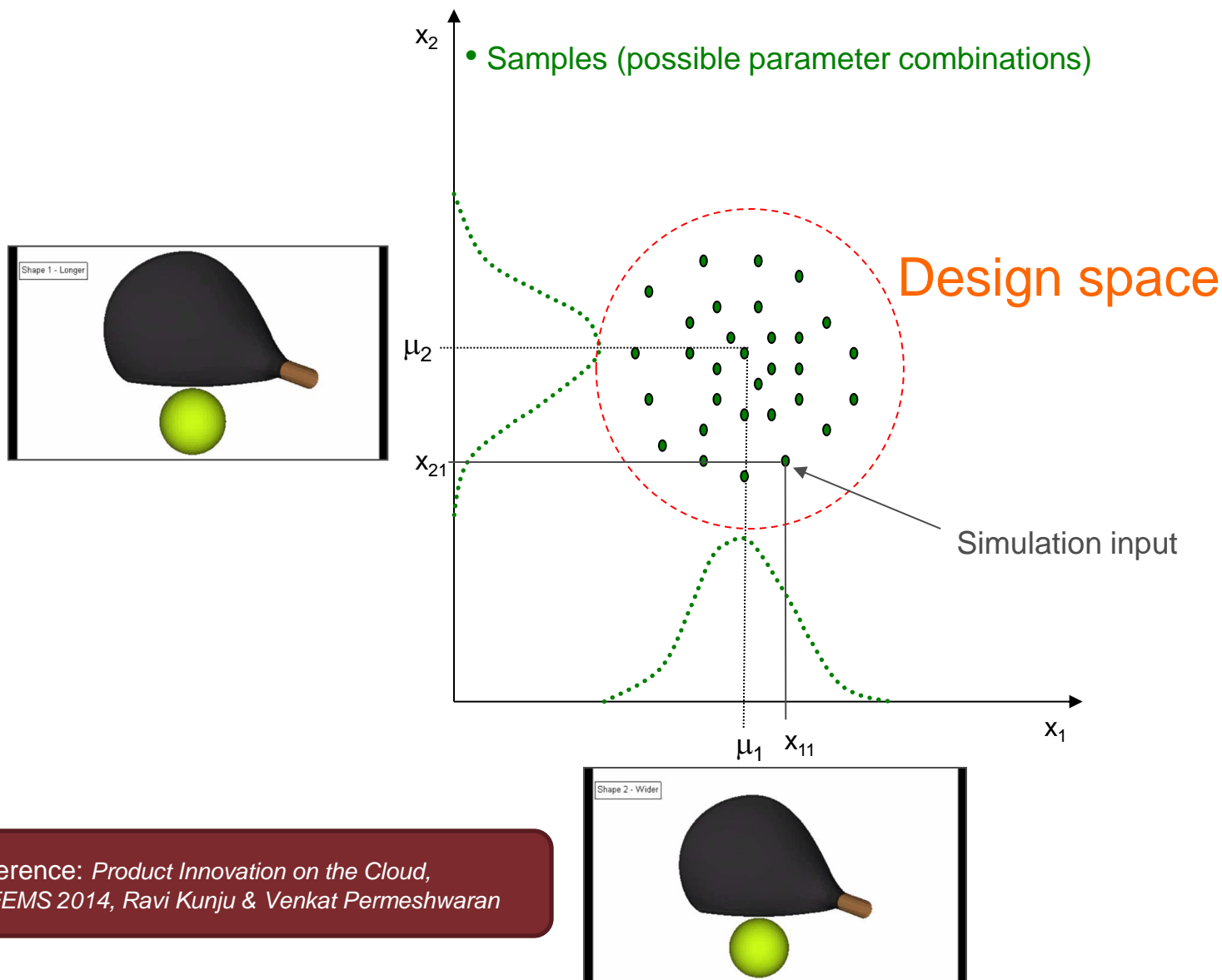
Best and Worst Case in the Runs!



Product Innovation- Golf Club- Example 2

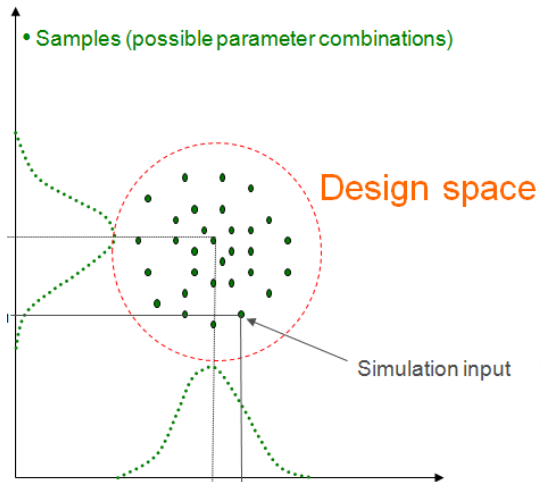
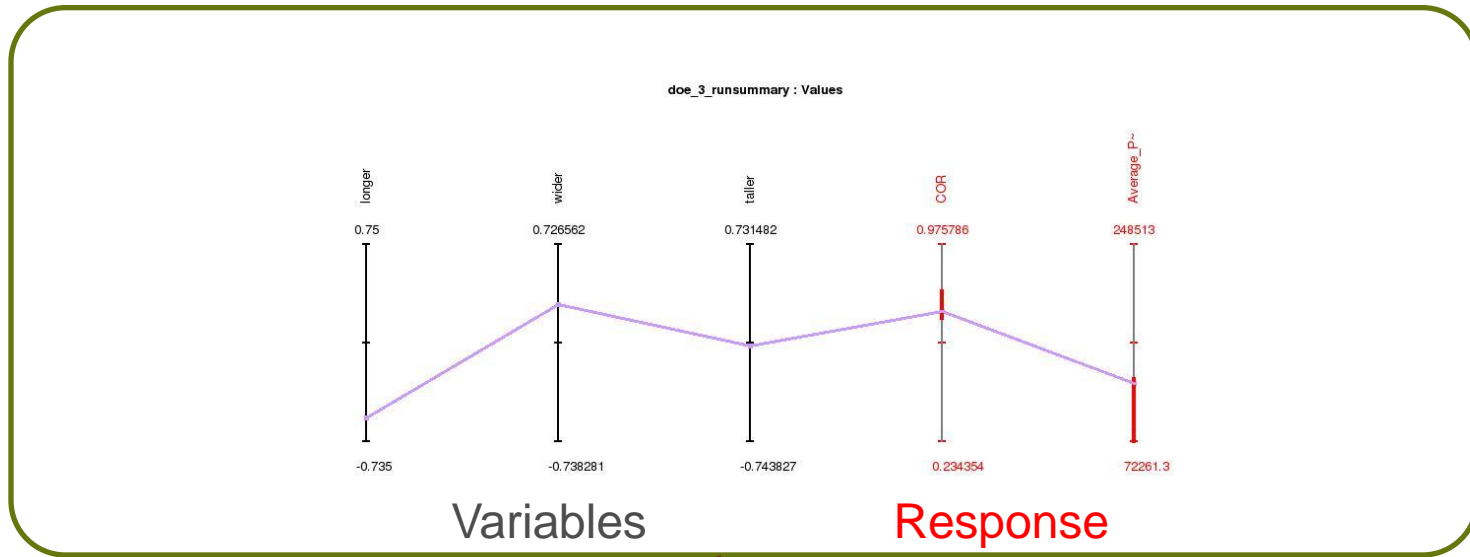


Infinite Exploration - Example

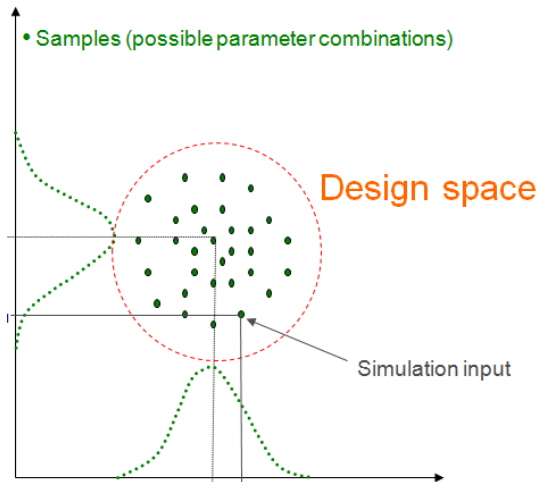
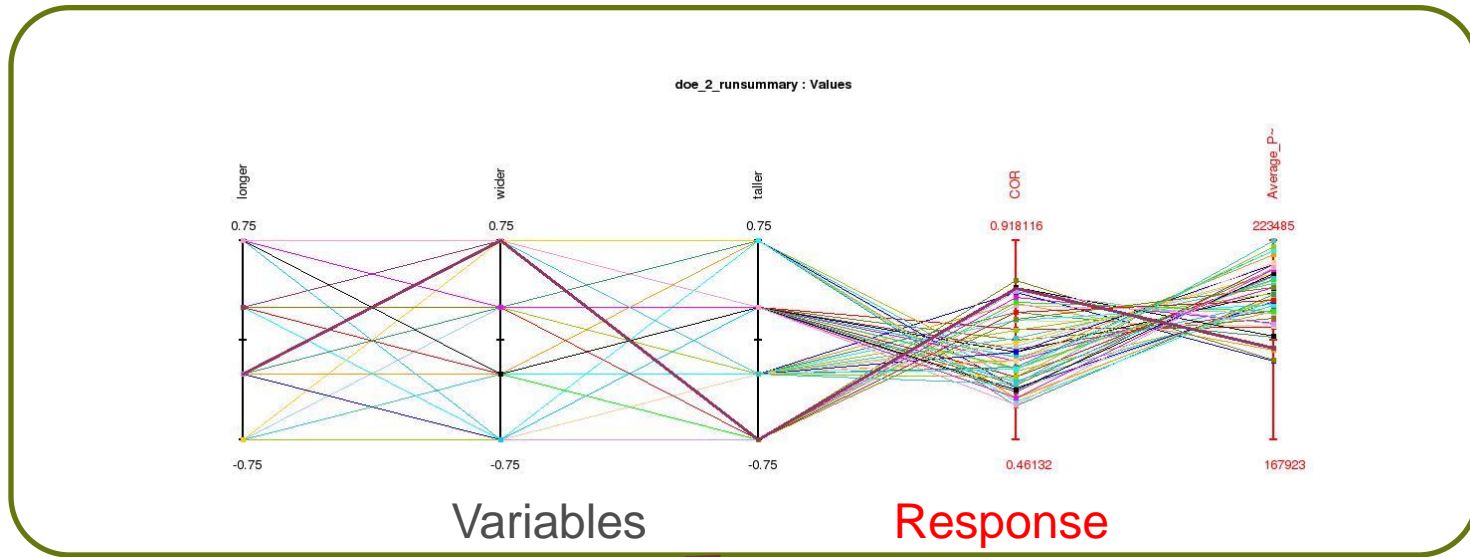


Reference: *Product Innovation on the Cloud*,
NAFEMS 2014, Ravi Kunju & Venkat Permeshwaran

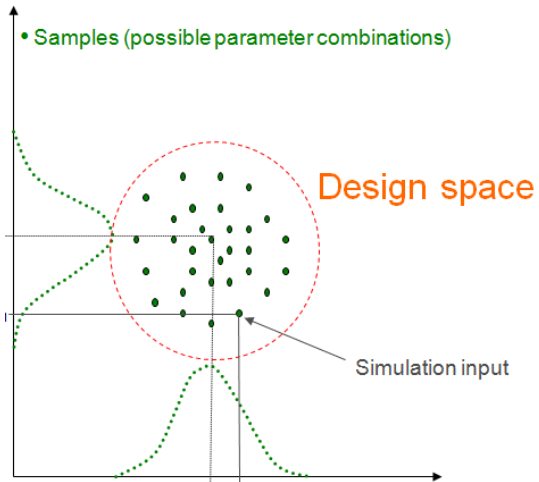
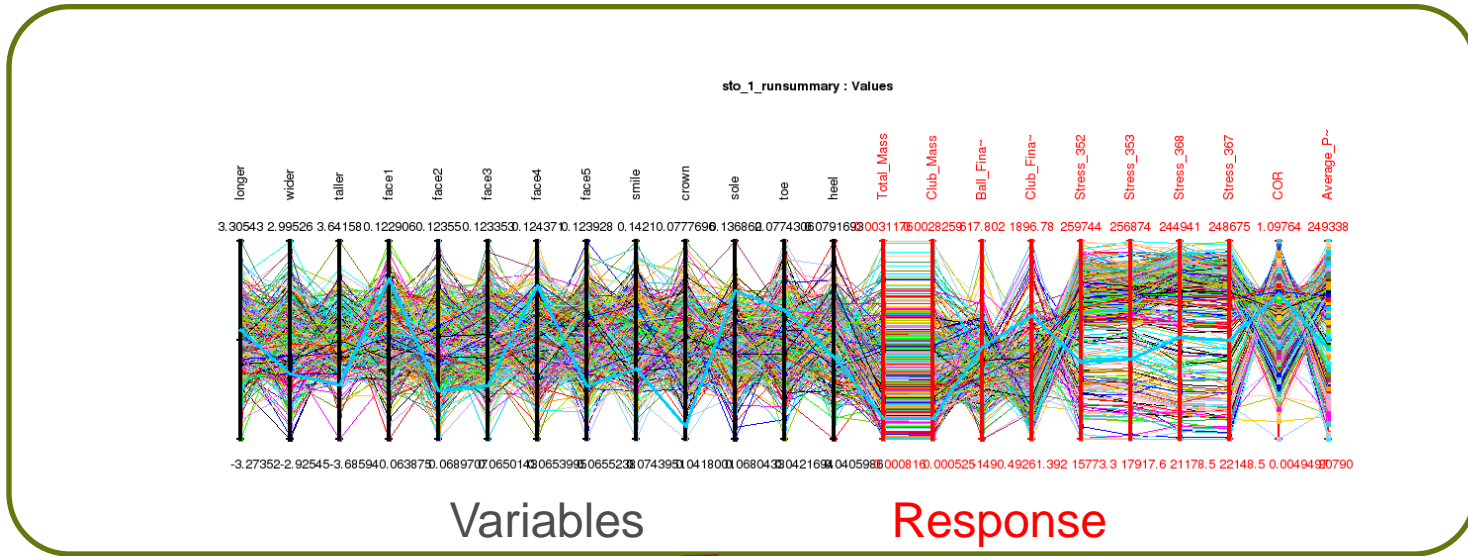
Infinite Exploration - Example



Infinite Exploration - Example



Infinite Exploration - Example



Results from Large DOE Run on the Cloud



Firefox v12.0.0 - Post-Processing

Altair Display Manager

v01:8086/pbsworks/ui/ihwod/ihwodportal.html?appid=1

Display Manager

ravi
0 Messages

File Options View Display Tools Main Preferences Help

Responses Variables Snake View

Variables

Input variables: 13
Output variables: 10
Samples: 100

Variables Samples Corridor Filter

Variable	Use	Min	Max
Stress_353	<input checked="" type="checkbox"/>	13288.672	254167.41
Stress_368	<input checked="" type="checkbox"/>	63679.805	249942.89
Stress_367	<input checked="" type="checkbox"/>	63425.652	247913.98
COR	<input checked="" type="checkbox"/>	0.65	0.8
Average_Peak_Stress	<input checked="" type="checkbox"/>	72261.31	150000

Use all Unsel all

And Or Find samples Default

doe_3_runsummary : Values

longer 0.75
wider 0.726562
taller 0.731482
COR 0.975786
Average_Peak_Stress 248513

-0.735 -0.738281 -0.743827 0.234354 72261.3

Close

Window Snip

Messages

Defining a Filter

The screenshot shows the HyperStudy v12.0.0 - Post-Processing interface. On the left, the 'Variables' panel is active, showing a table of variables with a red circle highlighting the 'Filter' section. The table lists variables and their minimum and maximum values. Below the table are radio buttons for 'And' and 'Or' logic, and buttons for 'Find samples' and 'Default'. On the right, a plot titled 'doe_3_runsummary : Values' displays data for five variables: 'longer', 'wider', 'taller', 'COR', and 'Average_P~'. Each variable has a vertical error bar and a horizontal line representing its value. The 'COR' and 'Average_P~' values are highlighted in red.

Variable	Use	Min	Max
Stress_353	<input type="checkbox"/>	13288.672	254167.41
Stress_368	<input type="checkbox"/>	63679.805	249942.89
Stress_367	<input type="checkbox"/>	63425.652	247913.98
COR	<input checked="" type="checkbox"/>	0.65	0.8
Average_Peak_Stress	<input checked="" type="checkbox"/>	72261.31	150000

doe_3_runsummary : Values

Variable	Value
longer	0.75
wider	0.726562
taller	0.731482
COR	0.975786
Average_Peak_Stress	248513.3

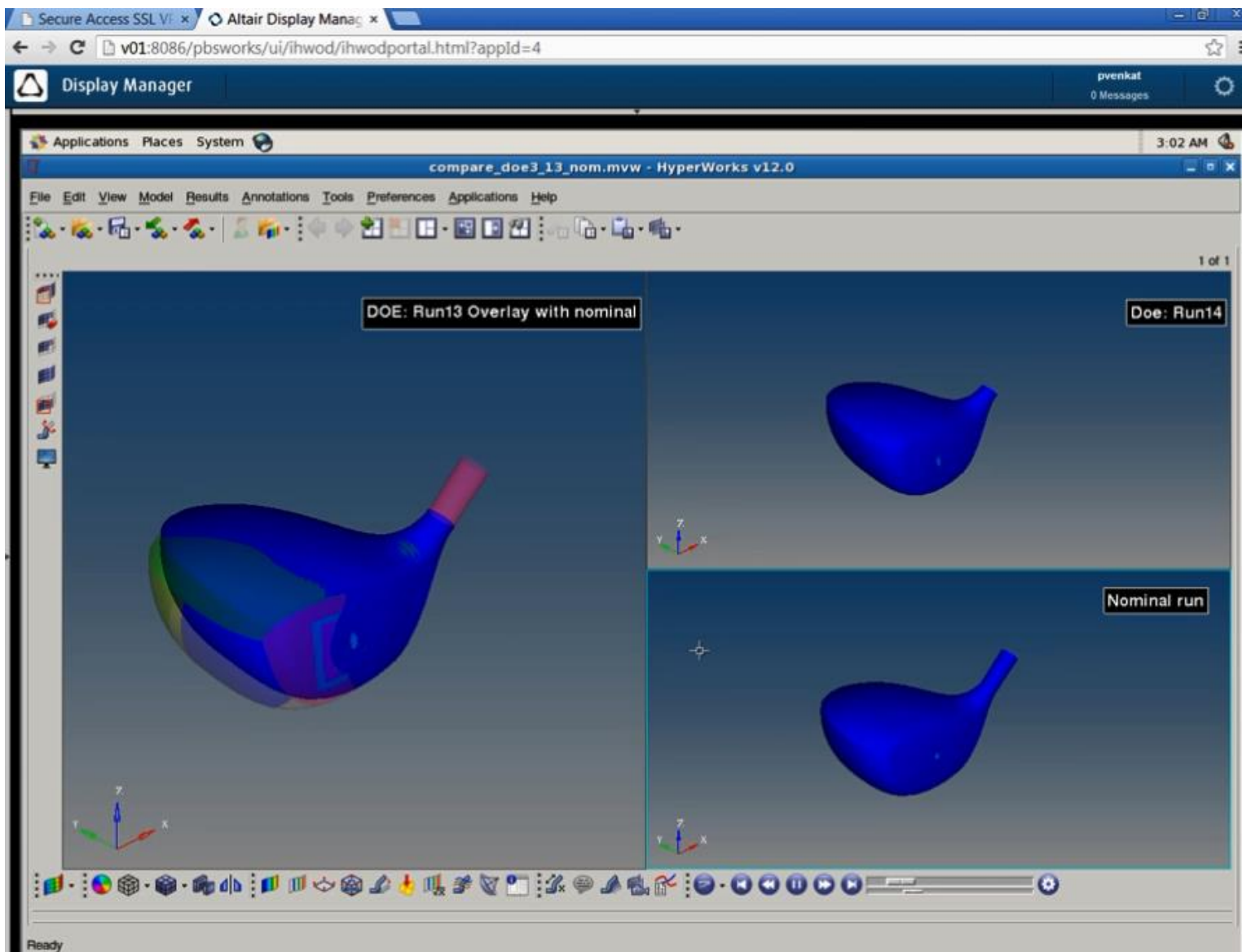
Isolating the best Possible Run from the Spread



The screenshot displays the HyperStudy v12.0.0 - Post-Processing interface. The main window shows a Snake View plot titled "doe_3_runsummary : Values". The plot displays five variables: longer, wider, taller, COR, and Average_P~. The values for these variables are: longer (0.75), wider (0.726562), taller (0.731482), COR (0.975786), and Average_P~ (248513). The plot also shows the range of values for each variable: longer (-0.735 to 0.75), wider (-0.738281 to 0.726562), taller (-0.743827 to 0.731482), COR (0.234354 to 0.975786), and Average_P~ (72261.3 to 248513). A purple line connects the mean values of the variables. The interface also includes a Variables panel on the left with input variables (13), output variables (10), and samples (100). A list of sample names is shown, with Row_0013 highlighted. The interface includes a menu bar (File, Options, View, Display, Tools, Main Preferences, Help) and a toolbar with various icons. The browser window shows the URL "v01:8086/pbsworks/ui/ihwod/ihwodportal.html?appId=1".

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

Video Comparing Nominal vs. Zeroed in Design



Time Savings Running on the Cloud

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

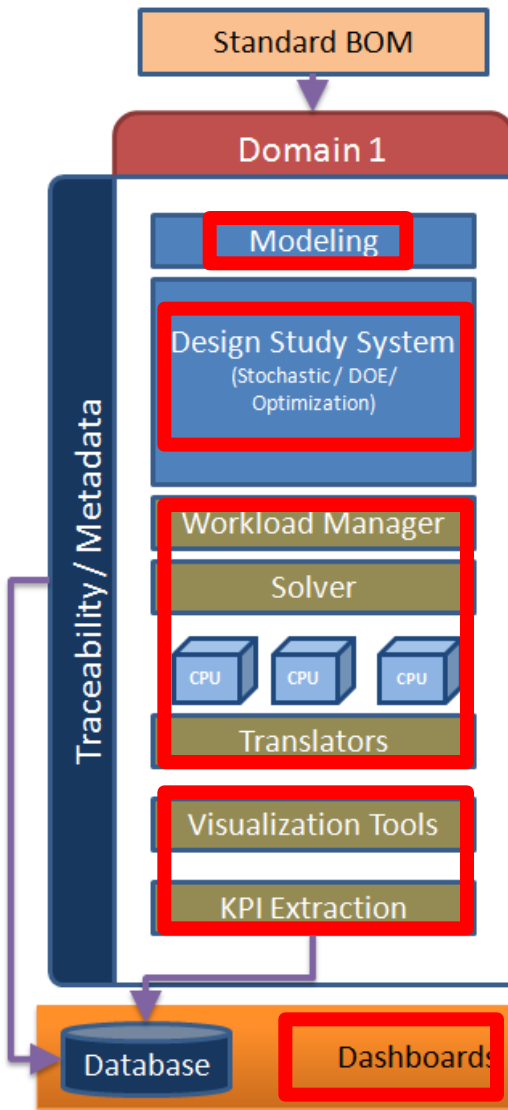


100 Runs DOE or Stochastic Run		Download Time (Hours)	Simulation Time (Hours)
	File Size	(50 Mbps Connection)	50 Mbps (Connection)
Crash Medium	10 Gb	2.5	0.5
Crash Large	50 Gb	11	2
CFD Medium	100 Gb	23	4
CFD Large	4 Tb	936	168

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

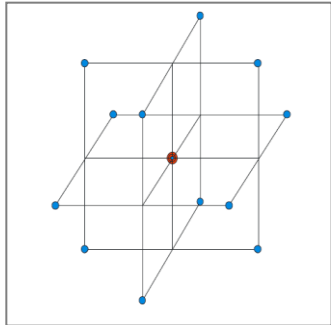


NVIDIA Kepler & Quadro Cards

Going Beyond

Step 1

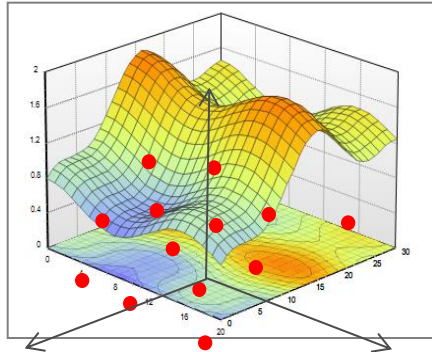
Creating an experimental design



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

Step 2

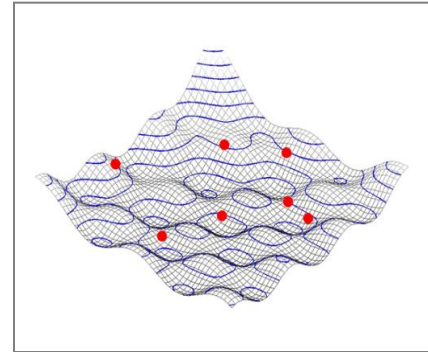
Build the surrogate model



- Least square
- Moving least square
- HyperKriging

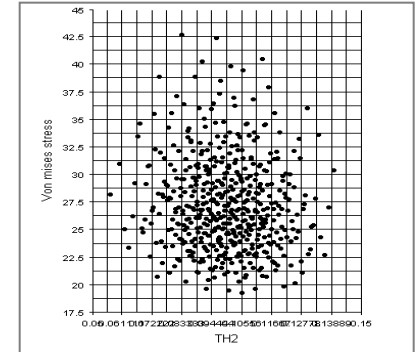
Step 3

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

Cloud Solutions

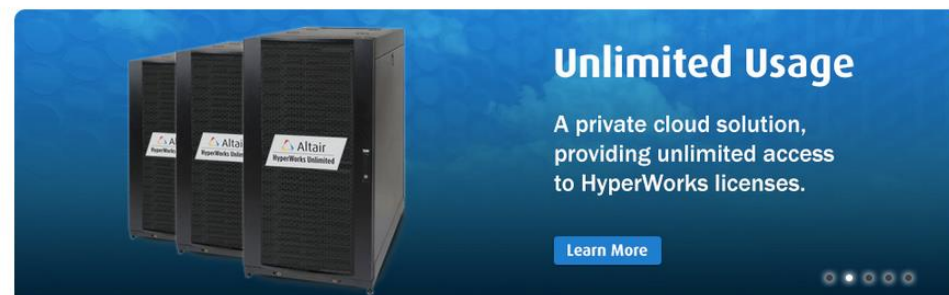


HPC Made Easy

Lowering the barriers to HPC access through cloud technologies.

[Learn More](#)

This banner features a dark blue background with a laptop, a desktop monitor, and a tablet displaying various data visualizations and software interfaces. A 'Learn More' button is located in the bottom right corner.



Unlimited Usage

A private cloud solution, providing unlimited access to HyperWorks licenses.

[Learn More](#)

This banner shows three server racks with the Altair HyperWorks logo on them, set against a blue background. A 'Learn More' button is in the bottom right corner.



Visualize Big Data

Remote visualization of big data through a single web portal, minimizing data transfer.

[Learn More](#)

This banner displays a laptop, a desktop monitor, and a tablet showing data visualization software. A 'Learn More' button is in the bottom right corner.

Thank You!