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...an HBM brand

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HyperWorks
Engineering Simulation Platform

PBS Works
On-demand Computing Technology

Altair ProductDesign
Product Innovation Consulting

HiQube
Enterprise Analytics Solutions

solidThinking
Industrial Design Technology

ilumisys
Solid State Lighting Products

Durability Overnight

A Grand Challenge

Oct. 2010

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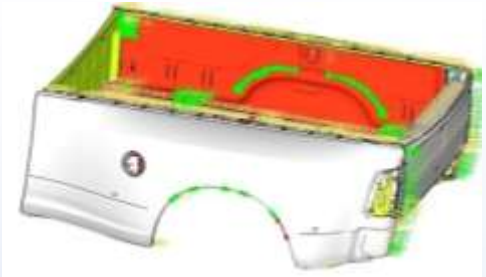
Agenda

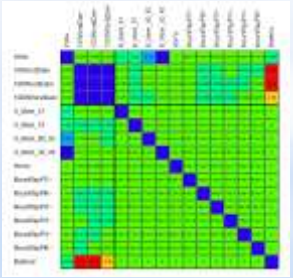
The Challenge



What does “Durability Overnight” mean?

Review the CAD2Crash24 “Grand Challenge”
Set the objectives
Introduce the key enablers and the process

The Results



What was the analysis outcome?

Baseline gating runs
DoE set up and results
Design insight from the study automation

The Lessons

What can we learn from this Grand Challenge?

CAE application throughout a development program
Process improvements
Review of efficiency strategies

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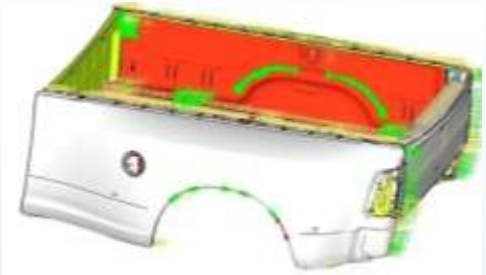

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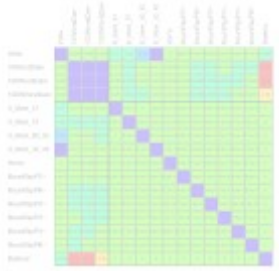

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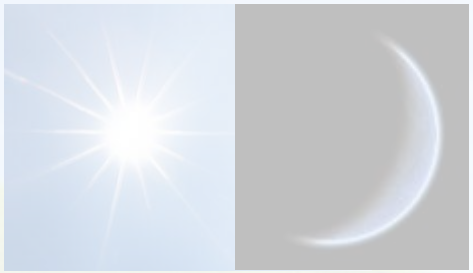

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CAD2crash24 timing report card

Task	Budget (Hours)	Actual (Hours)
	2	1.5
esh	2	1
	2	1.5
lts, Welds, Glues)	4	2
	2	2.75
	2	3.25
	2	1.5
	6	6.5
Reporting	2	1
Total	**24**	**21**

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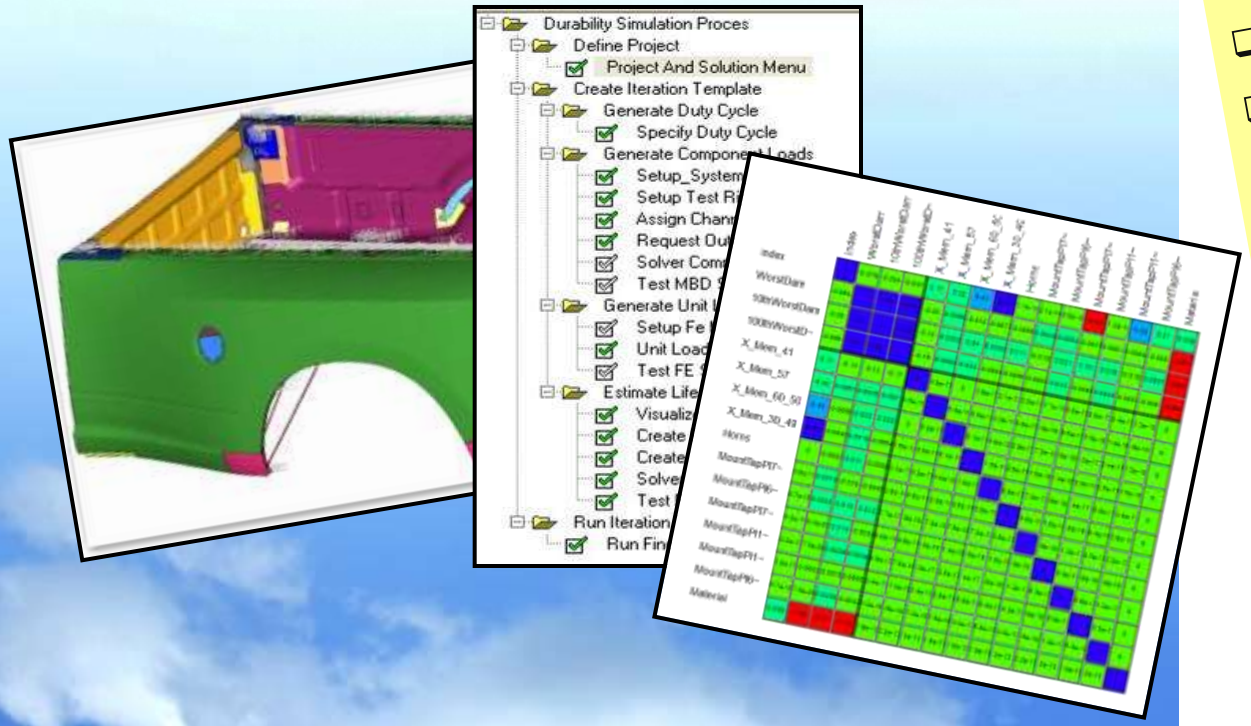
Push the boundaries again for EHTC

A "Grand Challenge" to build on the success of CAD2crash24 applying a combination of Altair HyperWorks and HyperWorks Partner Alliance products. Start with CAD one morning, complete fatigue simulation by the end of the same working day and have the results of a design study ready for review the next morning.



Durability Process

- ❑ *Meshing*
- ❑ *Assembly*
- ❑ *Normal Modes (Model Check)*
- ❑ *FE Load Location & Orientation*
- ❑ *Fatigue Simulation 70pc gating*
- ❑ *Reduced element set*
- ❑ *Fatigue Simulation 5pc gating*
- ❑ *Design variant study*

Developed in partnership with:

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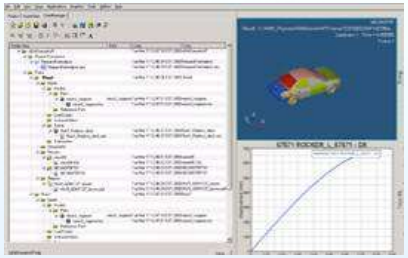
Key enablers

Hyperworks Process Automation

Comprehensive process automation framework for CAE automation, process guidance, and process integration



Capture Best Practices

Leverage Domain Expertise

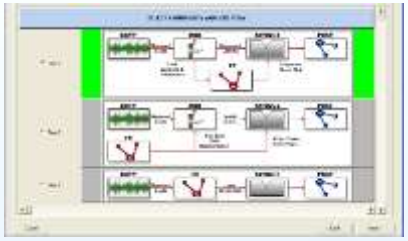
Improve Reliability & Repeatability

Improve Productivity

Integration

Durability Director

Integrating the data, tools and processes required to enable engineers to develop better products, faster



Combines Altair's industry experience with the HyperWorks platform

Provides an "off-the-shelf" level of increased efficiency

PBSWorks Job Management

Job Scheduling
Job Monitoring
Batchmeshing
Assembly

Shorten design times

lower infrastructure costs

Maximize the utilization of HPC systems

prioritize projects

HyperWorks Partner Alliance

DesignLife provides fatigue life prediction from finite element results even have prototype

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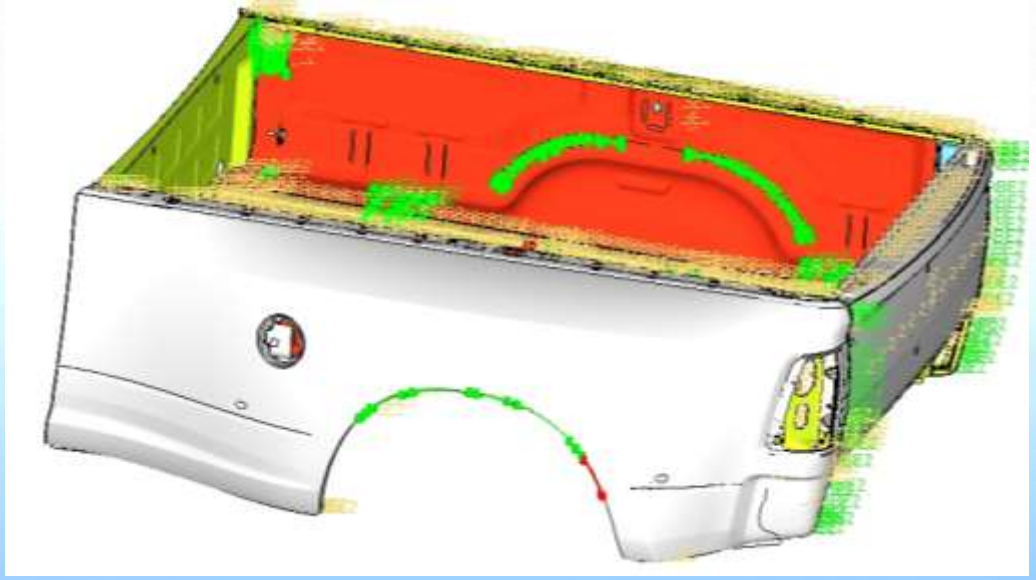
Compare and evaluate design alternatives

Better understanding of product performance

Get better products to market faster

The Durability Overnight model & study



Truck box meshed from CAD data provided by

Early design iteration for a new 8ft heavy duty dually pick-up box

90 parts
1110 spot welds
9 patches of adhesives

1.06 million elements

Concentrated mass of 1.45 Mg on the bed

2 loads variants from Chrysler duty cycles
3 material variants from Chrysler database
3 gauge variants (nominal & +/- 10%)

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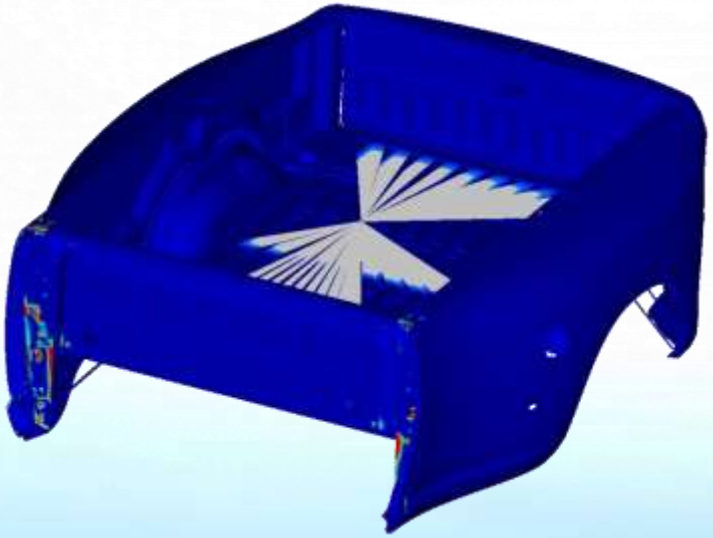
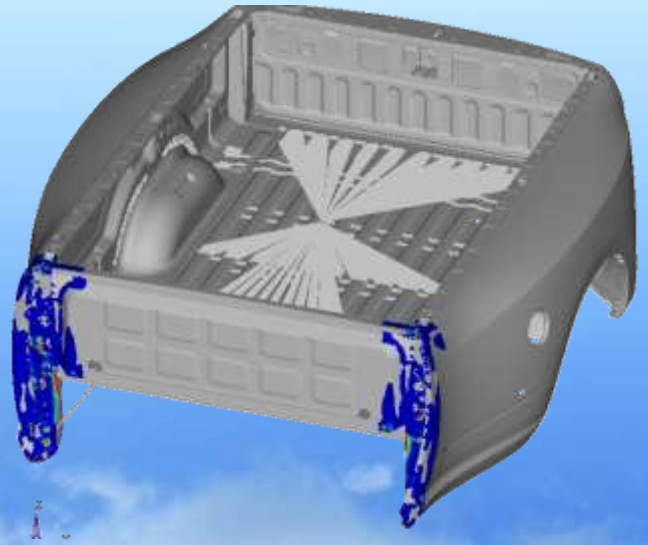
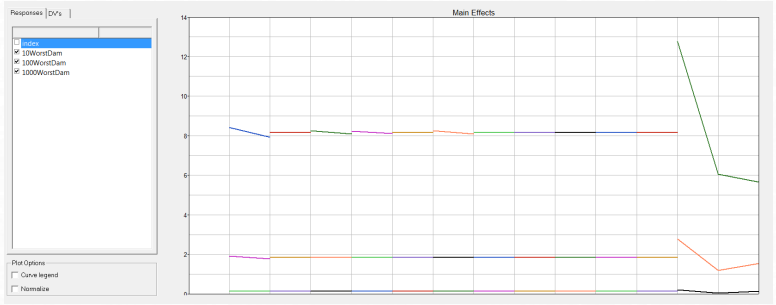
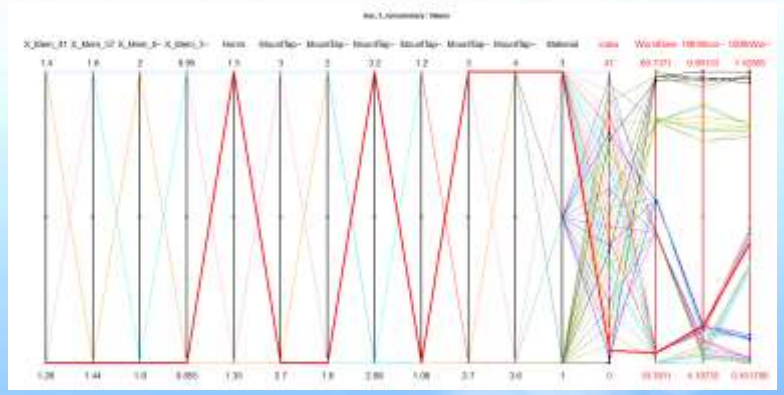
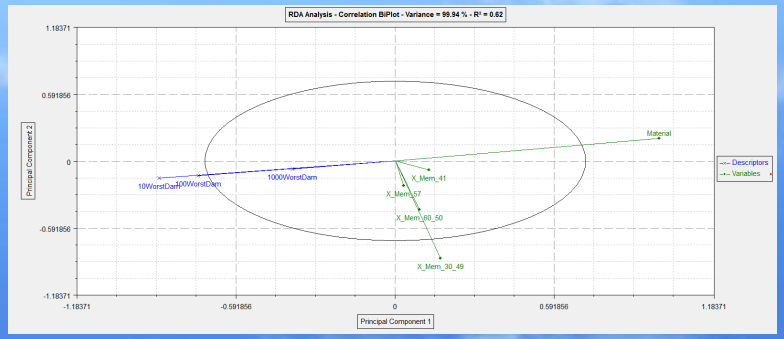
Simulation & study results











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Timing report card

Task	Budget (minutes)	Actual (minutes)
BatchMesh	60	27
Assembly	240	5
Connections		65
Load Mapping & Model Validation		180
Unit Load Step Association	20	5
Unit Response Analysis	20	16
Load History Assn & Subset Creation	20	10
Fatigue Analysis – 70% gating	60	16
Fatigue Analysis – 5% gating Reduced set	30	26
Fatigue Analysis – DoE Study	15*48	480
Total	1170 **19.5 hrs**	830 **13.8 hrs**

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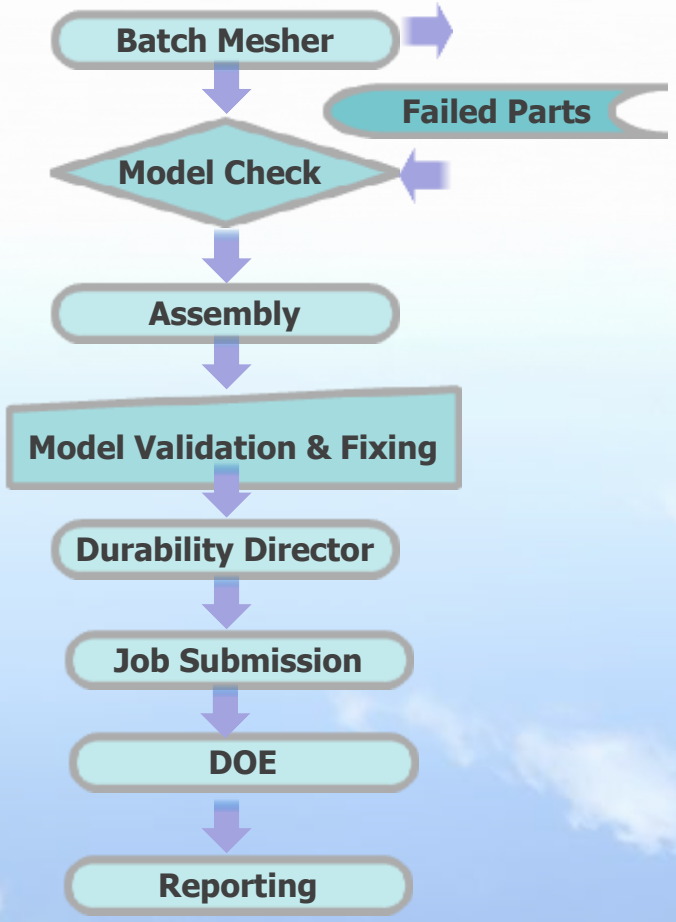
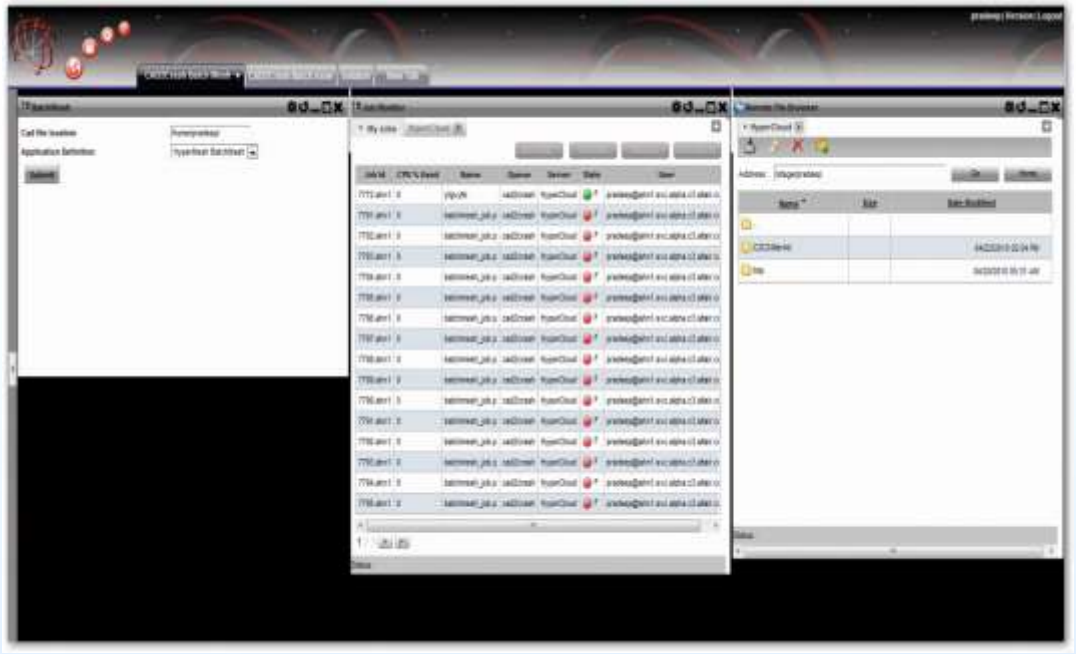
Durability Overnight – Process Overview

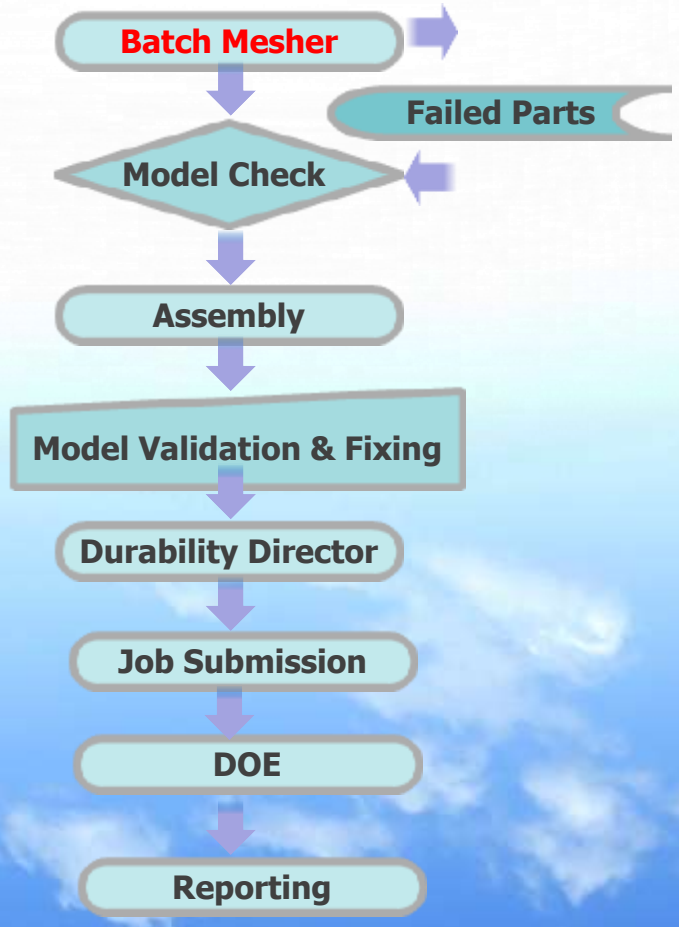


HyperMesh Batch Mesher

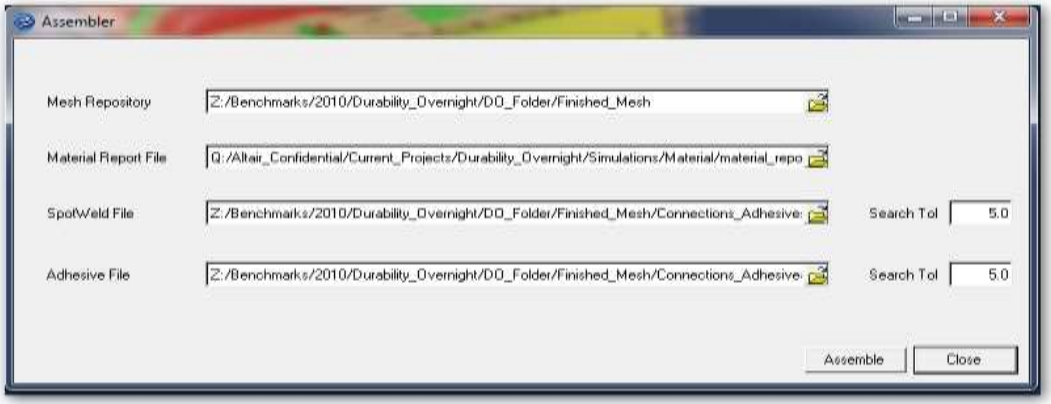


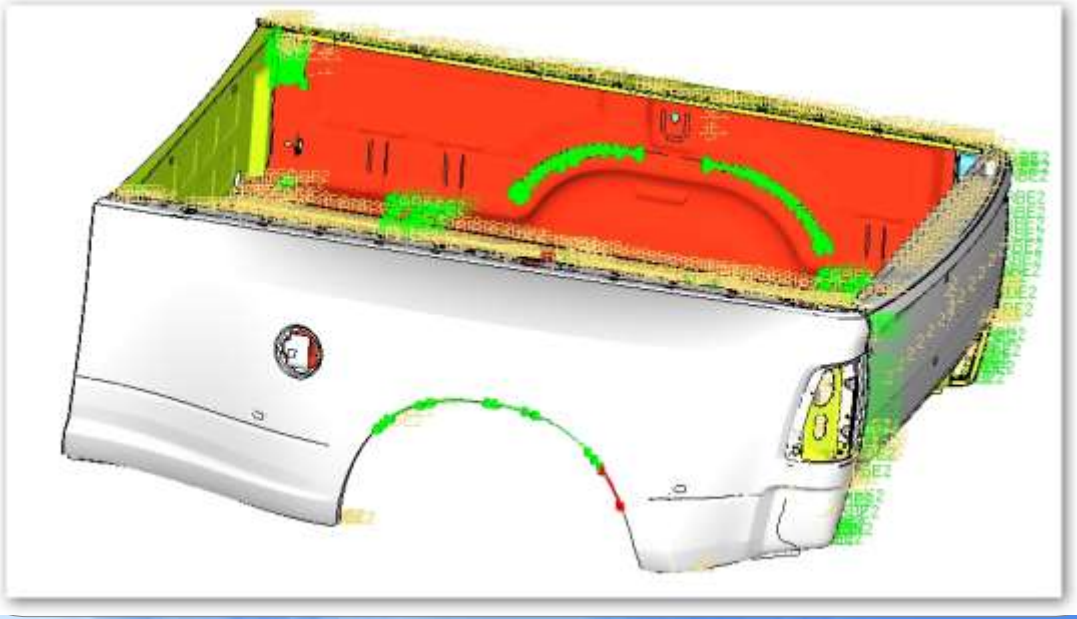
Submitted to "HyperWorks on Demand "

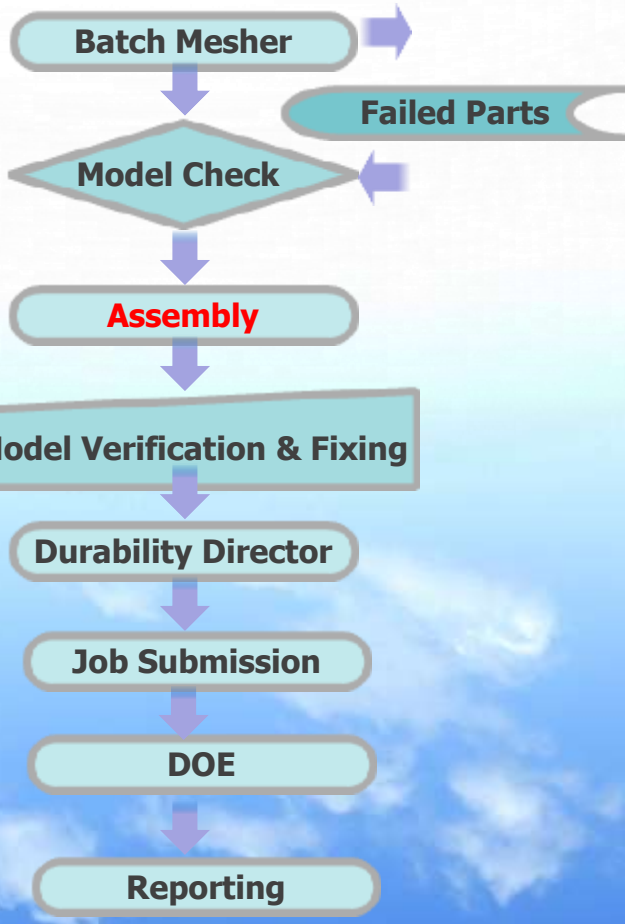
through PBS Catalyst



Assembly

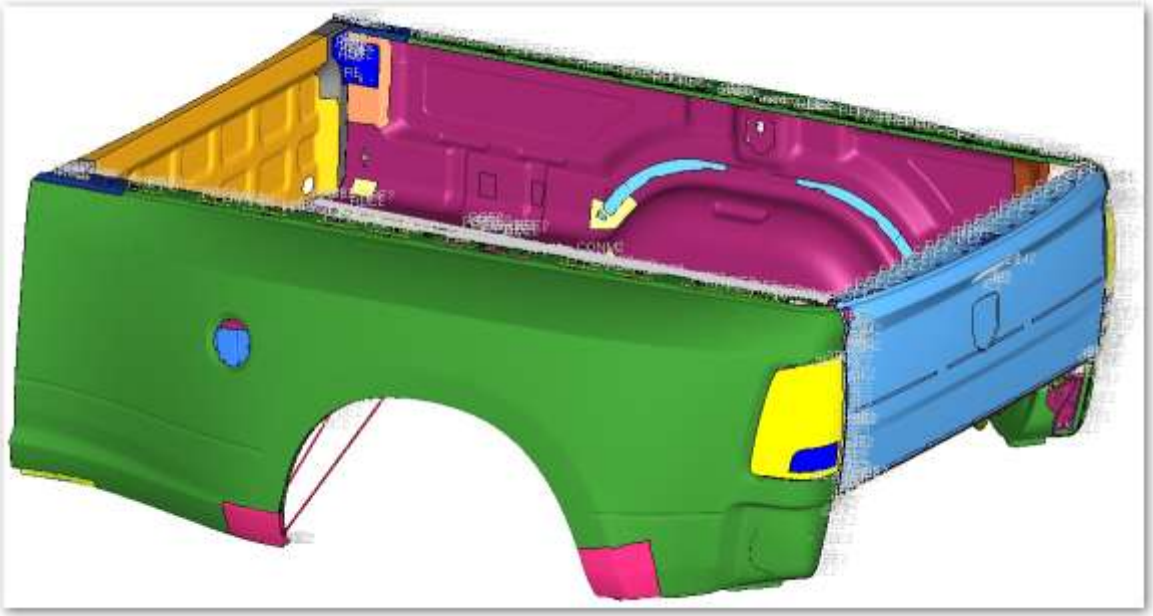


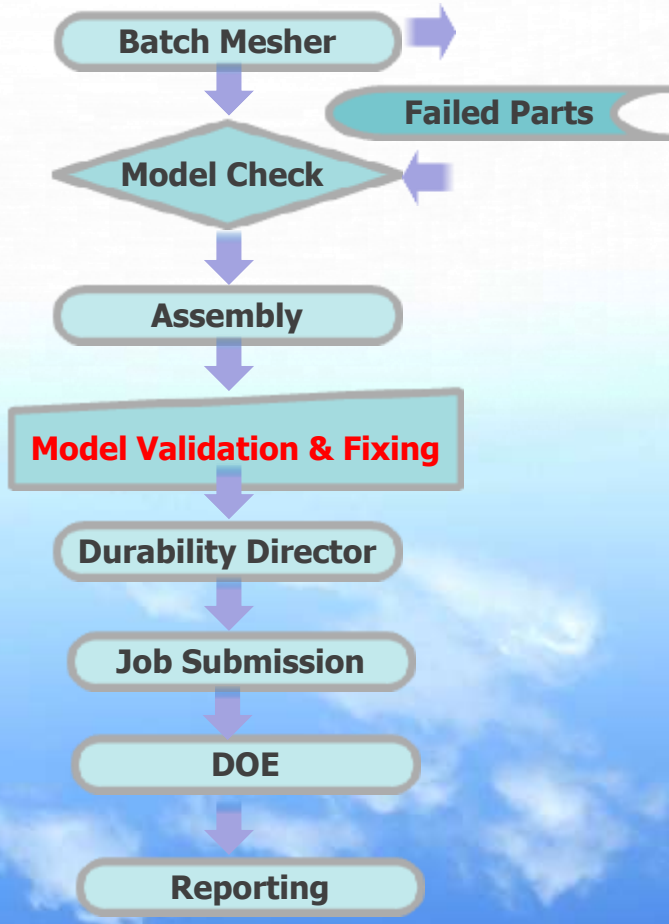




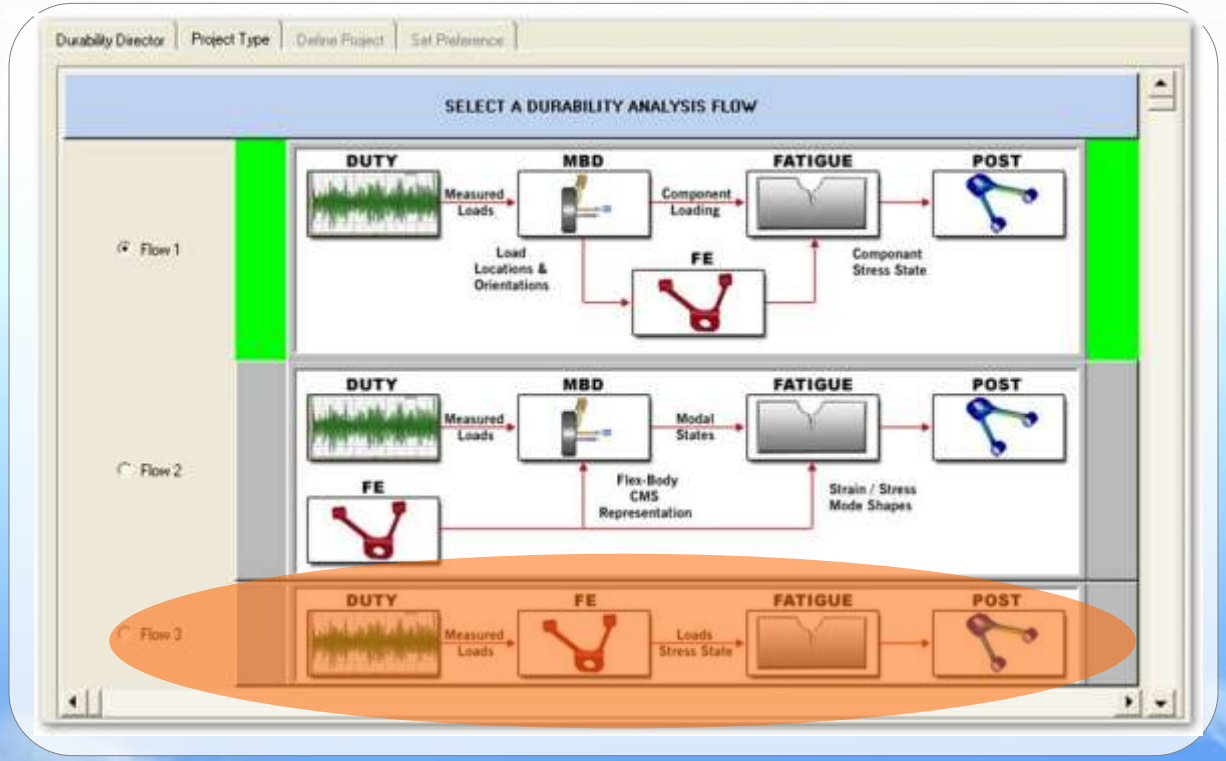
Model Verification

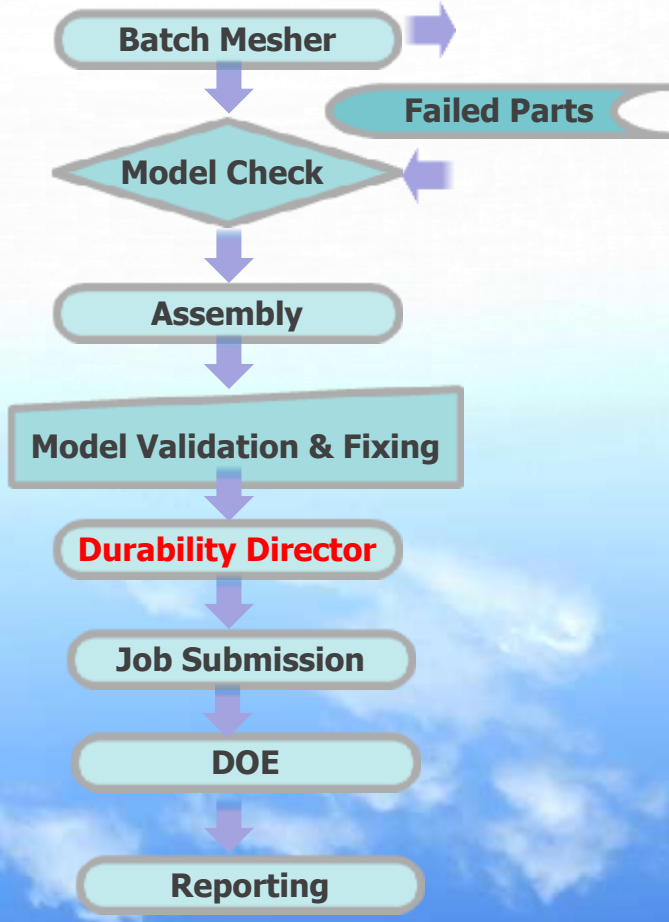
- ✓ Manual Verification and Fixing of Welds
- ✓ Manual Creation of Some Connections (Bolts)
- ✓ Normal Modes for Model validation





Durability Director





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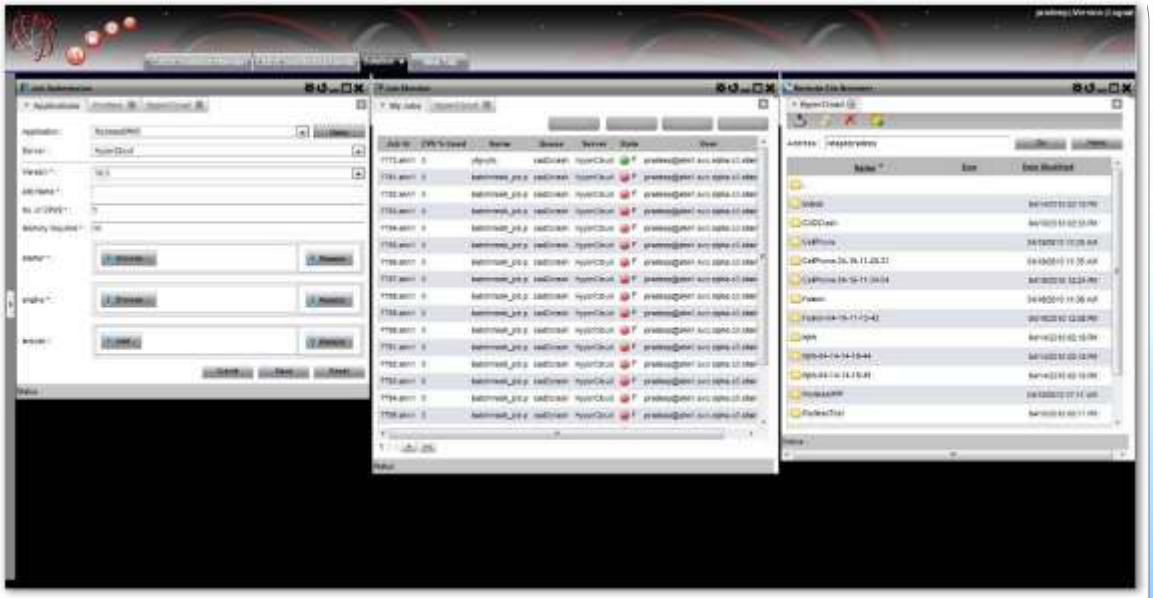
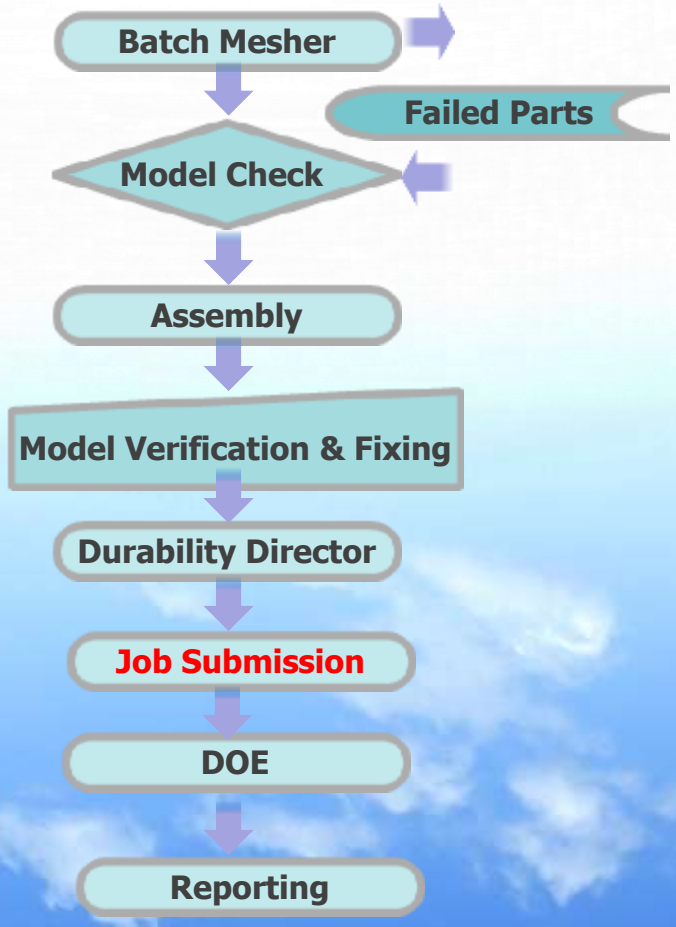
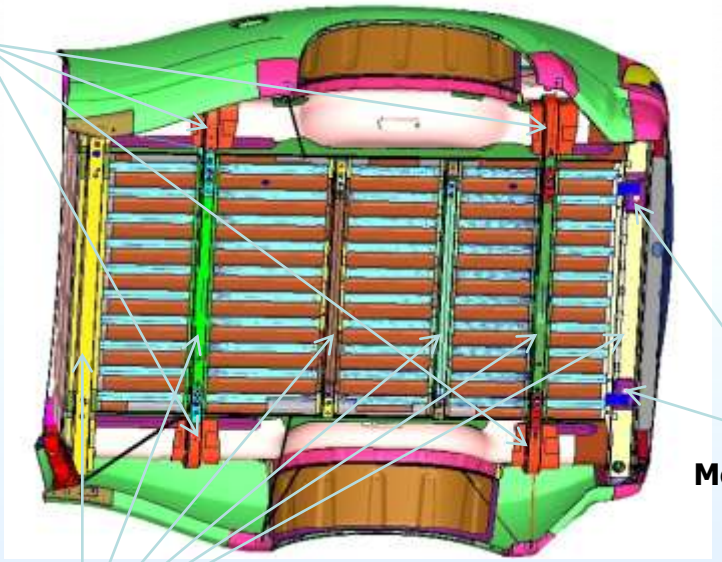
Job Submission Baseline



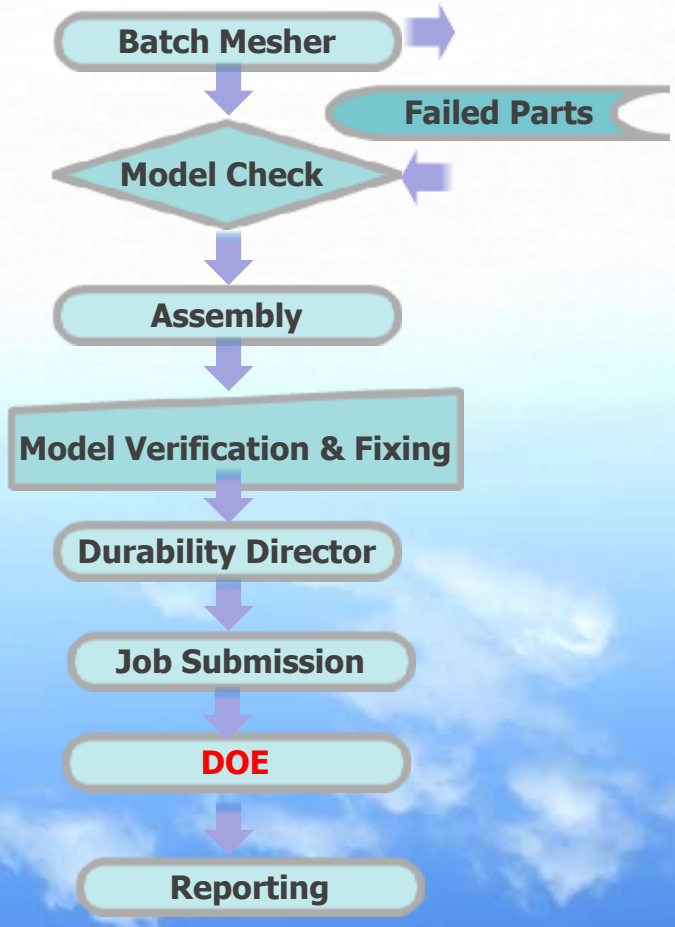
Fatigue Solver - ncode



Job Submission – DOE - Fatigue



Cross Members (there are mount tapping plates inside of cross members)



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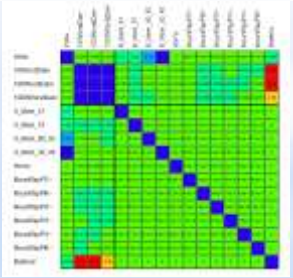

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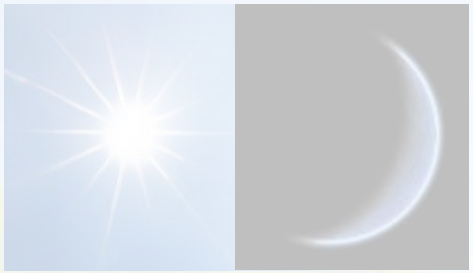

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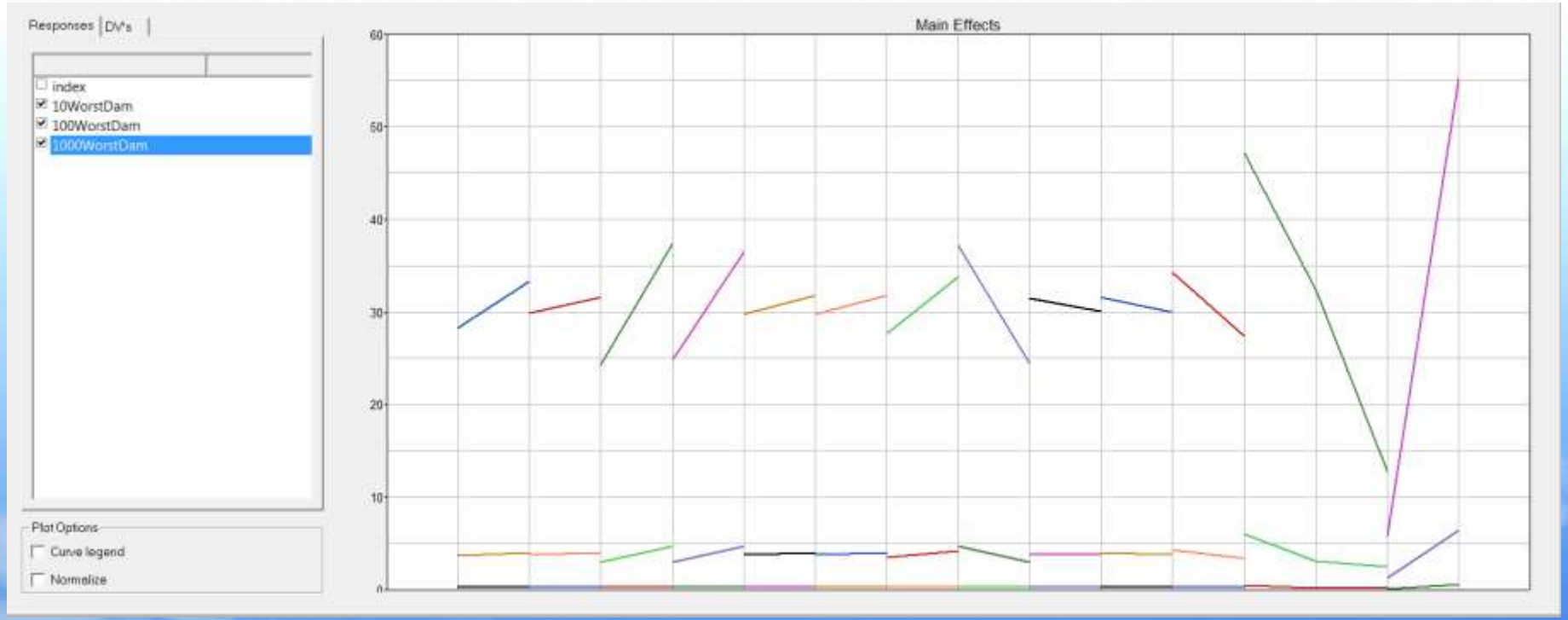
DoE Main Effects

From this chart, we can conclude that the first gauge and material variables have the most significant effect on the worst damage value.



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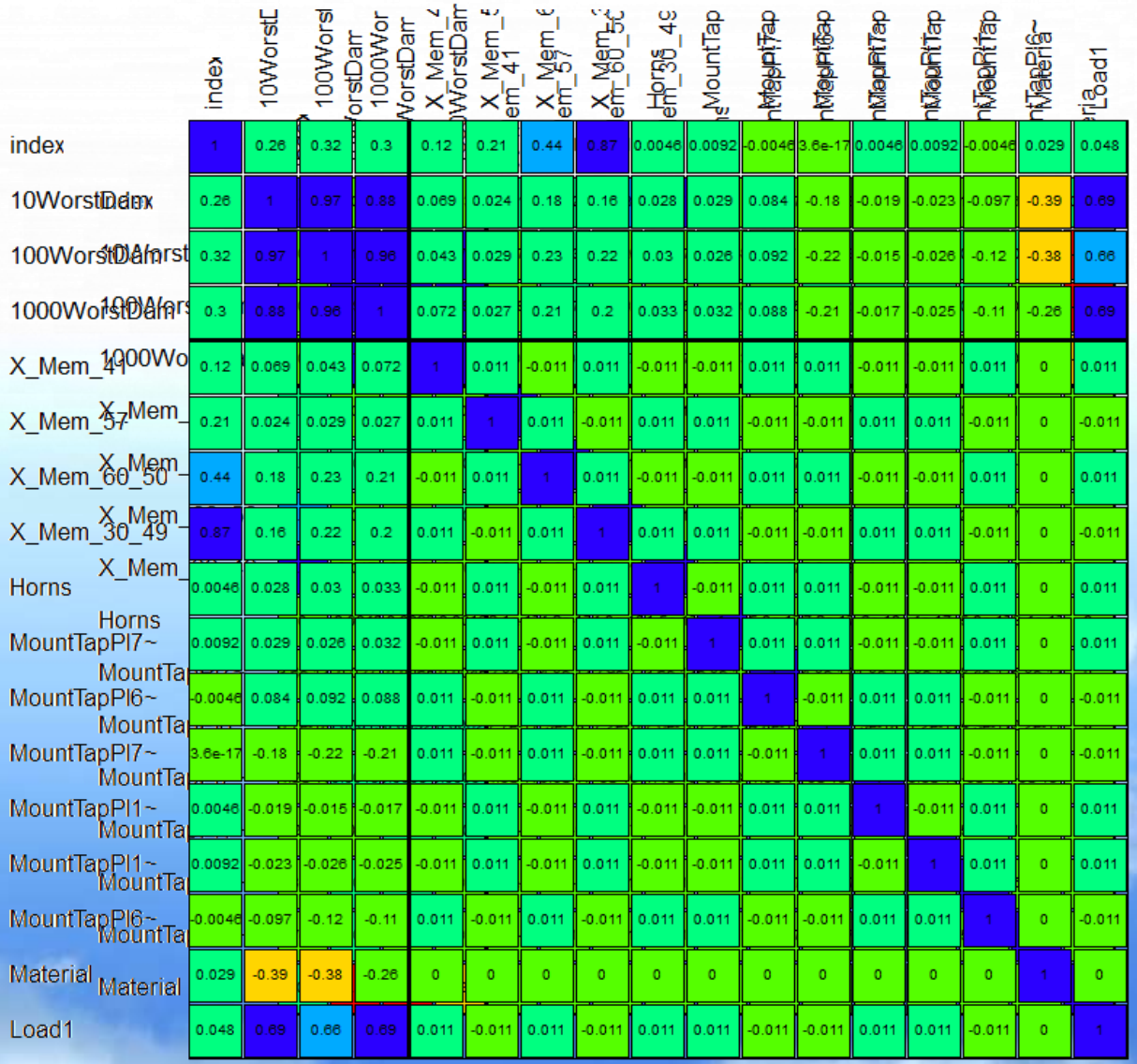
DoE Correlations

From this chart, we can conclude that material variable has the most significant effect on the worst damage values.

Blue (positive values) indicate significant positive correlation.

Red (negative values) indicate significant negative correlation



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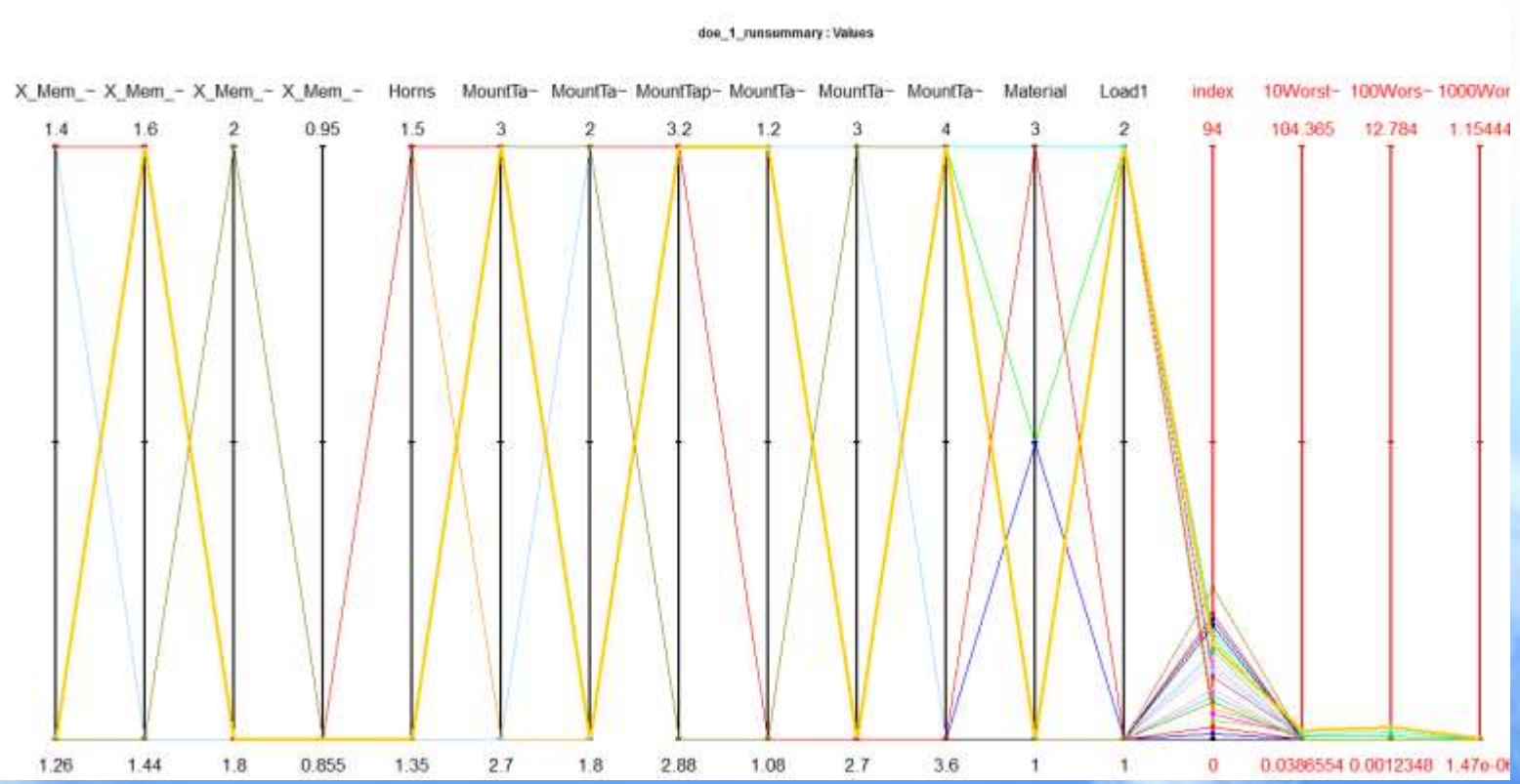
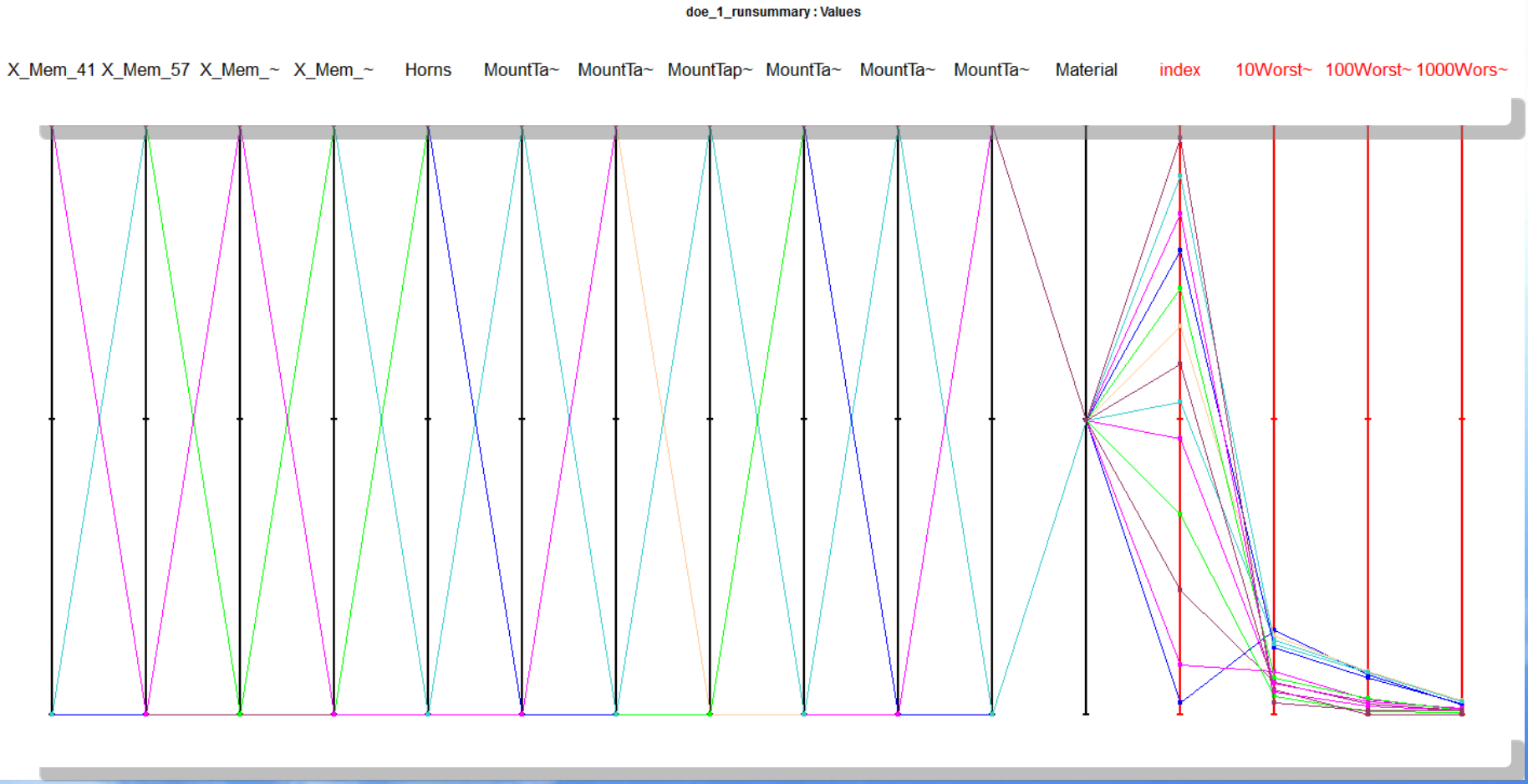
DoE SnakeView- With Load Variants

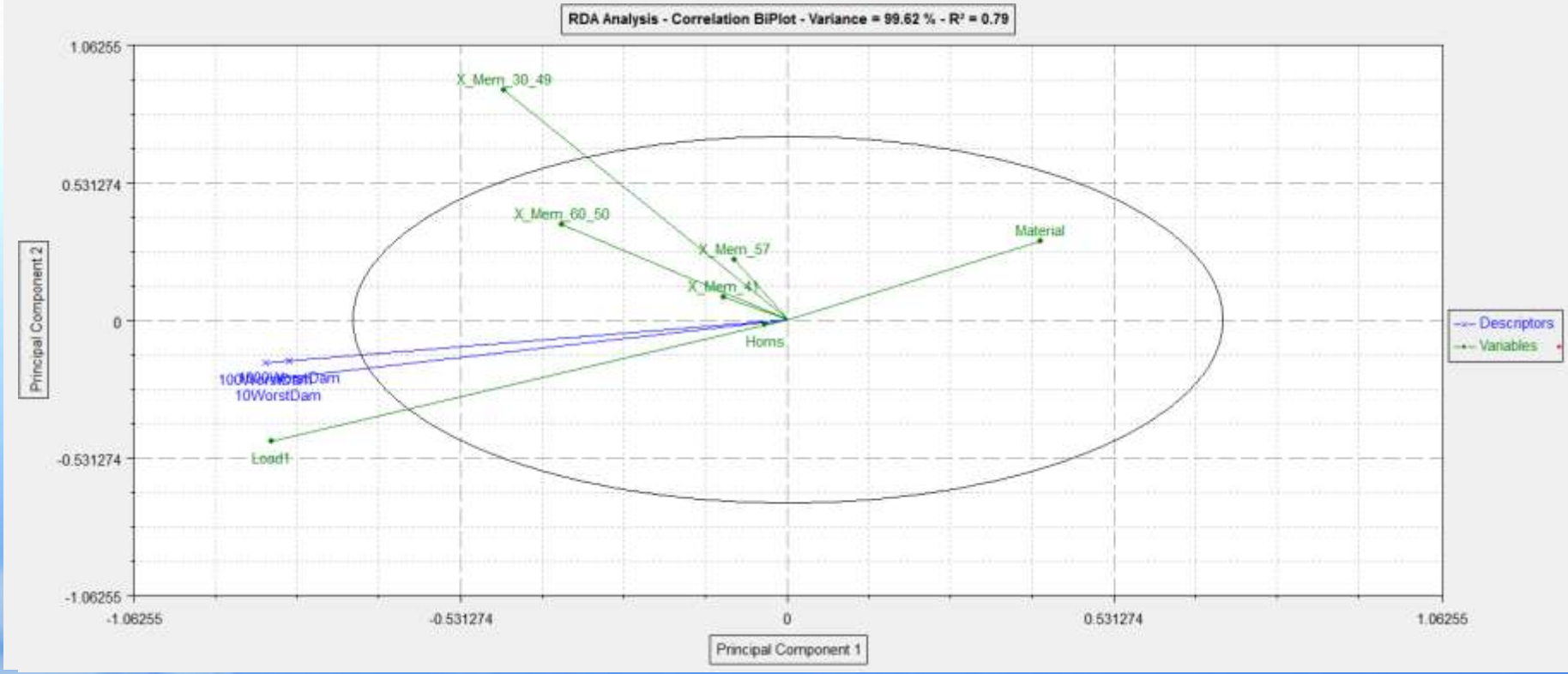


DoE SnakeView – Without Load Variants



DoE Redundancy Data Analysis

From this chart we observe that the damages are related to each other and inversely and strongly proportional to material.



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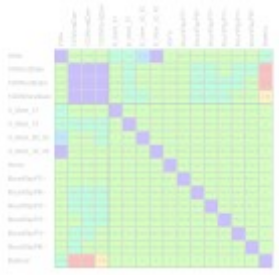

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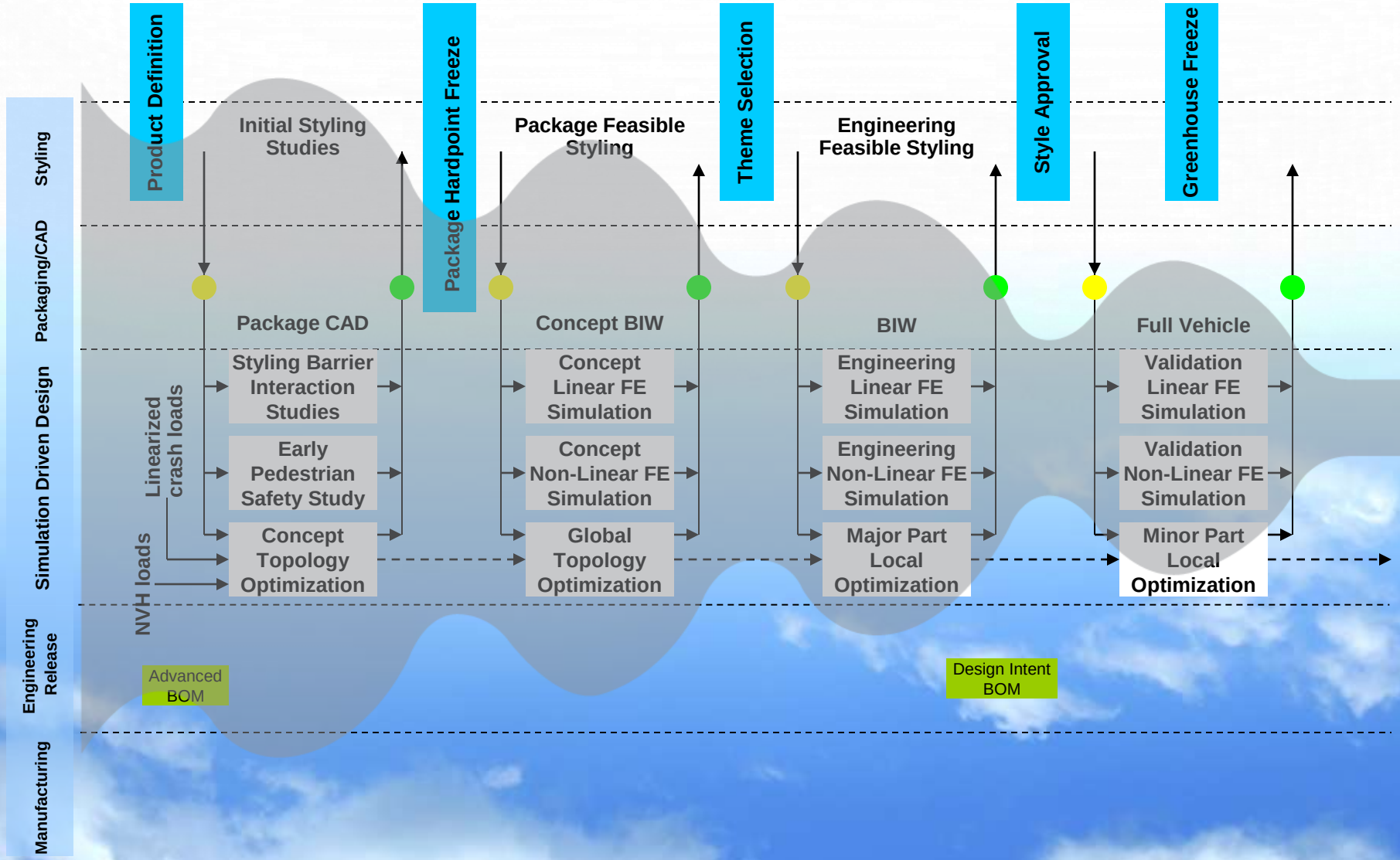
Modern CAE in a program landscape plan (1/2)



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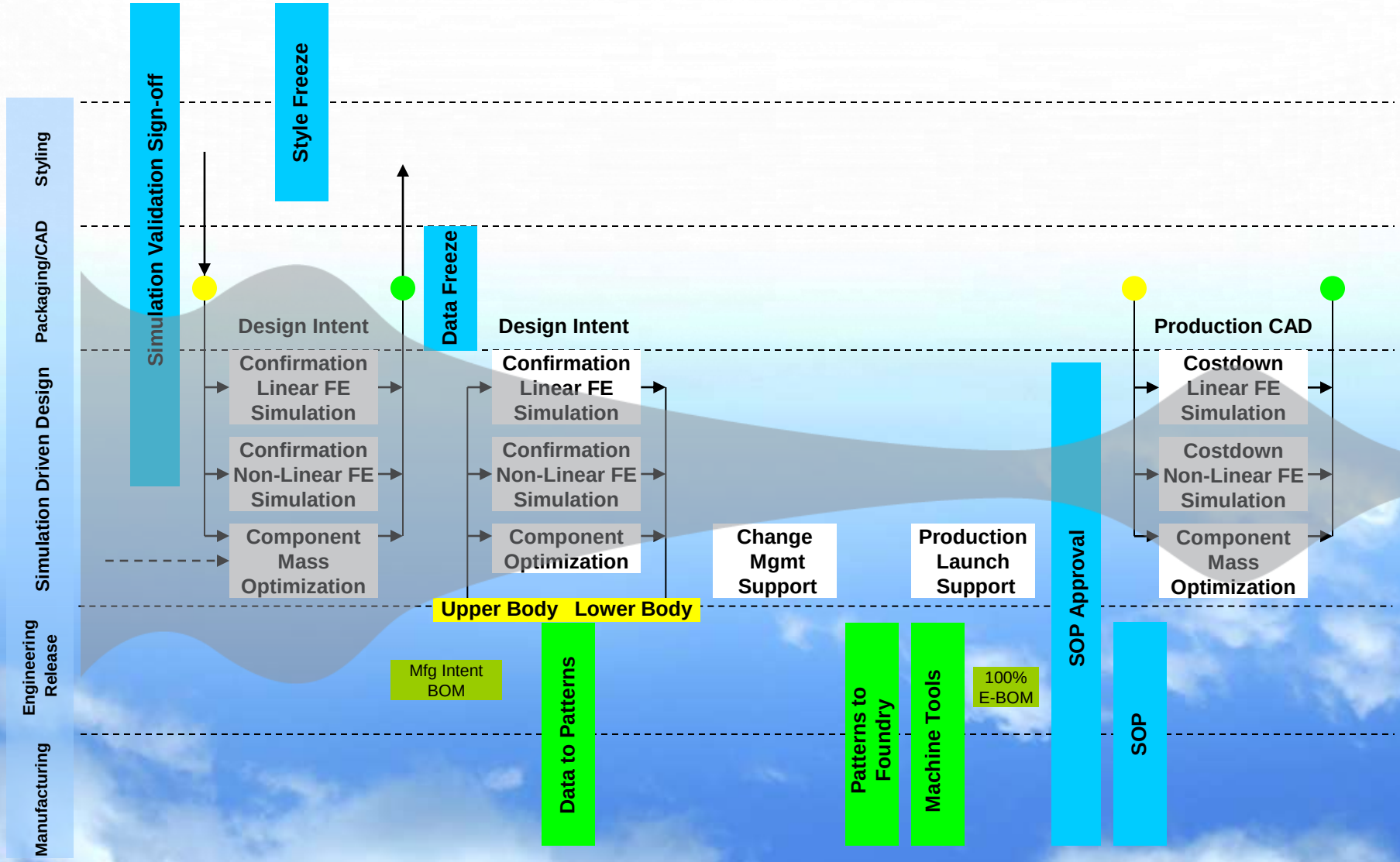
Modern CAE in a program landscape plan (2/2)



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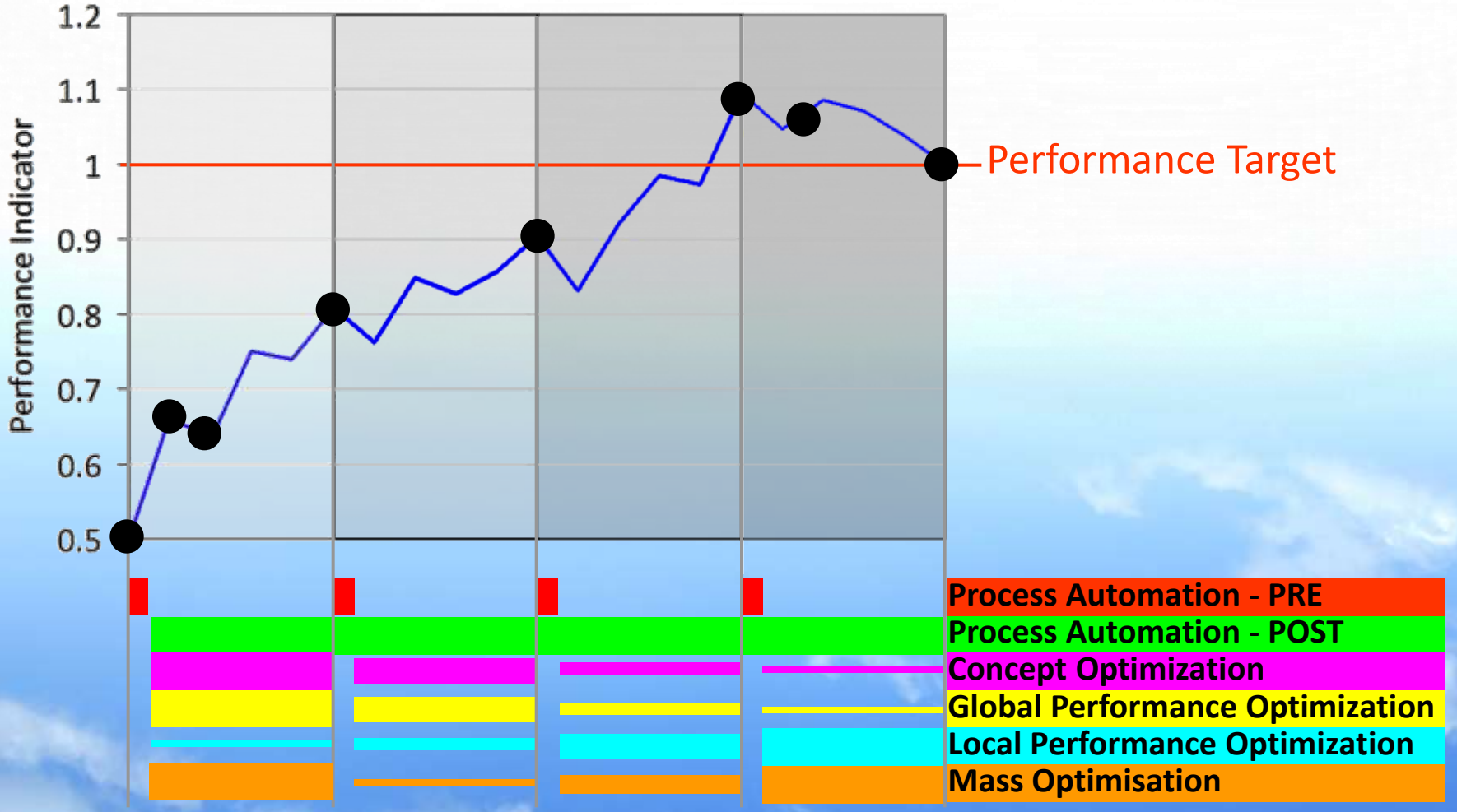
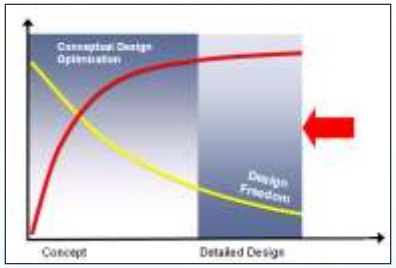
Simulation driven program performance

<Engineering Start> <Gateway 1> <Gateway 2> <Tooling Start> <Prototype >



Key strategies

Massive deployment of optimization



From concept to release

Global - identify opportunities and trade-offs in the body structure design

Local - topology analysis to define lightweight designs that meet vehicle targets.

Mass sensitivity analysis to identified the least contributing panels for all linear load cases

Focus engineers on high value tasks

Utilize automation

Can achieve a 30% engineering cost save for the customer

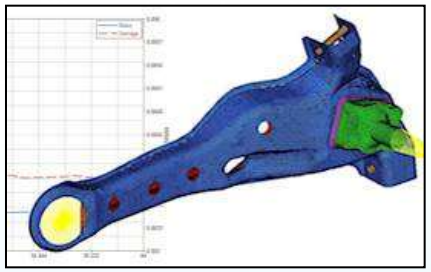
Facilitate faster simulation driven design

System integration

Process guidance

Process automation

Make informed design decisions

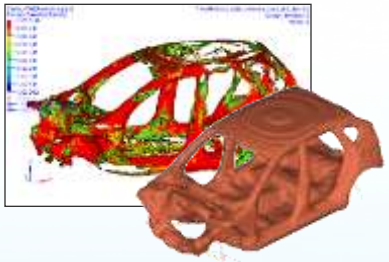


Using study techniques

DoE helps engineers to understand the relationship between design variables and overall system performance.

Stochastic studies assess reliability and robustness of designs and provide guidance to improve and optimize the designs

Apply technology in new ways



Move beyond "best practice"

New methods like the "moving boundary" crash optimization technique reduce design iterations and improve performance

Inspiration from technology application in other industries

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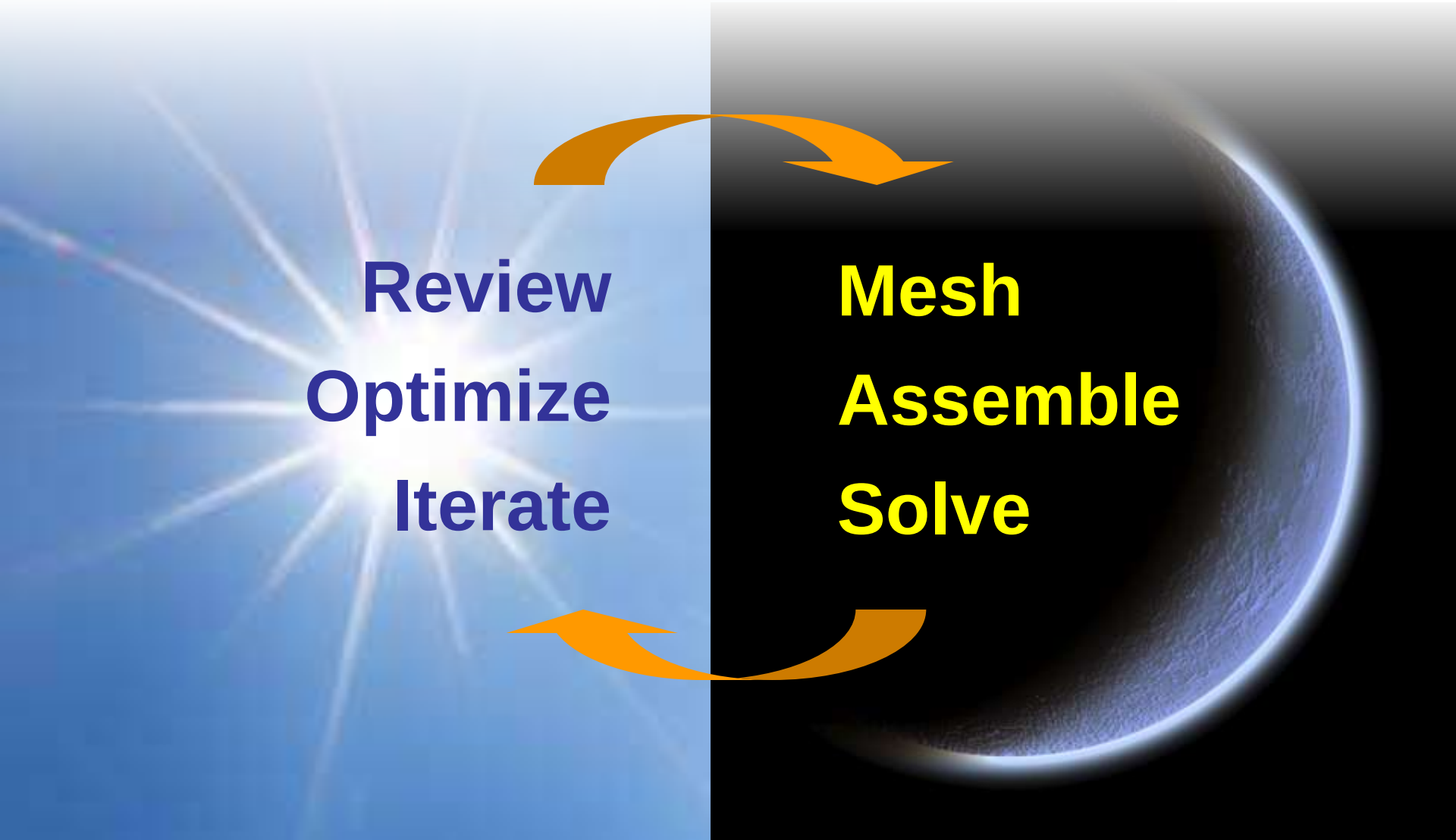
Let Engineers be Engineers



Conclusion

“ΠΑ ΒΩ ΚΑΙ ΧΑΡΙΣΤΙΩΝΙ ΤΑΝ ΓΑΝ ΚΙΝΗΣΩ ΠΑΣΑΝ”

“Give me a place to stand and with a lever I will move the whole world”

Archimedes

Use our Grand Challenges as your lever for change