Shape Deformation (I)

Volume-based deformation

Parametric deformation

Parametric deformation

Use succession of parameterized space varying deformation

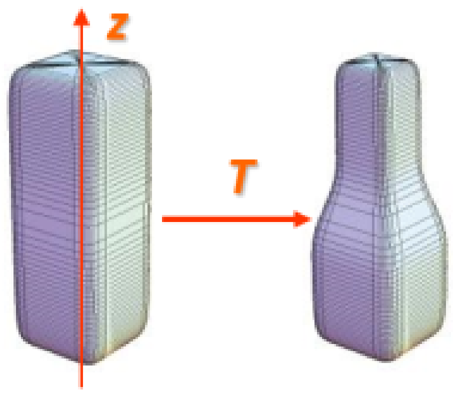
- Rotation: Bending, Twisting
- Scaling: Squeezing/tapering, Stretch

Old idea: First proposed in

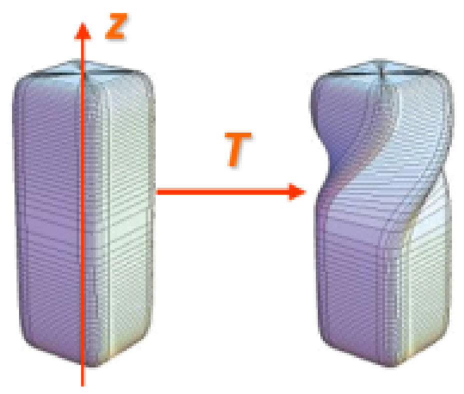
[Alan H. Barr. Global and Local Deformations of Solid Primitives. SIGGRAPH 1984]

(+) Explicit formulation $q = f(p)$

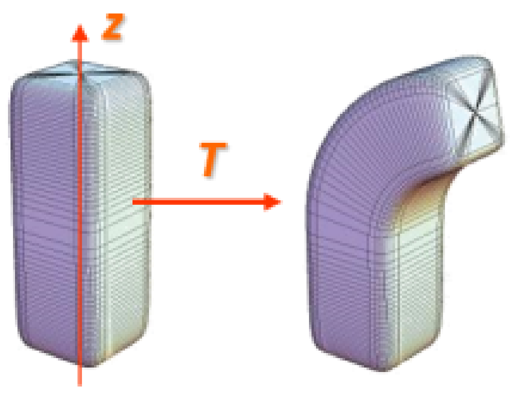
(-) Limited degrees of freedom



$$\begin{pmatrix} s(z) & 0 & 0 & 0 \\ 0 & s(z) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} p_x \\ p_y \\ p_z \\ 1 \end{pmatrix}$$



$$\begin{pmatrix} \cos\theta(z) & \sin\theta(z) & 0 & 0 \\ -\sin\theta(z) & \cos\theta(z) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} p_x \\ p_y \\ p_z \\ 1 \end{pmatrix}$$



$$\begin{pmatrix} \cos\theta(z) & 0 & -\sin\theta(z) & 0 \\ 0 & 1 & 0 & 0 \\ \sin\theta(z) & 0 & \cos\theta(z) & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} p_x \\ p_y \\ p_z \\ 1 \end{pmatrix}$$

Local deformers

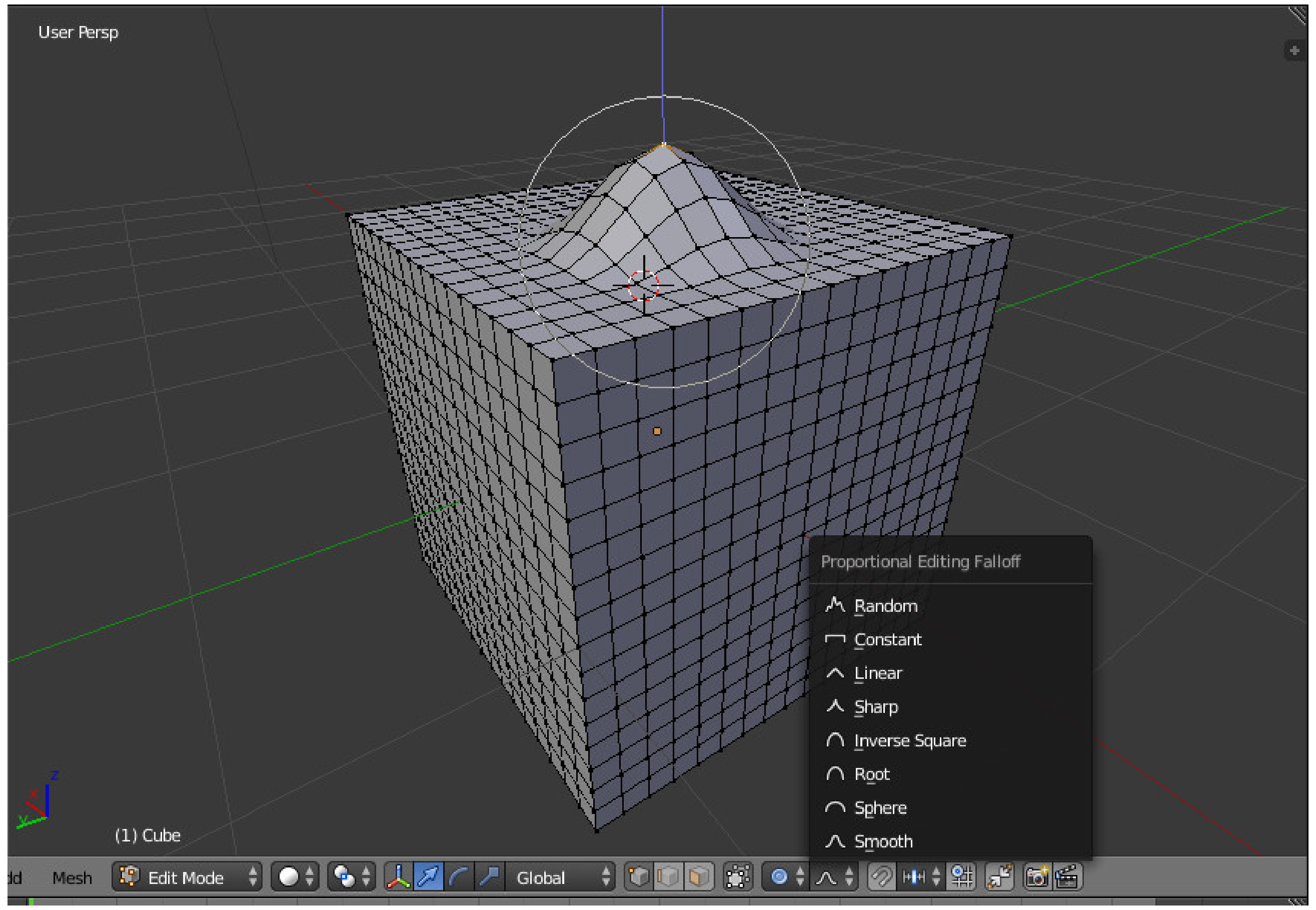
Variety of interactive local and parametric **deformers** in 3D modeling softwares

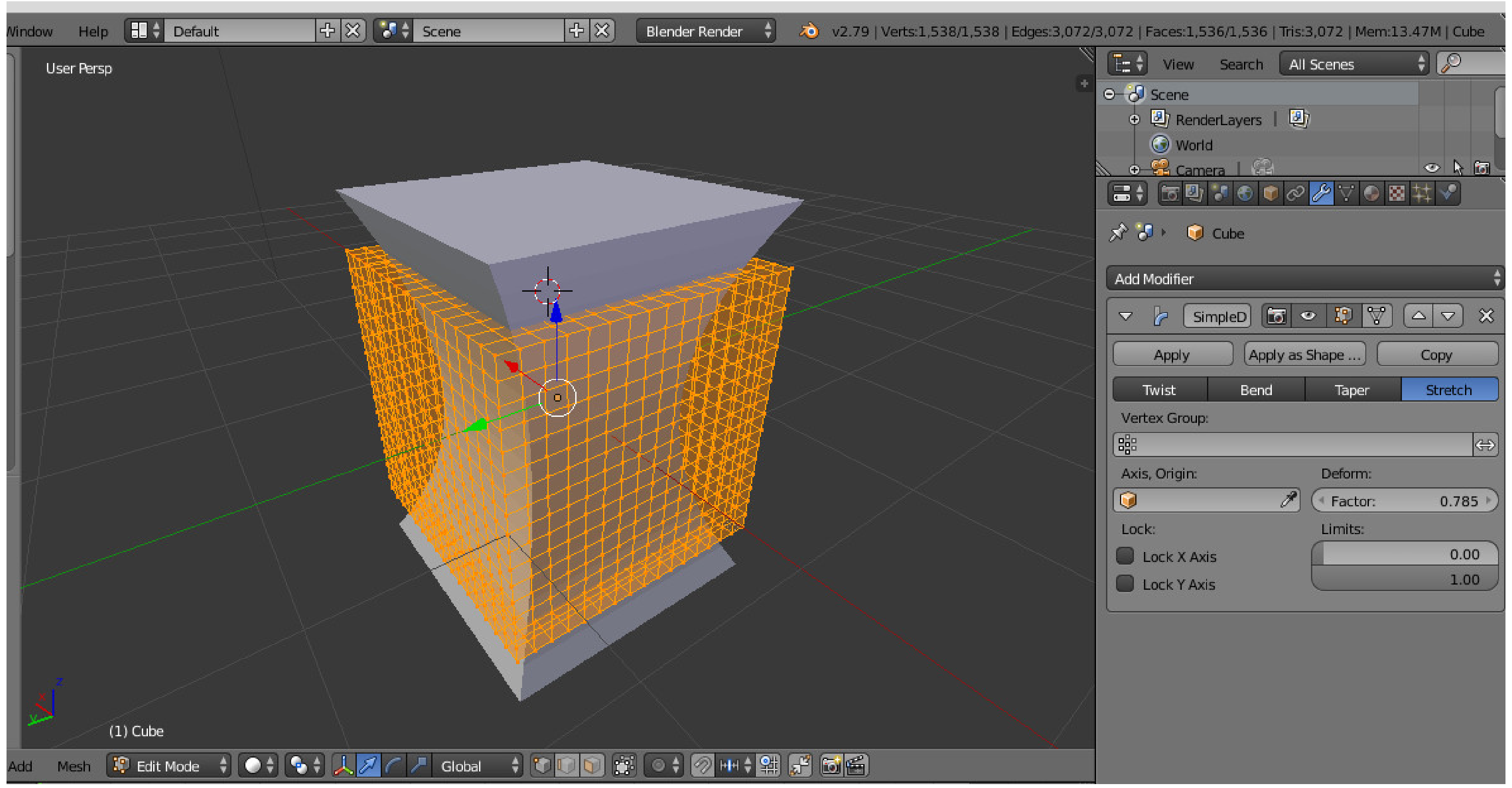
Example: Applying a translation t only locally around c

$$q = p + w(p)\,t \quad , \qquad w(p) = \exp(-\|p-c\|^2/\sigma^2)$$

t can be controled interactively

and other parameters (rotation axis, angle, etc) as well.





Deformers example cases

Q. How to model this interactive deformer ?

Input:

- c: Selected position on the surface
- t_{2D}: 2D displacement coordinates of the mouse on screen while dragging
- r: Circle radius

Computation:

For all positions of the surface p

...

Deformers example cases

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Deformers example cases

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Case of implicit surfaces

Undeformed implicit surface $S = \{p \in \mathbb{R}^3 \mid \ g(p) = 0\}$

Given a volume deformation $f : p \rightarrow f(p)$

The implicit surface S' deformed by f is defined by

$$S' = \{p \in \mathbb{R}^3 \mid \ (g \circ f^{-1})(p) = 0\}$$

$p \in S' \Rightarrow f^{-1}(p) \in S \Rightarrow g(f^{-1}(p)) = 0$