California State University at Northridge
19th Annual International Conference "Technology and Persons with Disabilities"

Creating Tactile Captions

In Three-Dimensional Computer-Aided Design

Stewart Dickson, Visualization Researcher
Computer Science and Mathematics Division

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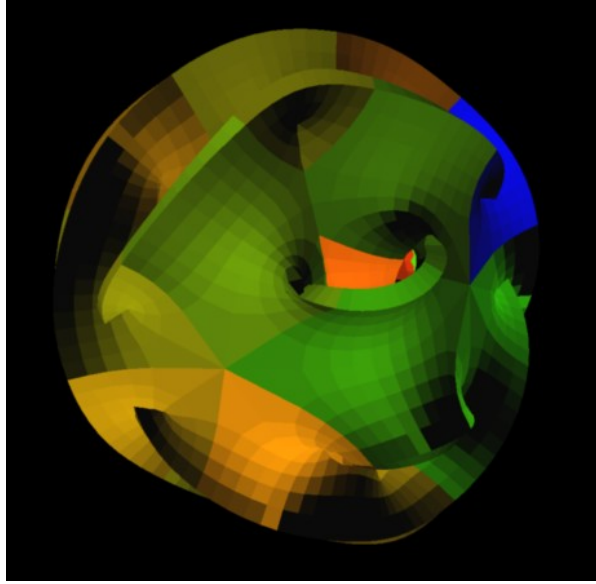
Calabi-Yau Manifold (with Andrew Hanson)

u1[a_,b_] := 0.5 ($e^{(a + I*b)}$ + $e^{(- a - I*b)}$)
u2[a_,b_] := 0.5 ($e^{(a + I*b)}$ - $e^{(- a - I*b)}$)

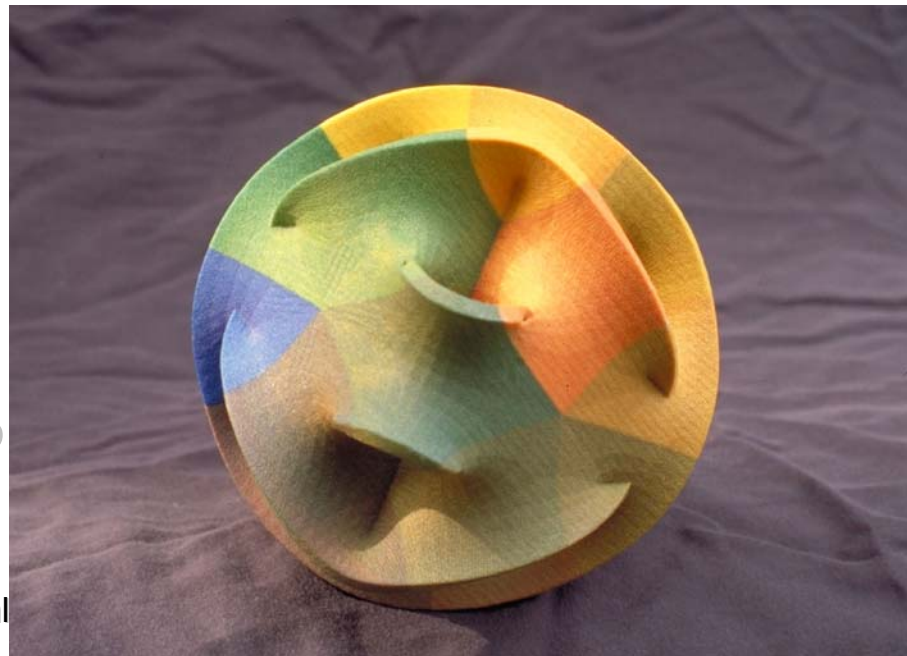
z1k[a_,b_,n_,k_] := $e^{(k*2*Pi*I/n)}$ *u1[a,b] $^{(2.0/n)}$
z2k[a_,b_,n_,k_] := $e^{(k*2*Pi*I/n)}$ *u2[a,b] $^{(2.0/n)}$

{x, y, z} -> { Re[z1k[a,b,n,k1]], Re[z2k[a,b,n,k2]],
Cos[alpha]*Im[z1k[a,b,n,k1]] + Sin[alpha]*Im[z2k[a,b,n,k2]]}

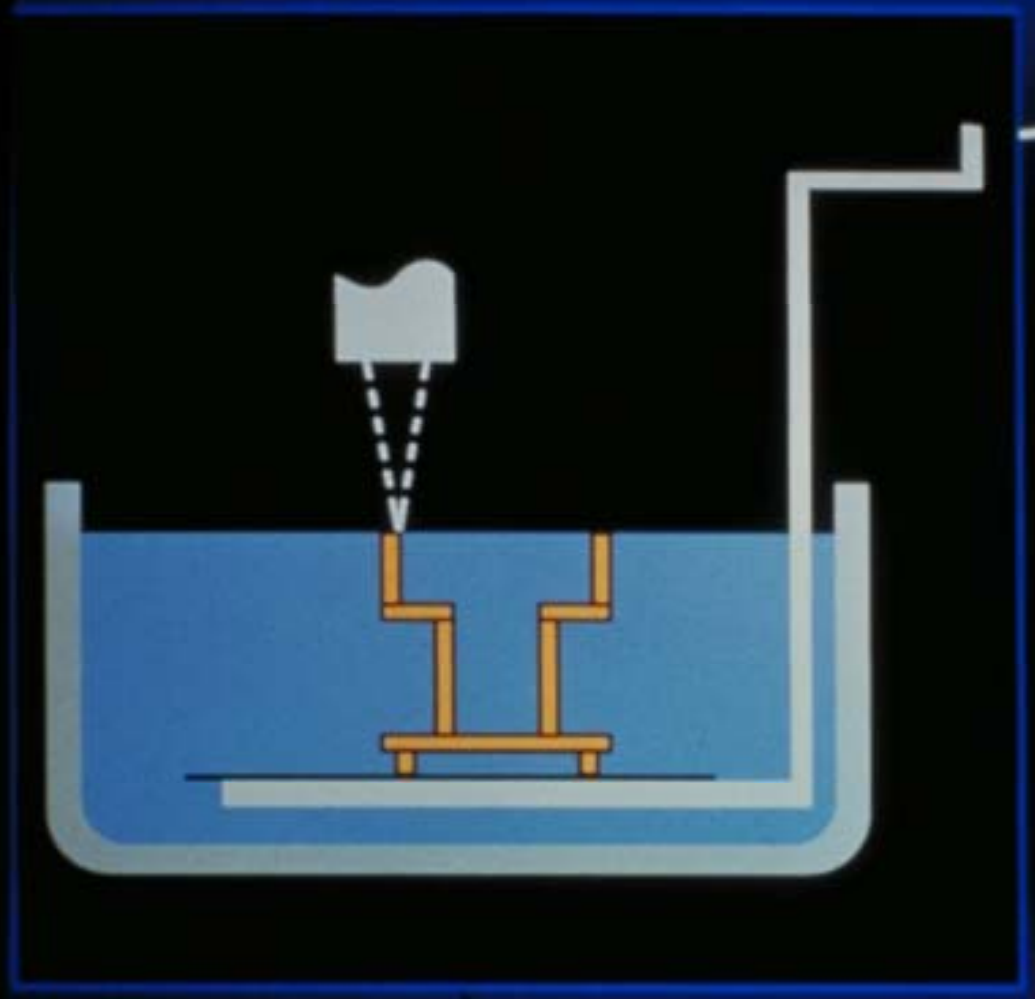
a: (-1.0,1.0); b:(0, Pi/2);
k2: (0, n - 1)
k1: (0, n - 1)



Creating Tactile Mathematics



http://emsh.calarts.edu/~mathart/Zoetrope2/Zoetrope2_prop.html



- Part Designed On CAD/CAM/CAE
- Transferred to and Sliced In SLA
- Partmaking Proces

3D SYSTEMS

Trefoil Torus-Knot:

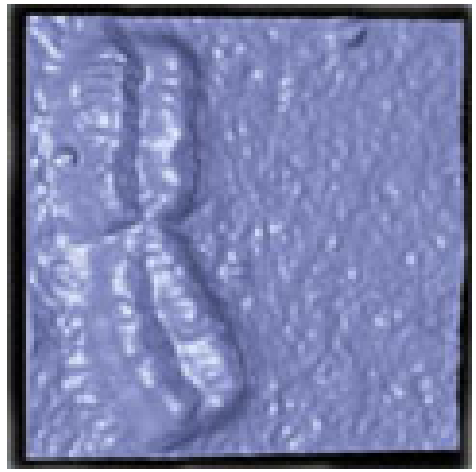
Tactile Mathematics

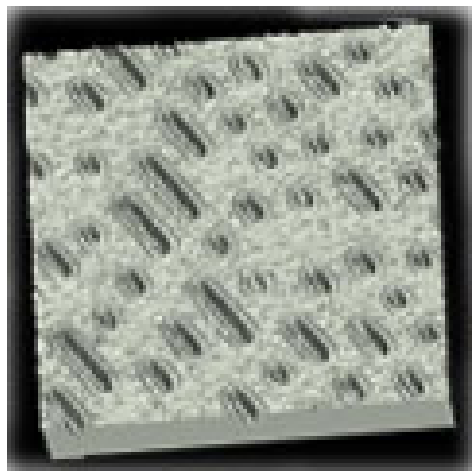
```
r1 = 1.0
r2 = 3.0

Bx [u_, v_] := (r2 + r1 * Cos[u/2.0]) * Cos[u/3.0]
By [u_, v_] := (r2 + r1 * Cos[u/2.0]) * Sin[u/3.0]
Bz [u_, v_] := r1 * Sin[u/2.0]

x [u_, v_] := N[Bx [u, v]] + r1 * Cos[u/3.0] * Cos[v - Pi]
y [u_, v_] := N[By [u, v]] + r1 * Sin[u/3.0] * Cos[v - Pi]
z [u_, v_] := N[Bz [u, v]] + r1 * Sin[v - Pi]
```

Tactile Microscopy





http://prism.asu.edu/projects/tactile.html

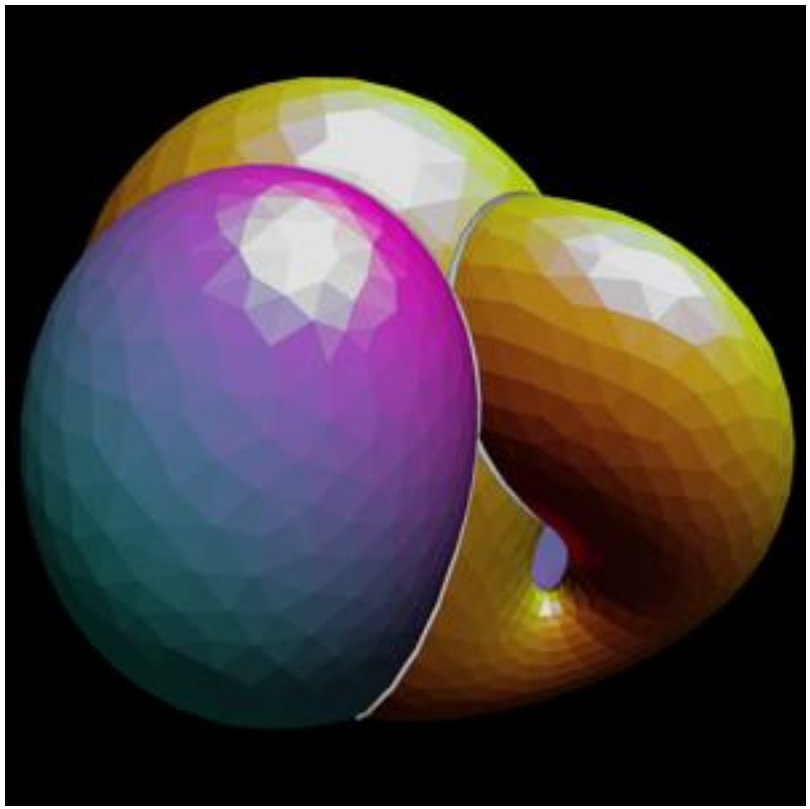
Tactile Chemical Modeling

http://web.njit.edu/~skawinsk/

http://web.njit.edu/~skawinsk/

“The Optiverse” (1998)

by George Francis, John Sullivan, Stuart Levy



http://new.math.uiuc.edu/optiverse/

“The Optiverse” (1998)

by George Francis, John Sullivan, Stuart Levy

QuickTime™ and a Photo decompressor are needed to see this picture.

http://new.math.uiuc.edu/optiverse/

Physical Models from Scientific Simulation

http://emsh.calarts.edu/~mathart/Tactile_Optiverse.html

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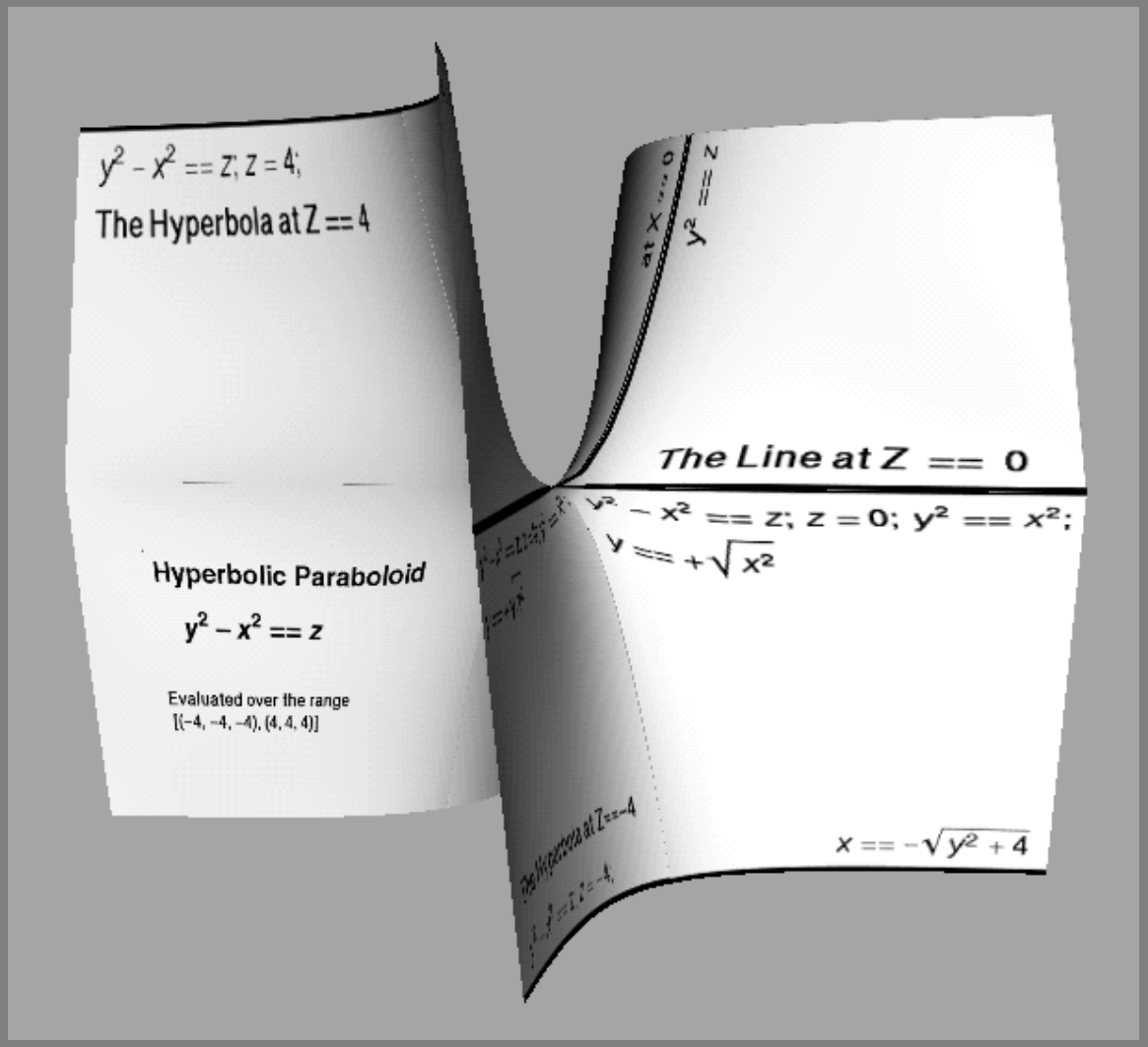
http://emsh.calarts.edu/~mathart/Tactile_Optiverse.html

Professor Bernard Morin

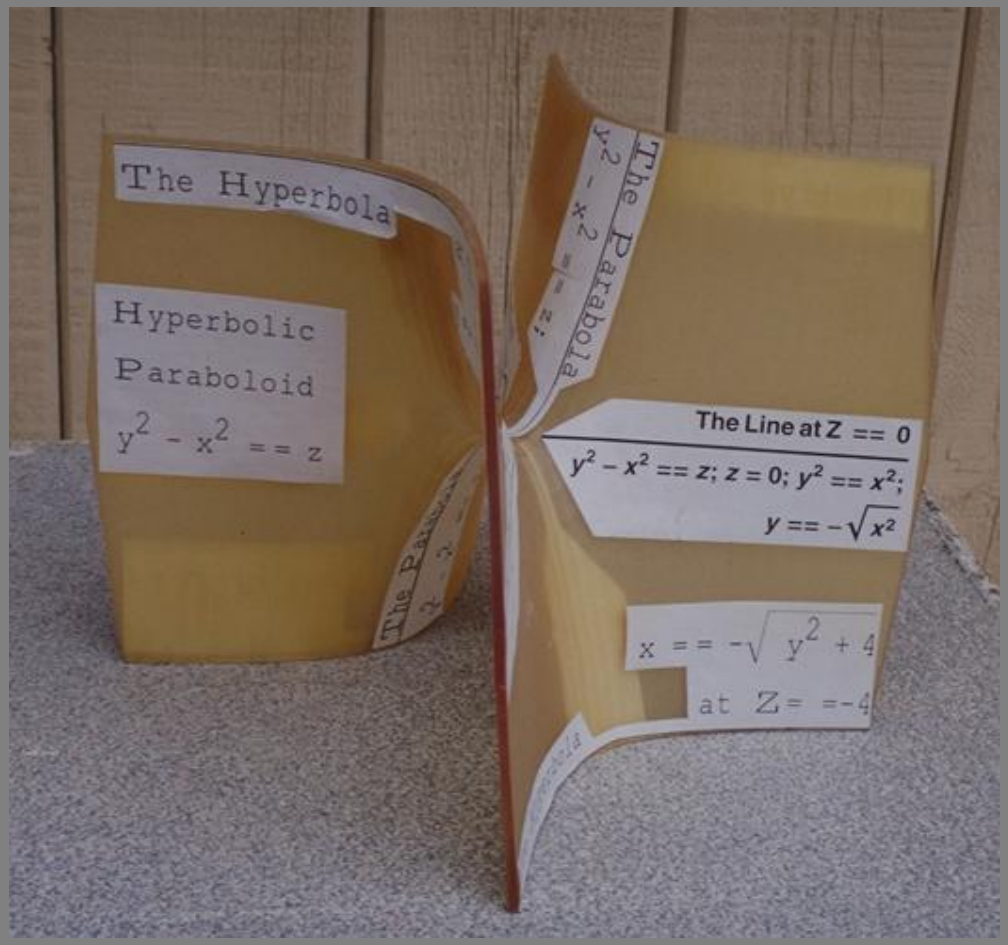
http://emsh.calarts.edu/~mathart/Tactile_Optiverse.html

Captions on a Mathematical Surface in Computer Graphics



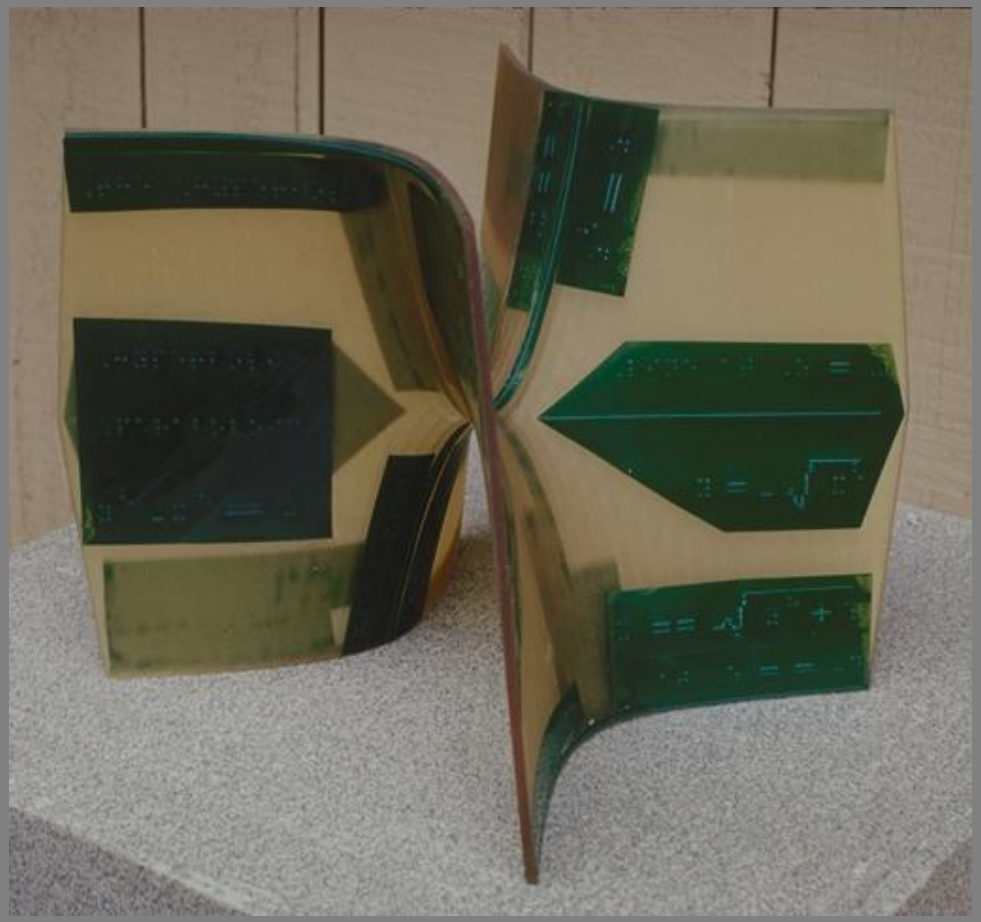
http://emsh.calarts.edu/~mathart/Annotated_HyperPara.html

Captions on a Tactile Mathematical Surface



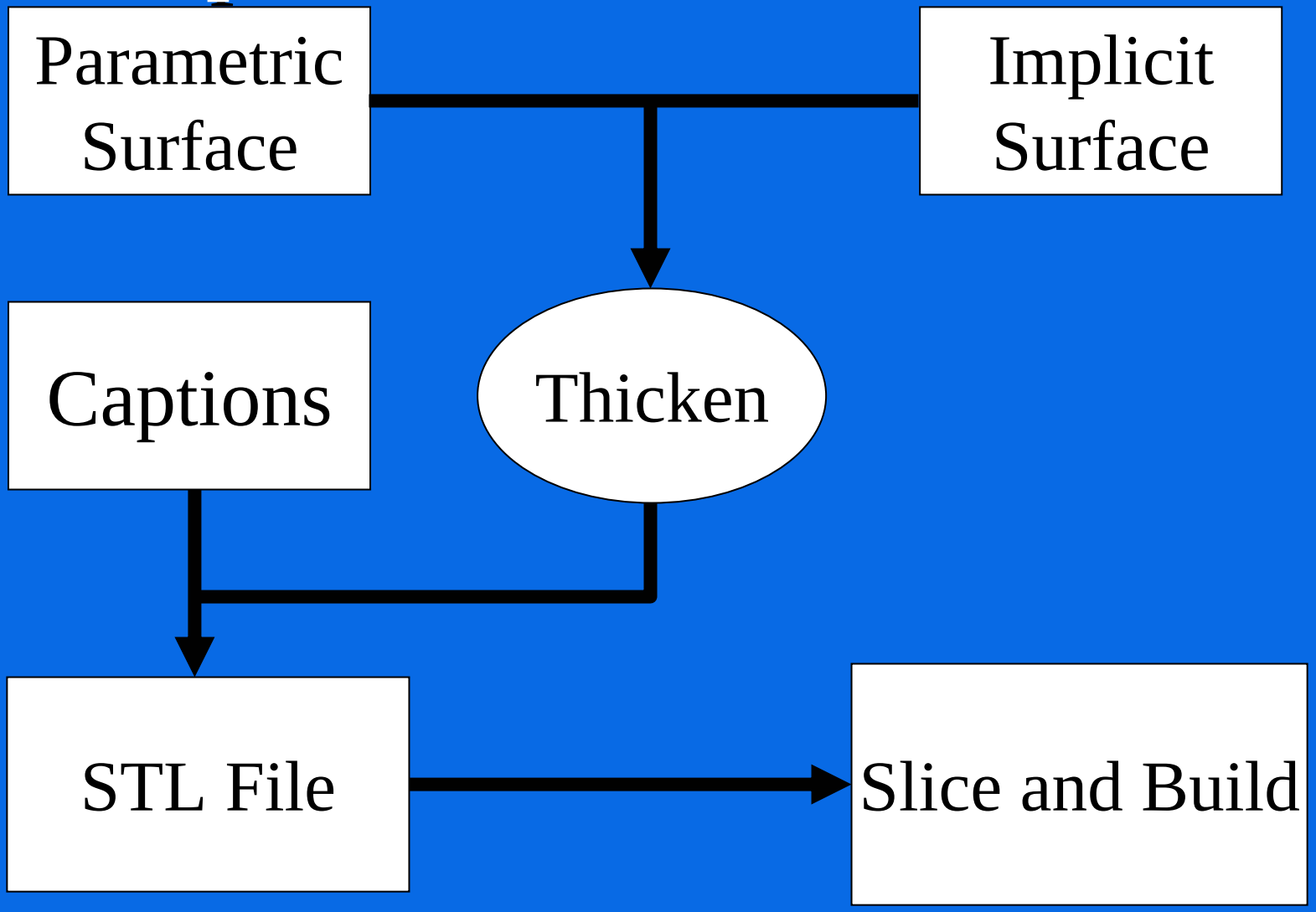
http://emsh.calarts.edu/~mathart/Annotated_HyperPara.html

DotsPlus Braille Captions on a Mathematical Surface

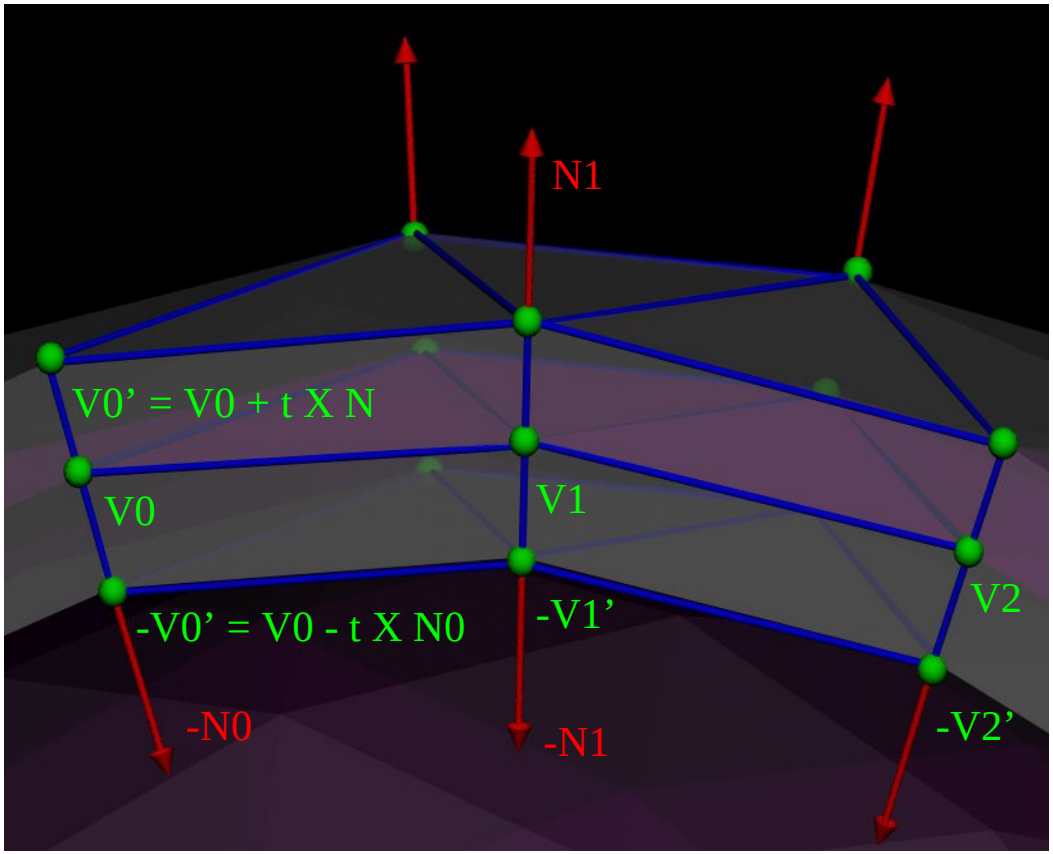


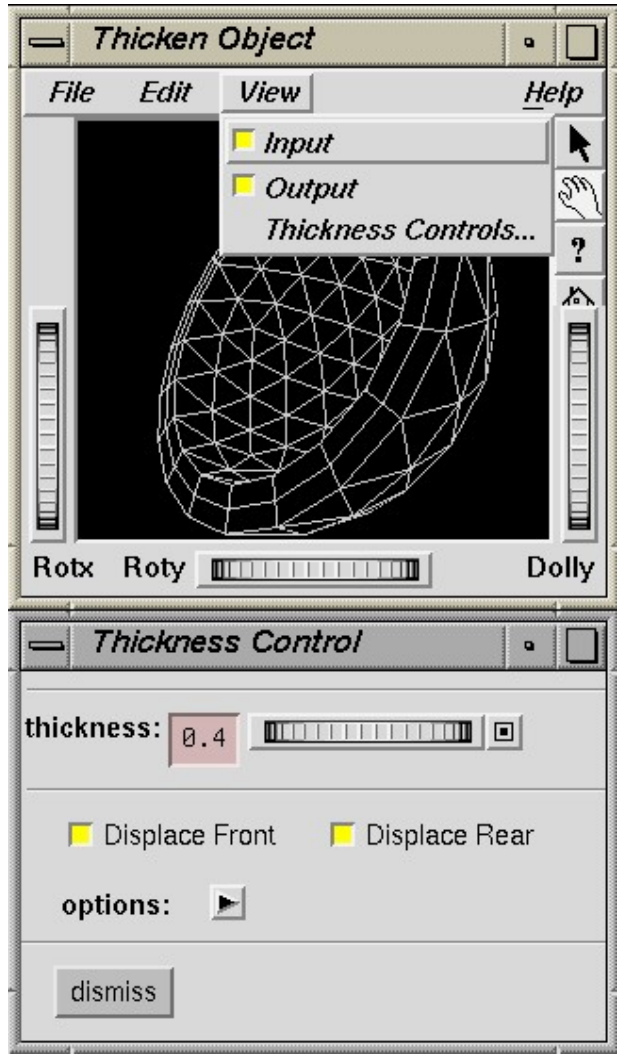
http://emsh.calarts.edu/~mathart/Annotated_HyperPara.html

Steps to Tactile Mathematics



Thickening a Polygon Mesh in CAD

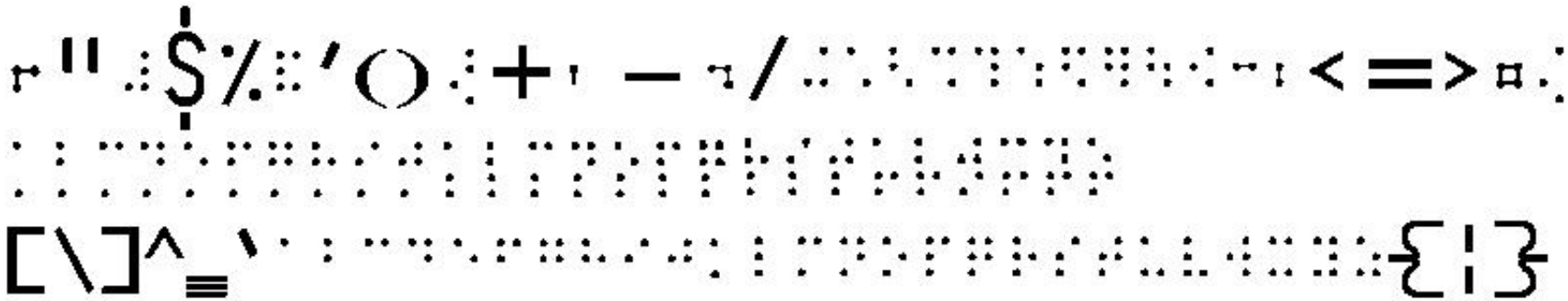




http://emsh.calarts.edu/~mathart/sw/objView/thicken.html

DotsPlus®

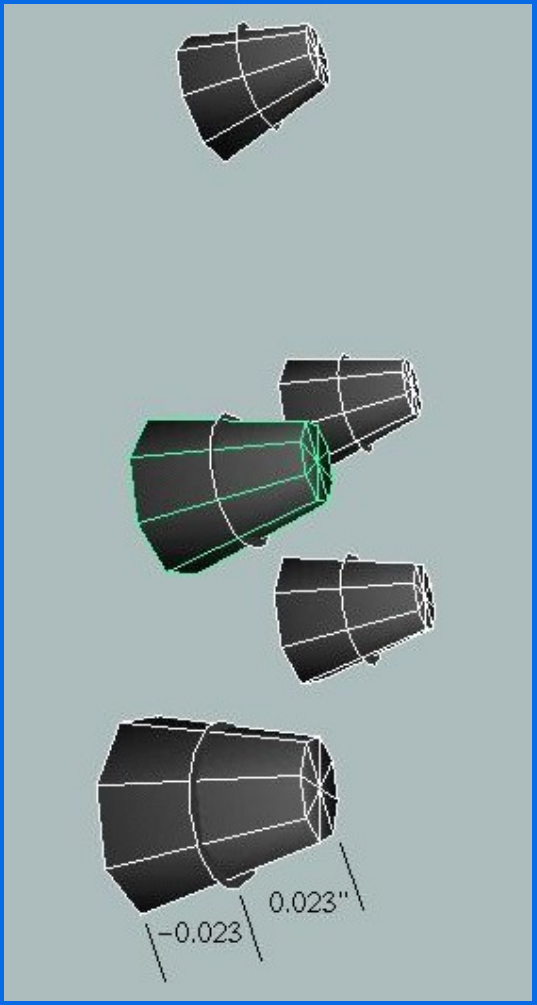
DotsPlus Font -- Rendered PostScript



Source: http://dots.physics.orst.edu/ ... dotsmac.sea.hqx Feb 20 1998

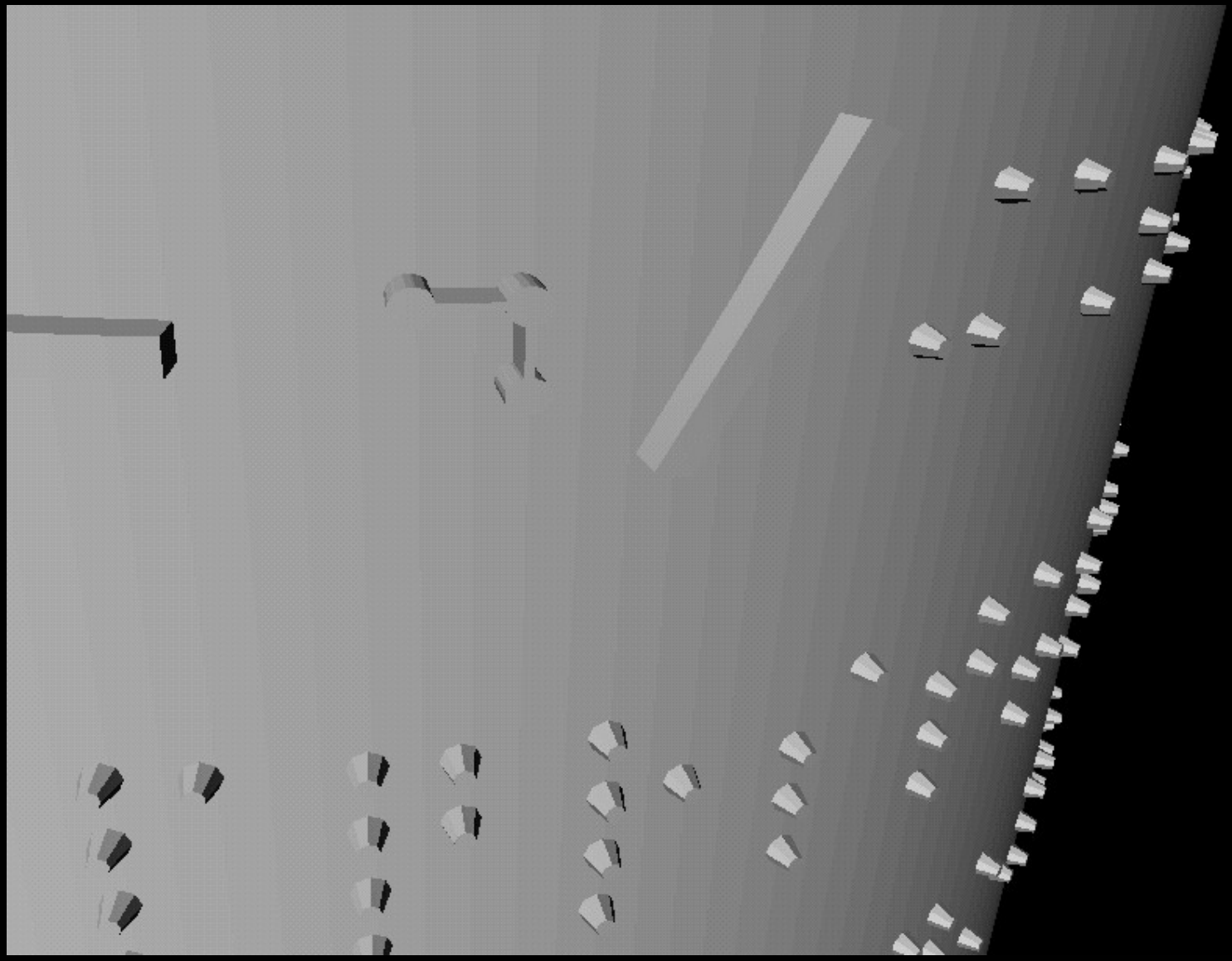
Documentation:
http://emsh.calarts.edu/~mathart/Tactile_Math/DotsCAD.html

3-D Braille Dot Geometry in CAD



http://emsh.calarts.edu/~mathart/Tactile_Math/DotsCAD.html

3-D Braille Typesetting in CAD

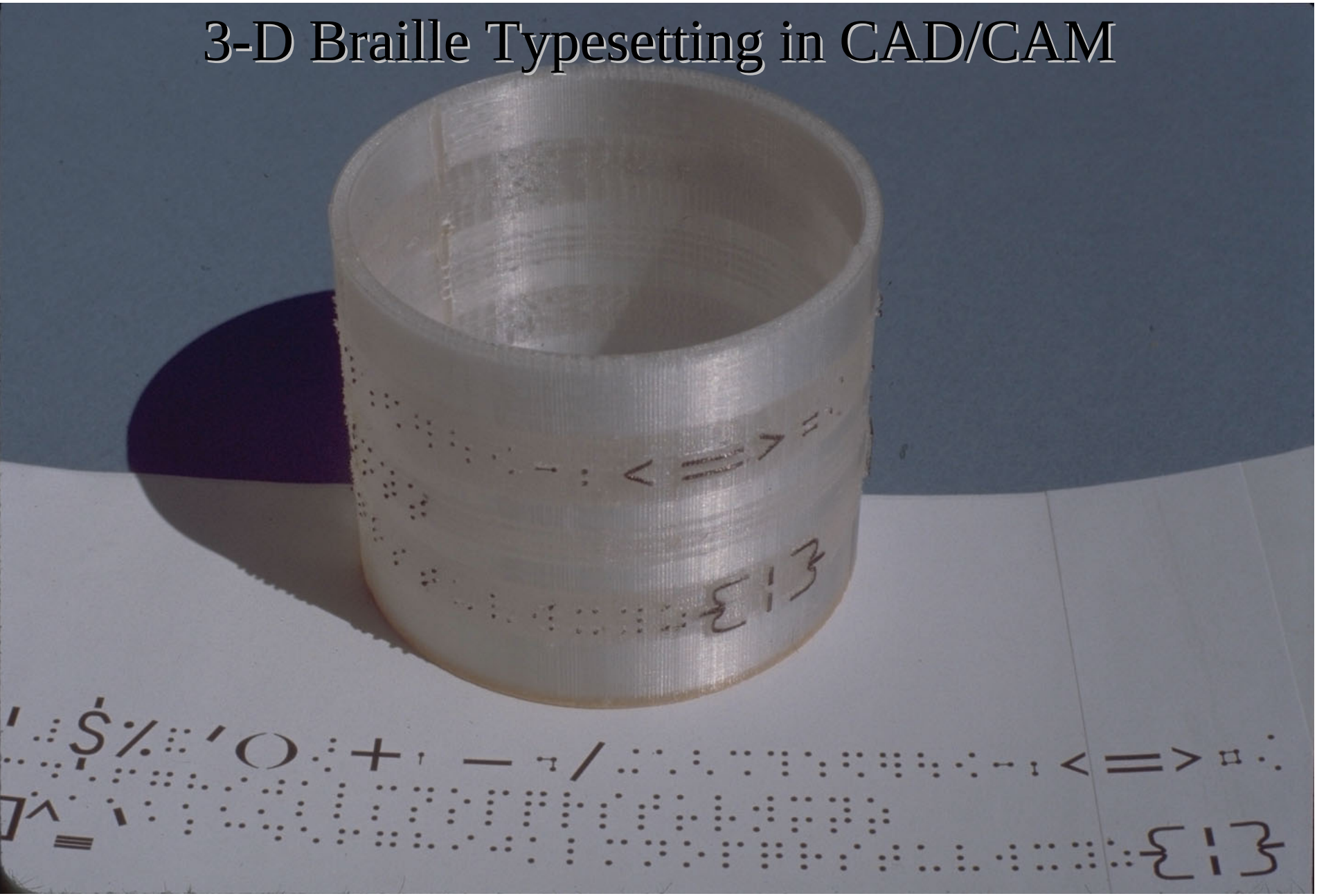


http://emsh.calarts.edu/~mathart/Tactile_Math/DotsCAD.html

3-D Braille Typesetting in CAD

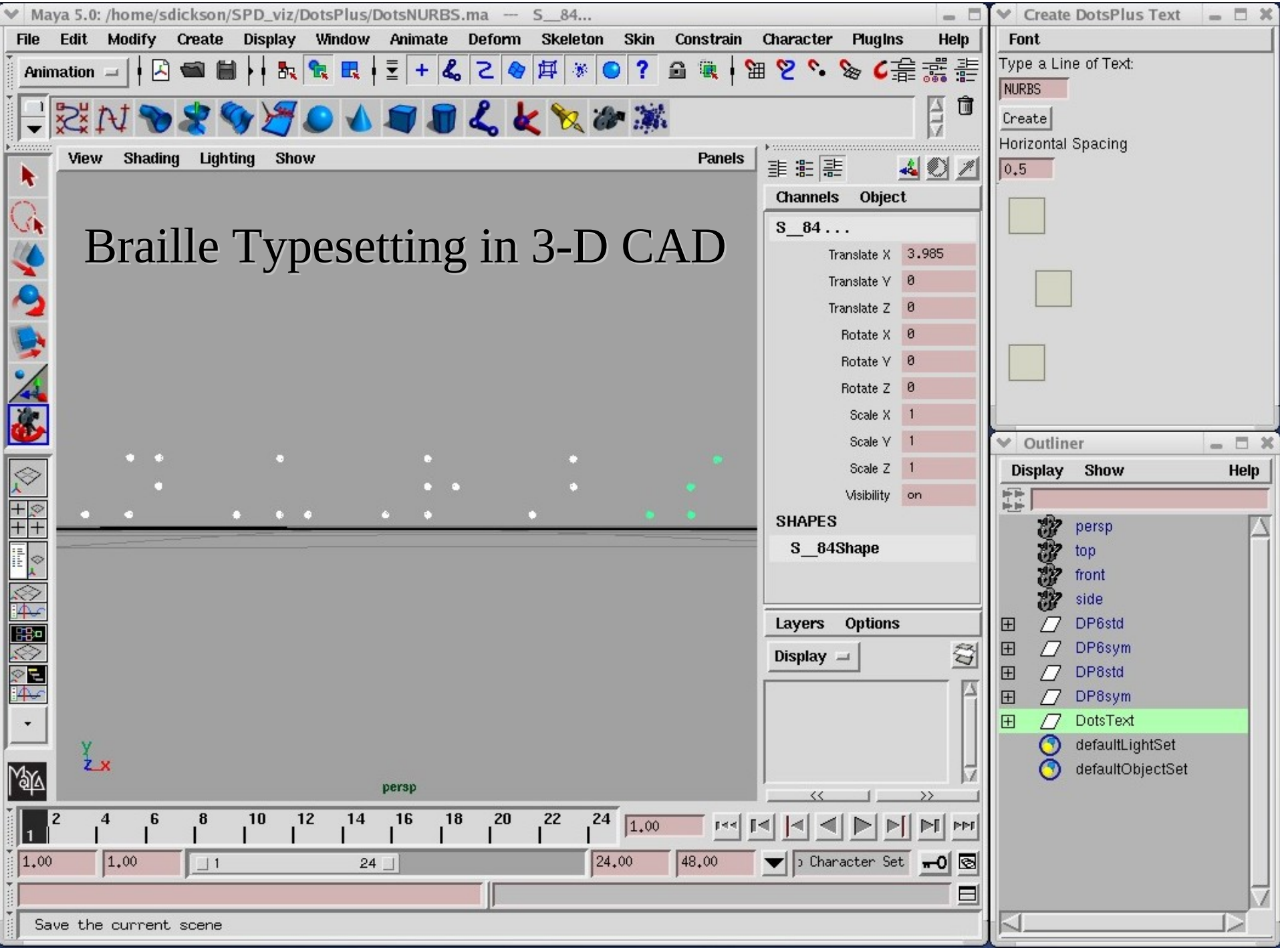
http://emsh.calarts.edu/~mathart/Tactile_Math/DotsCAD.html

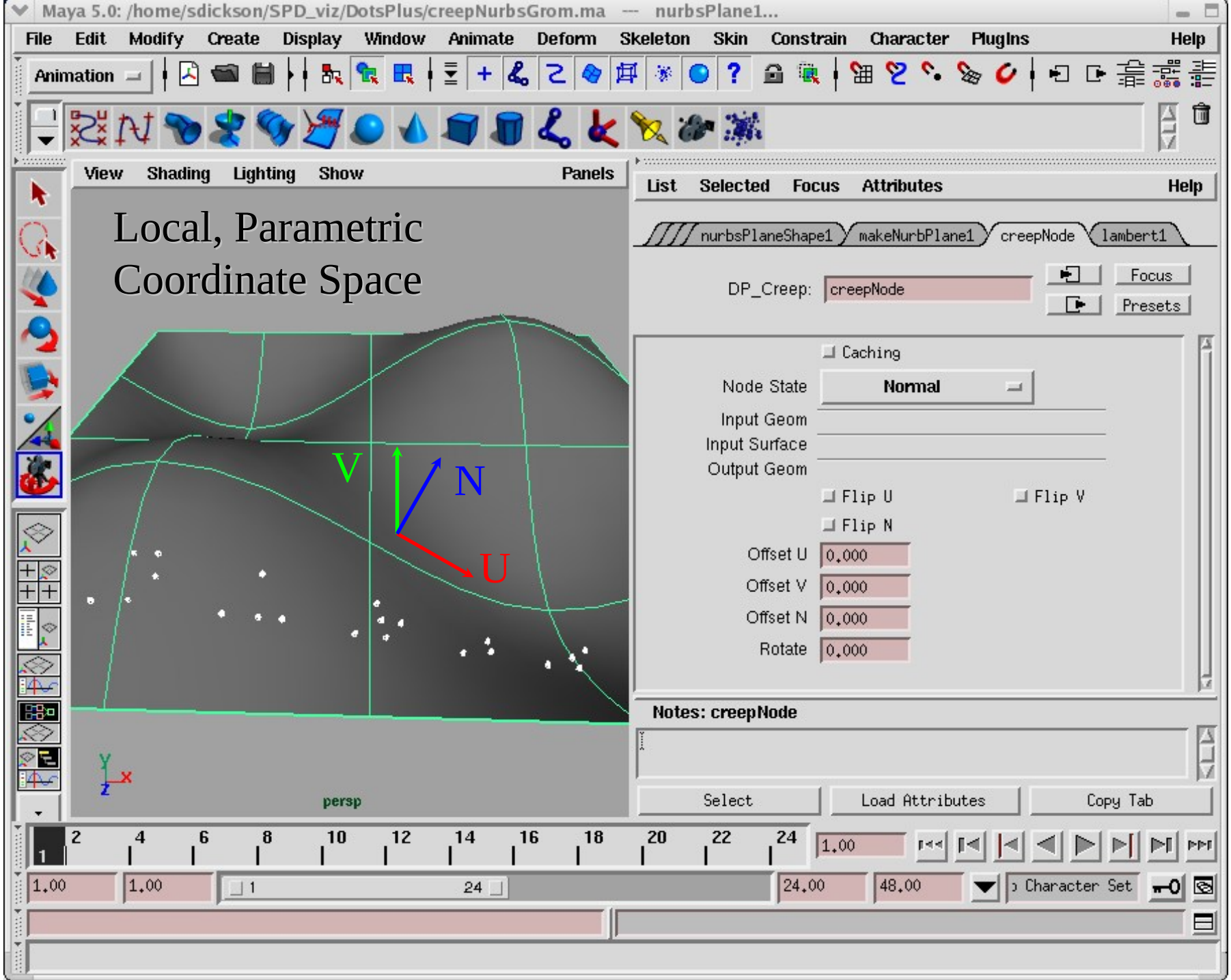
3-D Braille Typesetting in CAD/CAM



http://emsh.calarts.edu/~mathart/Tactile_Math/DotsCAD.html

Braille Typesetting in 3-D CAD




Local, Parametric
Coordinate Space
V
N
U
Maya 5.0: /home/sdickson/SPD_viz/DotsPlus/creepNurbsGrom.ma --- nurbsPlane1...
File Edit Modify Create Display Window Animate Deform Skeleton Skin Constrain Character PlugIns Help
Animation
View Shading Lighting Show Panels
List Selected Focus Attributes Help
nurbsPlaneShape1 makeNurbPlane1 creepNode lambert1
DP_Creep: creepNode
Focus
Presets
Caching
Node State Normal
Input Geom
Input Surface
Output Geom
Flip U
Flip V
Flip N
Offset U 0.000
Offset V 0.000
Offset N 0.000
Rotate 0.000
Notes: creepNode
Select
Load Attributes
Copy Tab
persp
Character Set

Problems with Current Tools

- Maya Creep Node requires NURBS Surfaces
- NURBS Surfaces do not port to Rapid Prototyping
- Scientific Visualization does not produce NURBS Surfaces

Possible Solution

- “Pseudo” Curve-on-Polygon Surface Mesh -> NURBS

DotsPlus® 3-D for

Alias Maya

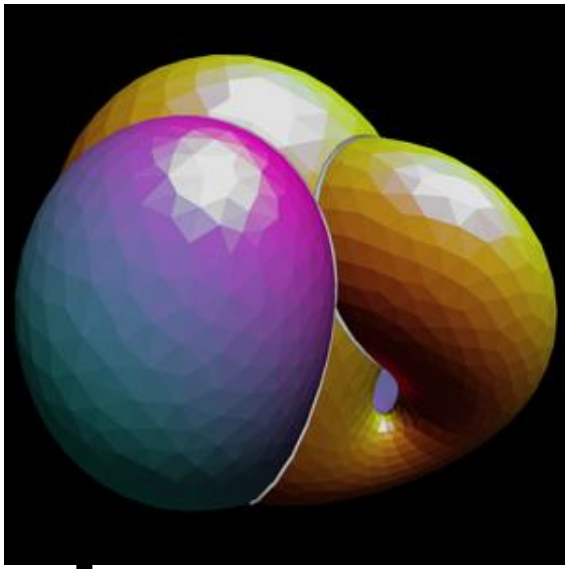
Open Inventor™

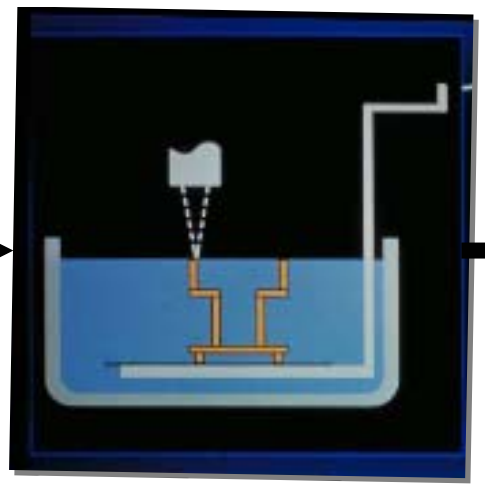
Apple MacOS-X

Linux i386

SGI Irix 6.5

Science Access





Research sponsored by Computer Science and Mathematics Division of Oak Ridge National Laboratory, managed by UT-Battelle, LLC for the U.S. DOE under Contract No. DE-AC05-00OR22725.

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Steven Wilkinson, “3D Plots of Implicitly Defined Surfaces,” http://library.wolfram.com/infocenter/MathSource/4189/.

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3D Systems, Stereolithography http://www.3dsystems.com.

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Stewart Dickson, "Braille Typesetting in 3-D …," http://emsh.calarts.edu/~mathart/Tactile_Math/DotsCAD.html.

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http://emsh.calarts.edu/~mathart/sw/objView/thicken.html
http://emsh.calarts.edu/~mathart/sw/objView/parameshmap.html

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New York: Springer-Verlag, 1997, ISBN: 3-540-61545-8.
http://www.springer-ny.com/detail.tpl?ISBN=3540615458

Side Effects Software, Inc., http://www.sidefx.com/.