Cad cleaning morphing and meshing with Altair tools

CINECA
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Altair

Introduction

Altair

Altair Introduction

Founded ...

In 1985 as a product design consulting company

Today

30+ years driving innovation

$300+ million in revenue

45+ offices in 22 countries

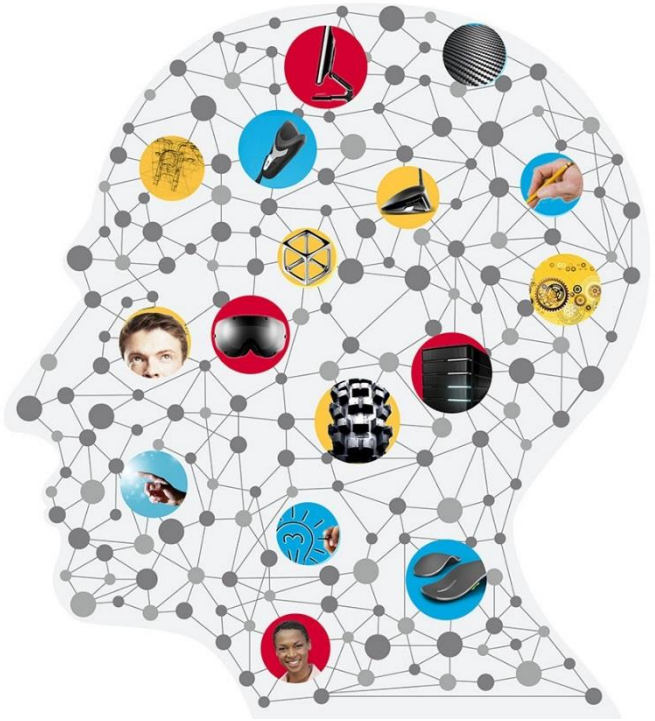
2,600+ creative designers, engineers, scientists, and developers

150+ technology and business partners

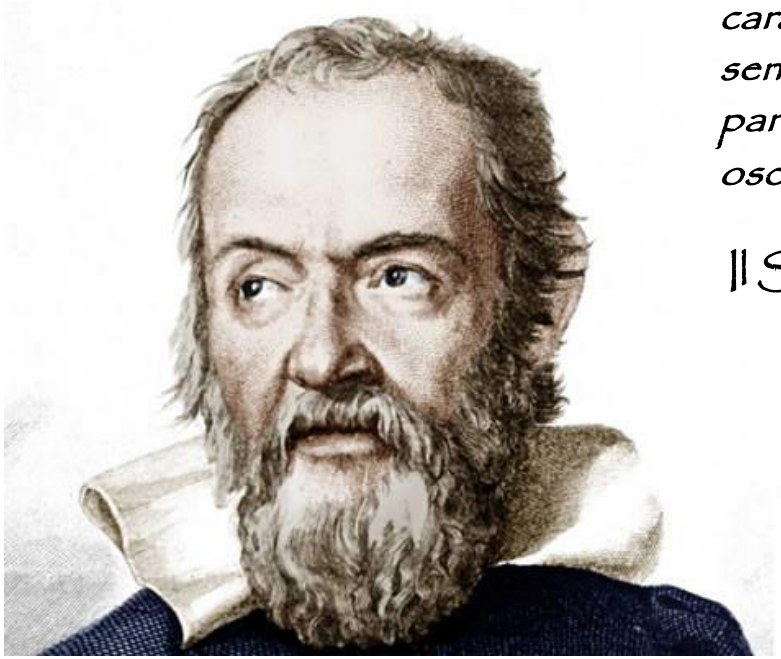
5000+ customers

Altair Vision

To radically change the way organizations **design products** and **make decisions**



Numerical Modeling Evolution



"Egli (l'universo) è scritto in lingua matematica, e i caratteri son triangoli, cerchi, ed altre figure geometriche, senza i quali mezzi è impossibile a intenderne umanamente parola; senza questi è un aggirarsi vanamente per un oscuro laberinto."

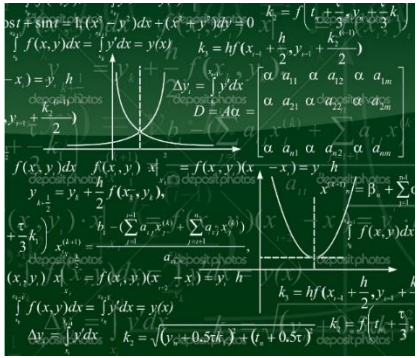
Il Saggiatore, Cap. VI

Galileo Galilei

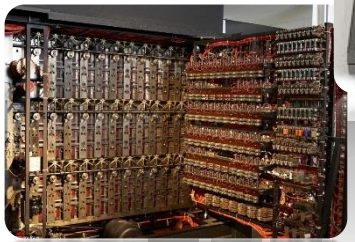
Numerical Modeling Evolution

Galileo Galilei

Numerical Modeling Evolution



The Nature “became Mathematic”, and the “Mathematic became” computing



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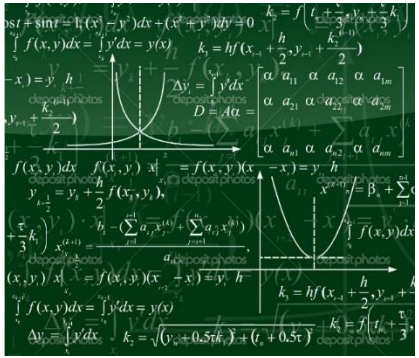

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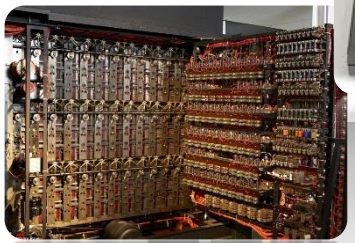
Software and Hardware are symbiotic



Altair Portfolio Evolution

To Increase our added value for the user at any level

Altair HyperWorks
Comp Mechanics
1996

PBS Works
2003

mecalog
HiQube
2006

solidThinking
2008

SimLab
2010

ACUSIM SOFTWARE
Synopsis CONSULTING
2012

FluiDyna
2014

EMSS
CLICK2CAST
Multiscale Design Systems
2015

CEDRAT
2016

Focus

- ✓Pre and Post Processing
- ✓Industrial process flow, the engineers daily working
- ✓ Morphing and Optimization of Multiphysics Phenomena

Pre and Post Processing

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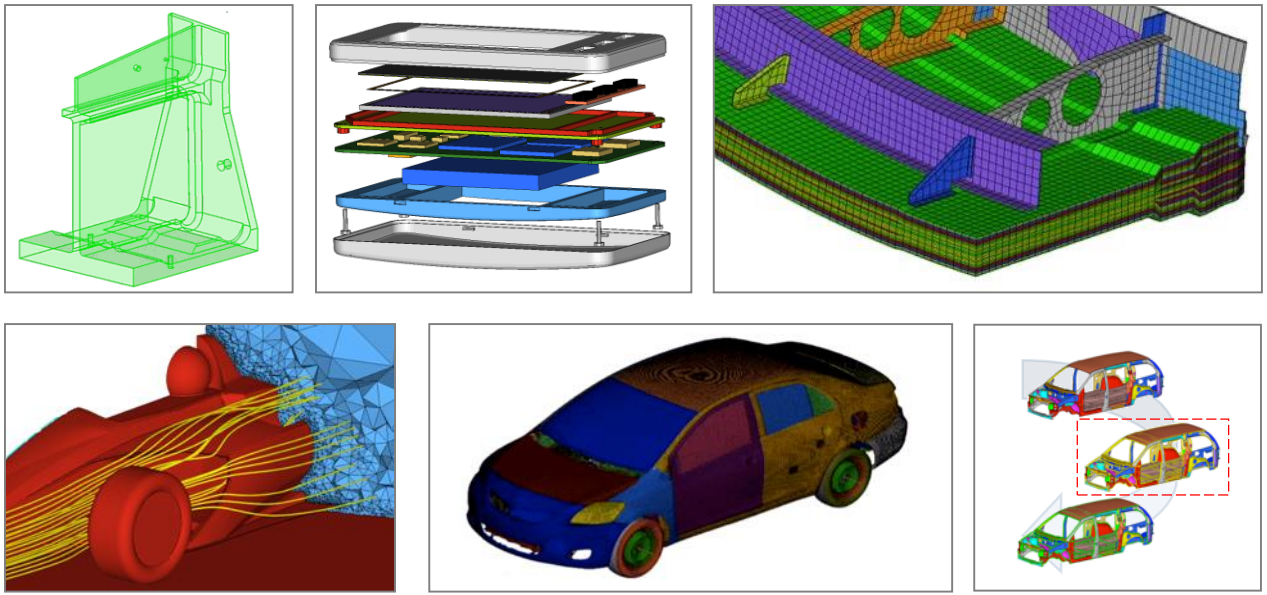
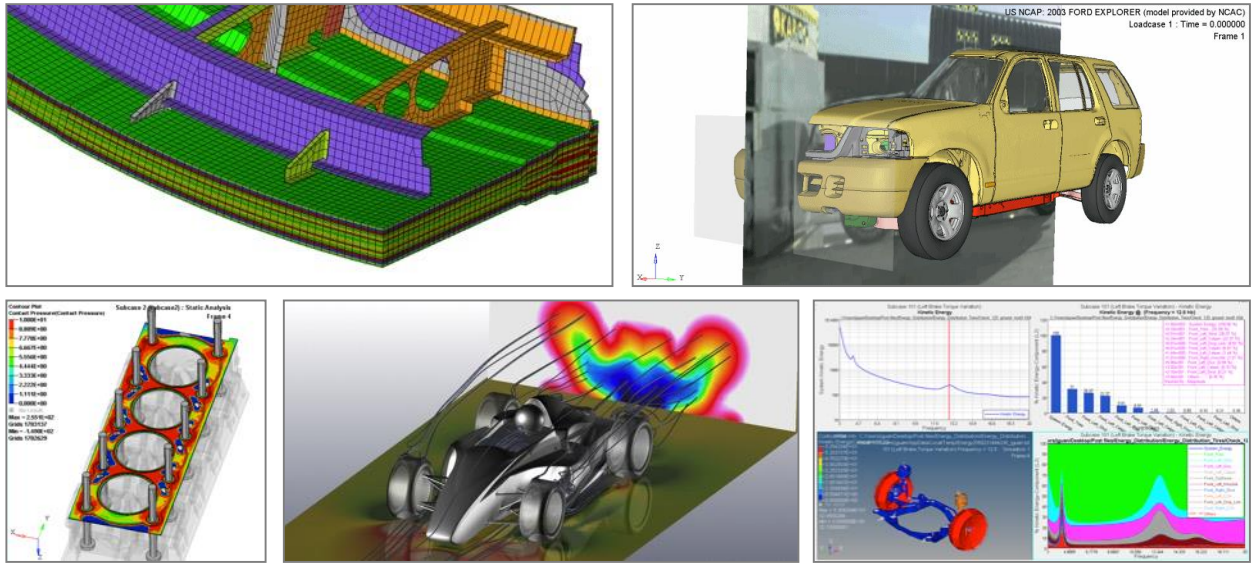
Modeling and Assembly

Meshing matters: HyperMesh's high quality mesh leads to accurate result. HyperWorks let engineers be engineers, operating in a neutral, integrated and easy-to-use environment that enables collaboration and process automation



Results Visualization & Validation

Analyze, understand and publish your simulation results with HyperView and HyperGraph, HyperWorks' best-in-class post-processing and visualization environment for CAE and test data.



Interoperability and Flexibility

Altair

Open, adaptable to ***your*** environment…

CAD

ACIS	JT Precise	SolidWorks
CATIA V4 / V5	Parasolid (in)	STEP
IGES (in)	Parasolid (out)	Tribon
IGES (out)	Pro/E	UG/NX

CAE

Adams	Femfat	Moldflow	Pam-Crash
Abaqus	Fluent	Moldex3D	RADIOSS
Actran	Ls-Dyna	MotionSolve	OptiStruct
AcuSolve	Madymo	Nastran	Samcef
Ansys	Marc	nCode	Simpack
CFD++	Matlab	Permas	StarCD

Custom

User-defined Interfaces	Scripting	Results Math

Industrial process flow, the engineers daily working

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… How we drive the Innovation

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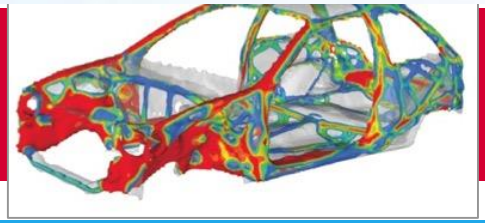
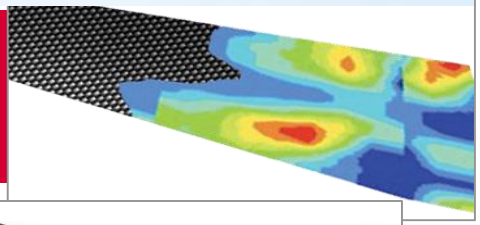
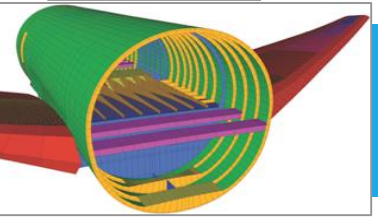
Concept | Specification | Design | Process | Validation | Manufacturing | Support

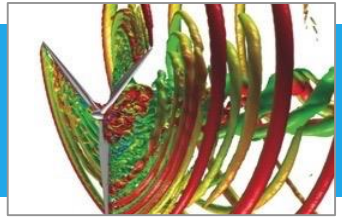


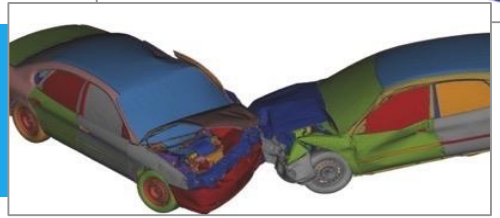
Getting to the right design





Saving time in the process





Access to the latest technologies

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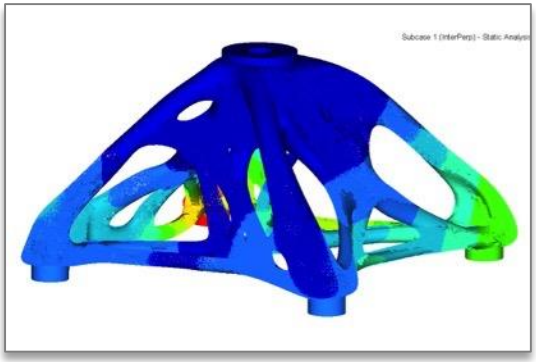
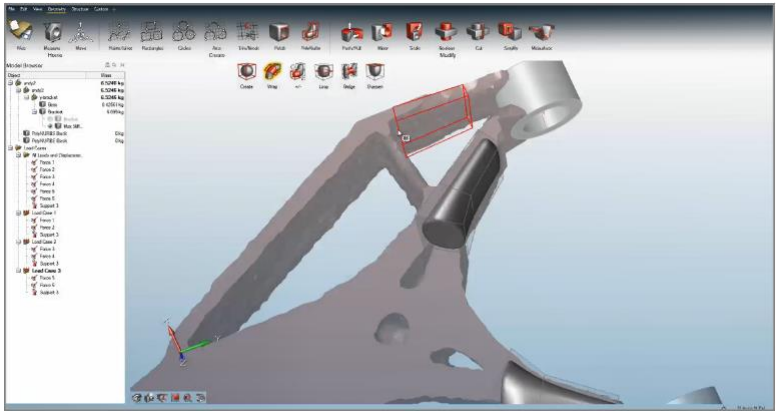
Pre Processing at concept level



- Easy define and mesh in accurate way the design space
- Rapidly setup the analysis taking into account all the needed loadsteps
- Provide the tool to easily interpret the optimization results



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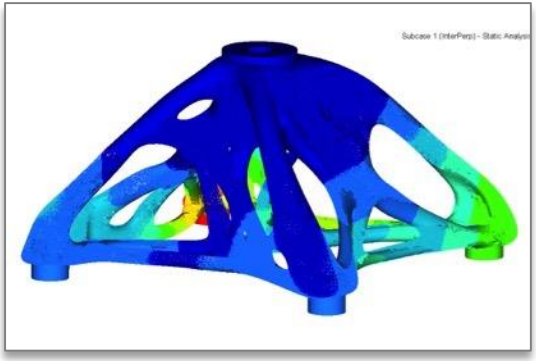

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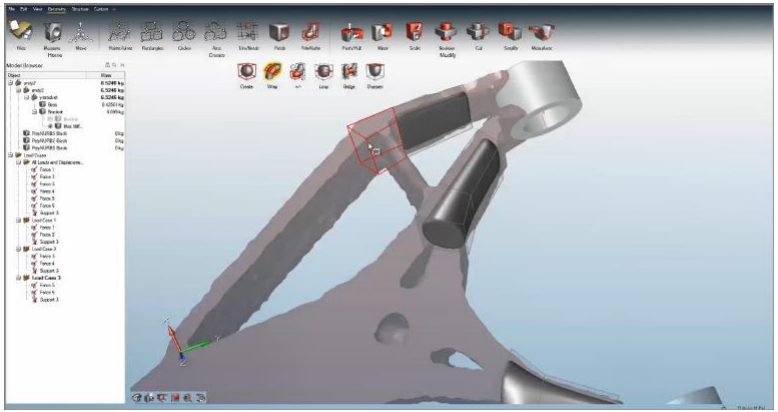

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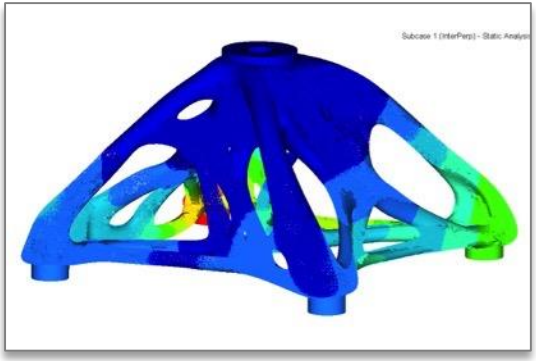

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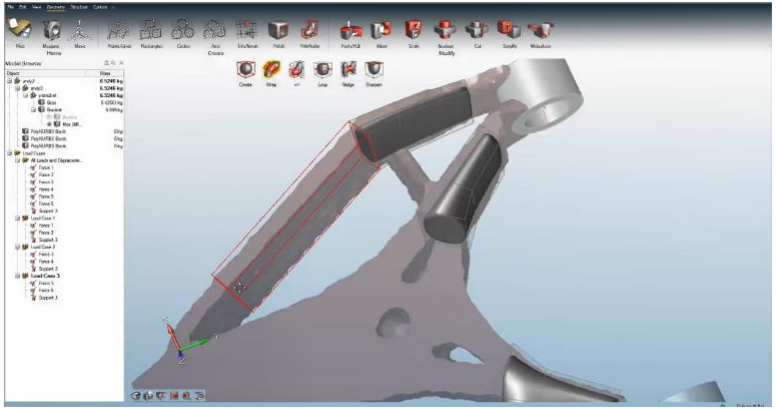

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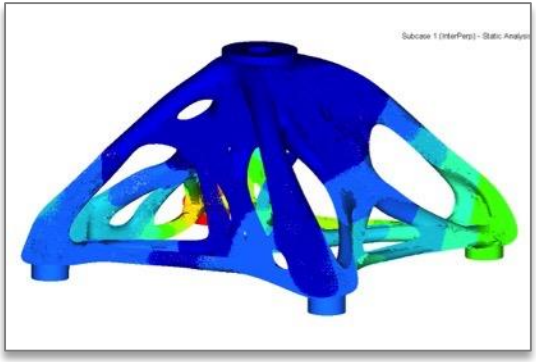

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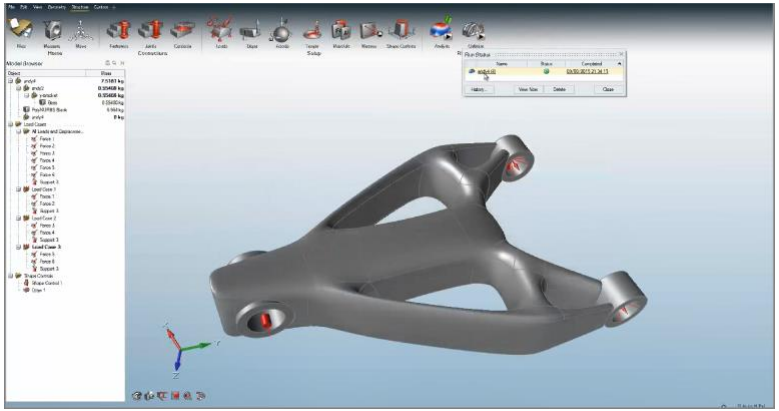
The PolyNurbs interpretation can be seen in two ways:

- as post processor in term of representation in a more untestable way the topology optimization results
- As preprocessor because the geometry can be used for a second optimization loop



Complex geometry model

Problem description:

- The B-pillar is mainly the result of two mechanical process
  - Roll laminating, in general with variable thickness
  - Stamping process

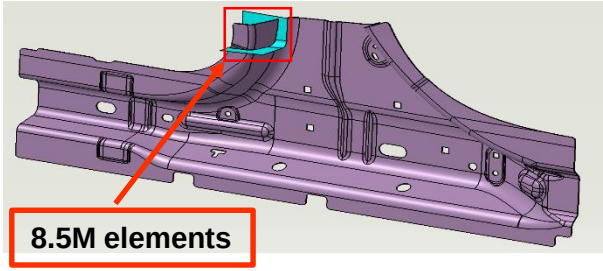
These process actually change the material properties:

- The first one stretch the texture along the laminating direction giving a sort of orthotropic behavior
- The second introduce some local residual plastic strain and thickness variation that must be take into account

The last point that we have to consider is the material degradation due to the thermal effect around the spot-weld (HATZ)

Advanced rupture modeling
Full vehicle side impact with refined B-pillar

- solid elements
- mesh size in the selected area: 0.075 mm
- MIT material law with EMC failure criteria

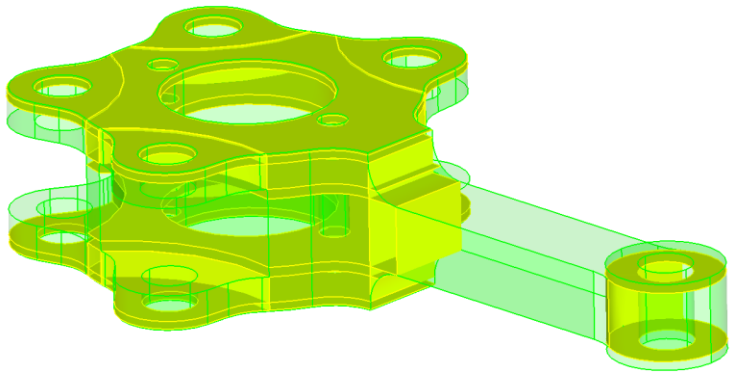


(Partnership for Advanced Computing in Europe)

Complex geometry model

The model are becoming more and more detailed and complex

- The Preprocessor must be able to deep interface with the CAD
- Be able to clean, trim and modify in a proper way the geometry
- Generate of good quality elements
- Manage very huge models



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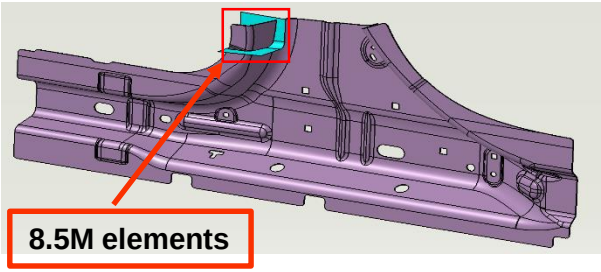

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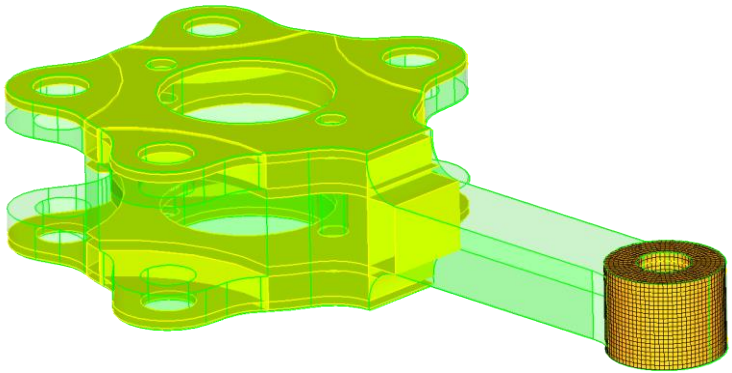

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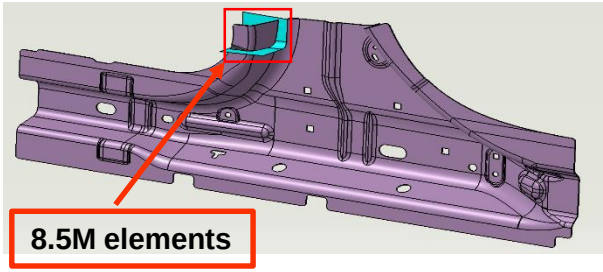

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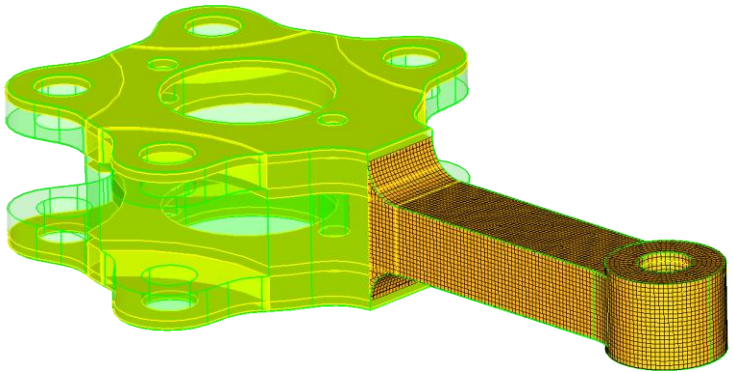

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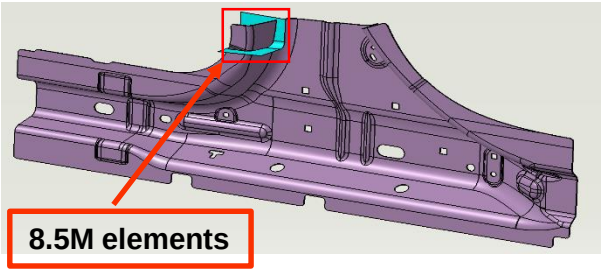

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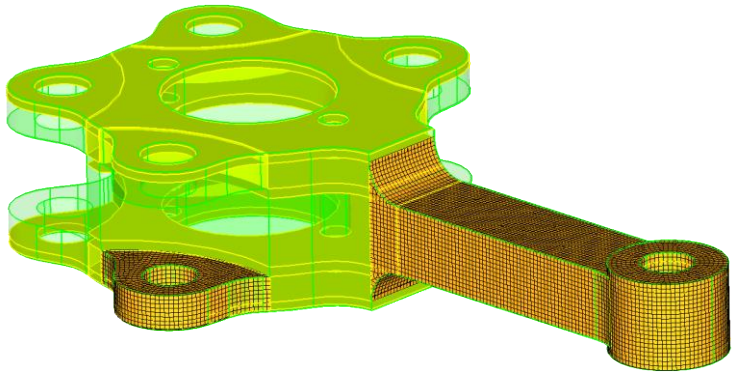

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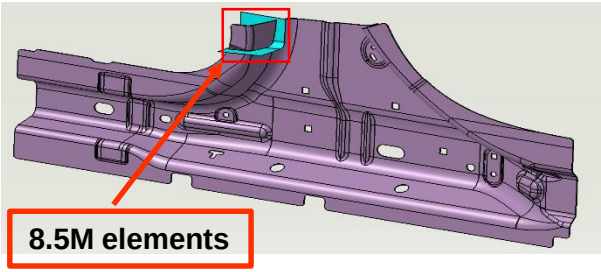

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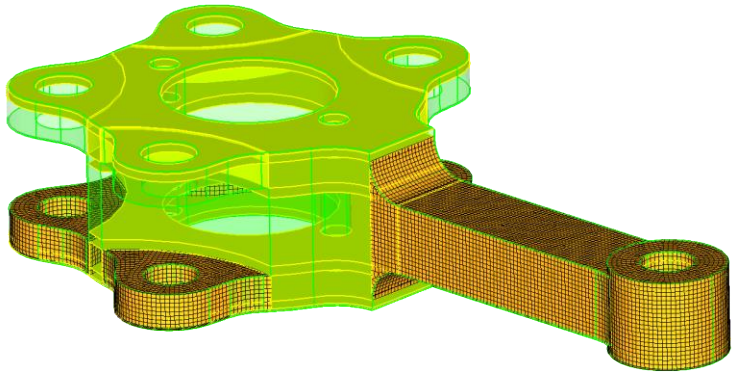

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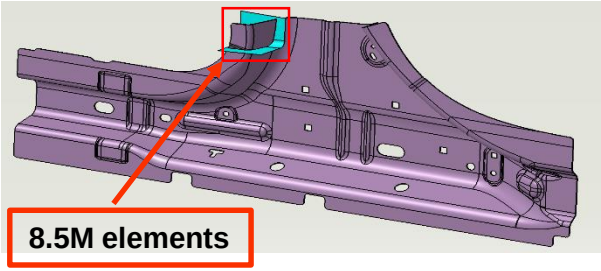

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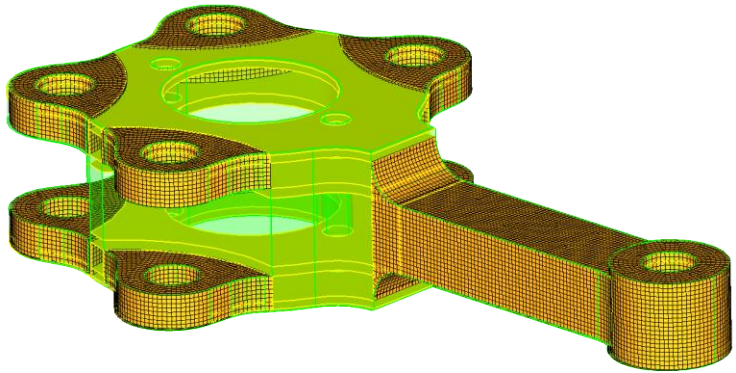

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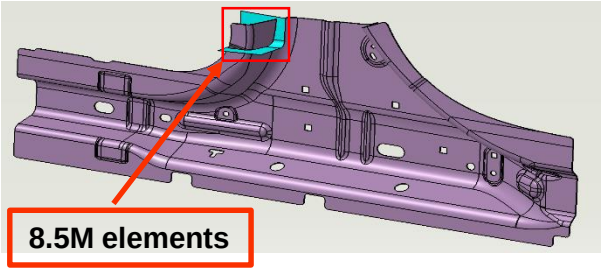

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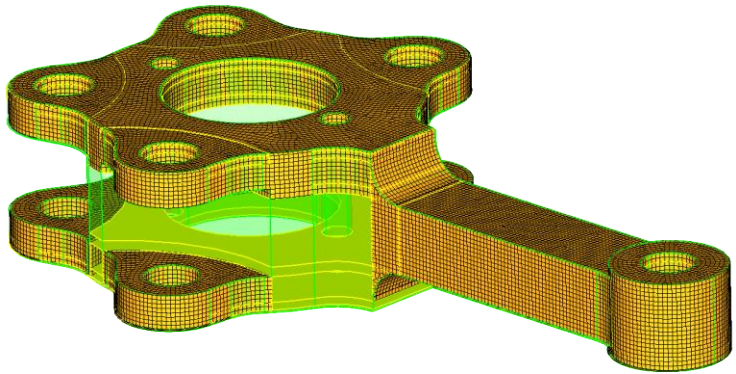

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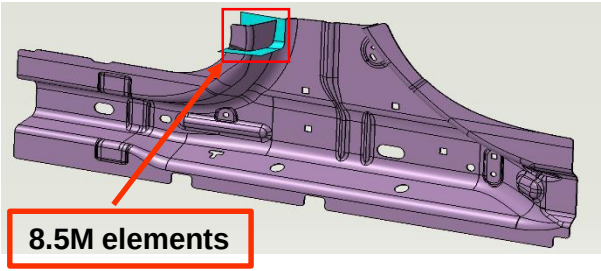

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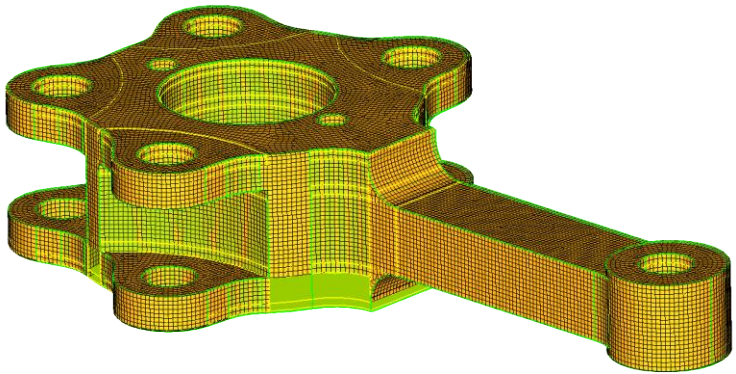

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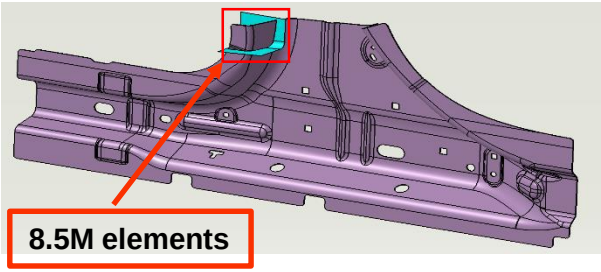

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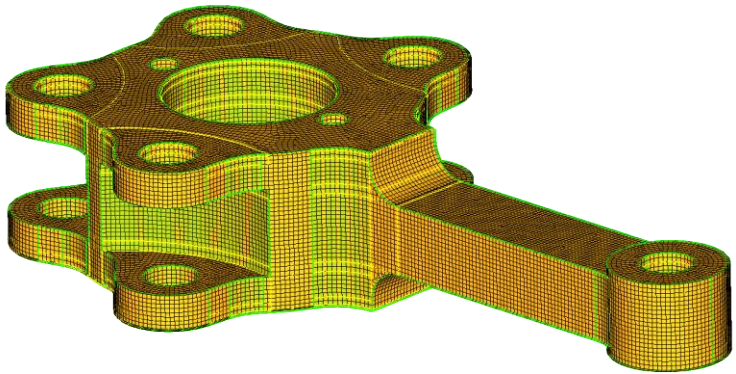

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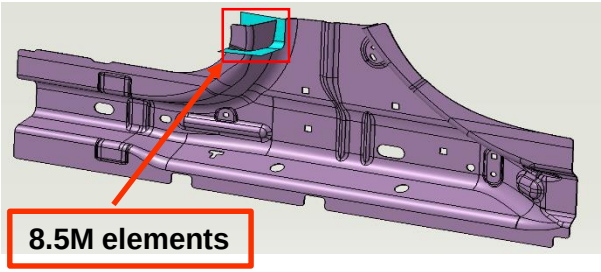

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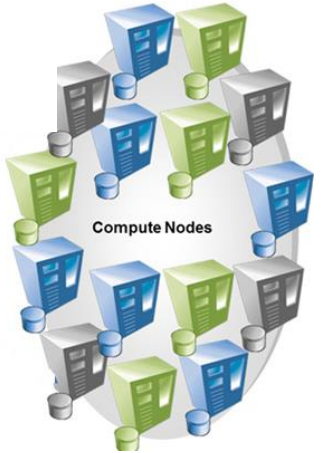
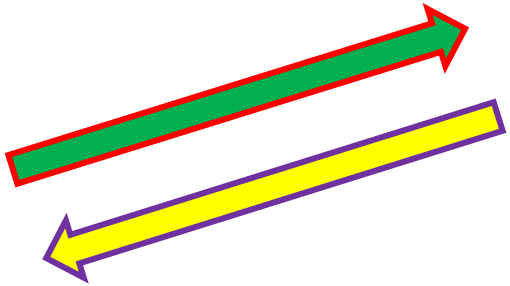
Post Processing – Remote visualization

- As the model complexity increase
- The amount of results to analyze became higher day by day

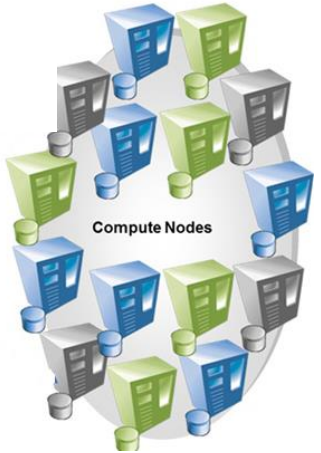


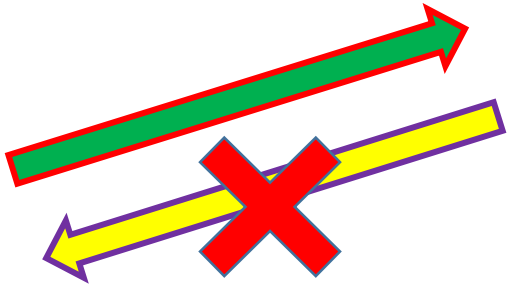


Post Processing – Remote visualization

- As the model complexity increase
- The amount of results to analyze became higher day by day

- Stop to move byte, start to move pixels
- Download just the report that can be automatically create

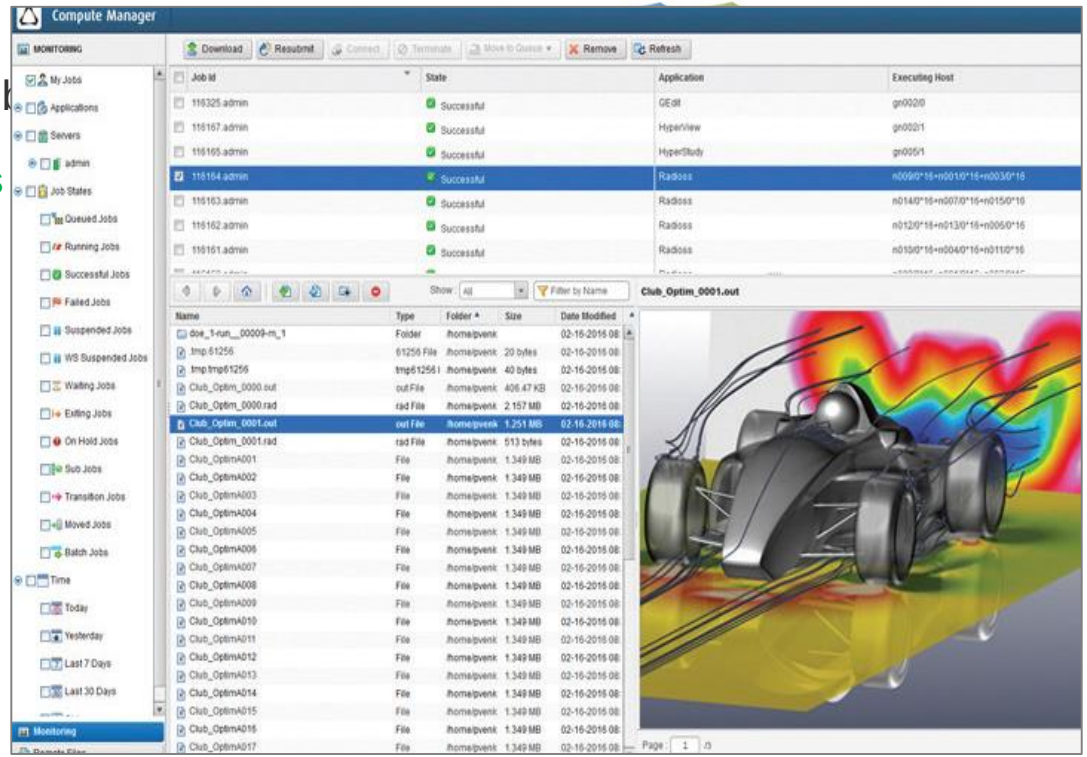




Post Processing – Remote visualization

- As the model complexity increase
- The amount of results to analyze

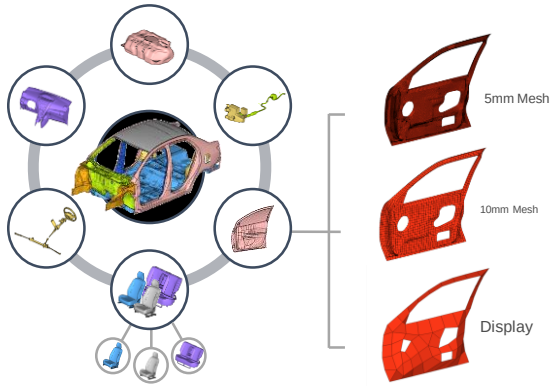
- Stop to move byte, start to move pixels
- Download just the report that can be automatically create

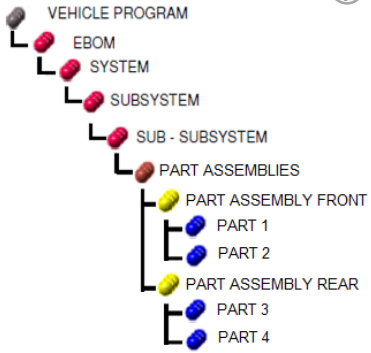


BOM Managing and Versioning comparison

SIEMENS TEAMCENTER

Windchill A PTC Product





- Inside the industrial environment the product “live” on the PLM system
- The capability to follow the product during its evolution is today mandatory

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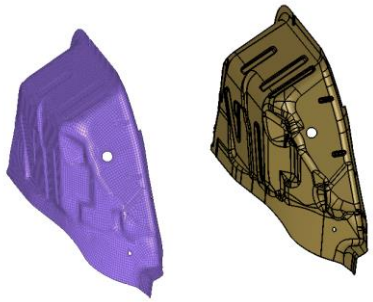
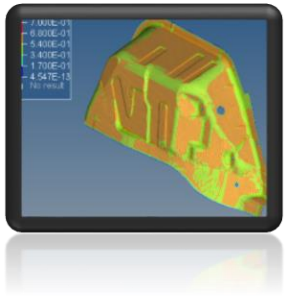




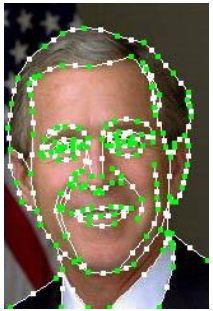
- Inside the industrial environment the product “live” on the PLM system
- The capability to follow the product during its evolution is today mandatory
- A common pain for the CAE structural analyst is the capability to compare the previous revision with the new one or an old platform with a new one
- All those comparison check can run within a cloud environment using the power of the clusters

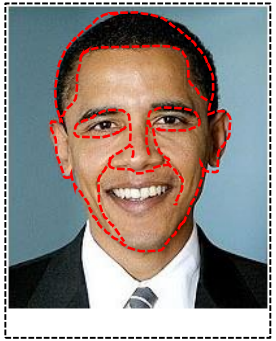
Morphing and Optimization of Multiphysics Phenomena

Altair

Morphing History

Over the past few years, "morphing" has become a catchphrase denoting a particular state-of-the-art graphic special effect and is among those elements defining the visual style of the 1990s. Morphing creates fluid and often surreal transformations by combining the cross-dissolving and the warping of images (in which certain areas are stretched or compressed).





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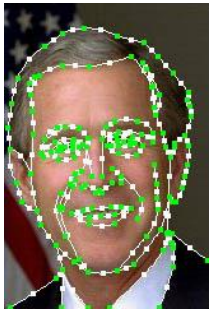

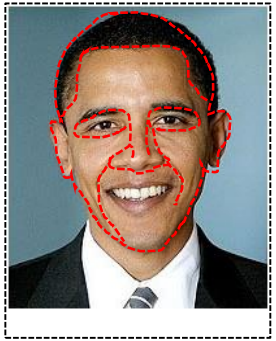

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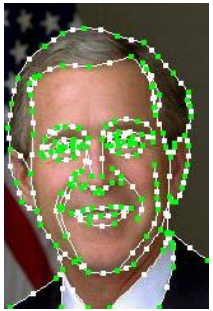

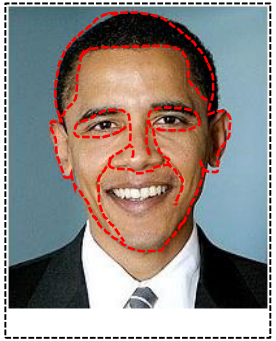

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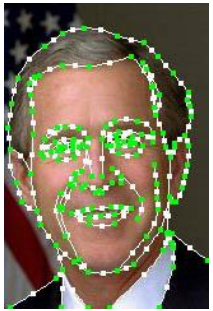
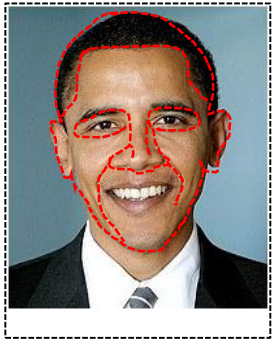
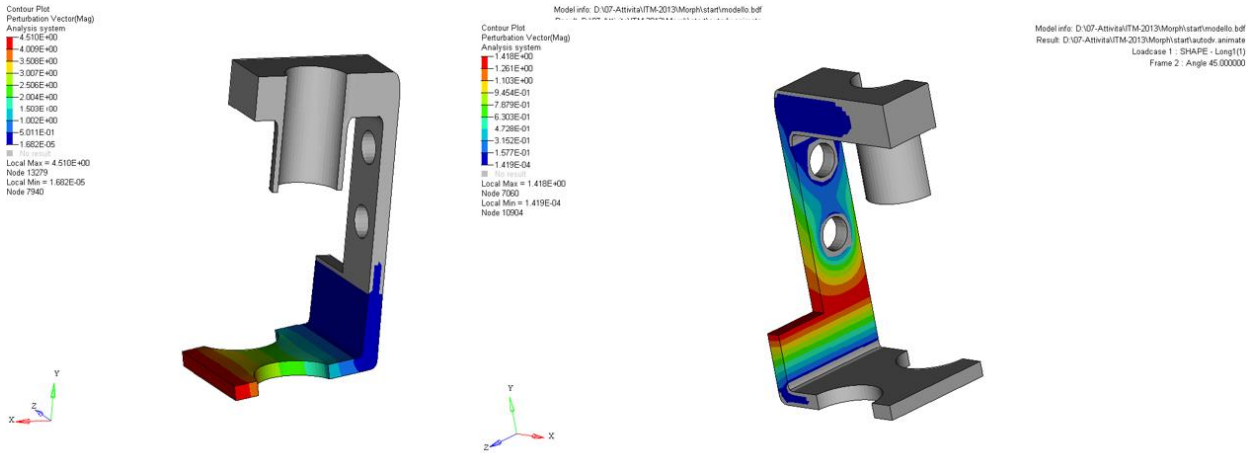




Morphing Technology and Engineering Applications

Morphing CAE benefits:

- Change the shape of your component without passing trougth the CAD
- Define shapes as design variables and use them in a optimization cycle



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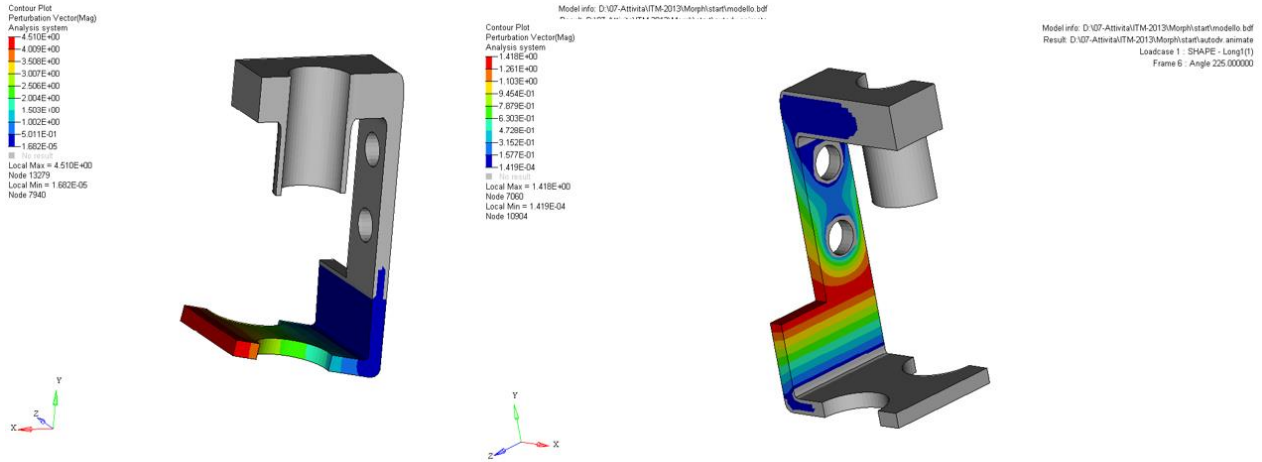

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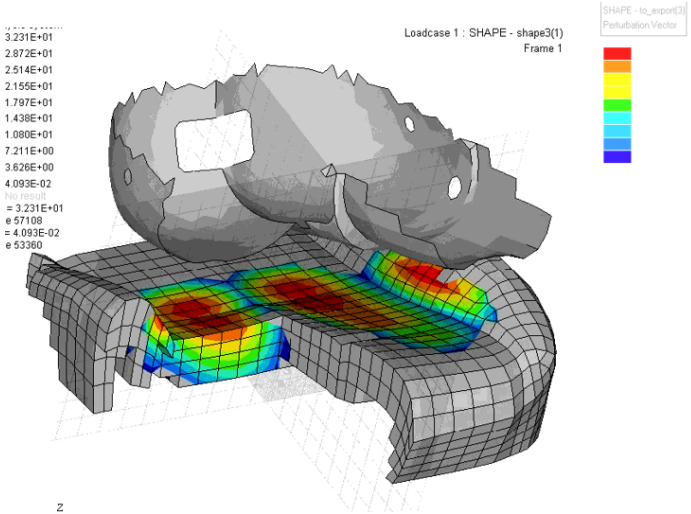

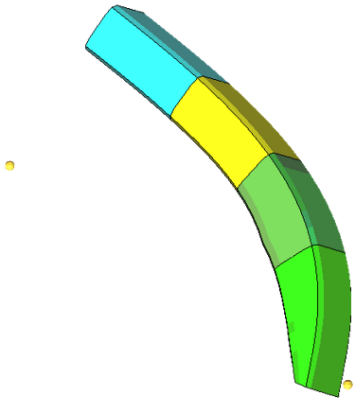

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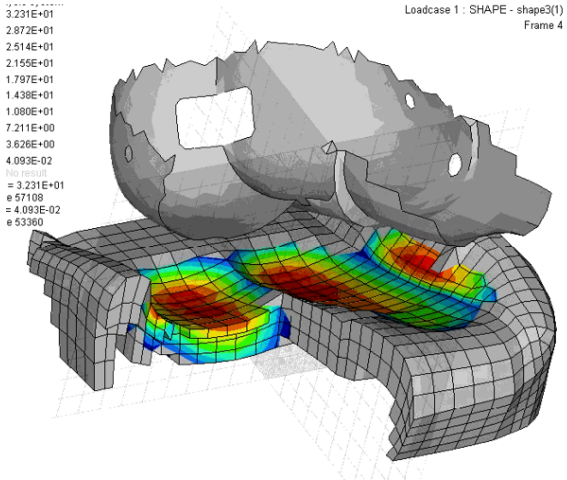
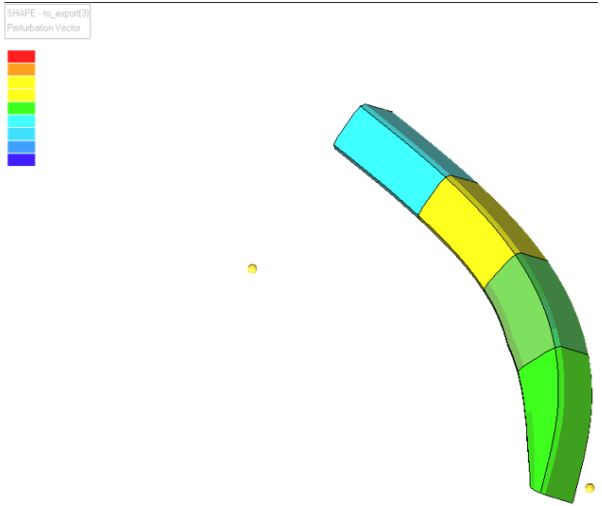
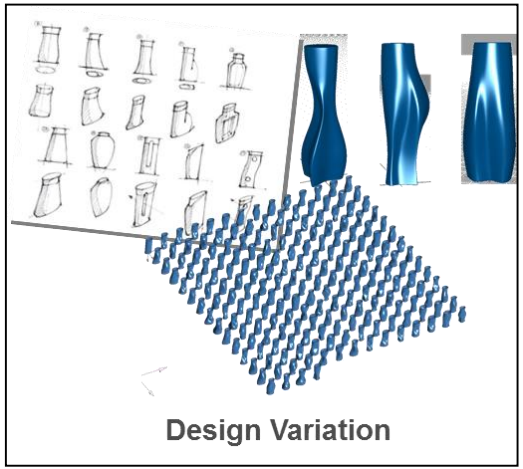


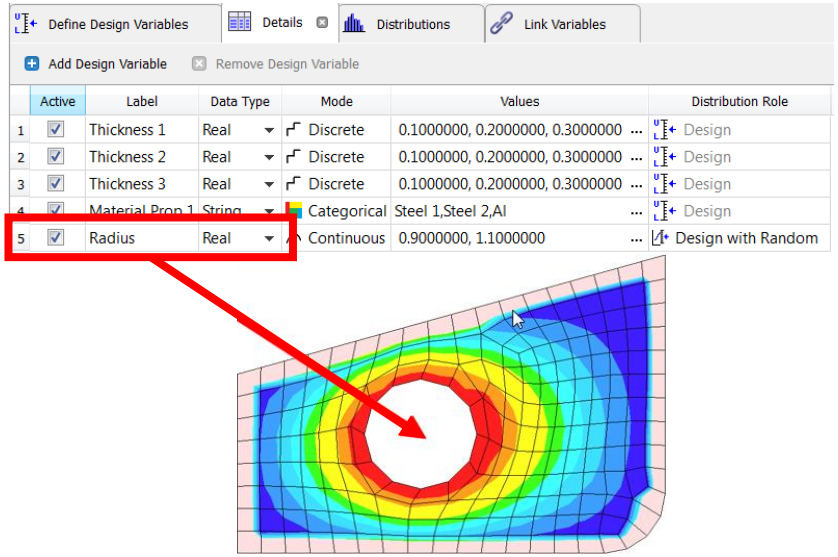


What-Why-How of HyperStudy

What is HyperStudy and what does it do?

- It is a multi-disciplinary design exploration tool for engineers and analysts
- It creates a set of smart designs, automatically evaluates these designs and guides you to gain insights from the data obtained.





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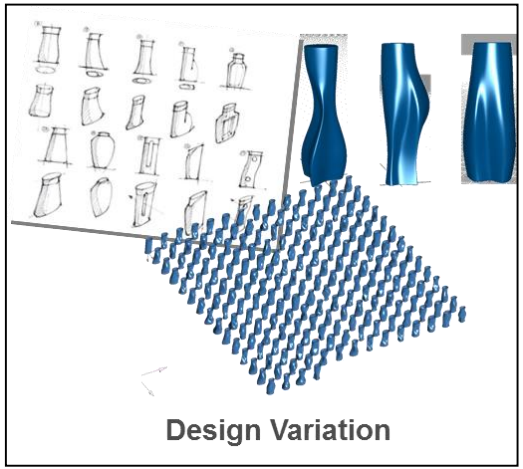

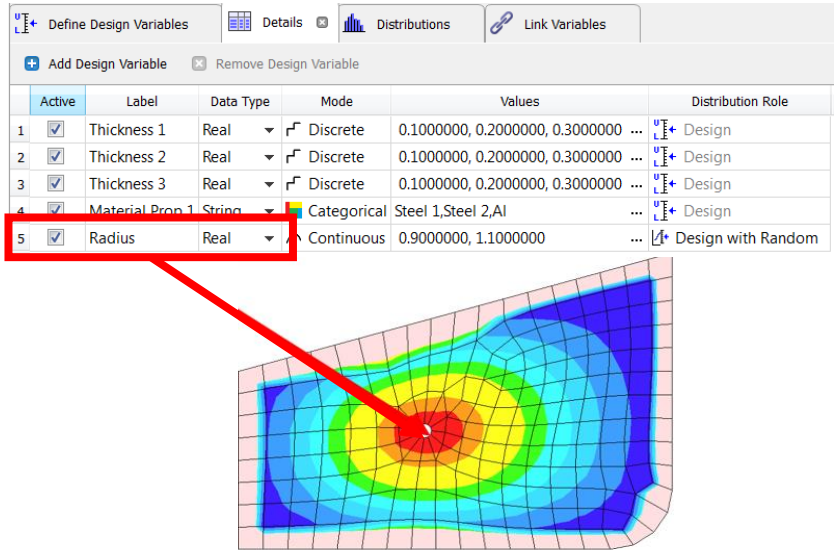

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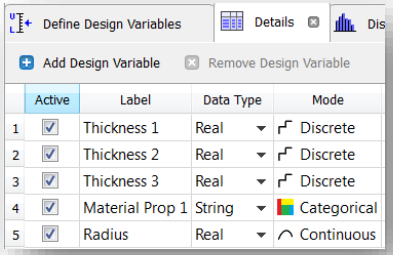

- HyperStudy is completely solver neutral, can carry on the design variable to the solver that you want
- Will extract the responses from those solvers
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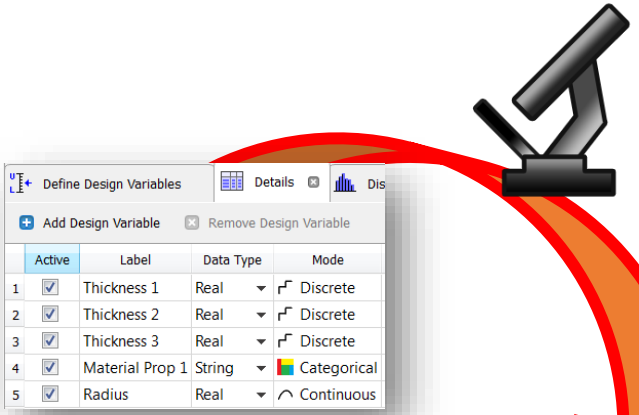

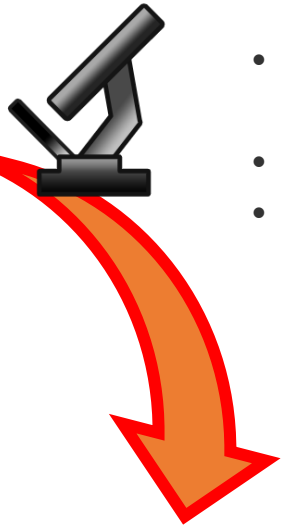

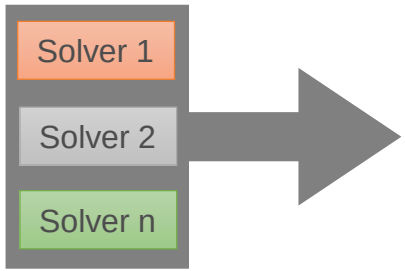

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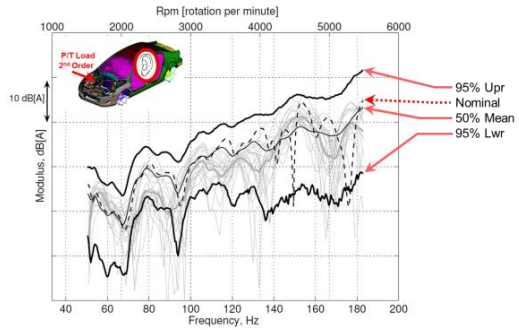
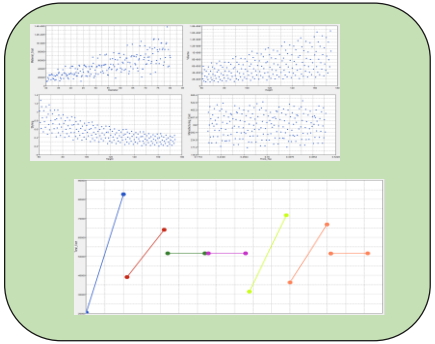


HyperStudy benefits

Altair

Investigate relationships

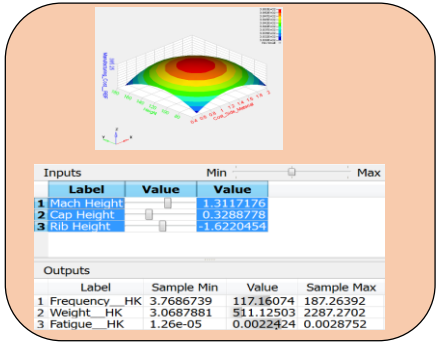
- Effects
- Interactions
- Correlations



Design of Experiments

Make predictions

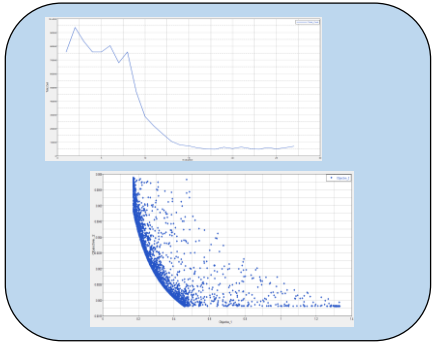
- Trade-Off
- Residuals
- “What if?”



Fit

Identify best design

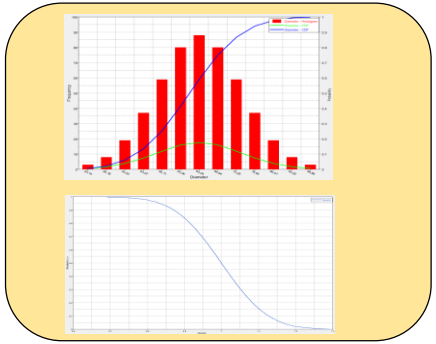
- Single Objective
- Multiple Objective
- Reliability Based



Optimization

Assess reliability

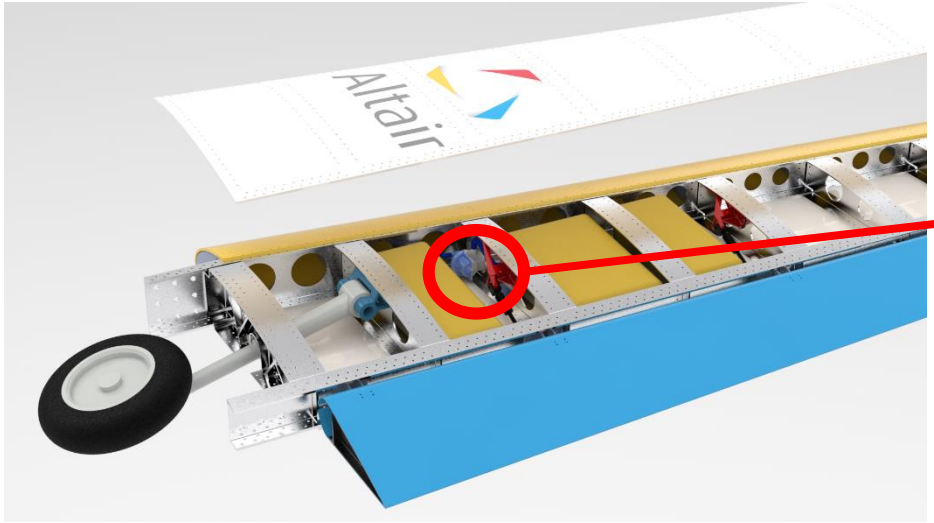
- Variational Study
- Reliability Plots
- DFSS

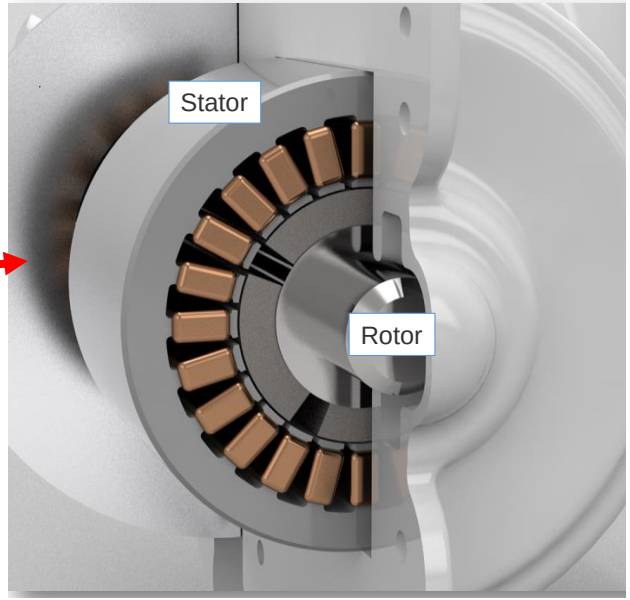


Stochastic

Multiphysics Optimization real case

- Design of a fuel pump permanent magnet motor in an airplane wing
- Reduce motor noise while maintaining the electromagnetic performances
- A multi-physics optimization application

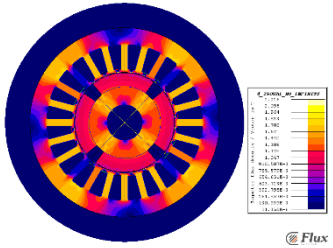


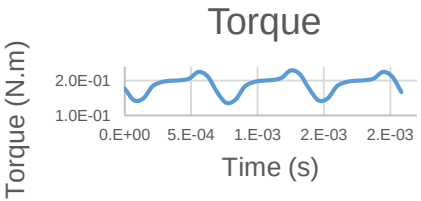


Multiphysics Optimization real case

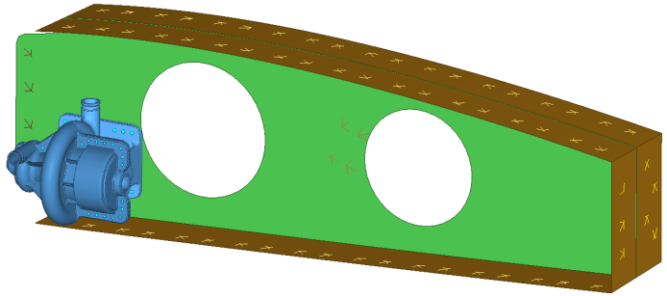
Altair

Electromagnetic Analysis

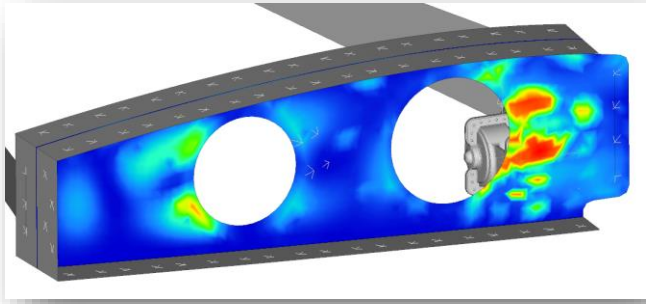




Vibration Analysis



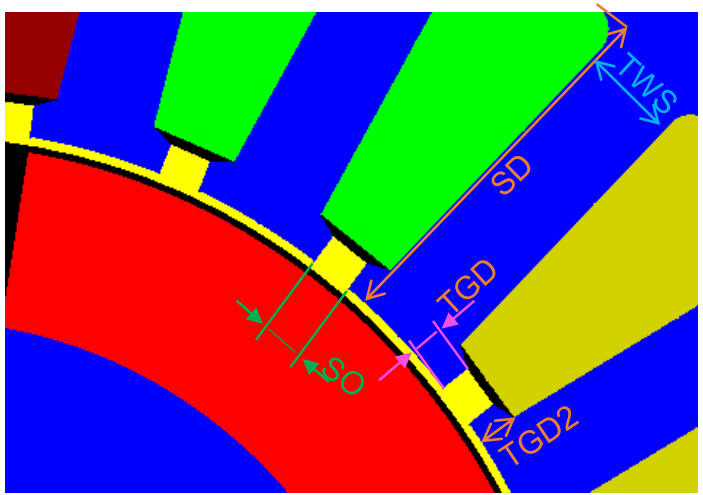
Equivalent Radiated Power (ERP)



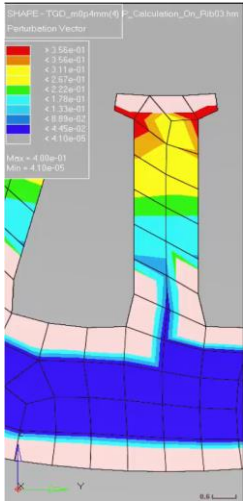
Optimization Problem Definition

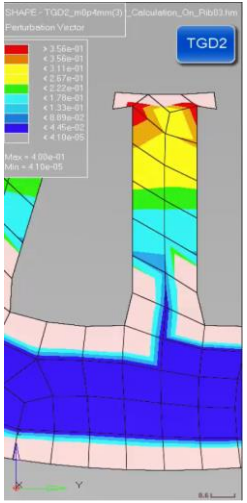
- The objective is to reduce ERP value while respecting 3 electromagnetic constraints
  - Mean torque >= 0.1888572 N.m
  - Max current density <= 2,758,639 A/mm²
  - Max saturation induction <= 1.6287 T

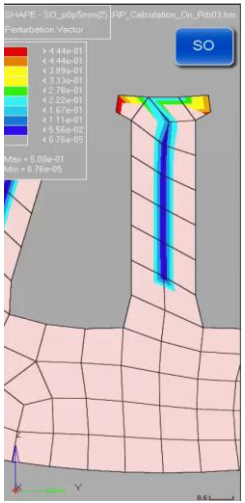
	Definition	Initial	Min; Max
SD	Slot depth	6.93	3.05; 9.9
SO	Slot opening	0.74	0.5; 0.8
TGD_2	Slot opening angle	0.72	0.5; 1.9
TGD	Opening depth	0.495	0.4; 1
TWS	Stator tooth width	1.683	1,16; 2.08
TORQUE_MEAN (N.m)	Mean torque	0.188857	
BTOOTH_MAX (T)	Max B on the tooth	1.6287	
J_MAX (A/mm²)	Max current density	2,758,639	
ERP (mW)	Equivalent radiated power	61.44	

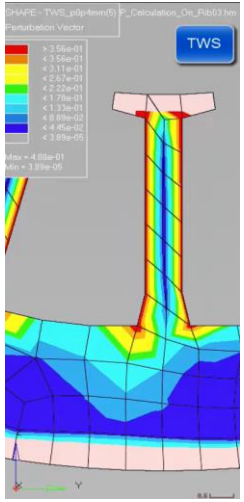


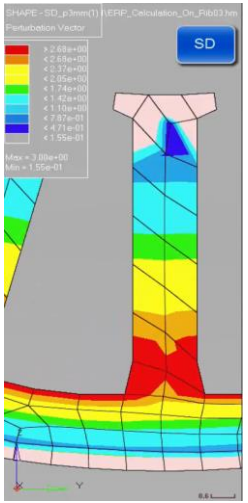
Shape Variables created by Morphing











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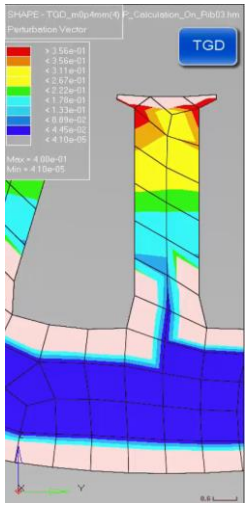
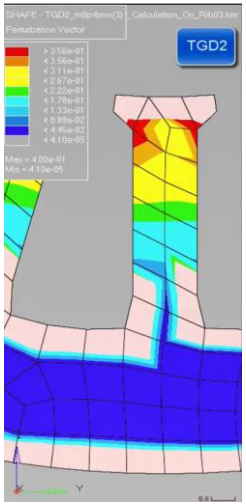
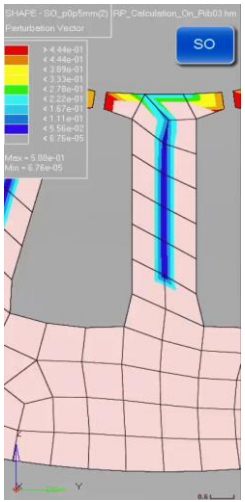
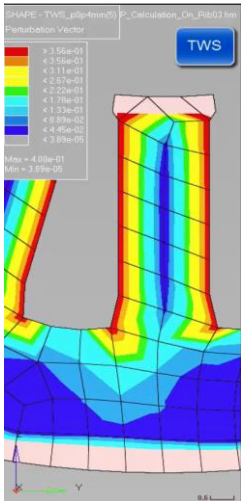
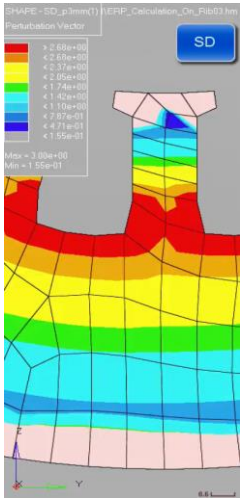






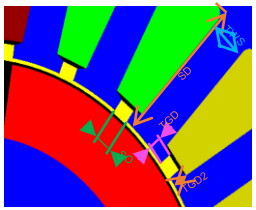


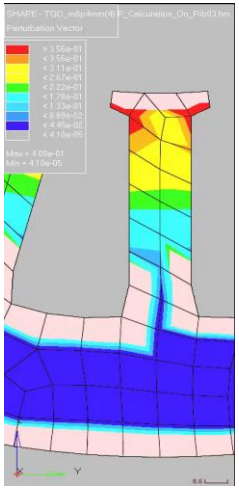


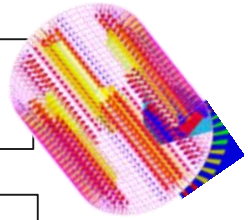
Multi-physics Optimization Workflow

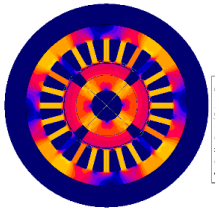
HyperStudy

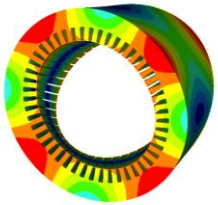
- Updates the Flux model, Flux remeshes
- Updates the OptiStruct model using morphing with HyperMesh-HyperMorph
- Executes Flux simulation
- Updates the OptiStruct loads with loads from Flux
- Executes OptiStruct simulation
- Extracts
  - Mean torque, Max current density, Max saturation induction
  - ERP from OptiStruct output









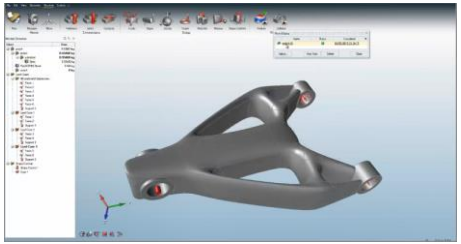


Conclusion

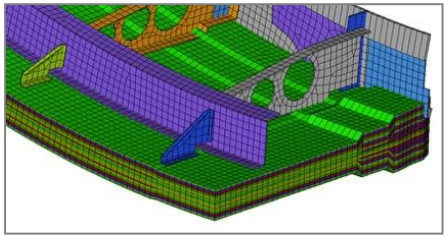
Altair

Take Away

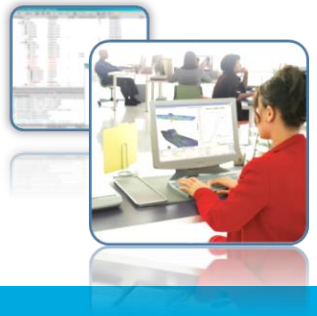
Concept phase: PolyNURBS to interpret the topology optimization results



Neutral PreProcessing Environment For High meshing modelling quality and assembly model

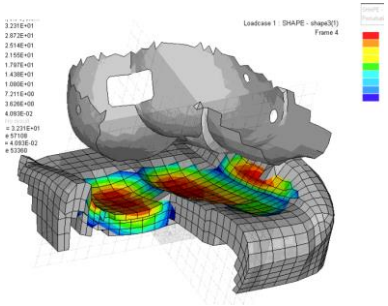


Cloud Installation and Remote Visualization

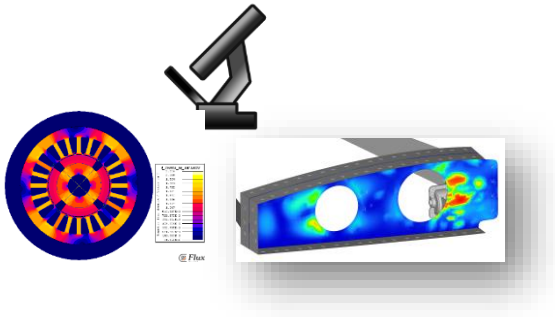


Take Away

Morphing: change the shape without affect your setup



HyperStudy and Multiphysics Optimization
Morphing Shape became Design Variables



Thank You For Attention