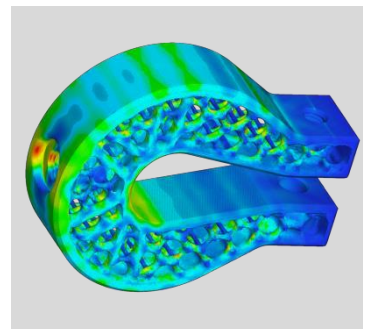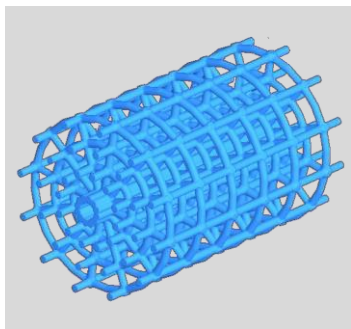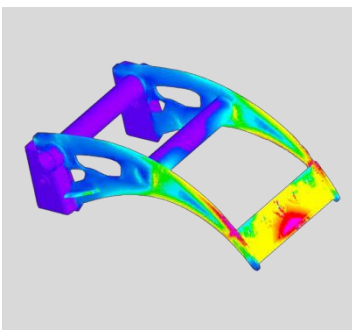# ProTOp®

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®, 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.

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.
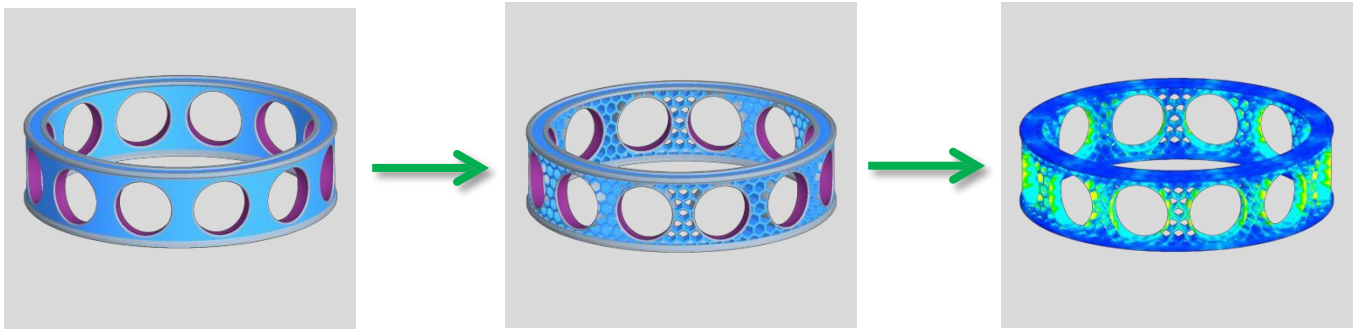
ProTOp® or ProTOpCI®?

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:
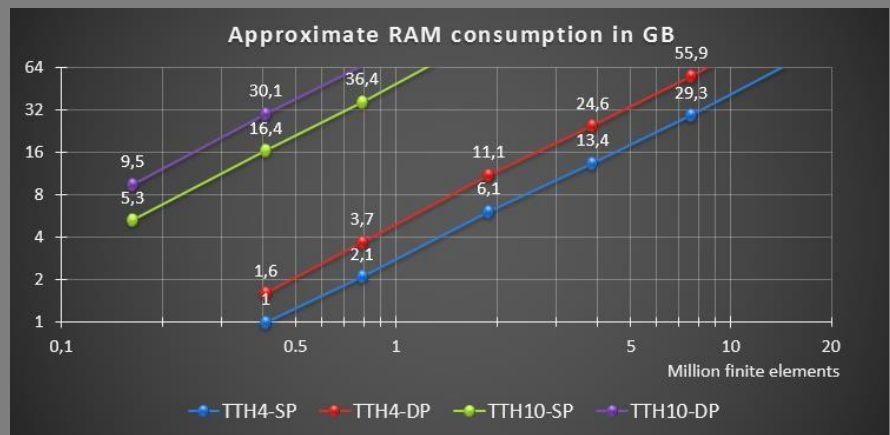
	ProTOp®	ProTopCI®
FEA model import from:	▪ PTC Creo® FNF file ▪ Simulia Abaqus® INP file	▪ PTC Creo® FNF file
Integration plug-in for:	-	▪ PTC Creo®

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

- Specialized custom-coded finite elements
- Hybrid custom-coded evolutionary/level-set optimizer
- High-performance sparse SLE solver
- Only highly parallelized HPC code

- 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

- 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 terms of CPU Time and 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.