

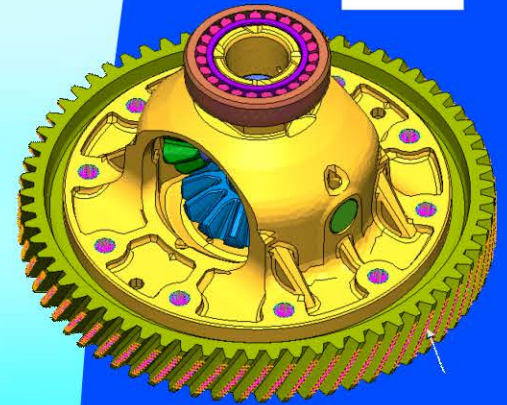
PERMAS

Freeform Optimization

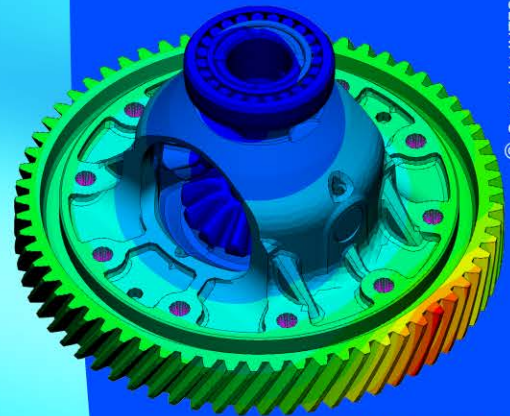
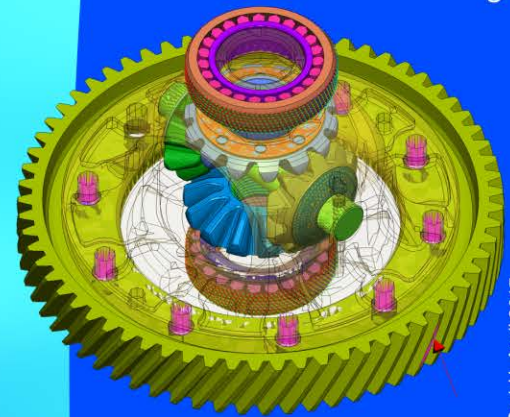
Save weight and improve endurance



- **Design space:** Definition by node set on the design surface, complete optimization model by VisPER.
- **Constraints:** Equivalent stress, principal stress, stress differences, effective plastic strain, weight, compliance, displacement, element quality, release direction, node values from external tools (e.g. safety factors).
- **Objectives:** Stress (inside and outside of design space), effective plastic strain, weight, compliance, node values from external tools (e.g. safety factors).
- **Analysis methods:** Linear and nonlinear static analysis (incl. contact), linear and nonlinear, steady-state and transient heat transfer analysis, frequency response analysis.
- **Optimization methods:** Homogenization of stress-like quantities with Optimality Criteria (OC). For other quantities used as constraints, a combined method of OC and mathematical optimization is applied.
- **Relaxation:** Of meshes at surfaces and in the design space for larger thickness changes and better element quality.
- **Results:** History plots, new node coordinates, thickness change, coordinate change, stress change, export of surface geometry.



Differential housing

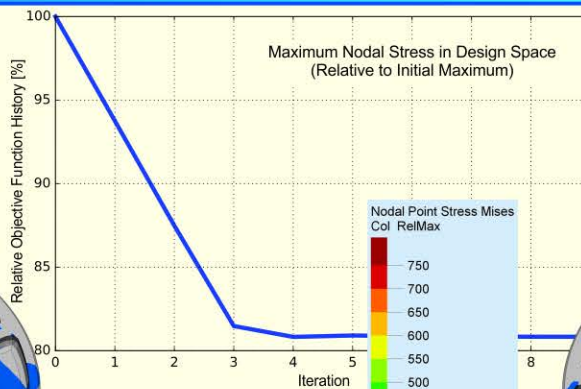
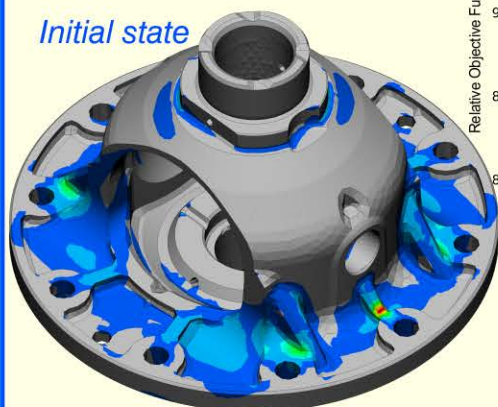


Displacements

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Maximum nodal stress of 65 load cases

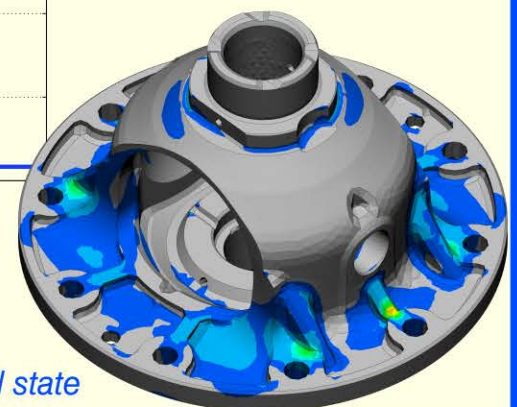
Initial state



Stress homogenization under constant weight condition

The force on one gear tooth is applied on all 65 gear teeth to fully represent the load.

Final state



**Easy set-up
of optimization
model**

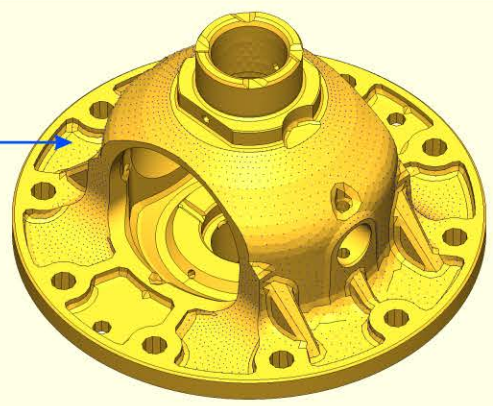
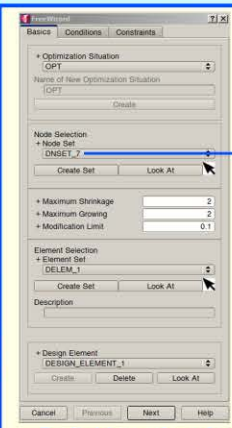


VisPER features the graphically guided description and post-processing of optimization models by:

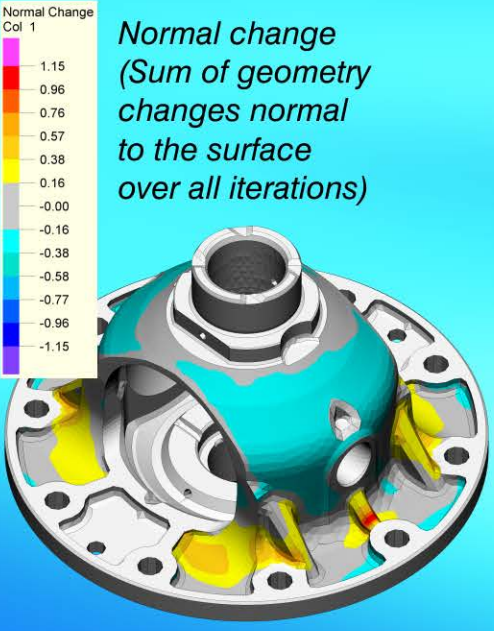
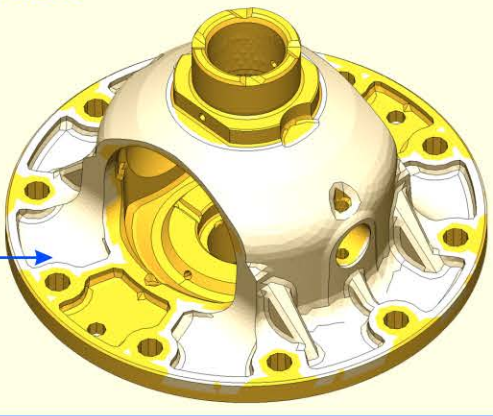
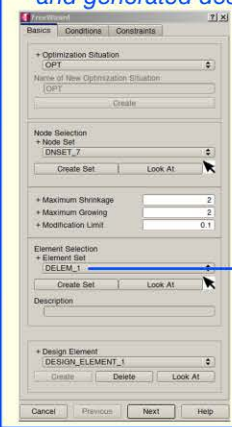
- Defining the design space,
- Defining the design parameters,
- Selecting objective function and design constraints,
- Defining manufacturing constraints,
- Post-processing of all optimization results.

Typical optimization definition process:

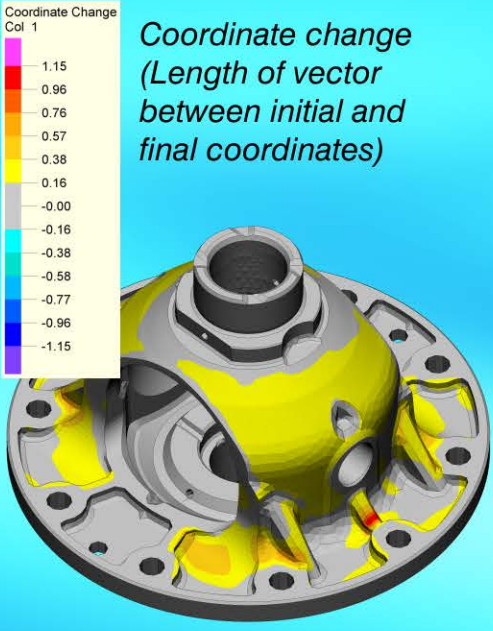
- Selection of surface node set for definition of design space
- Weight objective (for design space)
- Stress limit like von Mises or principal stresses (for design space)
- Additionally: displacement conditions to limit local displacements (outside of design space)



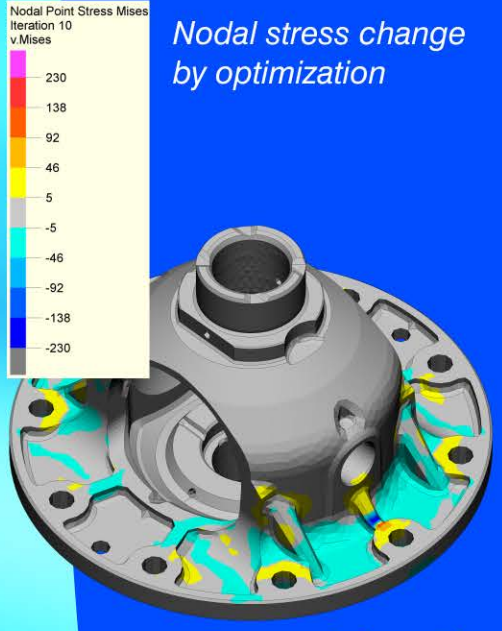
Definition of surface node set and generated design space



Normal change
(Sum of geometry changes normal to the surface over all iterations)



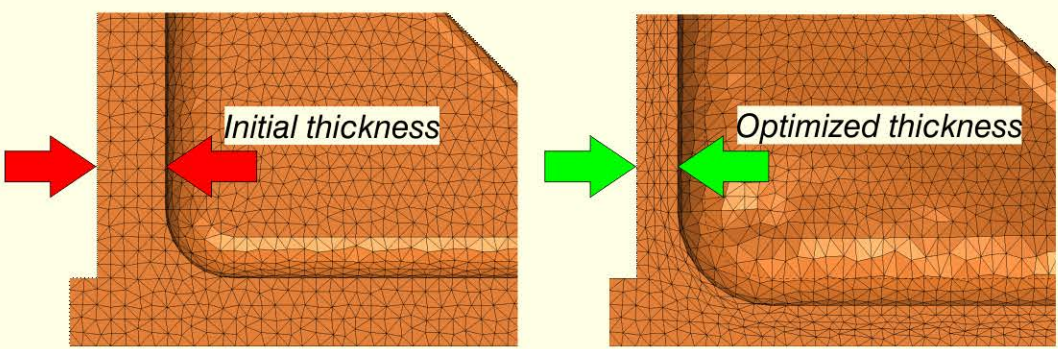
Coordinate change
(Length of vector between initial and final coordinates)



Nodal stress change
by optimization

Thickness change of a solid structure:

- Growing or shrinking of the wall thickness (with mesh relaxation)
- Always in normal direction (updated in each iteration)
- Useful for complex freeform surfaces (like for cast parts)



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