Single-branched geometry

organically shaped in the
web editor

The web editor enables the quick and clear generation of single-branched geometries that can be shaped in a variety of ways.

The generated curves, partial constructions or shapes can be saved and imported later at any time, just like the complete design.
The geometry is exported as a three.js BufferGeometry or as a mesh in GLTF format.

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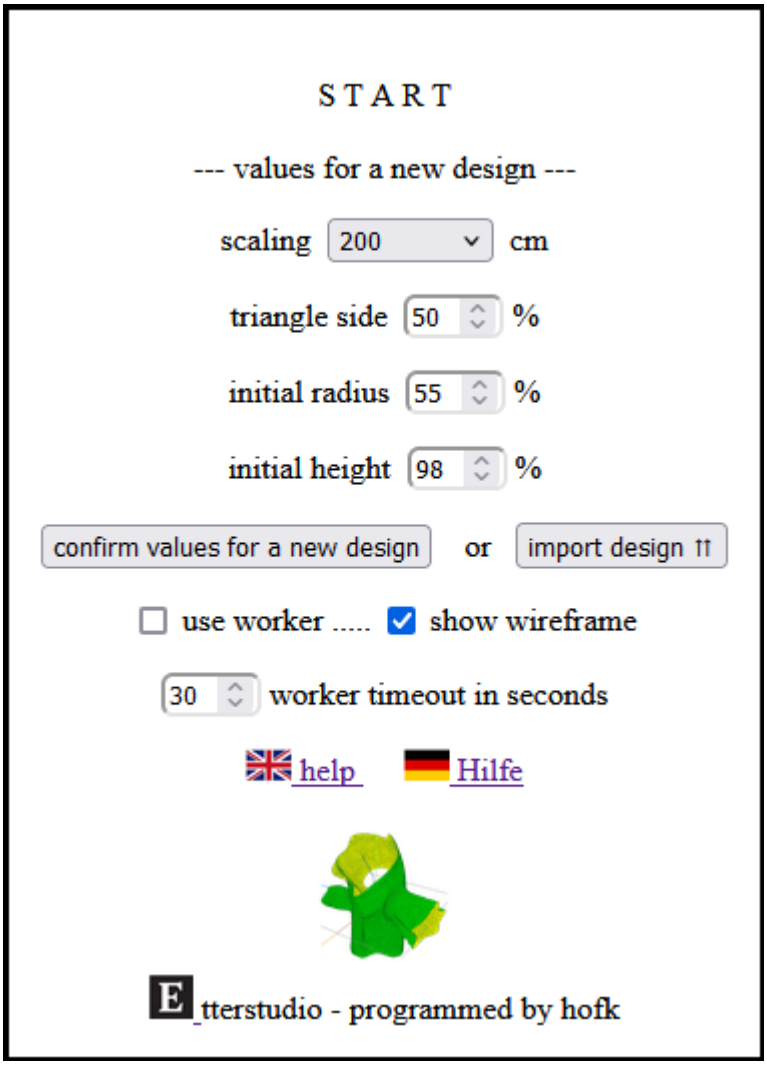
In the modal initial dialog,
you determine basic parameters
- for a new design or
- import a design, (saved
with **design ⇓** - see below).

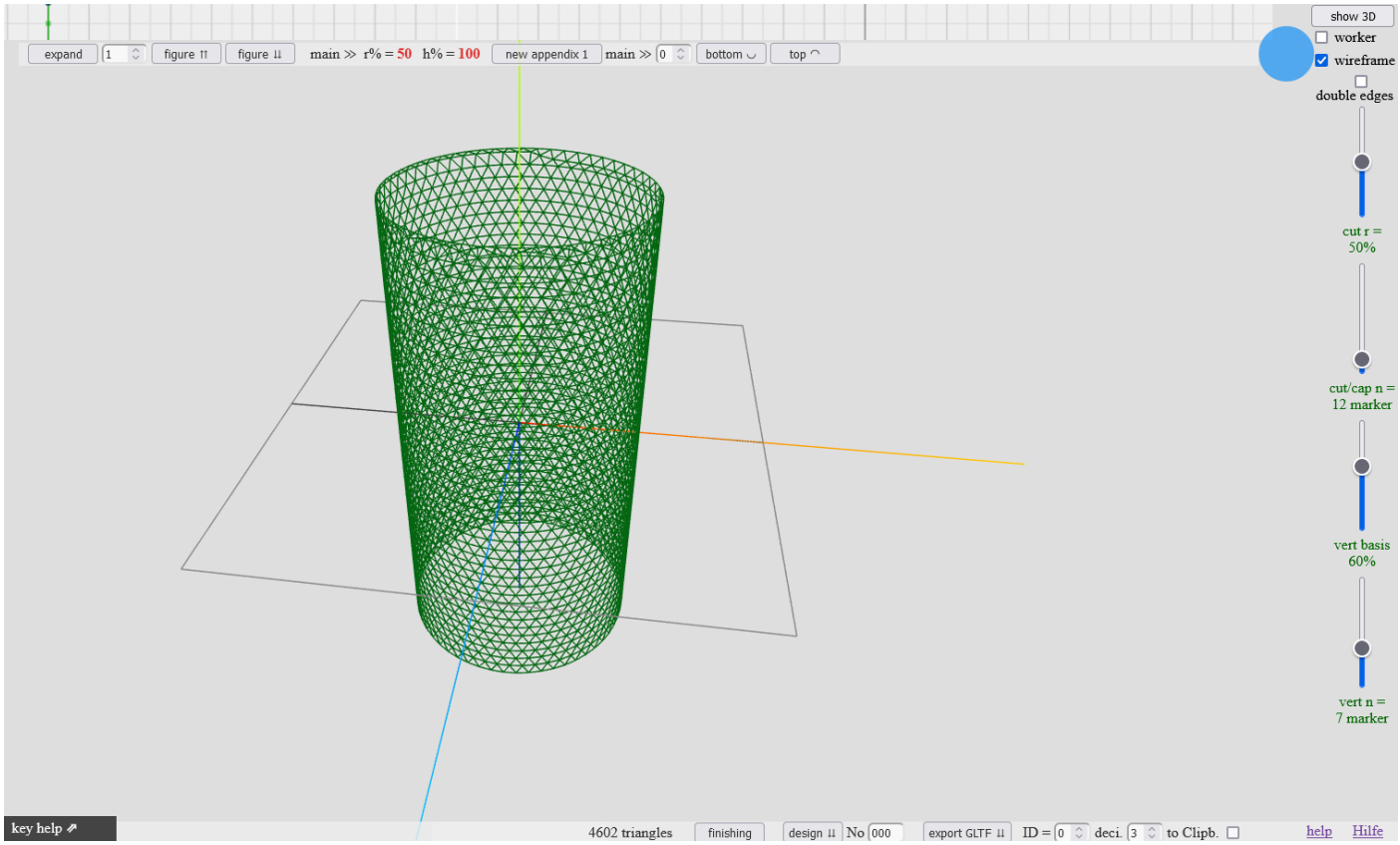
The possible scaling ranges from 40 to 200 cm.

Triangle side is used to define the relative size of the triangle sides for triangulation. Radius and height only refer to the main geometry. They can be changed later by stretching or compressing them with the mouse.

After confirming the dialog, the link to the PDF help file is located at the bottom right of the browser window.



If “show wireframe” is not checked, a two-color surface is also created.
This can be changed later at any time. The use of the web worker for complex geometries with small lengths of triangel sides can also be selected again and again. If the calculati-ons take too long without the web worker, the script terminates.



The main geometry is initially a simple cylinder.

The show 3D button at the top right restarts the triangulation calculation, positioning and deformation. The checkboxes worker and wireframe are taken into account.

Normally, the main geometry is completely merged with the appendices to be created using the **new append** button. This means that the double vertices on the common edges are merged into one vertex. If the **double edges** checkbox is ticked, no union is performed. This saves computing time in the development phase. However, it can also be used to create special effects such as gaps between the partial geometries. More on this below.

The **key help** table, initially at the bottom left, can be moved freely in the window.

The extent of the main construction area can be changed using the mouse pointer and the blue dot. To construct, drag the blue dot to the bottom right.

The construction area consists of two coordinate systems, the front view of the center line on the left and the top view on the right. In the top view, the three blue markers with

which the center curve can be changed are initially positioned on top of each other. The green markers in the left coordinate system are used to edit the cross-sections.

Mouse actions with key pressed (see also table key help)

.....

- on the blue markers when the crosshairs turn red:

m	⇒	move	move marker,
i	⇒	insert	insert marker in the center to the next,
d	⇒	delete	delete marker

- on the green or red markers:

c	⇒	cut	edit cut (cross-section), new coord. system, marker turns red,
s	⇒	shape	load file with cross-section shape, file selection,
r	⇒	remove	remove cross-section, red marker turns green again ,

Green and red markers can be hidden behind blue markers (top, bottom, ..) but are clickable. Red markers can be edited as required using the c key.

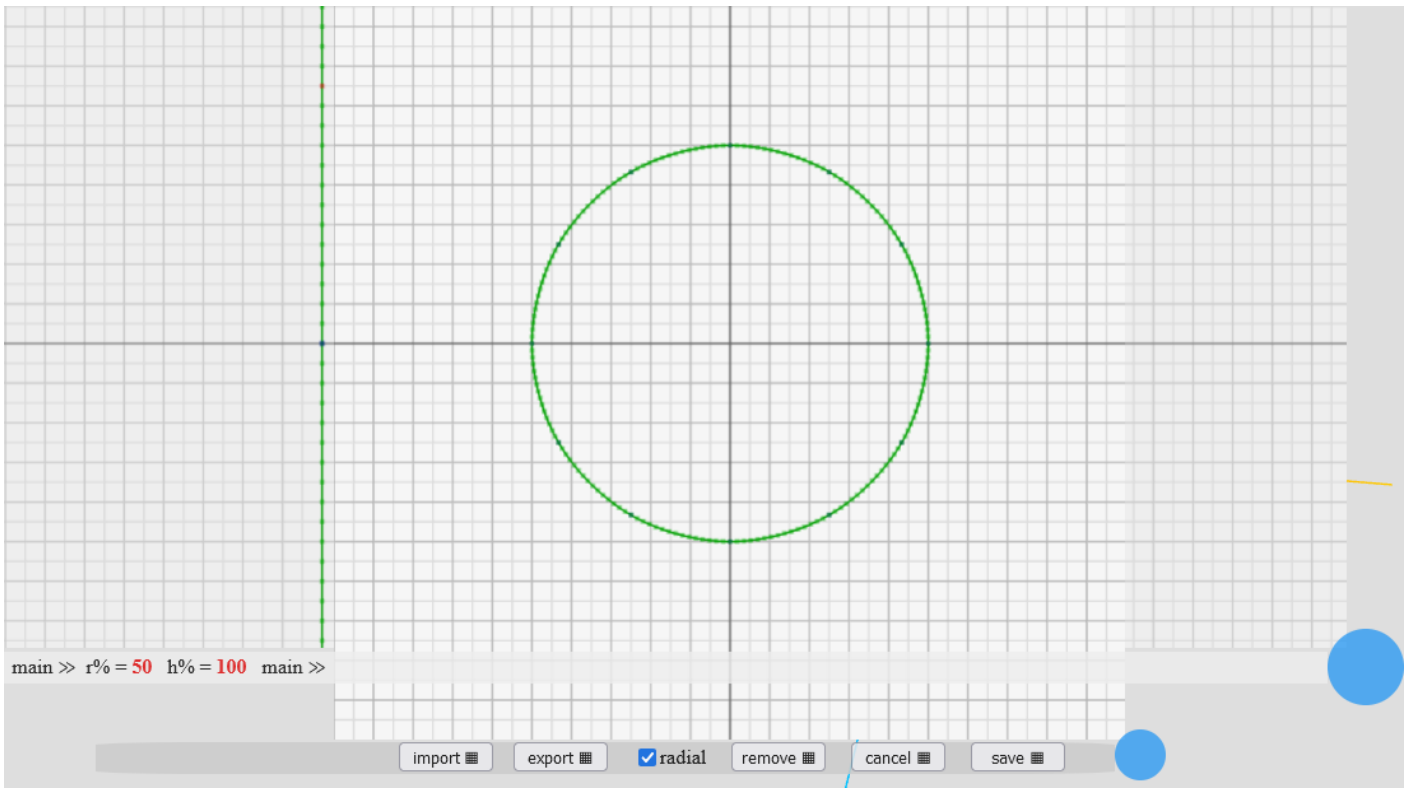
- somewhere in the left coordinate system:

v	⇒	vertical	new coordinate system for selecting the vertical to be processed on the circumference (only formally as a circle, no real cross section!)

.....

The new coordinate system (after clicking with the c key on the green marker) for editing the cross-sections moves horizontally if you move the mouse slowly over the smaller blue point without pressing a mouse button.

The two upper sliders on the right side of the window can be used to specify the percentage cutting radius **cut r** and the number of markers **cut/cap n** - *in advance!* The initial radius is preset.



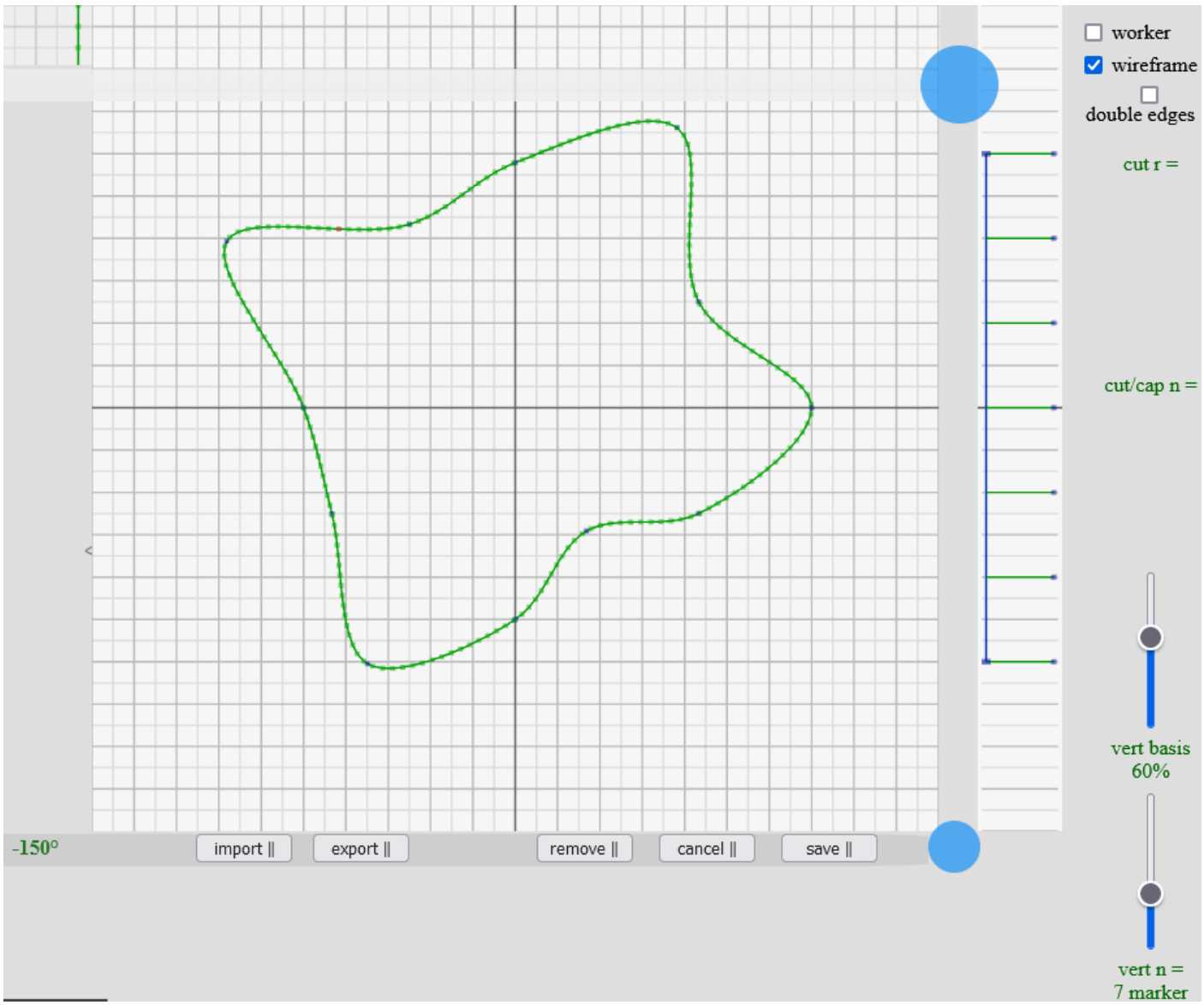
Use the **m key** to move a **blue** marker and the **s key** to scale all markers simultaneously. This produces a resulting intersection curve. If the **radial** checkbox is selected, only radial movements are possible. Then save with **save** ▦.

Actions performed can be made ineffective with the **cancel** ▦ button. The currently edited cross-section is deleted with **remove** ▦. With **export** ▦, the data of the section is displayed and can be exported.

You can transfer them to a text editor or download them. Note the checkbox at the bottom. to Clipb. ☐ When selected, the data is copied to the clipboard. With **import** ▦ such cross-section data is loaded.

Only the cross-sections at the lower and upper ends (cannot be removed, but can be set to the specified radius with the **r key**) and those at the red markers (can be hidden behind blue markers!) are used to form the envelope curve .

The **green** markers on the section curve are used for **vertical editing** and can be clicked on using the **v key** . The marker turns **red** and an editable display of the relative heights of all vertical planes appears on the right. This means that it does not matter in which sectional view the vertical editing is called up. The distinction between the markers is clearest in the display called up with **v** in the first coordinate system on the left.



The vertical angle is displayed to the left of the import button. At the bottom is 0°, on the left the angles are negative.

Use the **vert basis** slider to set the relative representation of the base height on the left-hand side of this narrow construction area. The purpose of this is that you can display large expansions with a small value and edit compressions more precisely with a large value. The **vert n** slider determines the number of heights to be displayed in advance.

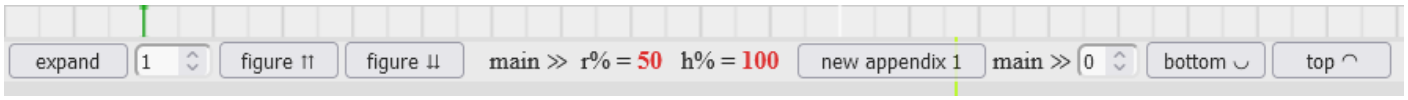
The base height can be subsequently changed by holding down the **n key** with the mouse. The markers on the right of the surface are not changed and the vertical distribution changes. The sliders are not changed and indicate the initial values!

Use the **m key** to move the individual heights on the right-hand side as required; the index is displayed next to the blue dot. Overlaps of the marker lines are also useful if you edit the cross-sections accordingly and, for example, turn the upper edge inwards or outwards.

Press **save** ‖ to save. If you now click on a red marker with the **v key**, the saved display is loaded and can be edited. Press **cancel** ‖ to cancel without saving and **remove** ‖ to remove the vertical arrangement. Just like the cross-section, the vertical distribution can also be exported. The data generated with **export** ‖ contains the relative heights and, as the last element, the value of the base. The **import** ‖ button can be used to load a vertical distribution.

After closing the height editing, a vertical distribution (red marker) can also be removed by pressing the **r key** and clicking. Only the edited areas on the perimeter are used for the overall vertical arrangement. Here too, red markers can be hidden behind blue ones, but can be selected! Reference arrangements are also required for the vertical arrangement. They are located at -90° and +90° and cannot be deleted but can be edited. The attempt to delete them is acknowledged with the message that this is not possible for the vertical reference arrangements.

There are some values and buttons at the bottom of the main construction area.

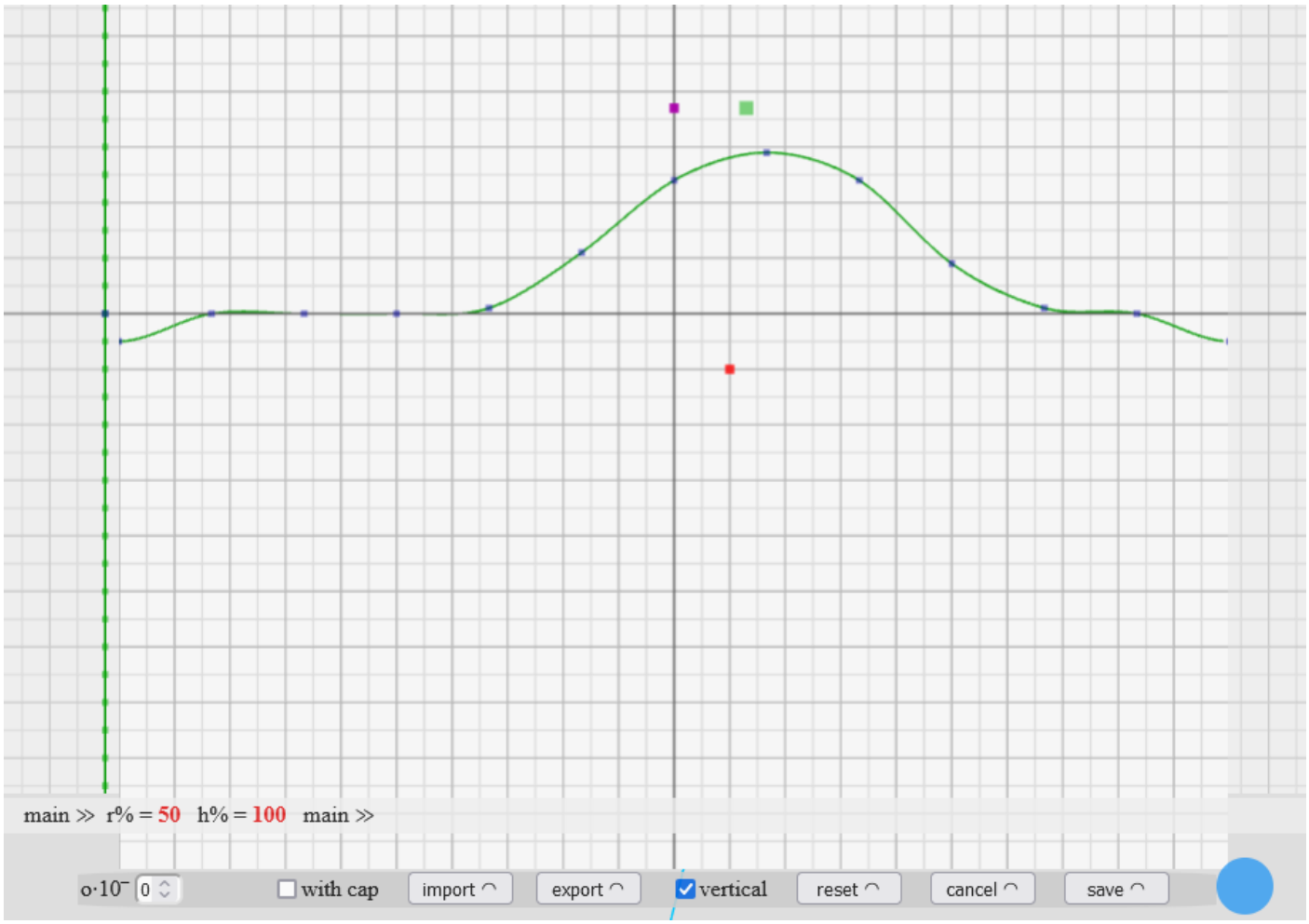


The number in the right-hand input field indicates the current index of the appendix, starting with 1, whereby 0 stands for the main geometry. The value in this field is used to select the processing of the main geometry or an appendix. Incorrect entries are intercepted with a warning message.

By entering a scaling value (0.05 ... 2.0) and clicking on the expand button, you can scale the diameter of the figure being edited. However, the cutting curves remain unchanged.

The figure can be saved using the **figure** ⇊ button. Only the cross-sections, vertical distributions, edges and caps are saved, but not the centerline. This allows you to load a saved figure into other appendices or the main geometry with **figure** ⇈. However, you must note that the triangle size from the start dialog is not changed.

Use the **bottom** ◡ and **top** ◠ buttons
to select the processing of the lower and upper boundary curves and the caps in an extra coordinate system.



The number of blue markers on the boundary curve is selected in advance using the slider **cut/cap n** on the right, the angle in the middle is 0° and the angles to the left are displayed negatively up to -180° when moving with the **m key** on the crosshairs. The left and right markers are identical in content (-180° = 180°). They are moved synchronously. The minimum point of the curve at **bottom** ◡ and the maximum point at **top** ◠ represent the limit according to the selected height. This means that every curve moved in parallel produces the same result. Normally you move the markers **vertically**, but for special effects you can deactivate the checkbox and move the marker slanted.

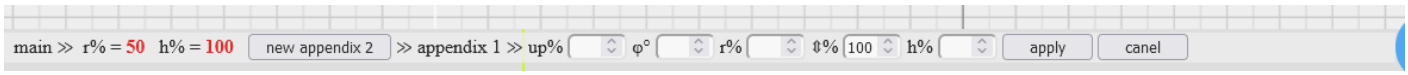
If **with cap** is selected, a cap is generated. Use the red marker and the t (translate) key to change the position of the center, the green marker and the o (opening) key to change the upper opening of the cap and the magenta marker and the h (height) key to change the cap height. For very small openings, increase the decimal exponent $o \cdot 10^{-}$ in the input field on the left. Initially, the slightly larger green marker is located below the height

marker. The red marker can be moved freely, the height marker only vertically and the opening marker only horizontally and partially limited, as it must not exceed the radius.

The **import, export, reset, cancel, save** functions are available using the buttons at the bottom, similar to the cross-sections.

With the **new appendix ..** button,
which also shows the index of the next appendix, a new appendix is generated. The fixed values for the radius and height of the main geometry are displayed to the left.

After clicking on **new appendix 1** you will get the following display.

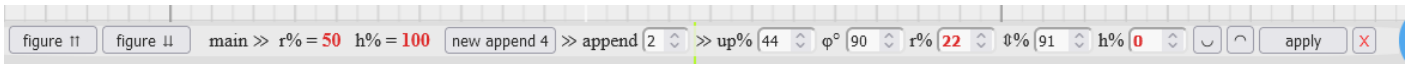


For a new appendix, enter the relative level **up** to the main geometry,
the position angle **φ** in ° and the relative radius **r**, the relative elongation of the hole in the main geometry ⇳ and the relative height **h** (or length). The angle 0° results in an appendix to the front (z axis), negative angles are possible. Radius and height are also initial here and are then changed by stretching or compression.

If a 0 is entered for the height **h**, only a corresponding hole is created in the main geometry. Subsequent stretching is therefore not possible. With **apply** the values are accepted and the 3D representation is displayed, with **cancel** the creation of the appendix is canceled. If you forget to enter a value, a warning message appears.

With **apply**, the values for radius and height are fixed and displayed in red. It is no longer possible to make changes; further changes to the shape are made by stretching, compressing, moving markers and editing cross-sections and verticals.

Once an appendix has been created, the buttons ◡ ◠ for editing the lower and upper boundary curves/caps and a button with an **x** appear on the right.



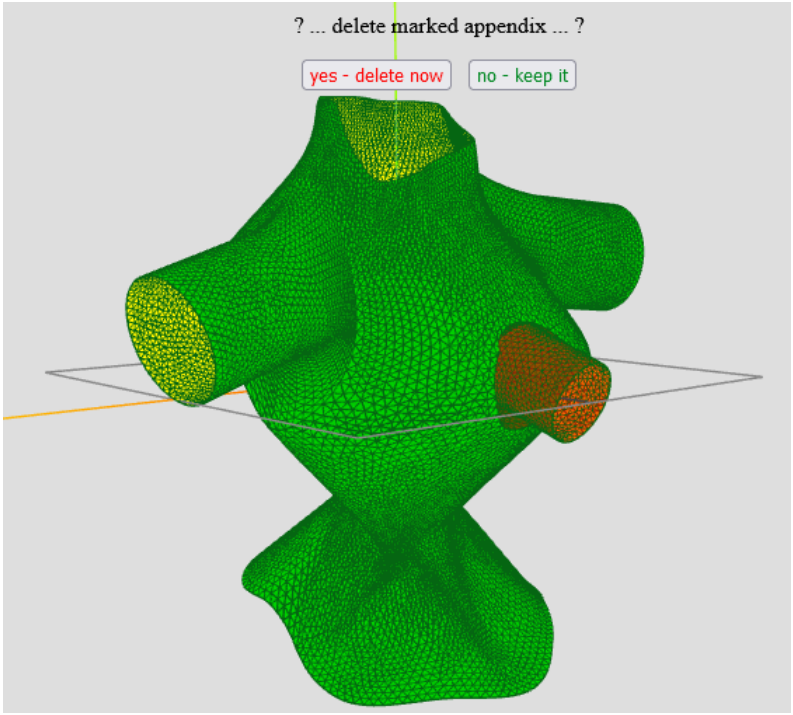
In the picture, 3 appendices have already been created and appendix 2 is selected.

After clicking on the x button, the corresponding appendix highlighted in red in the 3D view. This allows you to keep track of multiple appendices and you can now choose between the buttons

yes – delete now

or no – keep it

delete the appendix or keep it in the construction.



appendix can be deleted ⇒

Caps are not marked in color,
but are of course also deleted.

Use the **figure** ⇊ button to save the figure of the main geometry or an appendix. The figure consists of the cross-sections, vertical distributions and the boundary curves and caps. The bending, stretching/compression and displacement of the center line are not included. However, you can use the **figure**⇈ button to load such a figure into the main geometry or an appendix as required.

IMPORTANT !

The construction surfaces always refer to the appendix with the index after ≫ append or to main ≫ for the main geometry.

If you move the lower marker on the vertical axis (for an appendix) in the left main construction area (front view of the center line), the start of the appendix moves away from or closer to the main geometry. The connection geometry automatically adapts to this.

The position of the appendices (**up, ϕ**) and the stretching ⇳ determine the holes in the main geometry. If these are too close together or at the edge, an error occurs in the triangulation algorithm for the main geometry (typically `front[m] is undefined`) and the script aborts or the browser issues a message about its slowdown. The upper and lower boundary curves must also not be too close.

The (**approximate!**) triangle length of the triangulation, which is defined in the initial modal dialog, significantly influences the possible minimum distance. A prior check of the distance has not yet been integrated and is also problematic, as the triangulation is not static and too large a distance value would have to be selected for safety reasons. It is better to determine the possible approximation through tests in a given case.

With the **design ⇊** button, a complete design is copied into a text field, marked there and, if **toClipb.** is selected, copied to the clipboard. The data can be saved immediately using the download button. The design can be loaded in the initial dialog when the application is started. Unlike the shape, the exported design also contains the bends, extensions/compressions of the center lines of the main geometry and the appendices. For a convenient ongoing backup, press the **space bar** and the design is immediately downloaded with a sequential three-digit number: nnn-dsgn.txt. The initial number can be entered in three digits (No).
A separate folder should be created for each new design.

Use the **export GLTF ⇊** button at the bottom right to copy the complete three.js geometry definition into a text field, where it is marked and possibly copied to the clipboard. This allows you to copy it directly into a three.js project. The data can be downloaded and exported as a GLTF mesh using a button. The mesh must be displayed with the **wireframe** option in the viewer (e.g. https://gltf-viewer.donmccurdy.com/). Before saving, you can enter the ID of the design or geometry and the number of decimal places to be exported in the input fields. When exporting, the ID is part of the heading (as a comment), for the design, the identification after D,S is the third entry.

The main geometry and the appendices (with connection and caps) are always combined into a single geometry after the design and before the 3D display and exported if required. If the **double edges** checkbox is ticked, the separate partial geometries are simply connected to each other. This means that all seam points are duplicated and the two vertex normals at the seam are different. Otherwise, the duplicate vertices are merged and all indices of the triangles are recalculated. This results in uniform vertex normals for the entire geometry. This produces different results at the seams during finishing. The choice of variant can also be of interest for the further use of the geometry.

The exported geometry definition has the following structure, for example.

```
/*... indexed BufferGeometry  ID 0 ... */

const geometry_0 = new THREE.BufferGeometry();
geometry_0.indices = new Uint32Array( [ 4,
  ...
       312 ] );
geometry_0.positions = new Float32Array( [ 9.9,
  ...
      35.6 ] );
geometry_0.setIndex( new THREE.BufferAttribute( geometry_0.indices, 1 ) );
geometry_0.setAttribute('position', new THREE.BufferAttribute( geometry_0.positions, 3 ));
```

The **finishing** button takes you to an additional final processing of the geometry in the 3D display with the help of Raycast. A warning with instructions is displayed and the process can be canceled. If the finishing process is started, it is no longer possible to return to the general editing of the geometry. The geometry can only be exported, the design must be saved beforehand! The selection of **double edges** must be made in advance if required.

During final editing, you can use the mouse and a few buttons to create local bumps and indentations on the surface. All steps can be undone using the button 

that then appears to the left of the click checkbox.

For circular local changes with a radius and a depth (or height), various functions can be selected for the radius, from simple multiplication * to various angle function variants.

If **singly** is selected, each point is moved outwards (forwards, forth) or inwards (backwards, back) along its own vertex normal, otherwise the normal of the point determined by mouse and raycast is used uniformly for all points.

If the **click** checkbox is selected, you only need to click on the surface as the forth and back radio buttons are active. Alternatively, you can click using the f or b keys. The use of the f and b keys has priority, even if the **click** checkbox is selected.

Click and press the p (point) key to set points for a curve. The point on the vertex is marked in red. With the second point, the curve is symbolically displayed as a tube with the selected radius. The selected depth cannot be displayed. The set points can be removed one after the other by pressing the r (remove) key.

Local surface changes can also be created during curve processing with forth or back.

After pressing the e (end of curve) key, the curved change is realized.
The selected function is also relevant here. Each point is shifted along its vertex normal.
It is therefore important to make the correct setting for **double edges** in advance, depending on the requirements.

Possible errors due to the non-deterministic triangulation algorithm:

For example, a stretch ⇳ 100% resulted in no 3D display and an error message appeared in the console. After changing to 99% or 101%, the triangulation in this particular case worked without any problems and the script was not terminated.

In other cases, the script aborts and you have to start again.

It therefore makes sense to save partial results very frequently - press the **space bar**.

The freely movable keyboard helper:

The areas stand for the different construction coordinate systems or machining areas.

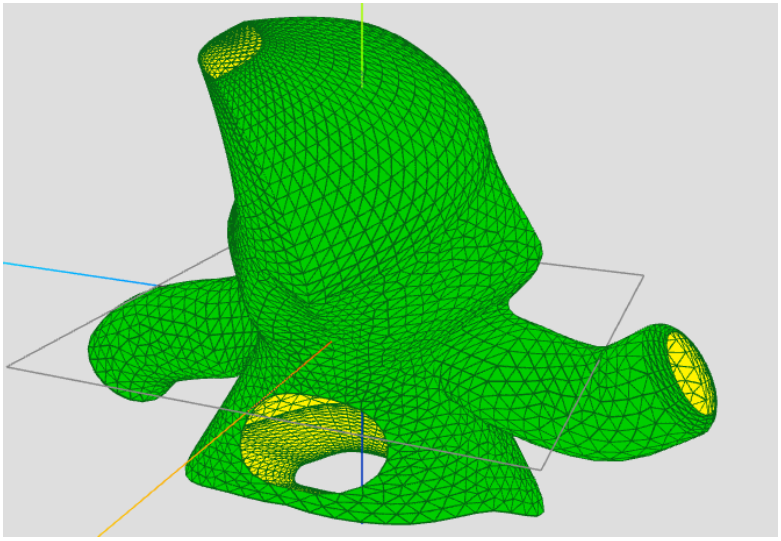
MAIN main construction centerline front view left, top view right,
CUT cross-section machining,
VERT vertical machining, narrow system, one dimension,
CAP edges and caps,
FIN 3D finishing via raycast in the 3D view

***** press key on mouse click / on movement / always ***** key help ⇗		
area	**key**	**meaning / effect**
	␣	(spacebar) download design file: nnn-dsgn.txt
MAIN	m	on blue - move
.	i	on blue - insert
.	d	on blue - delete
.	c	on green - open CUT editing for the clicked elevation point
.	s	on green - load file with cross-section shape, file selection
.	r	on green - remove cross section
.	v	left system: open VERTical editing on the circumference
CUT	m	on blue - move
.	s	on blue - scale cross-section shape
.	v	on green - open VERTical editing
VERT	n	on blue left - change in base height
.	m	on blue right - move the individual heights
CAP	m	on blue - move edge height
.	t	on red - translate position of the center, any
.	o	on green - upper opening of the cap, horizontal
.	h	on magenta - change of cap height, vertical
FIN 3D	f	forth - take if not click box checked
.	b	back - take if not click box checked
.	p	set a point for the curve
without click:	r	remove last curve point
without click:	e	end of curve formation

Start of the design file of a geometry

```
D,S,0,200,0.067,|
```

`D,S,` stands for Design, ID = `0,` scaling = `200`cm, triangle side = `0.067`



The ID, scaling and triangle side values can be changed using a text editor.

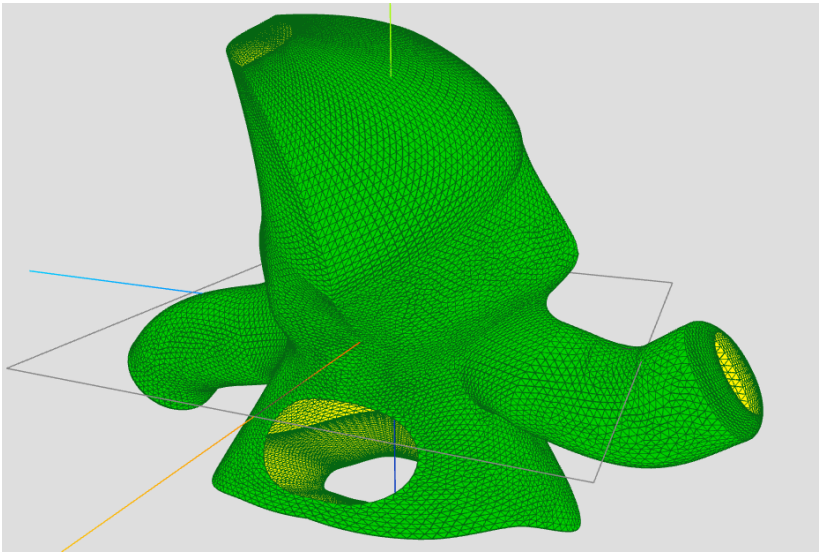
The scaling is visible on the construction areas during editing.

Values other than those in the selection can also be specified.

A reduced triangular side usually works without any problems. If not, change the value slightly. When enlarging, the script may well stop more often because the boundary lines are too close together. In the picture, only two triangles fit between the hole and the lower boundary of the main geometry.

After changing to

```
D,S,7,20,0.03,|
```



you get the following picture:

This is helpful if you only realize later that you want to add an appendix or hole and it no longer works with the original size of the triangle sides.