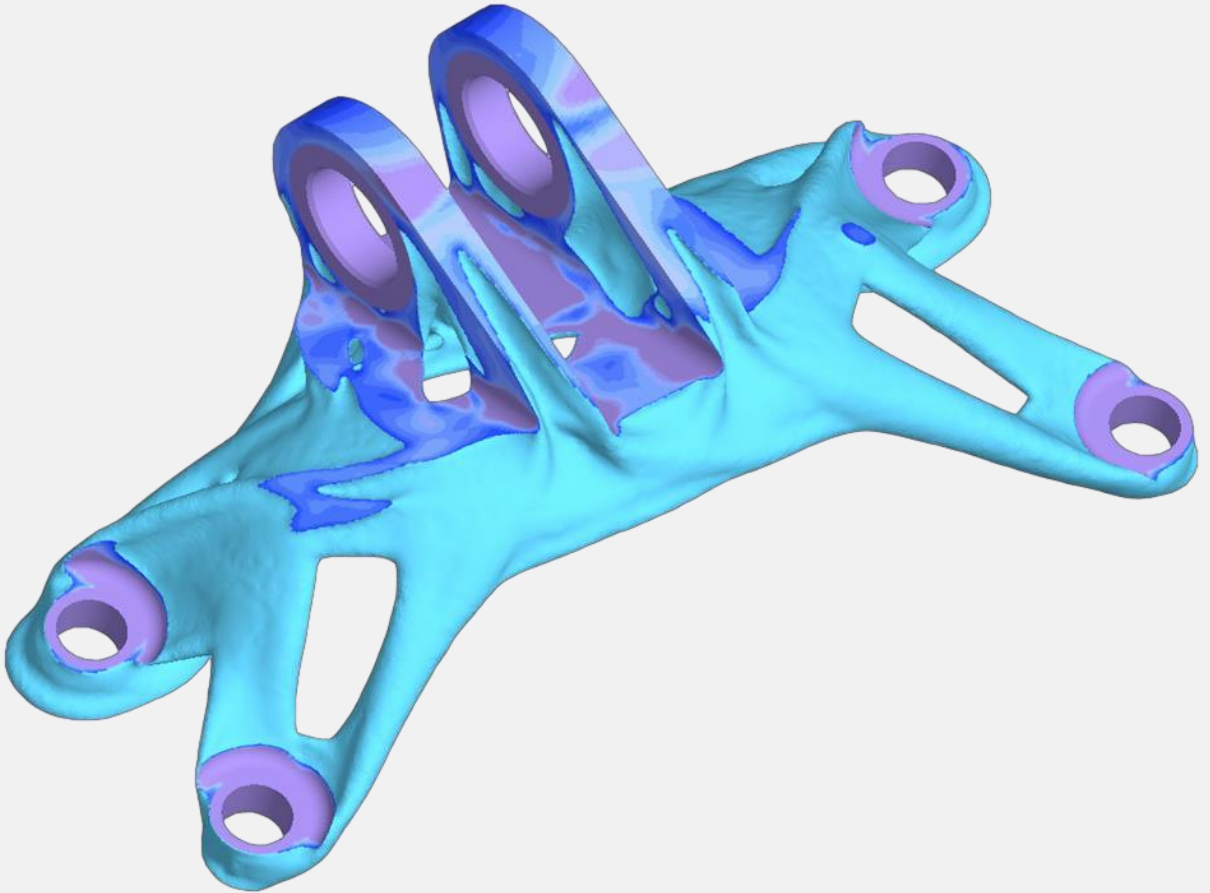




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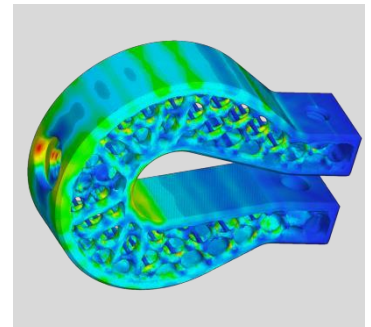
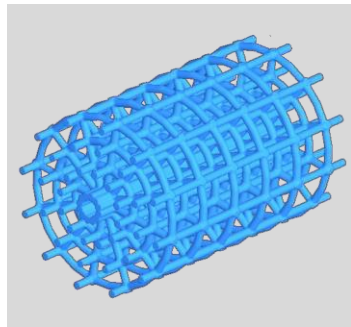
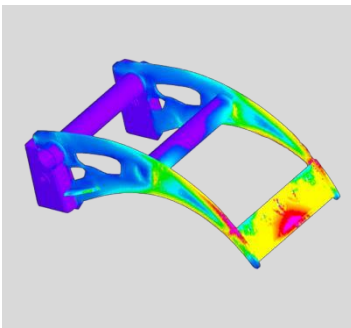
ProTOp®

High performance topology optimization
developed by engineers for engineers

ProTop® is standalone topology optimization software that takes as input FNF and INP files, generated by PTC® Creo® and Simulia Abaqus®, SolidWorks® Simulation, respectively.

Explore ProTop® and ProTopCI® Capabilities

- Easily find minimum-strain energy designs that exhibit minimal stresses, while efficiently removing stress concentrations.
- Prolong the life span and increase the resistance to crack fatigue of your structural parts.
- Reduce the weight and material cost of your products.
- Efficiently solve multi-million-element models, involving contacts and plasticity if required.
- Deliver high-quality optimized designs.
- Smooth and improve the design obtained, and export it to popular CAD and 3D printing formats.
- Easily create innovative shell or/and lattice designs.
- Generate and adjust your desired lattice configuration on the fly.
- Immediately optimize your lattice structure to remove stress concentrations.



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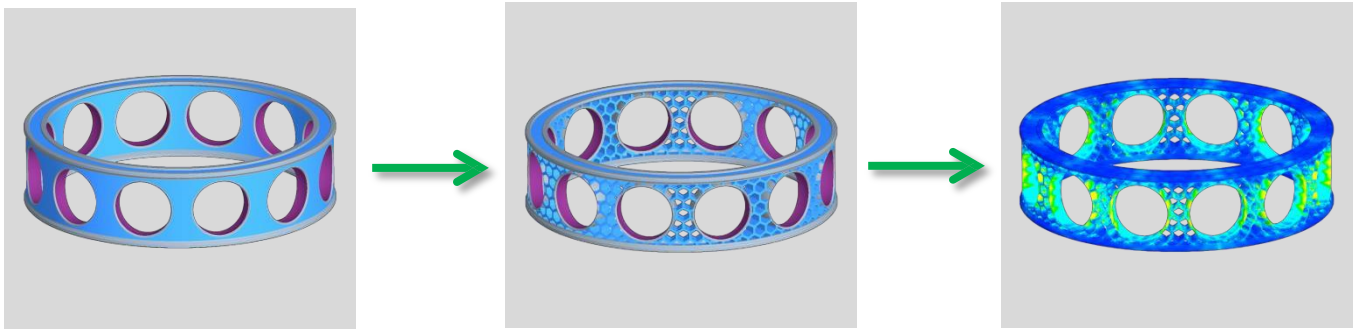
<https://www.gia.ch/topologieoptimierung/>

ProTop® contains powerful configuration tools that can be used to reconfigure any solid region into a lattice, shell, or mixed shell / lattice / solid structure.

ProTop® tools perform this for you numerically - no CAD work is required.
necessary.

Lattice structures in ProTop® and ProTopCI®

- Prepare the CAD model of your solid part, in your favorite modeler.
- Apply BCs as usual, to define and complete your FEA model.
- There's no need to carry out CAD modeling of a shell or lattice structure.
- Import your FEA model into ProTop®/CI and select the desired lattice pattern.
- Adjust your lattice configuration as desired.
- Create any number of additional (different) lattice configurations, if required.
- Quickly check your design by running ProTop®/CI initialization FEA.
- Simply proceed with optimization cycles to improve the design and remove stress concentrations.
- Use ProTop®/CI export tools to smooth and export your design.



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ProTop® or ProTopCI®?

ProTop® and ProTopCI® share the same numerical procedures, making them identical in the computational sense. The only differences are related to their import capabilities and interfacing features, as indicated in the following table:

| | ProTop® | ProTopCI® |
|--------------------------|---|--|
| FEA model import from: | <ul style="list-style-type: none"> ▪ PTC Creo® FNF file ▪ Simulia Abaqus® INP file ▪ SolidWorks® Simulation INP file | <ul style="list-style-type: none"> ▪ PTC Creo® FNF file |
| Integration plug-in for: | - | ▪ PTC Creo® |

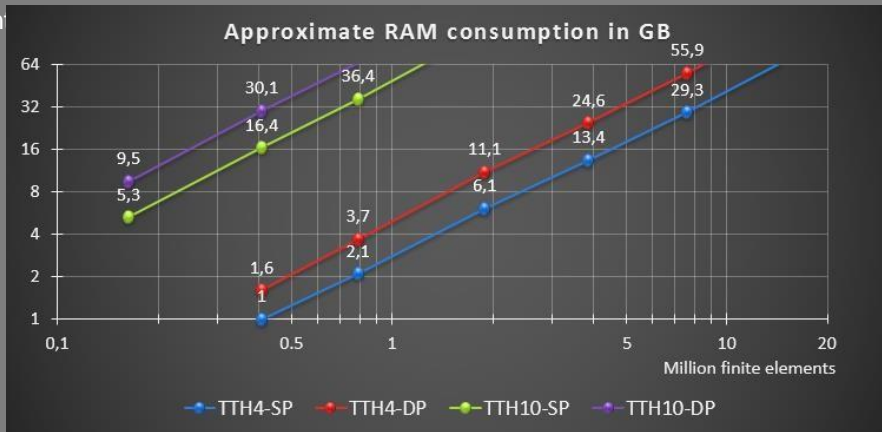
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Abaqus / SolidWorks is a registered trademark of Dassault Systems Simulia Corporation in the US and/or other countries.

- | | | |
|---|--|--|
| <ul style="list-style-type: none"> • Specialized custom-coded finite elements • Hybrid custom-coded evolutionary/level-set optimizer • High-performance sparse SLE solver • Only highly parallelized HPC code | <ul style="list-style-type: none"> • Semi-active element technology • Smart Start - from functionality • Interactive load case management • Special semi-contact elements for efficient contact and fastening modeling • Special semi-plastic elements for better designs | <ul style="list-style-type: none"> • Unique shell and/or lattice generation and optimization tools • Numerical shell or lattice generation from solid models – no additional CAD work necessary. • Full 3D (solid finite element) lattices - immediately ready for optimization with ProTop/CI. |
|---|--|--|

In practical topology optimization, FE models quickly become quite large, because of the need to use rather small elements. Finite element analysis of such models requires a large amount of memory (RAM) to solve the problem in a reasonable time.

ProTop® and ProTopCI® are very efficient in RAM consumption, but in spite of that, limited RAM may quickly prevent computing the results efficiently. To get a feeling for approximate RAM requirements, the figure below depicts the situation for a simple test structure, meshed by tetrahedrons (full material design; no void regions).



ProTop® and ProTopCI® offer special technologies to solve very large models extremely efficiently with RAM consumption far below the levels given in the figure above.



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