

# Introduction to Blender

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# Chapter 1

## Modeling of geometric objects

### 1.1 Blender user interface

Documentation: [Blender manual](#), [Blender interface](#), [Tutorials](#)

**Structure of the interface.** Read the [manual](#) to be familiar with the structure of the Blender interface (see Fig. 1.1), in particular, read about and practice:

- Read about **Topbar** and **Status Bar**.
- Read about the **workspaces**, especially about **Layout** workspace and the following *Editors*: **3D Viewport**, **Outliner**, **Properties**, and **Timeline**. During these classes, we will also use the **Modeling**, **Shading**, and **Rendering** workspaces.
- Be familiar with the **regions** inside the editors, like header, context menu, toolbar, sidebar, footer, etc.
- Practice using **Tabs** and **Panels** in the *Properties* editor (right-bottom area).
- Understand components of the scene in the *Outliner* editor (see **Scene collection**).
- Use **Navigation Gizmo** ([navigation gizmo](#)) in the *3D Viewport* editor to rotate, zoom in and out, change projection mode of the scene. Toggle camera view and change the projection.
- Be familiar with the **Sidebar** in *3D Viewport* editor, especially with the **Item** properties ([sidebar](#)).
- Switch between **Object mode** and **Edit mode** (use [Tab] key).
- Save the project to output file in the native Blender format.

### 1.2 Adding new objects and object transformations

Documentation: [Geometry modeling in Blender](#)

Basic tips:

- Press **[Tab]** to switch between **Object mode** and **Edit mode** in *3D Viewport* editor.
- In **Edit mode**, you need to indicate the type of selected element:
  - Press **[1]** - selecting vertices.
  - Press **[2]** - selecting edges.
  - Press **[3]** - selecting polygons.
- A single click on an item selects one item, a quick double-click selects the entire item.
- To transform object select the object and then choose the type of transformation: translation, rotation, scaling or complex transformation in the *Toolbar*. Similarly, one can select an element (e.g., vertex) of the object and choose the type of transformation.

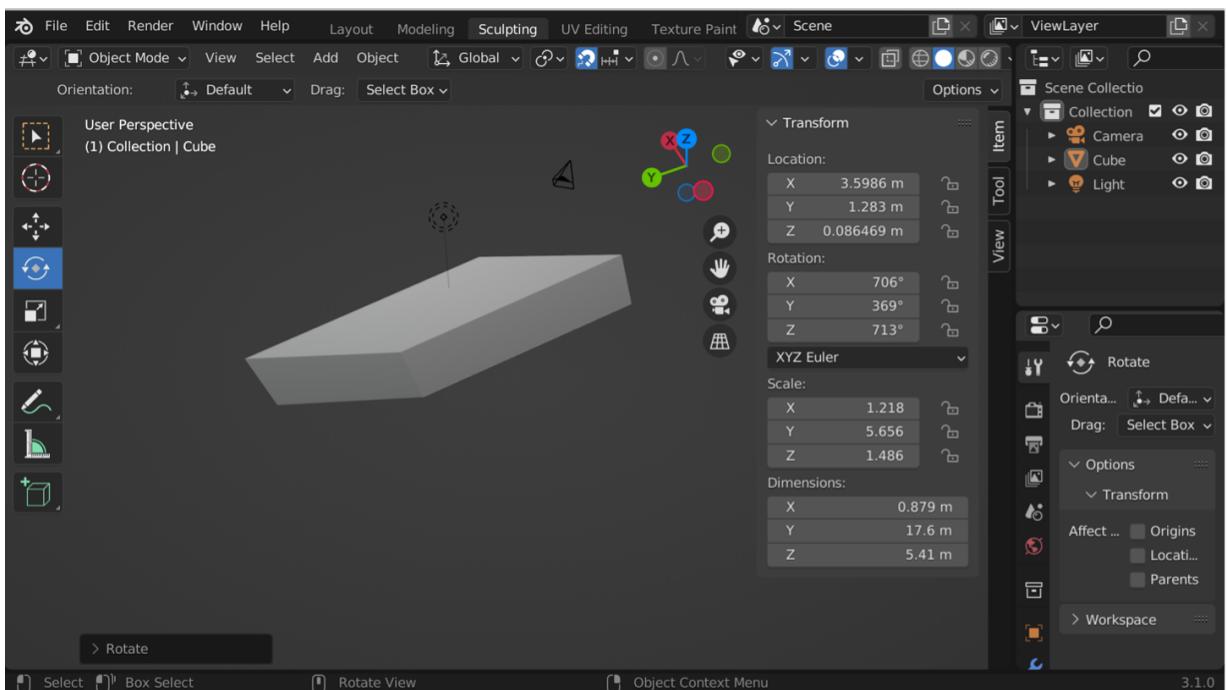


Figure 1.1: Blender interface.

### Exercise - Robot

Create an object resembling a humanoid robot (see Fig.1.2):

1. Switch on *Modeling->Object mode*.
2. Switch on *View->Sidebar*.
3. Set grid scale to 0.2m (see [Viewport overlays](#)).
4. Add cube object (*Add->Mesh->Cube*).
5. Give object original name in *Scene collection* (e.g., *robot*).
6. Translate, scale and rotate the cube object to form required shape. Use *Snap to grid* tool while dragging (press [Ctrl]) (see [snapping](#) manual for details). Copy objects. Change view. Adjust position and size in *Sidebar* manually.
7. Add another cube object or object of other shape.
8. Practice **Snap to** tool (see Fig.1.2).
9. Repeat the actions until you achieve the intended goal.
10. Finally, save your project to `blender/robot.blend` file in the git repository.

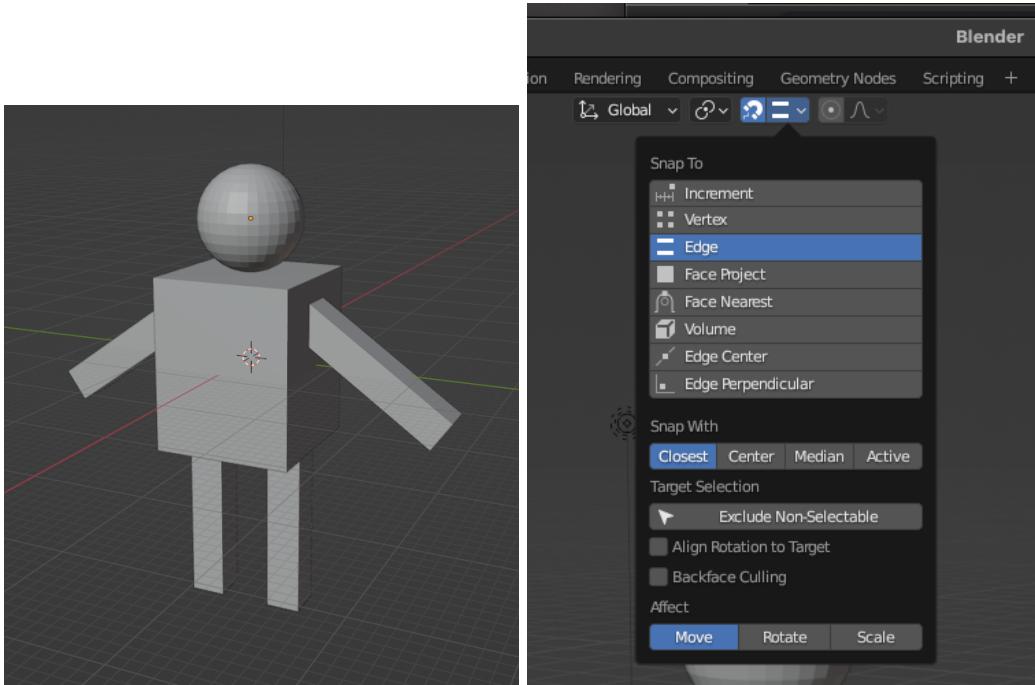


Figure 1.2: Left: Example robot object. Right: Snapping tool.

## 1.3 Creating simple object

### Exercise - House

1. Switch to *Modeling->Object mode*.
2. Add *Cube* object.
3. Set its pivot in the center of the lower base of the cube (see Fig. 1.3):
  - (a) Select the cube object.
  - (b) Go into edit mode ([TAB]).
  - (c) Choose all of the object's vertices ([A]), and then translate it to required position ([G]).
  - (d) Exit edit mode ([TAB]).

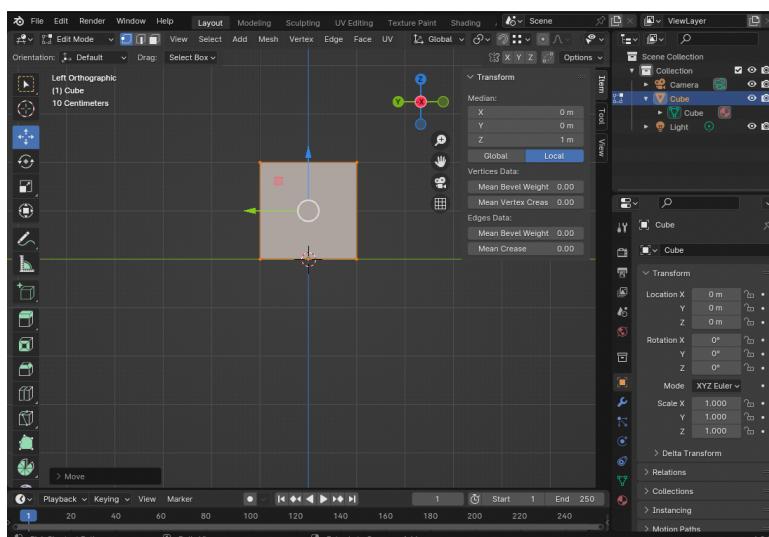


Figure 1.3: Moving object in *Edit mode* to change pivot point location.

4. Scale the object to arbitrary dimensions of [3,2,1.2].
5. Copy and paste the object.
6. Use Snap (to vertices) to stack objects (see Fig. 1.4):
  - (a) Switch on *Snap To Vertex* tool.
  - (b) Select the copied object.
  - (c) Move the object (press [G]) until you see the orange rectangle/circle showing position of the vertex to which the object will be snapped.
  - (d) Press left mouse button to confirm new position.

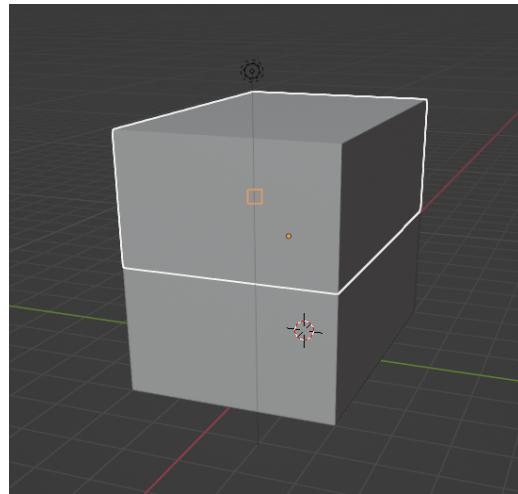


Figure 1.4: Connecting objects using *Snap To Vertex* tool.

7. Switch to *Modeling->Edit mode->Face select*.
8. Select the top polygon of the top object and scale it to resemble the roof of a house (see Fig. 1.5).

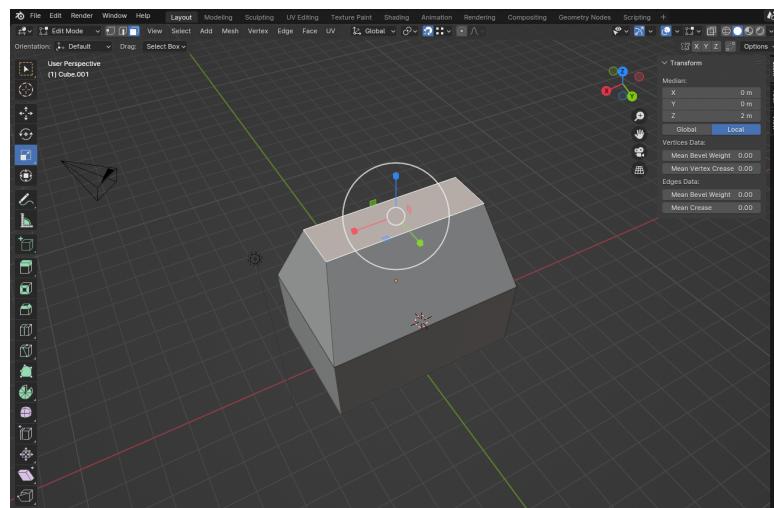


Figure 1.5: Connecting objects using *Snap To Vertex* tool.

9. Save your project to `blender/house.blend` file in the git repository.

## 1.4 Editing objects

### Exercise - Table

1. Switch to *Modeling->Object mode*.
2. Add *cube* object and change it name to "leg".
3. Scale the object to a shape resembling a table leg (e.g., to [0.18,0.18,0.9]). Remember to move the pivot point of the object to the center of the bottom face.
4. Switch to *Modeling->Edit mode->Edge select*.
5. Select four edges of the bottom face and use *Bevel* modifier from the left *Toolbar* to add chamfer to the leg object (see Fig.1.6).

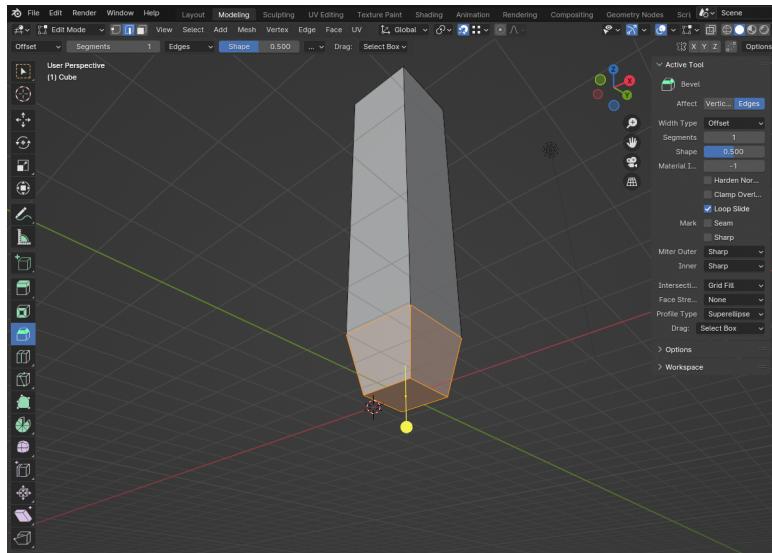


Figure 1.6: Cutting off the end of the table leg.

6. Select the side edge of the leg and add *Bevel* modifier. This time, increase the number of segments to round the edge of the table leg (see Fig.1.7). Repeat this operation for two more edge but the last edge should remain sharp (i.e., without bevel).

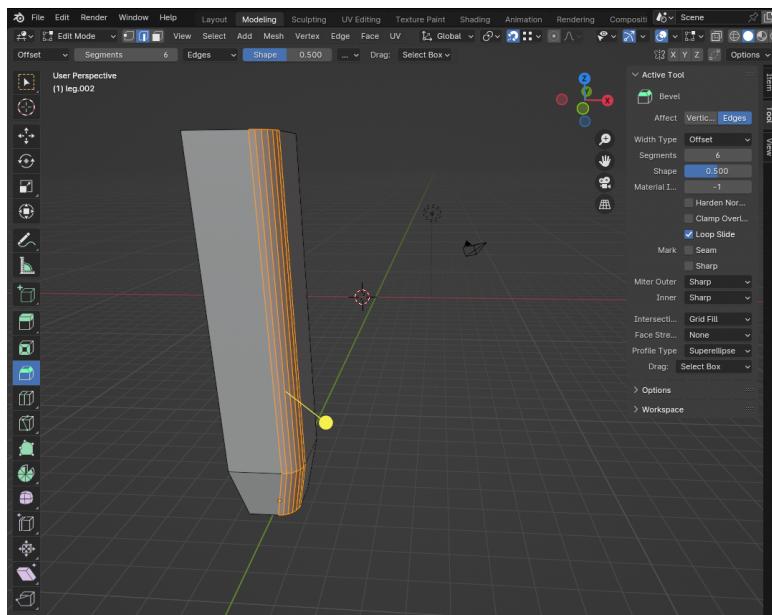


Figure 1.7: Rounding the edges of the table leg.

7. Return to *Modeling->Object mode*.
8. Use *Shade Smooth* from the RMB (right mouse button) menu to smooth the shading of the object (see Fig. 1.8).

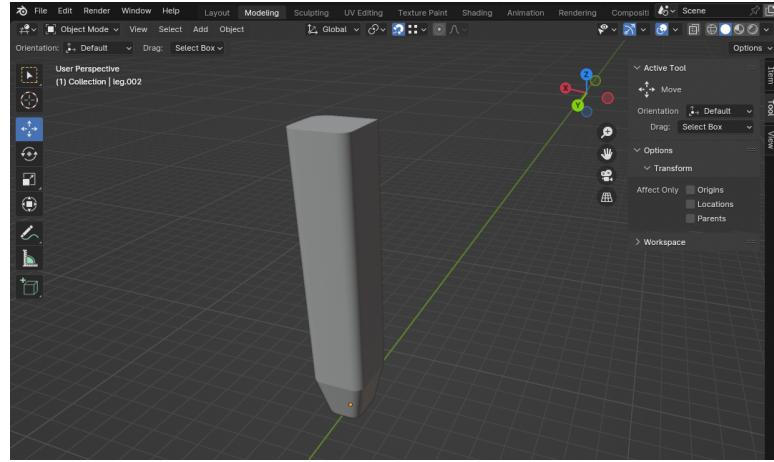


Figure 1.8: Smoothing the table leg.

9. Use *Shade Auto Smooth* from the RMB menu to switch on the automatic smoothing.
10. Add another *cube* object and change it name to "table-top".
11. Scale the object to a shape resembling a table top (e.g., to [1.25,2.5,0.09]).
12. Move the table top so that the leg is on the corner of the table top. Use the *Snap To Vertex* tool (select object, press [G], and move the object to activate the snapping vertex) (see Fig.1.9).

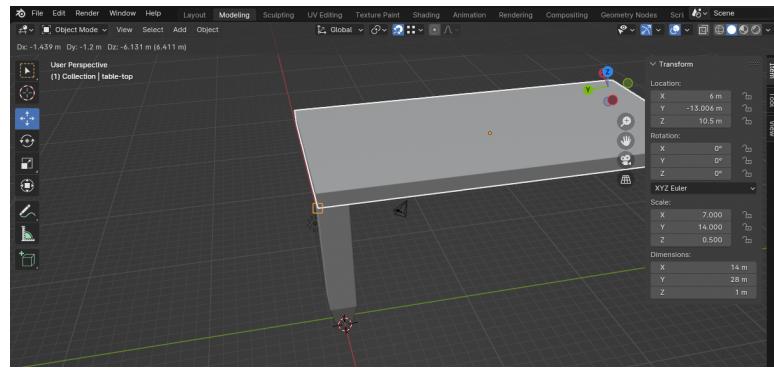


Figure 1.9: Snapping leg to the corner of the table top.

13. Copy and paste the leg, then move it to another corner of the table top. Repeat the operation for all remaining legs.
14. Select the table-top object and switch to *Modeling->Edit mode->Face select*. Select the upper face of the table.
15. Use *Inset* tool from the left *Toolbox* to divide this face into smaller triangles and create a rectangular area (see Fig. 1.10).

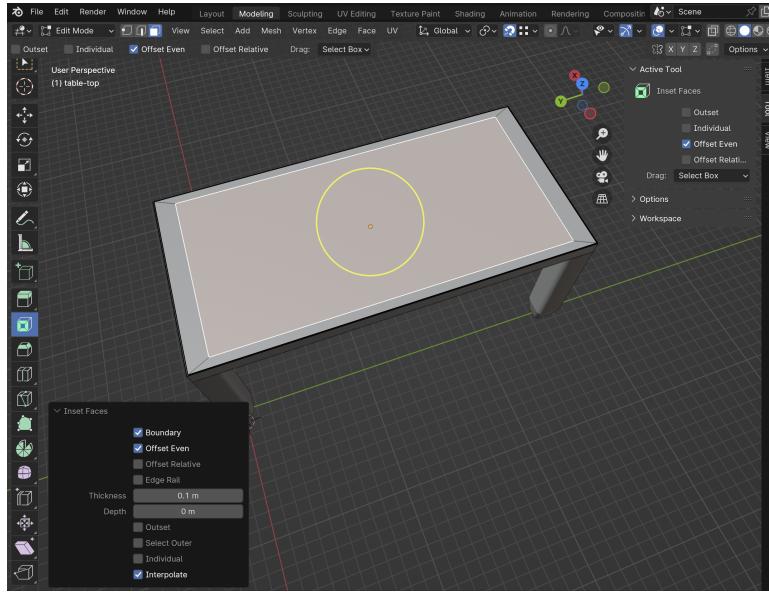


Figure 1.10: Insetting the table top.

Repeat this operation for two more edge

16. Use *Extrude* tool from the left *Toolbox* to extrude a rectangular area and create an indentation in the table top (see Fig. 1.11).

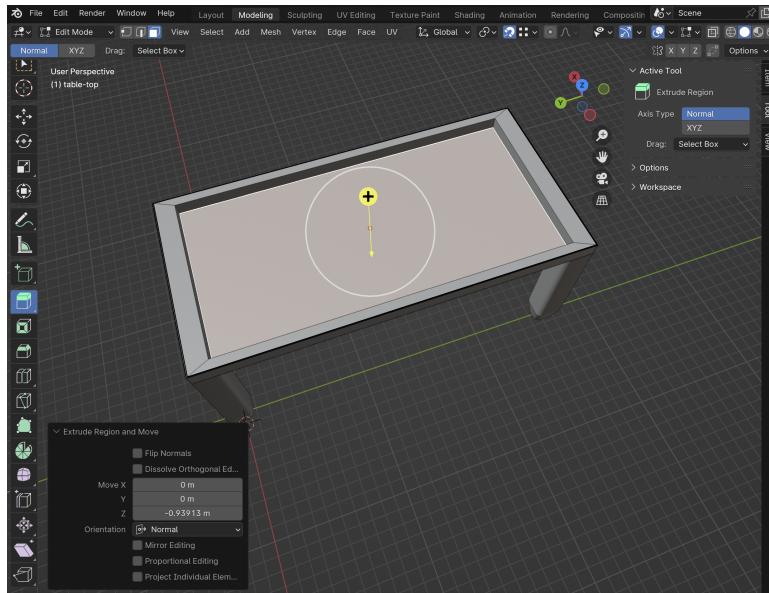


Figure 1.11: Extruding the table top.

17. Switch to *Modeling->Object mode* and select one of the legs.

18. Add material to the leg using the *Properties* editor (see Fig. 1.12). Select the material icon, add default material (Principled BSDF). Then, set the *Base Color* to RGB=[0.15,0.21,0.3], *Matalic* to 1, and *Roughness* to 0.1. Rename this material to *leg-material*.

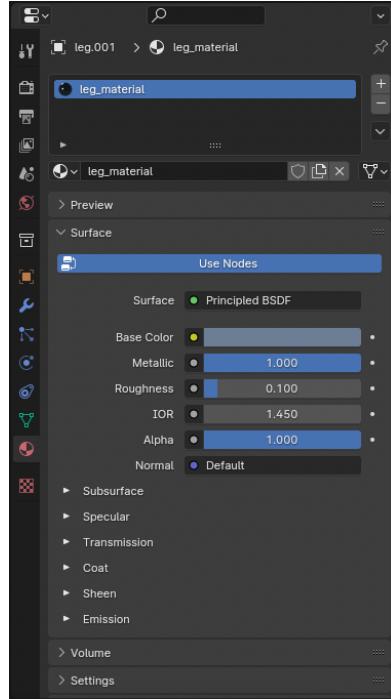


Figure 1.12: Material properties.

19. To see the material mapped on the table leg, the viewport shading must be changed to *Material preview*. One can also change the HDR environment map used for the ambient lighting (see Fig. 1.13).

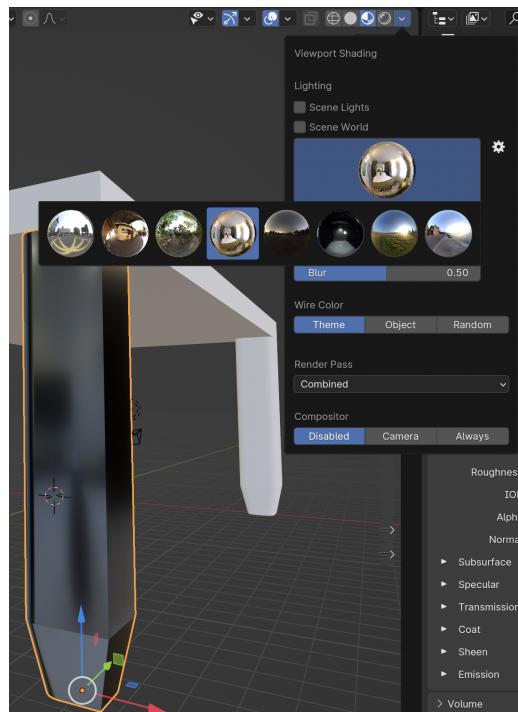


Figure 1.13: Viewport shading modes

20. Add the same *leg-material* to remaining legs (see Fig. 1.14).

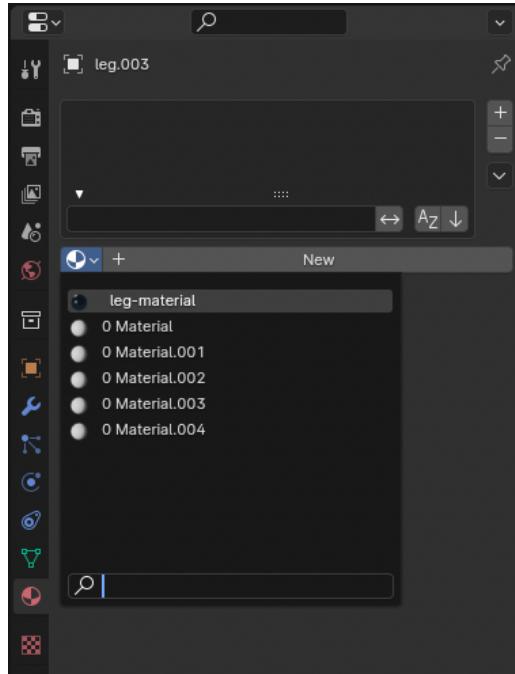


Figure 1.14: Using the same material for different objects.

21. Select table top in the *Object mode* and *Material* in the *Properties editor*.
22. Add two new Principled BSDF materials. Change the *Base Color* to  $\text{RGB}=[0.06, 0.06, 0.06]$  and  $\text{RGB}=[0.006, 0.1, 0.006]$ . Rename the materials to *table-material* and *green-material*, respectively. Be sure that you have two material on the list.
23. Select table top in the *Object mode*, then switch to *Modeling->Edit mode->Face select*.
24. Select inner surface of the table (see Fig. 1.15) and select *Data* in the *Properties editor*.

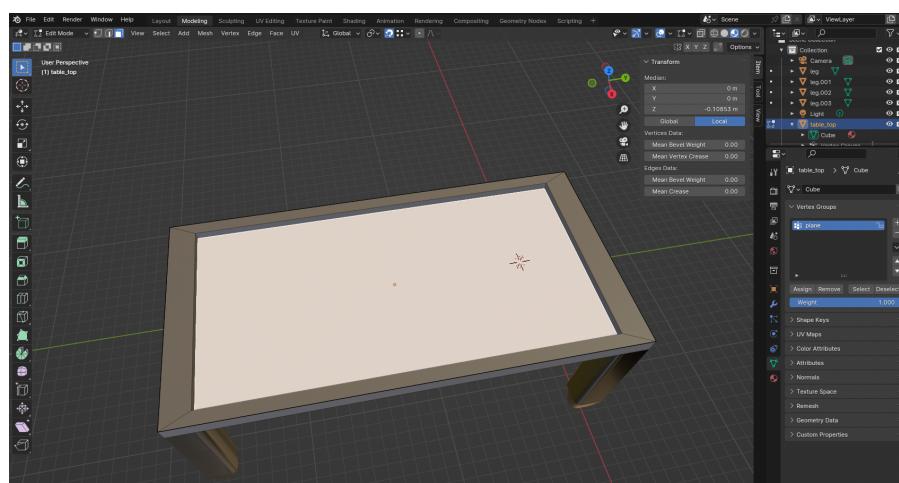


Figure 1.15: Creating vertex group.

25. Add new vertex group and rename it to *plane*.
26. Press [Assign] button to assign the selected surface to created vertex group. Use [Select] and [Deselect] buttons to test if the geometry was correctly assigned to the vertex group.
27. Switch to *Material* properties and select the *green-material* on the list.
28. Press [Assign] button to assign the *green-material* to *plane* vertex group. This vertex group must be selected before assigning the material.

29. Switch to *Modeling->Object mode*.
30. Add *Plane* object to increase its size to cover large part of the background. Rename the object to *ground*
31. Switch to *Modeling->Object mode*.
32. Select *Camera* in *Scene collection*.
33. Press camera icon in the *Navigation Gizmo*. Select *View* in the sidebar of the *3D Viewport* editor. Check *Camera to View* checkbox (see Fig. 1.16).
34. Use *Navigation Gizmo* to place a table object in the camera's field of view.
35. Uncheck *Camera to View* checkbox.

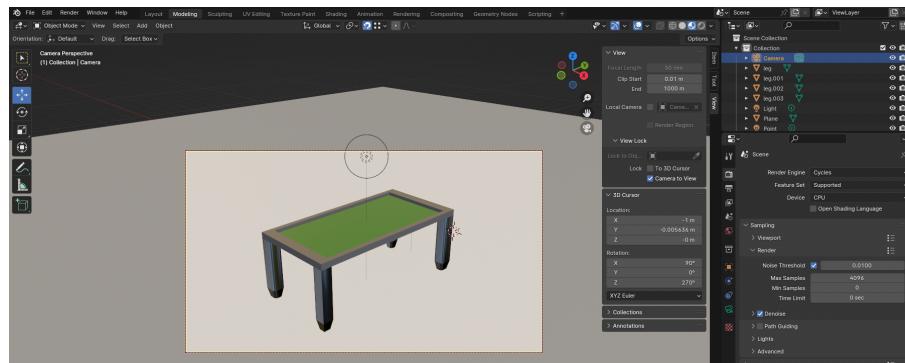


Figure 1.16: Setting camera parameters.

36. Switch to *Modeling->Object mode*.
37. Switch *Viewport shading* to *Rendered*.
38. Add point light (*Add->Light->Point* and move it in a position over the table).
39. In the *Properties* editor select light properties and change *Power* to 200 W and *Radius* to 0.1 m (see Fig. 1.17).

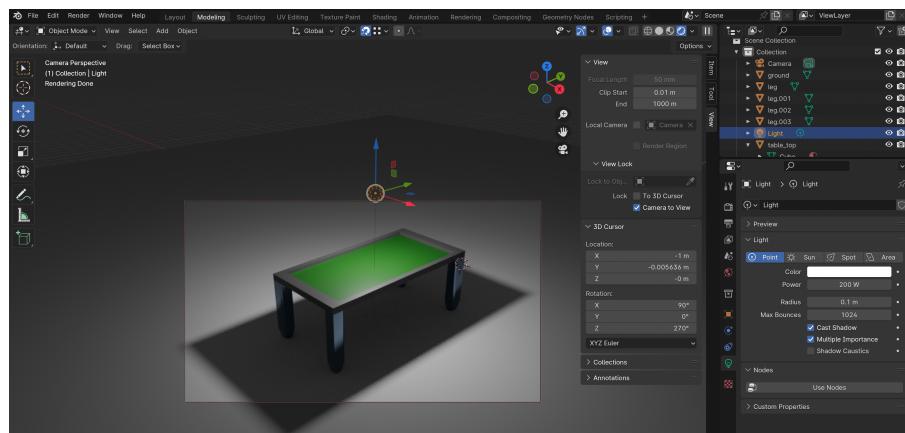


Figure 1.17: Adding point light.

40. Select *Render* in the *Properties* editor and change *Render engine* to *Cycles* (see Fig. 1.18).
41. Render image (*Render->Render Image*) (see Fig. 1.19).

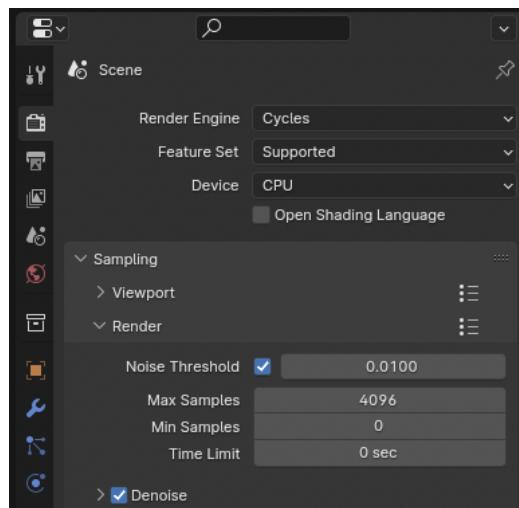


Figure 1.18: Switching to Cycles renderer.



Figure 1.19: The final rendering of the table.

42. Save your project to `blender/table.blend` file in the git repository.

## 1.5 Self-work

### Creating your own objects

- Build a complex object resembling a robot, truck, train, car, etc. The object should consist of at least a dozen of the basic objects, like Cube, Sphere, Cylinder, Cone, Ring (Torus), or planes (Plane).
- Transform and edit basic shapes to extrude faces, bevel edges, etc.
- Assign materials to objects.
- Setup camera and lighting.
- Render an image that best represents your object.

## 1.6 Case study - Loco

*The instruction was developed by mgr inż. Katarzyna Gościewska*

**Objectives:** Create model of a locomotive (see Fig.1.20) to practice:

- Mesh *Subdivide* and *Loop Cut*.
- Snapping.
- Using *Extrude*, *Inset*, and *Bevel*.
- Object shading using *Shade Smooth* and *Autosmooth*.

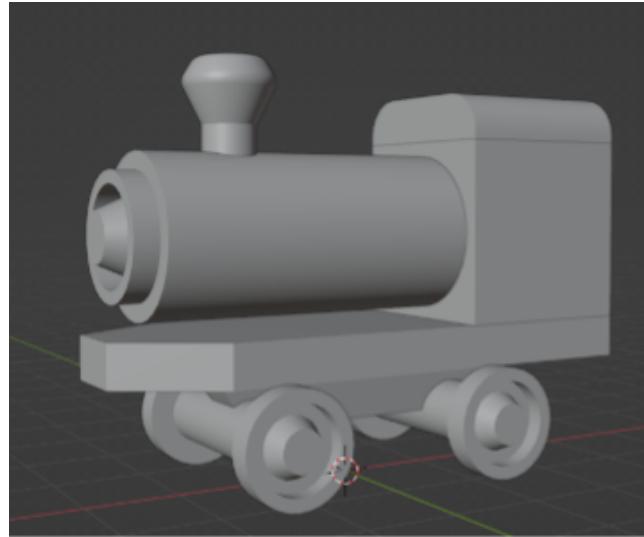


Figure 1.20: File names with corresponding views.

### Exercise - Loco model

1. To accurately reproduce the shape of the model, insert to Blender projections images delivered as separate files. Set the appropriate view (orthographic projection on the selected plane) and then drag the file with the image to the Blender window. Use Gizmo located in the upper right corner of the 3D Viewport window to switch between views. The projection images correspond to the views defined in Fig.1.21.
2. Create cube with a transformation point located in the cube base.
  - (a) Select cube in *Object Mode* and switch to *Edit Mode*.
  - (b) In face selection mode, use *Select/Tweak tool* to select bottom face, next, use *Mesh/Snap/Cursor to Selected* from the menu to set the cursor in the middle of the bottom face (see Fig.1.22, top row).
  - (c) Switch to *Object Mode* and choose from menu *Object/Set Origin/Origin to 3D Cursor* to change the properties of the entire object by setting the transformation point at the cursor position (see Fig.1.22, second row).
  - (d) Move the created cube to the (0,0,0) position, then, create two more copies of this cube placing them next to each other (see Fig.1.22, third row).
3. To create the Loco platform (chassis):
  - (a) Scale-down the first cube in OZ direction, next scale-up in OX. Do not change the size in OY direction. See results in Fig.1.22 (bottom row).
  - (b) Create inset and decrease its OY dimension using scaling (see Fig.1.23, top).
  - (c) Extrude the polygon downwards and narrow it again with Inset + CTRL as follows (see Fig.1.23, center and bottom):
    - i. Select a smaller polygon, activate the Inset tool, click inside the yellow circle and hold down the left mouse button, then drag the mouse to activate the tool.
    - ii. Keep the left mouse button pressed and hold down CTRL and move the mouse to create the geometry.

- iii. Release CTRL and adjust the size of the wall by moving the mouse; end by releasing the mouse button.
  - (d) Shear the front platform on the two vertical edges using *Bevel edge* and adjust the shape by moving or scaling the front polygon (see Fig.1.24).
4. To create the Loco cabin:
- (a) Select the second cube in *Object Mode*.
  - (b) Use *Snapping* to place the cube on the platform. First, define the snapping type - open the snap menu and set *Snap to/Vertex* and *Snap with/Closest* and *Affect/Move* (see Fig.1.25, top row). Then click on the cube with the left mouse button, hold and move the object looking for a place where the objects will join each other (until an orange circle appears). The platform and cube are the same width, so they are easy to match based on vertex snaps.
  - (c) Choose the third cube and place it on the previous one using snapping (see Fig.1.25, center row). If it is hard to arrange objects on top of each other, try to change the view.
  - (d) Select the top cube and go to *Edit Mode* to lower its height. Select the top face and move it down along the Z axis (see Fig.1.25, bottom row, left).
  - (e) Mark two opposite edges and make a bevel using *Bevel* increasing the number of segments (see Fig.1.25, bottom row, center and right).
  - (f) In *Object Mode*, select the platform and go to *Edit Mode*, where select its rear vertical face. Then put a 3D Cursor there via *Mesh/Snap/Cursor to Selected*. Go back to *Object Mode* and add a new cube object (it will position itself at the 3D Cursor location). The added cube is scaled (reduced) - it will be the basis of the element, similar to a connector (see Fig.1.26).
  - (g) With the new cube object selected, go to *Edit Mode* and model the element as a connector (looking from the side, it should have the shape of an inverted L letter, to achieve this, add new grid lines and extrude on the outer part from the bottom) (see Fig.1.26).
5. To create the Loco smokebox:
- (a) In *Object Mode*, add a new cylinder object. Rotate it around OY axis and scale accordingly (symmetrically with respect to the YZ plane). Mount it to the cabin wall (use *Snaps* with the *Snap to/Face* option) (see Fig.1.27).
  - (b) In *Edit Mode*, on the front face of the cylinder, inset twice to create three rings made of polygons with a circle in the center (see Fig.1.27). Mark the inner ring and *Inset with extrusion*. The ring made of polygons can be selected by holding down [CTRL+ALT] and clicking on one polygon (closer to its longer edge). Repeat the *Inset with extrusion* for the outer ring.
6. To change shading of the smokebox (see Fig.1.28):
- (a) In *Object Mode* select the smokebox cylinder, then, right click and select *Shade Smooth->Right side pane->Object Data Properties (Green icon)->Normals->enable Autosmooth (30 or 60 degrees)*. *Autosmooth* can be set for each object separately.
7. To create wheels:
- (a) Select the platform and switch to *Edit Mode*. Select the lower edge of the train platform and bring up the 3D Cursor there (use *Mesh/Snap/Cursor to Selected*) (see Fig.1.29, first row, left).
  - (b) In *Object Mode* insert the cylinder, which will be an axle of the wheels. Rotate and scale cylinder (see Fig.1.29, first row, center and right). Hold down the SHIFT key to scale the object precisely.
  - (c) Select the cylinder and switch to *Edit Mode*. Select both bases of the cylinder and create a new edge by pressing [E] (*Extrude*), then [0] and [Enter] (to create a new edge without adding geometry). Scale up the polygon. Click and drag inside the yellow handle to activate the tool, and then set *Thickness* to 0 and adjust the *Depth* (see Fig.1.29, second row).
  - (d) Model the wheels using *Inset* and *Inset+CTRL*, or after activating the *Inset tool*, enter the parameters (Thickness and Depth) (see Fig.1.29, third row).
  - (e) In *Object Mode*, copy the axle with two wheels and paste it in the location in the front of the loco (see Fig.1.29, bottom row).

8. To create chimney:

- (a) Switch to *Object Mode*, select the smokebox and switch to *Edit Mode*. Switch on the top view, select the middle edge on the cylinder, and set the 3D Cursor on this edge (*Mesh/Snap/Cursor to Selected*) (see Fig.1.30, top row, left).
- (b) In *Object Mode*, insert a new cylinder, scale it, and move along the edge to the front of the train (see Fig.1.30, top row, center and right).
- (c) In *Edit Mode* extrude and scale the upper face of the chimney to form a shape presented in Fig.1.30 (third row).
- (d) Use the *Bevel tool* to bevel and round the chimney edges (see Fig.1.30, bottom row).

9. Bevel other edges of the loco, e.g. on all edges of the train cabin, rims of the front of the train or wheels (see Fig.1.31).

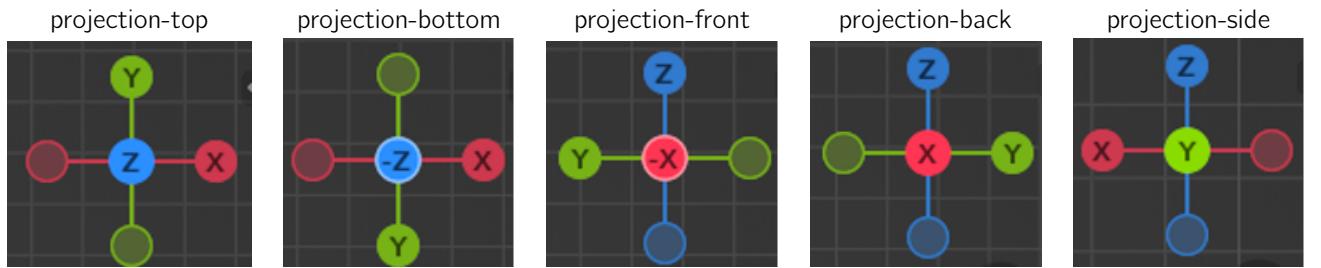


Figure 1.21: File names with corresponding views.

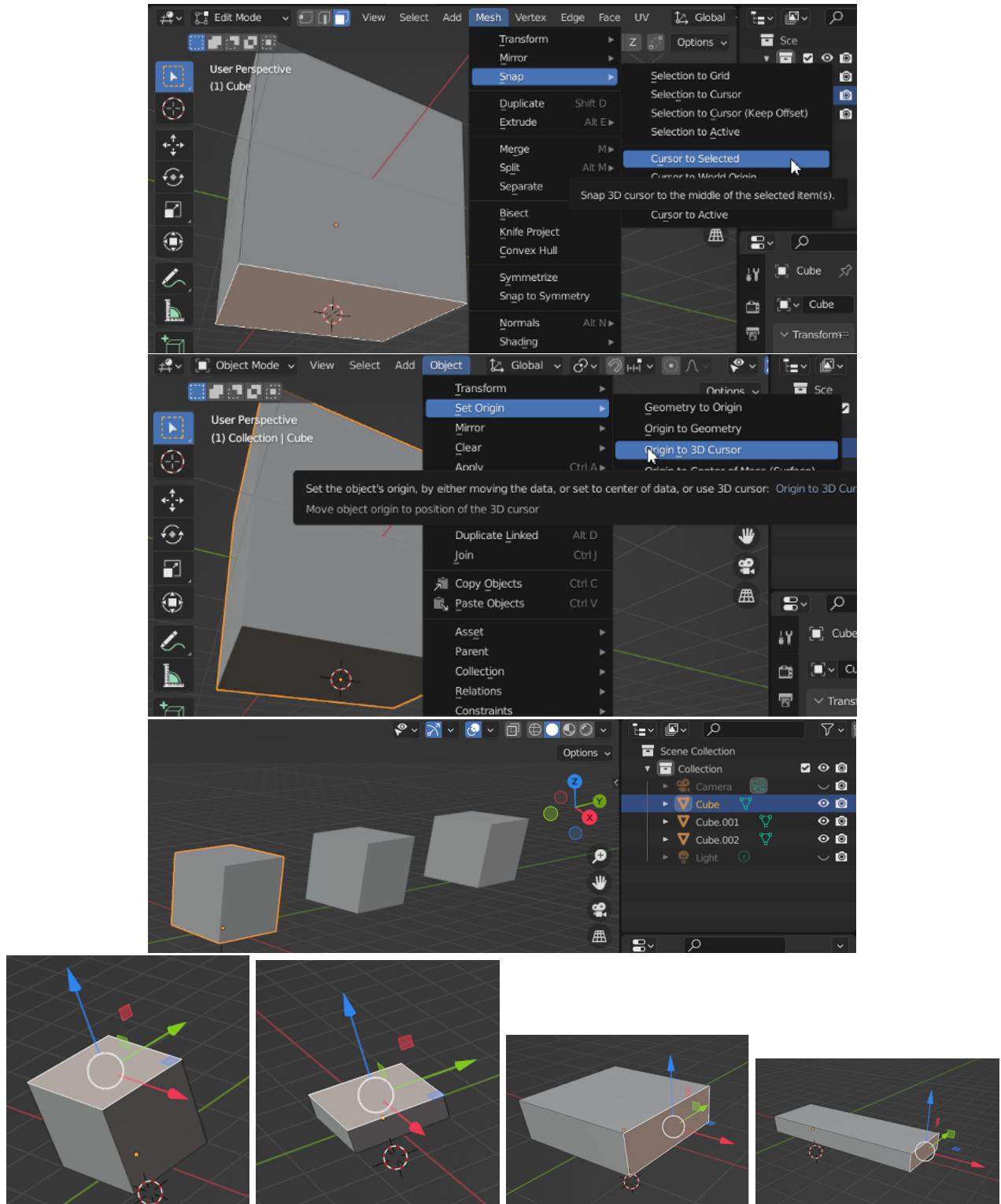


Figure 1.22: Modeling of the loco platform.

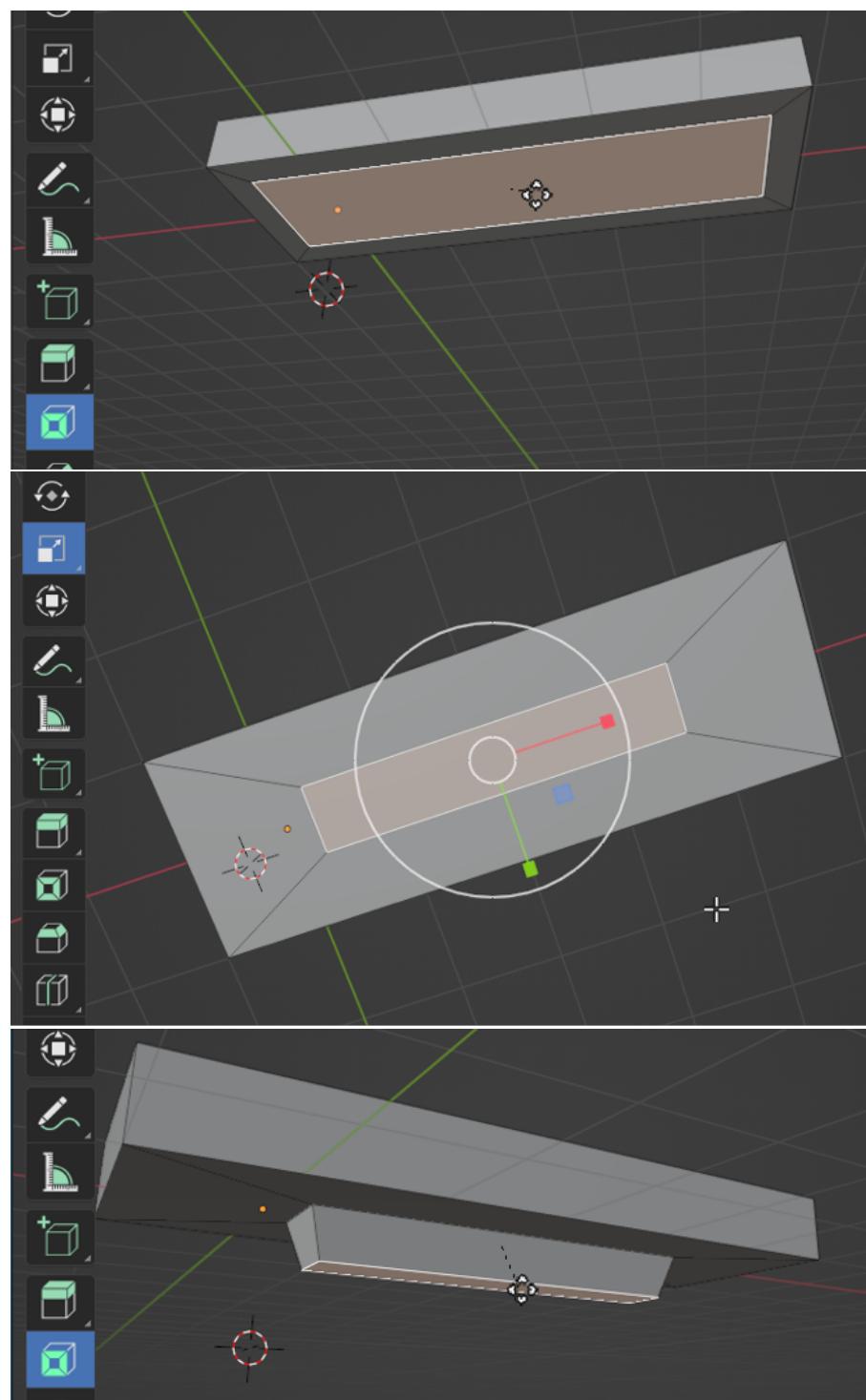


Figure 1.23: Platform inset

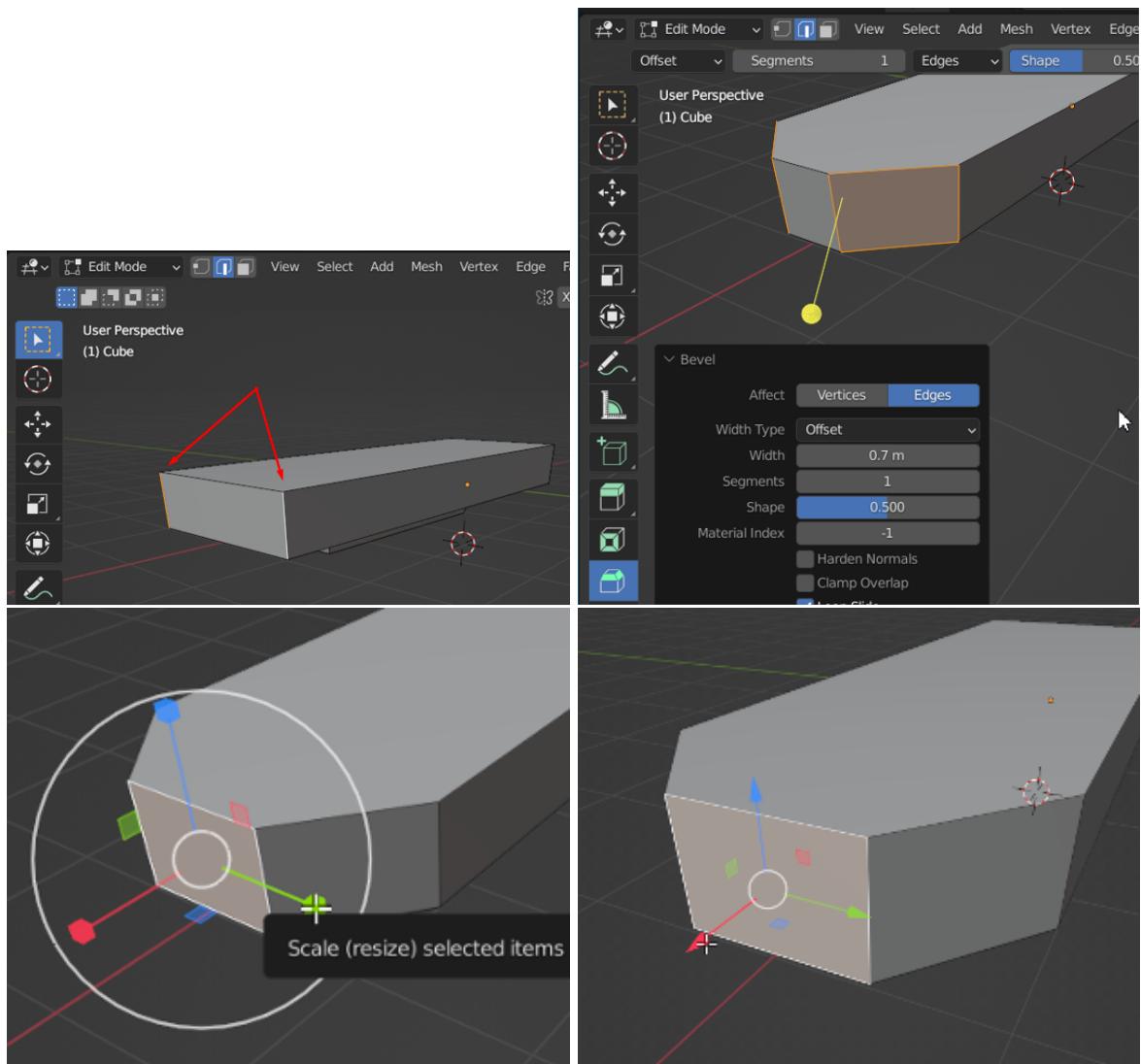


Figure 1.24: Modeling of the loco platform (bevel edge tool).

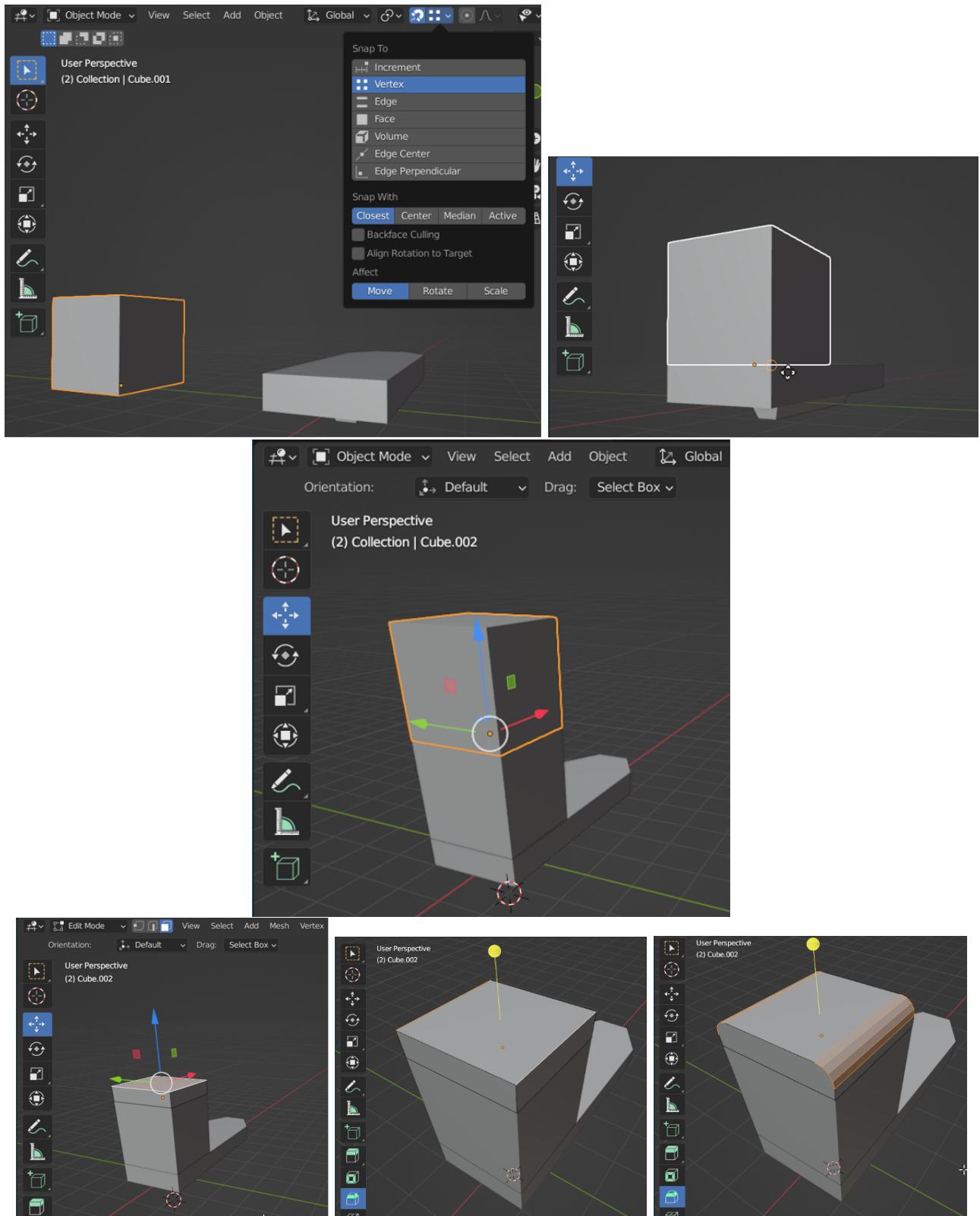


Figure 1.25: Creating loco cabin.

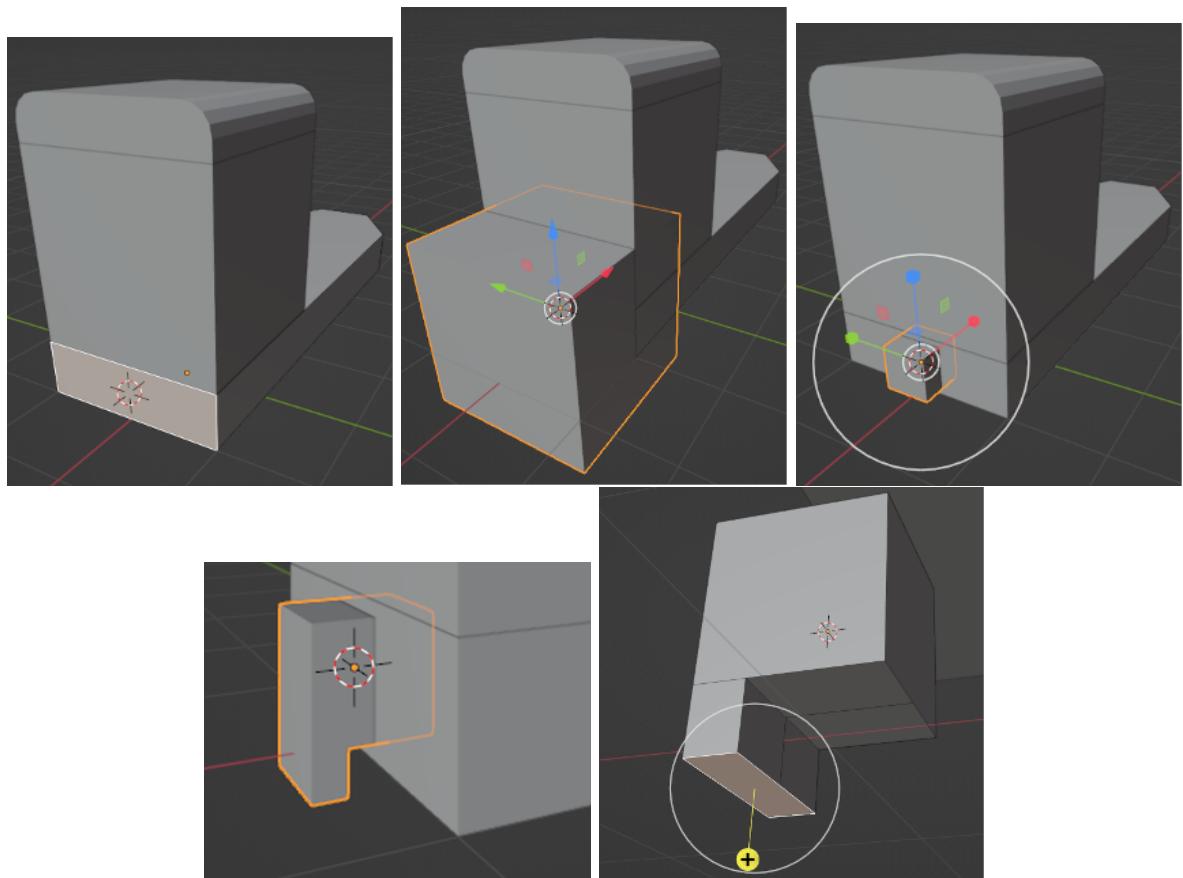


Figure 1.26: Modeling of the connector.

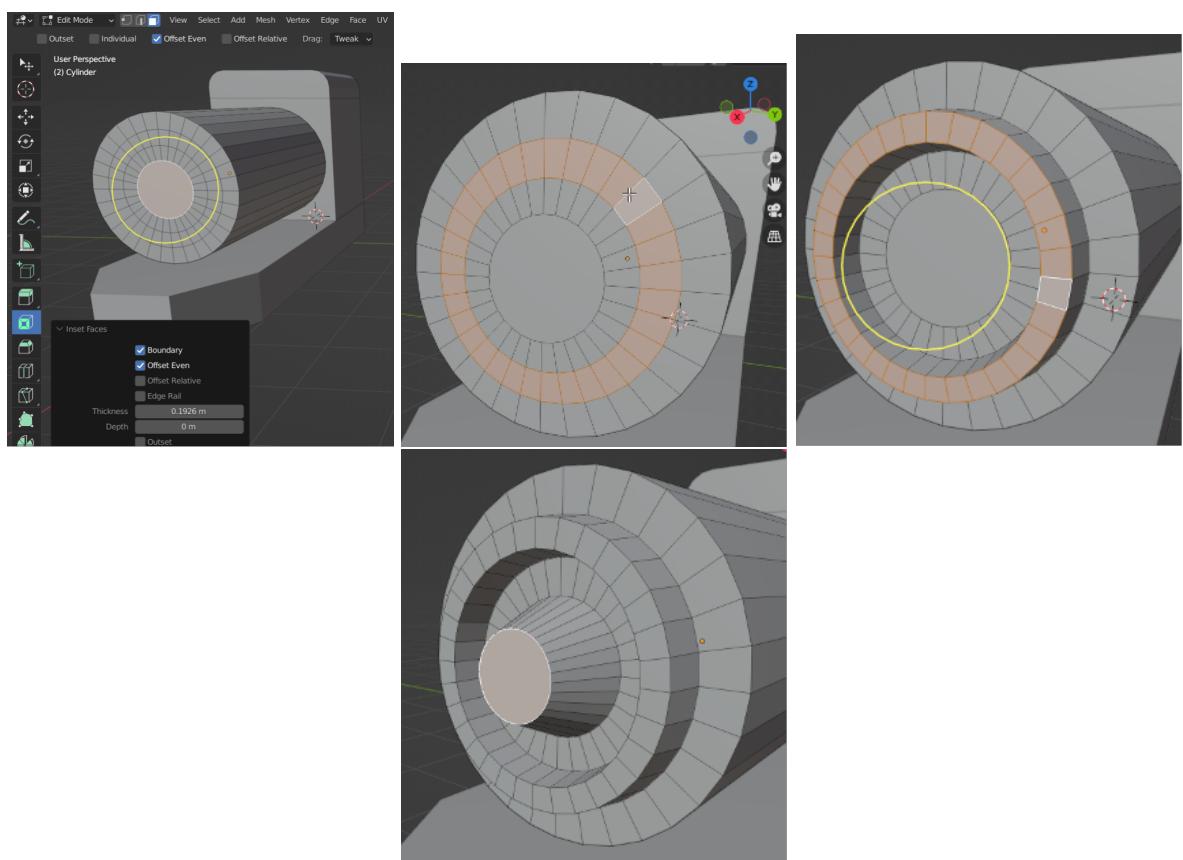


Figure 1.27: Modeling of the front of the smokebox.

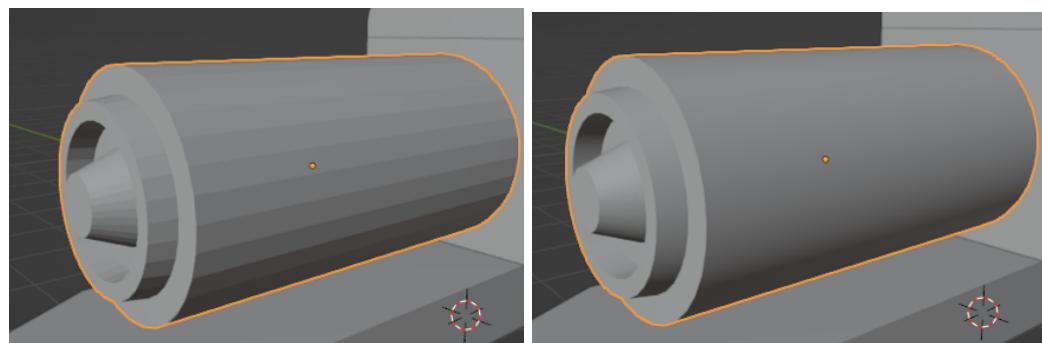


Figure 1.28: Autosmoothing of the object surface.

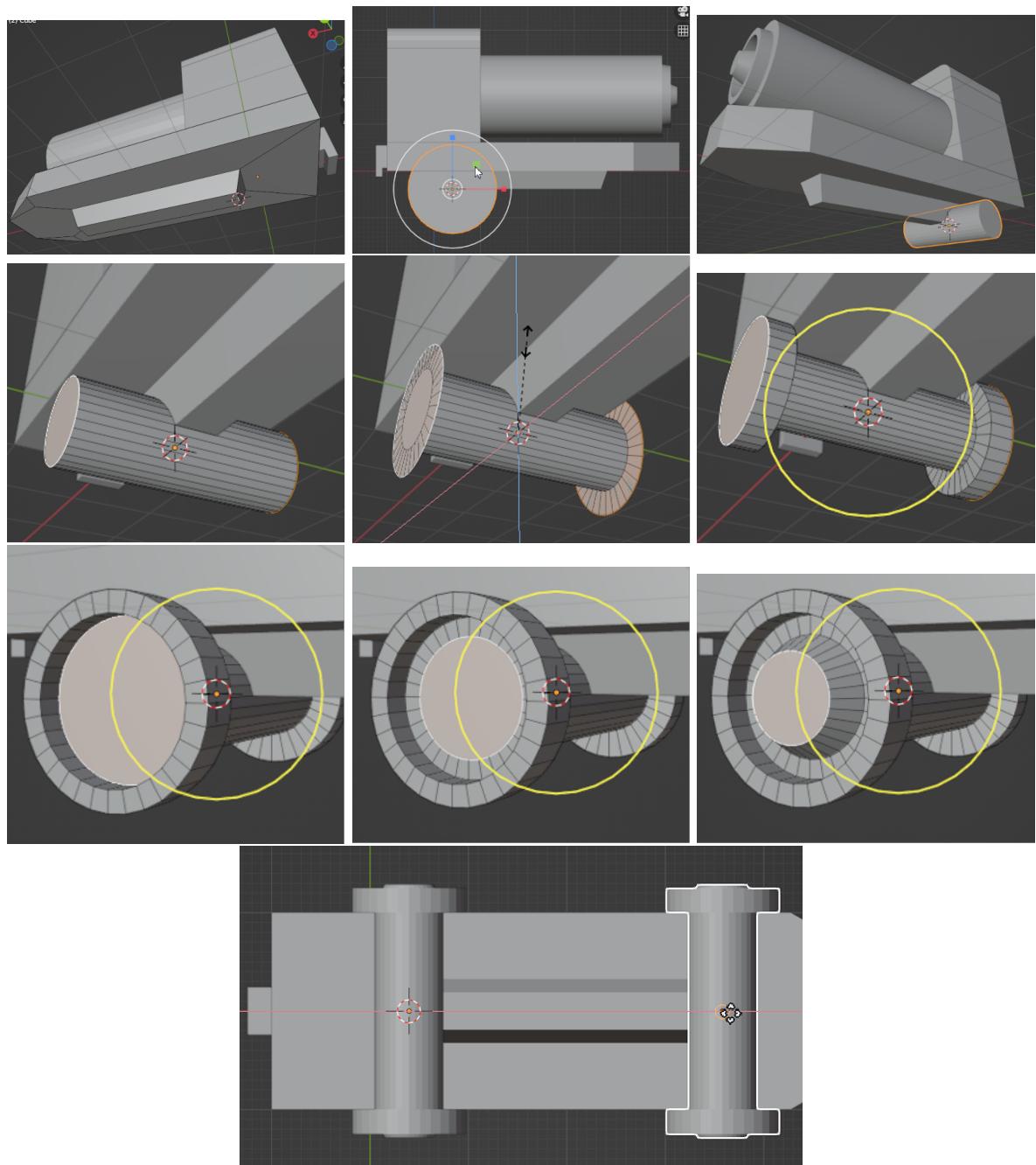


Figure 1.29: Modeling of the axles with wheels.

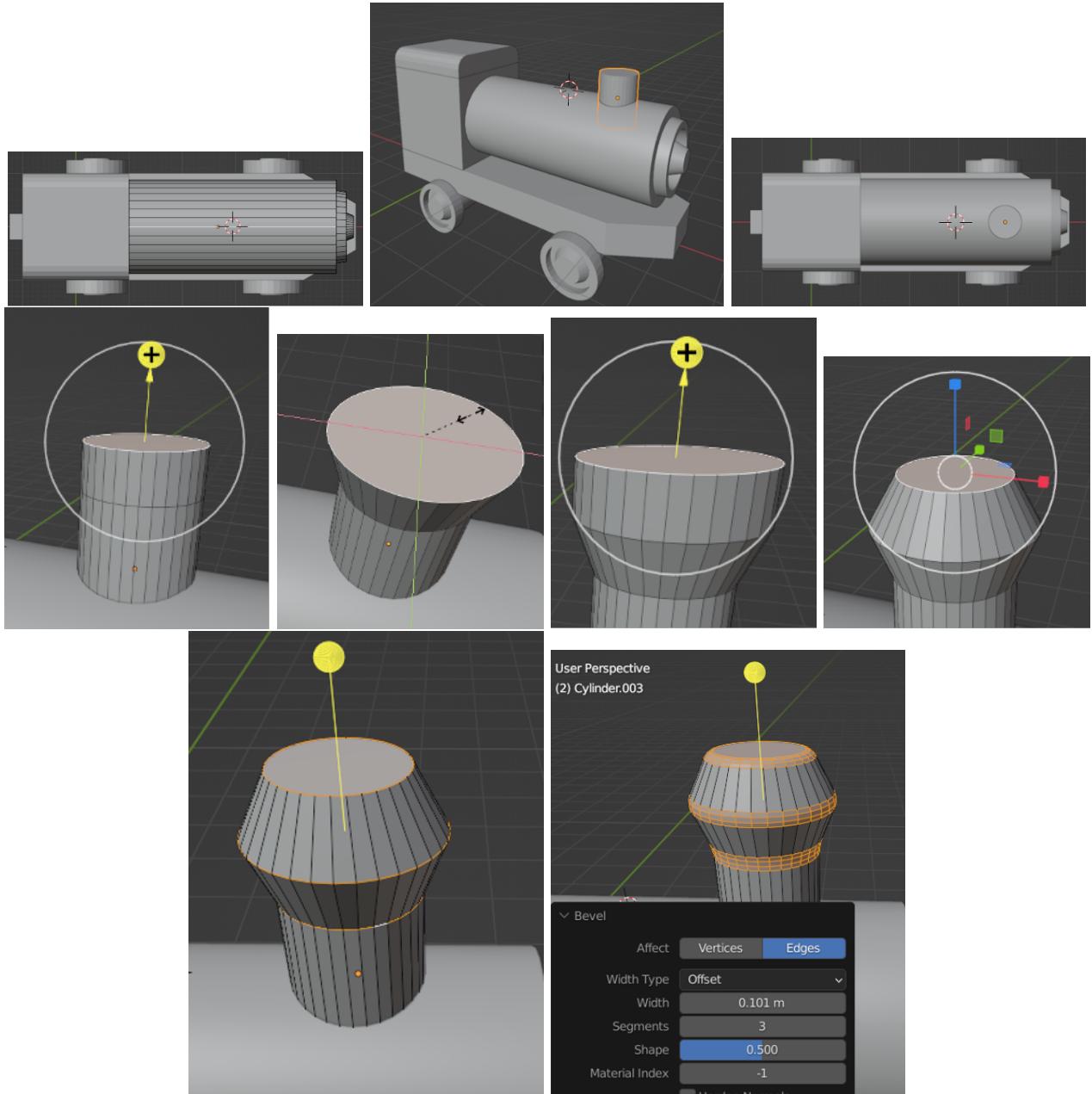


Figure 1.30: Modeling of the chimney.

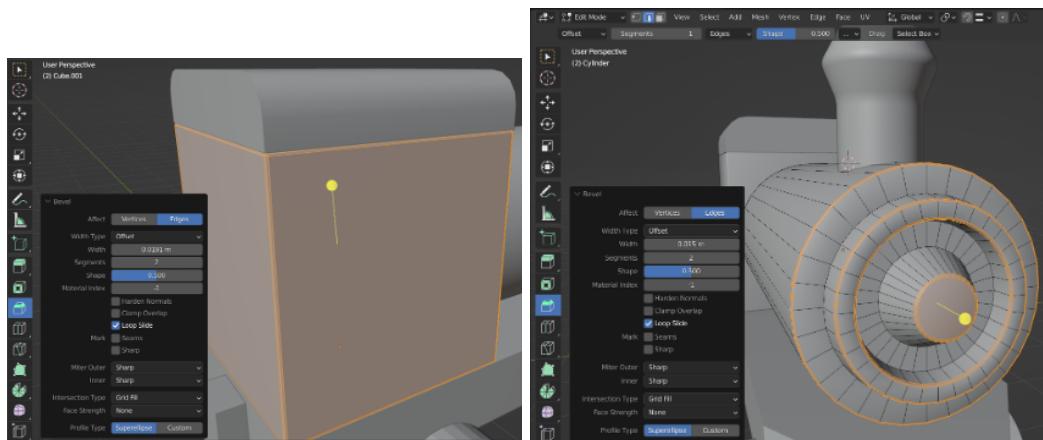


Figure 1.31: Beveling the selected edges.