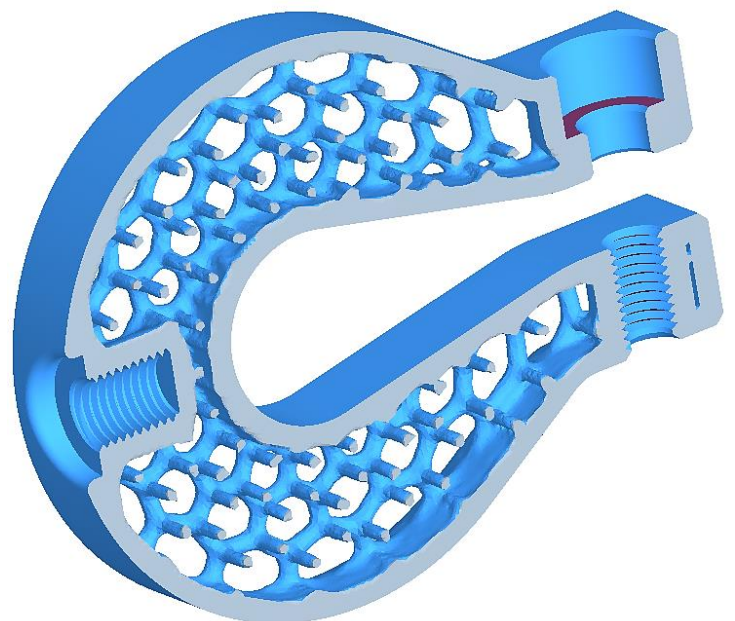
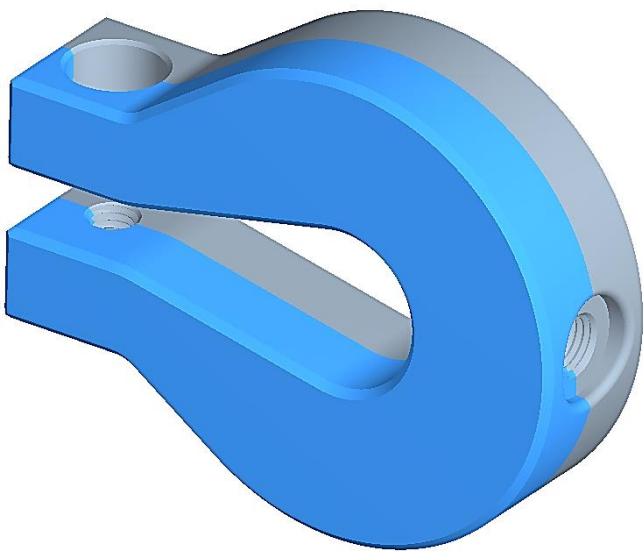




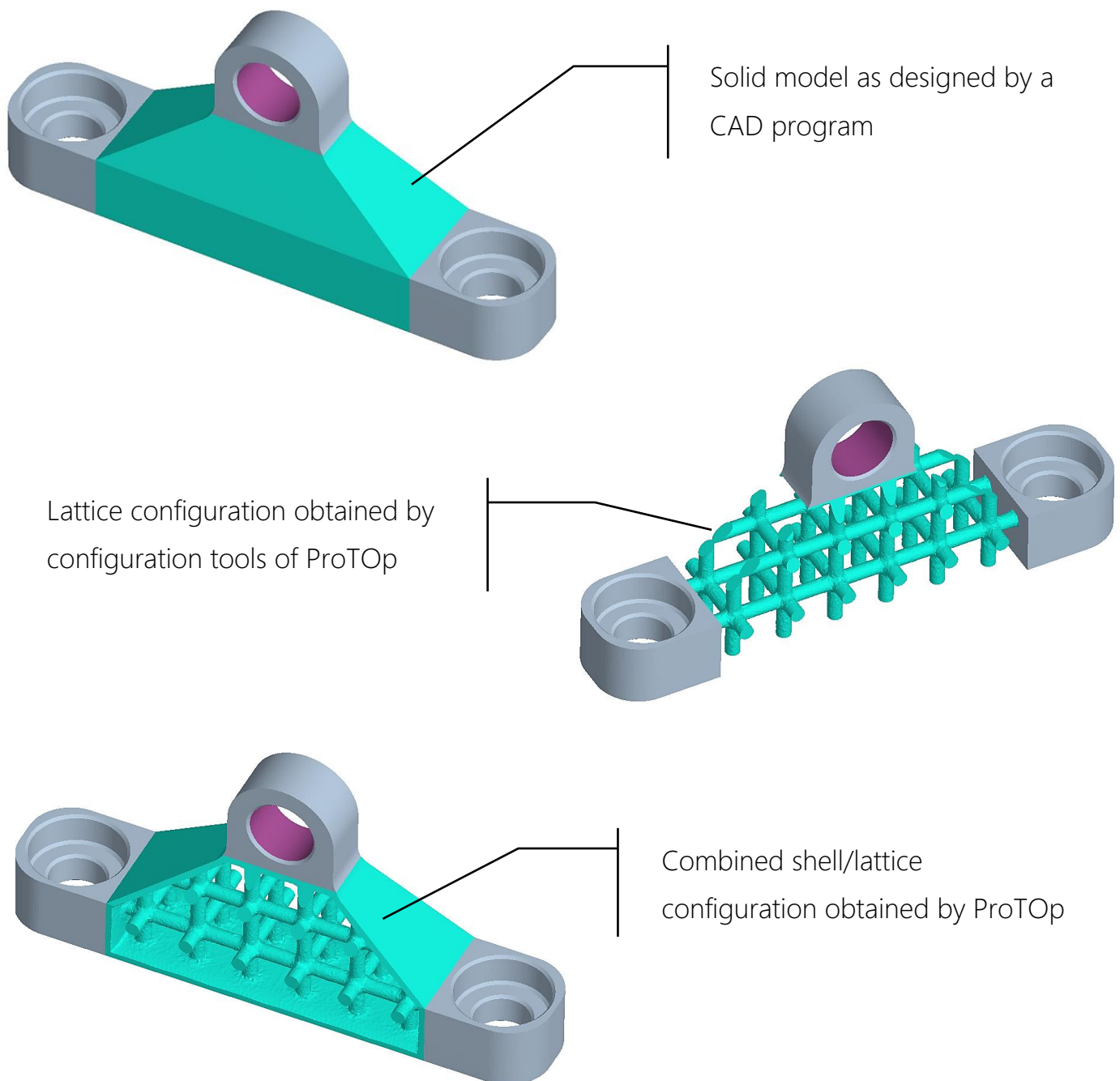
CAESS ProTOp

Shell and lattice structures FAQ



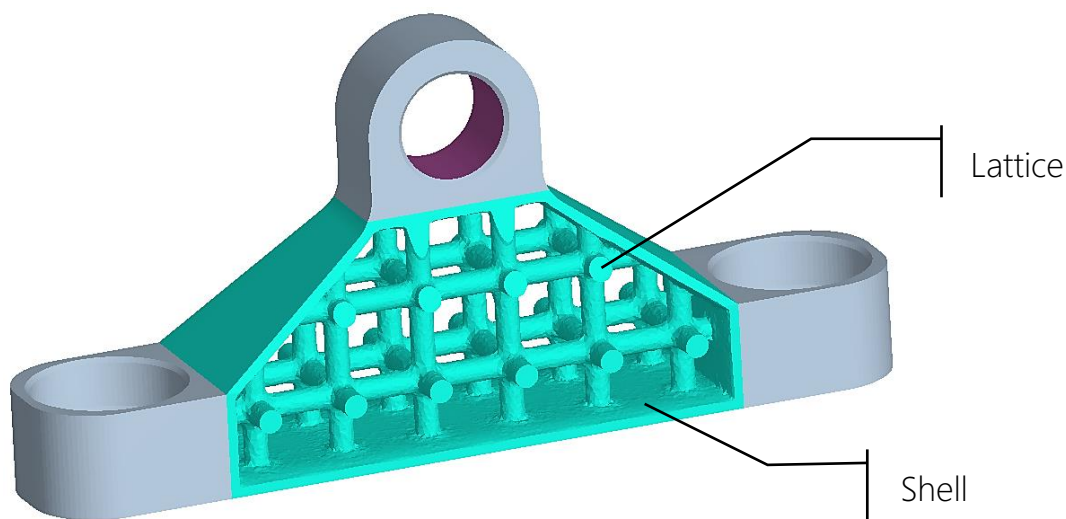
1. Does the shell or lattice structure of any particular region of the part has to be defined within the CAD program?

Answer. No. The CAD model to be imported into ProTop is typically a solid structure. Configuring any region of this solid model as a shell/lattice structure is done within ProTop by using its configuration tools.

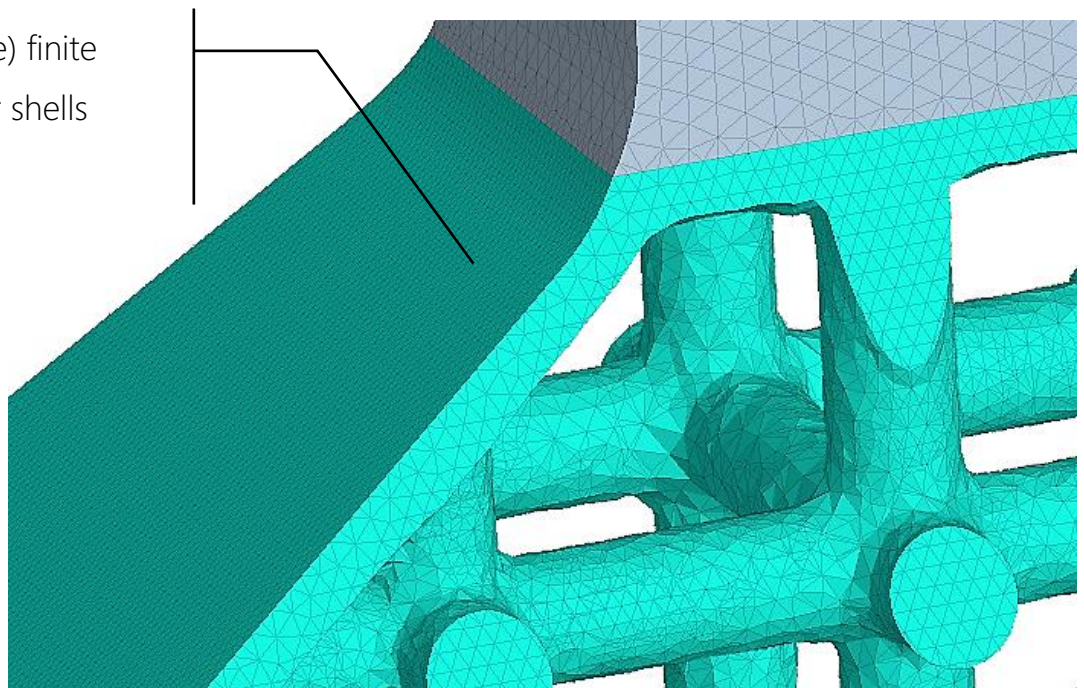


2. What is actually meant in ProTOp by the terms shell or lattice structure? Is this related to finite element types involved, i.e., shell or beam finite elements?

Answer. No. In ProTOp every structure has to be modelled only by solid (volume) finite elements. The terms shell and lattice structure are used here to address structures that at least partially have a shell-like or a lattice-like form; but the finite elements involved are always solid finite elements.

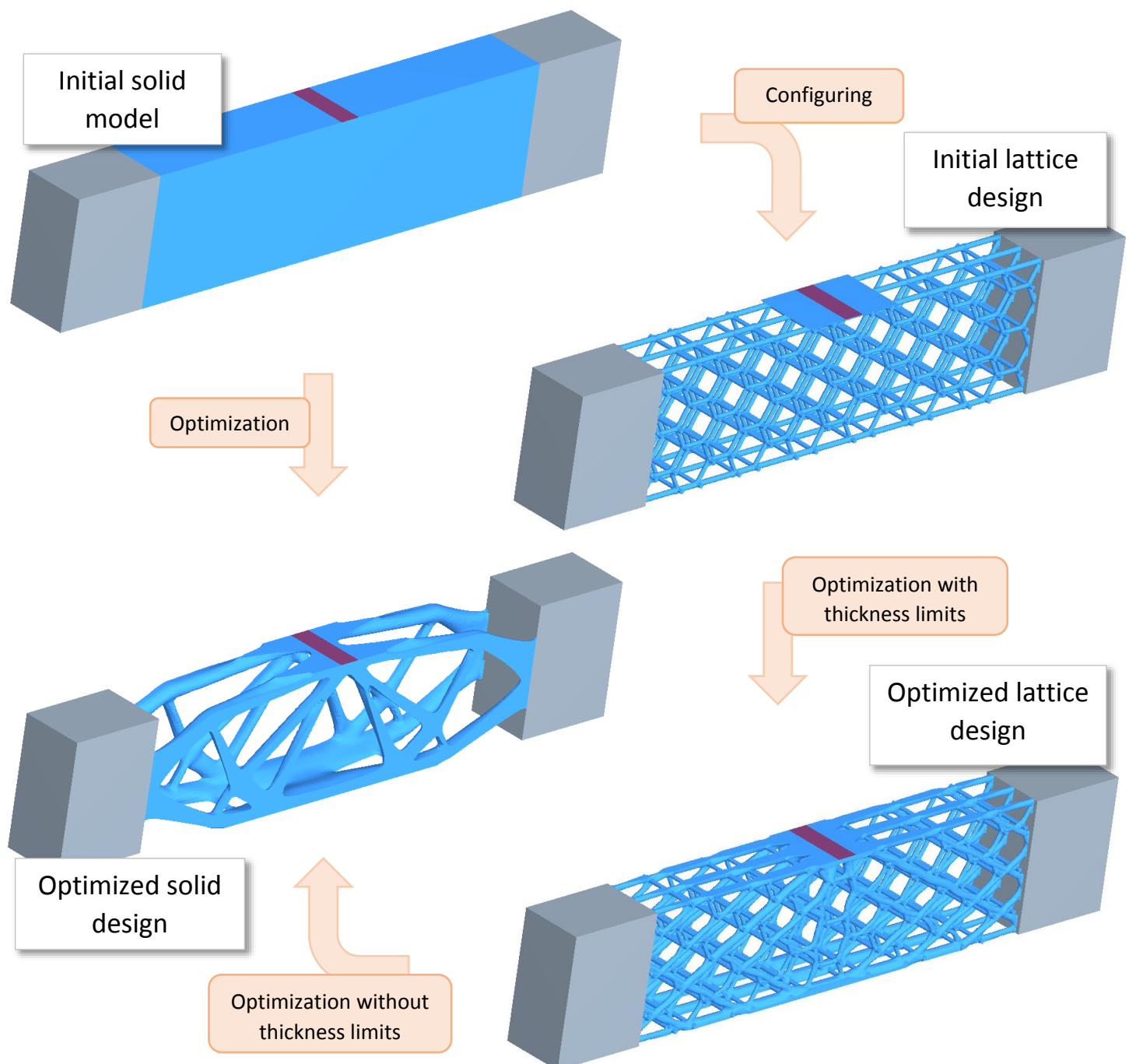


Only 3D solid (volume) finite elements are used for shells and lattices



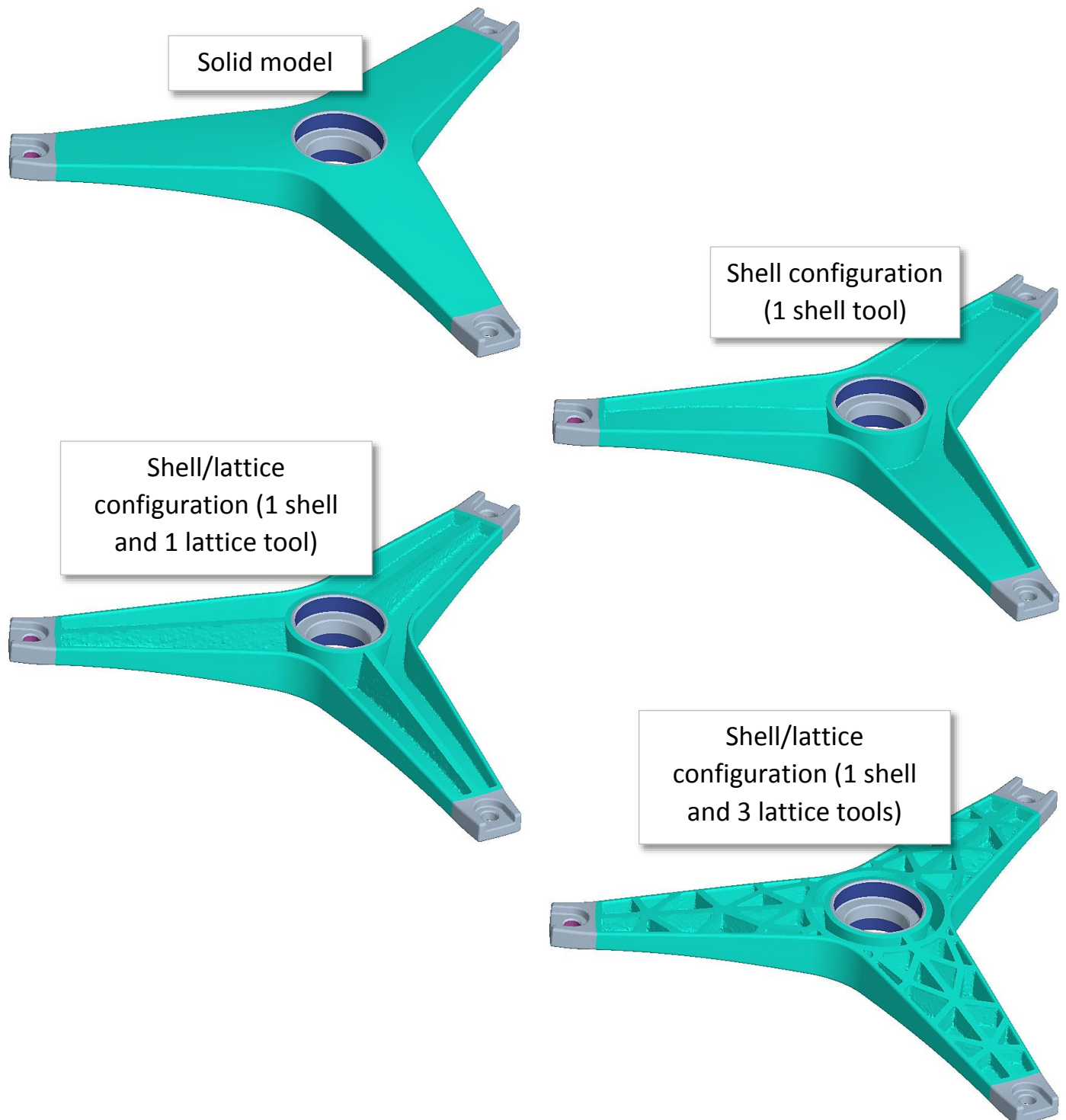
3. Does ProTOP perform real topology optimization of a shell/lattice structure or is this only shape optimization?

Answer. ProTOP always does proper topology optimization. Thus, any region of a shell/lattice structure can emerge from void or completely vanish, if the user does not prevent this by prescribing lower limits on thicknesses. In fact, running topology optimization on a shell/lattice structure without any thickness limitations ultimately yields the same optimal design as obtained by optimizing a solid model.



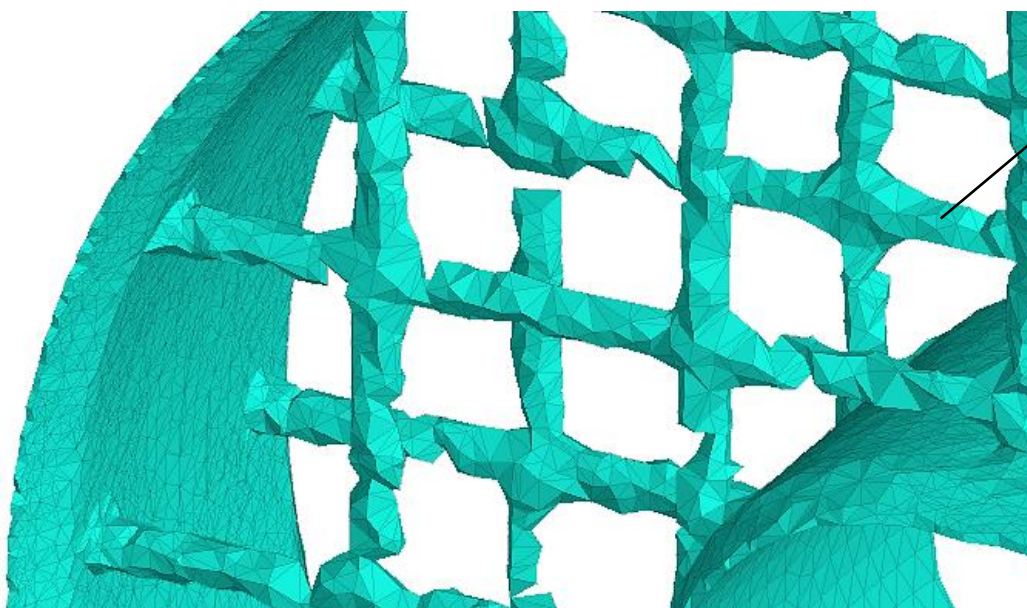
4. The set of lattice cell types is limited. Is there a way to obtain more sophisticated lattice patterns?

Answer. Yes. In fact, all configuration tools (solid, shell, lattice) can be arbitrarily engaged to configure the model as a combination of any number of individual solid/shell/lattice configurations.

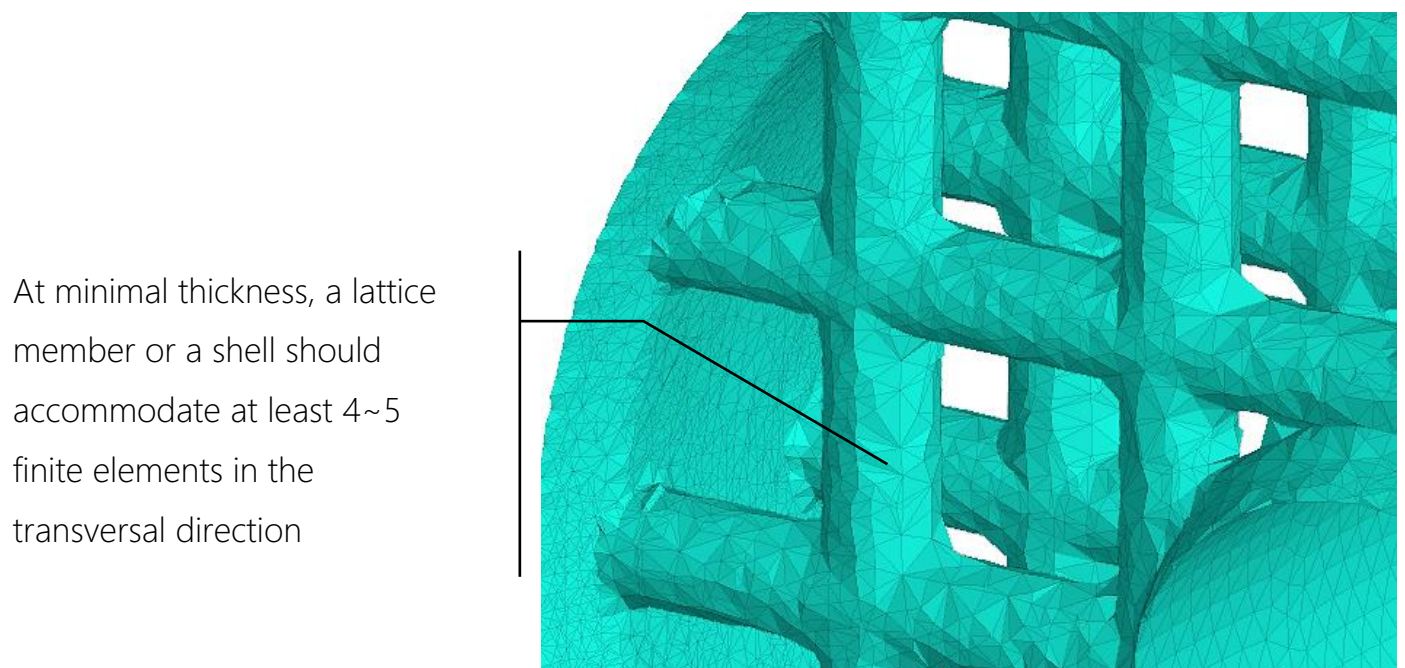


5. The shell/lattice designs might look relatively coarse before and even after optimization. What are the reasons for this?

Answer. It is important to note that for successful shell/lattice structure optimization the FE meshes that are fine enough are absolute necessity. As a rule of the thumb, at least 4 to 5 finite elements have to fit within the minimal thickness prescribed for a shell or lattice structure. Coarser meshes may be used but the results might be relatively rough.



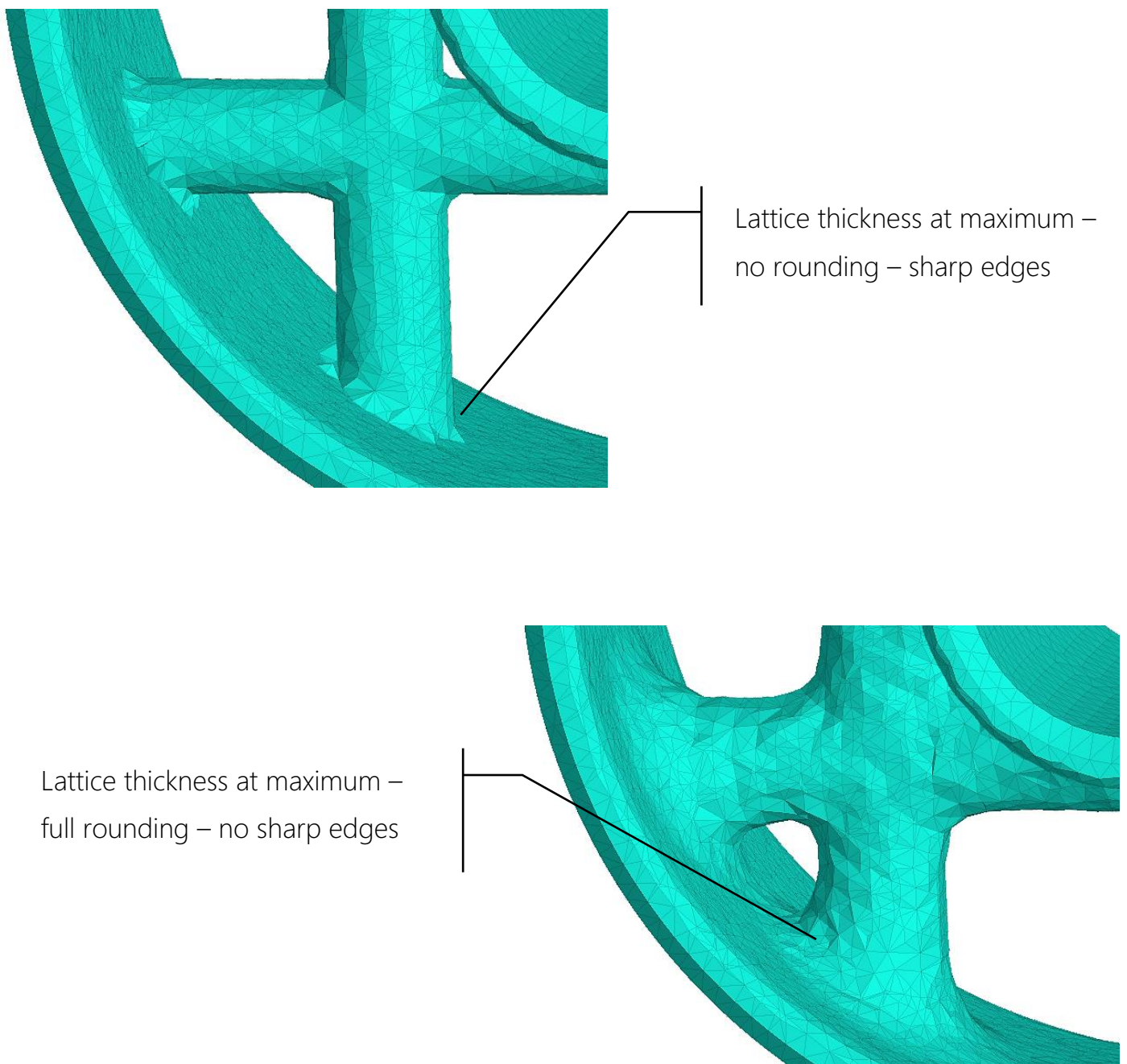
This FE mesh is far too coarse for given lattice thicknesses



At minimal thickness, a lattice member or a shell should accommodate at least 4~5 finite elements in the transversal direction

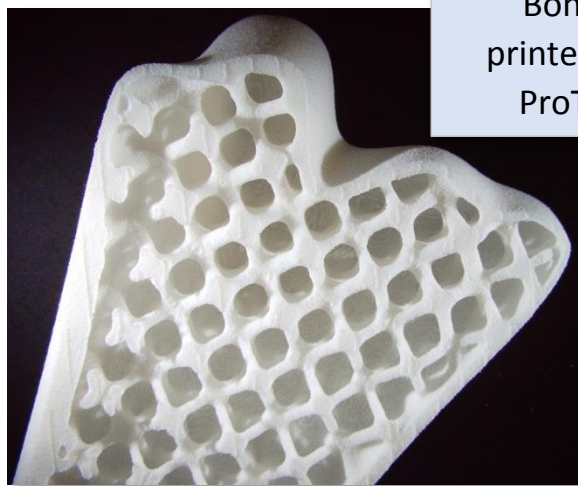
6. ProTOp configuration tools offer rounding of the lattice crossings and lattice-shell interfaces. Is this not a job for the optimizer?

Answer. In general: yes, the optimizer should shape properly the material/void interfaces according to the stress state. However, for a shell/lattice structure with prescribed thickness limits, there are often regions where the final design is a minimum- or maximum-thickness design. In these cases rounding prevents the final design to exhibit sharp edges.

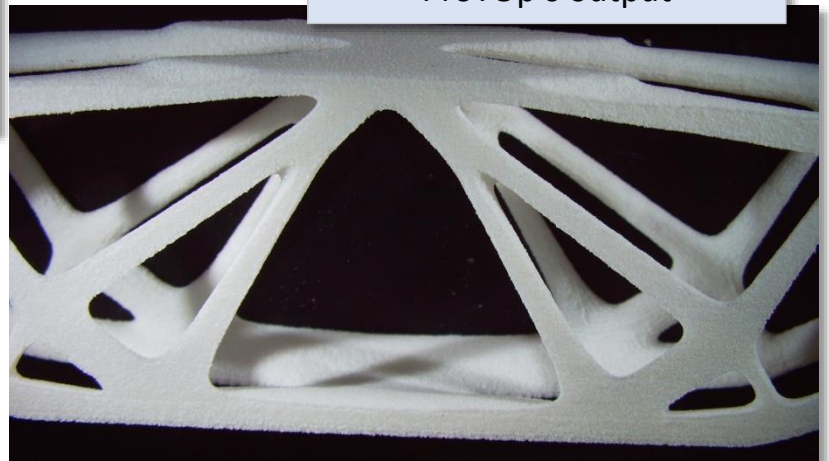


7. Can the obtained optimal designs be used directly as input for the 3D printing machines?

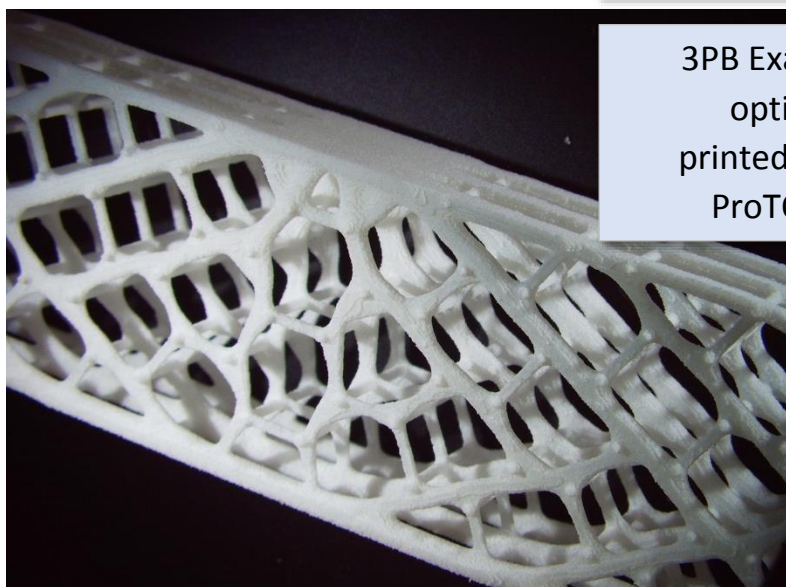
Answer. Yes. ProTOp contains good surface mesh smoothing and checking tools. Consequently, the exported surface meshes are error free and can be used directly as input for a 3D printer.



Bone (one half);
printed directly from
ProTOp's output



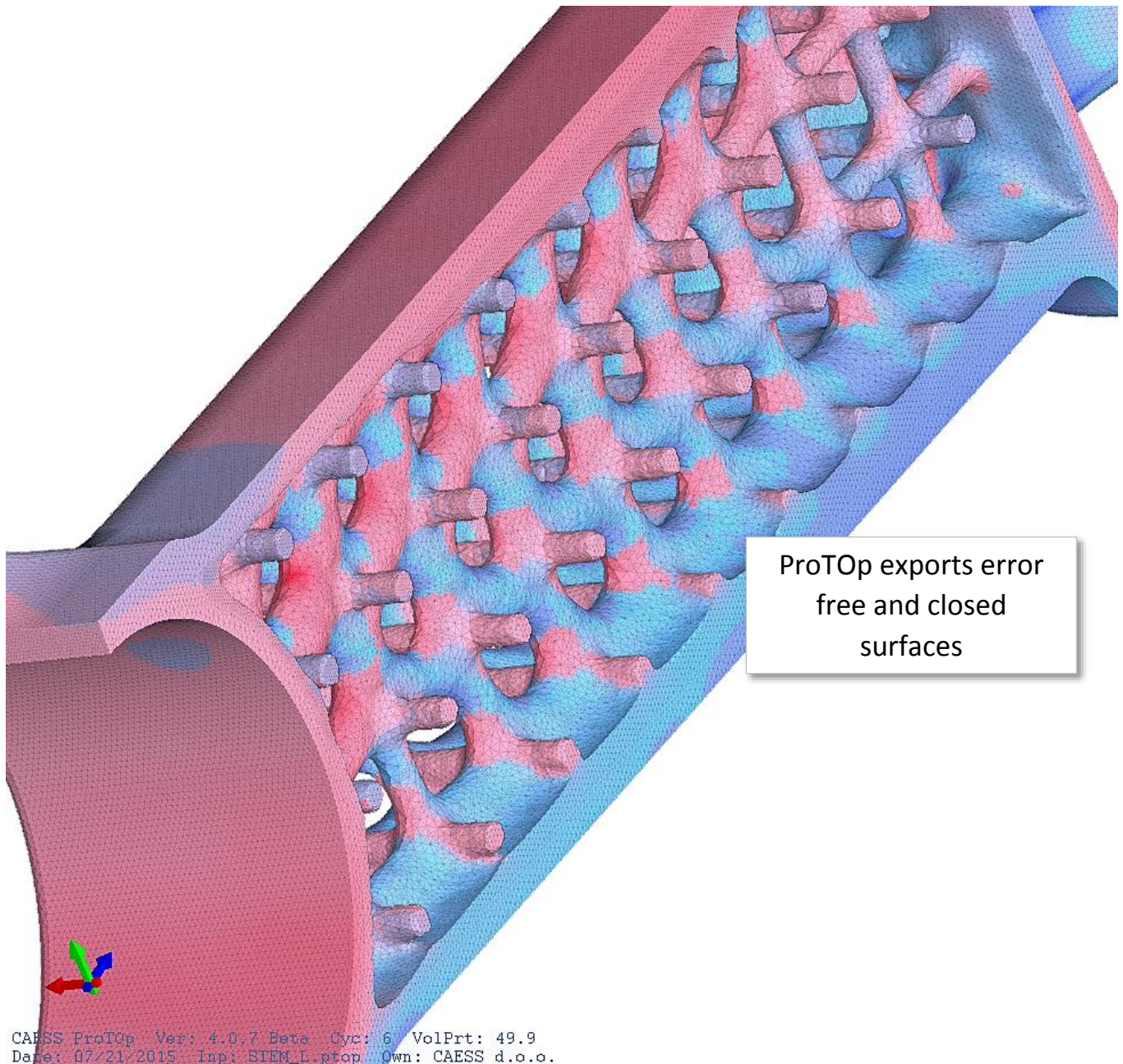
3PB Example (solid
optimization);
printed directly from
ProTOp's output



3PB Example (lattice
optimization);
printed directly from
ProTOp's output

8. Is it possible to import the optimized shape into a CAD program as a solid body?

Answer. This depends on your CAD system, but in general, there are two options. Firstly, ProTop can export a STEP file, which typically contains a large number of triangles; some CAD systems may import this without problems, other may have difficulties. Secondly, ProTop can export a STL or OBJ file, which is usually not considered as a solid body CAD object; however, STL/OBJ files exported by ProTop are error free closed surfaces and may be used to generate a FEM model for any further FEA.



ProTop exports error
free and closed
surfaces

Contact us at...

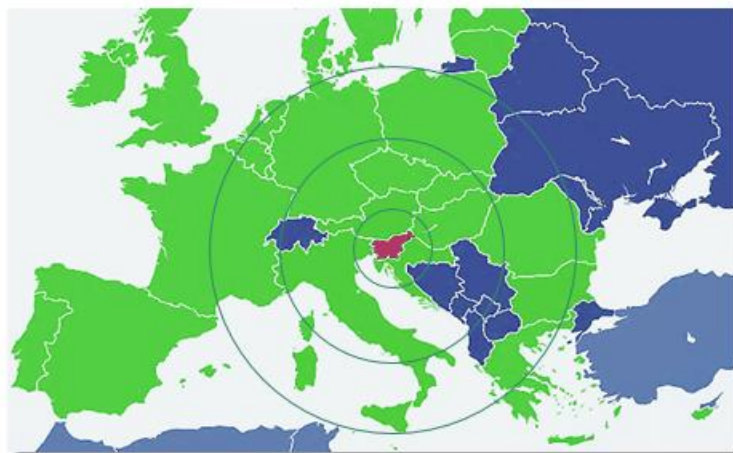
info@caess.eu

We will be glad to discuss your needs and we will do our best to fulfill your expectations.

Our location within Slovenia



and Europe



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