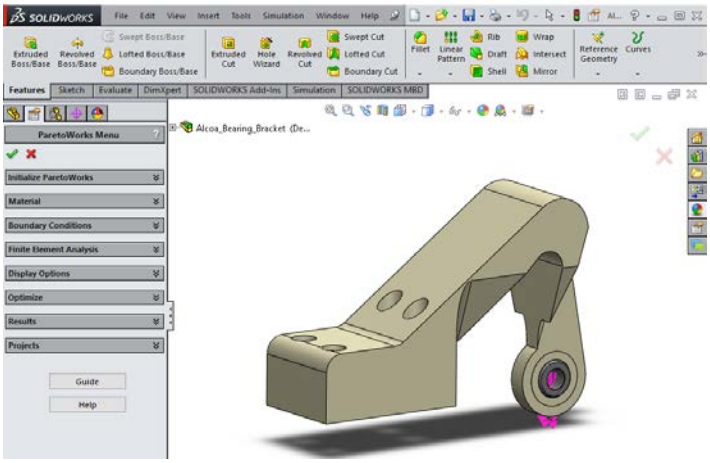
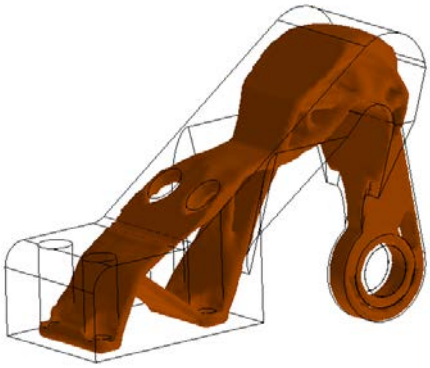
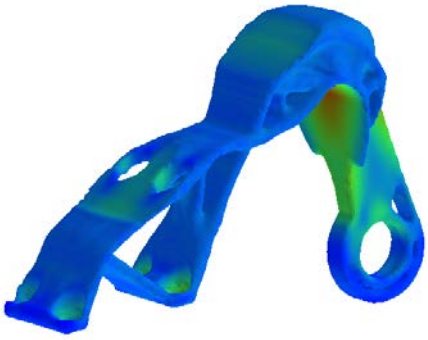
Designing Light-Weight Parts using ParetoWorks







CERTIFIED Solution Partner

SOLIDWORKS

ParetoWorks

ParetoWorks is an Add-in to SOLIDWORKS for fast and easy topology optimization.

Using ParetoWorks, one can create lighter and better-performing products.

ParetoWorks has a built-in super-fast FEA solver.

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Why Topology Optimization?

Weight Reduction: A Trial-and-Error Process Today

For engineering companies to be competitive, they have to create lighter and better-performing products. For example, given a structural problem in Figure 1a, engineers need to figure out where and how to remove material. Often, one of the tools engineers use is finite element analysis (FEA); see Figure 1b.

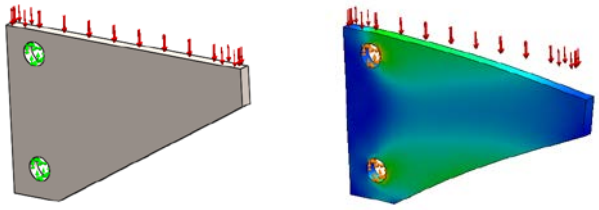


Figure 1: (a) A structural problem: reduce the weight by 50%. (b) FEA provides hints where to remove material

Unfortunately, FEA can only provide hints on where one should remove material. The actual process of carefully removing material can be arduous and error-prone. Figure 2 illustrates a few designs that an engineer might generate. There is no guarantee that the final design generated through this trial-and-error process is even close to optimal.

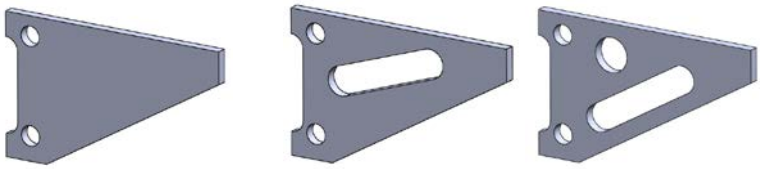


Figure 2: Finding light-weight designs however is a trial-and-error process.

Creating light-weight products is an arduous and error-prone process today.

Topology Optimization: A Powerful Design Tool

Topology optimization is a powerful automated process for **performance-constrained weight reduction**. It relies heavily on FEA, but it automates the process of material removal, resulting in a highly optimized design. For example Figure 3 illustrates an optimal design generated through topology optimization, using ParetoWorks.

Figure 3: An optimal topology for the problem in Figure 1a.

Through topology optimization, one can generate optimized designs in minutes.

As a second example, consider the bridge problem in Figure 4a. The objective is to reduce the weight of the bridge while satisfying various design constraints. Through topology optimization one can create, within minutes, the optimal bridge illustrated in Figure 5b.

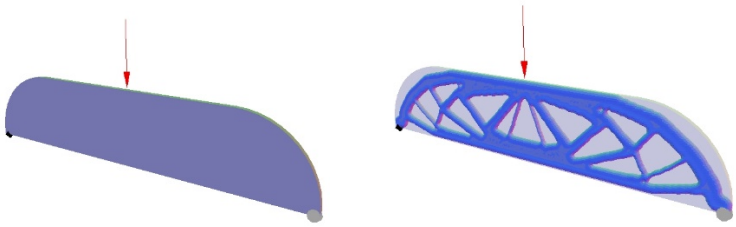


Figure 6: (a) A bridge-design problem, and (b) topology optimized design.

Topology Optimization Saves Time

Topology optimization provides rapid solutions to design problems, shaving weeks off product development cycles. For example, Figure 7 illustrates two distinct design solutions, that are optimal for their respective loading scenario. To be able to arrive such designs in a matter of minutes open new frontiers in product development.

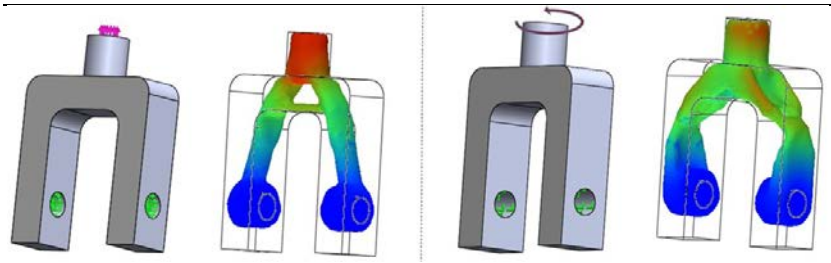


Figure 7: Topology optimized design under (a) tensile loading, and (b) torsional loading

Topology optimization can shave weeks off product development cycles.

Topology Optimization Today

How does Topology Optimization Work?

There are several topology optimization methods and software implementations. Underneath, all of them rely on FEA and optimization techniques; see Figure 8. They however differ on the specific FEA method, the optimization technique, the number of iterations required, ease-of-use, constraint handling, multi-load and multi-physics capabilities, etc.

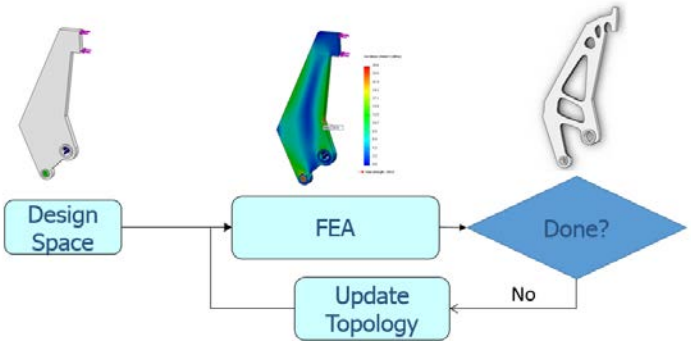


Figure 8: Topology optimization relies on iterative FEA and optimization.

Topology optimization relies on FEA and various optimization techniques.

Topology Optimization and 3D Printing

There is a lot of excitement today in 3D printing (additive manufacturing). Through 3D-printing one can fabricate parts of virtually any shape. It offers several advantages over traditional manufacturing, and has the potential to revolutionize the way things are made. Topology optimization directly

caters to 3D printing in that the output from topology optimization is typically an STL file, that can be directly 3D printed. Further, for most 3D printing processes (especially, metal 3D printing), material reduction is critical, and through topology optimization, one can dramatically reduce the amount of material used in a design. Figure 9 illustrates the seamless integration of topology optimization and 3D printing.

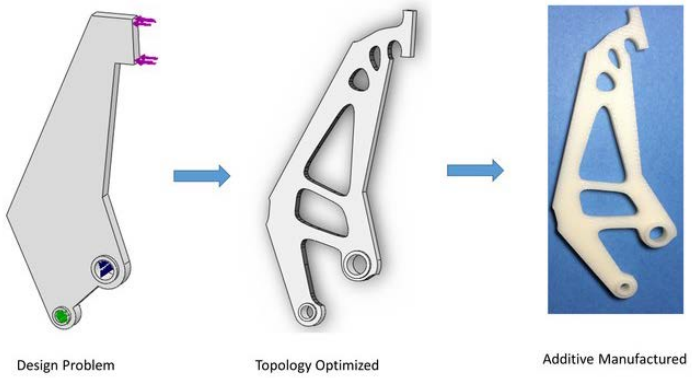


Figure 9: From design problem to 3D printing via topology optimization.

The output from topology optimization can be directly 3D printed, or used as a concept in traditional CAD.

Topology Optimization: ParetoWorks

ParetoWorks is Easy-To-Use

ParetoWorks is an Add-in to SOLIDWORKS for topology optimization. Designers can work within the comforts of SolidWorks, and explore topology optimization designs rapidly. ParetoWorks is a full featured topology optimization tool-box, that is capable of handling multi-body, multi-load topology optimization problems at blistering speeds.

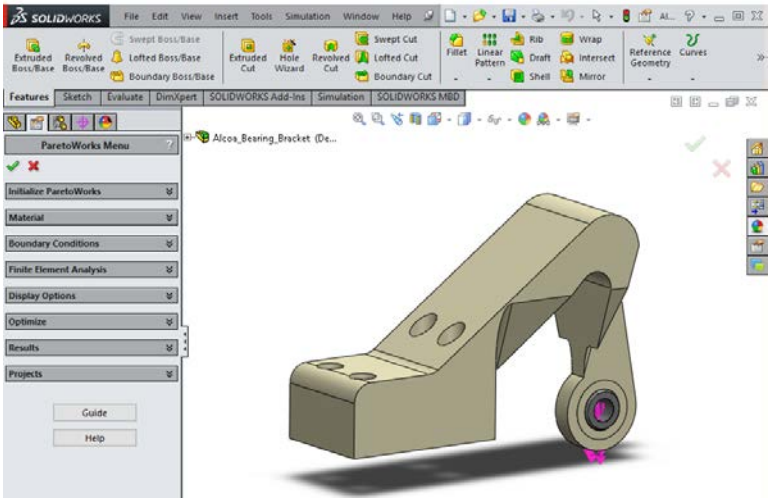
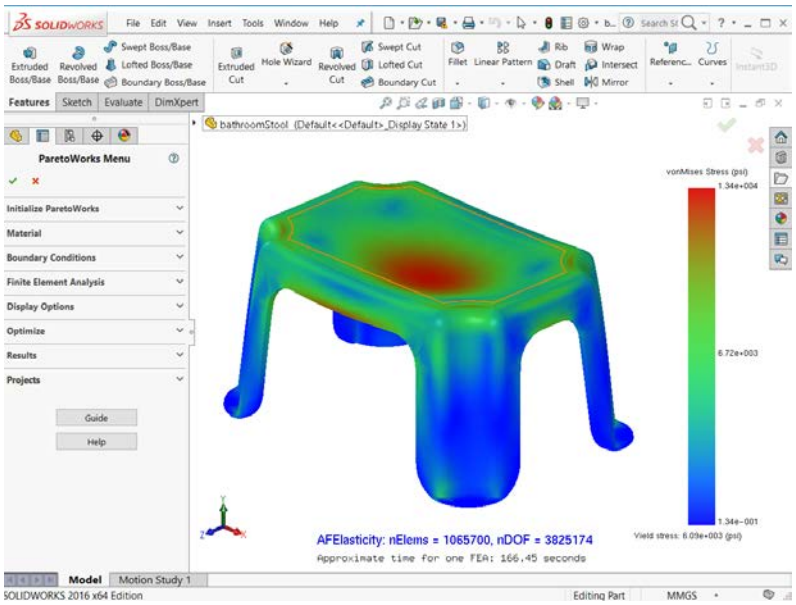


Figure 10: ParetoWorks is a SolidWorks Add-In for topology optimization.

ParetoWorks is an easy-to-use, state-of-the-art topology optimization Add-in to SOLIDWORKS.

ParetoWorks is Self-Contained

ParetoWorks has a built-in fast FEA solver, and does not require SolidWorks Simulation, i.e., ParetoWorks only requires SolidWorks standard. Further, the FEA technology used in ParetoWorks has been designed from scratch to be robust and extremely fast, to meet the demands of topology optimization. ParetoWorks is capable of handling extremely complex SolidWorks models with ease. Figure 11 illustrates FEA of a plastic stool using ParetoWorks.

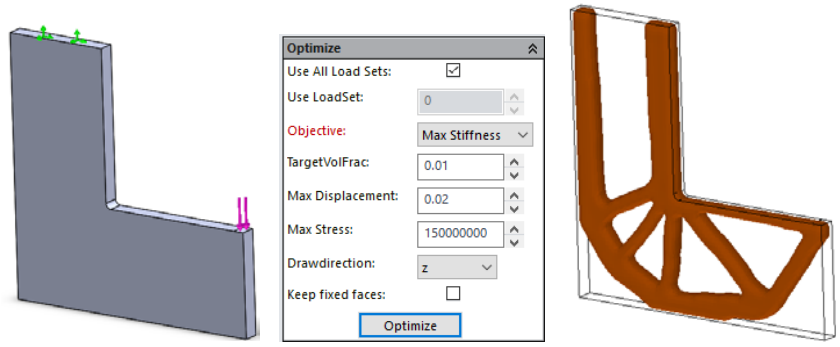


ParetoWorks has a built-in FEA solver, and only requires SolidWorks Standard, for FEA and topology optimization.

Figure 11: ParetoWorks has a built-in FEA solver.

ParetoWorks is Constraint-Driven

ParetoWorks builds upon on the cutting-edge FEA engine to solve complex *constraint-driven* topology optimization problems. Designers can impose stress, displacement, manufacturing and design constraints, and ParetoWorks will seek light-weight topologies that satisfy these constraints. For example, Figure 12 illustrates a design problem, constraints imposed and the final topology. Observe that the desired (target) volume fraction is 0.01, but the stress allowed is 150 MPa. ParetoWorks stops at a volume fraction 0.45, when the stress limit is reached.



ParetoWorks is constraint-driven. Designers can impose stress, displacement, manufacturing and design constraints, and ParetoWorks will seek light-weight topologies that meet these constraints.

Figure 12: ParetoWorks is constraint driven.

ParetoWorks can not only solve *traditional stiffness-driven* problem (as above), but also more challenging, and arguably more important, *strength-driven problems*. For example, for the problem posed in Figure 12, Figure 13 illustrates the optimized topology when the objective is set to "Max Strength"; the topology is significantly different from the one in Figure 12.

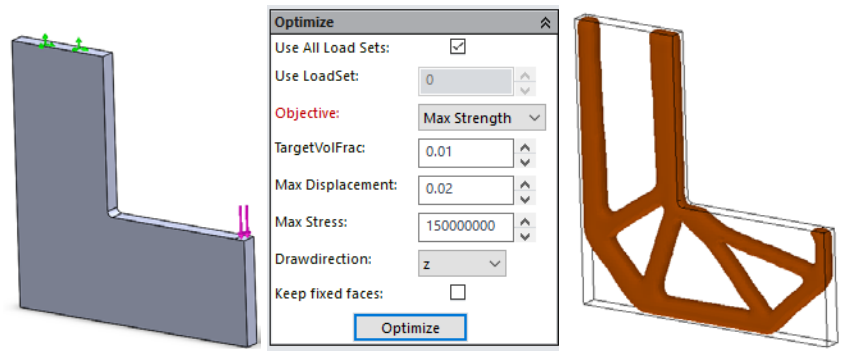


Figure 13: A strength-driven problem in ParetoWorks.

ParetoWorks can solve both traditional 'stiffness-driven' problems and 'strength-driven' problems.

ParetoWorks is Powerful

ParetoWorks can also handle both multi-load and multi-body problems. For example, Figure 14 illustrates the GE-GrabCAD design optimization problem that attracted several hundred design engineers from all around the world. While engineers spent several weeks generating light-weight designs, ParetoWorks can generate a topology optimized solution in less than an hour.

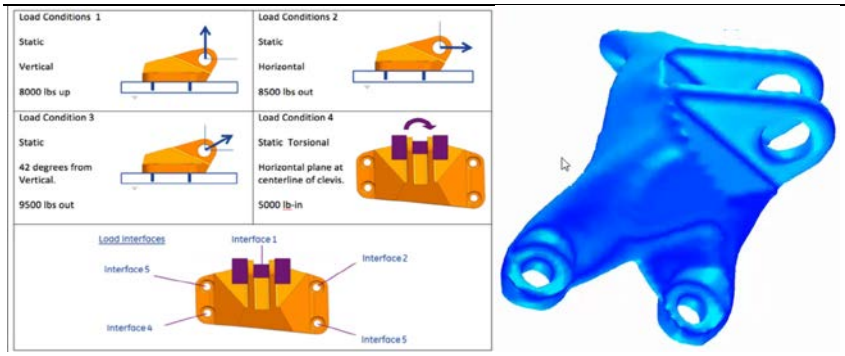


Figure 14: ParetoWorks optimized result for the GE-GrabCAD problem.

ParetoWorks can solve multi-load and multi-body topology optimization problems.

ParetoWorks is Robust and Fast

ParetoWorks relies on a proprietary optimization engine that is both robust and unbelievably fast. You will not find 'hanging' surfaces, so your topology is ready to be 3D-printed. You also don't need to wait for hours for the topology optimization result. On a typical desktop, ParetoWorks can generate insightful designs in minutes.

ParetoWorks is Inexpensive

Compared to competing software solutions, ParetoWorks is inexpensive, and you will recover the cost of your investment through a single client project. Contact us directly at support@sciartsoft.com or contact your SOLIDWORKS reseller, to get a full-featured ParetoWorks trial license.

"I should note that a single run, from when you hit go till it converges at a solution, took anywhere from 20 to 30min. for this part. Considering that this is conducting FEA with 60,000 to 80,000 nodes at each iteration and running an opto. algorithm, this seemed blindingly fast to me. I was super impressed with this having played with other optimization software."

- Mark G., Charlton & Hill Welding Ltd.

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