How the COMSOL App Builder Changed
My FEA Workflow

Beyond Apps



COMSOL Day Stuttgart

See what is possible with multiphysics modeling

By Perry Tauer

Mechanical Engineer – Pressure Vessel Design

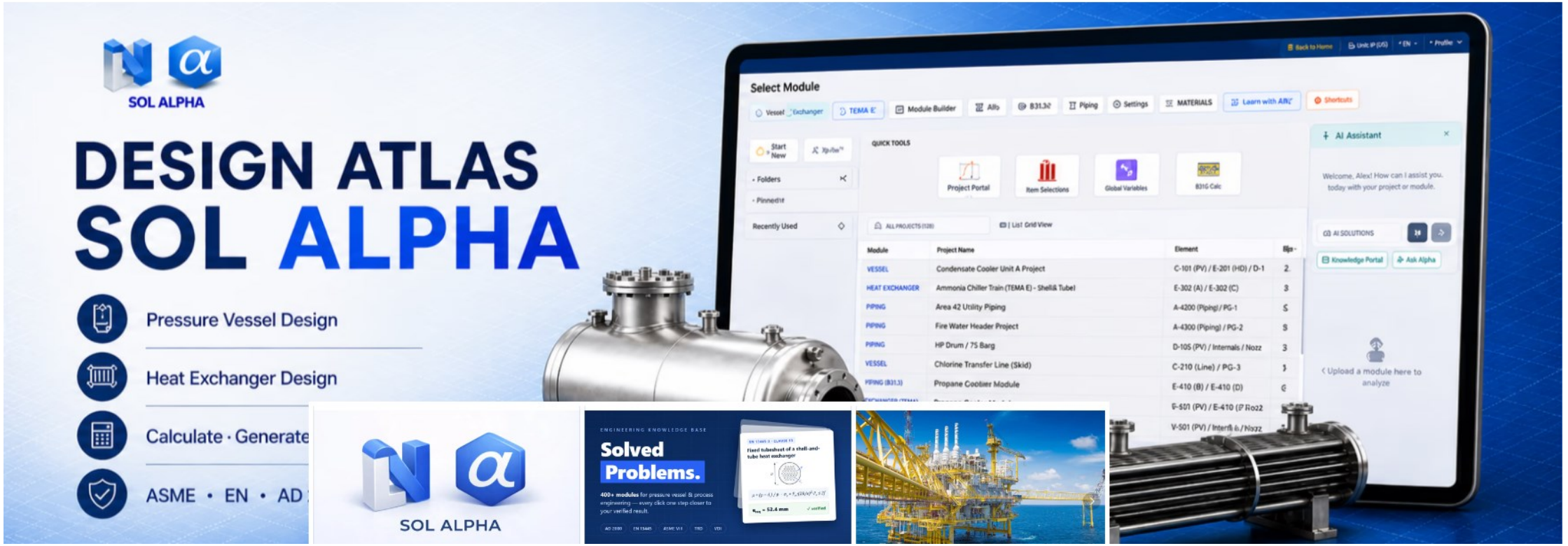
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From Design to Verification — all from a single Source



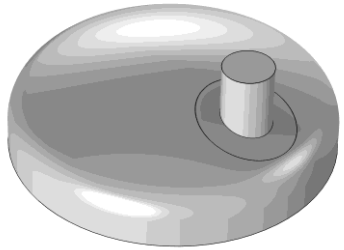
No switching between software tools — just one clearly structured workflow.

One task, one goal.

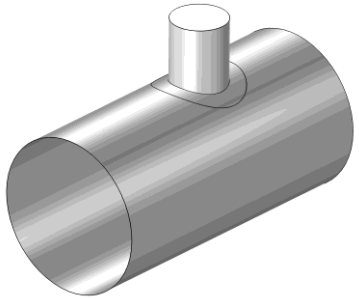
The combination of COMSOL and SOL-ALPHA makes it possible: review-ready documentation in just a few steps.

Pressure Vessel Design — Special Solution for Standard Parts

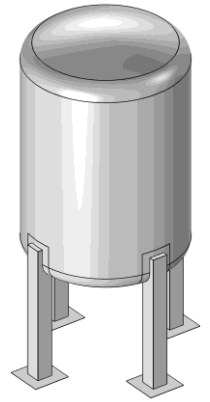
Strength proofs in pressure vessel design often follow similar principles, yet each has unique requirements. Using the flexible COMSOL Application Builder, we have developed tailored applications that enable fast and reliable design of commonly used components.



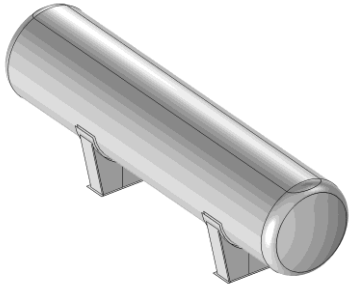
Head Nozzle



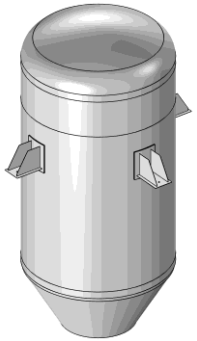
Cylinder Nozzle



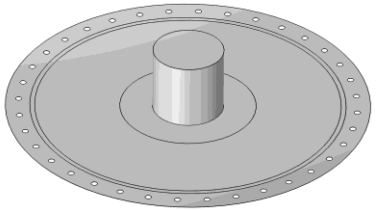
Leg Support



Saddle Support



Bracket Support



Flat Nozzle

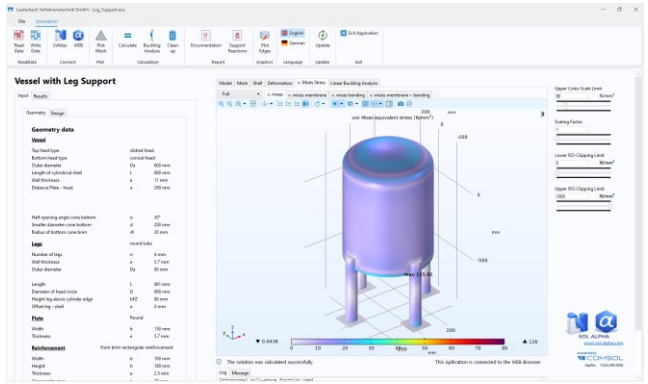
Fully automated FEA: Input — Calculation — Result Check

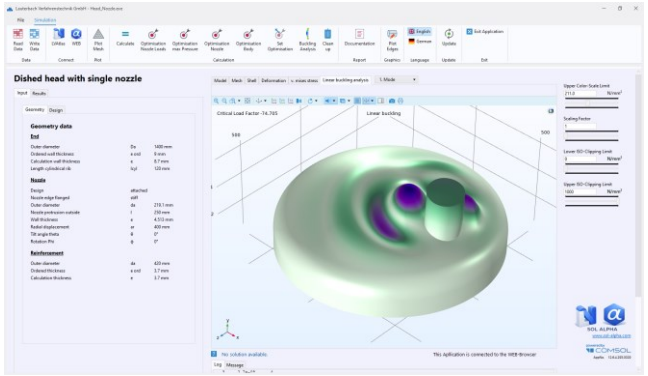


From data input to model generation and results.

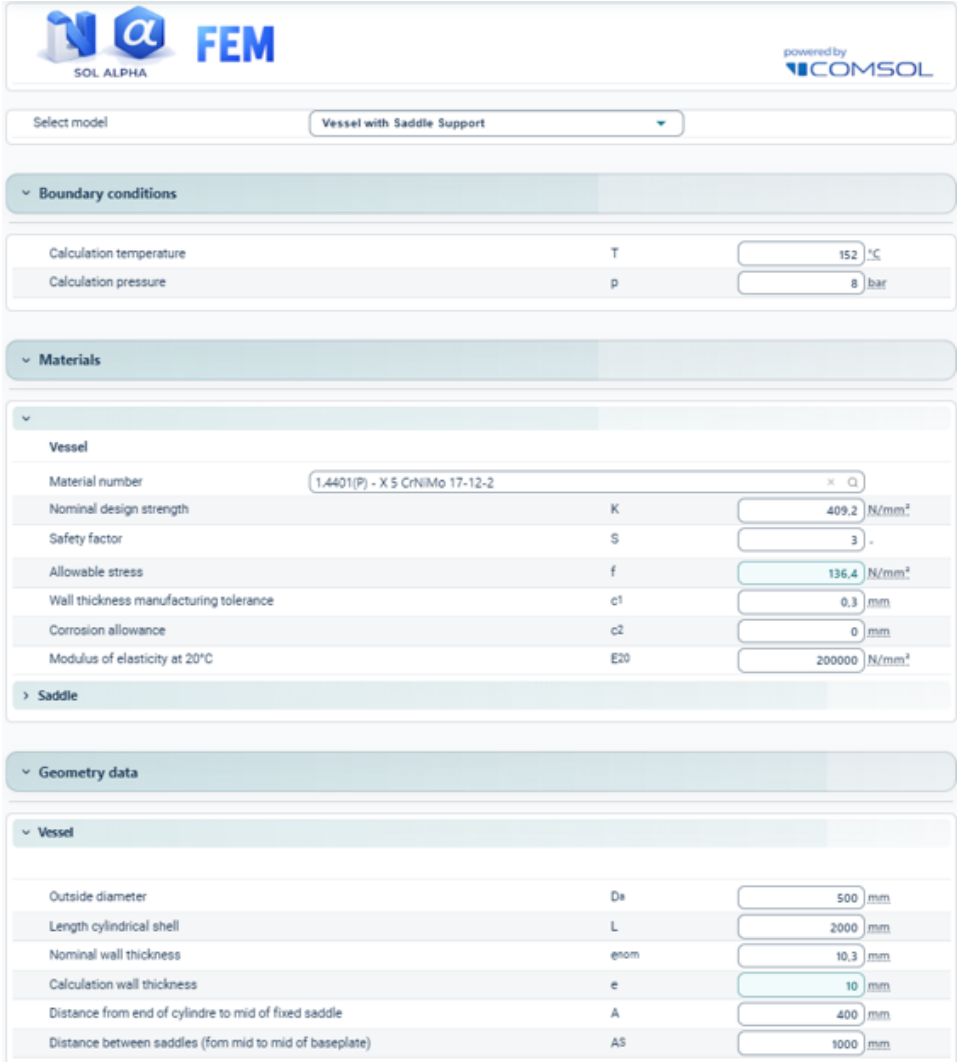
A clear workflow enables precise design, with every step fully automated.

More time to focus on what matters.





The Input Form — Start with Sol-Alpha

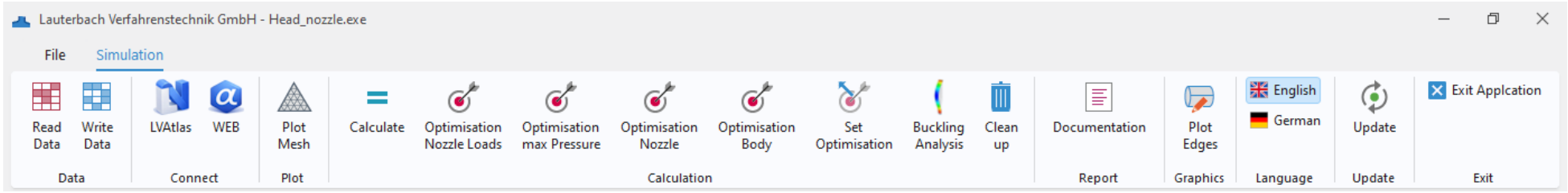


All calculation parameters are entered via the input form and then transferred to the application.

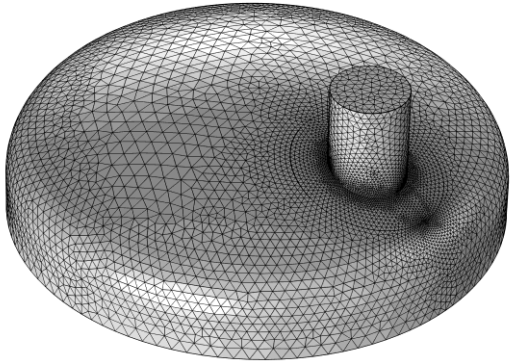
Comprehensive material databases eliminate the need for time-consuming searches through design codes.

SOL-ALPHA

The Application — one Framework, many Possibilities









The ribbon serves as the central control interface. It provides access to tasks such as connecting to Sol-Alpha, importing data, generating meshes and running various calculations.

The Application — Overview of Data Input ; Output of Results

Input | Results

Stress evaluation

	Stress	Allow. stress	Load
Body			
Close to nozzle / transition Reinforcement			
Primary membrane stress	14.11 N/mm²	211 N/mm²	6.69%
Primary + secondary stress	26.78 N/mm²	422 N/mm²	6.35%
Near transition brim			
Primary membrane stress	15.78 N/mm²	211 N/mm²	7.48%
Primary + secondary stress	25.3 N/mm²	422 N/mm²	6%
Brim area + board			
Primary membrane stress	20.13 N/mm²	211 N/mm²	9.54%
Primary + secondary stress	35.76 N/mm²	422 N/mm²	8.47%
General			
Primary membrane stress	9.97 N/mm²	140.67 N/mm²	7.09%
Total primary stress	14.98 N/mm²	211 N/mm²	7.1%
Nozzle			
Near head / reinforcement			
Primary membrane stress	20.65 N/mm²	198 N/mm²	10.4%
Primary and secondary stress	39.76 N/mm²	396 N/mm²	10%
General			
Primary membrane stress	6.94 N/mm²	132 N/mm²	5.26%
Total primary stress	13 N/mm²	198 N/mm²	6.57%
Reinforcement			
Near nozzle			
Primary	16.98 N/mm²	211 N/mm²	8.05%
Primary + secondary stress	25.57 N/mm²	422 N/mm²	6.06%
Near transition head			
Primary membrane stress	16.98 N/mm²	211 N/mm²	8.05%
Primary + secondary stress	25.57 N/mm²		6.06%
General			
Primary membrane stress	0 N/mm²	140.67 N/mm²	0%
Total primary stress	0 N/mm²	211 N/mm²	0%

Geometry | Design

Thermodynamic boundary conditions

Temperature	T	100 °C
Internal pressure	p	1 bar

Material

Modulus of elasticity of head	E	200000 N/mm²
Modulus of elasticity of nozzle	E	212000 N/mm²

Stress evaluation

Allowable stress head	f	140.7 N/mm²
Allowable stress on nozzle	f	132 N/mm²
Allowable stress Reinforcement	f	140.7 N/mm²

Additional loads at the nozzle

Reference plane loadacting	Intersection	
Reaction force at end of nozzle	consider	
Force in X-direction	Fx	-4800 N
Force in Y-direction	Fy	3500 N
Force in Z-direction	Fz	4300 N
Moment around X-axis	Mx	-1400 N·m
Moment around Y-axis	My	2100 N·m
Moment around Z-axis	Mz	2600 N·m

Optimisation (utilisation = 100 %)

Load increase factor		1
Maximum allowable pressure	pmax	0 bar

Mesh parameters

Element size	48 mm

Geometry | Design

Geometry data

End

Outer diameter	Da	1400 mm
Ordered wall thickness	e ord	9 mm
Calculation wall thickness	e	8.7 mm
Length cylindrical rib	lcyl	120 mm

Nozzle

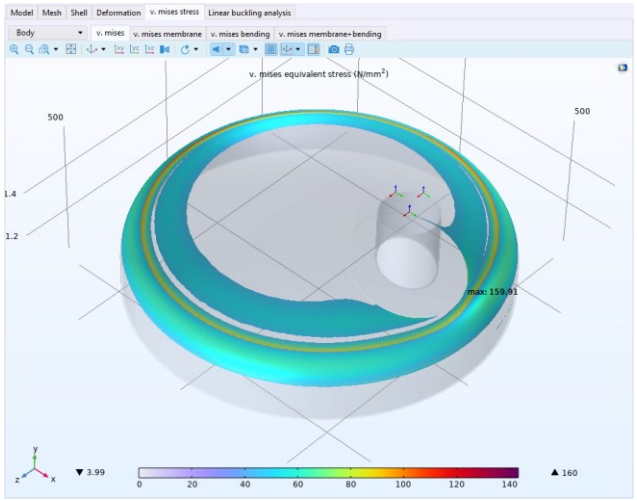
Design	attached	
Nozzle edge flanged	stiff	
Outer diameter	da	219.1 mm
Nozzle protrusion outside	l	250 mm
Wall thickness	e	4.513 mm
Radial displacement	ar	400 mm
Tilt angle theta	θ	0°
Rotation Phi	ϕ	0°

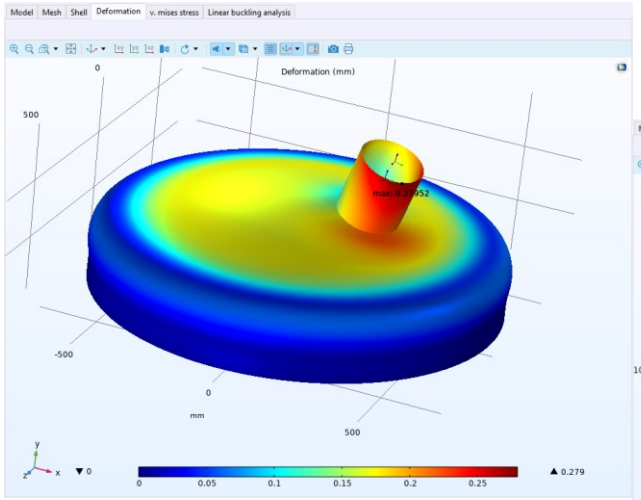
Reinforcement

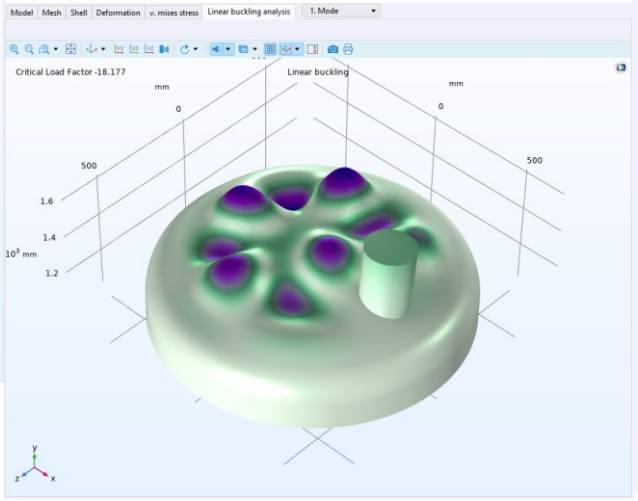
Outer diameter	da	420 mm
Ordered thickness	e ord	3.7 mm
Calculation thickness	e	3.7 mm

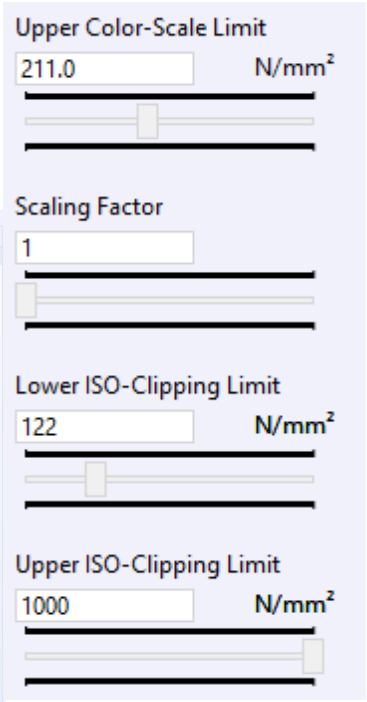
SOL-ALPHA

The Application — The Graphics Display ; all Result Plots for deeper Insight



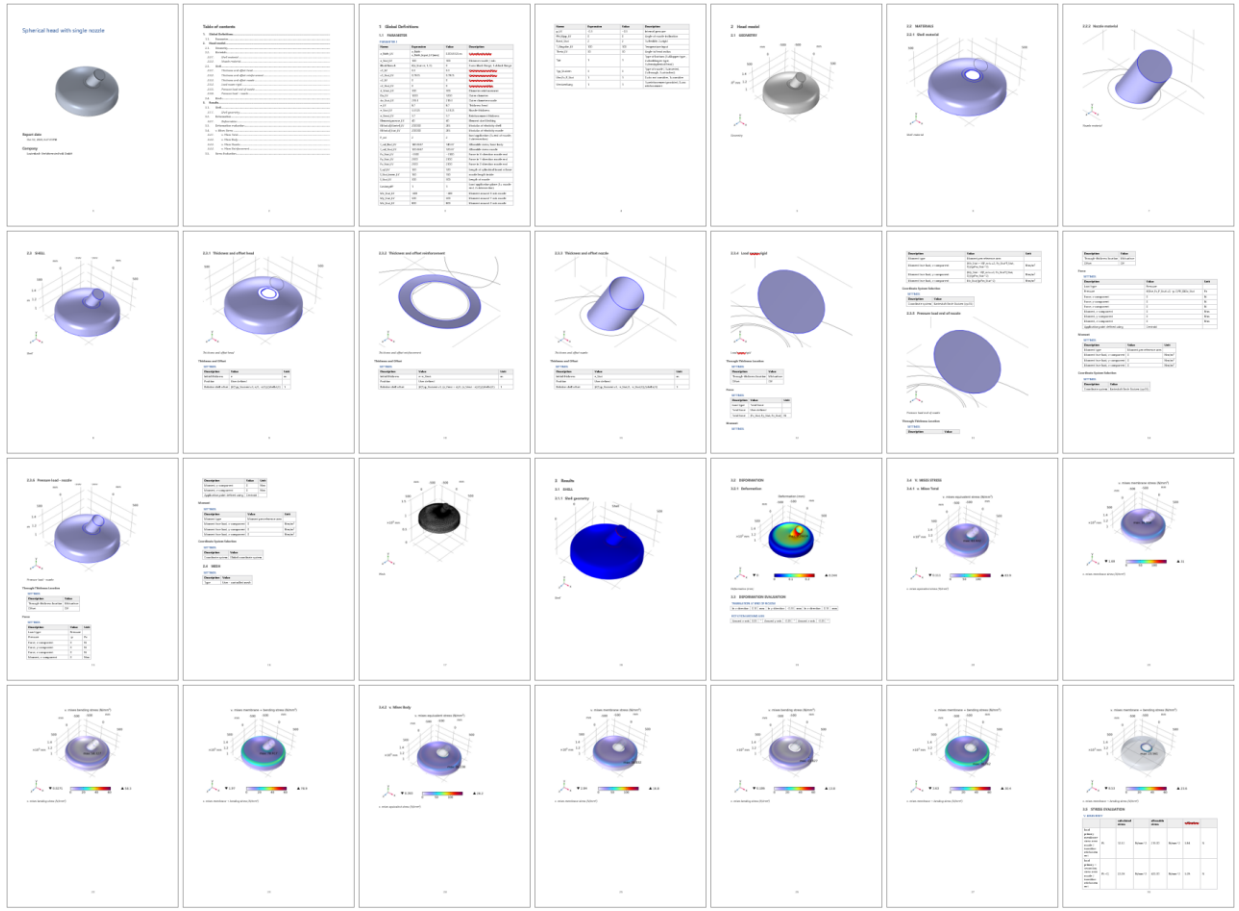






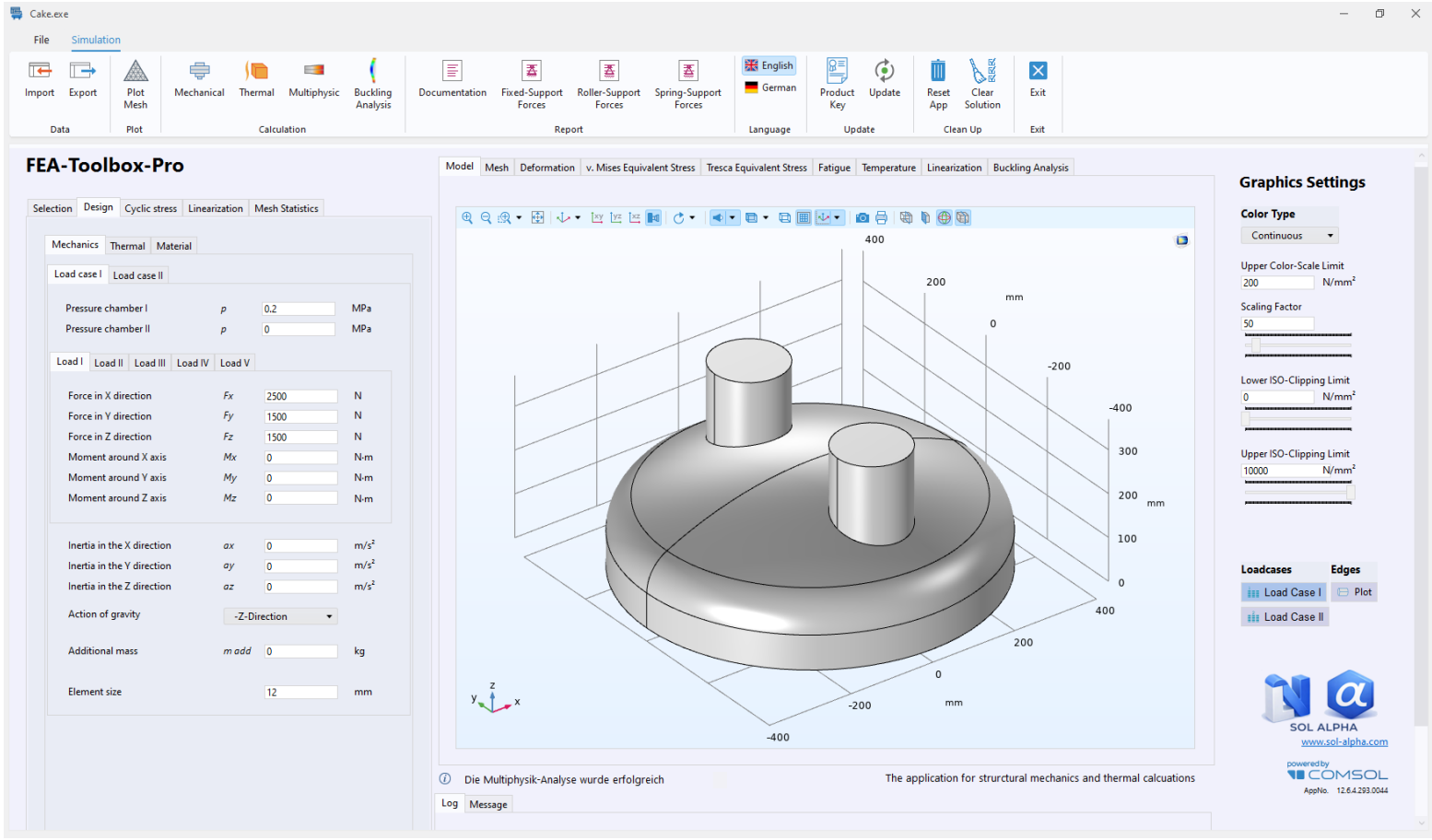
All result plots can be quickly customized via the graphics settings for results-focused documentation.

The Application — Documentation Output



Automatically generated documentation makes the FE analysis traceable and provides a sound basis for a fast and reliable review.

FEA-Toolbox Pro – an exceptional Tool for demanding Tasks

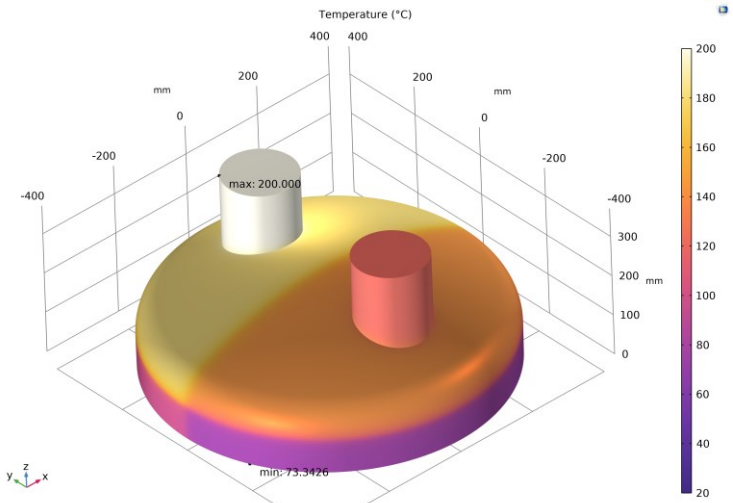


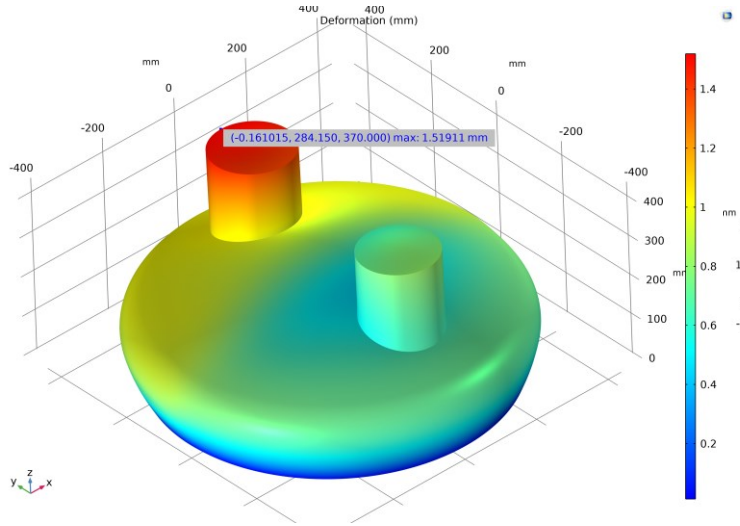
Our FEA-Toolbox Pro showcases the capabilities of the COMSOL Application Builder

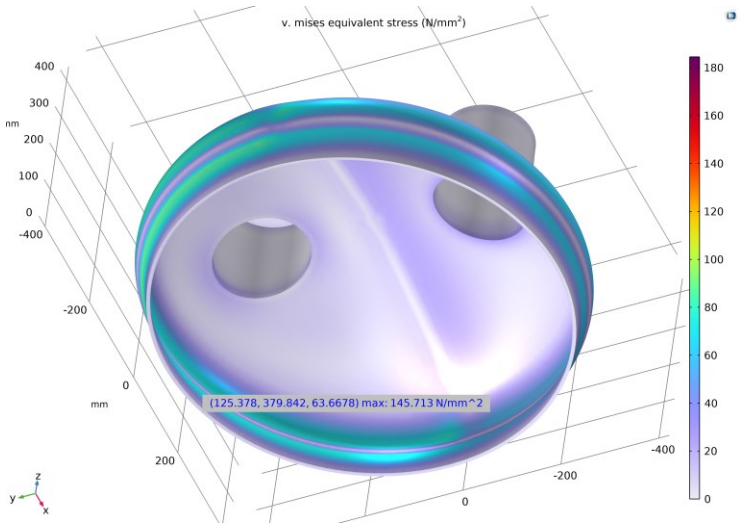
Workflow-based, semi-automated analysis

from design to strength proof.

FEA-Toolbox Pro – Multiphysics

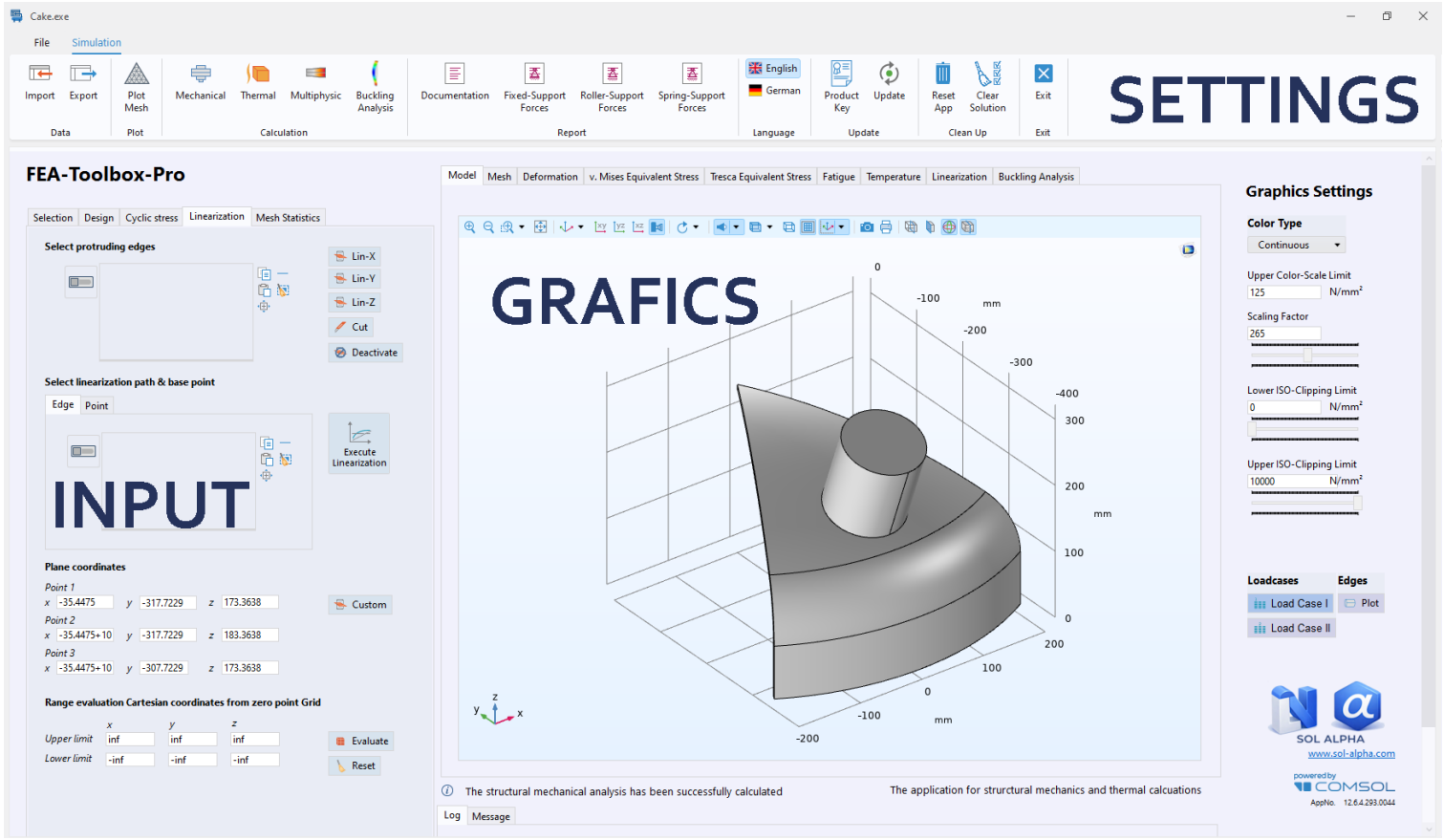






The tool supports structural, thermal and coupled thermomechanical analyses. Thermal expansion and the resulting stresses. All in one application.

FEA-Toolbox Pro – one Tool, one Workflow

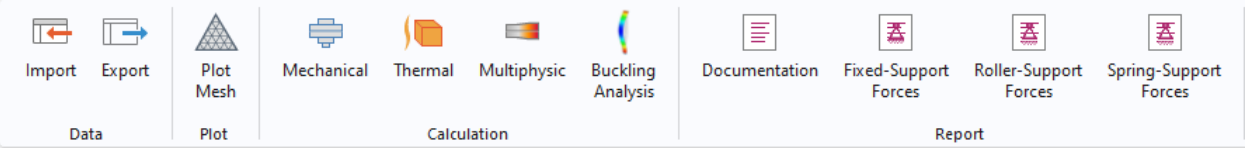


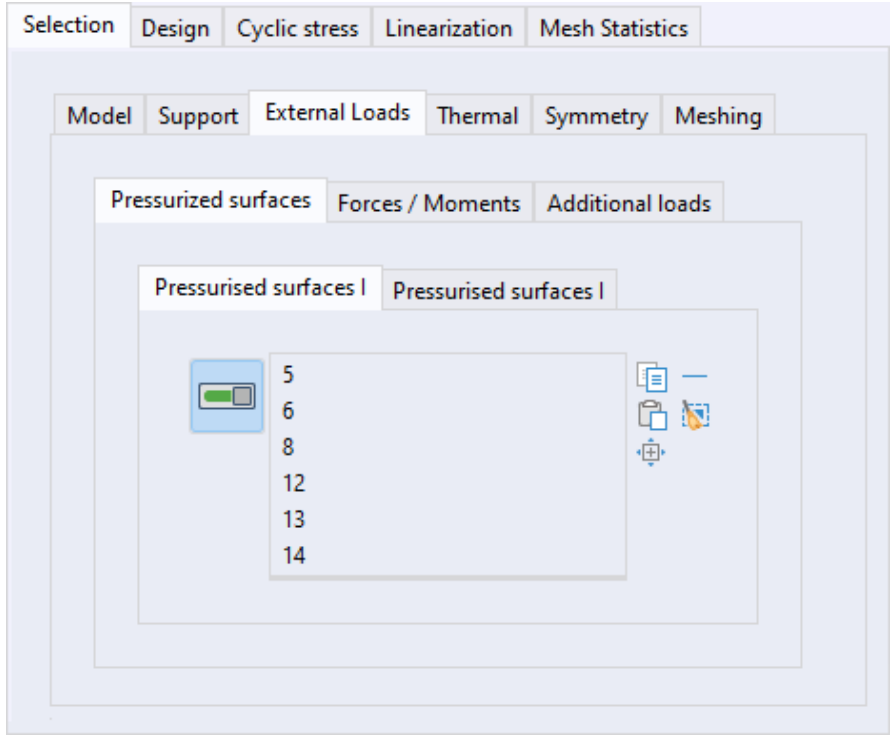
FEA-Toolbox Pro is available as a standalone application.

All boundary conditions and design parameters are entered directly in the app. The core layout remains unchanged:

input area, graphics display and settings.

FEA-Toolbox Pro – Ribbon Bar ; Selection Panel

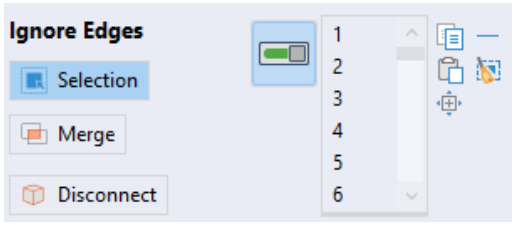


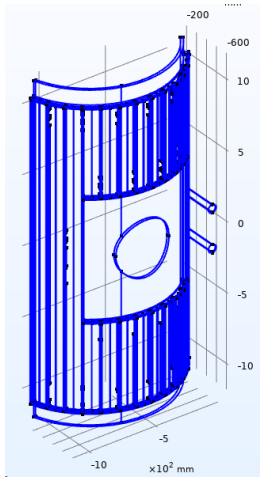


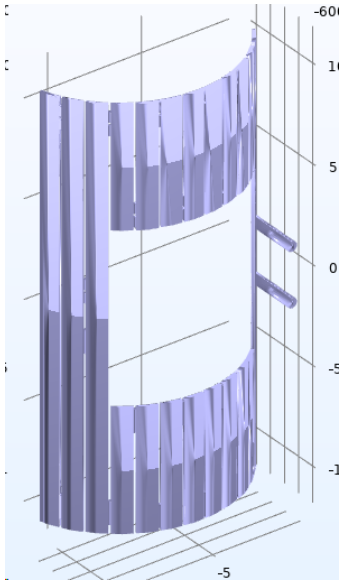
In FEA-Toolbox Pro, the ribbon also serves as the central control interface for running calculations and generating documentation.

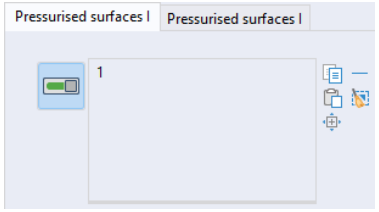
The selection panel serves as the central input interface. All boundary conditions can be defined easily here. The simulation environment is predefined, eliminating the need for time-consuming setup.

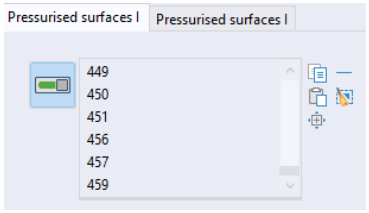
FEA-Toolbox Pro – Unique Tool ; Face Selection

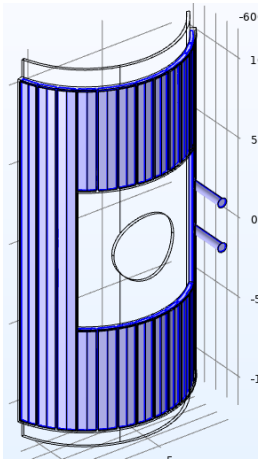








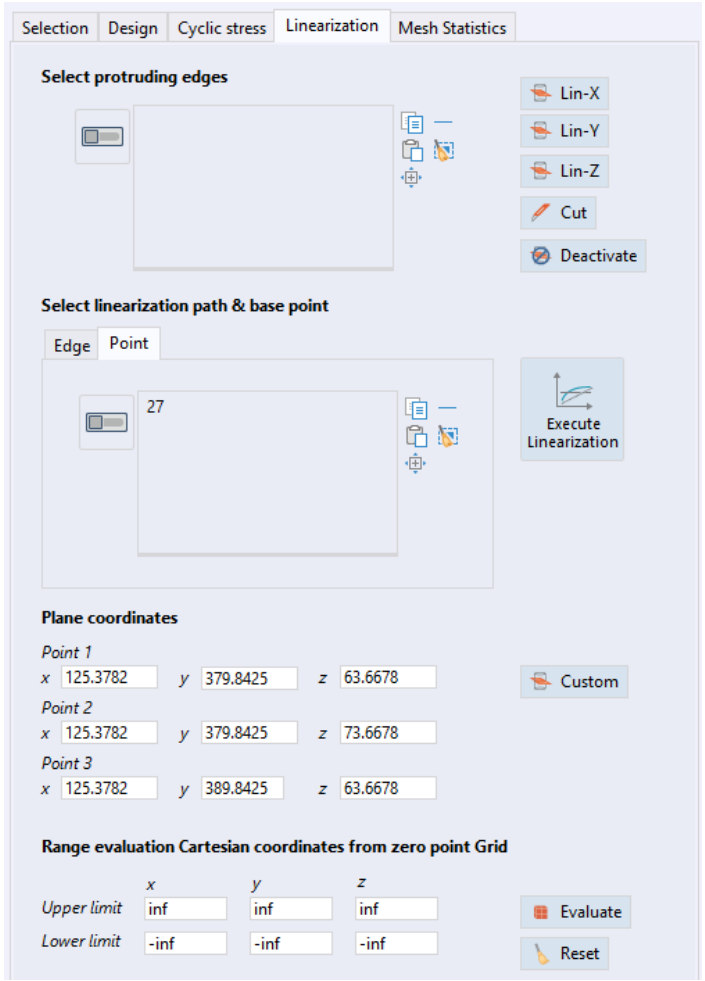


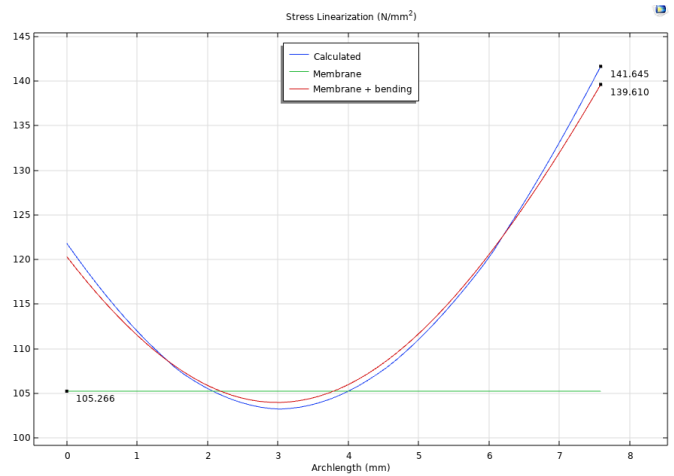


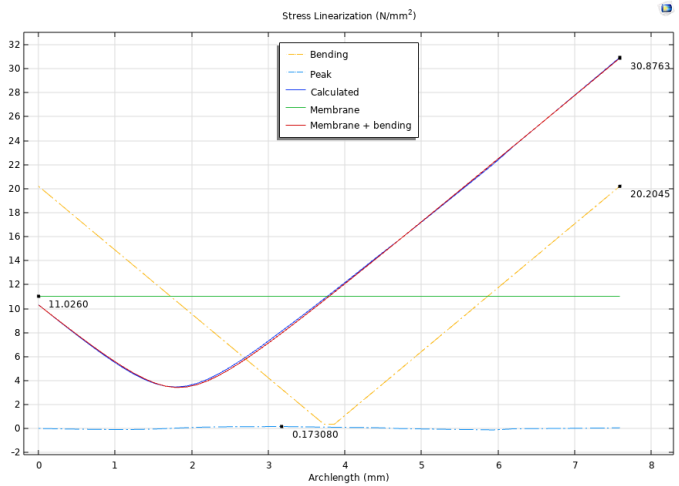
The versatility of the Application Builder and its Java integration enable the development of complex, tailored tools.

One example is a topology tool that allows hundreds of surfaces to be selected with just a few clicks.

FEA-Toolbox Pro – Unique Tool ; Linearization







The linearization tool enables code-compliant stress linearization at the point of maximum stress with just a few clicks. Flexible and precise – a tailored, indispensable tool for strength proofs.

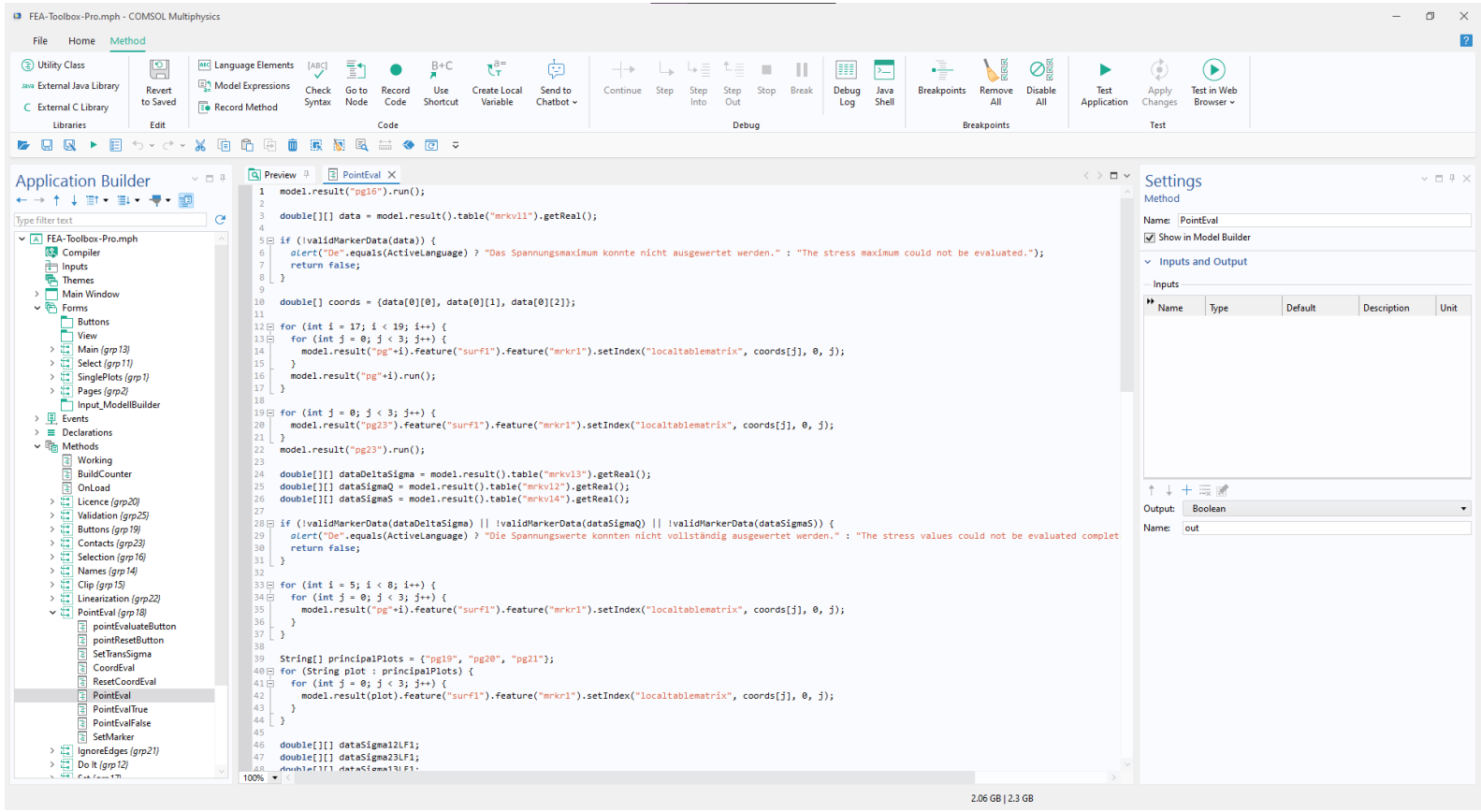
FEA-Toolbox Pro – Unique Tool ; Cyclic Stress

Point of the location of the critical equivalent stress range			
Coordinate	x	40.316	mm
Coordinate	y	397.963	mm
Coordinate	z	59.2025	mm
Equivalent stress range	$2\sigma va$	193.98	N/mm²
Equivalent mean stress	$\bar{\sigma}$	40.566	N/mm²
Largest principal stress difference	$max\ \Delta\sigma ij$	167.7	N/mm²
Stress range	$\Delta\sigma$	132.79	N/mm²
Maximum principal stress difference			
Max. principal stress difference 1-2	$\Delta\sigma 12\ max$	74.577	N/mm²
Max. principal stress difference 2-3	$\Delta\sigma 23\ max$	93.119	N/mm²
Max. principal stress difference 3-1	$\Delta\sigma 13\ max$	-35.62	N/mm²
Minumum principal stress difference 1-3			
Min. principal stress difference 1-2	$\Delta\sigma 12\ min$	27.063	N/mm²
Min. principal stress difference 2-3	$\Delta\sigma 23\ min$	8.5566	N/mm²
Min. principal stress difference 1-3	$\Delta\sigma 13\ min$	-167.7	N/mm²

Another feature is the determination of load parameters for fatigue calculations based on two load cases. The application automatically evaluates the relevant location and determines all relevant parameters.

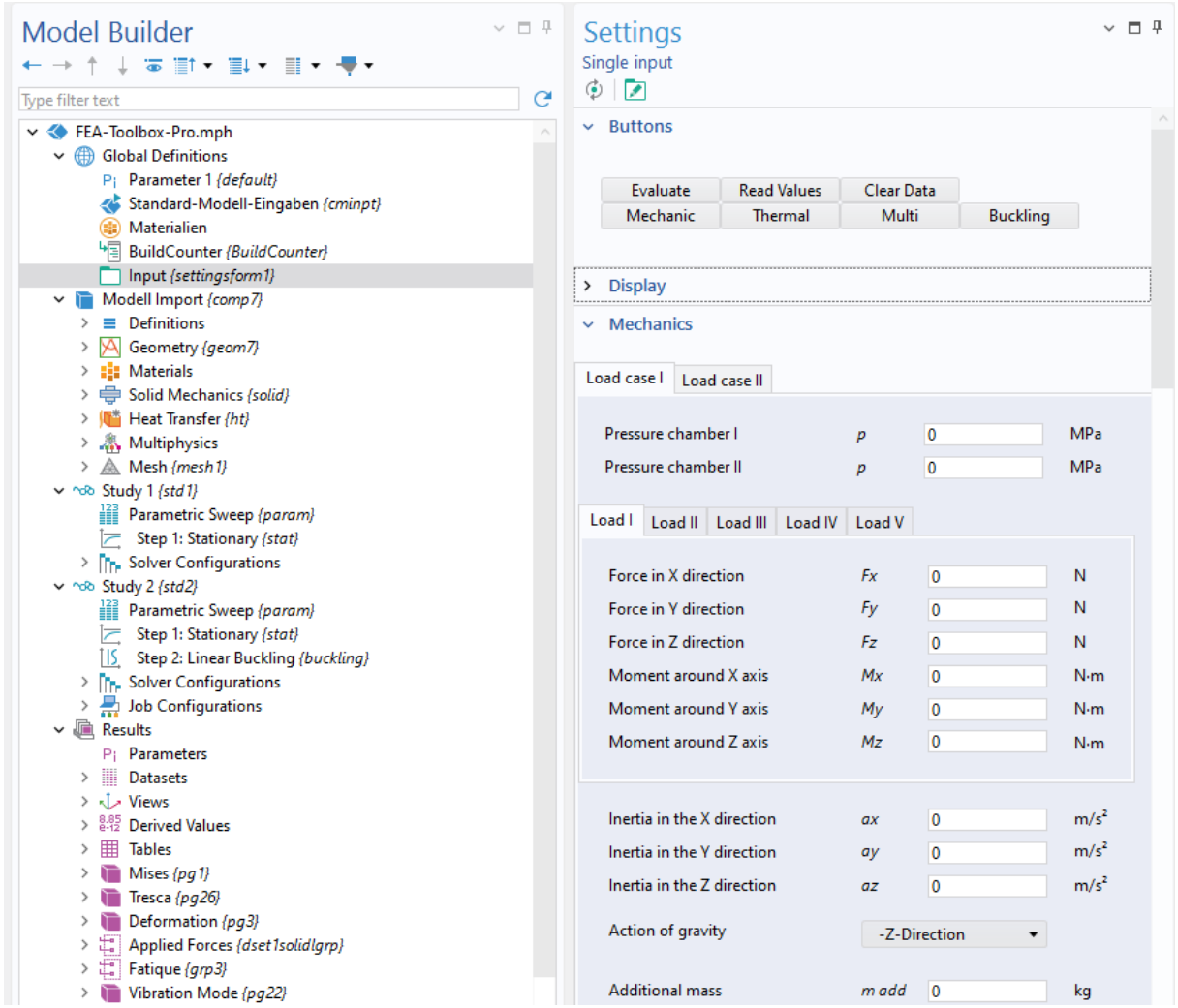
These can then be used to determine the allowable number of load cycles, for example in accordance with DIN EN 13445-3, Clause 18.

FEA-Toolbox Pro – Application Builder



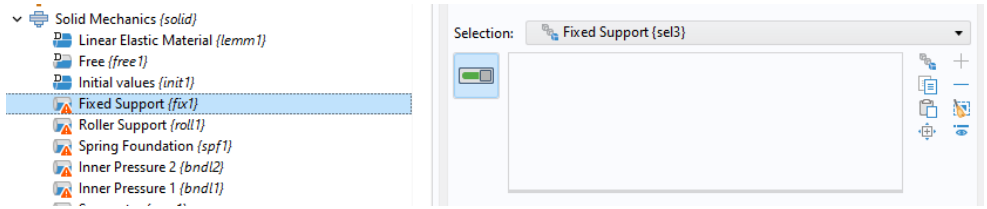
So far, I've shown how we use the Application Builder to create applications. But its impact goes further: it has also changed how we build and reuse our own simulation models.

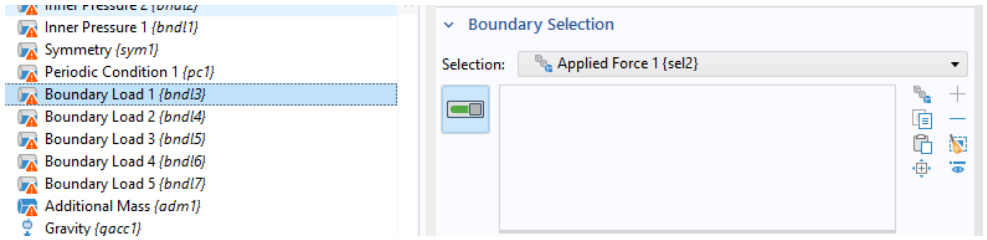
Application Builder – Model Builder

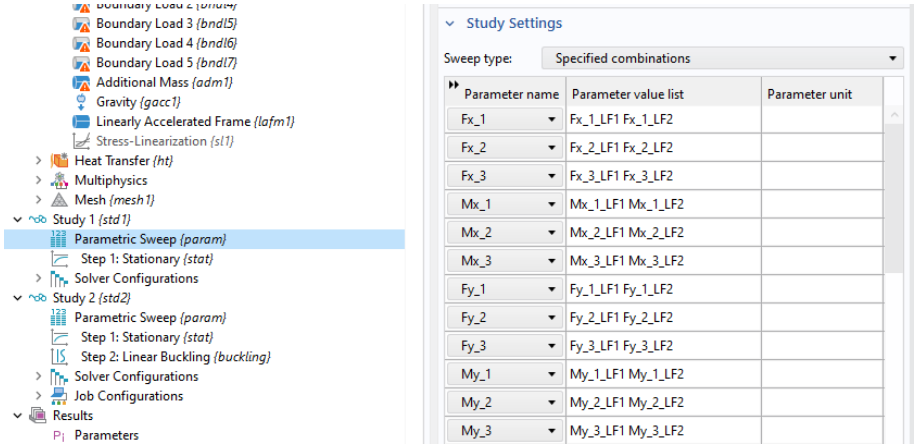


The Application Builder does not stand alone. Creating custom applications is a distinctive strength of COMSOL Multiphysics. Combining the Application Builder with the Model Builder takes FEA to a new level: predefined templates for complex calculations allow multiple analyses to be completed within just a few hours.

Model Builder – Application Builder







Prelinked boundary conditions and result plots provide a clear input structure that minimizes errors and saves valuable time. Model nodes with empty selections can remain in COMSOL without causing errors.

Populate the selections, enter the design parameters and start the calculation.

It couldn't be simpler.

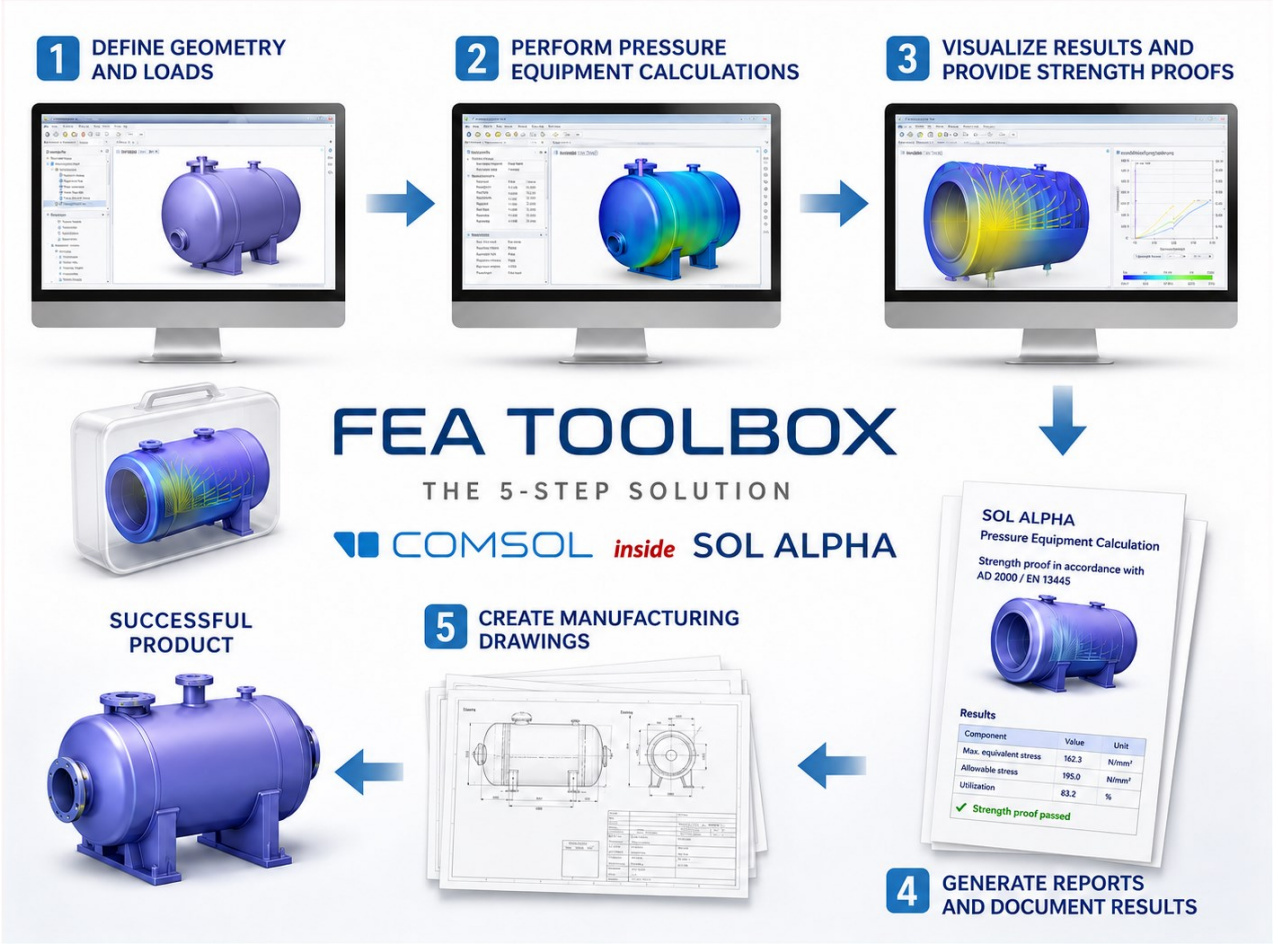
SOL-ALPHA

Time is precious – focus on what matters most

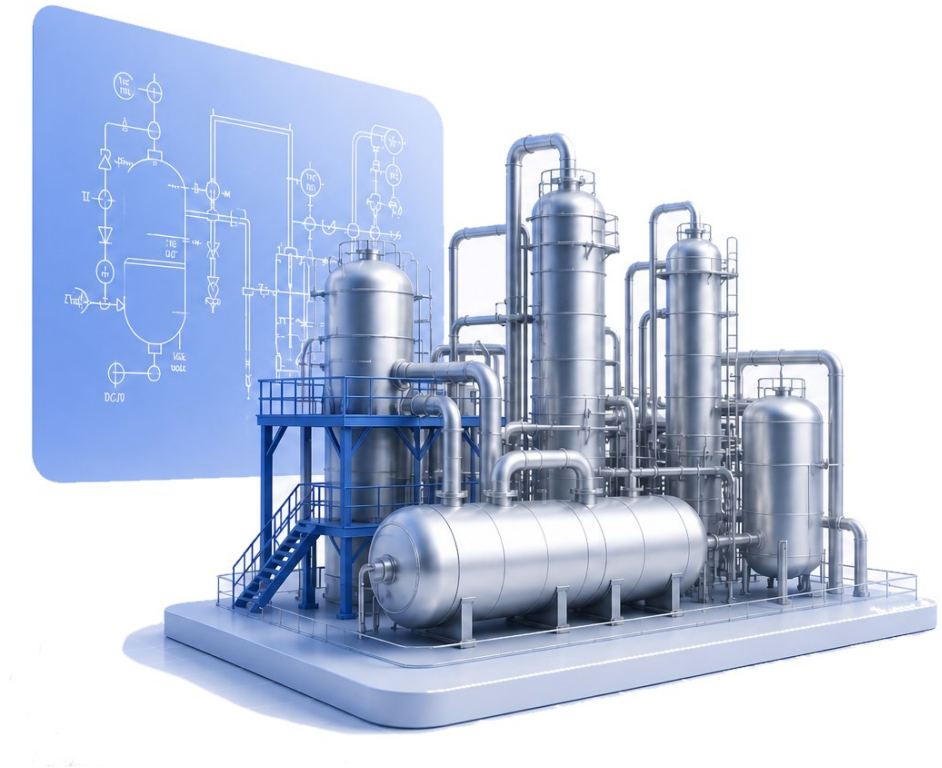
COMSOL has done more than just speed up my calculations.

It has changed how I think about reusable simulation models and automated computational workflows.

With the COMSOL Application Builder, quality creates value.



Thank You!



SOL ALPHA

COMSOL Day Stuttgart

See what is possible with multiphysics modeling