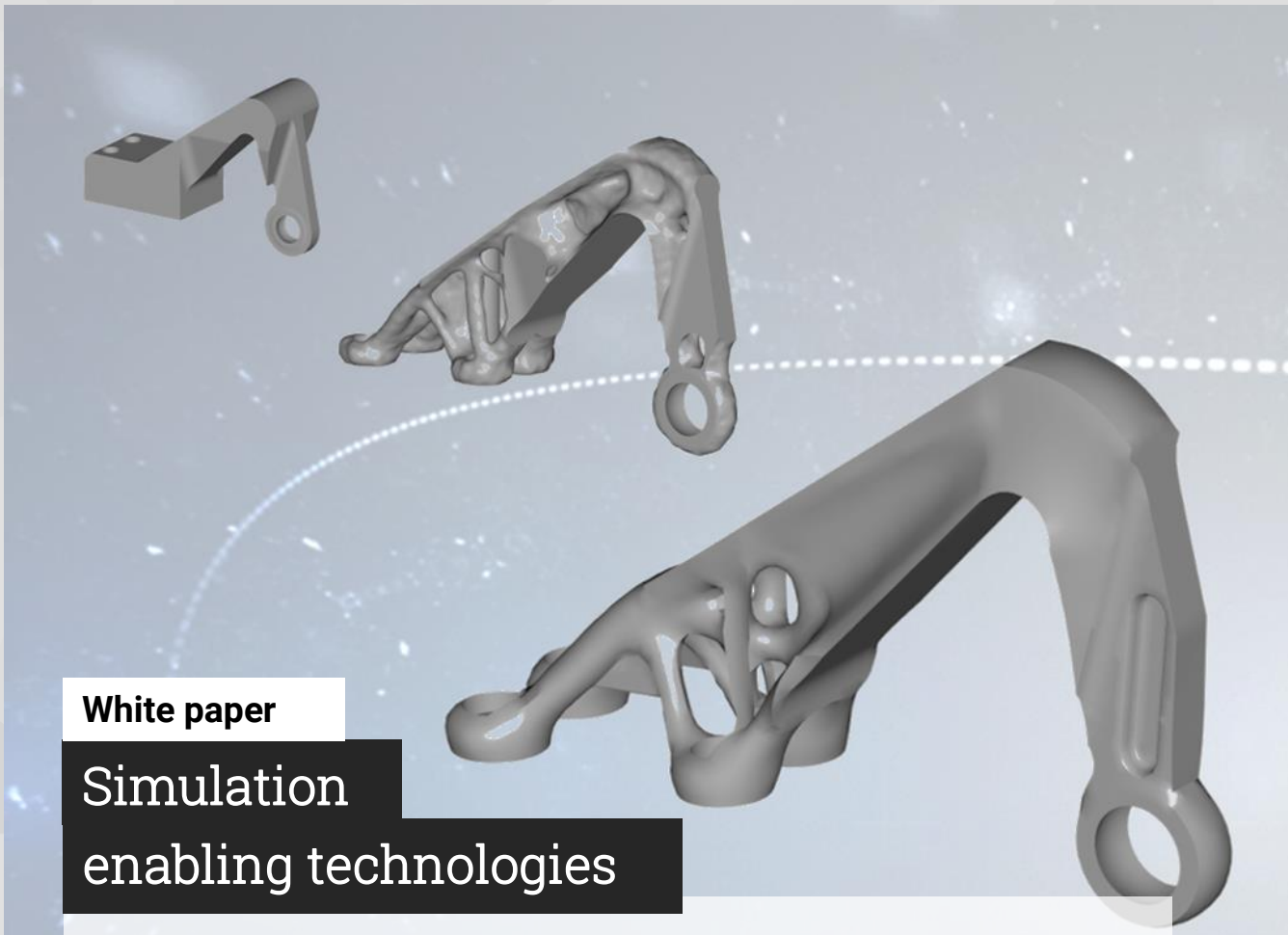
BETA
SIMULATION SOLUTIONS

physics on screen



White paper

Simulation enabling technologies

Optimization Process for Products Made with Additive Manufacturing.

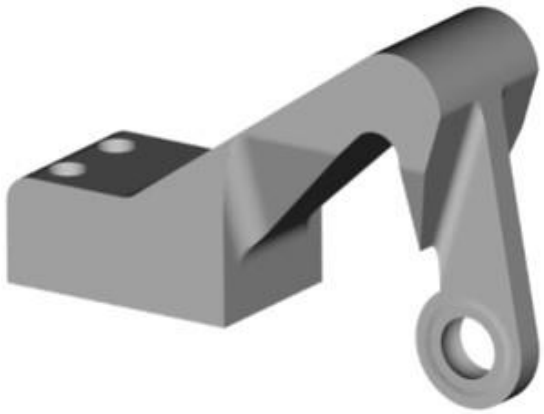
A case of an Airplane Bearing Bracket.

In this case, an automated optimization process to set-up an optimization analysis in ANSA, run it with the EPILYSIS solver, as well as evaluate the results in the META post-processor is created, by employing the ANSA Task Manager.

Additive Manufacturing (AM) enables the production of complicated geometries, until now, not possible to PRODUCE with conventional methods. This allows for the pursuit of more cost-efficient designs. To achieve this, engineers employ optimization techniques to determine these optimum designs.

Optimizations of products vary to achieve optimum mass, volume, size, or shape. Using FEA simulations, engineers can simulate and optimize the possible optimization scenarios. However, direct results, from the optimization solvers, might produce designs not suitable for manufacturing. Thus, models generated from optimization analyses need to be repaired manually before proceeding to manufacturing. Consequently, specific tools which will help the user retrieve and repair the FEA optimized model and generate a ready-to-manufacture shape are in demand. BETA CAE Systems provides a complete tools package to completely set-up such an analysis in ANSA, run it with the EPILYSIS solver, as well as evaluate the results in META pre-processor.

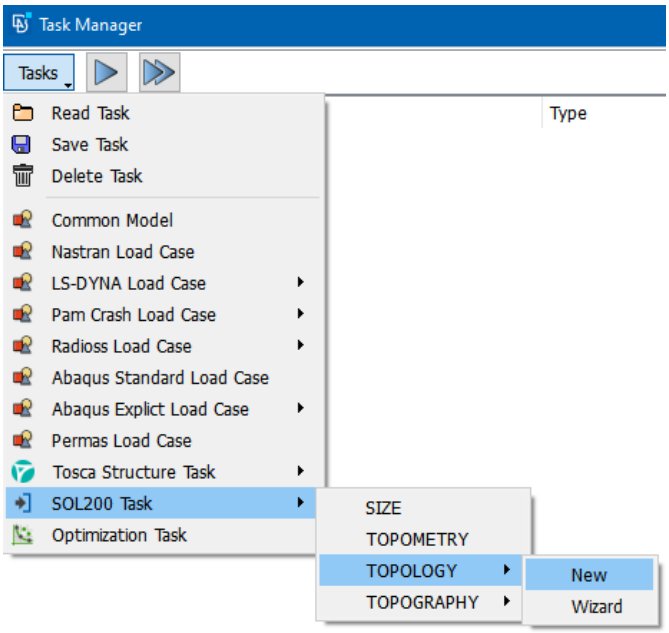
A case of an Airplane Bearing Bracket

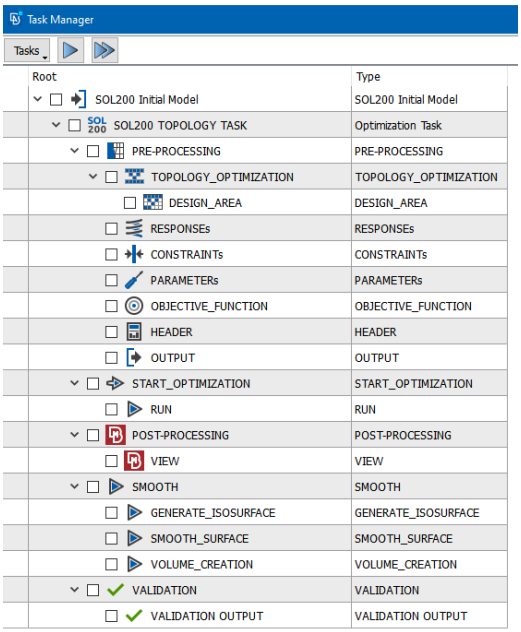


A bearing bracket is a common component on control surfaces of various aircrafts. As a dynamic component that interfaces with moving parts, the bearing bracket must conform to a certain geometrical envelope as well as sustain large loads in various directions. Redesigning the bracket for AM could provide significant weight reduction.

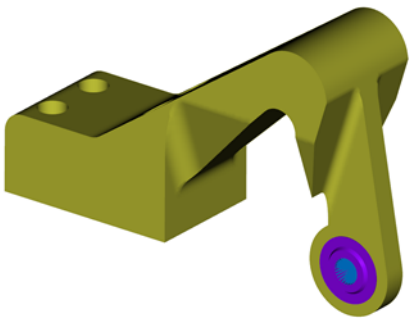
A Guided Workflow

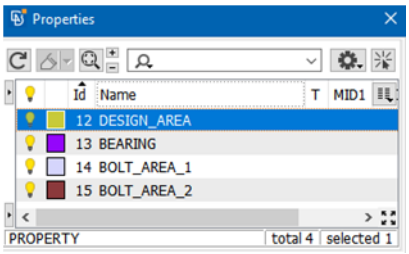
The whole process can be completed with the guidance of the ANSATask Manager, a tool for organizing and automating complete processes.



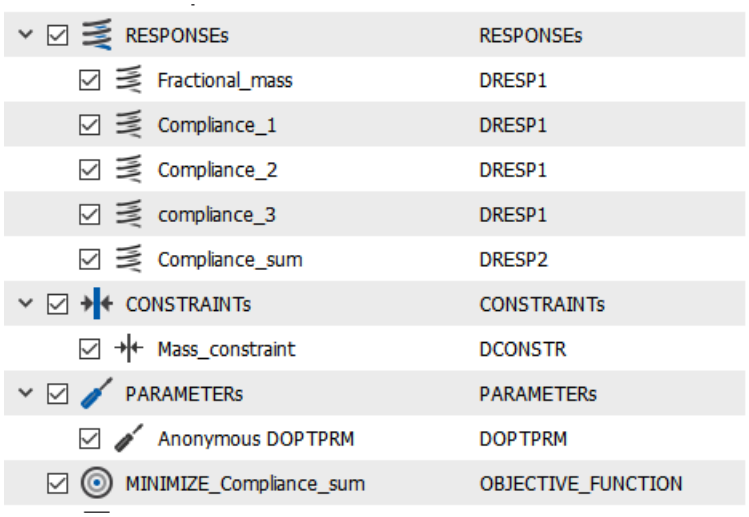


Directly from the Task Manager it is possible to generate all solver data needed for the optimization analysis. Following the guidance of the Task Manager, the first step is to define the **DESIGN AREA** of the model.

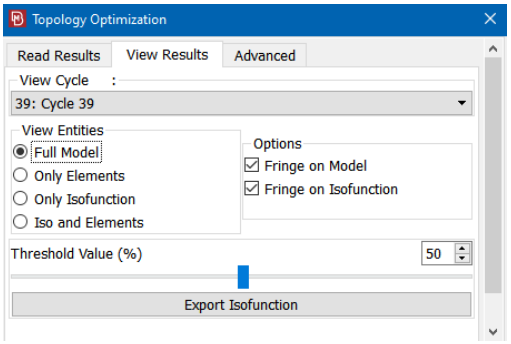


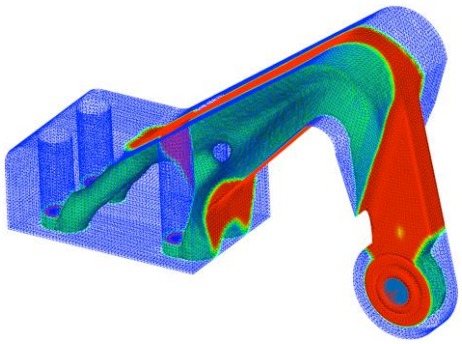


Next, the generation of **RESPONSEs** and **CONSTRAINTs** takes place. As we have several load cases, several responses will be needed. In this simulation the mass reduction needs to be reduced in a way to comply with all the loads. Thus, it is necessary to assign each Compliance Response to each load case and one Compliance Response that it will summarize all the loads. Additionally, Fractional Mass is needed as a Constraint.



While all the necessary data are defined, the Task Manager can send the file to the **EPILYSIS** solver. Once the simulation is finished, the result is directly loaded to the next object of the Task flow. In the **META** post- processor all necessary files generated by the **EPILYSIS** solver are automatically loaded in the dedicated toolbar

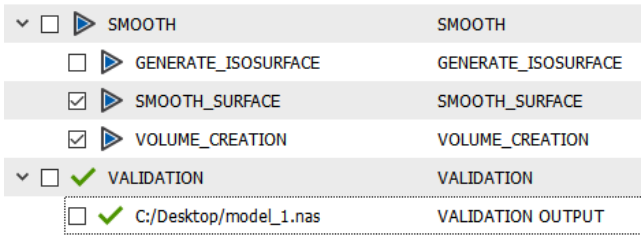


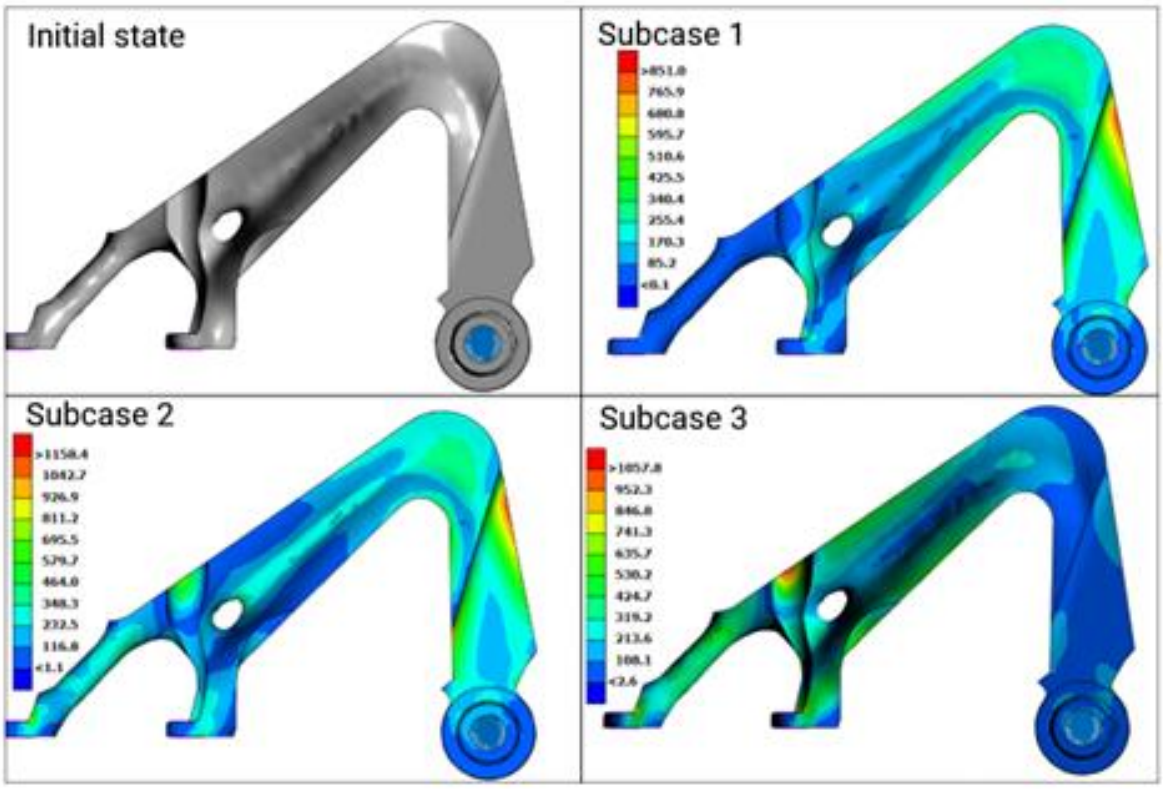


Taking advantage of the technology of isofunction we can not only view the model in a smoother drawing mode, but also control the threshold value of it. Eventually, to verify the model, the option to Export the isofunction as a solver file is also available.

Since the mass reduction has reached our goal, from 0.87kg to 0.27kg, it is essential to verify its stiffness. Thus, re-importing the optimized geometry in ANSA and re-applying the loads is nacessary.

Via the **SMOOTH** object the initial geometry will be replaced with the new optimized shape. The last section of the workflow is the **VALIDATION**, where the updated shape will be tested with the same loads.

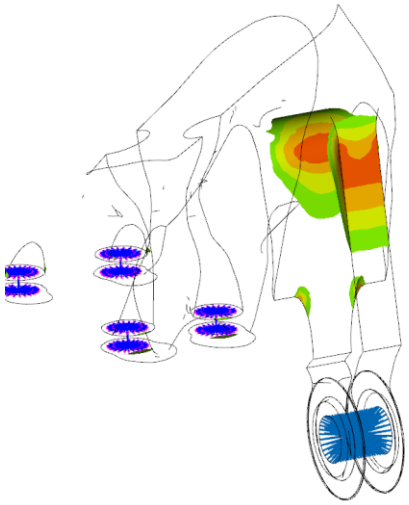




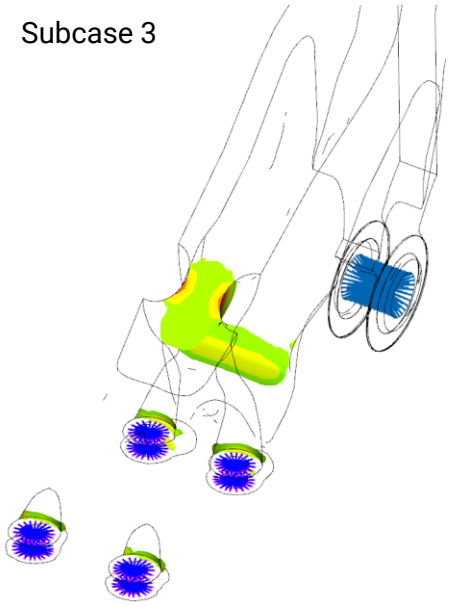
Shape modification on FE-model

It is possible that the directly exported by the solver model, might not respect fully the yield stress limit. At this point the areas with the highest stresses need to identified and modified.

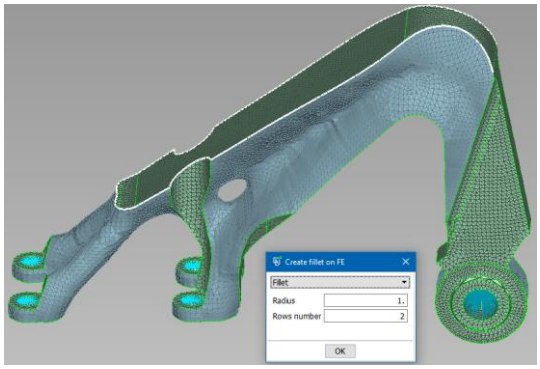
Subcase 2

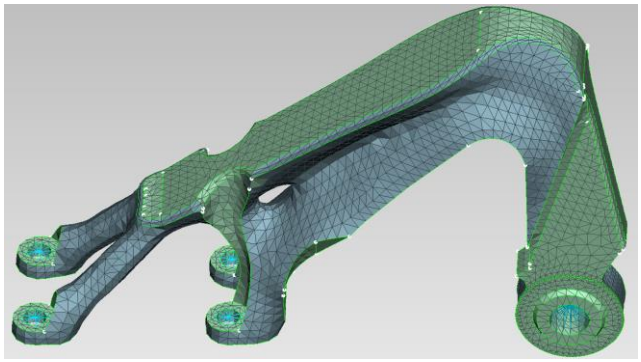


Subcase 3

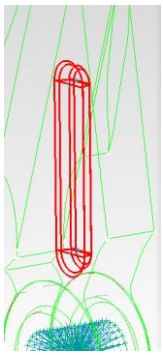


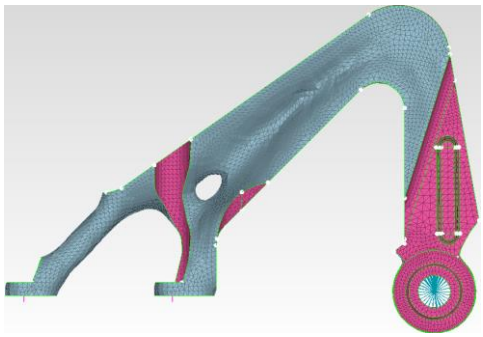
Reviewing the results in META, the highest stresses are located on the sharp edges of the model. Thus, these sharp areas need to be modified into fillets.



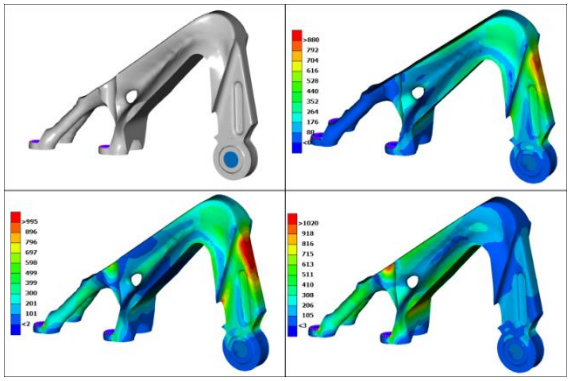


Still, there are areas with low stresses. In these areas the reduction of mass can be applied by generating specific shapes such as, a Bead.





Once the volume elements are regenerated, the model is ready for re-inspection.



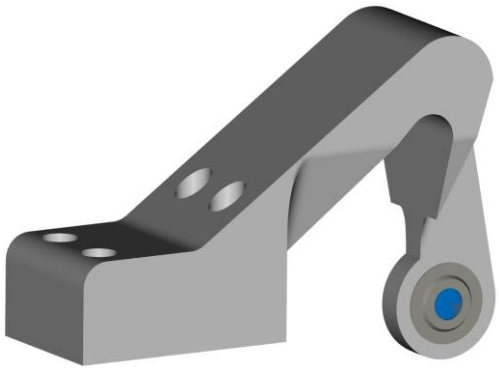
Initial and Optimized Model Comparison table

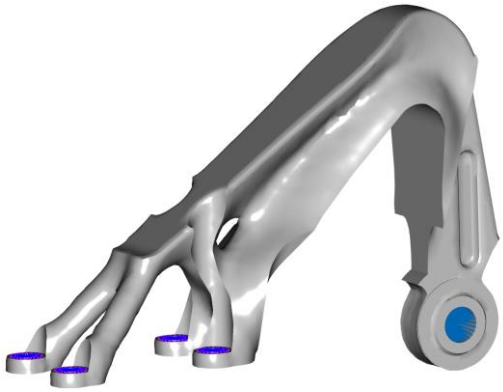
	Initial Model	Optimized model	Initial Model	Optimized model	Initial Model	Optimized model
	Subcase 1		Subcase 2		Subcase 3	
Displacement (mm)	1.14	1.68	1.25	1.66	0.78	1.54
Stresses (MPa)	795.9	829.5	926.7	1077.1	477	877

Mass (kg)	Initial Model	Optimized model
	0.87	0.27

Conclusions

Using the automated process of the ANSA Task Manager it is possible to reach a component's optimum design proposal in an impressive short period of time. Keeping only 30% of the initial volume, the Yield stress limit of 1100 MPa was not violated. The Topology algorithm recognized the areas without stresses and gradually removed material. Topological repair of the optimizer result by advanced tools even for tough additive manufacturing cases is also possible.





About BETA CAE Systems International AG
BETA is a simulation solutions provider, dedicated to the development of state-of-the-art software systems for CAE. For almost 30 years, we have been developing tools and delivering services for the front-runners in numerous sectors by listening to their needs and taking up even the most demanding challenges. For more information on BETA CAE systems, our products, and our services, visit www.beta-cae.com

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