



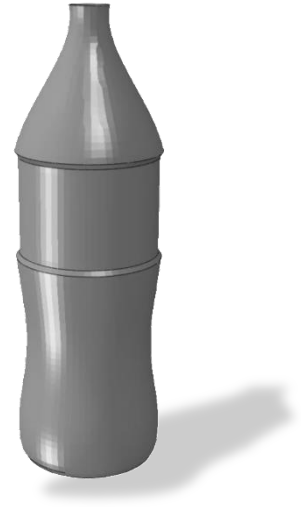
3DEXPERIENCE®

The Tosca Tuesdays

Tosca Tuesday #6

Basics: Sizing optimization

Example: Sizing optimization of a bottle

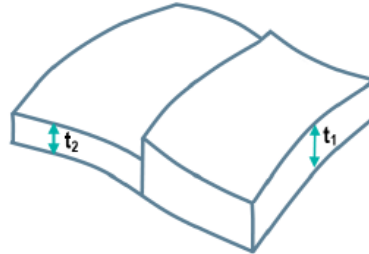


Basics | Sizing optimization

Fundamental concept

- **Design variables:** Thickness value of each shell element from a given design area
- **Goal:** Calculate an optimal thickness distribution of a given model under consideration of all boundary conditions, constraints and geometric restrictions
- **Result:** Optimized thickness value for all corresponding design elements

Design variables:
Thickness value of shell elements



Basics | Sizing optimization

Fundamental concept

- **Design variables:** Thickness value of each shell element from a given design area
- **Goal:** Calculate an optimal thickness distribution of a given model under consideration of all boundary conditions, constraints and geometric restrictions
- **Result:** Optimized thickness value for all corresponding design elements
- **Examples of possible tasks:**
 - Minimize volume / weight under displacement constraints
 - Minimize displacements under volume constraint
 - Maximize eigenfrequencies under certain constraints
 - Minimize total-strain energy (maximize stiffness) under volume constraint
 - ...

Basics | Sizing optimization

Fundamental concept

- **Design variables:** Thickness value of each shell element from a given design area
- **Goal:** Calculate an optimal thickness distribution of a given model under consideration of all boundary conditions, constraints and geometric restrictions
- **Result:** Optimized thickness value for all corresponding design elements
- **Possible geometric restrictions:**

Cluster groups

Frozen areas

Shell thickness bounds

Symmetry restrictions

Tosca Tuesday #6

Basics: Sizing optimization

Example: Sizing optimization of a bottle

Example | Bottle

Get started ...

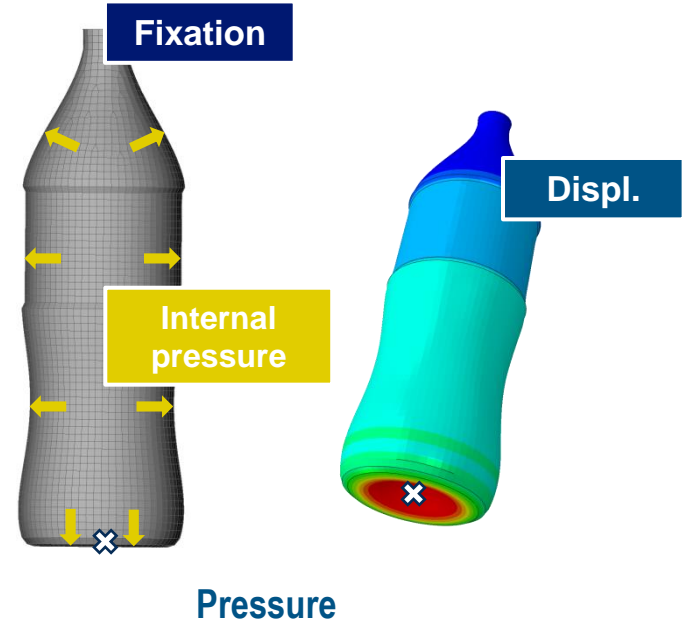
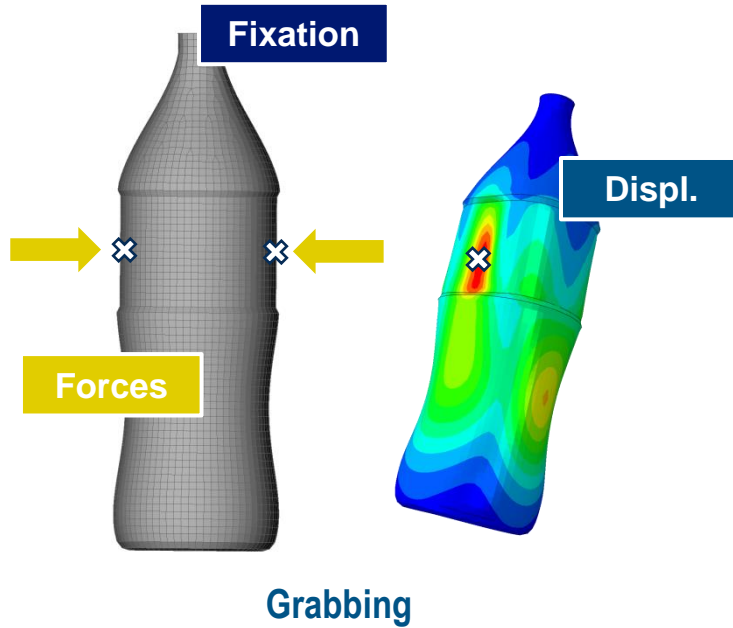
- ▶ Start Abaqus CAE (at least version 6.13, preferable 6.13-4)
- ▶ File → Import → Model → “bottle.inp”
- ▶ File → Set Work Directory → Choose Directory



Example | Bottle

Basic model: Loading and boundary conditions

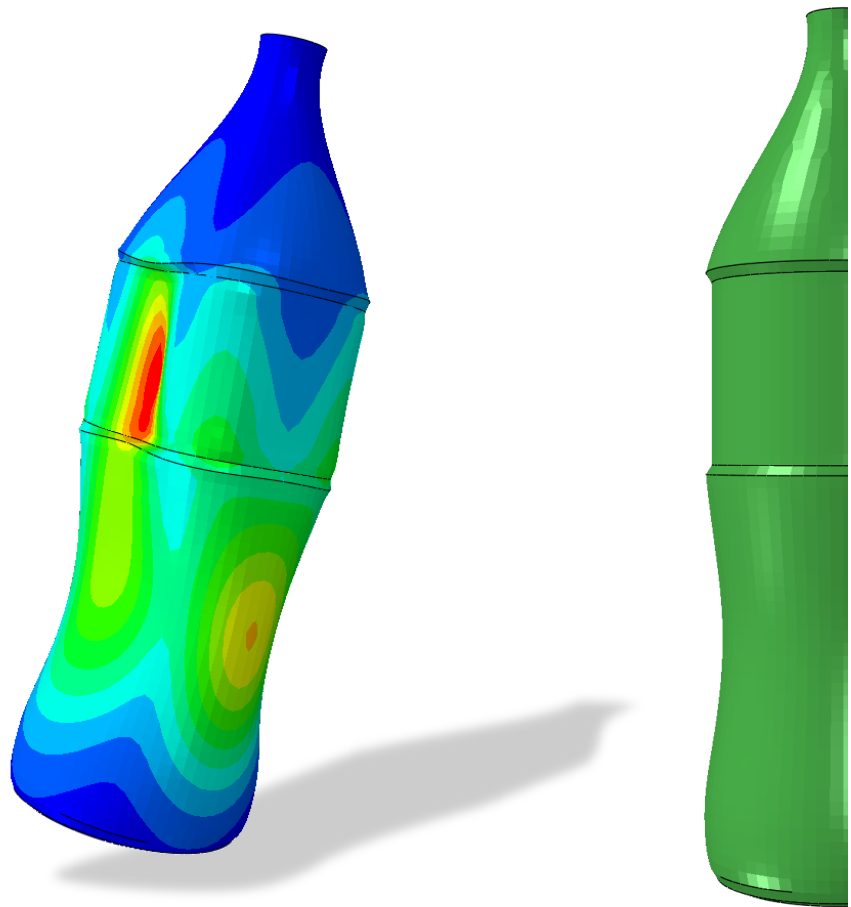
⊗ Nodes for displacement constraints



Example | Bottle

Sizing Optimization: Setup

- **Objective function**
 - Minimize weight
- **Geometric restrictions**
 - Rotational symmetry
 - Boundaries for thickness values
 - Cluster groups

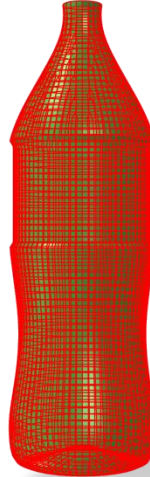


Example | Bottle

Sizing Optimization: Used element sets



Complete model



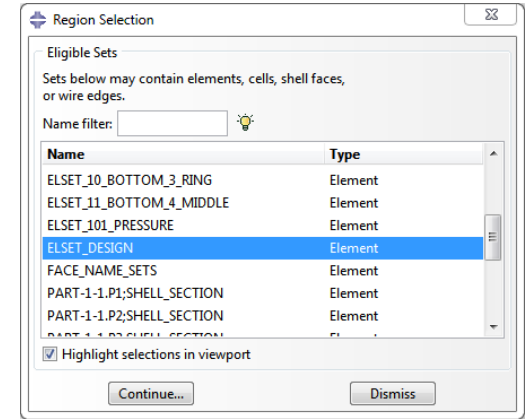
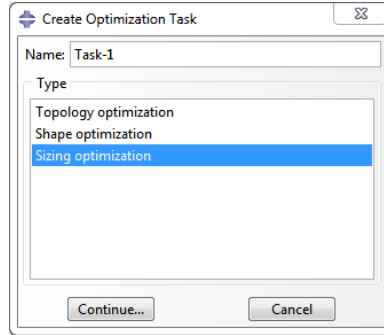
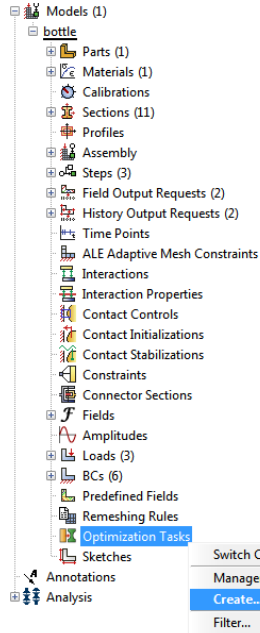
Design elements



Cluster groups

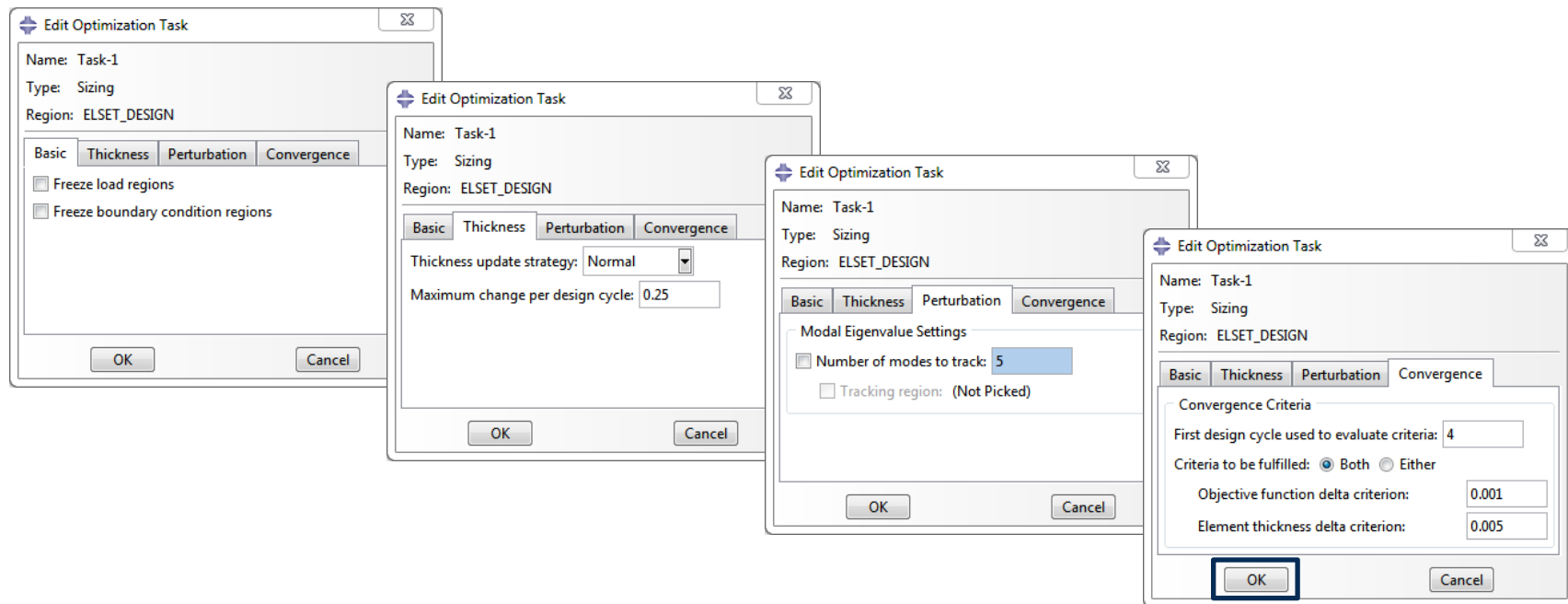
Example | Bottle

Step 1: Sizing optimization task



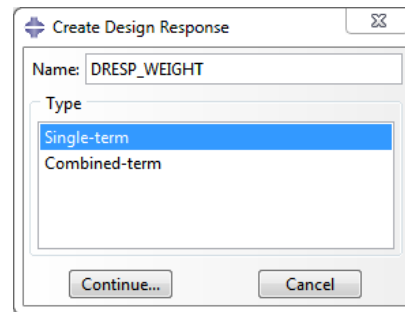
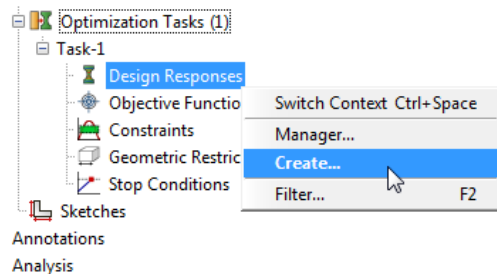
Example | Bottle

Step 1: Sizing optimization task – Default settings



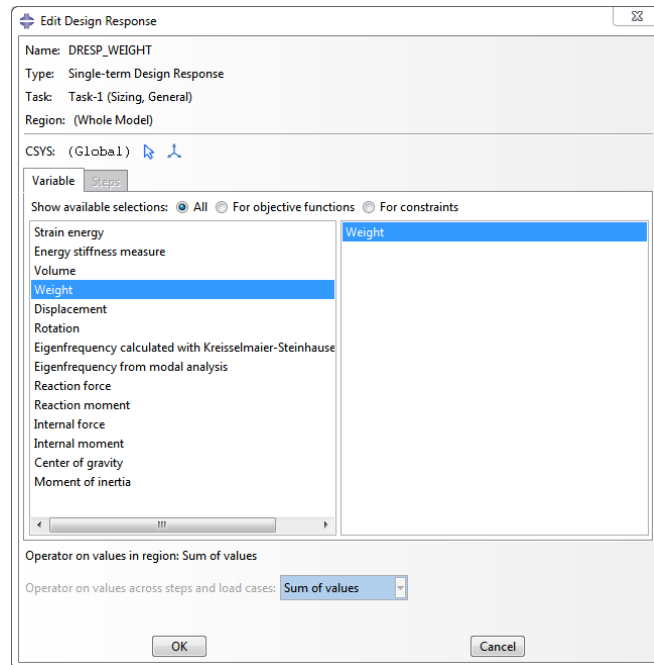
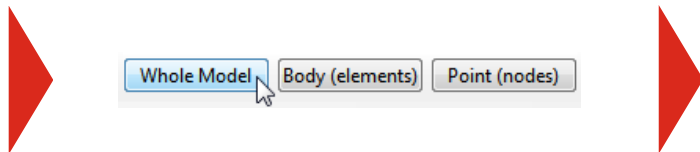
Example | Bottle

Step 2: Design response for weight



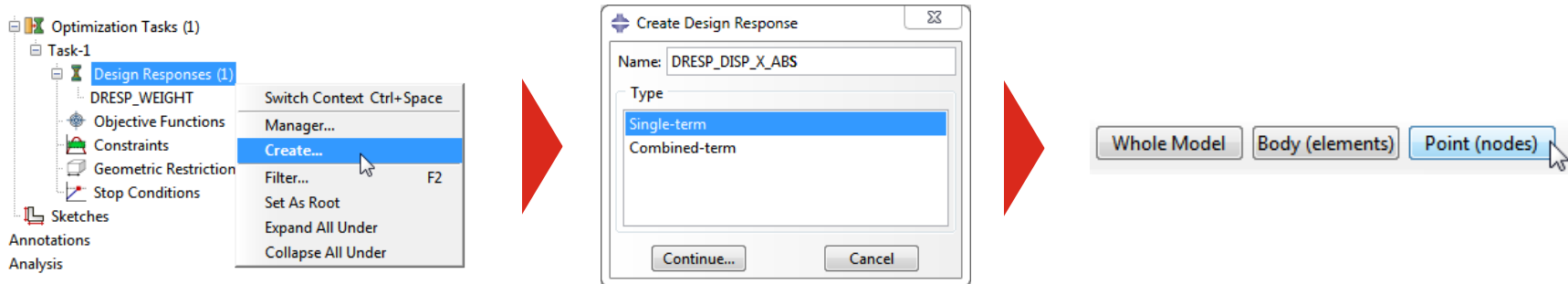
Example | Bottle

Step 2: Design response for weight



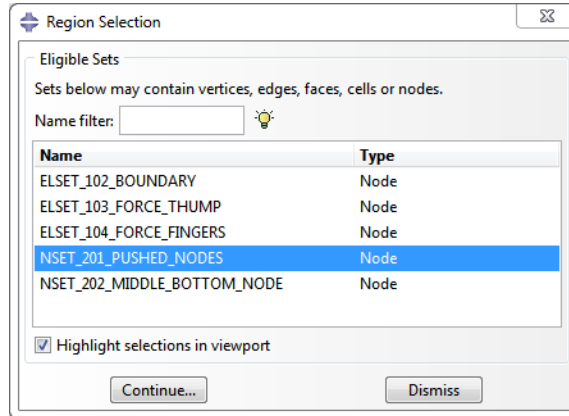
Example | Bottle

Step 3: Design response for displacement (Grabbing)



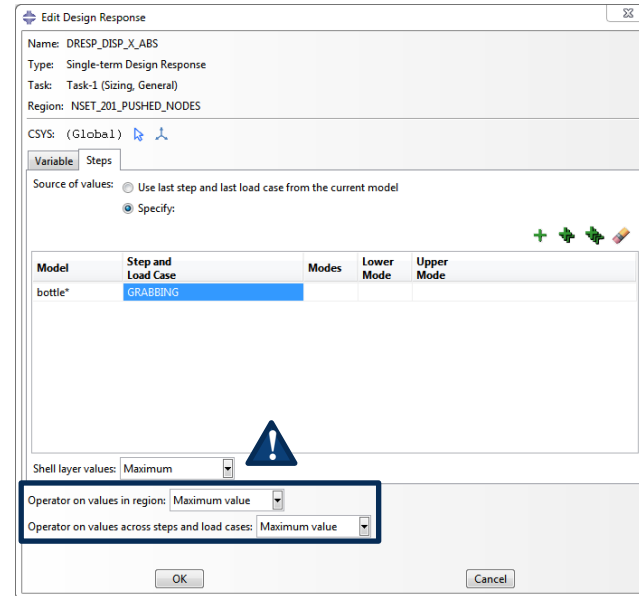
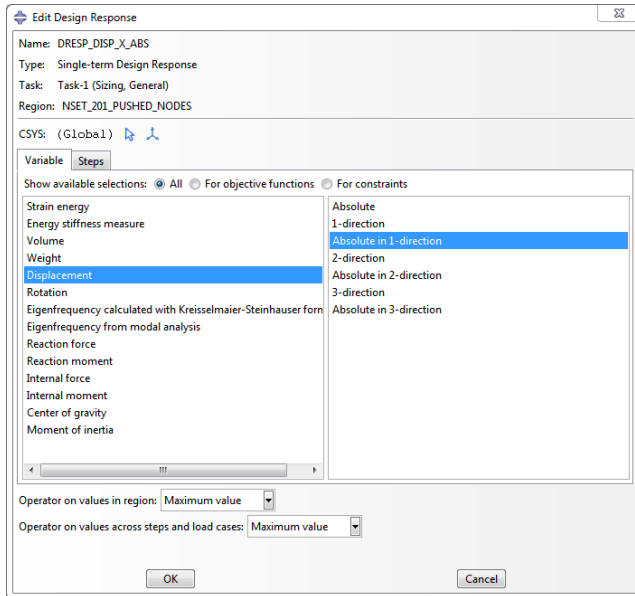
Example | Bottle

Step 3: Design response for displacement (Grabbing)



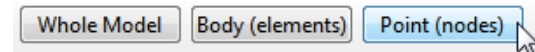
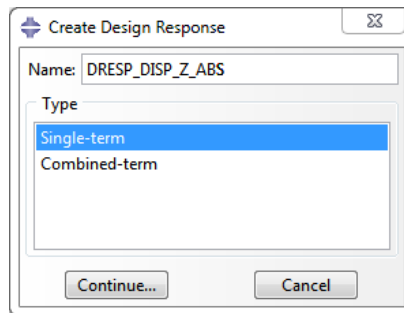
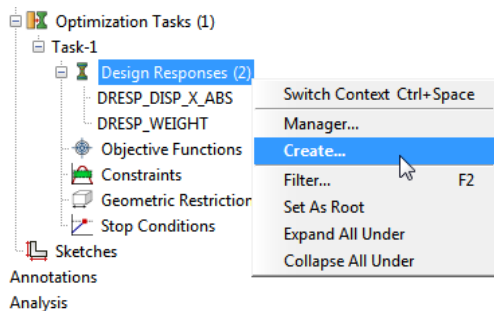
Example | Bottle

Step 3: Design response for displacement (Grabbing)



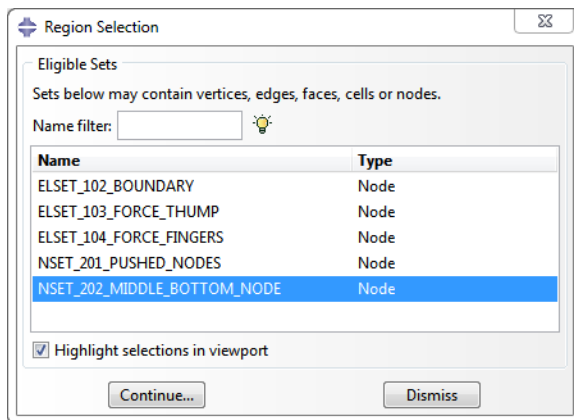
Example | Bottle

Step 4: Design response for displacement (Pressure)



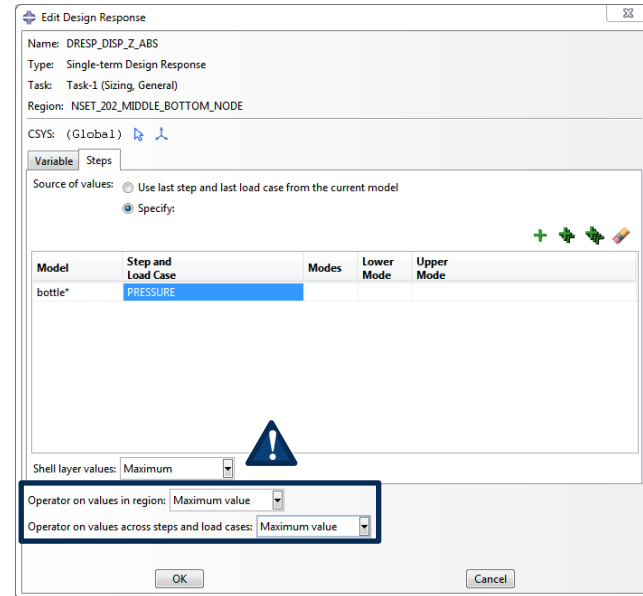
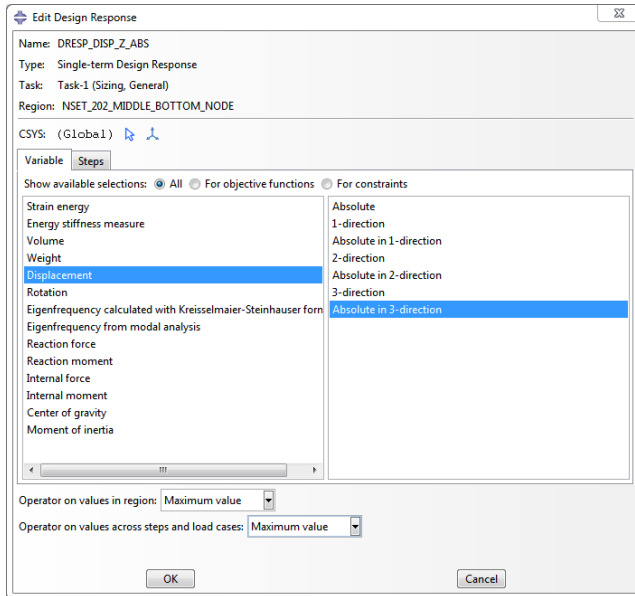
Example | Bottle

Step 4: Design response for displacement (Pressure)



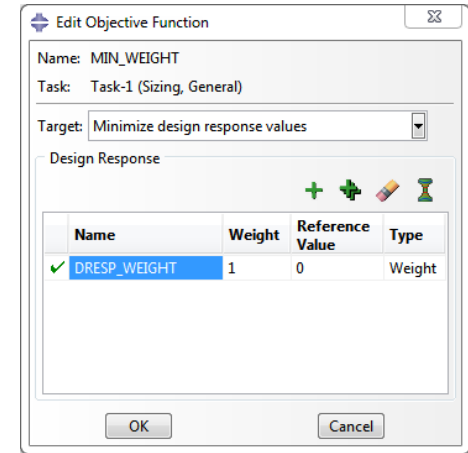
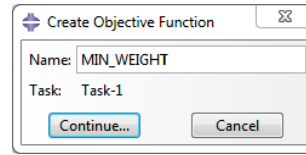
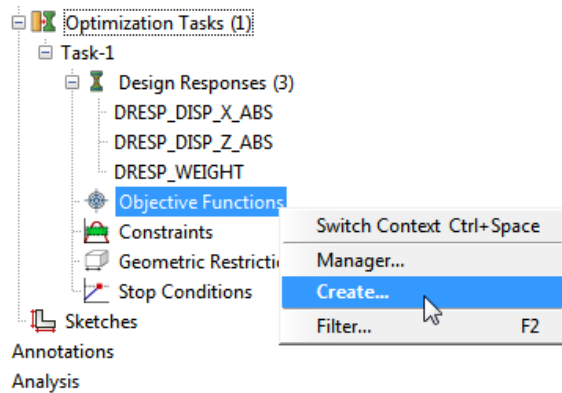
Example | Bottle

Step 4: Design response for displacement (Pressure)



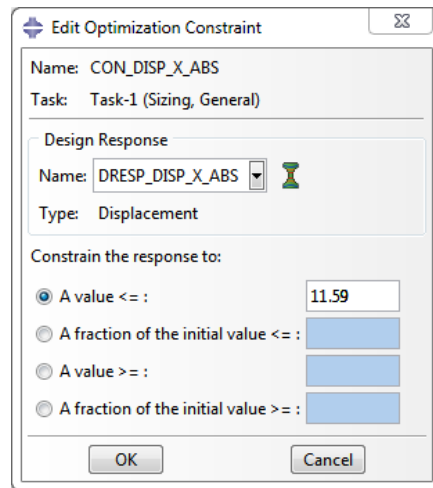
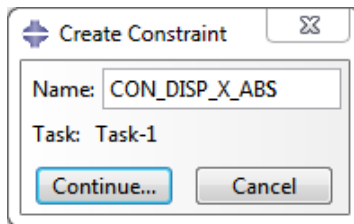
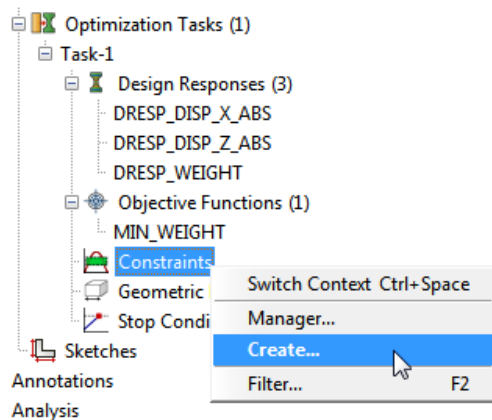
Example | Bottle

Step 5: Objective function (→ Minimize weight)



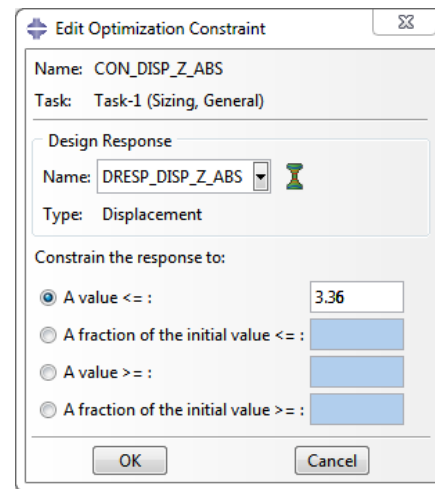
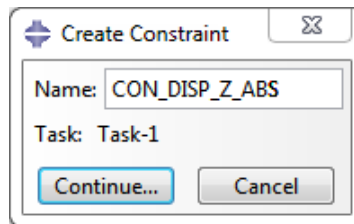
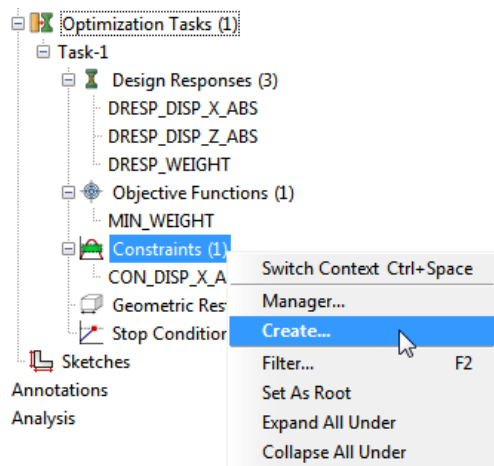
Example | Bottle

Step 6: Constraint for displacement (Grabbing)



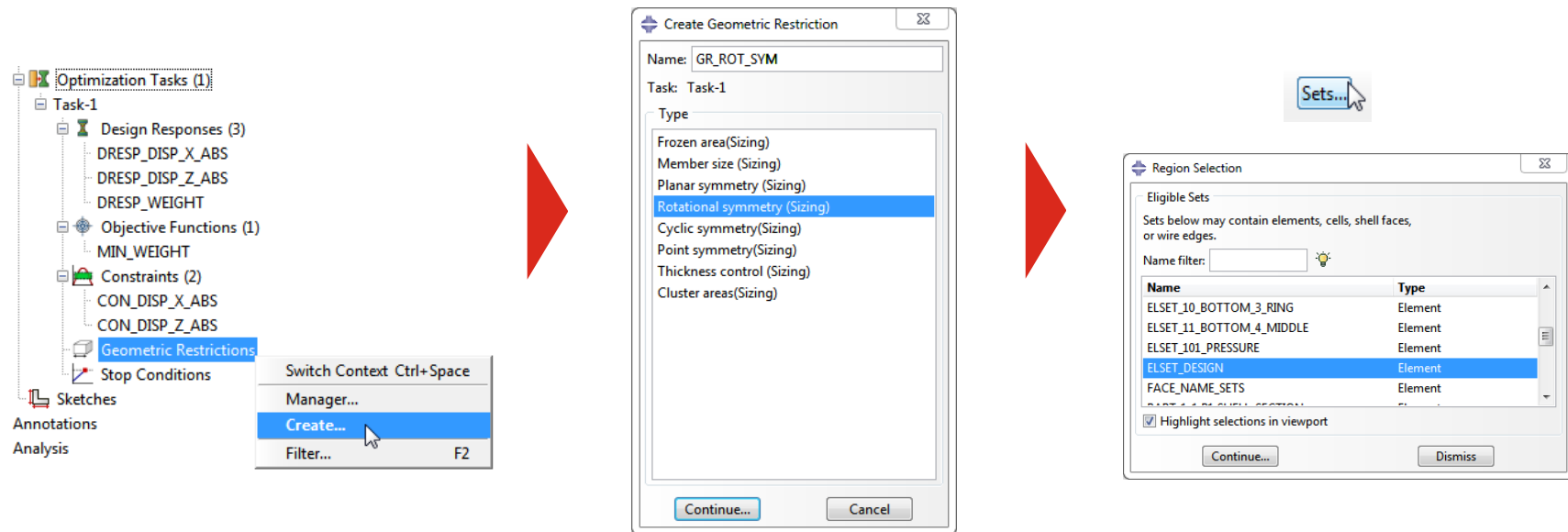
Example | Bottle

Step 7: Constraint for displacement (Pressure)



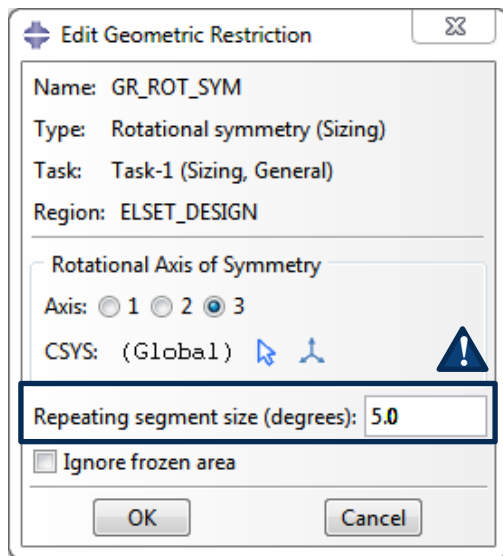
Example | Bottle

Step 8: Geometric restriction for rotational symmetry



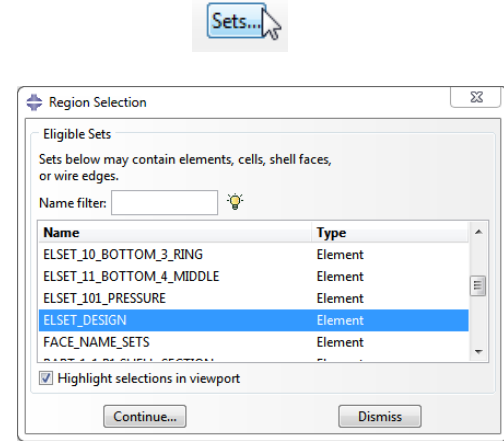
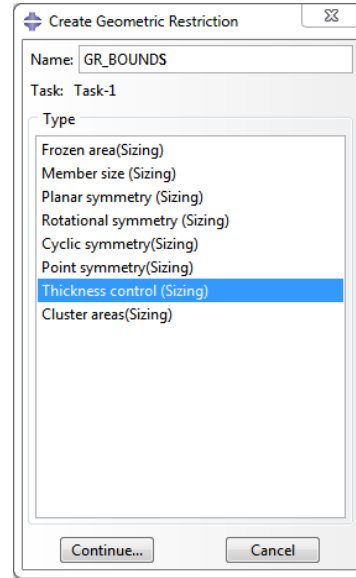
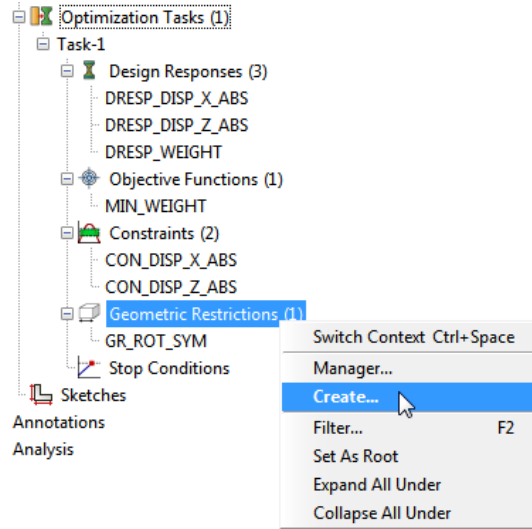
Example | Bottle

Step 8: Geometric restriction for rotational symmetry



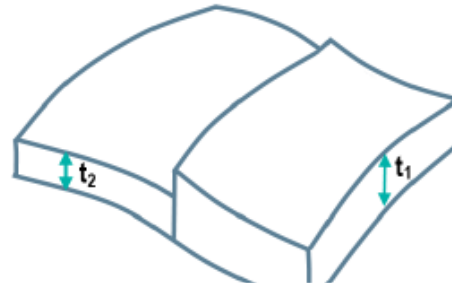
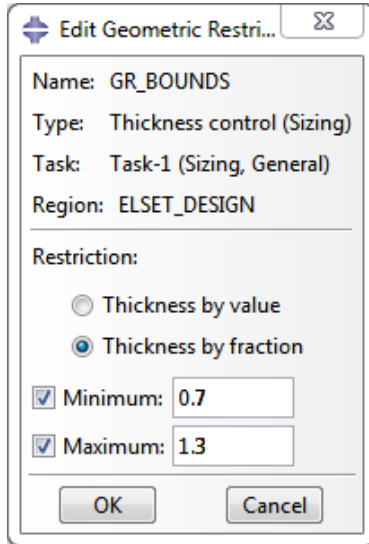
Example | Bottle

Step 9: Geometric restriction for thickness bounds



Example | Bottle

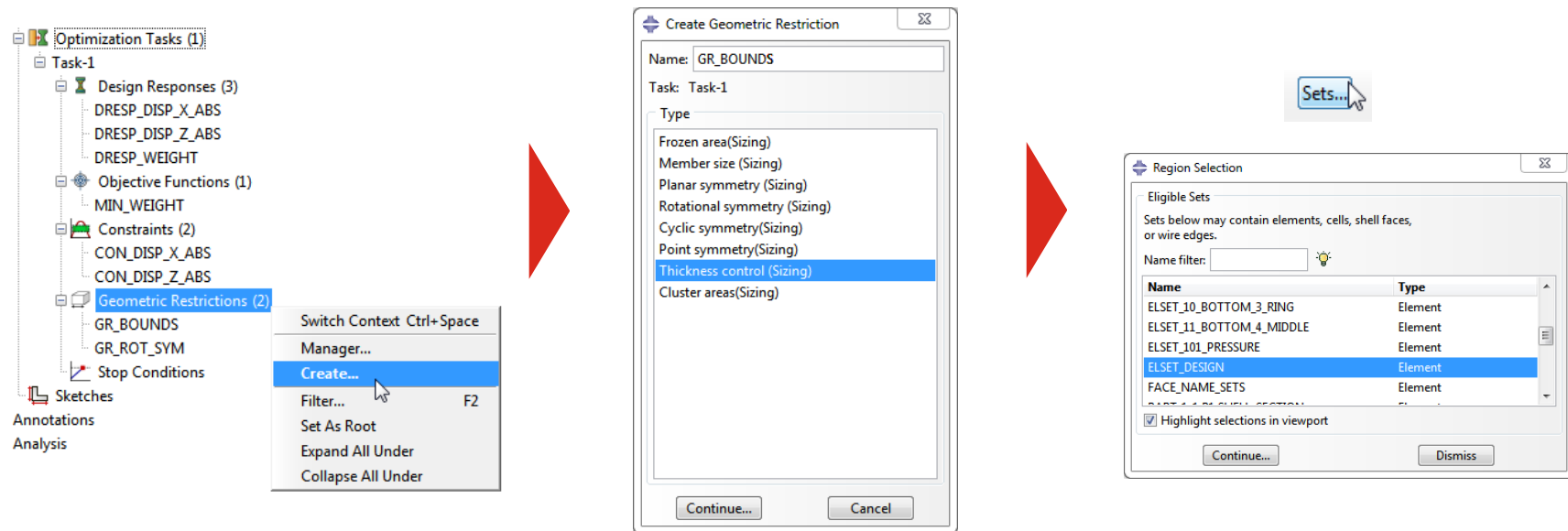
Step 9: Geometric restriction for thickness bounds



$$0.7t \leq t \leq 1.3t$$

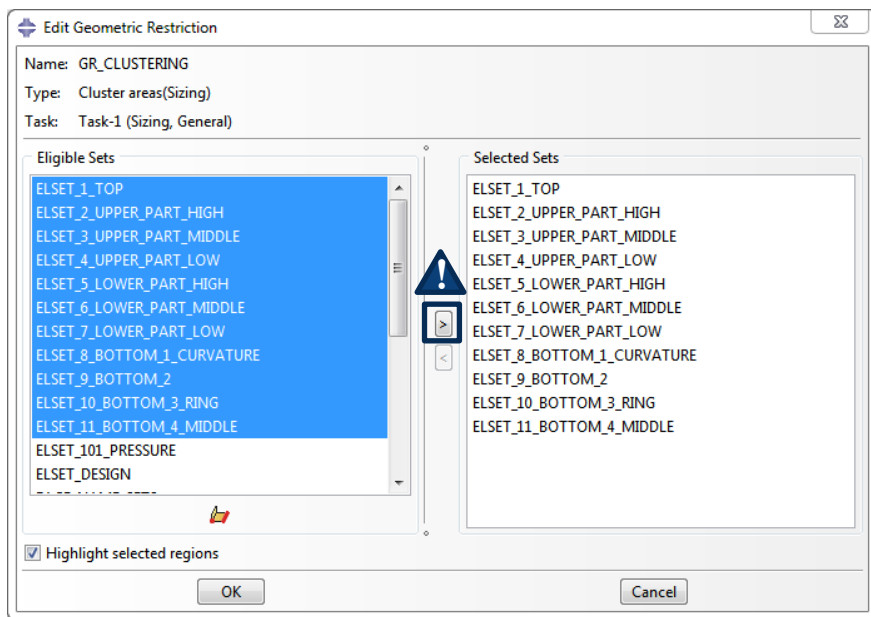
Example | Bottle

Step 10: Geometric restriction for cluster groups



Example | Bottle

Step 10: Geometric restriction for cluster groups



Cluster groups

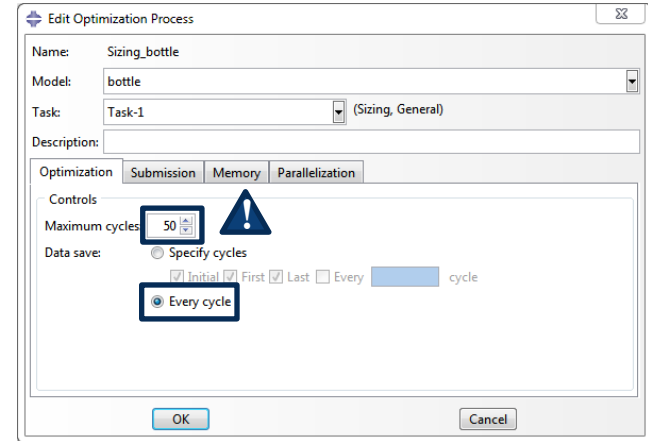
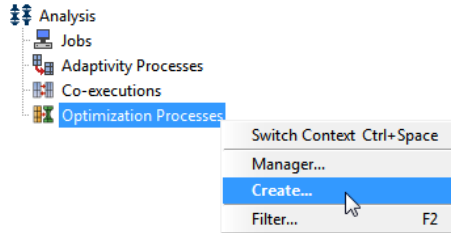
Example | Bottle

Step 11: Submission of the optimization task

Optimization Tasks (1)

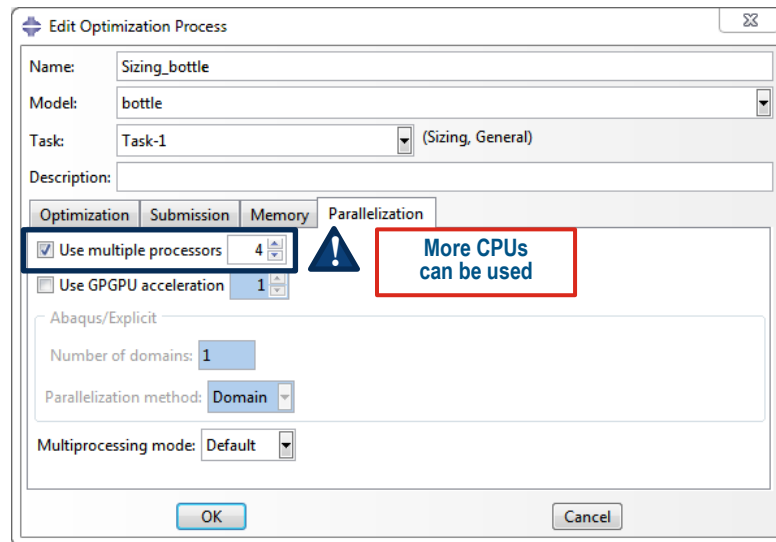
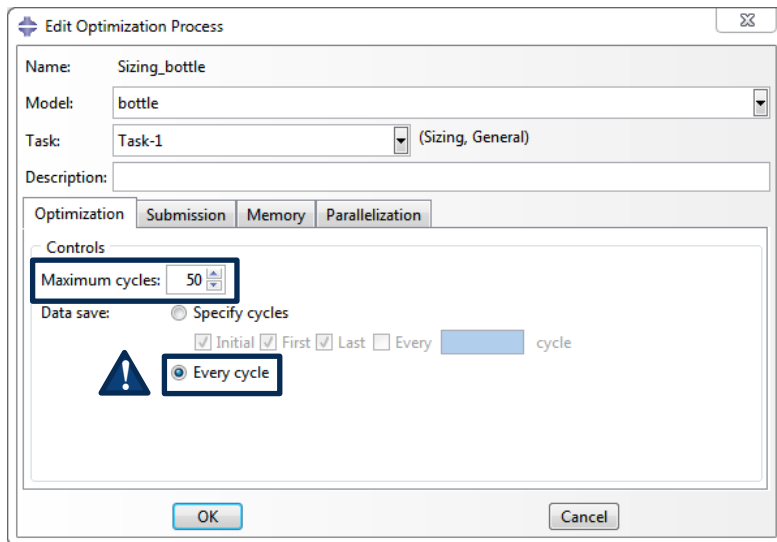
Task-1

- Design Responses (3)
 - DRESP_DISP_X_ABS
 - DRESP_DISP_Z_ABS
 - DRESP_WEIGHT
- Objective Functions (1)
 - MIN_WEIGHT
- Constraints (2)
 - CON_DISP_X_ABS
 - CON_DISP_Z_ABS
- Geometric Restrictions (3)
 - GR_BOUNDS
 - GR_CLUSTERING
 - GR_ROT_SYM
- Stop Conditions



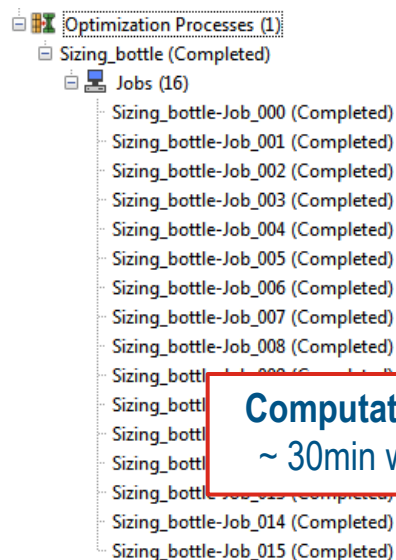
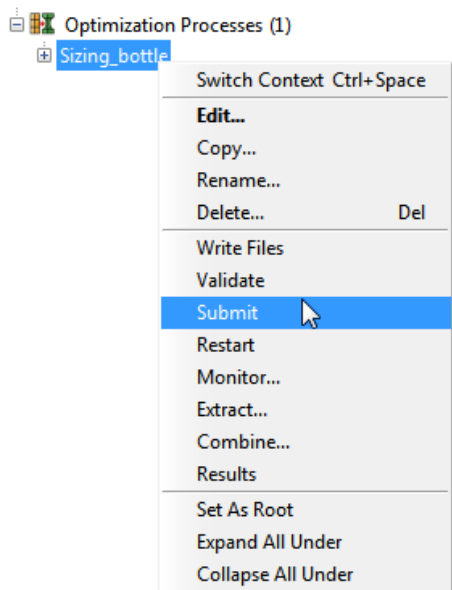
Example | Bottle

Step 11: Submission of the optimization task



Example | Bottle

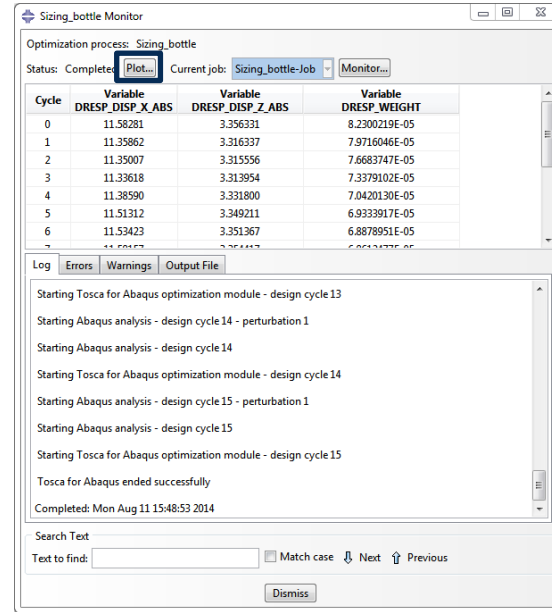
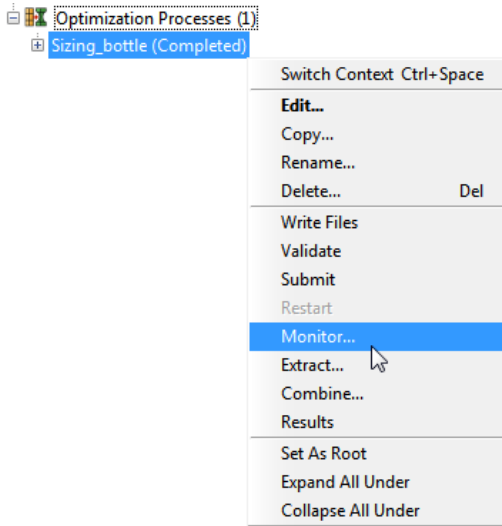
Step 11: Submission of the optimization task



Computational time:
~ 30min with 4 CPUs

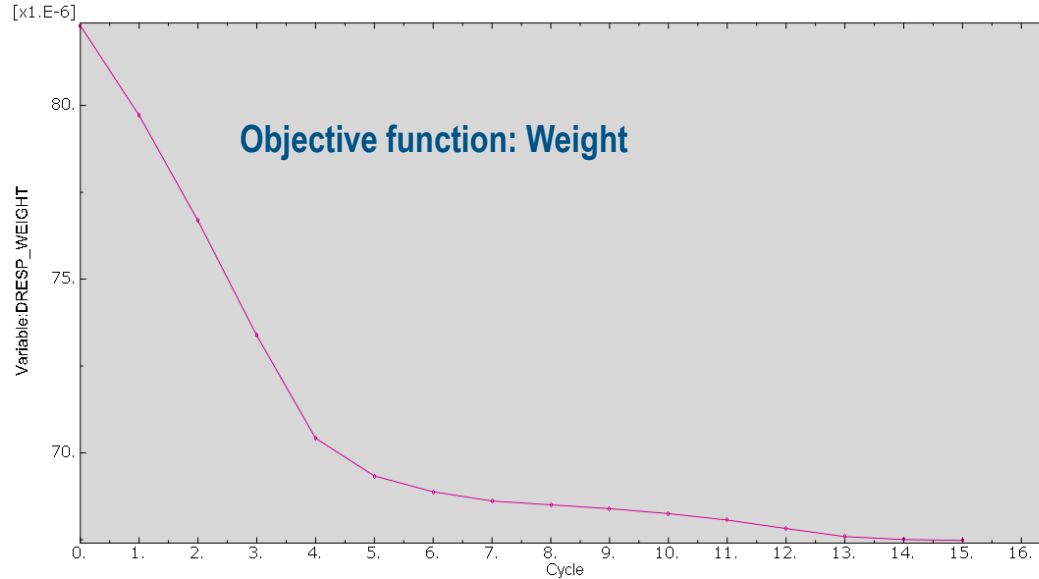
Example | Bottle

Step 11: Submission of the optimization task



Example | Bottle

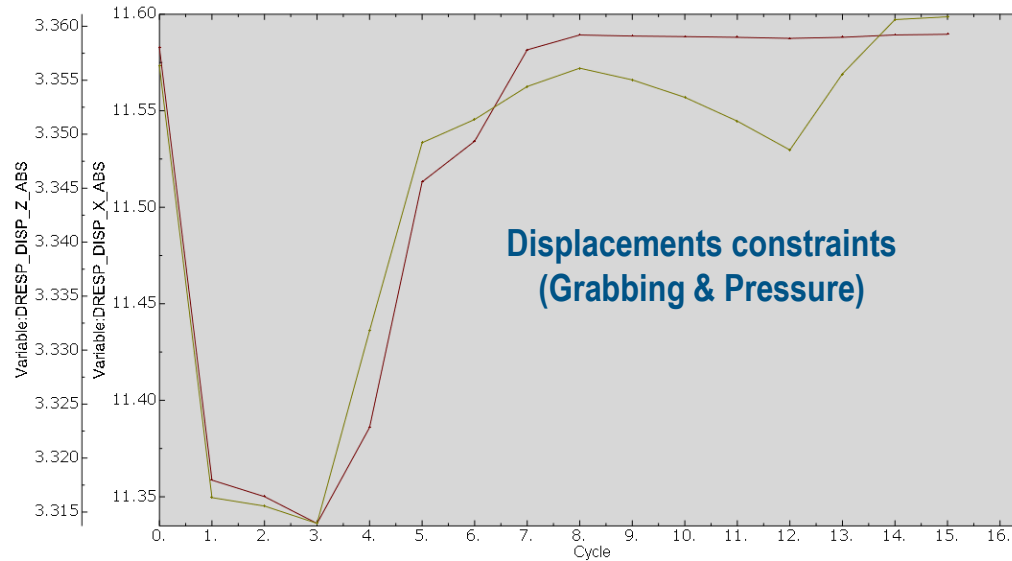
Step 11: Submission of the optimization task



Modify axis display options (font, size, color) by double-clicking

Example | Bottle

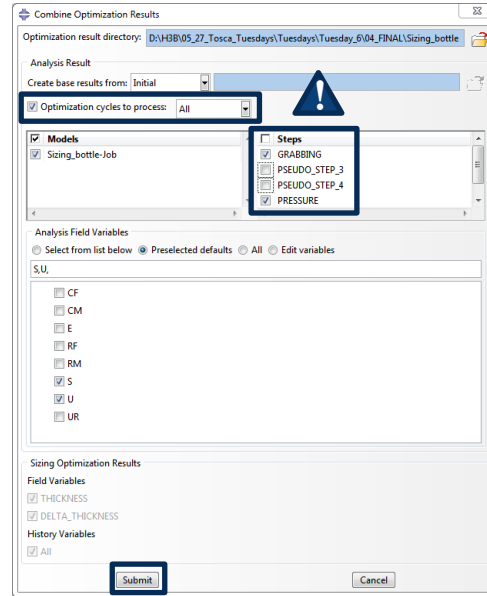
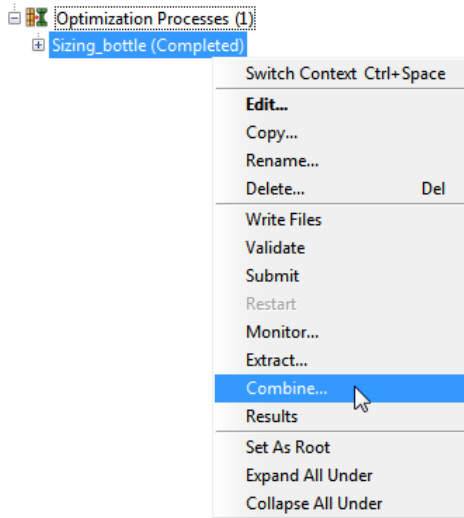
Step 11: Submission of the optimization task



Modify axis display
options (font, size, color)
by double-clicking

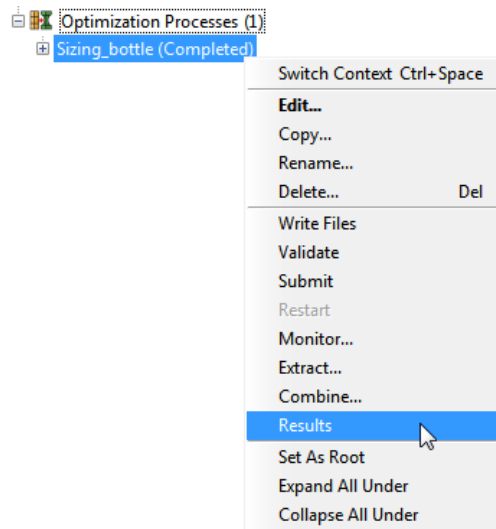
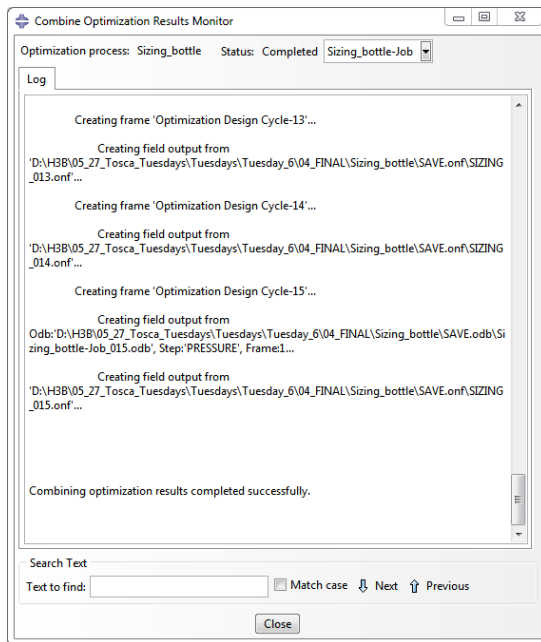
Example | Bottle

Step 12: Visualization (⚠ Optimization has to be completed)



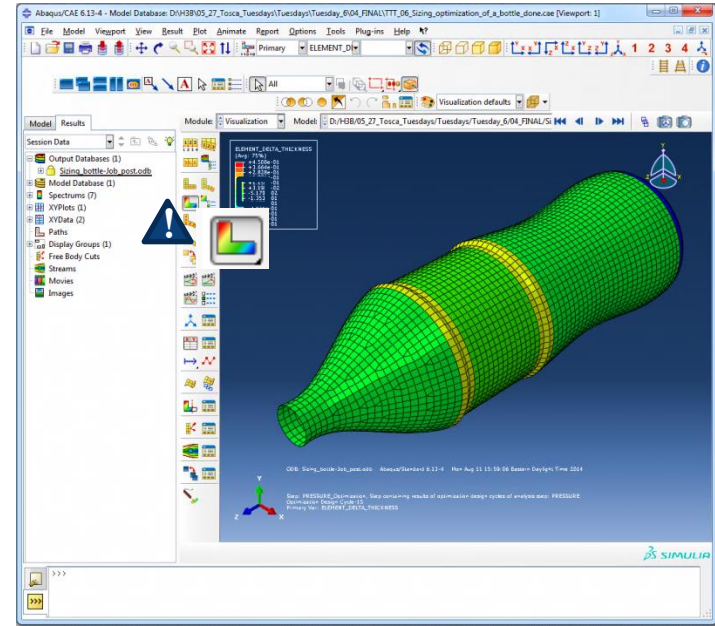
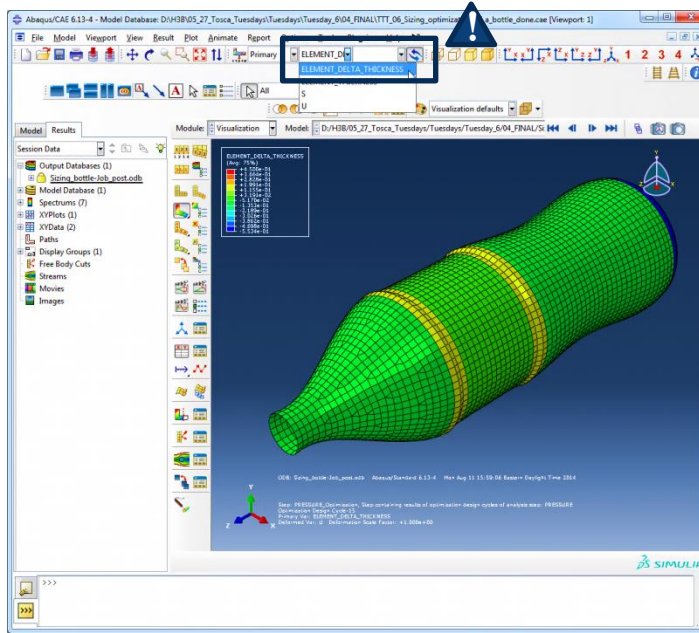
Example | Bottle

Step 12: Visualization



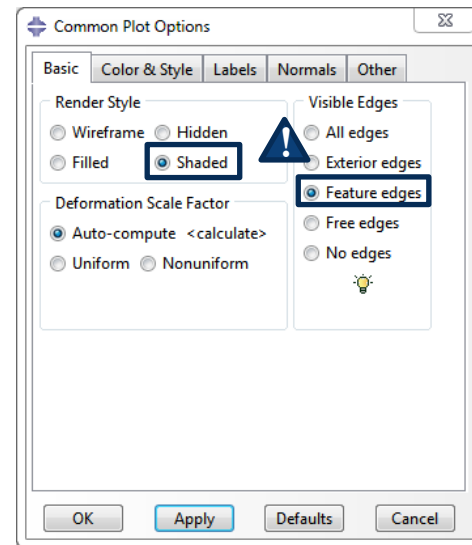
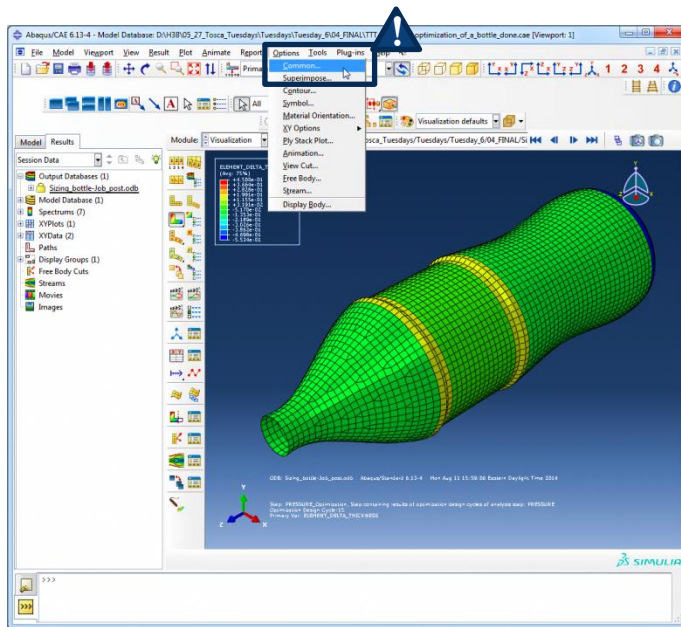
Example | Bottle

Step 12: Visualization



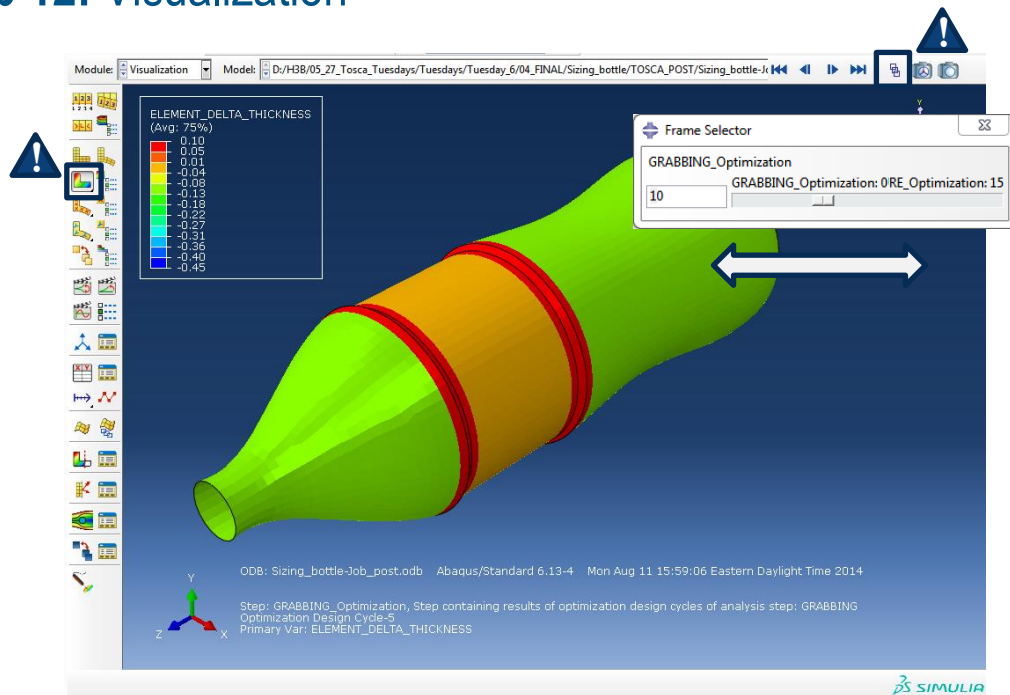
Example | Bottle

Step 12: Visualization

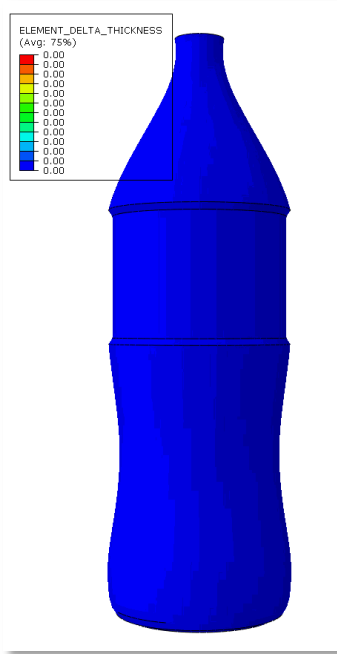


Example | Bottle

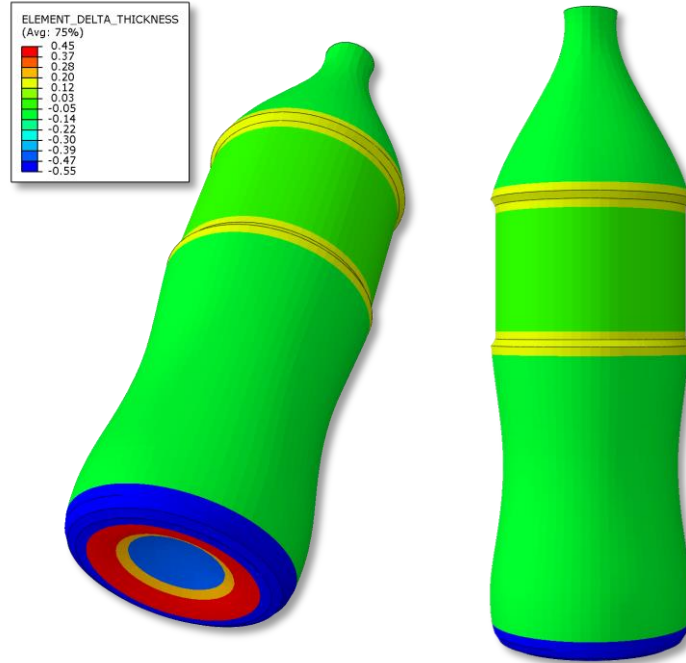
Step 12: Visualization



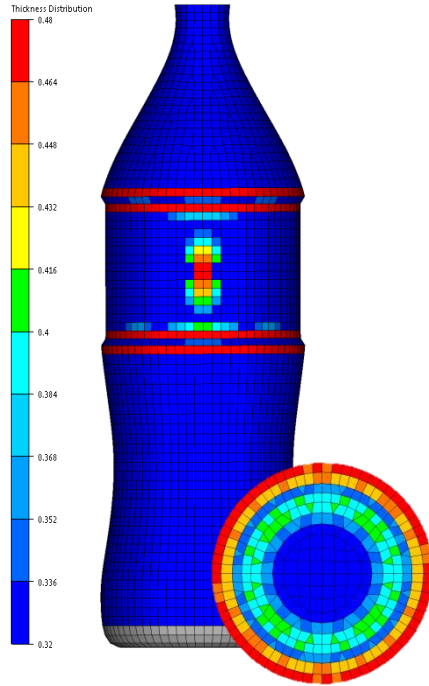
Scroll through each optimization cycle



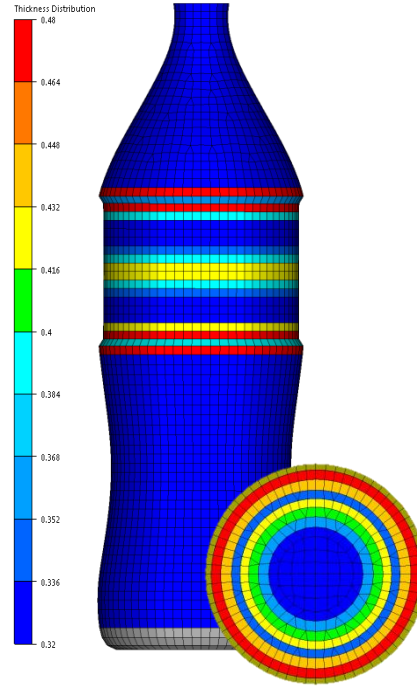
Sizing Optimization



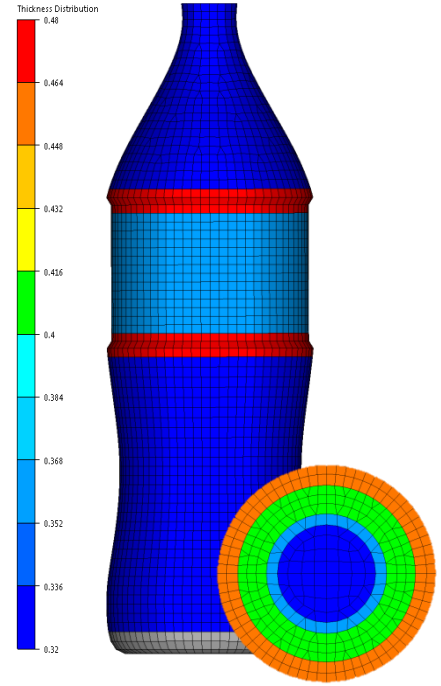
Final change in thickness



No restrictions



Rotational symmetry



Rotational symmetry
& Cluster groups

