CAESS

Center for Advanced Engineering Software and Simulations

PTC® PartnerAdvantage SILVER

Topology optimization of solids, shell, lattice structures by ProTOp®

Technological Innovation and Materials Seminar 2015 in Tel Aviv, Israel

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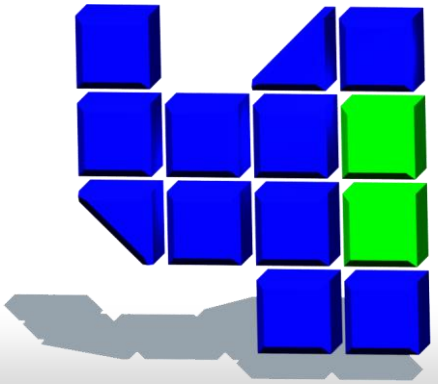

CAESS
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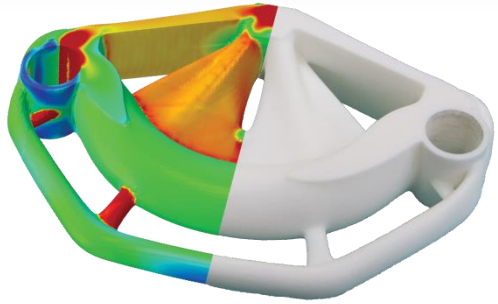
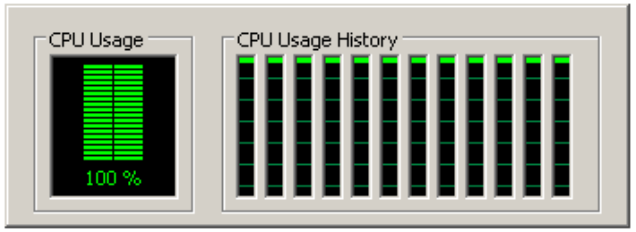
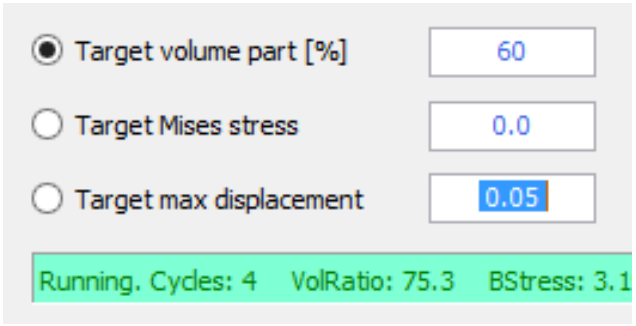
PTC® PartnerAdvantage SILVER

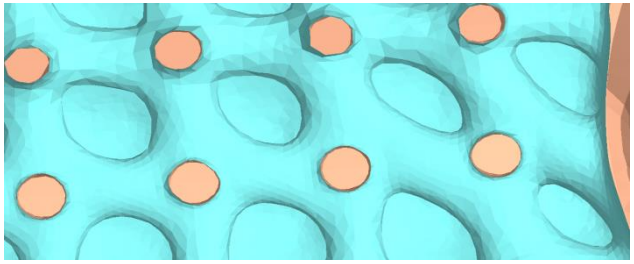
CAESS ProTOp®

- Cost-effective and user-friendly software to get a stiff and higher-strength structure with less material
- A standalone software package containing its own FEA solvers, only high-performance and fully parallelized code; no scripting
- Interactive optimization and target adjustments on desire
- Solid, shell and lattice structures definition and optimization
- Smooth generated structural boundaries – optimized parts are practically ready for 3D-printing and manufacturing

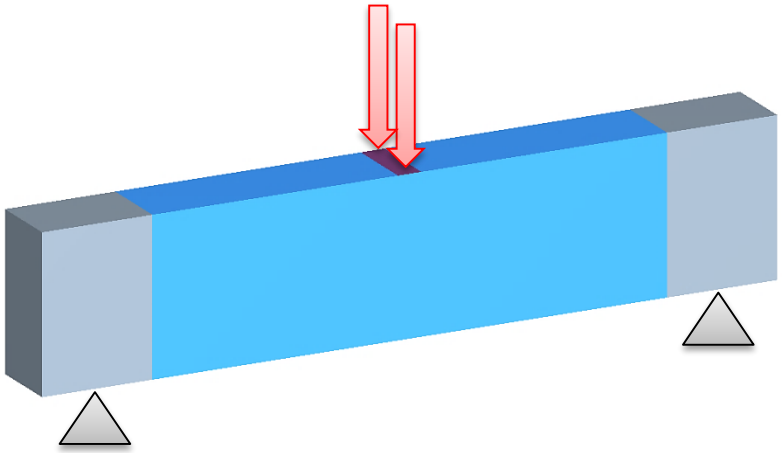




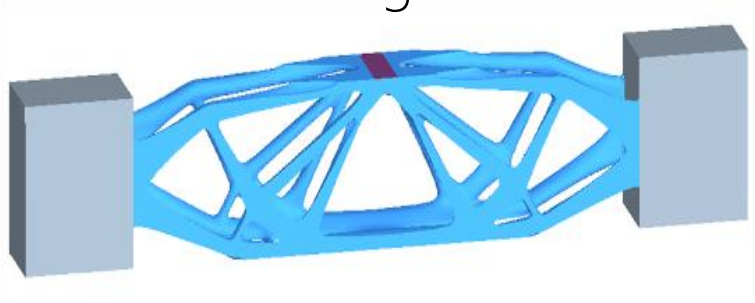


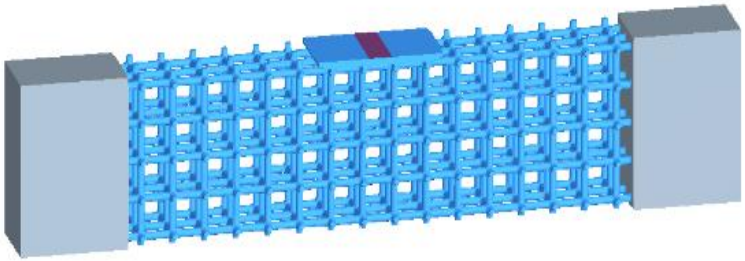


Introduction

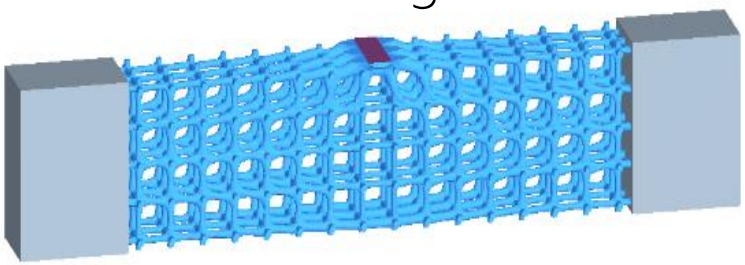


Optimal design from solid configuration



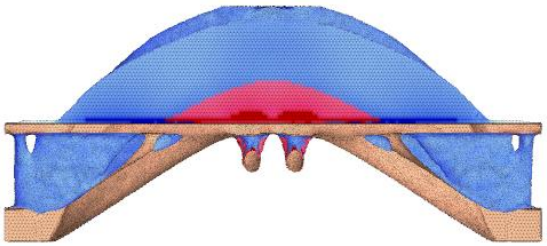


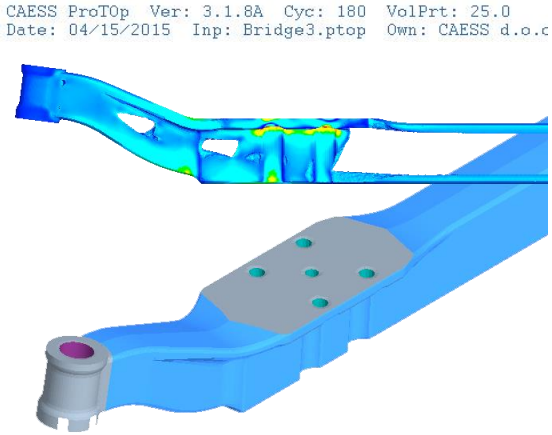
Optimal design from lattice configuration



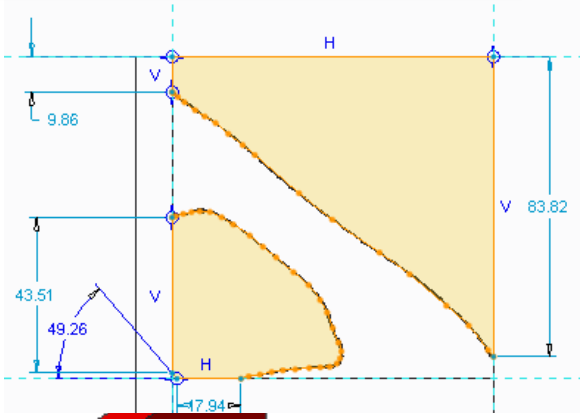
Why to use optimization?

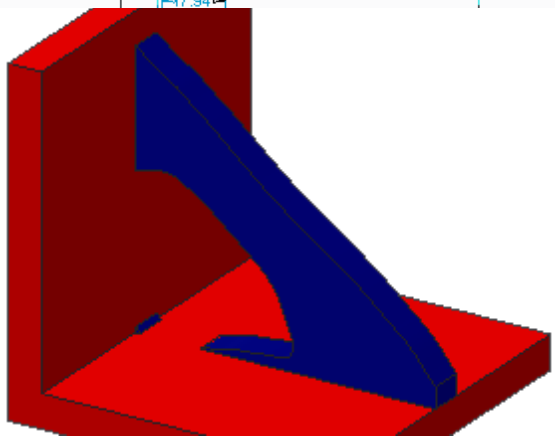
Get good design ideas



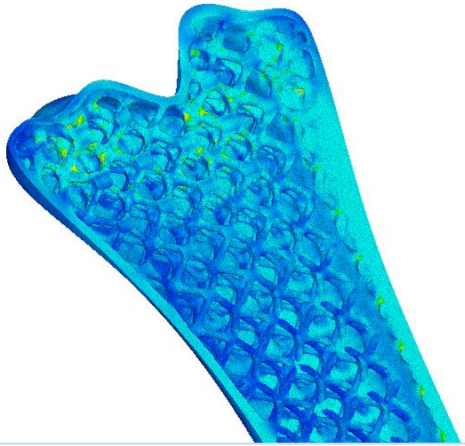


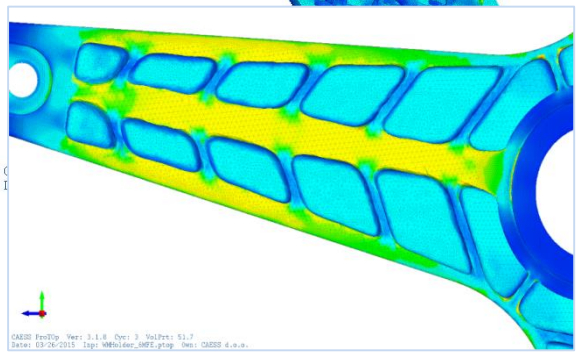
Get structures for redesign



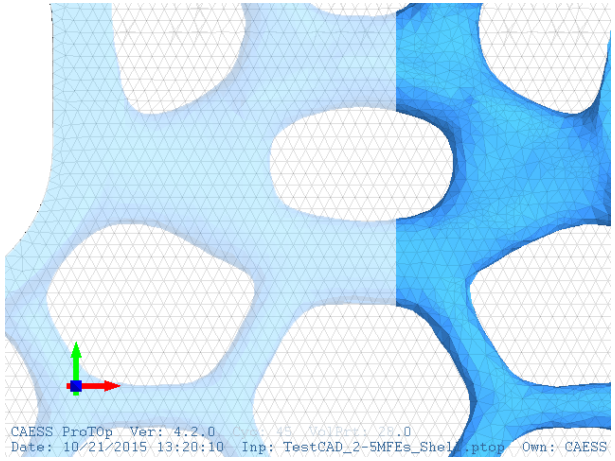


Get the final 3D model



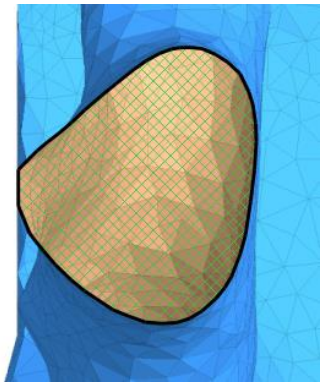


Why use optimization on lattice structures



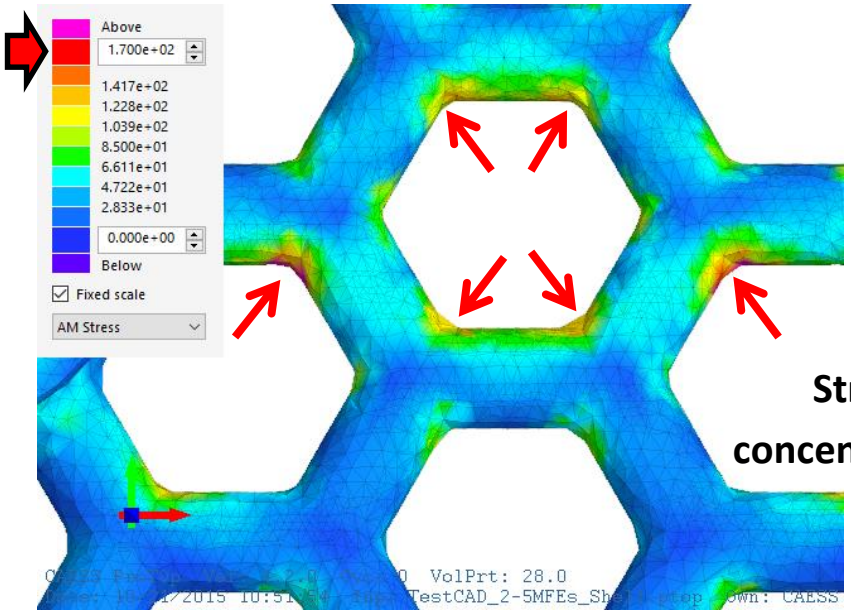
Full 3D solid optimization domain for lattice structure creation and optimization

A-A section



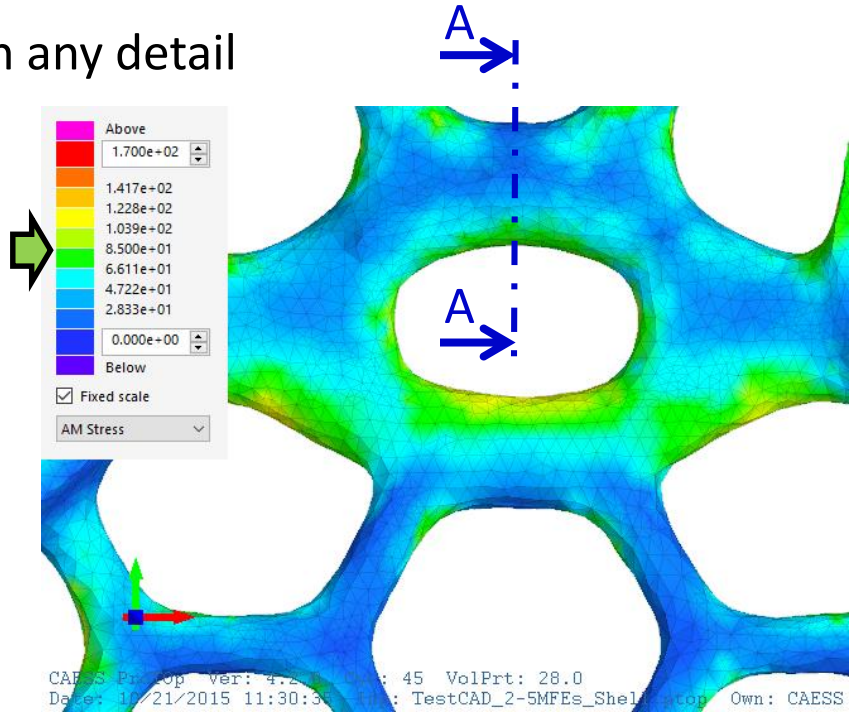
Full shaping freedom

Full 3D shell/lattice structures optimization in any detail



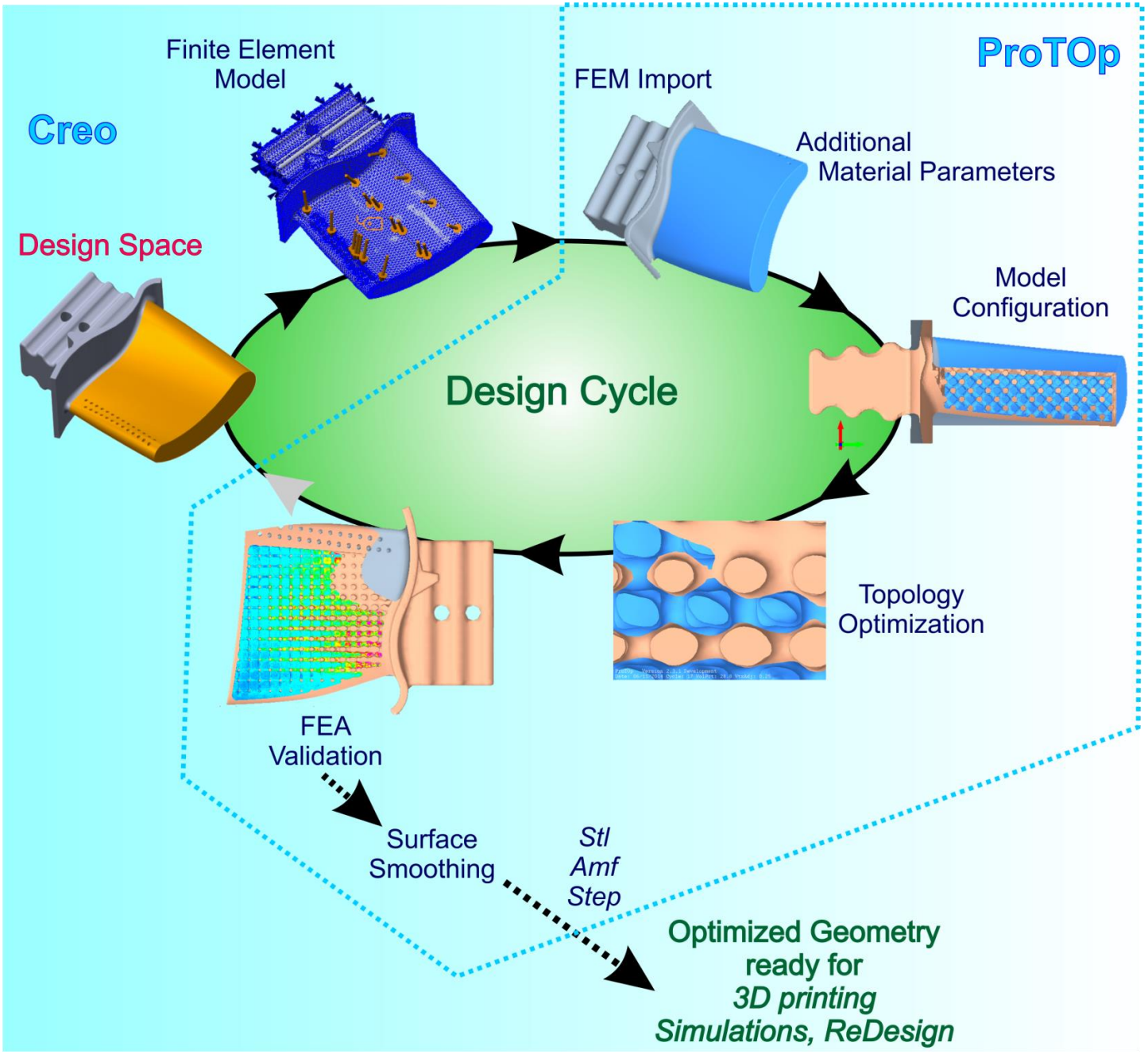
Created initial lattice structure

Stress concentrations



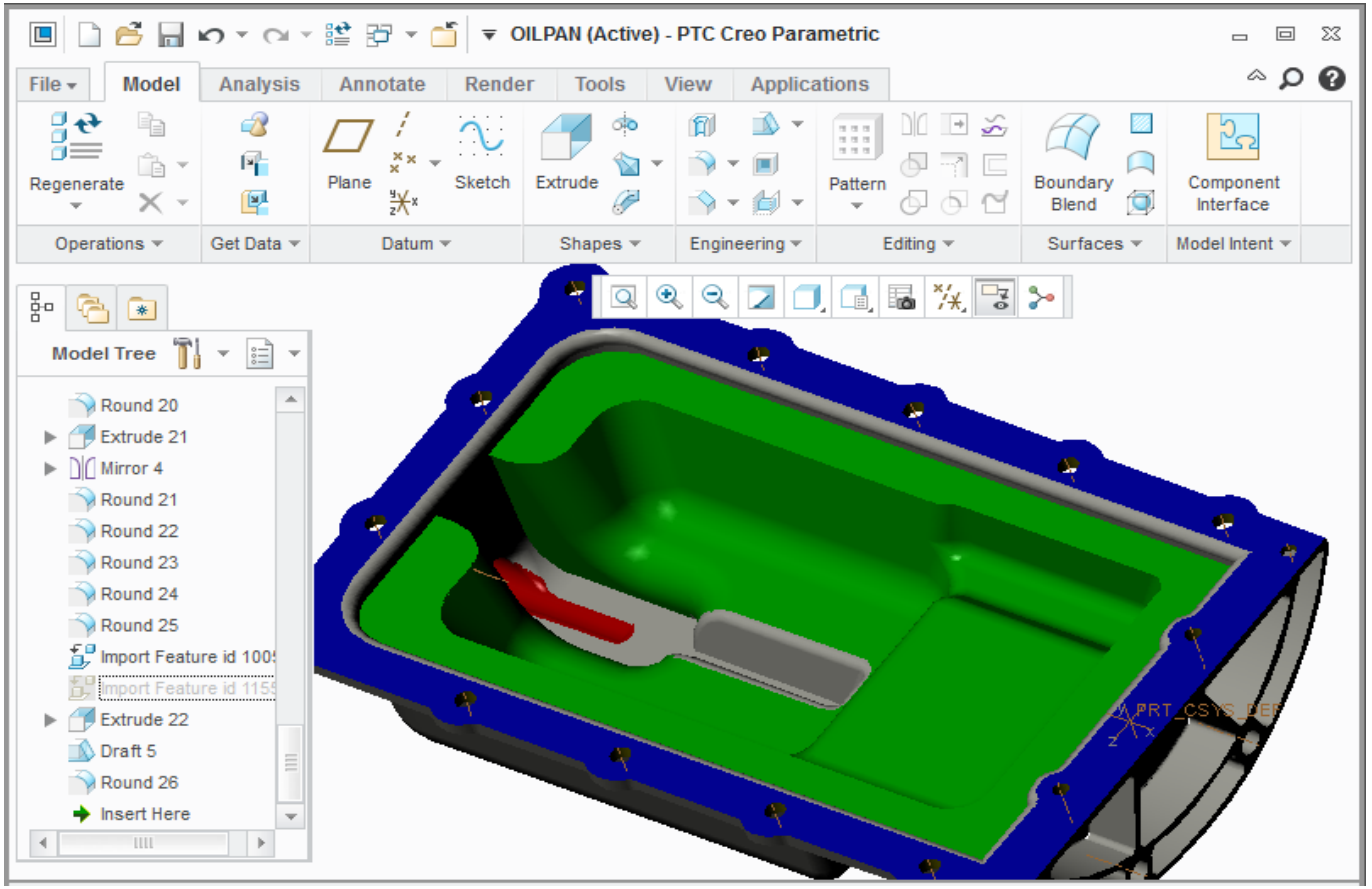
Optimized structure

Design Workflow



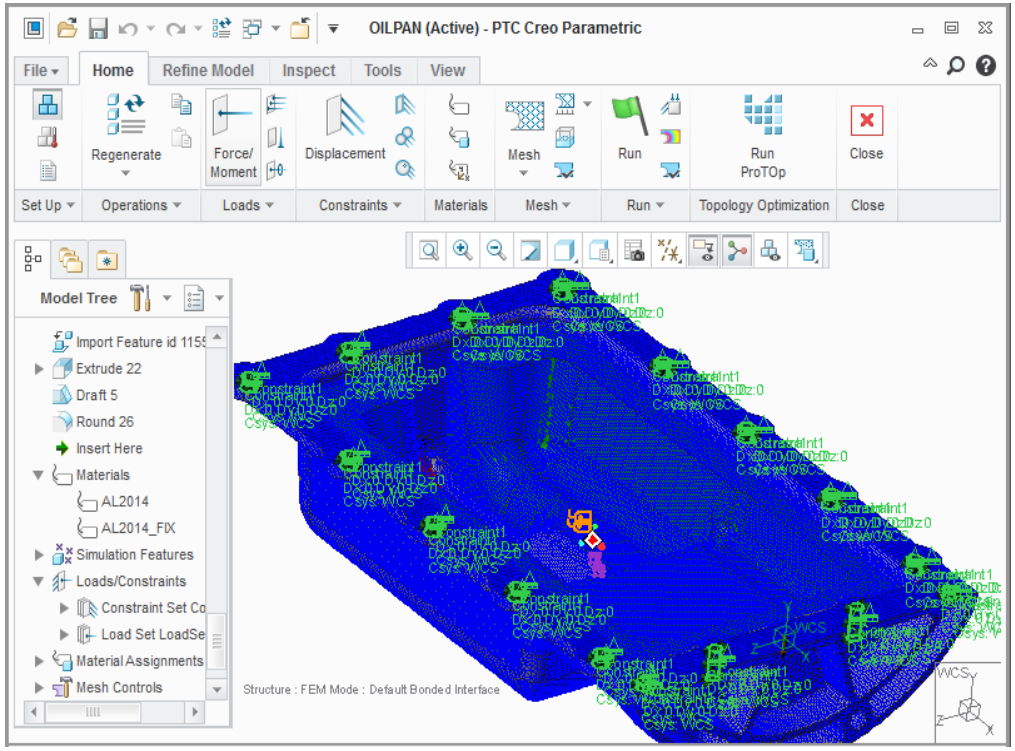
Creating CAD Model (by PTC Creo)

- Model should include all details (interfaces, functional requirements, adding's for mechanical treatments), to get the right stiffness and possibility of direct manufacturing after optimization



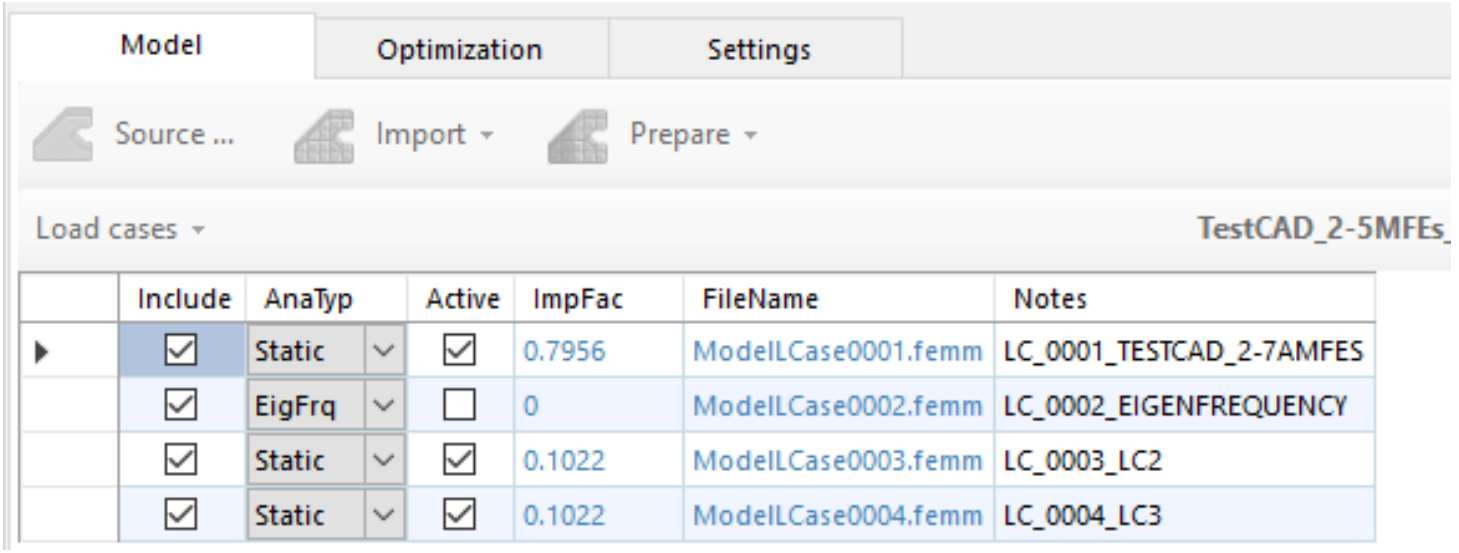
Creating FE (finite element) Model (also by PTC Creo)

- Creating volume regions
- Material definition (*_FIX*, *_FIXC*, *_CAD*)
- BCs and Loads and their sets
- Mesh control
- Create Load cases
- Run ProTOp or Export FNF

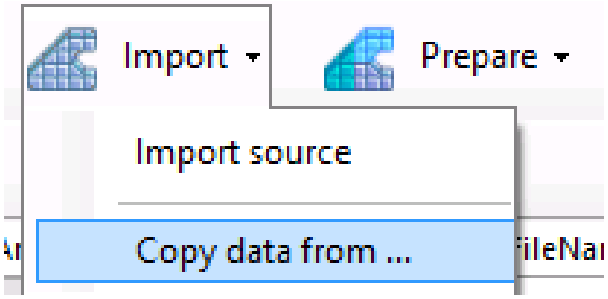


Run ProTOp or Import FE model

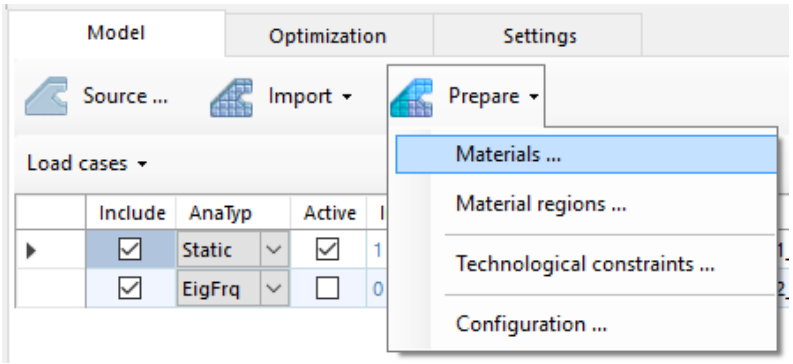
Model tab

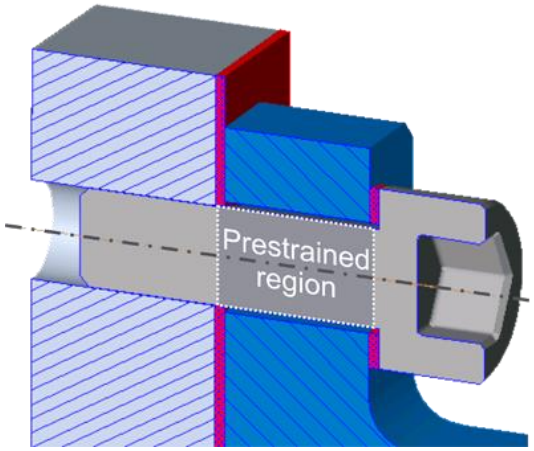


	Include	AnaTyp	Active	ImpFac	FileName	Notes
▶	☑	Static	☑	0.7956	ModelLCase0001.femm	LC_0001_TESTCAD_2-7AMFES
	☑	EigFrq	☐	0	ModelLCase0002.femm	LC_0002_EIGENFREQUENCY
	☑	Static	☑	0.1022	ModelLCase0003.femm	LC_0003_LC2
	☑	Static	☑	0.1022	ModelLCase0004.femm	LC_0004_LC3



Model preparation, **Materials**





Materials Tool

Material propertis | Help

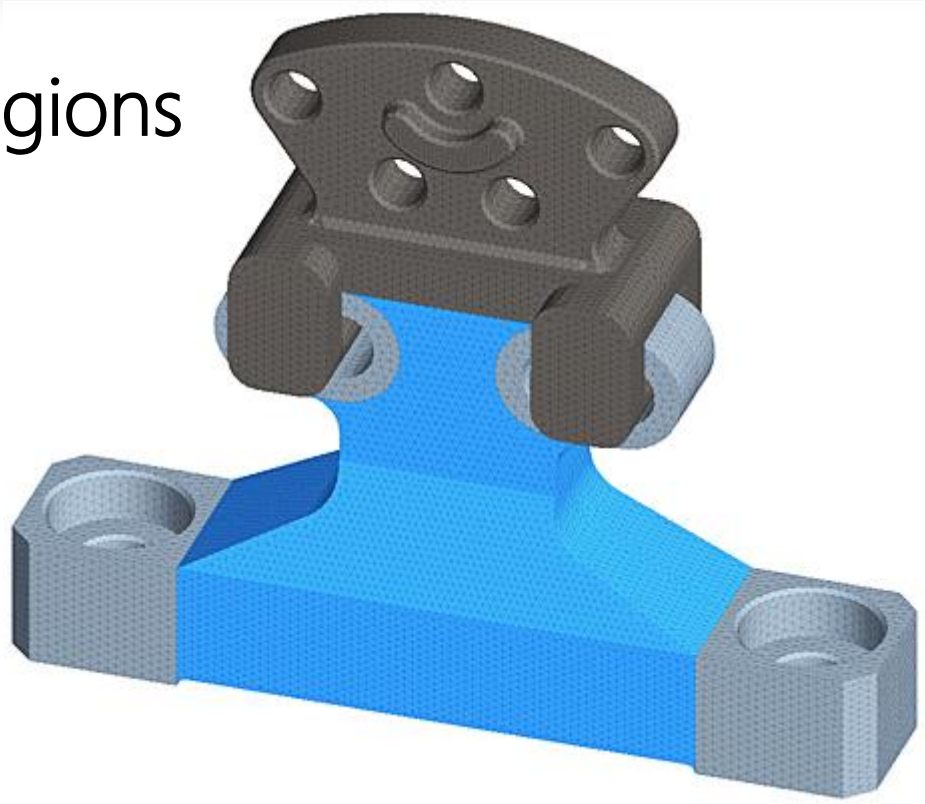
	Id	Name	ElaM	PoissR	MasDen	YStress	YHarden	ThExp
	1	TIALLY_FIX	117211	0.33	4.45323E-09	0	0.001	1.026E-05
	2	TIALLY1_CAD	117211	0.33	4.45323E-09	0	0.001	1.026E-05
	3	TIALLY_VL	117211	0.33	4.45323E-09	450	0.001	1.026E-05
	4	TIALLY_VR	117211	0.33	4.45323E-09	450	0.001	1.026E-05

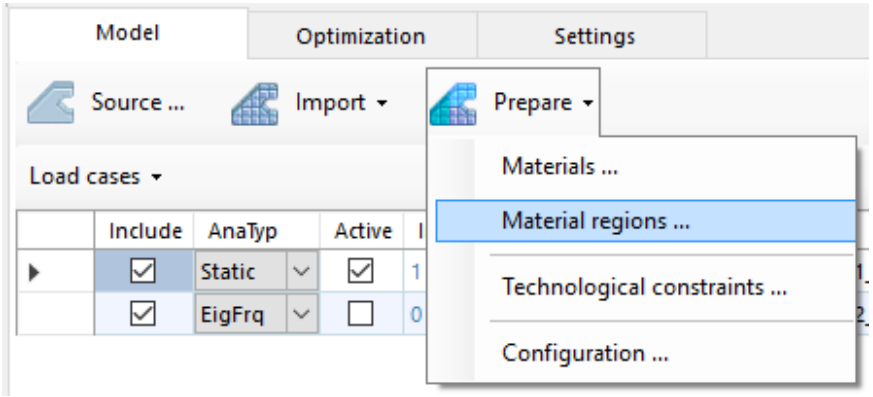
Material fields

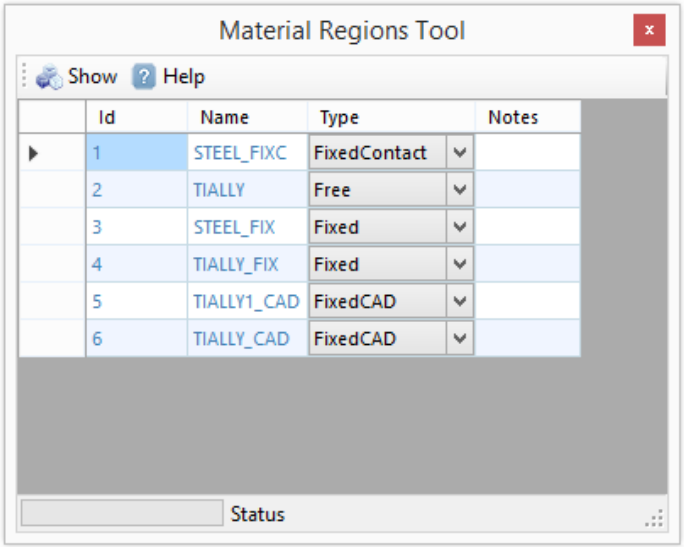
	Id	Name	PreStrain
	1	TIALLY_FIX	-0.0015
	2	TIALLY1_CAD	0
	3	TIALLY_VL	0.0005
	4	TIALLY_VR	0.0005

Model preparation, **Materials regions**

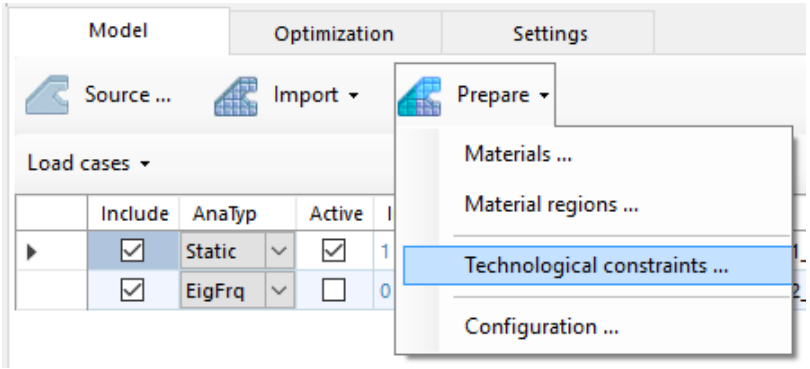
- Light blue – optimization region (modified by the optimizer)
- Light gray – fixed region (not modified by the optimizer)
- Gray – fixed region; excluded from FEA (e.g., if needed for 3D print, no BCs and Loads on CAD regions)

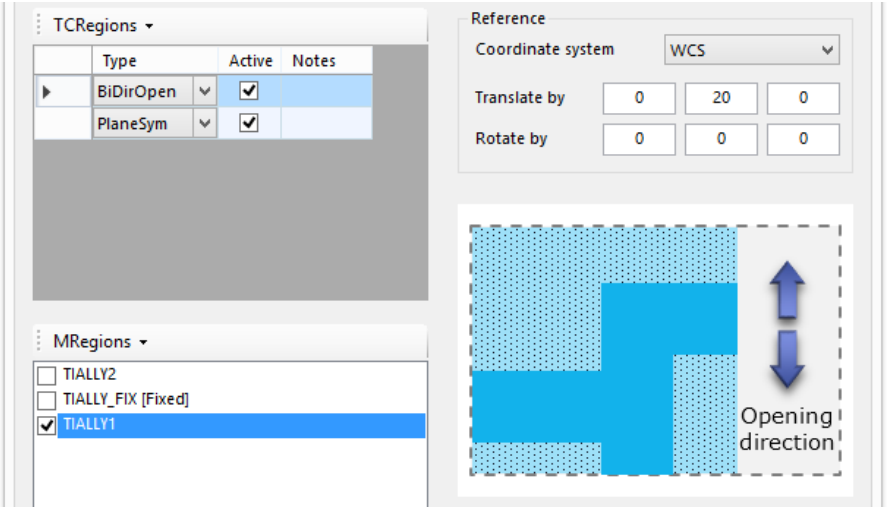






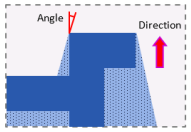
Model preparation, Technological constraints …

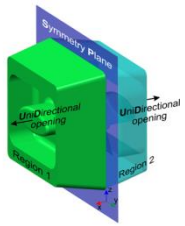




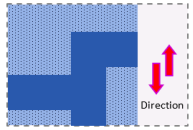
Adding technological constraints:

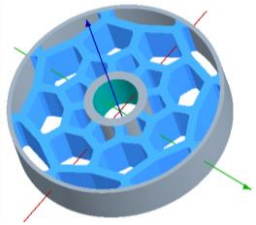
- UniDirOpen



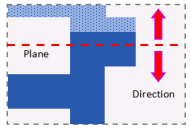


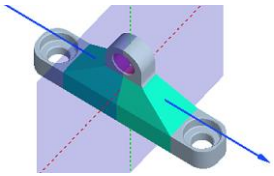
- BiDirOpen



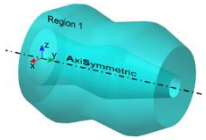


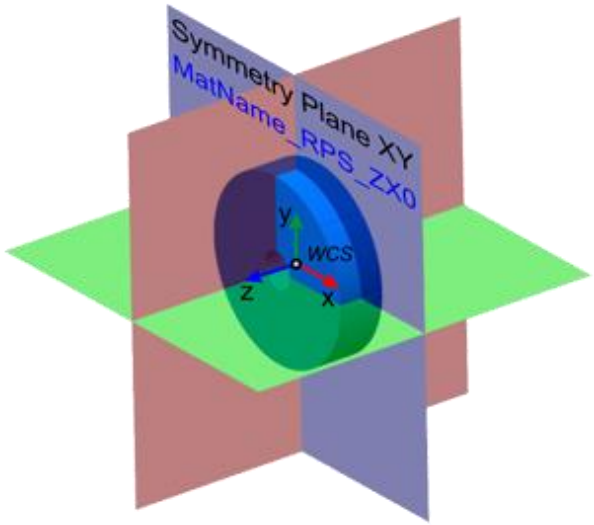
- PlaneSym





- AxiSym

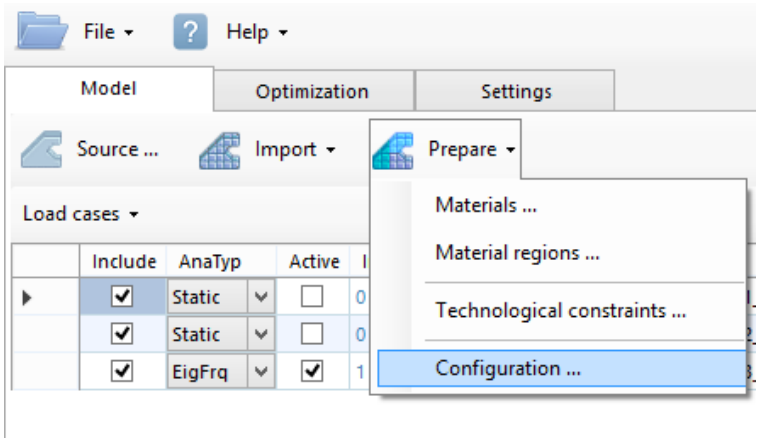


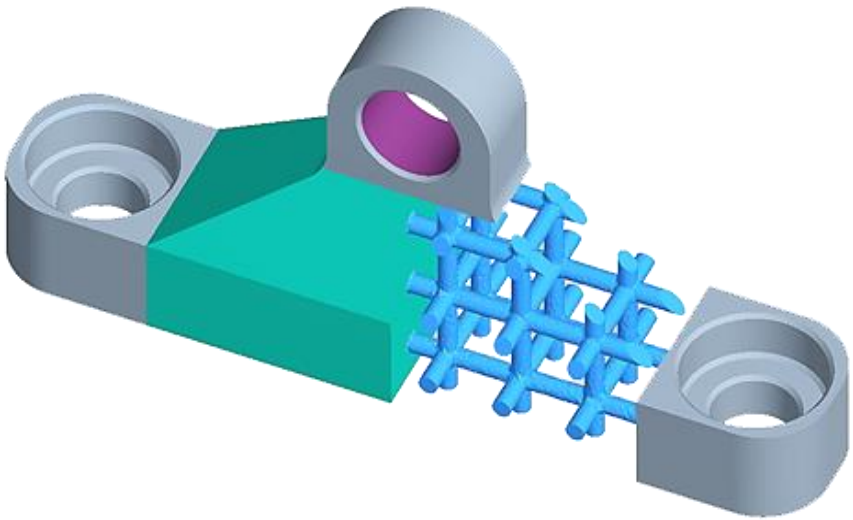


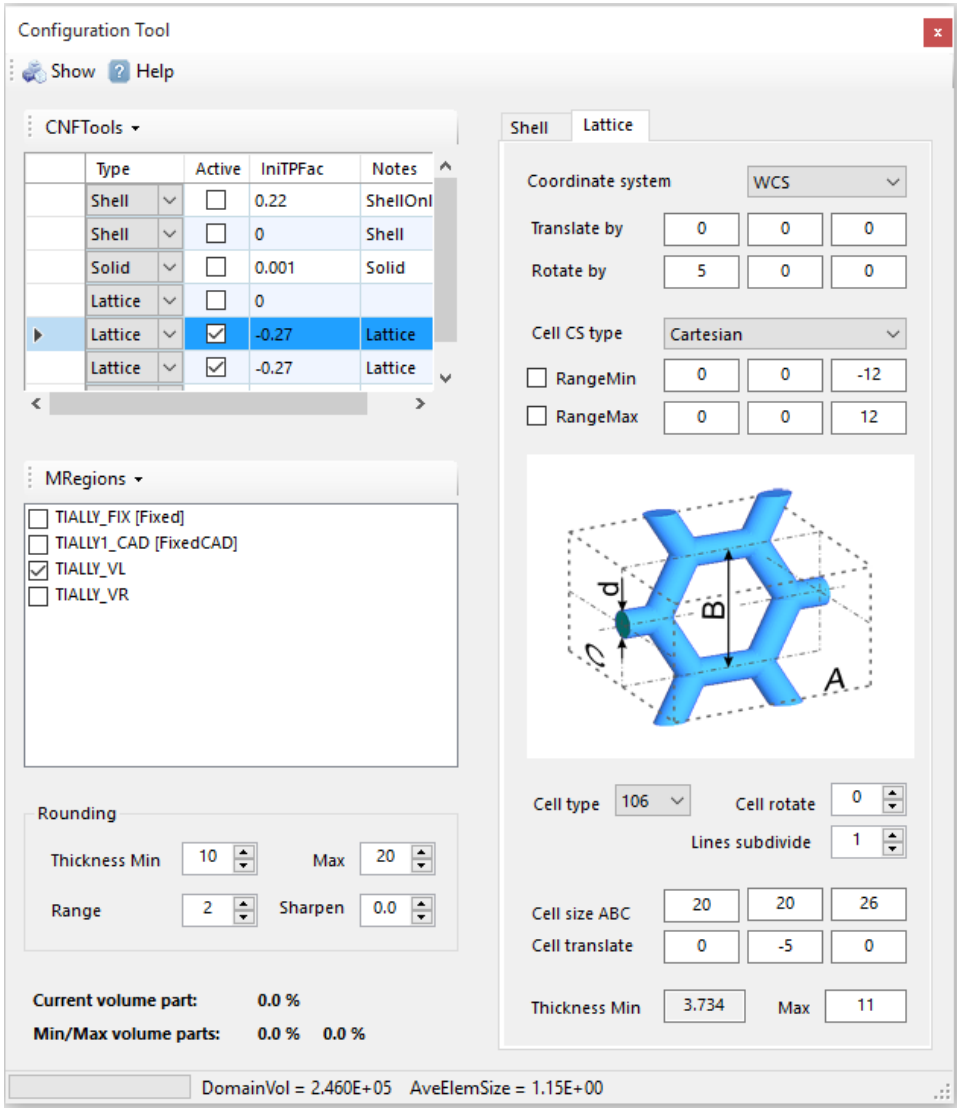
Model preparation, **Configuration** …

Configuring the model:

- ❑ Solid configuration,
- ❑ Shell / lattice configuration.

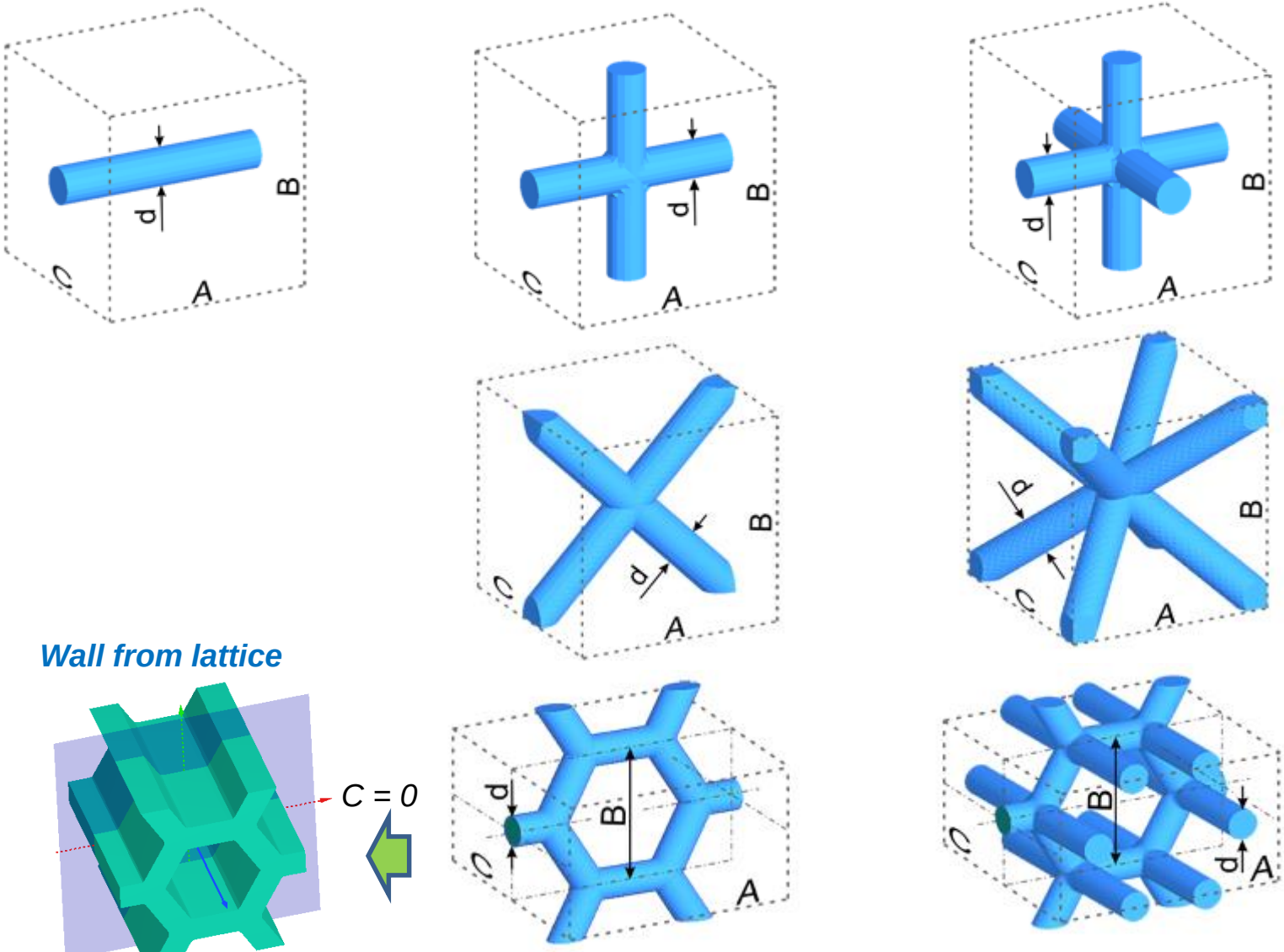






Model preparation, Configuration …

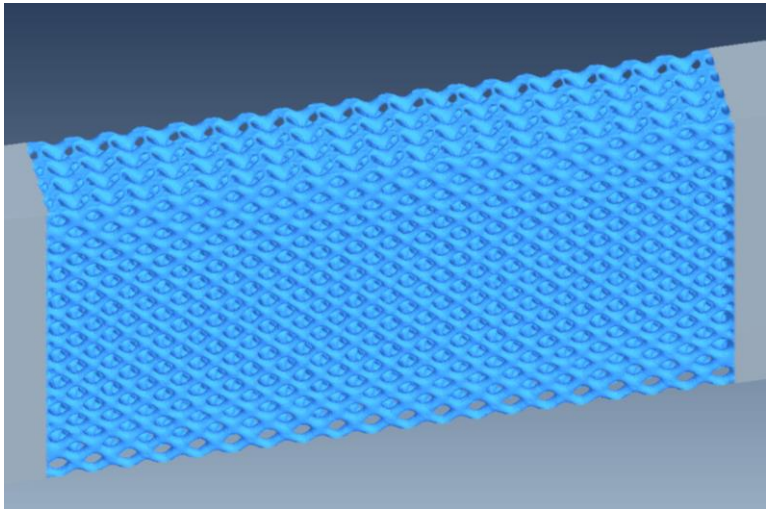
Cells **1D** **2D** **3D**



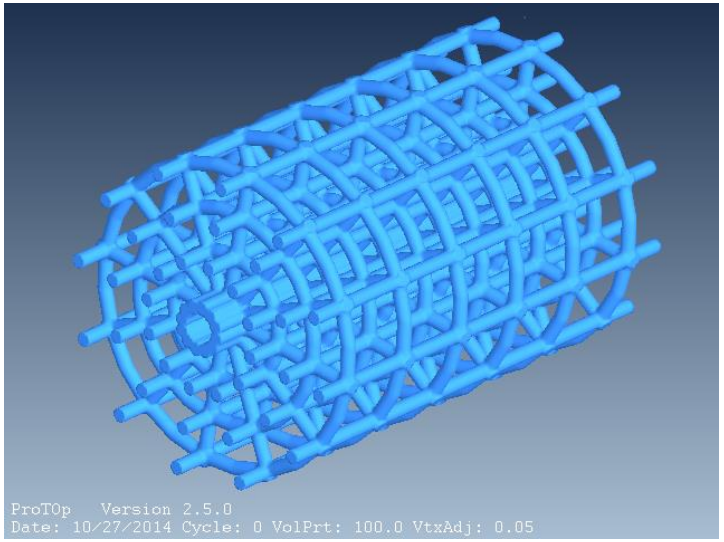
Wall from lattice

Model preparation, Configuration …

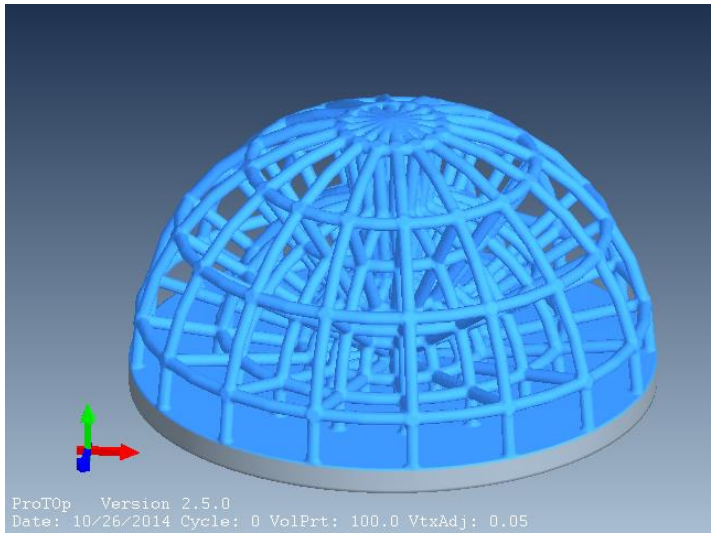
Coordinate systems



Cartesian CS



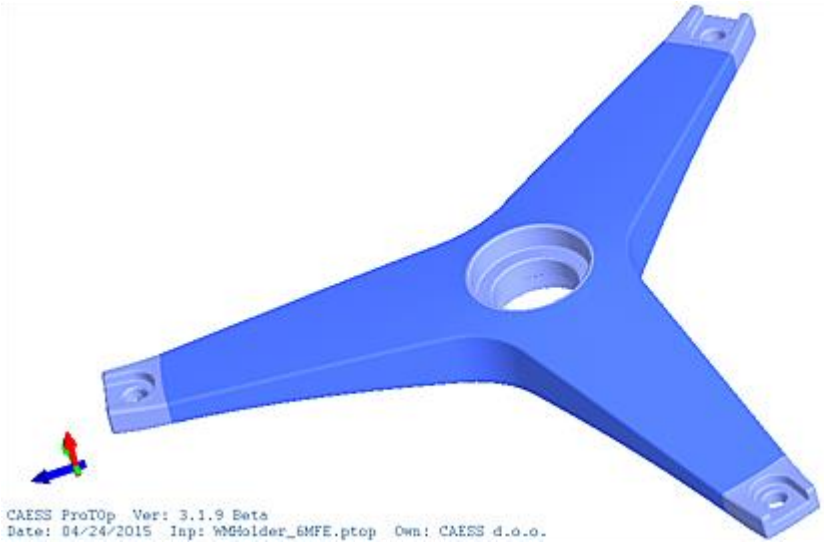
Cylindrical CS



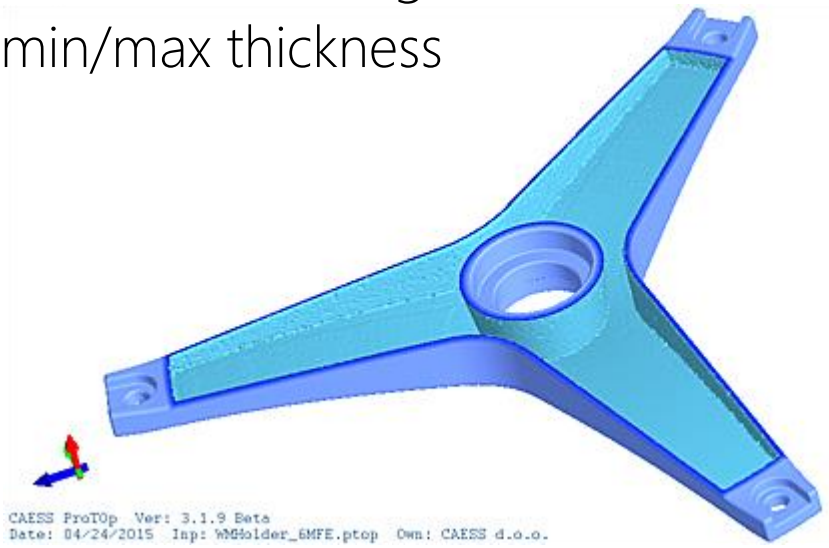
Spherical CS

Model preparation, Configuration …

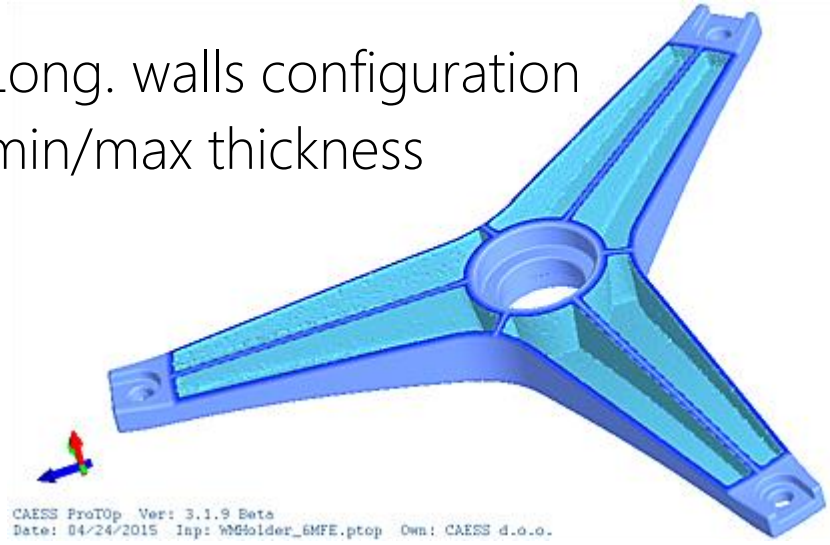
Initial model (solid from Creo)



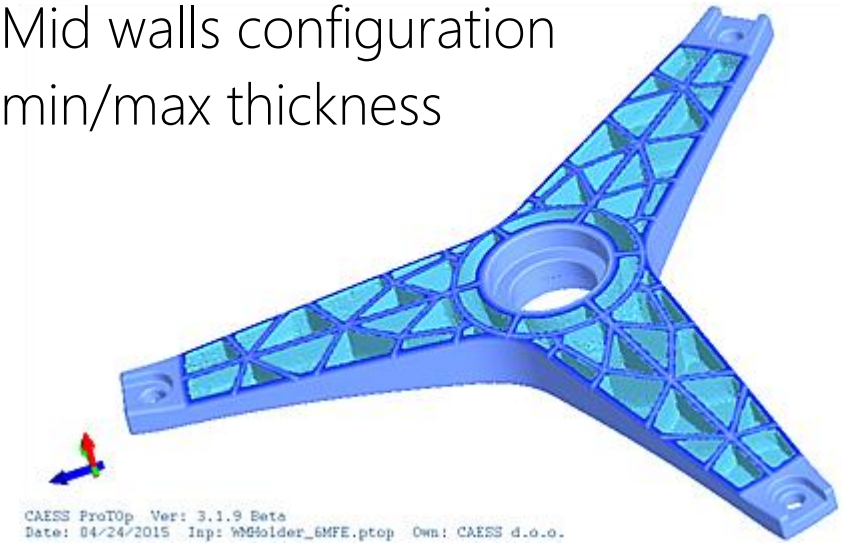
Outer shell configuration min/max thickness



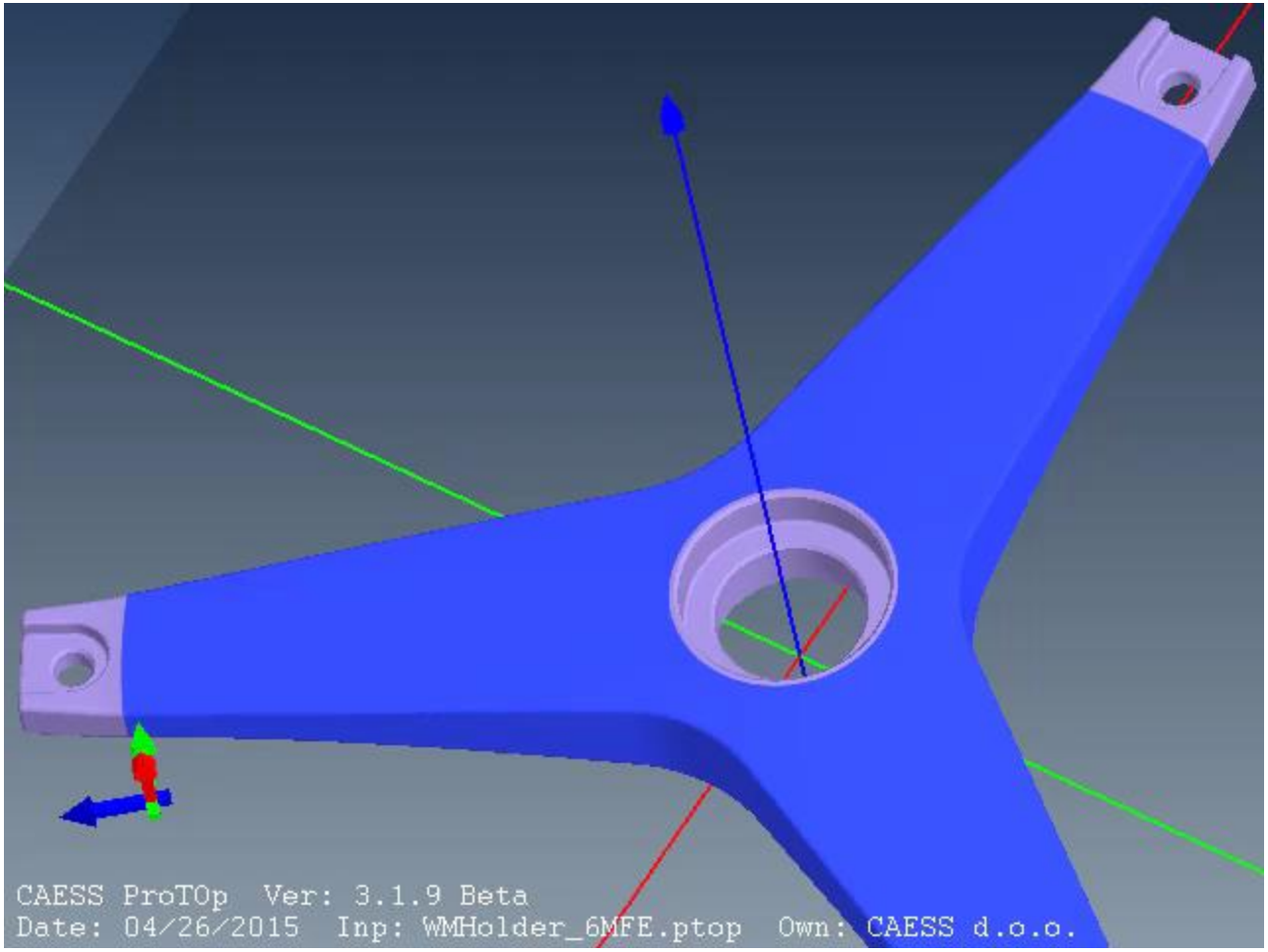
Long. walls configuration min/max thickness



Mid walls configuration min/max thickness

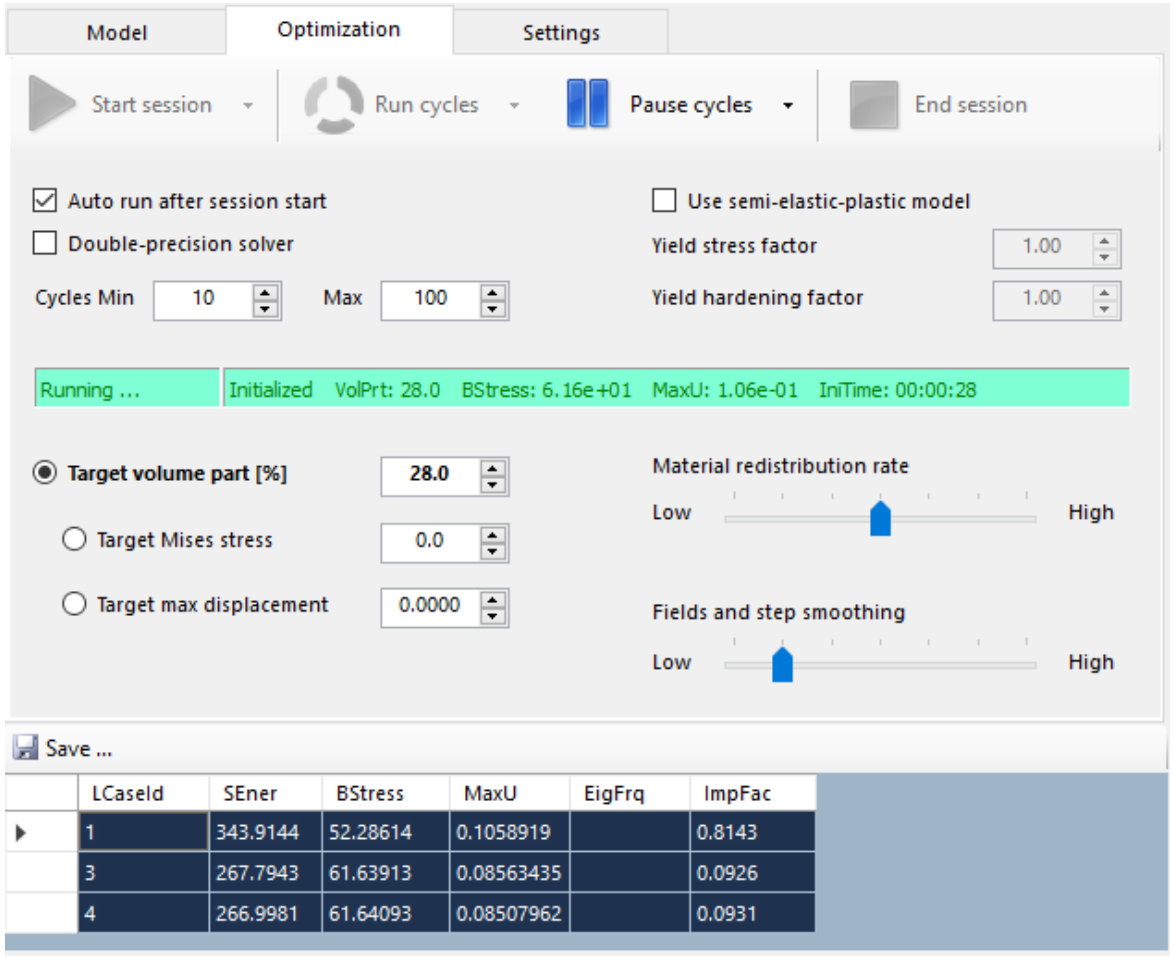


Animation, Washing machine drum holder



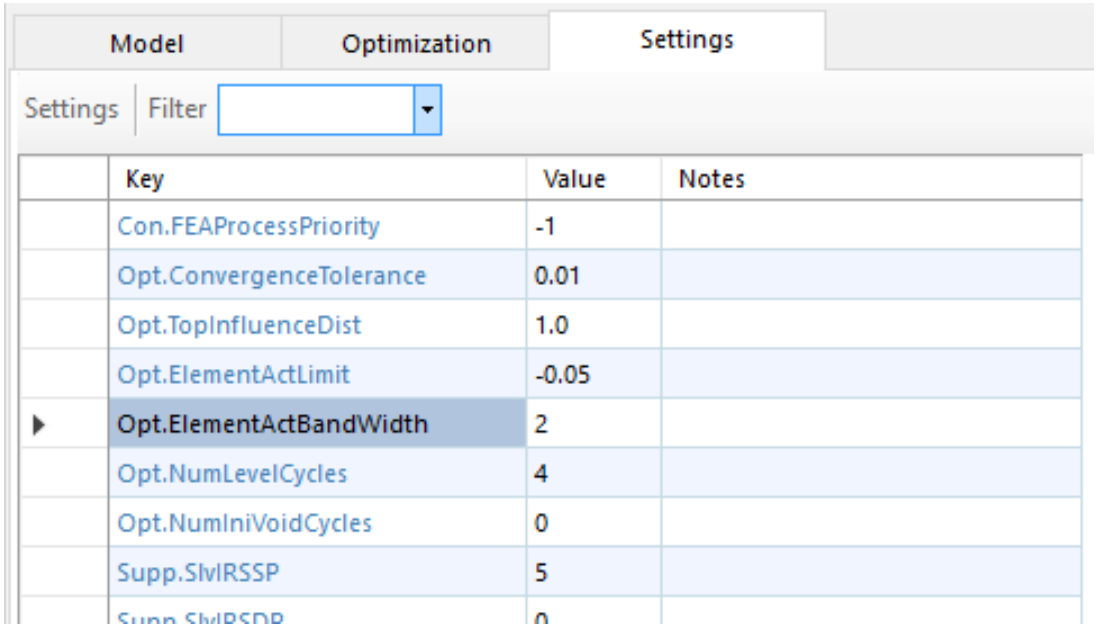
Run ProTOp or Import FE model

Optimization tab



Run ProTOp or Import FE model

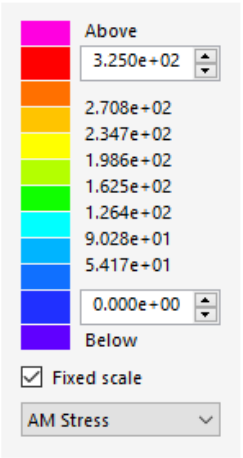
Advanced settings tab



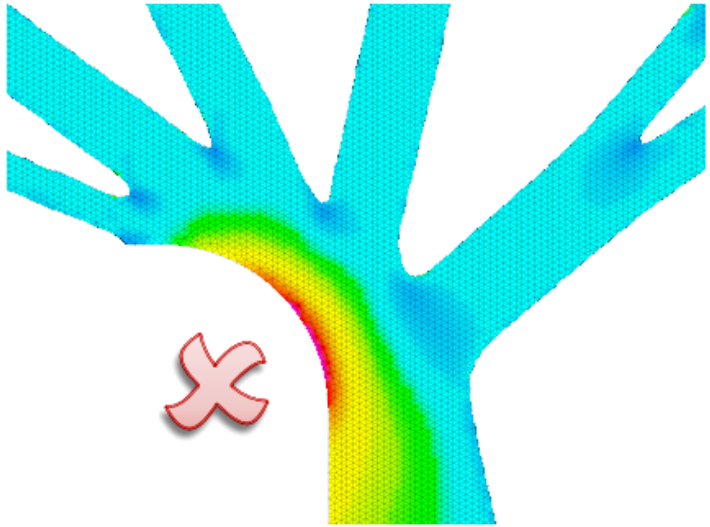
Key	Value	Notes
Con.FEAProcessPriority	-1	
Opt.ConvergenceTolerance	0.01	
Opt.TopInfluenceDist	1.0	
Opt.ElementActLimit	-0.05	
Opt.ElementActBandWidth	2	
Opt.NumLevelCycles	4	
Opt.NumIniVoidCycles	0	
Supp.SlvIRSSP	5	
Supp.SlvIRSDP	0	

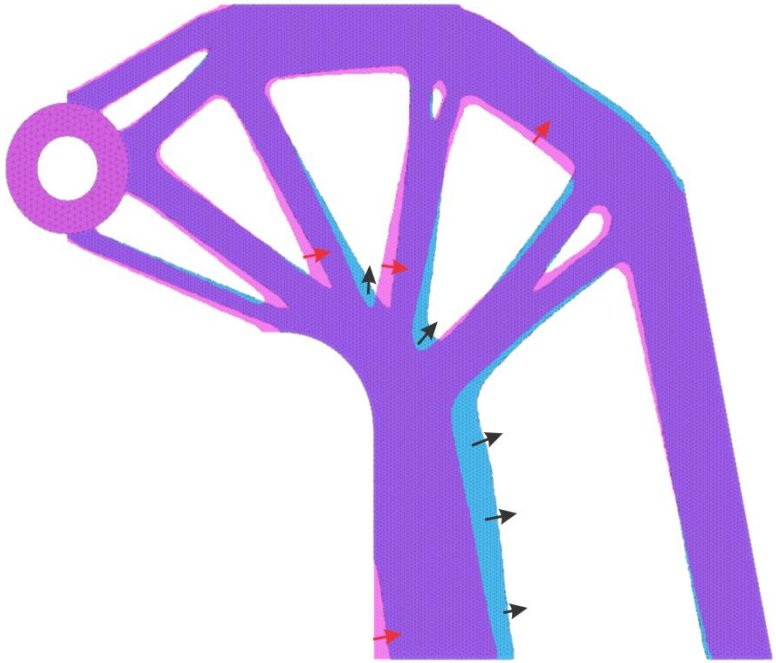
ProTOp® functionalities, Semi-elastic-plastic material behavior

Diminish stress concertation by elastic plastic material behavior

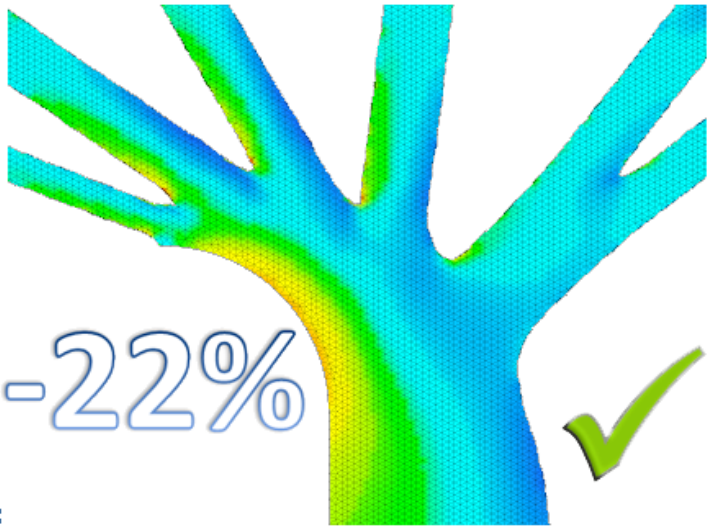


Optimized: Linear elastic behavior
Validated: Linear elastic behavior



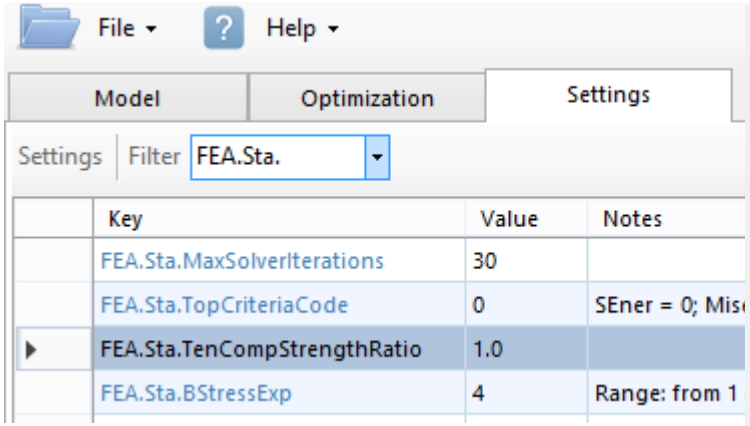


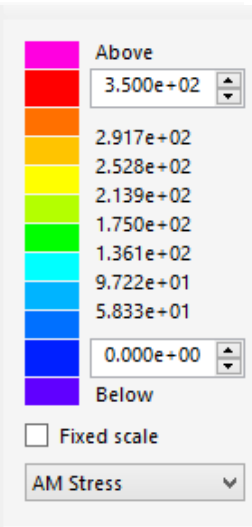
Optimized: Elastic plastic behavior
Validated: Linear elastic behavior

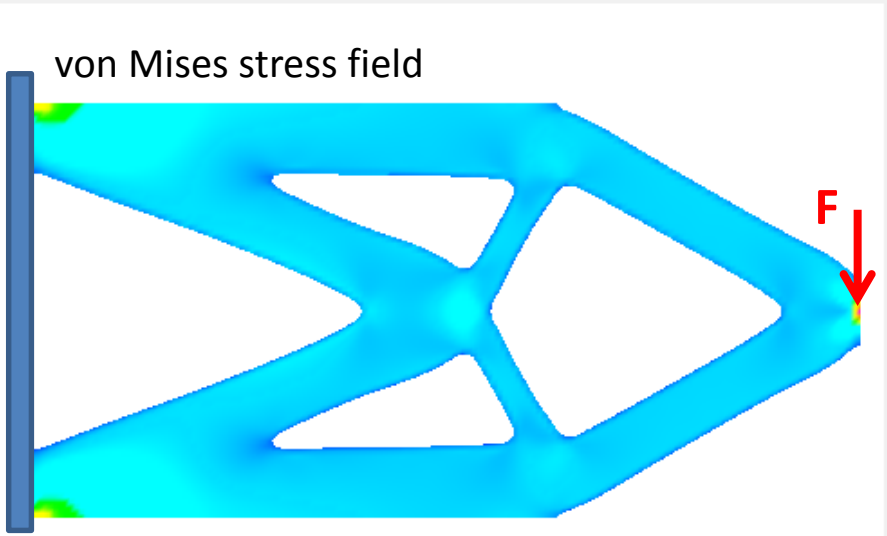


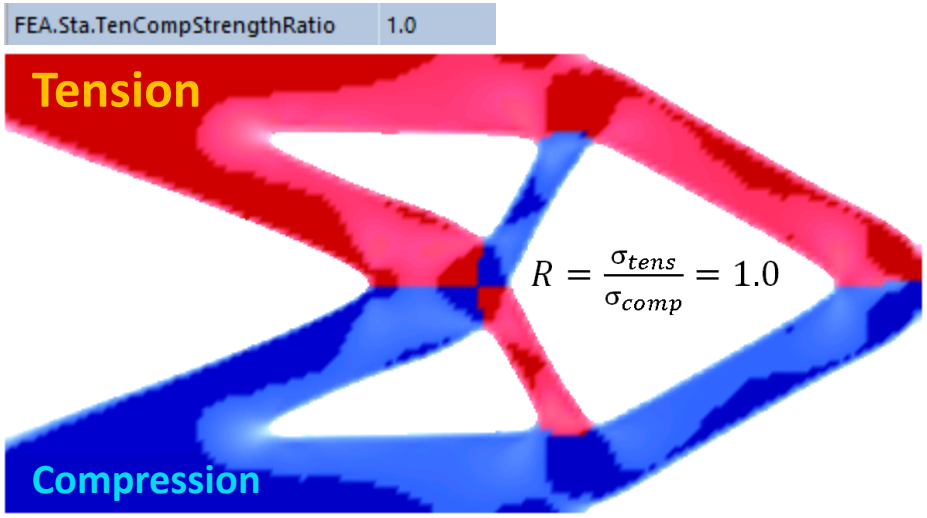
CAESS ProTOp Ver: 4.2.0 Cyc: 0 VolPrt: 50.0
Date: 09/30/2015 08:53:58 Inp: AnglePlate_EPx.ptop Own: CAESS

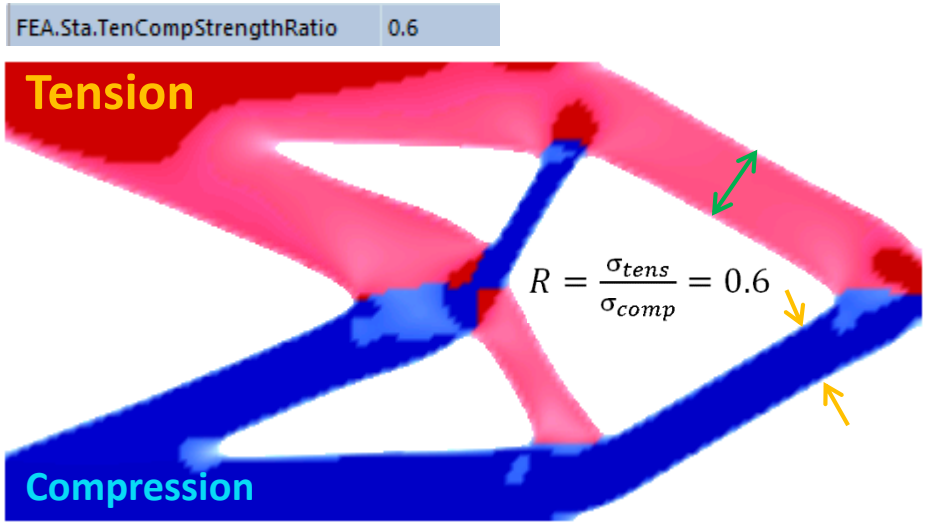
ProTOp® functionalities, Tens./Comp. Stress controlling





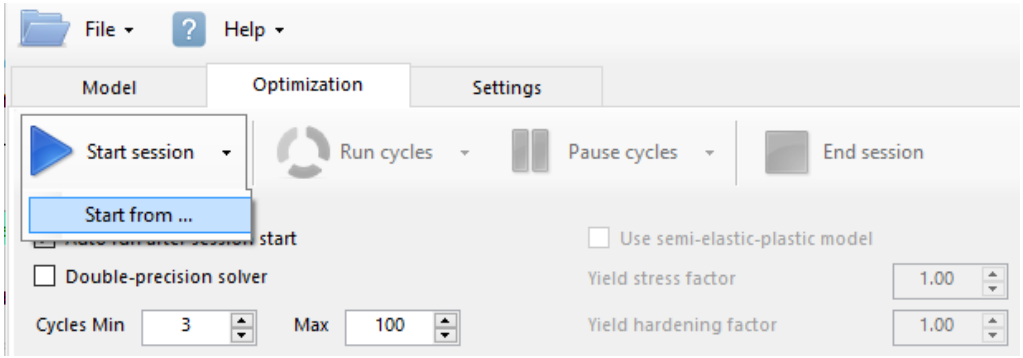


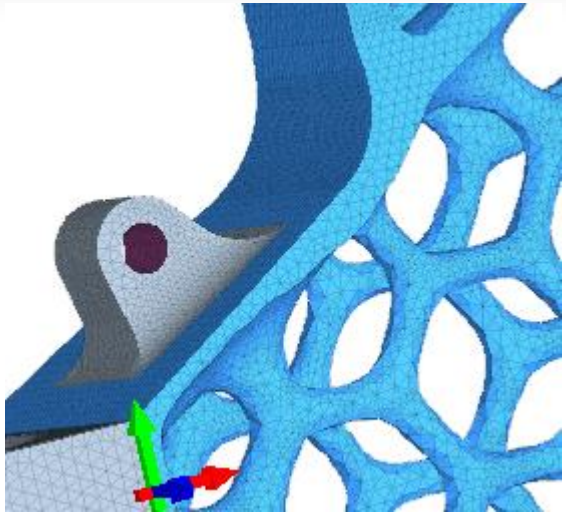




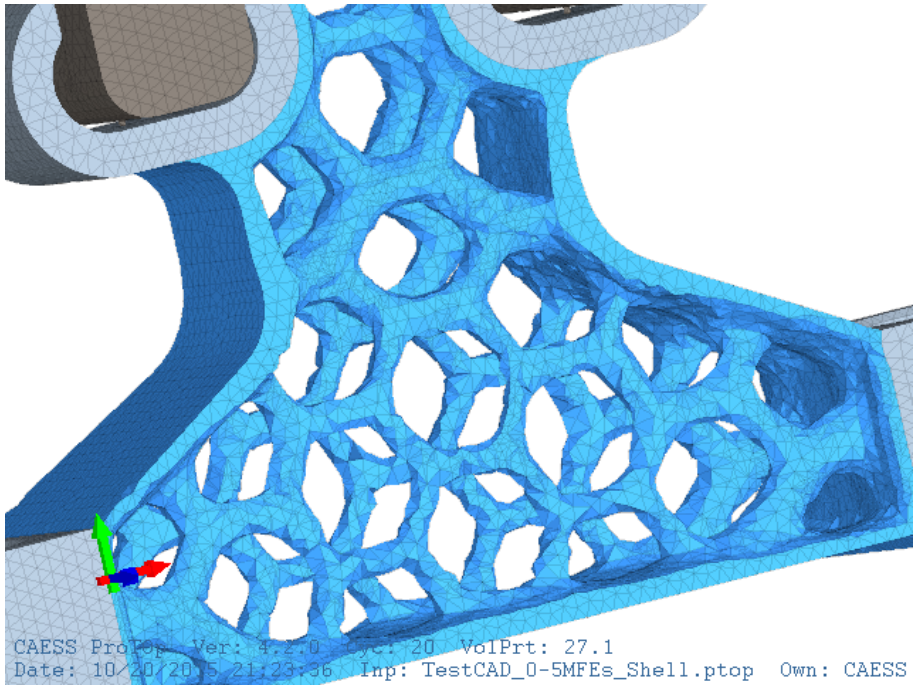
On crack initiation resistant structure

ProTOp® functionalities, *Start from...* mode

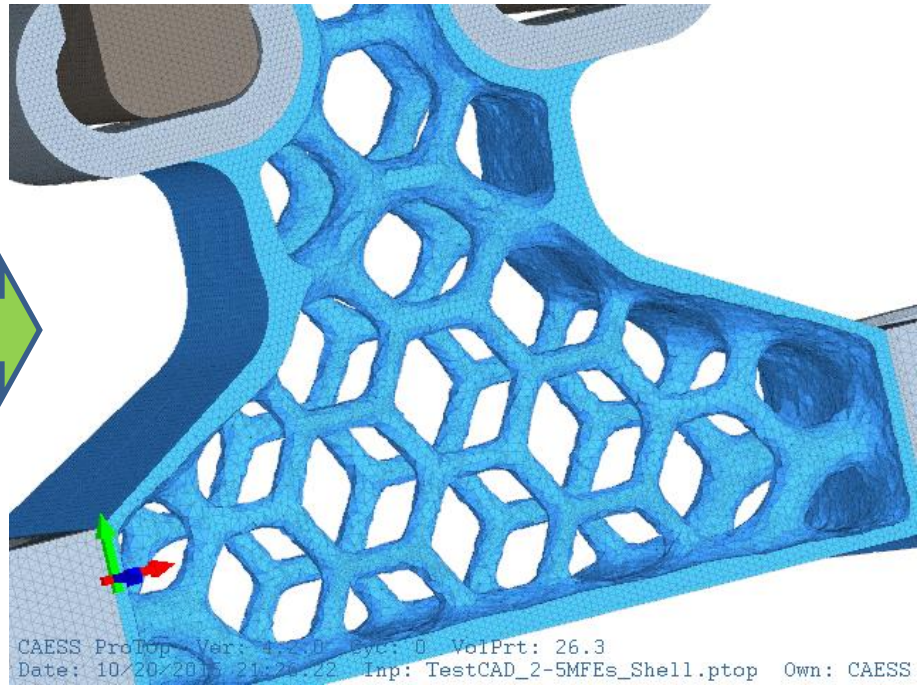




Small FE model (0.5 MFEs)

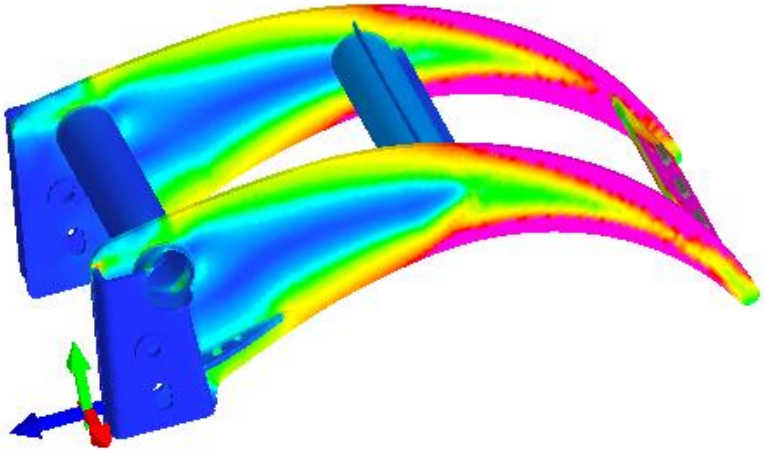


Larger FE model (2.5 MFEs)



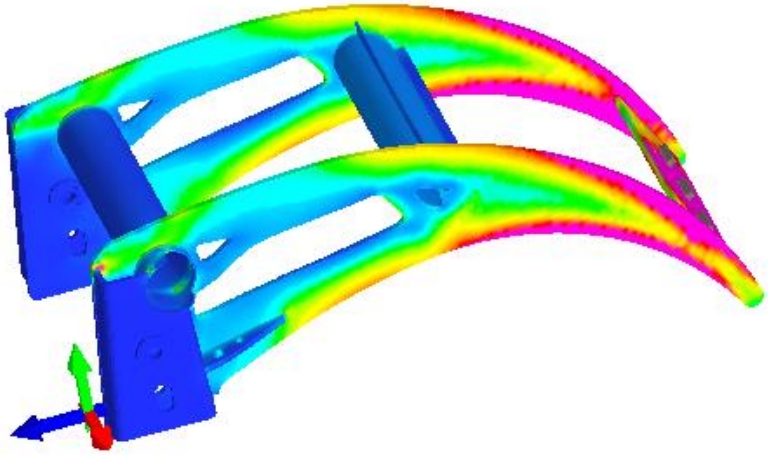
Optimization of welded structure made of thin plates

Initial model (solid from Creo)



CAESS ProTOp Ver: 4.2.0 Cyc: 0 VolPrt: 100.0
Date: 10/24/2015 10:42:05 Inp: Jaw.ptop Own: CAESS

Optimized shape



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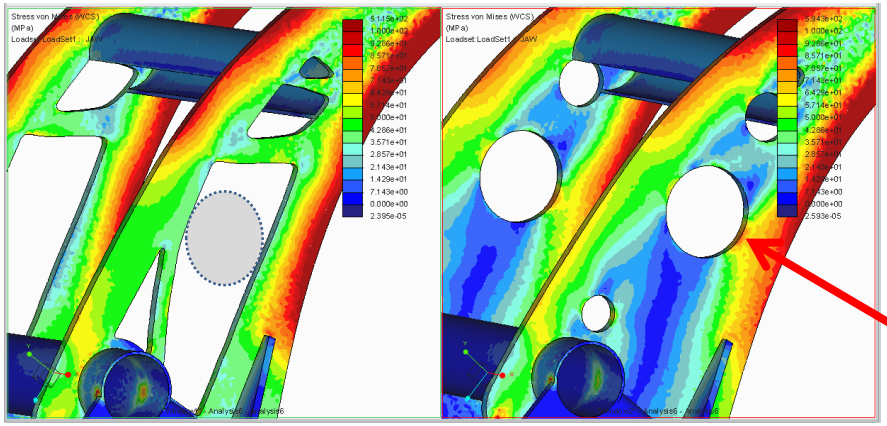
Date: 10/24/2015 10:46:14 Inp: Jaw.ptop Own: CAESS

Optimal shape vs. just holes

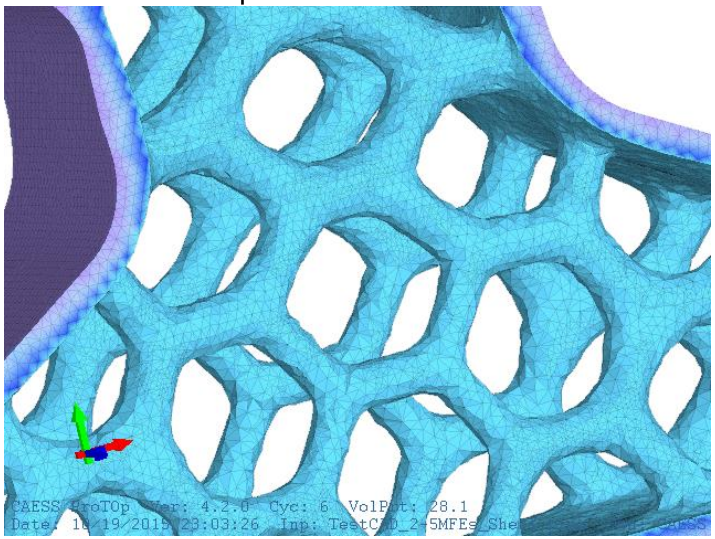


PTC Creo Simulate

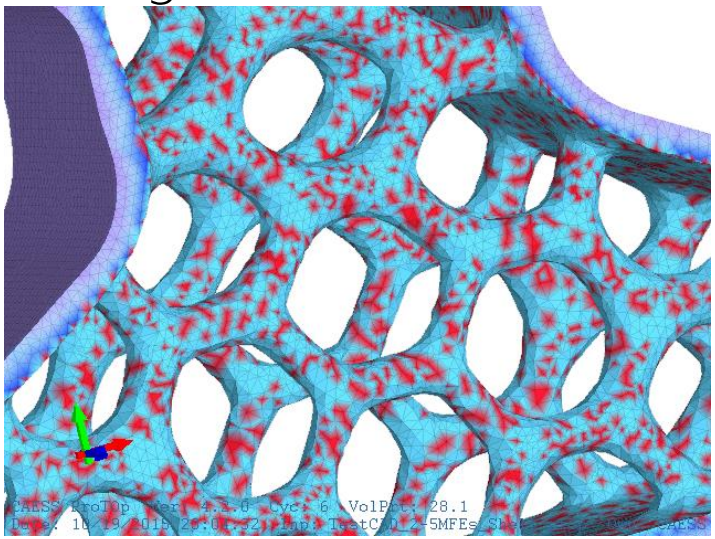
Stress concentration at hole,

Smoothing and export

Surface after optimization



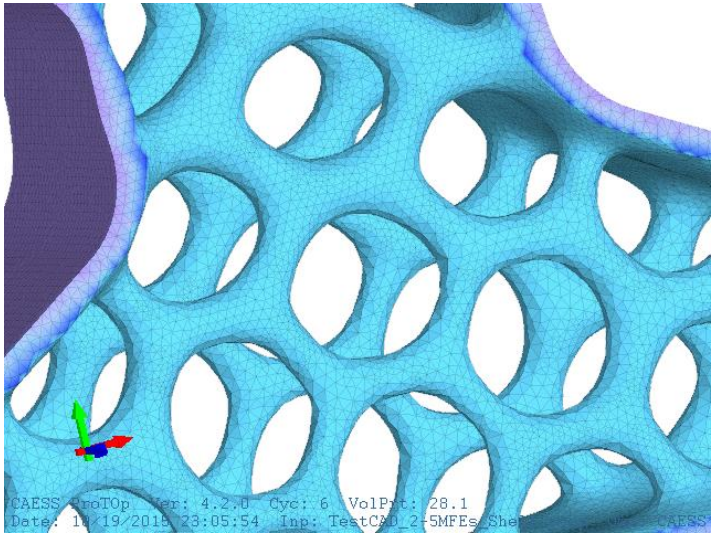
Smoothing



Surface tools:

- Surface mesh errors check
- Mesh simplification
- Peaks and pits removal
- Smoothing

Errors free and smoothed surface



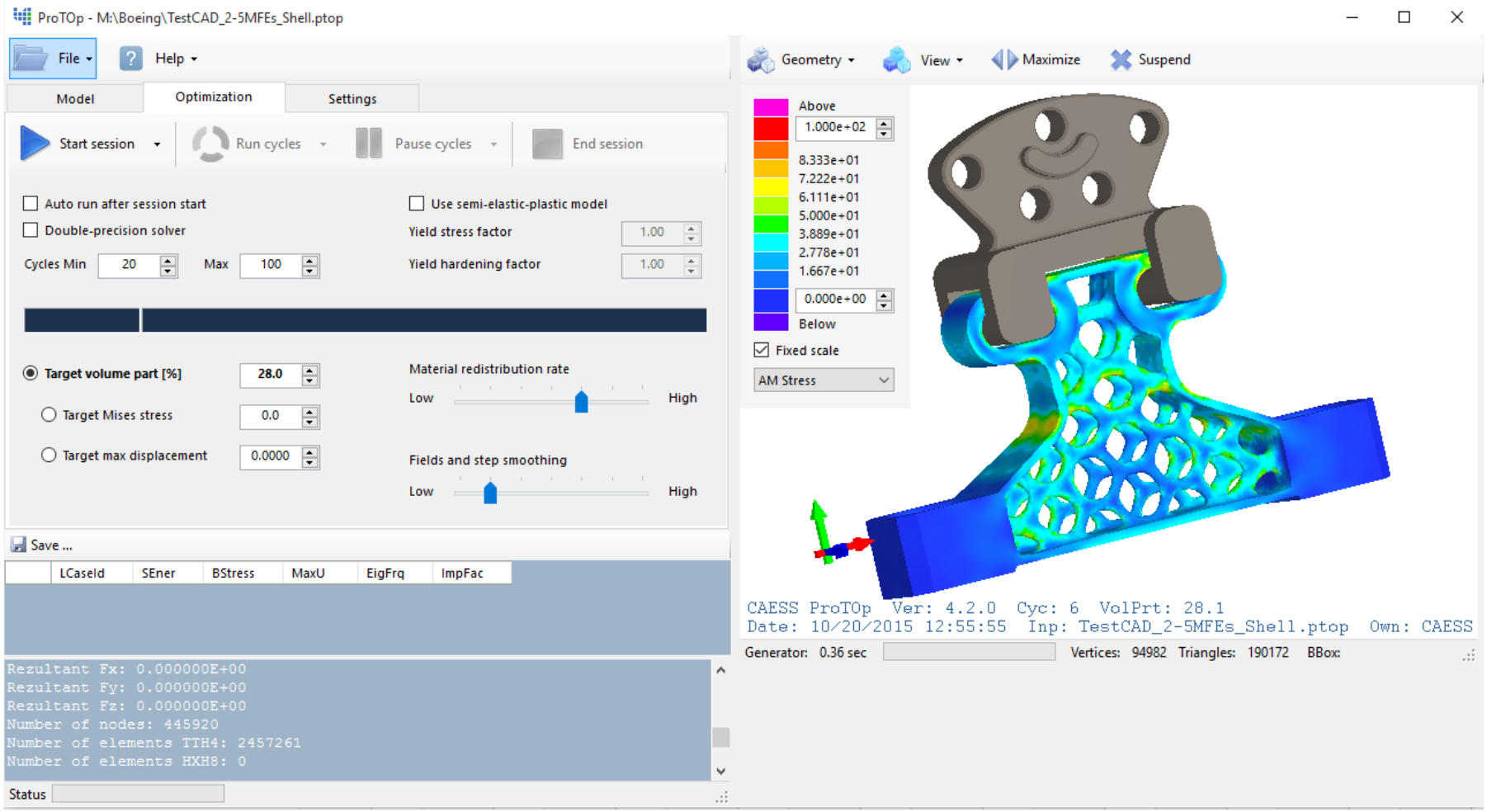
Export to STL, AMF or STEP formats

Additive Manufacturing

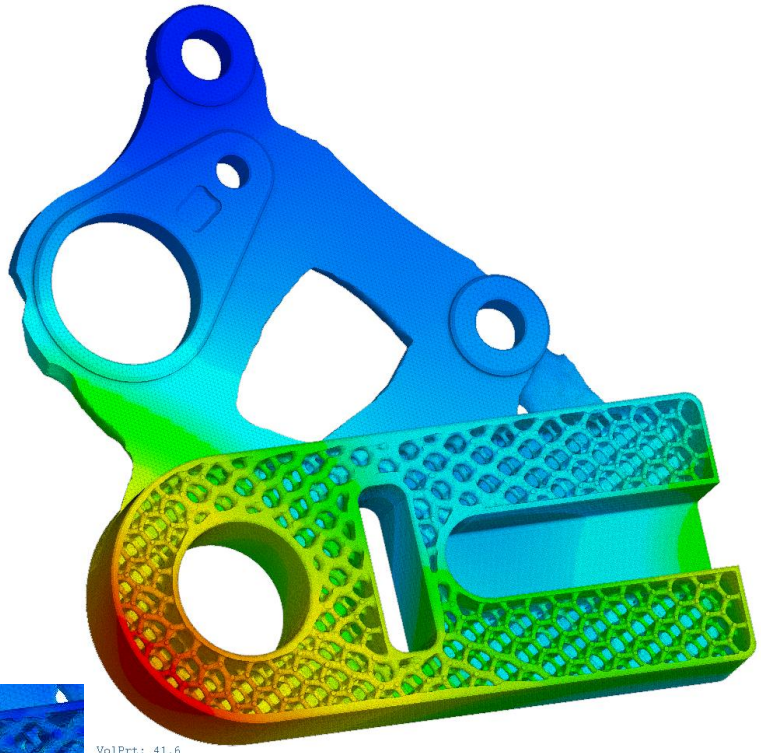
ProTOp® solution perfectly suited for new **Additive Manufacturing technologies.**

- Freedom of design
- Complex geometry
- Lattice structure
- Export to STL

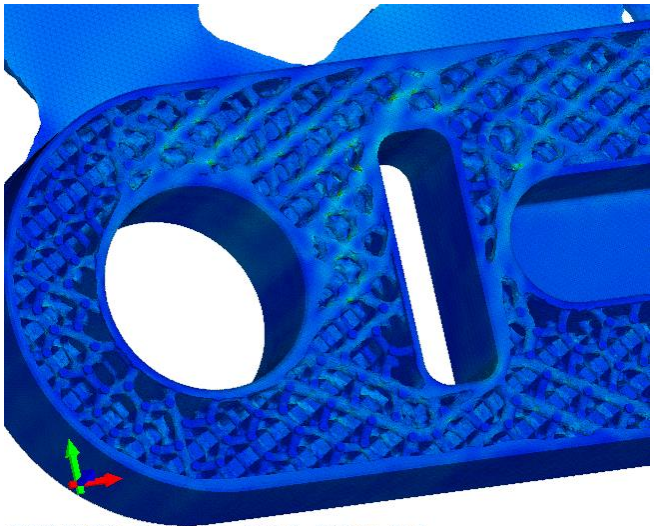
Live Demo: Brakcet



Simultaneously optimization of solid, shell and lattice structure



VolPrt: 41.6

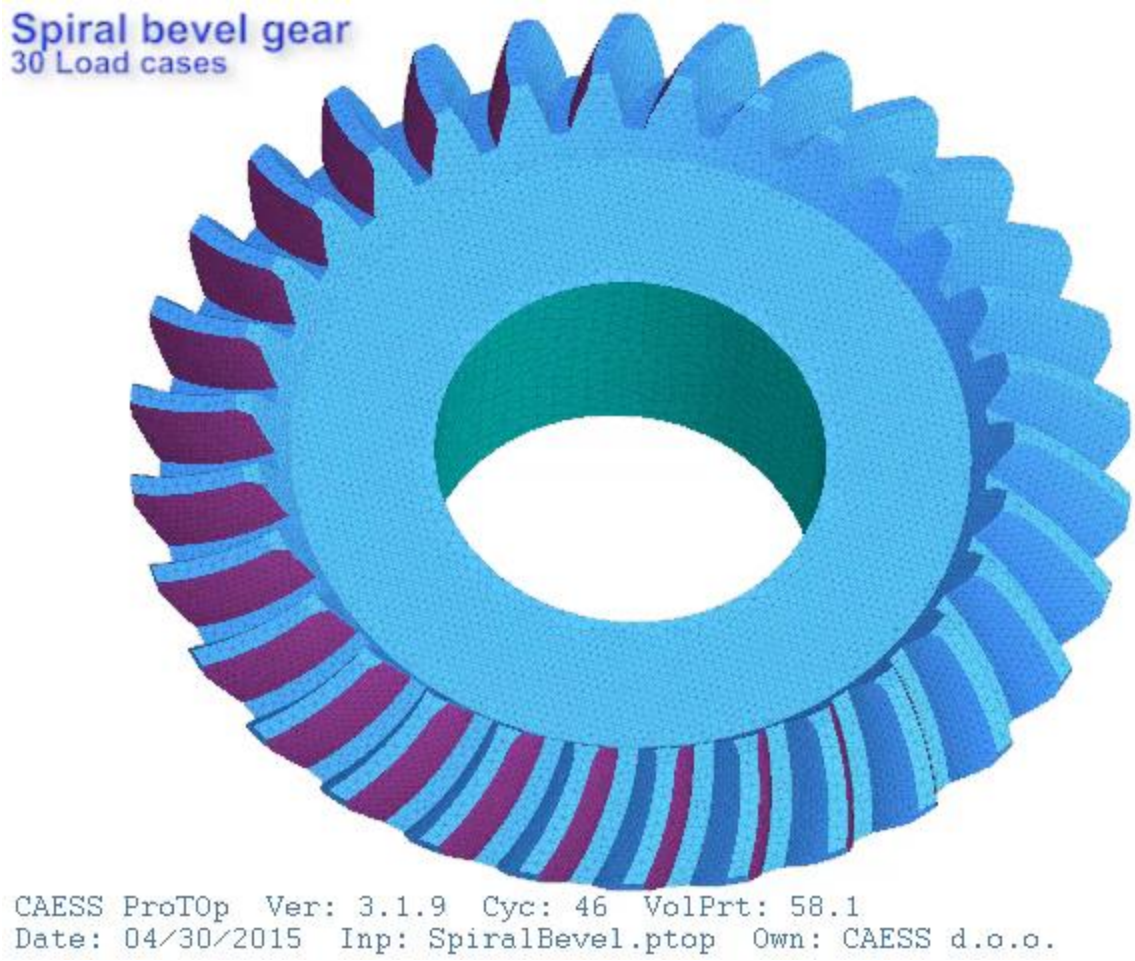


CAESS ProTOp Ver: 4.0.0 Cyc: 9 VolPrt: 40.9
Date: 06/03/2015 Inp: SolidShellLattice.ptop Own: CAESS d.o.o.

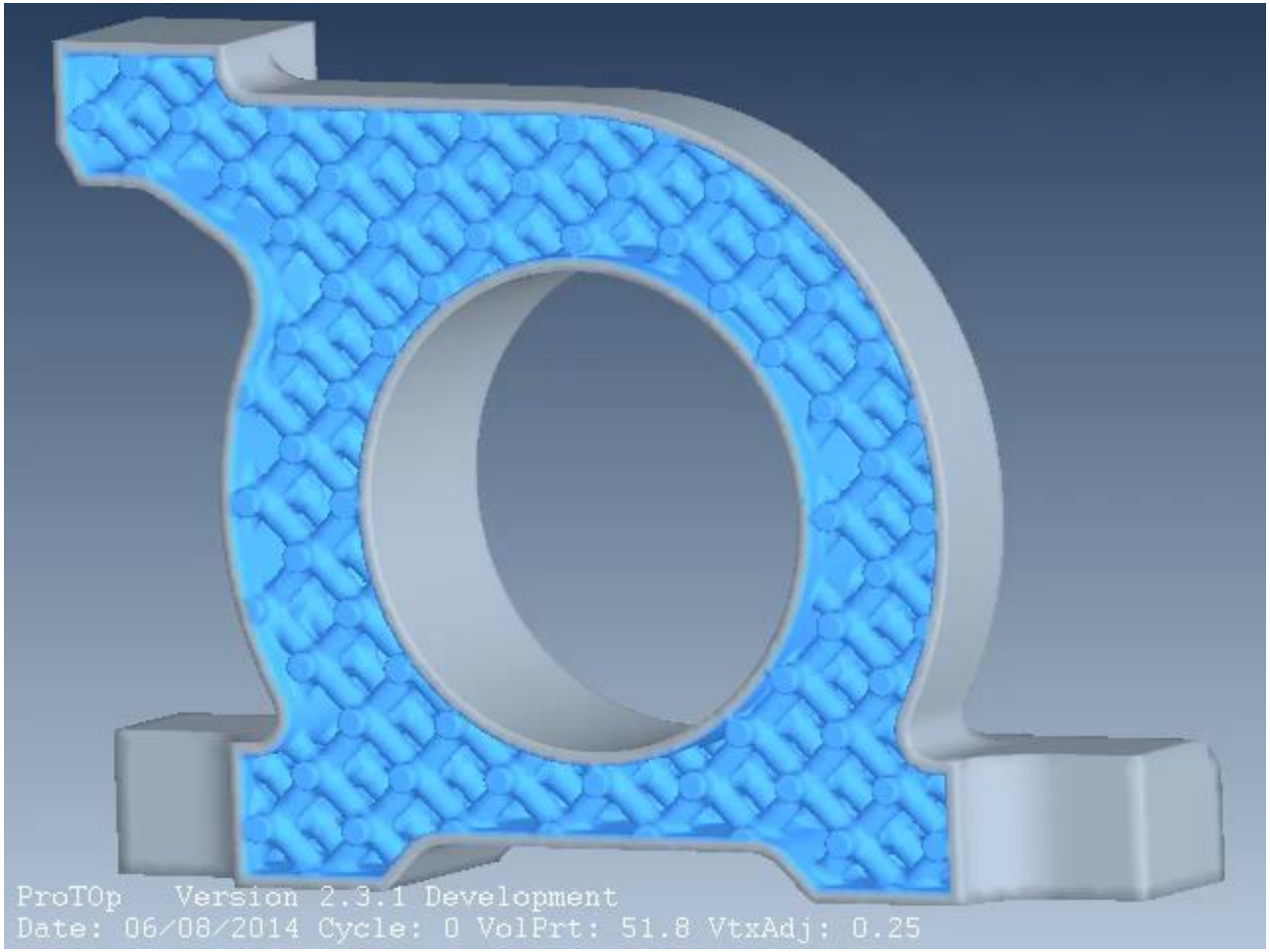
Animation, Pressure cover

Animation, Oil pan

Animation, Spiral bevel gear



Animation, Bearing holder



CAESS

Center for Advanced Engineering Software and Simulations

SILVER

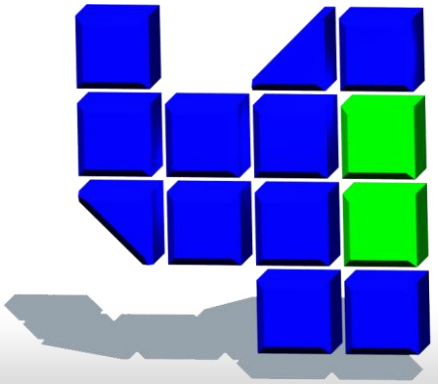
PTC® PartnerAdvantage

Thanks!

CAESS in collaboration with our partner

LRPS

LASER RAPID PRODUCTION SYSTEMS



 www.caess.eu