

Volume-based modeling with Symvol for Rhino.

Aim: The study of the process of the geometric modeling with using Constructive Solid Geometry (CSG) and Function Representation (FRep).

Task: Create of 3D models using the geometric modeling system - Rhino.

Result: The source code. The report.

Theoretical part:

Volume-based modeling is connected with Constructive Solid Geometry technique (CSG) (Requicha & Voelcker, 1977) that considers simple solids (primitives) as an elementary units of the model. Typically they are the objects of simple shape: cuboids, cylinders, prisms, pyramids, spheres, cones. More complex models in CSG can be constructed by applying set-theoretical operations to primitives, union, intersection and difference, as well as geometric transformations of those sets.

Volume-based modeling allows us to model as typical parts using conventional tools, as regular an irregularly lattices and cellular microstructures (Fryazinov, et al., 2013) (Pasko, et al., 2011).

Using preinstalled software Rhino 5 with Plugin Symvol. The screenshot of main widow is shown in Figure 1

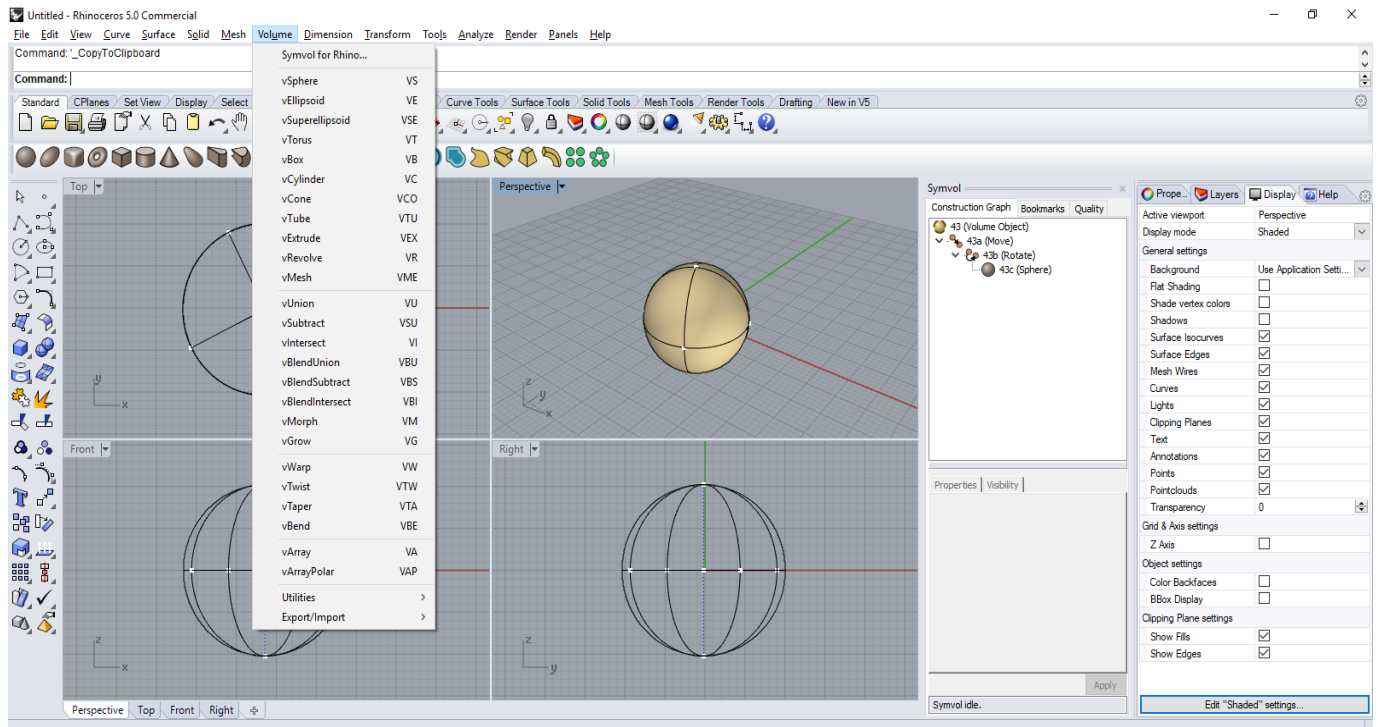


Figure 1 The screenshot of main widow



Figure 2 Main menu of plugin

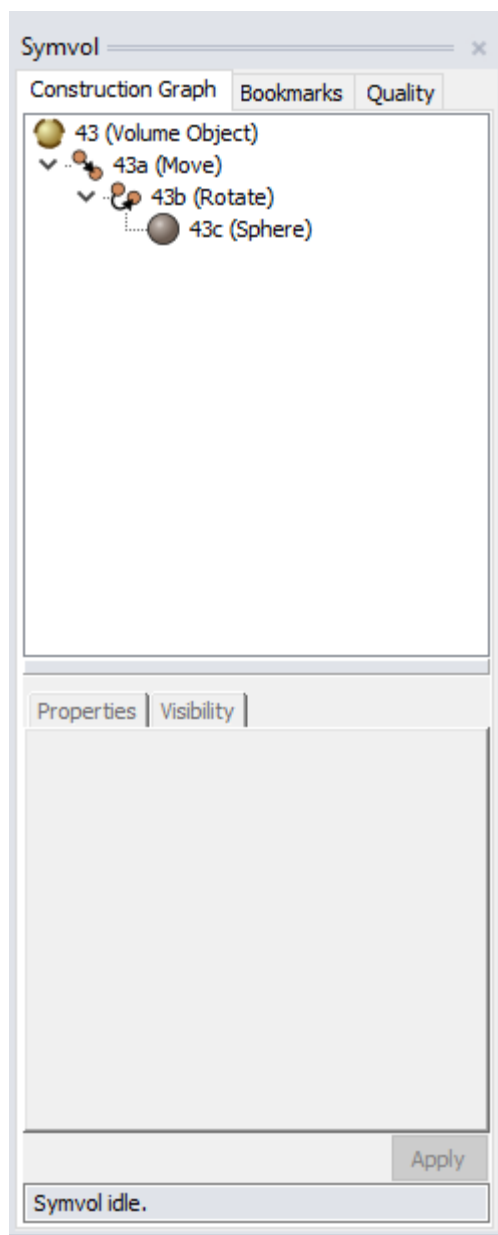


Figure 3 CSG tree of the modeling scene with properties

Applying CSG operations for primitives:

1. Create two shapes (torus and cone in example Figure 4a).
2. Choose union operation in menu Figure 2 and select your primitives.
3. In the properties window you can change operation to subtract or intersect (Figure 4b).
4. Change operation on blending: In the CSG tree window to click right mouse button and change operation on blend (Figure 4c).

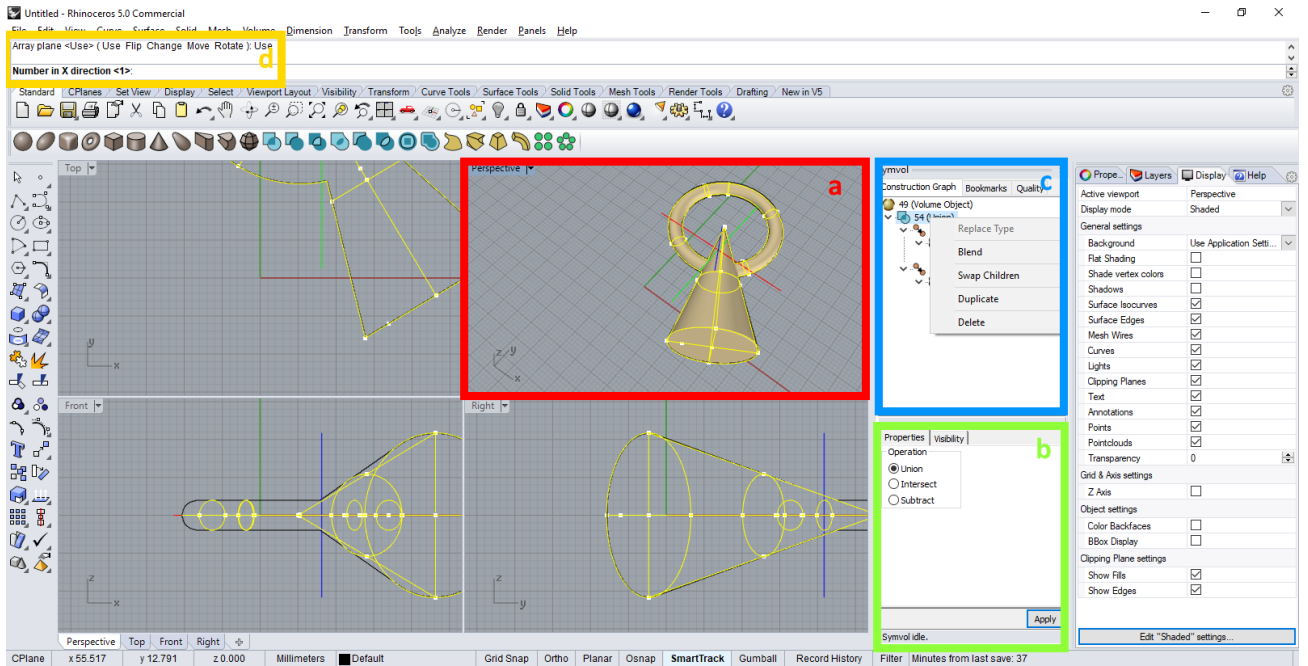


Figure 4 Example union operation

Create cellular objects.

1. Select operation “Array” in menu Figure 2
2. Choose your shape.
3. Set parameters: number of shapes in X,Y and Z direction (Figure 4d).
4. Set parameters: spacing between repeated shapes in mention directions (Figure 5).

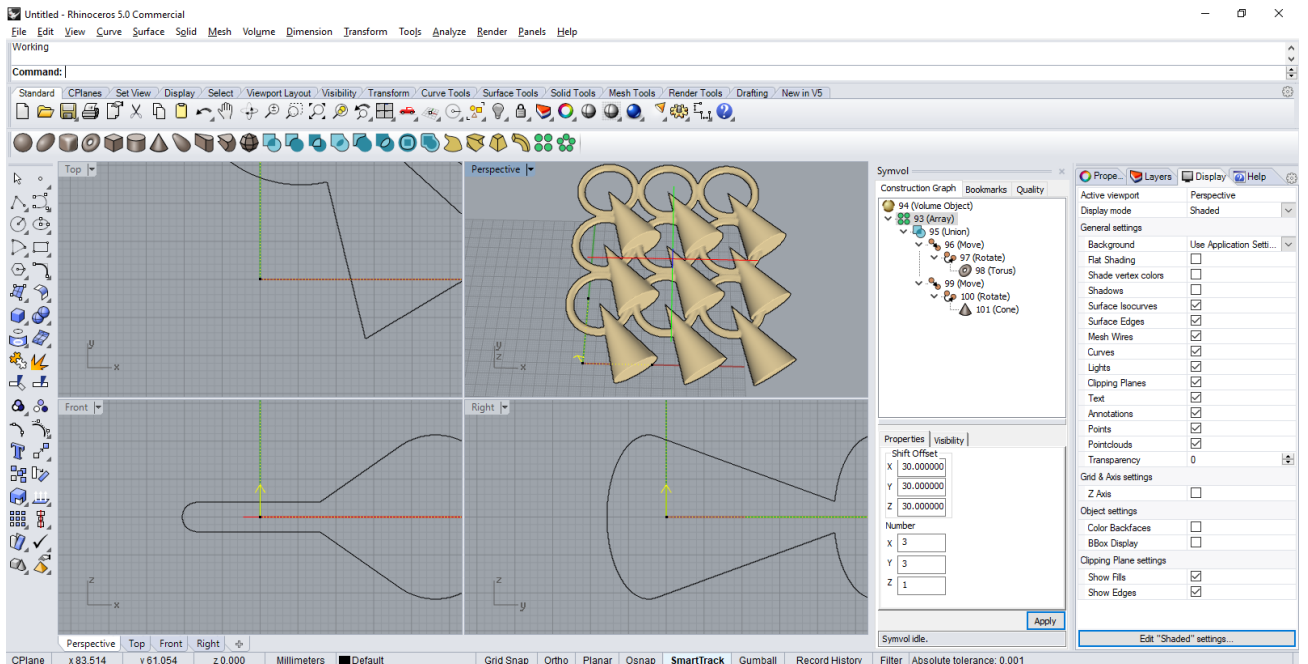
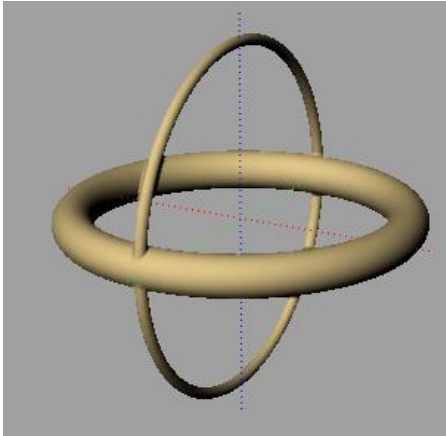


Figure 5 Operation “array”

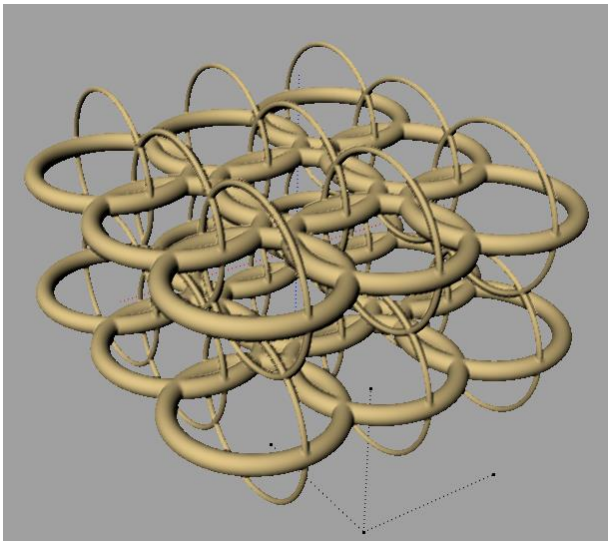
Tasks:

Create your own shape with cellular microstructure.

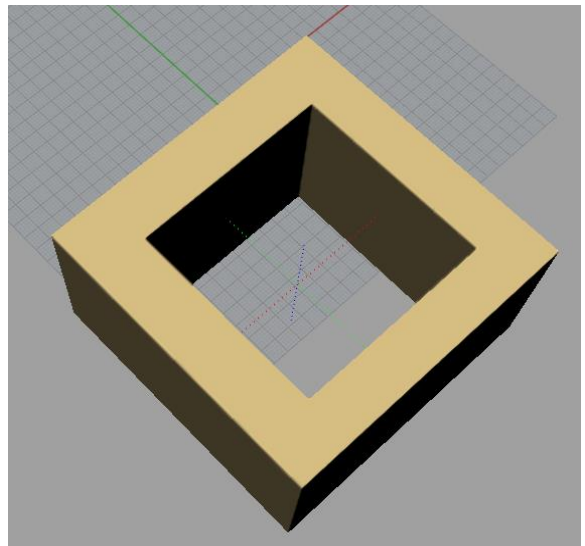
Example:



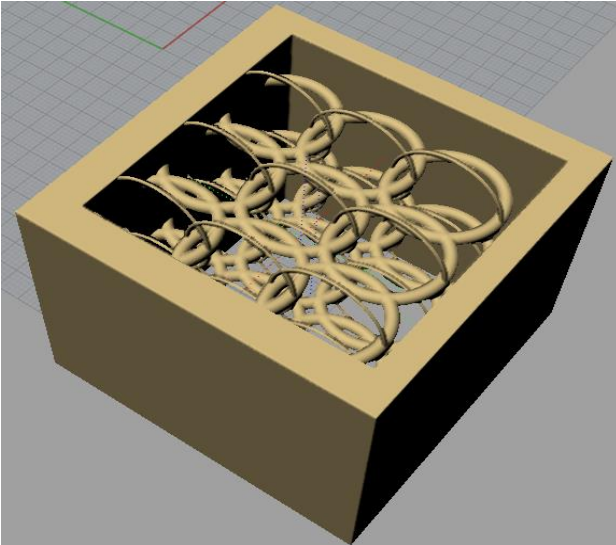
(Array) x10 x10 x10



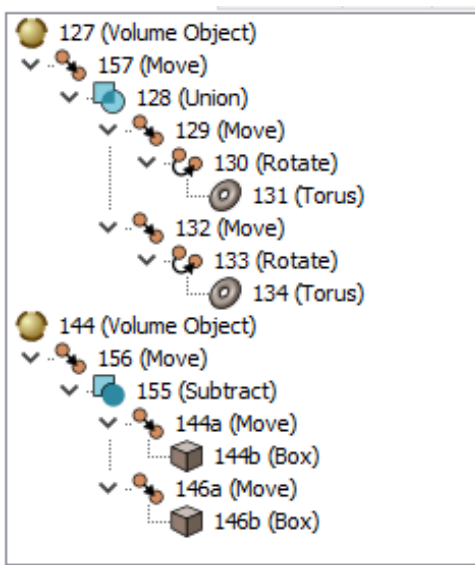
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Result:



Tree of the shape:



References

- Fryazinov, O., Vilbrandt, T. & Pasko, A., 2013. Multi-scale space-variant FRep cellular structures. *Computer-Aided Design*, 45(1), p. 26–34.
- Pasko, A. и др., 2011. Procedural Function-based Modelling of Volumetric Microstructures. *Graphical Models*, 73(5), p. 165–181.
- Requicha, A. G. & Voelcker, H. B., 1977. *Constructive solid geometry*, Rochester: College of Engineering & Applied Science. The University of Rochester.