

Altair

HyperWorks®

Additive Manufacturing + solidThinking Inspire: Making Lightweight, Low-Volume Designs a Reality

4 October 2014

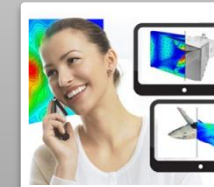
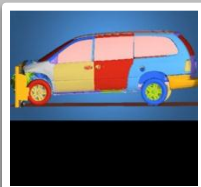
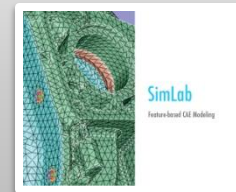
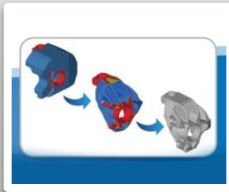
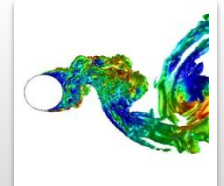
Ujwal Patnaik
Altair Engineering Canada, Ltd.

Altair Overview



A global software and technology company founded in 1985

There are **44** offices in **22** countries and **2,200** engineers, scientists, developers and creative thinkers.



Blue Chip Customer Base



Automotive	Aerospace	Heavy Equipment	Government
Life/Earth Sciences	Electronics/ Consumer Goods	Energy	Architecture

5,000 customers worldwide



The synergy between our **software** and **services** organizations keeps Altair close to industry challenges and uniquely positioned as a **valued, long-term partner** to support the dynamic needs of our clients.





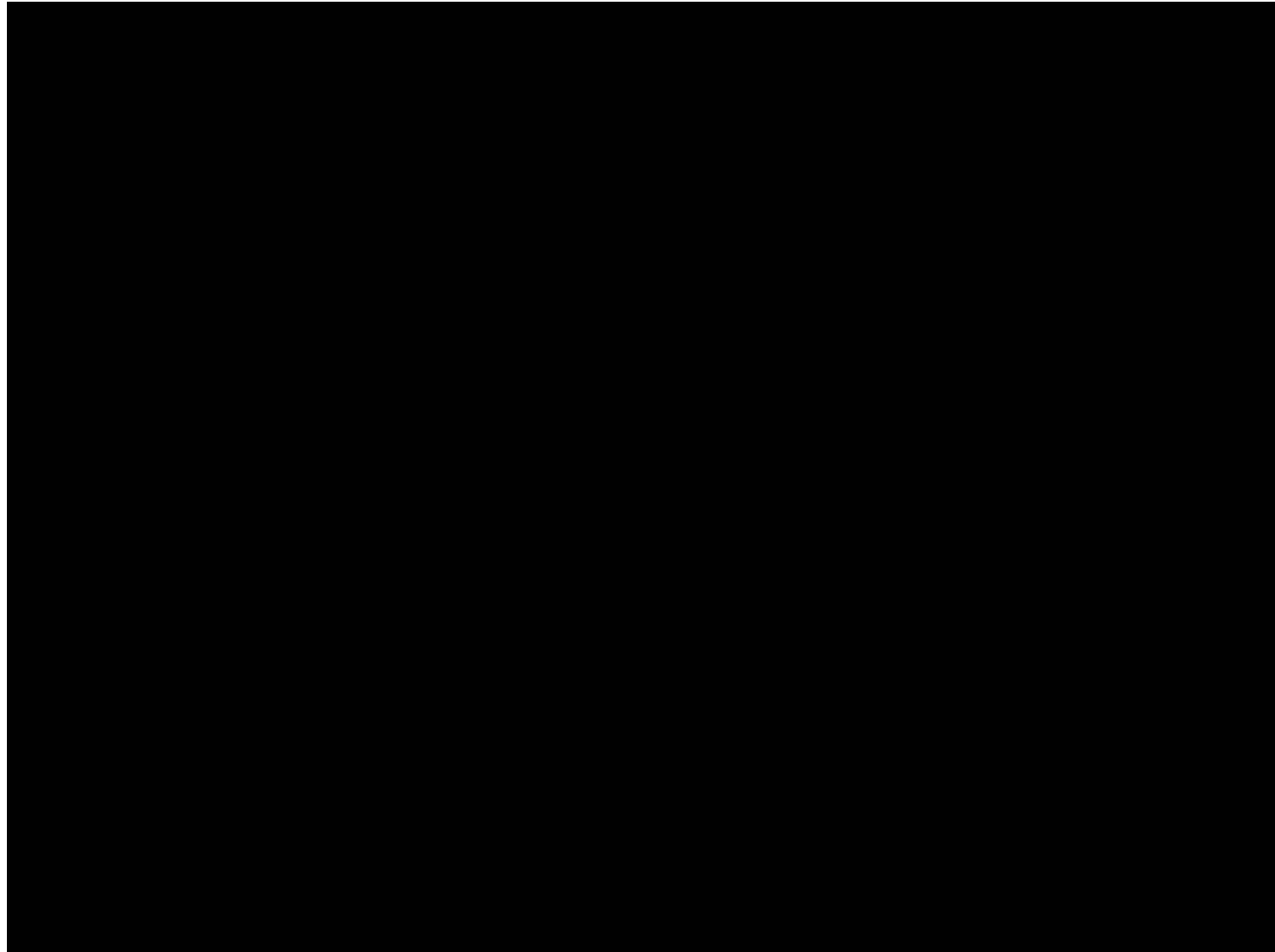
INSPIRE

solidThinking®

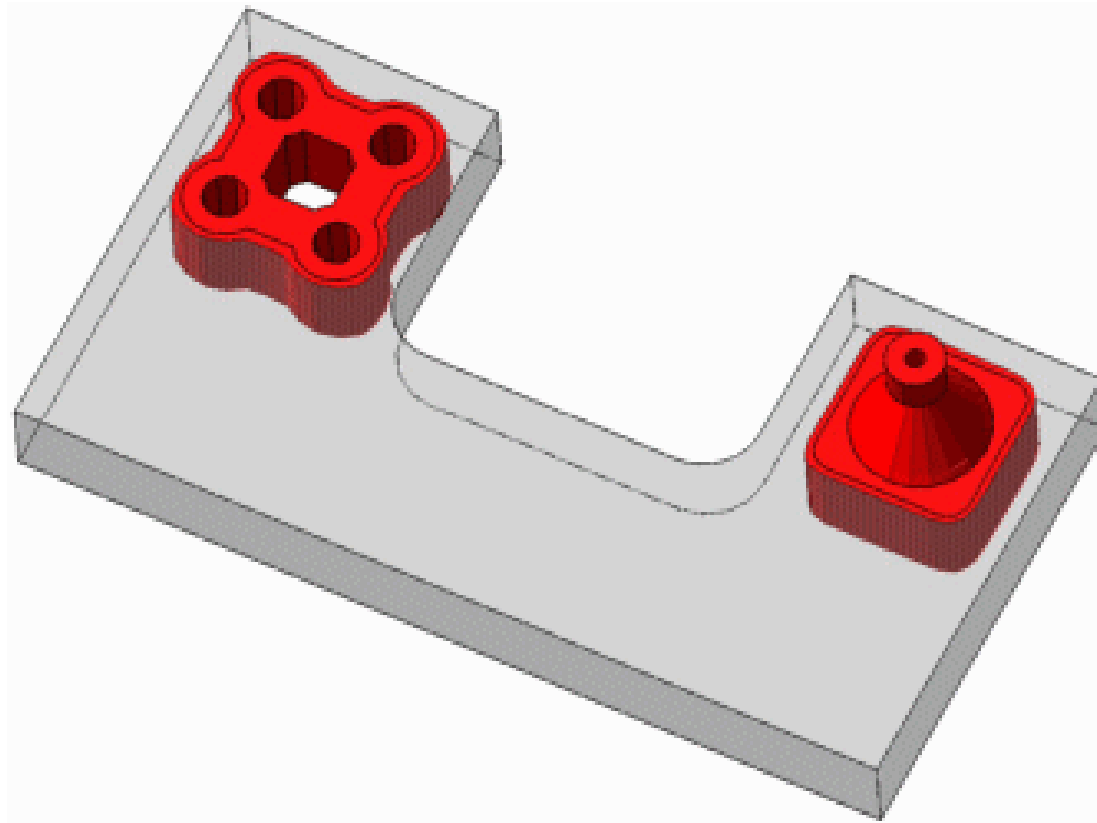
2014

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Video



What is topology optimization



- solidThinking Inspire is a tool for designers and design engineers
- provides the best material distribution for a given design space and loading

solidThinking Inspire 2014



Files Points/Lines Rectangles Circles Arcs Trim/Break Push/Pull Solid Edit Simplify/Patch Parts Shape Controls Loads/Supports Analyze Optimize Measure Trans/Rotate Views Show/Hide Configure

Create and/or Simplify Geometry

Generate Ideal Shape

Verify Structural Performance

SI (m kg N Pa)

solidThinking Inspire 2014

The screenshot displays the solidThinking Inspire 2014 software interface. At the top is a toolbar with icons for various functions: Files, Points/Lines, Rectangles, Circles, Arcs, Trim/Break, Push/Pull, Solid Edit, Simplify/Patch, Parts, Shape Controls, Loads/Supports, Analyze, Optimize, Measure, Trans/Rotate, Views, Show/Hide, and Configure. Below the toolbar, a workflow is shown with five yellow callout boxes:

- Geometry Simplification**: Remove imprints, rounds, fillets, holes and pockets. This step shows a red triangular part being simplified into a grey one.
- Concept Generation**: Evaluate concepts with maximum stiffness or minimum mass. This step shows the grey part being evaluated into a yellow lattice structure.
- Analysis**: Investigate linear static and normal modes analysis on a model. This step shows the yellow lattice structure being analyzed, with a blue stress distribution overlaid.
- Smoothing Options**: Create surface models from Inspire and export as a geometry file for refinement in CAD. This step shows the yellow lattice structure being smoothed into a more refined yellow surface model.
- Concentrated Mass Parts**: Create a concentrated mass either on a part or at a point in space. This step shows a black sphere being added to the model.

On the right side, the **Analysis Explorer** window is open, showing the following data:

Run: Bellcrank_04022014_1 Max Stiff
Load Case: Load Case 1
Result Type:
Displacement
Factor of Safety
Percent of Yield
Tension and Compression
Maximum Shear Stress
von Mises Stress
Major Principal Stress

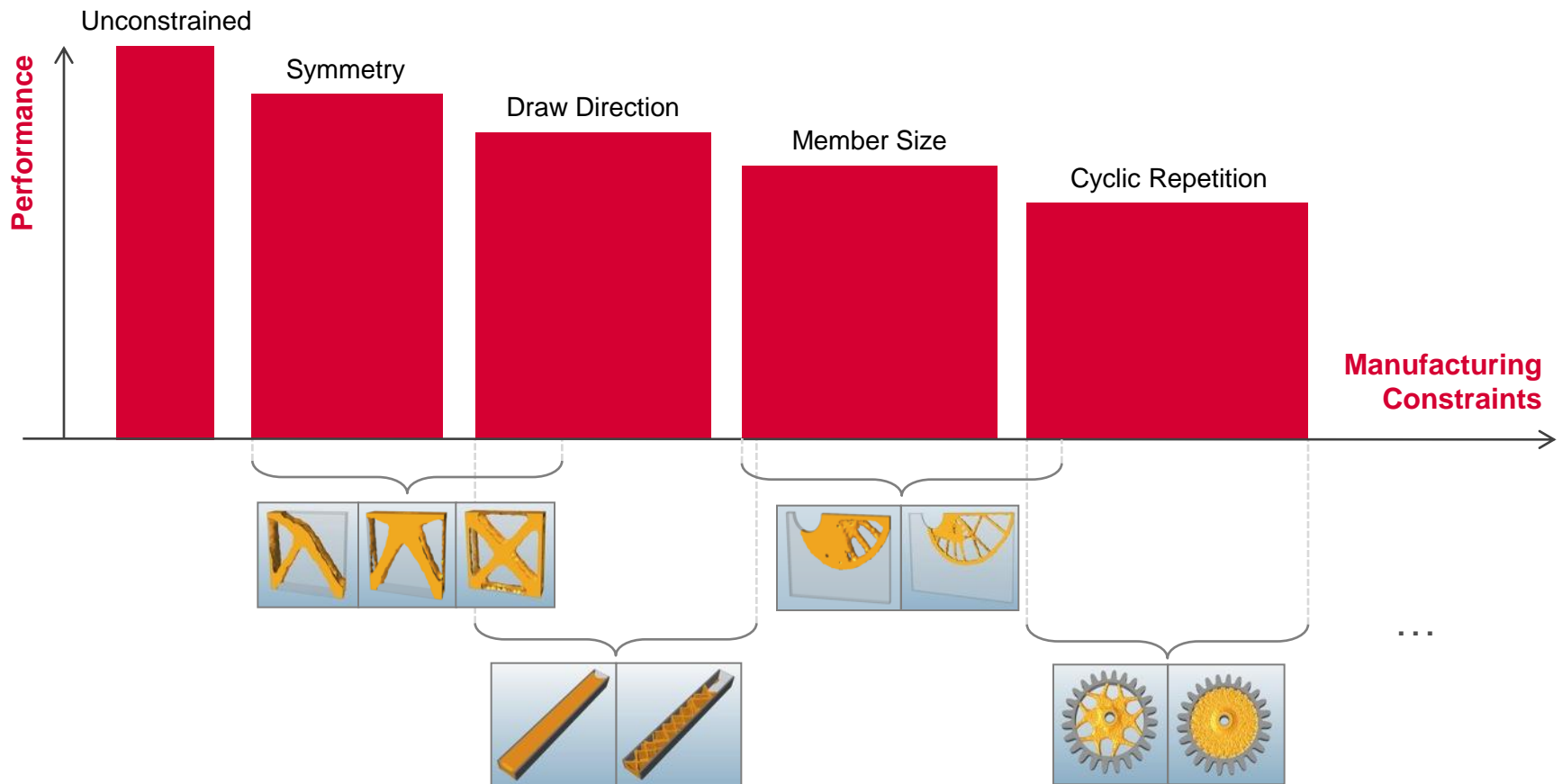
von Mises Stress:
Max: 4.024e+07 Pa
-4.024e+07 Pa
-3.623e+07 Pa
-3.223e+07 Pa
-2.822e+07 Pa
-2.421e+07 Pa
-2.021e+07 Pa
-1.620e+07 Pa
-1.220e+07 Pa
-8.190e+06 Pa
-4.184e+06 Pa
-1.783e+05 Pa
Min: 0.000e+00 Pa

Animation:
Show:

In the bottom right corner, the text **INSPIRE solidThinking 2014** is displayed.

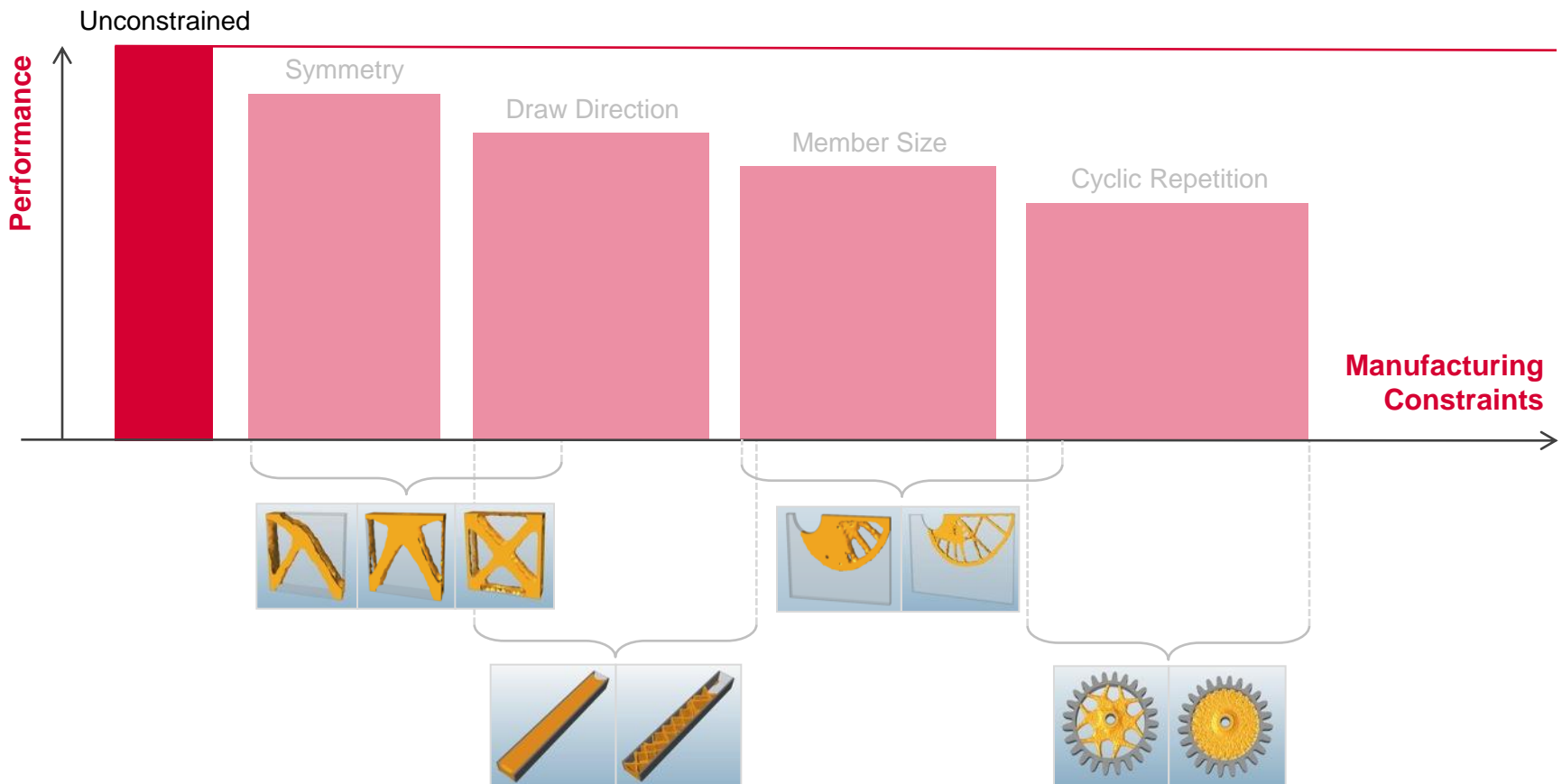
Manufacturing Constraints

Topology optimization provides the most efficient structure for a given load situation, but for traditional manufacturing designers always have to **trade performance for manufacturability!**



Additive Manufacturing - Technology Symbiosis

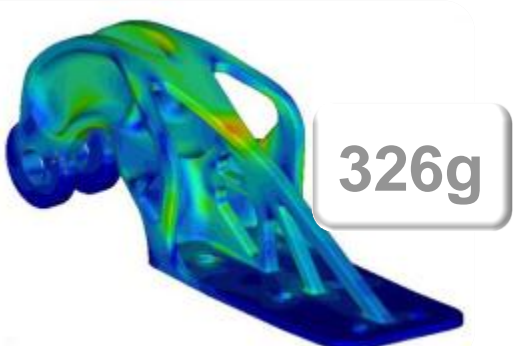
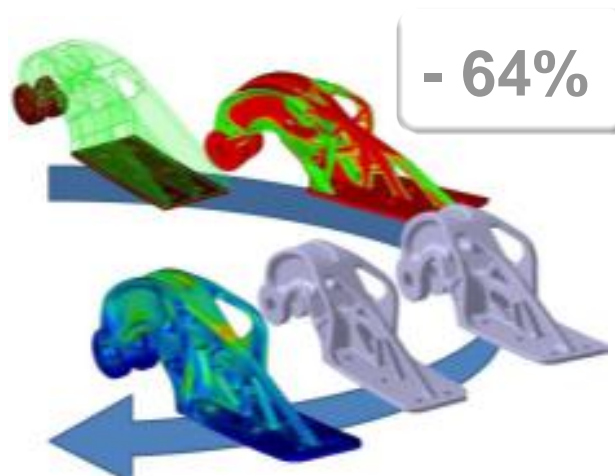
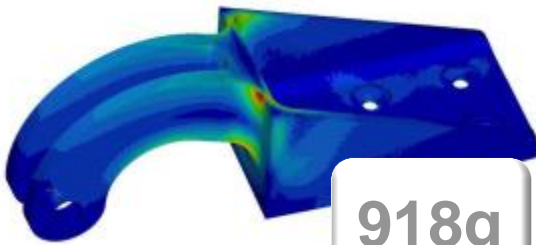
Additive manufacturing is lifting the constraints of traditional manufacturing processes, giving designers the ability to grow practically any shape, enabling the use of fully optimized lightweight designs that do not sacrifice performance.



EADS – Additive Manufacturing

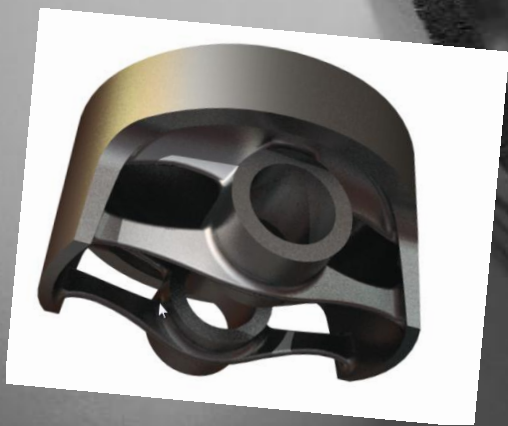
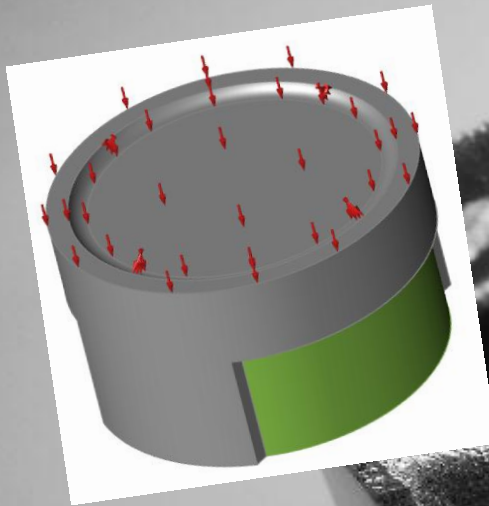
EADS

“...optimized design retained the *same characteristics* in terms of stiffness and bolt loading, while *reducing the stresses* on the part....”



“solidThinking Inspire (with OptiStruct engine) allowed us to maximize the weight saving benefits of the ALM process.”

Jon Meyer EADS Innovation Works



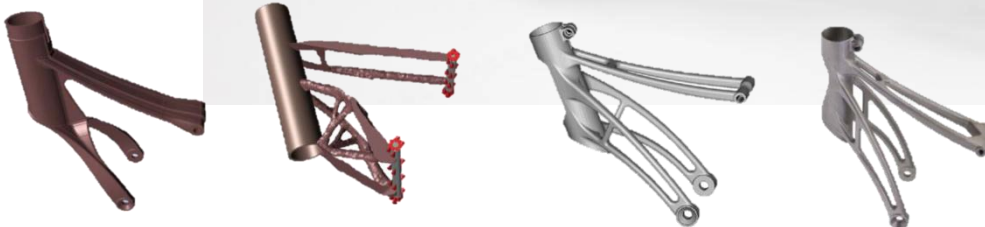
32% Weight Reduction

Unlock the
lightweight
potential of AM with
concept
generation
and
organic
interpretation.

RENISHAW 
apply innovation™

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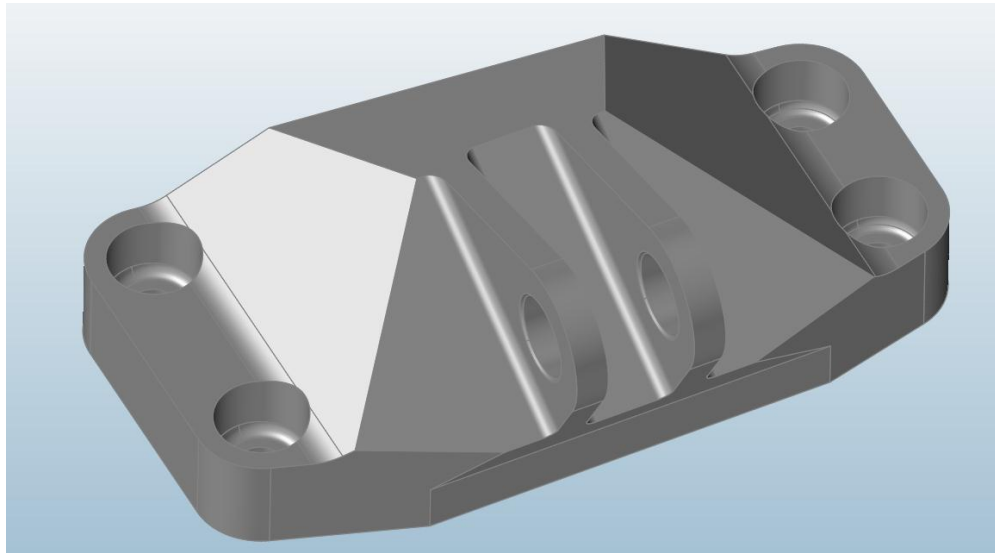




45% Lighter than Original

Revolutionizing
the additive
manufacturing
design process for the
world's first 3D
printed bike frame

solidThinking®



Reference: GE jet engine bracket AM challenge
<http://grabcad.com/challenges/ge-jet-engine-bracket-challenge>

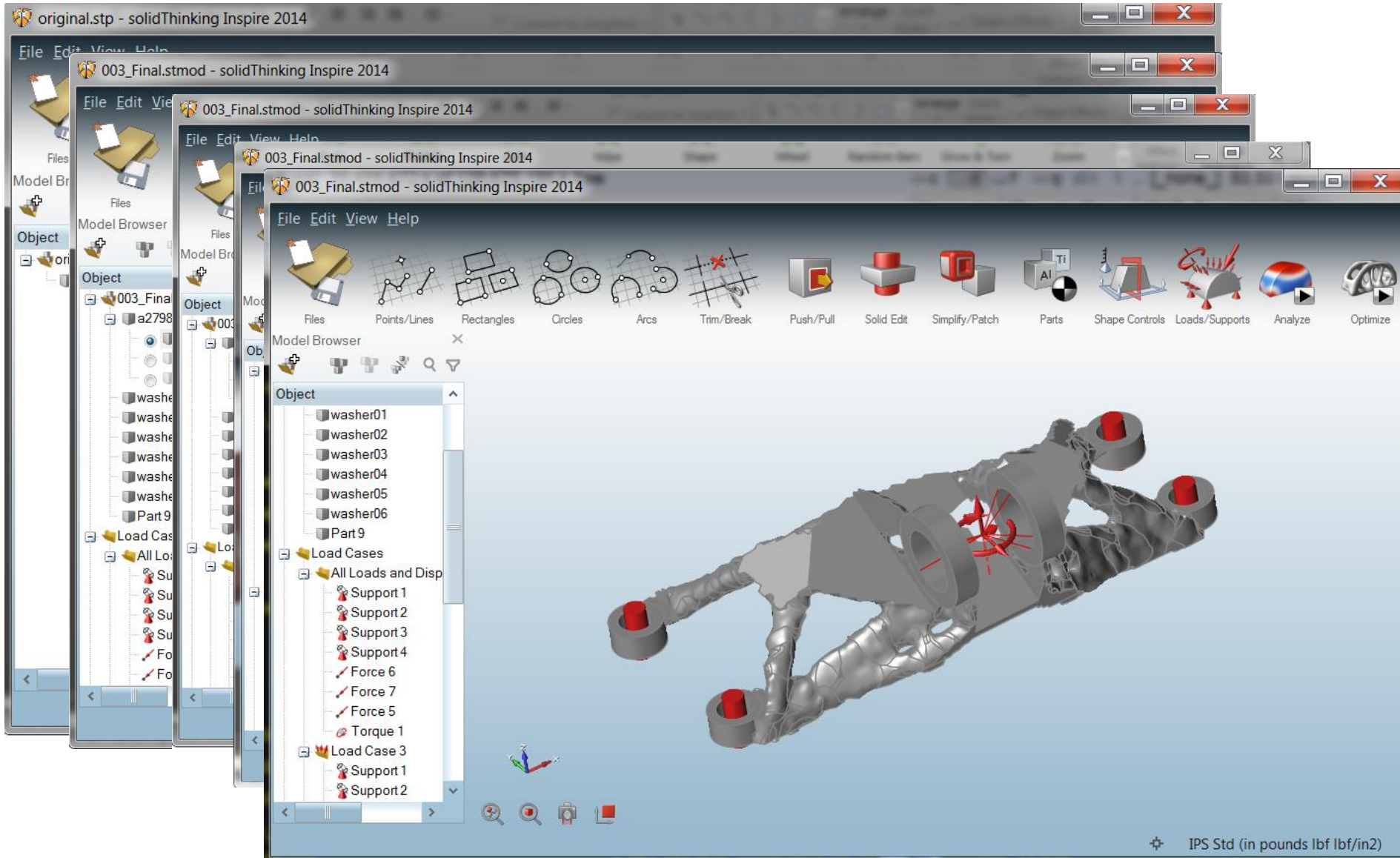
<p>Load Conditions 1</p> <p>Static</p> <p>Vertical</p> <p>8000 lbs up</p>	<p>Load Conditions 2</p> <p>Static</p> <p>Horizontal</p> <p>8500 lbs out</p>
<p>Load Condition 3</p> <p>Static</p> <p>42 degrees from Vertical.</p> <p>9500 lbs out</p>	<p>Load Condition 4</p> <p>Static Torsional</p> <p>Horizontal plane at centerline of clevis.</p> <p>5000 lb-in</p>
<p><u>Load Interfaces</u></p>	

How to find the best Design?

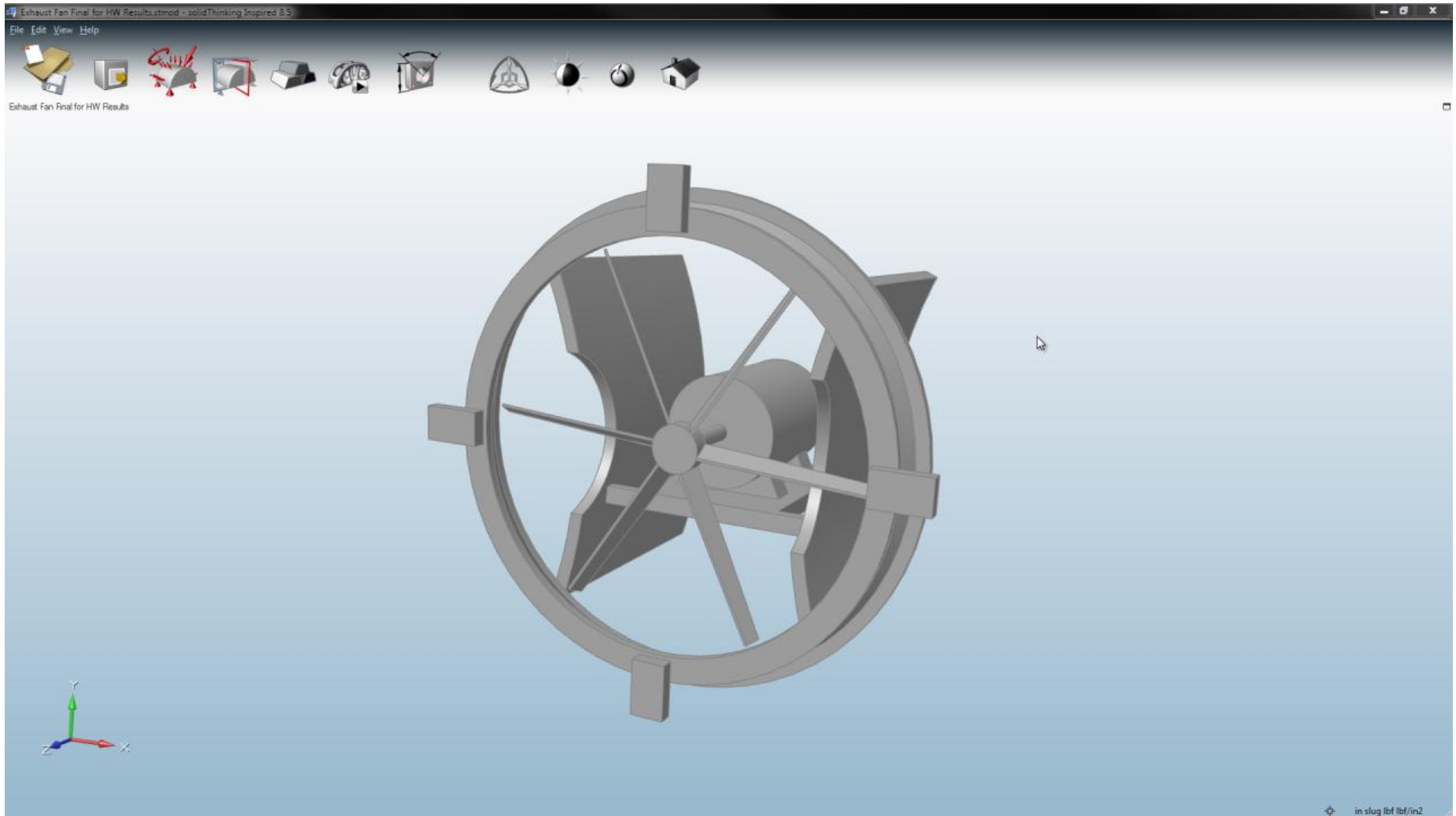
Load Conditions:

1. Max static linear load of 8,000 lbs vertical up.
2. Max static linear load of 8,500 lbs horizontal out.
3. Max static linear load of 9,500 lbs 42 degrees from vertical.
4. Max static torsional load of 5,000 lb-in horizontal at intersection of centerline of pin and midpoint between clevis arms.

solidThinking Inspire



Demo



Concluding Remarks

- **Additive manufacturing**
 - Structural freedom – complexity in shape and topology
 - Individualized product (medical applications etc.)
 - Accelerated processing – no tooling needed
- **Topology optimization**
 - Maximizing design freedom – complex free-forming ‘bionic’ structures
 - Path to optimal structures made with AM technology!
- **Altair Technology**
 - **OptiStruct** support optimization for comprehensive engineering process
 - Topology made easy for designers with **Inspire**
 - New technology creating optimal lattice structures coming soon



INSPIRE

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2014

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