TaSC® Product Status

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LSTC

Abstract

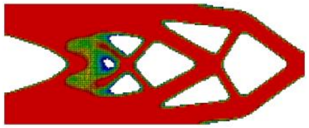
The LS-TaSC product status is presented. The current capabilities are discussed together with illustrative examples and release dates. In addition, the current development directions, such as new capabilities and CAE integration, are also revealed.

LS-TaSC Status

Willem Roux

Collaborators: Imtiaz Gandikota, Liangfeng Luo, Philip Ho, David Wynn

Today's talk

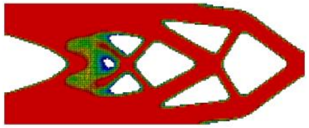


Current directions in topology

Capabilities of the latest version

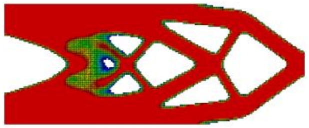
New development

Current Directions



- Multi-criteria / MDO
  - Gas mileage mandates
- Automated design
  - Faster, improved design cycle
- Materials
  - Composites and porous materials

LS-TaSC goals



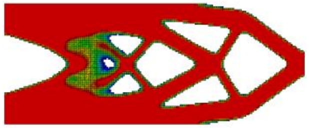
The race is both to the able and the swift.

LS-TaSC have:

- Specifically developed for large, highly nonlinear problems. Valid for linear.
- Imbedded in the design process

LS-TaSC

New Team Members



Imtiaz Gandikota

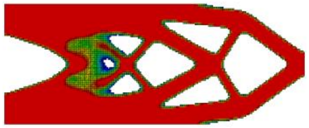
- Started in August 2013
- Support for both LS-OPT and LS-TaSC

Attila Nagy

- Starting soon
- Methods development, DSA, composites.
- Worked with Gürdal and Dave Benson.

Existing LS-PrePost collaboration

- Luo Liangfeng, David Wynn, and Philip Ho



Version 3.0

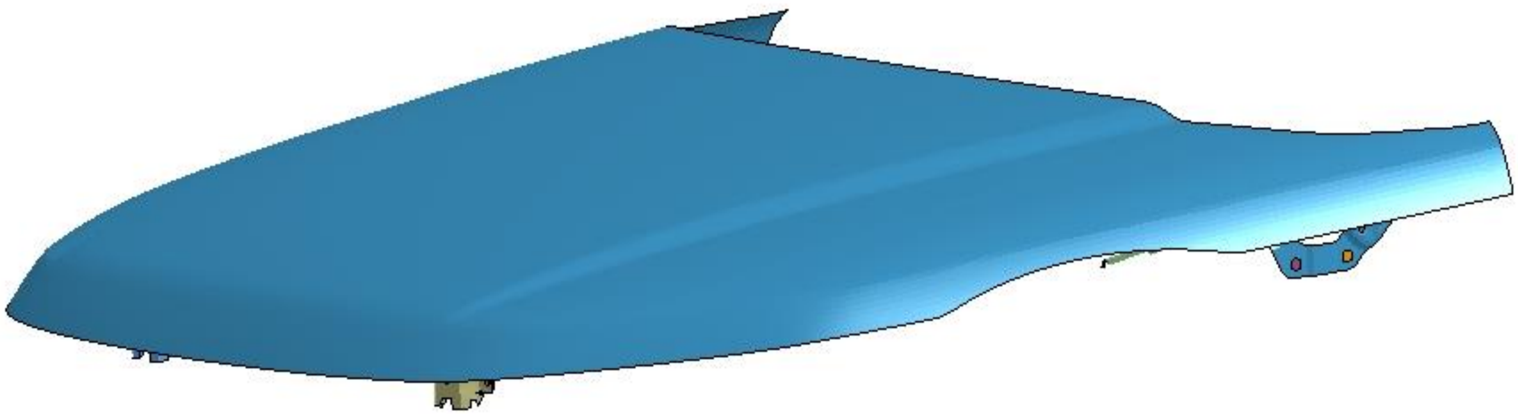
Available on the ftp site.

Major New Features

- Free surface design of solids
  - Geometry definitions
  - Automatic mesh smoothing
- Integration with LS-PrePost

Several minor features.

Bonnet Case Study

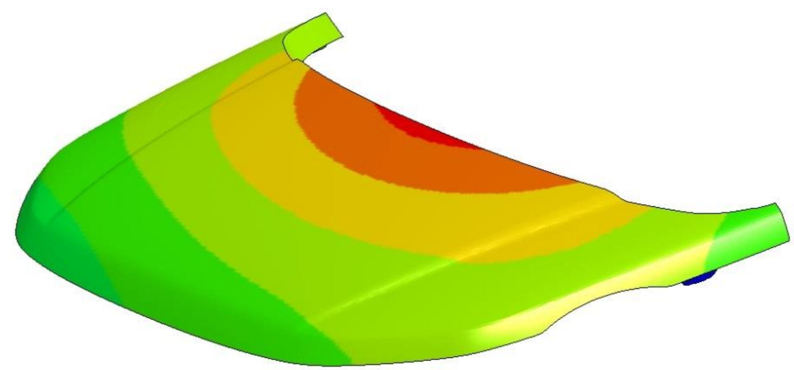


One design for three nonlinear load cases, each with a constraints.

During the design process, the algorithm will remove 90%-99% of the structure. Mesh refinement is therefore required.

Example courtesy of JRL.

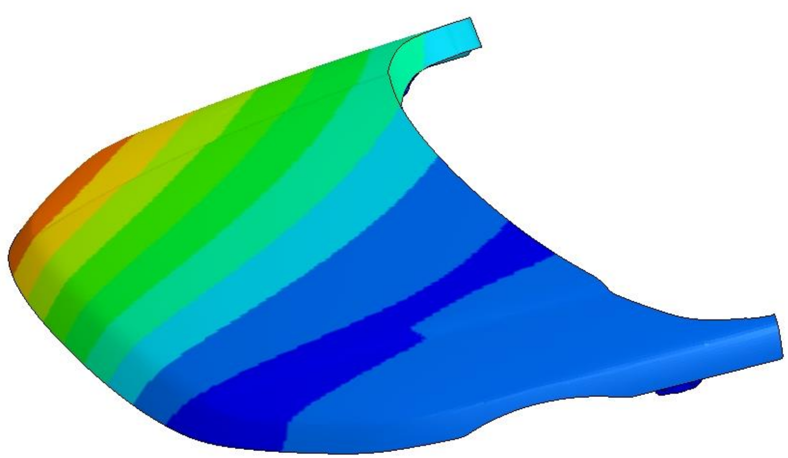
Load Cases

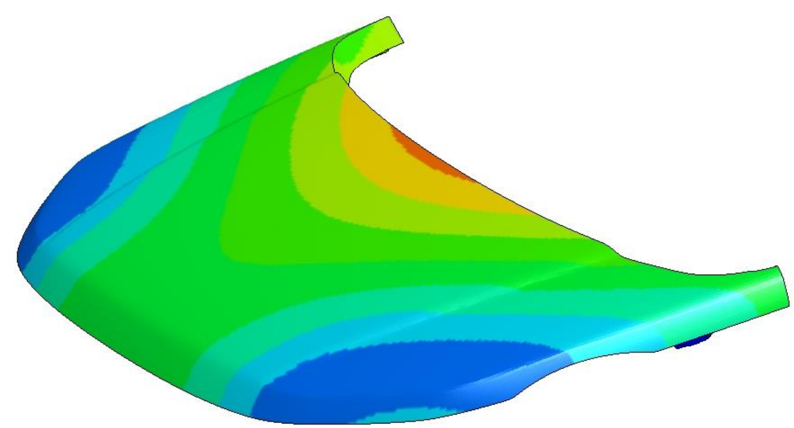


Load cases:

- Rear beam response
- Latch bend response
- Torsion response

Nonlinear including contact





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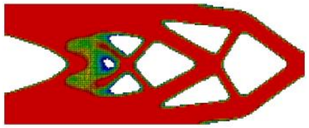
Dynamic weighing



Dynamic weighting makes sure that the structural design is valid for all load cases.

Can be considered a variation on multi-criteria design, because the weighing is done considering response values.

Chose load case weights w_i such that $k_1 R_1 = k_2 R_2$, with k chosen considering the bound on constraint R of load case i.

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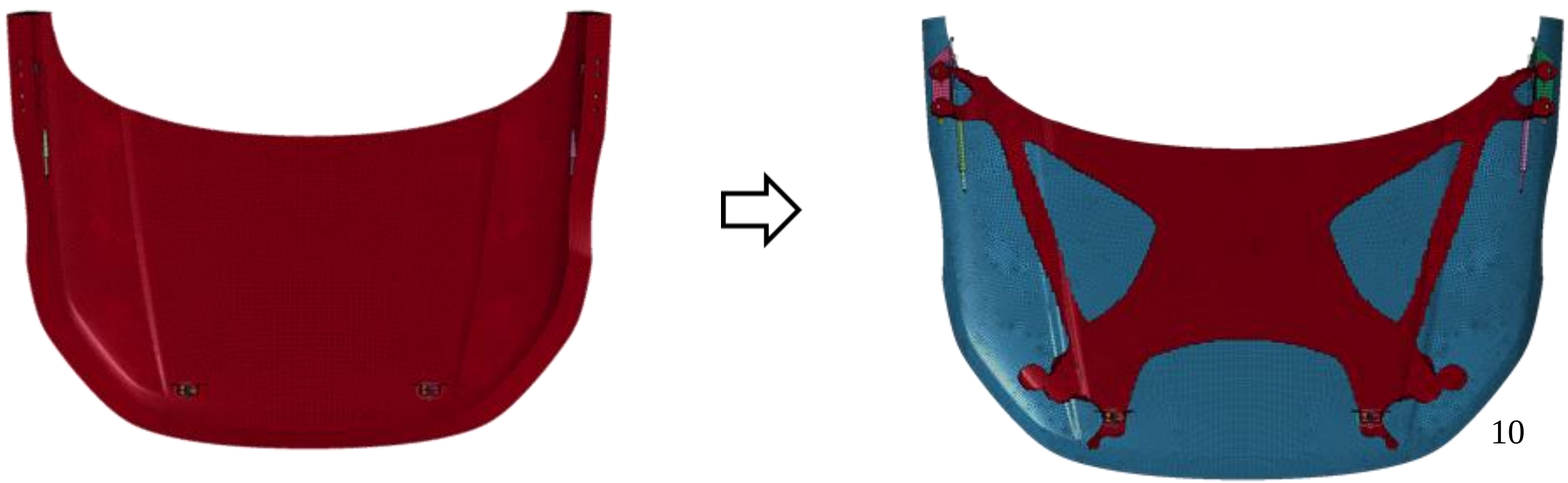
First phase

First phase has 10% mass fraction from initial design.

Dynamic weighing considering the constraints bounds, but the constraints are not active in this phase, because the final design will be lighter.



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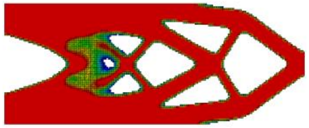
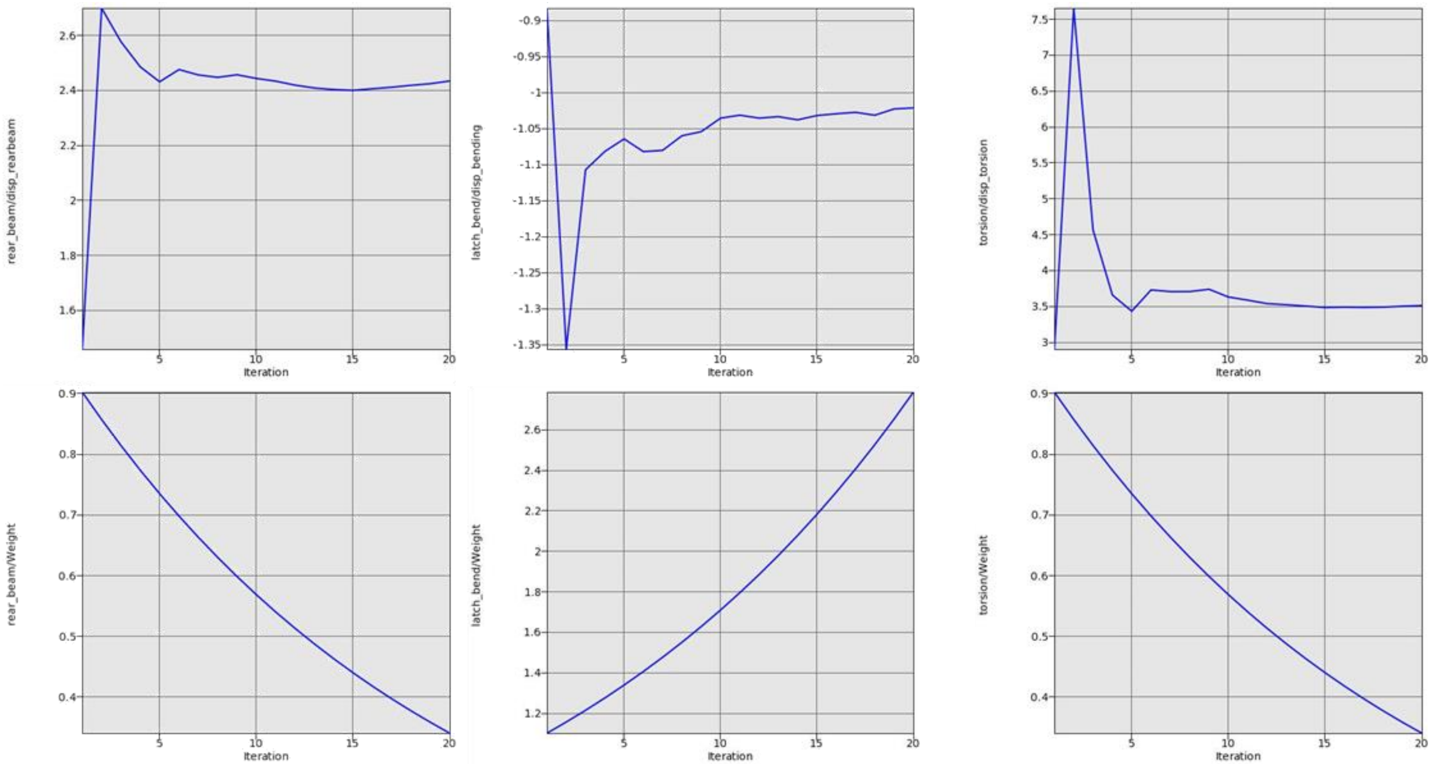


Dynamic scaling results

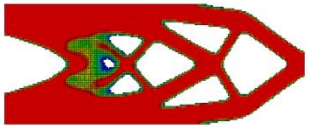
Dynamic scaling considering constraint bounds

Constraint

Weight



Phase II

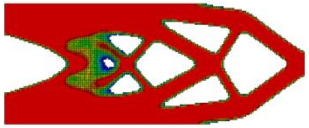


Refined mesh of phase I design as initial design

A constraint bounds for each load case.

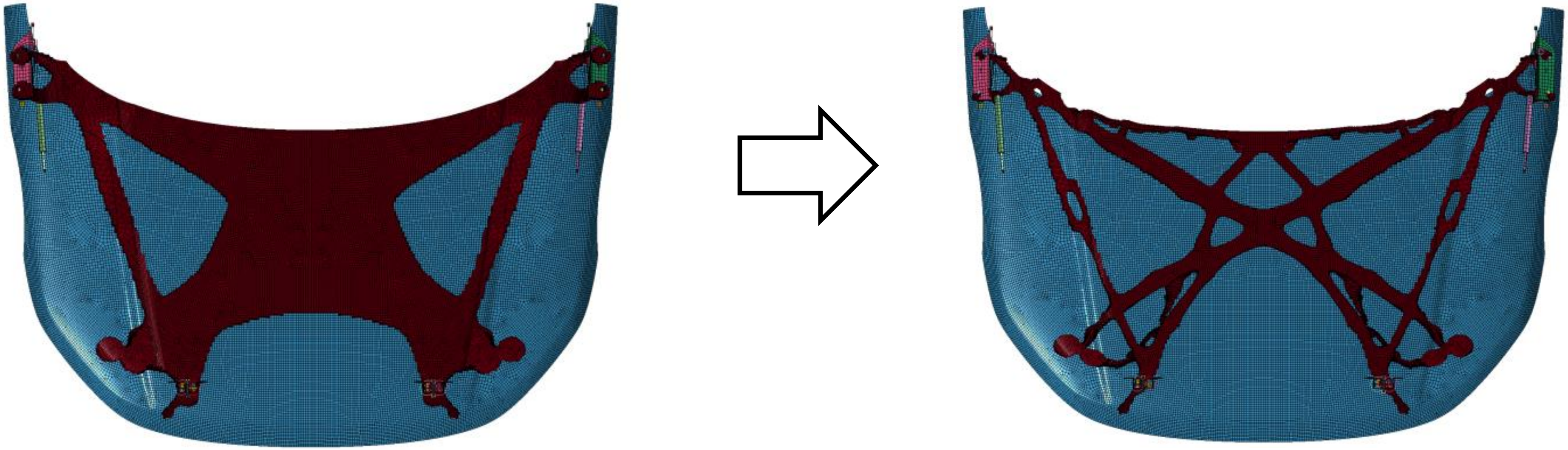
Dynamic weighing to balance the weighing of the multiple load cases.

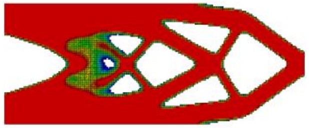
Target mass fraction of 1% (10% of phase I final design).



Phase II

Mass fraction of 7% of original design (24.4% from phase I final design)



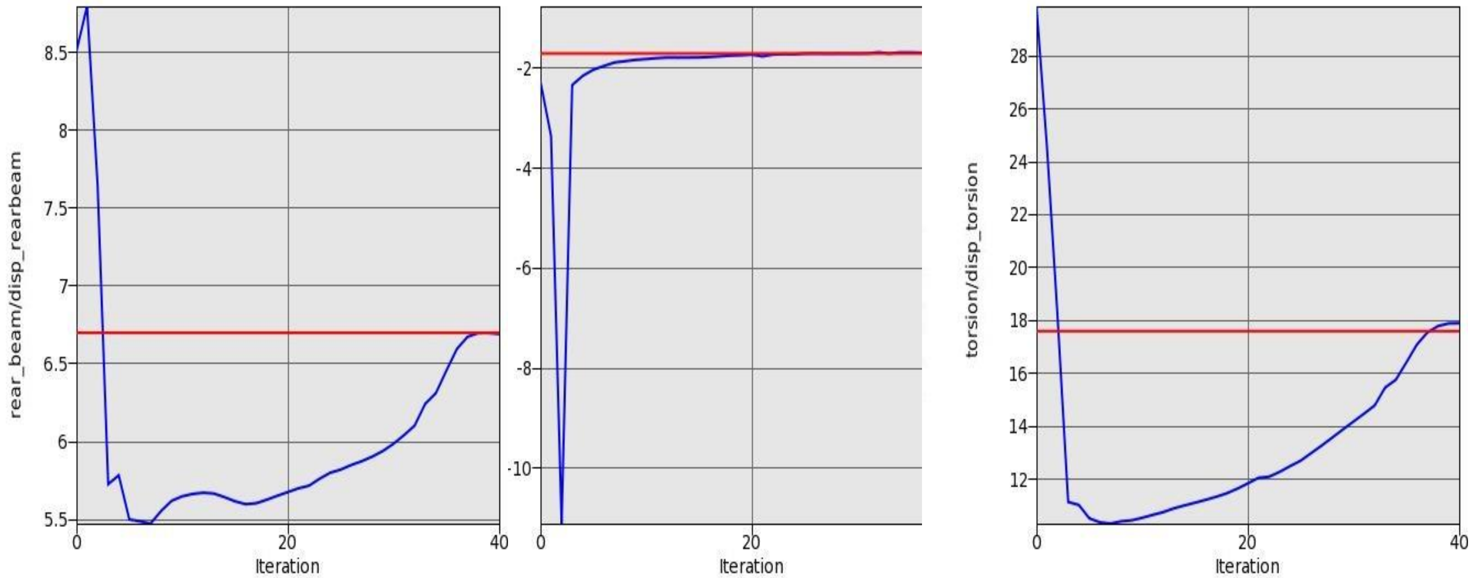


Phase II constraints

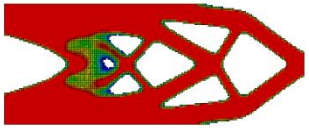
Beam response: R1= 6.69 (≤ 6.7)

Latch bend response: R2= -1.66 (≥ -1.7)

Torsion response: R3= 17.9 (≤ 17.6)

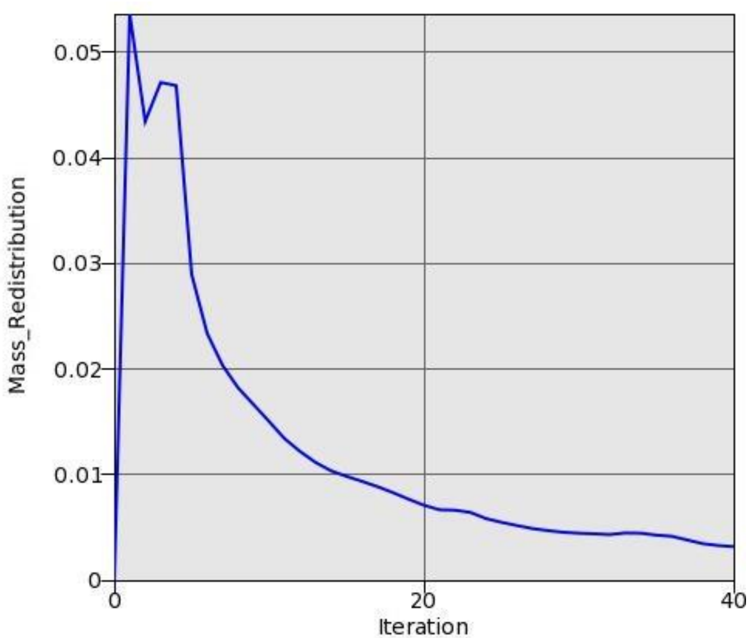


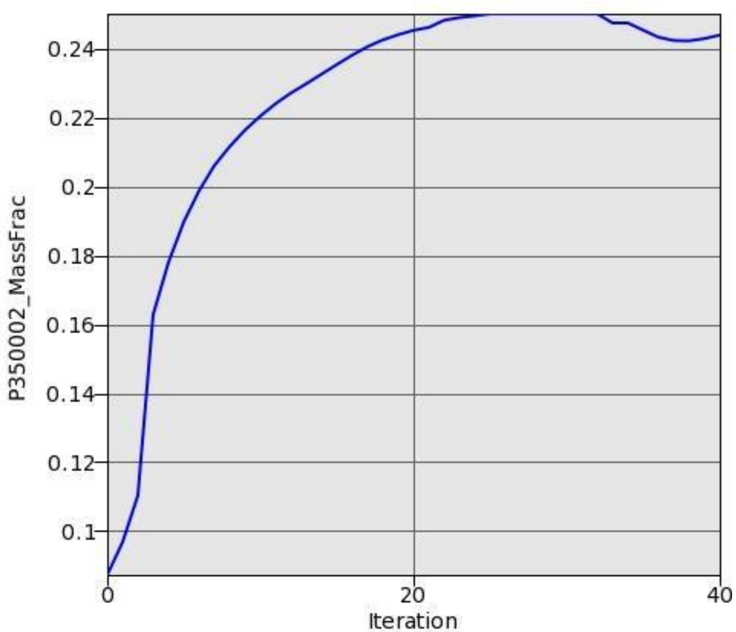
LS-TaSC



Phase II convergence

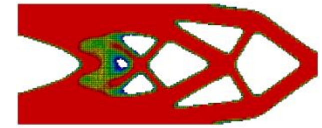
Mass redistribution and part mass.





LS-TaSC

Free surface design



Redesign of the surface of solids to have an uniform stress (removing the stress concentrations).

Similar to biological growth methods.

Extrusion and symmetry geometry definitions are allowed.

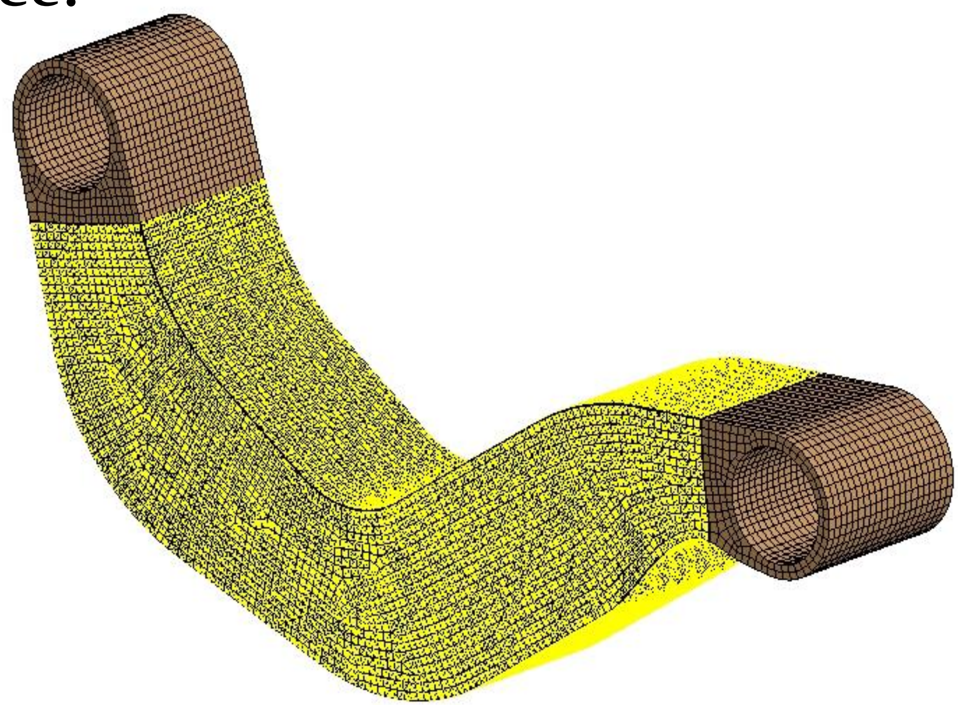
Casting and forging geometry definitions are implied.

Retaining a good mesh is a key technology area.

Very quick to set up the design problem.

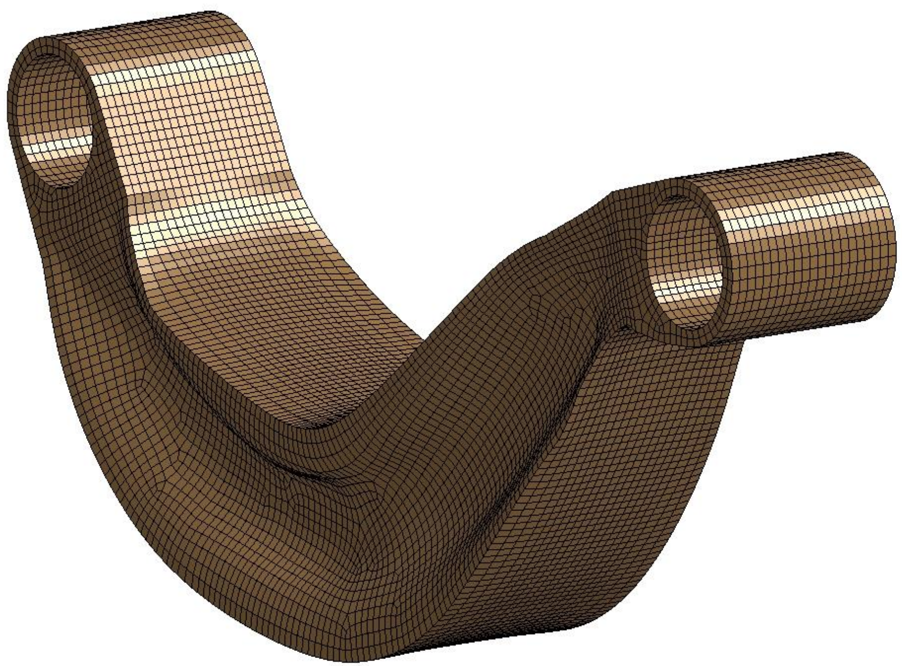
Component surface design

Component example with the yellow surface selected for redesign. Setting up a problem consists of defining a surface.

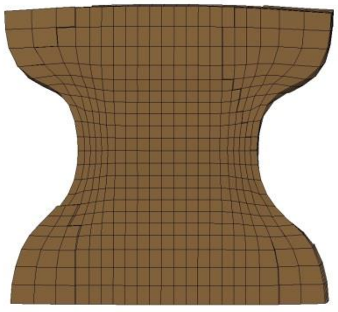


Component shape design

Design at iteration 16 shows that flanges are created.



Cross-section



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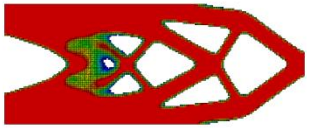
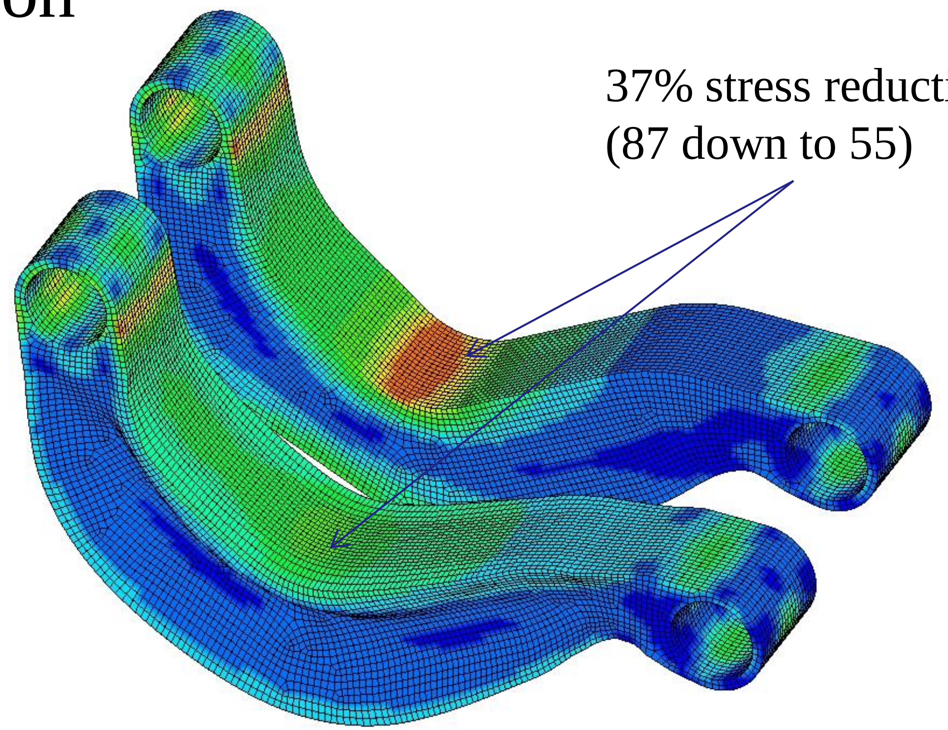


Component shape design

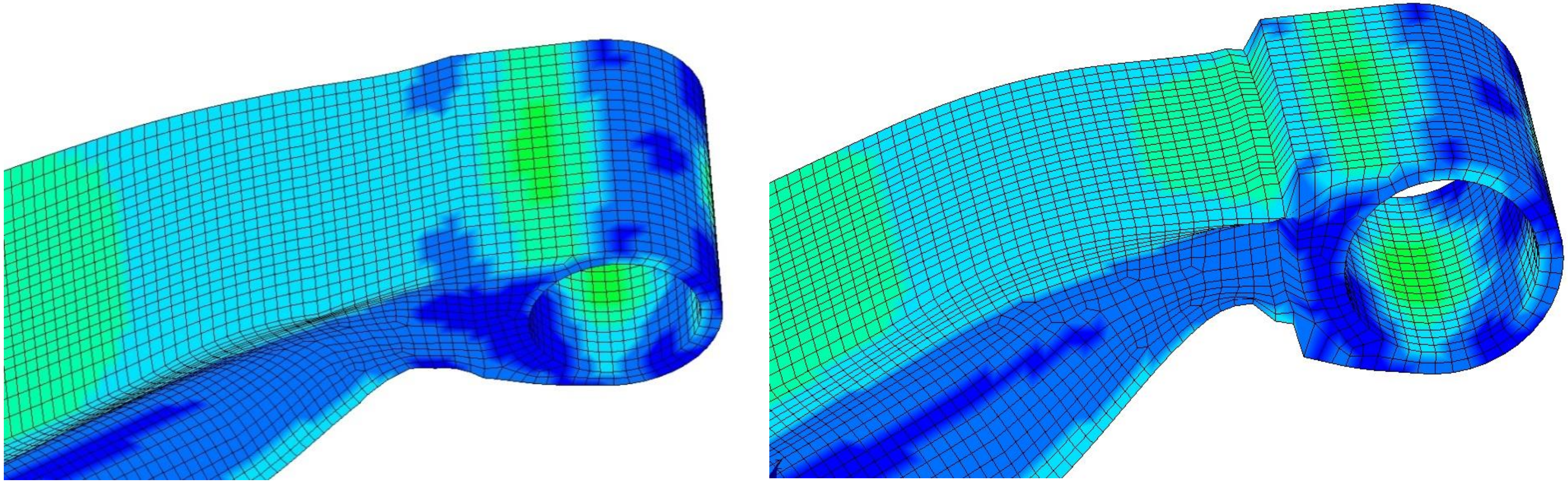
Comparing the Von Mises stress at iteration 16 with the original design shows a 37% improvement.



Edge smoothing

The edge of the surface can be deformed.

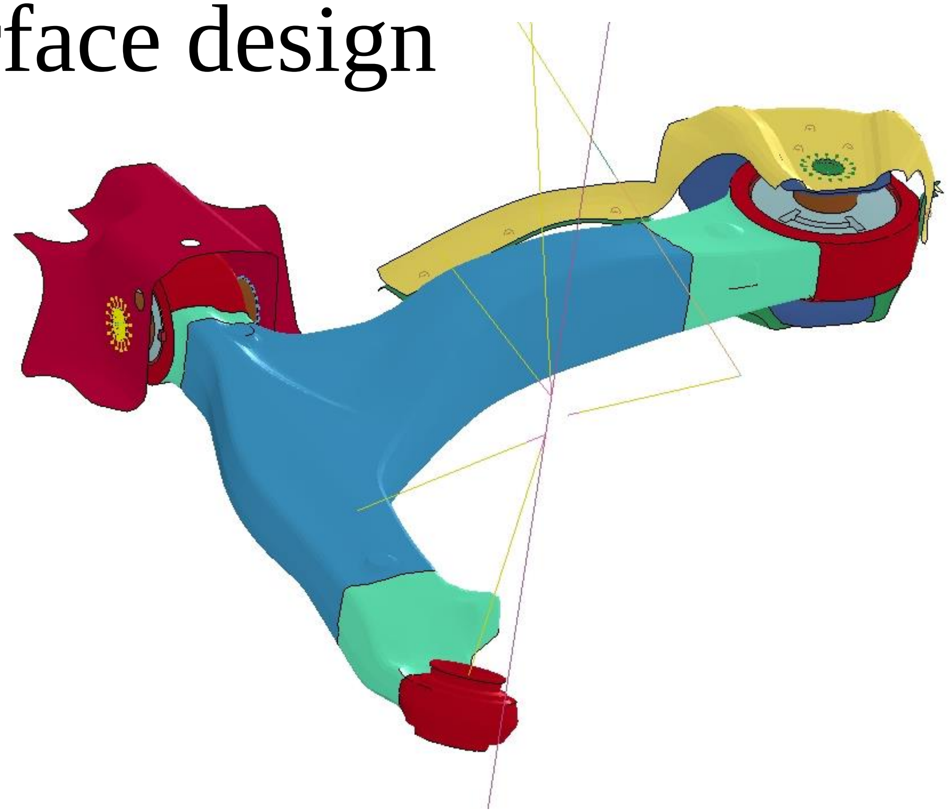
Below with and without edge smoothing.



Suspension example

Nonlinear behavior.

Outer surface design



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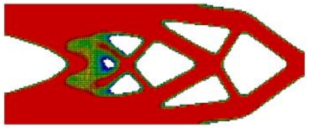
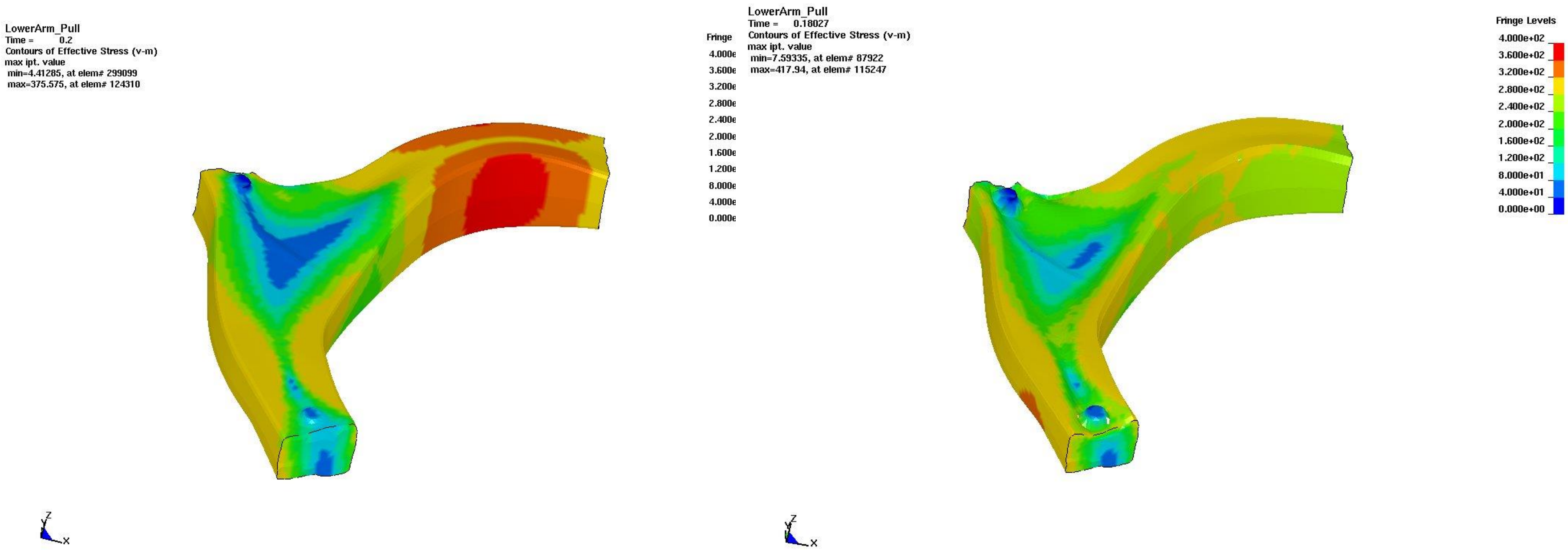
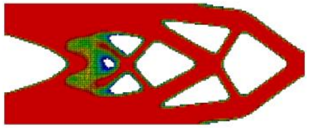


Final von Mises stress

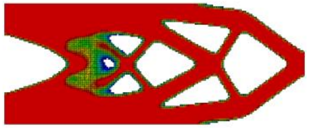




GUI

Demo by Imtiaz.

LS-TaSC



Version 3.1

User-defined results (MDO)

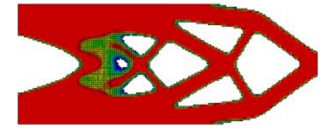
More integrated post pro-processing

Outer surface of design

Revised constraint GUI panel

Many topology methodology improvements

LS-TaSC



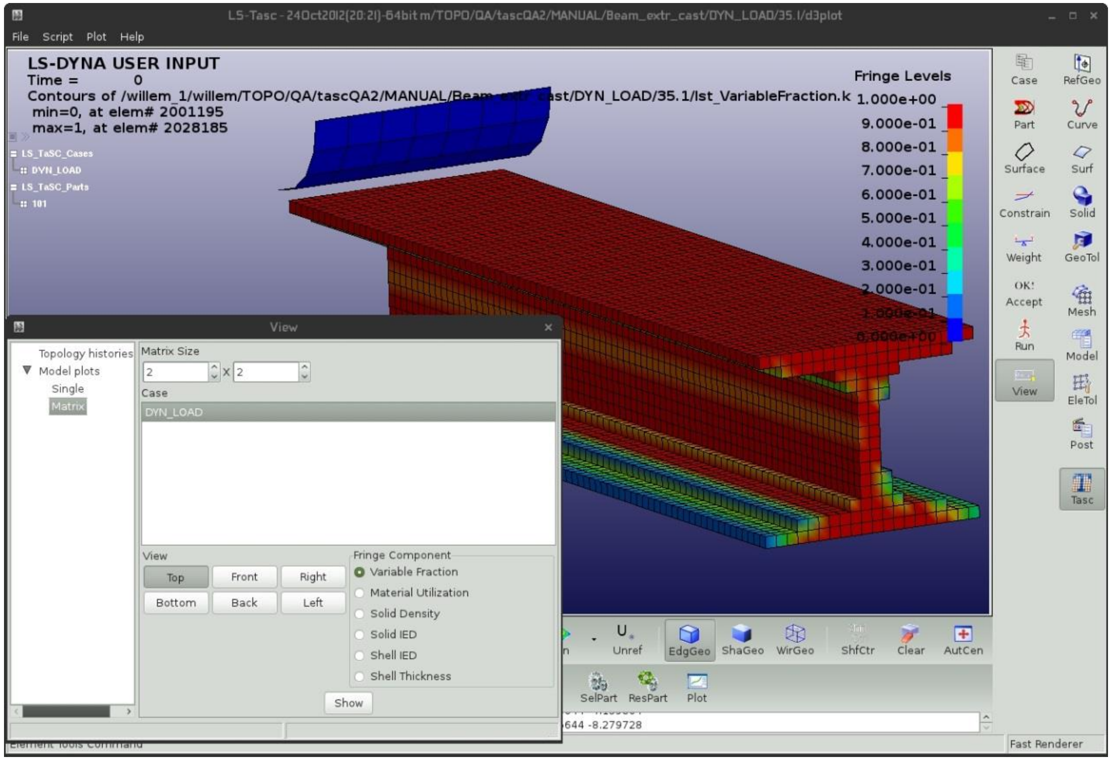
User results

- Request from a large customer.
- Enable multi-disciplinary design with results from different software.
- User must convert results to an material utility value; you can, for example, incorporate DSA values from other disciplines.
- This is only for advanced users; should work for a large variety of cases.

LS-TaSC

LS-PrePost Integration

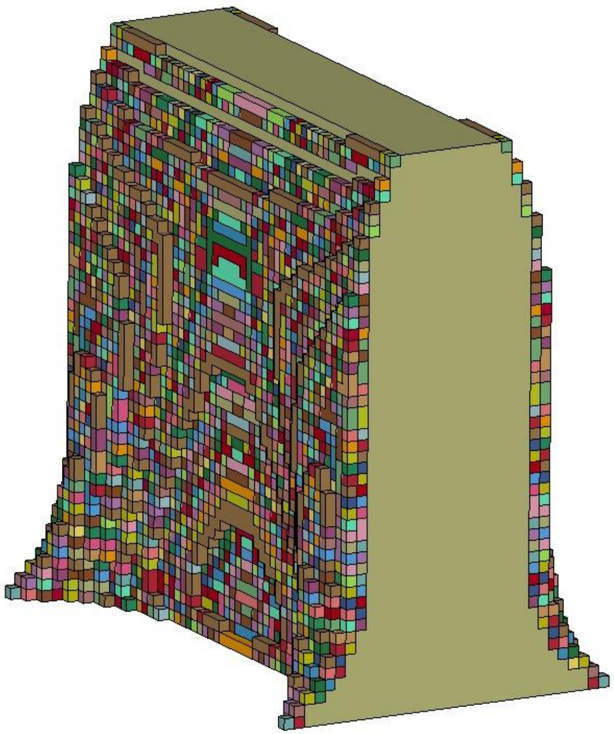
Post-processing is integrated.



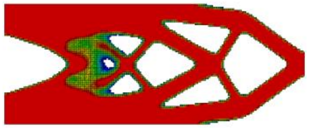
Outer surface of design

Various old capabilities:

- Can create a surface containing part.
- Matrix plot
- Optimum design with all elements

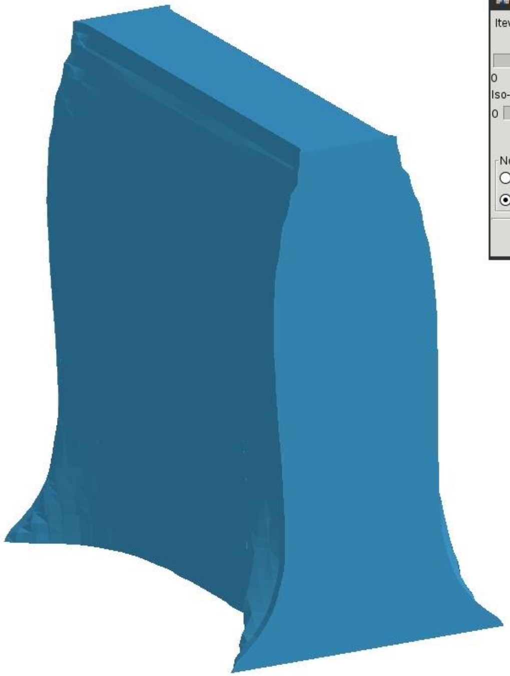


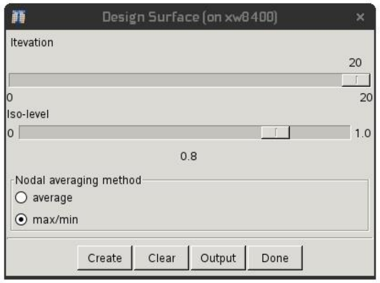
Outer surface of design



Create surface containing optimum design.

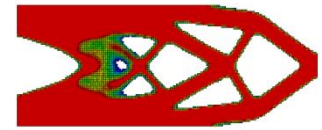
It is possible to request for an iteration and variable value.





LS-TaSC

Constraints Panel



Reorganized for allow more types of constraints.

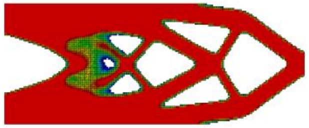
In the past you were limited to stiffness and reaction forces.

In the future any type of response will be allowed.

Dynamic weighing will be moved to this panel.

LS-TaSC

Methodology improvements



New(ish) product for nonlinear problems, started of with the HCA methodology.

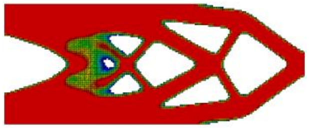
First we created a framework containing:

- LS-Dyna integration
- LS-PrePost integration
- Computational geometry
- Large models ($10^6 - 10^7$ elements)
- Distributed computing

Going forward a larger focus on the methodology.

LS-TaSC

Methodology improvements

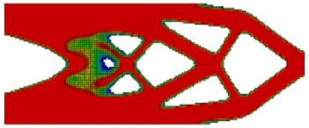


Version 3.1 contains large improvements in all aspects of the biomimetic topology methodology:

- Solid/Void scheme
- Constraints handling
- Variable bounds

In the future we will have a mixture of biomimetic and DSA techniques.

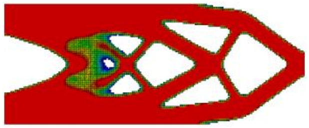
Model size



The technology is being developed for very large models.

A model size of 5 000 000 elements is common.

Summary



LS-TaSC is for the topology and shape design of very large, nonlinear problems.

Version 3.0 is a big step forward containing:

- Free surface design
- LS-PrePost integration

The important features for version 3.1 are

- Important methodology improvements.
- User / MDO results
- Outer surface of optimum