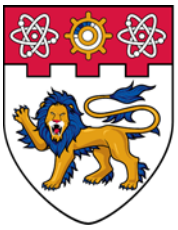

NANYANG TECHNOLOGICAL UNIVERSITY
SINGAPORE

CZ3003
COMPUTER GRAPHICS and VISUALIZATION

LAB 4 REPORT

Implicit Solids

LAB GROUP: **SSP6**

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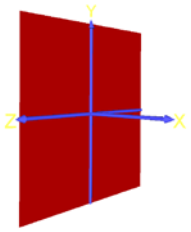
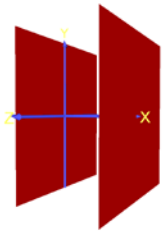
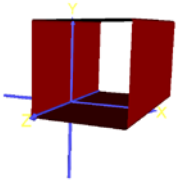
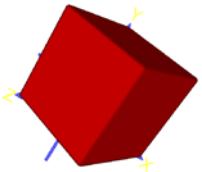
School of Computer Science and Engineering

Nanyang Technological University

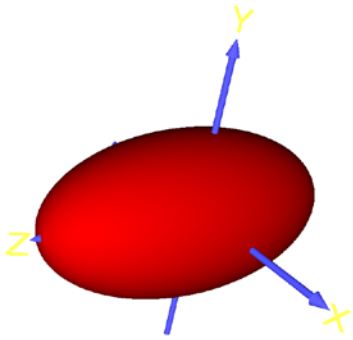
Contents

Build Basic FShape

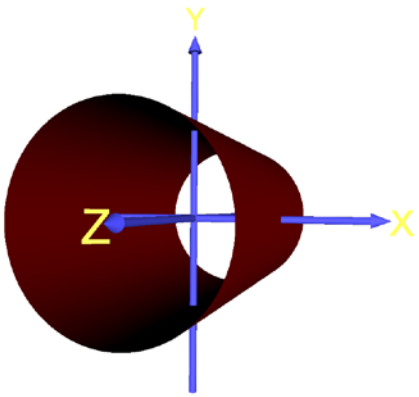
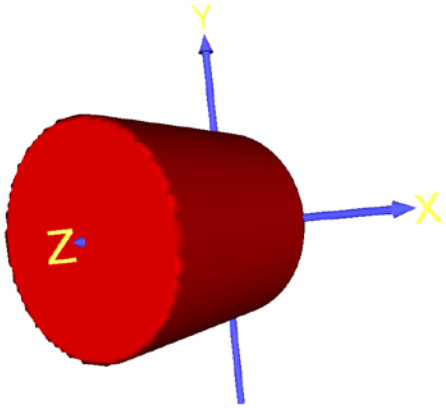
Plane halfspace

# Plane	1 Plane	2 Plane	4 Plane (open box)	6 Plane (close box)
View				
Formula:	X >= 0	X >= 0 1-X >= 0	X >= 0 1-X >= 0 Y >= 0 1-Y >= 0	X >= 0 1-X >= 0 Y >= 0 1-Y >= 0 Z >= 0 1-Z >= 0
Source	FShape_Plane_ Halfspace_1.wrl	FShape_Plane_ Halfspace_2.wrl	FShape_Plane_ Halfspace_4.wrl	FShape_Plane_ Halfspace_6.wrl

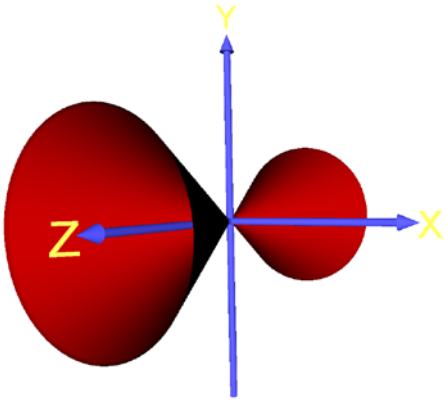
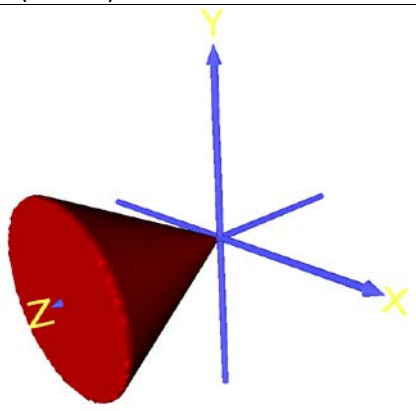
Ellipsoid

	Ellipsoid
View	
Formula:	1^2-(x/0.5)^2 - (y/0.5)^2 - (z)^2 >= 0
Source	FShape_Ellipsoid.wrl

Cylinder

	Cylinder (Open)	Cylinder(Closed)
View		
Formula:	0.5^2-x^2-y^2 >= 0;	0.5^2-x^2-y^2 >= 0; Z >= 0; 1-z >= 0; min(1-z, z, 0.5^2-x^2-y^2) >= 0
Source	FShape_CylinderOpen.wrl	FShape_CylinderClose.wrl

Cone

	Cone (Open)	Cone(Closed)
View		
Formula:	(x)^2 + (y)^2 -((z)*0.5)^2 >= 0	(x)^2 + (y)^2 -((z)*0.5)^2 >= 0 Z >= 0; 1-z >= 0; min(1-z, z, (x)^2 + (y)^2 -((z)*0.5)^2) >= 0
Source	FShape_2Cone.wrl	FShape_Cone.wrl

Build Complex FShape with Basic FShape

Ambitious

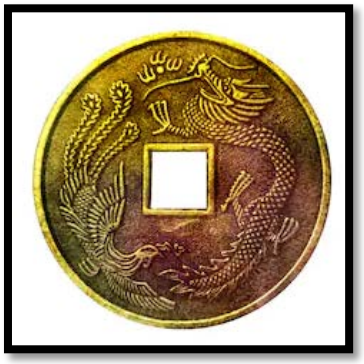


Fig 1 Golden Bell *Fig 2 Ancient Coin*

- I would like to create a bell with a circular "hook" (fig 1) to be replaced with Ancient Coin (fig 2) instead.

Goals

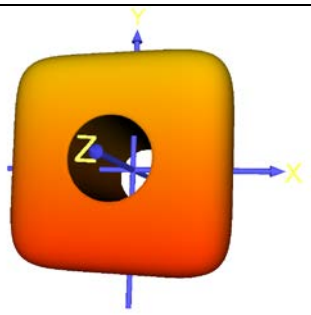
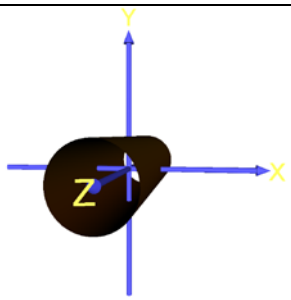
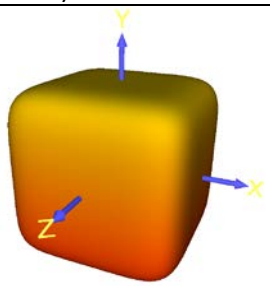
- Due to its complexity of the design and scale of this lab,
  - The dragon logo (fig 2) is omitted and the inner bell mechanism (fig 1).
  - The top portion of the bell will represent the "cone-like" shape instead.
  - The junction between the Ancient Coin (fig 2) and Golden Bell (fig 1) will be connected by a "handled-like" shape
- The idea here is to create similar FShape that represent the fig 1 and fig 2 with the help of basic FShapes (plane-half space, ellipsoid, cylinder, and cone) using VRML software.

Plan

- Identify FShapes and It's purpose Fig 1
  - x2 Cones
    - External (Basic structure of the bell)
    - Inner (Enabled Hollow)
  - x4 Sphere (Derived from Ellipsoid)
    - 2 partition sphere with different size (outer layer shape of the bell)
    - 1 Inner Sphere (the component that rings the bell)
    - 1 top portion Sphere (to show some curvature)
  - x1 Cylinder
    - Attached the inner sphere from the bell "hook"
  - x1 Ellipsoid
    - The handle of the bell
- Identify FShapes and It's purpose Fig 2
  - x2 Cylinder
    - Thick edge of the coin
    - Shape of the coin
  - x2 Half-Space Plane
    - (Plane 4)
      - Hole of the coin
    - (Plane 6)
      - Inner edge of the coin

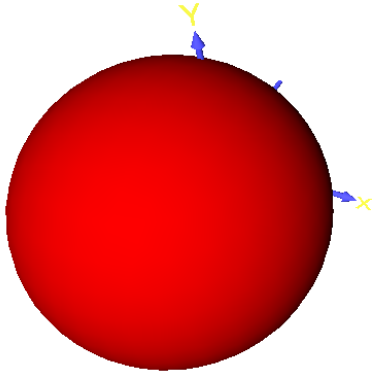
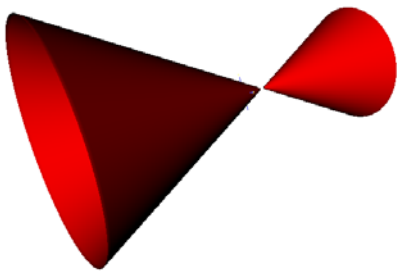
Implementation

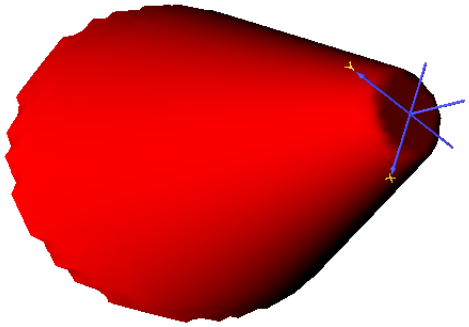
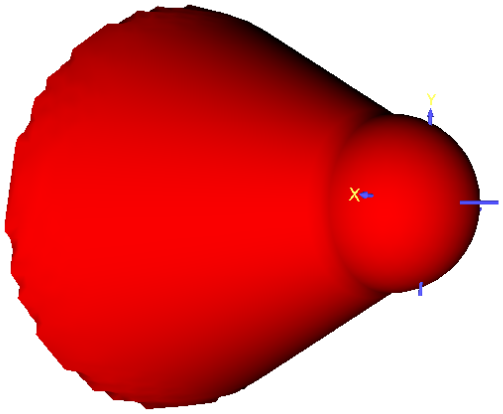
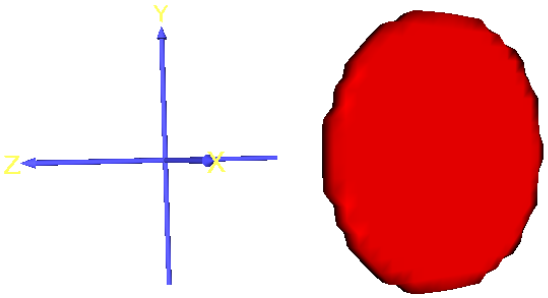
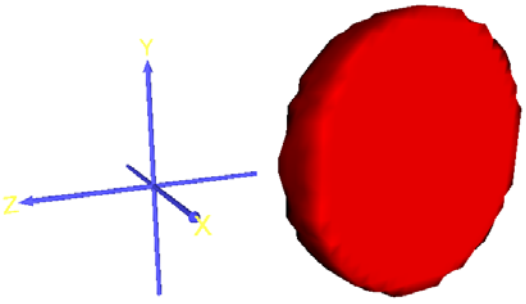
- Analysis of given CSGsolid.wrl

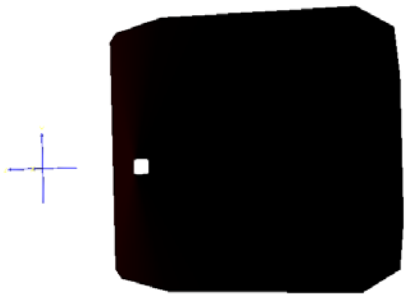
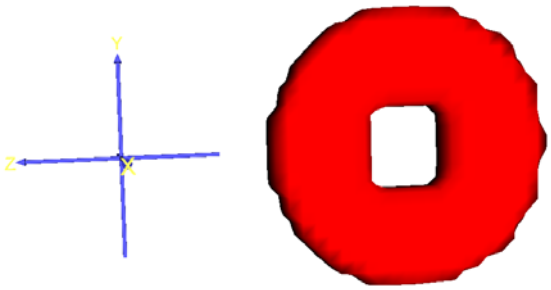
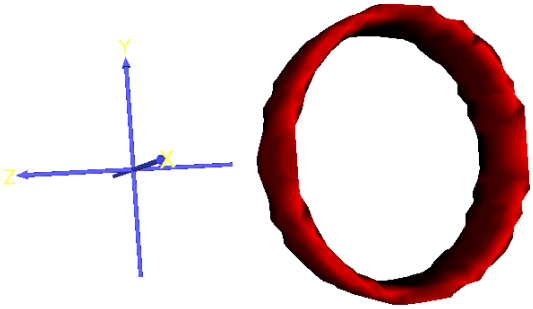
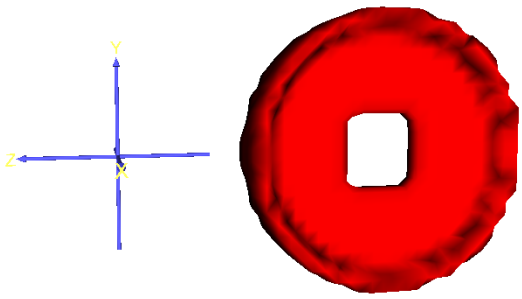
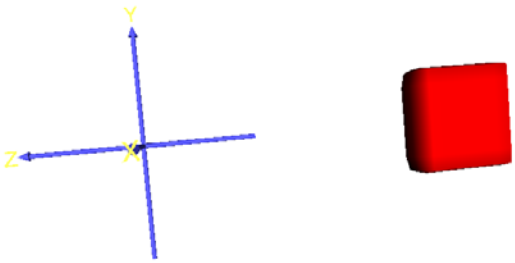
Given	Composite	Cylinder	Square-like (From Sphere)
View			
Formula:	Min(0.25^2-x^2-y^2, 0.7^6-x^6-y^6-z^6) >= 0	0.25^2-x^2-y^2 >= 0	0.7^6-x^6-y^6-z^6 >= 0
Color	Notice: Color has a gradient where they use U, V, W to implement.		
Source	CSGsolid.wrl		

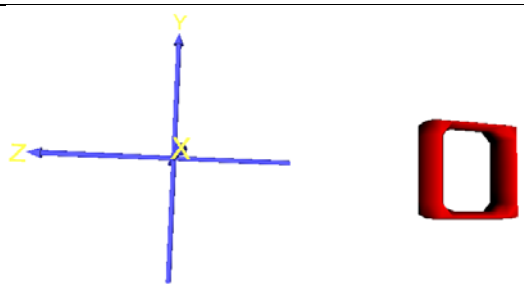
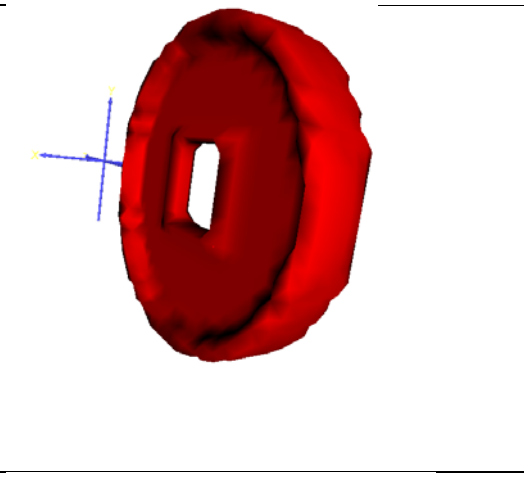
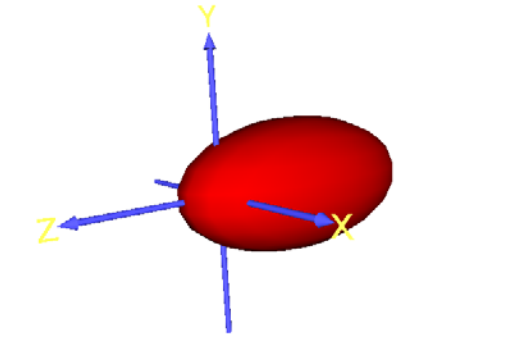
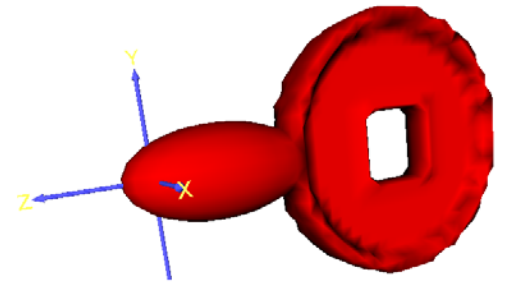
- Configuration
    - Adjust and increase the bbSize by 20 20 20 to express more definition of the FShapes.
    - Set the RGB color to red to standardize the work process.
- Step by Step formation (Note: some finer details are skipped since basic FShapes has explained, the steps are not in order during the experimentation process).

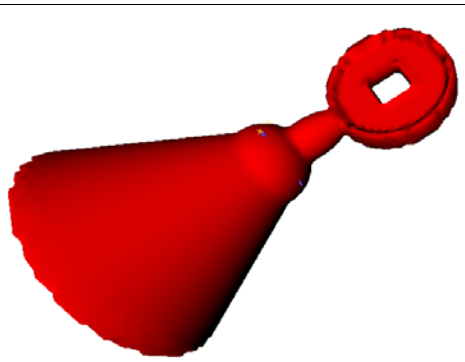
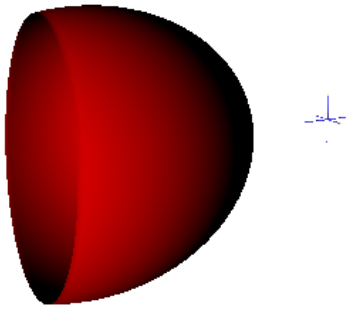
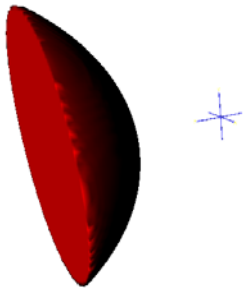
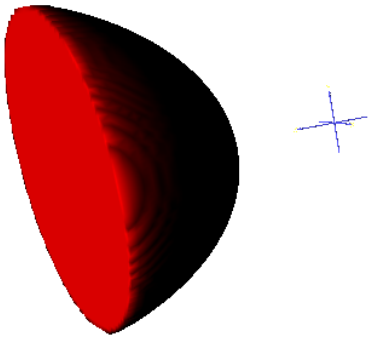
Source: FShape_Composite.wrl

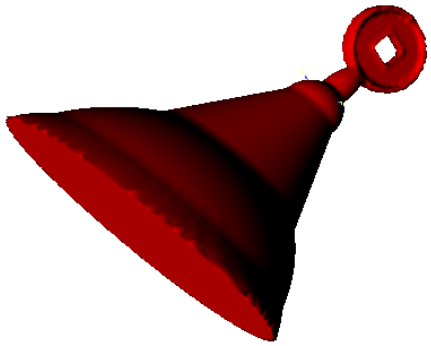
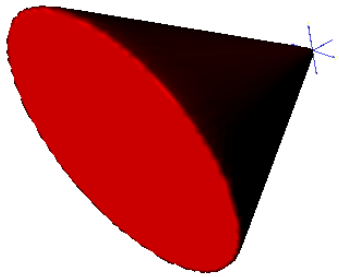
#	Step	View	Formula
1	Top Portion of Bell w/ Sphere		1^2-(x)^2 - (y)^2 - (z-0.5)^2 >= 0
2	Develop Cone Portion of the Bell		(x)^2 + (y)^2 - (((z)*0.5)+0.7)^2 >= 0

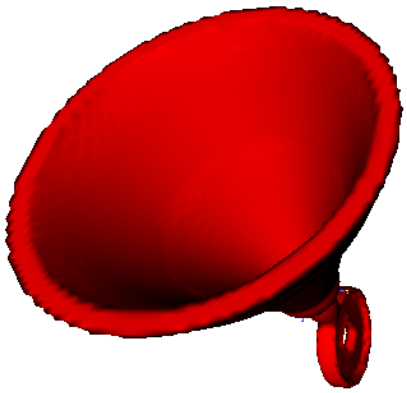
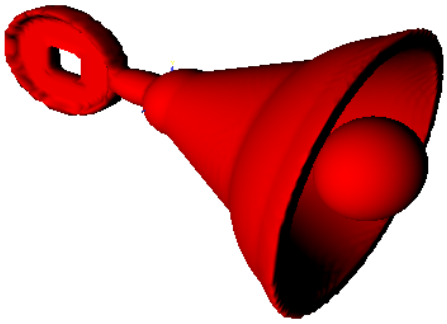
3	Adjustment of Cone Portion of the Bell		(x)^2 + (y)^2 - (((z)*0.5)+0.7)^2 >= 0; Z >= 0; 4-z >= 0; Min(z,4-z, (x)^2 + (y)^2 - (((z)*0.5)+0.7)^2) >= 0;
4	Combination of Step 1 and 3		Max(Min(z,4-z, (x)^2 + (y)^2 -(((z)*0.5)+0.7)^2)), Min(z,4-z, (x)^2 + (y)^2 - (((z)*0.5)+0.7)^2)) >= 0;
5	Develop Coin Shape		Min(1.5^2-(y)^2-(3+z)^2,0.1-x,0.1+x) >= 0
6	Develop Coin Edge Shape		Min(1.6^2-(y)^2-(3+z)^2,0.3-x,0.3+x) >= 0

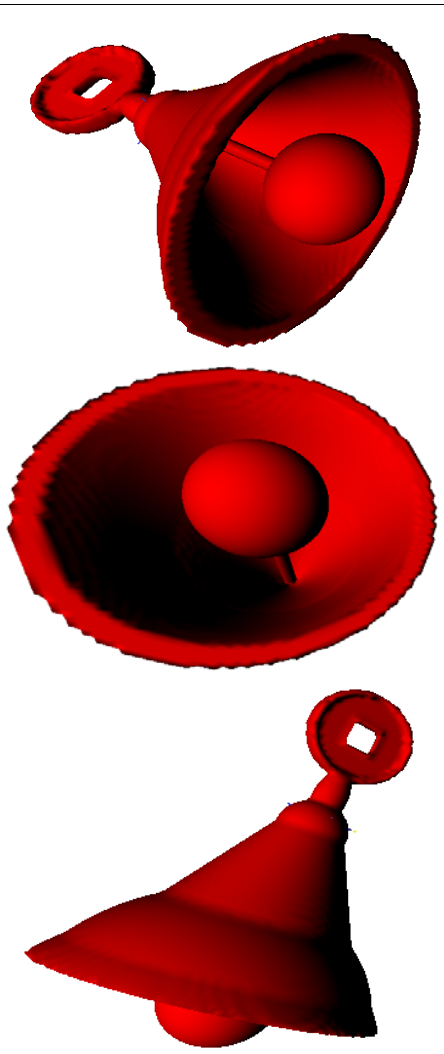
7	Develop Square Hole of the Coin		Min(z-2.6,z+3.4,0.4-y,0.4+y) >= 0;
8	Combine Step 5 and 7		Min(Min(1.5^2-(y)^2-(3+z)^2,0.1-x,0.1+x),-Min(1.5^2-(y)^2-(3+z)^2,0.1-x,0.1+x)) >= 0
9	Continue to Develop Step 6		Min (Min(1.6^2-(y)^2-(3+z)^2,0.3-x,0.3+x),-1.4^2-(y)^2-(3+z)^2) >= 0
10	Combine Step 8 and 9		Max(Min(Min(1.5^2-(y)^2-(3+z)^2,0.1-x,0.1+x),- Min(1.5^2-(y)^2-(3+z)^2,0.1-x,0.1+x)), Min (Min(1.6^2-(y)^2-(3+z)^2,0.3-x,0.3+x),-1.4^2-(y)^2-(3+z)^2)) >= 0
11	Develop Inner Edge		Min(-z-2.5, z+3.5, 0.5-y, 0.5+y, 0.2-x, 0.2+x) >= 0;

12	Continue Develop Inner Square Edge by Combining Step 11 and Step 7		Min(Min(-z-2.5, z+3.5, 0.5-y, 0.5+y, 0.2-x, 0.2+x),- Min(z-2.6,z+3.4,0.4-y,0.4+y)) >= 0
13	Final Development of Coin by Combining Step 12 and 10		Max(Max(Min(Min(1.5^2-(y)^2-(3+z)^2,0.1-x,0.1+x),- Min(1.5^2-(y)^2-(3+z)^2,0.1-x,0.1+x)), Min (Min(1.6^2-(y)^2-(3+z)^2,0.3-x,0.3+x),- 1.4^2-(y)^2-(3+z)^2)), Min(Min(-z-2.5, z+3.5, 0.5-y, 0.5+y, 0.2-x, 0.2+x),- Min(z-2.6,z+3.4,0.4-y,0.4+y))) >= 0
14	Create Connector (Ellipsoid) between Coin and Bell		1^2-(x/0.5)^2 - (y/0.5)^2 - (z+0.7)^2 >= 0;
15	Combine Step 13 and 14		Max(1^2-(x/0.5)^2 - (y/0.5)^2 - (z+0.7)^2, Max(Max(Min(Min(1.5^2-(y)^2-(3+z)^2,0.1-x,0.1+x),- Min(1.5^2-(y)^2-(3+z)^2,0.1-x,0.1+x)), Min (Min(1.6^2-(y)^2-(3+z)^2,0.3-x,0.3+x),- 1.4^2-(y)^2-(3+z)^2)), Min(Min(-z-2.5, z+3.5, 0.5-y, 0.5+y, 0.2-x, 0.2+x),- Min(z-2.6,z+3.4,0.4-y,0.4+y)))) >= 0

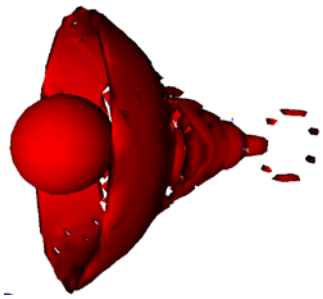
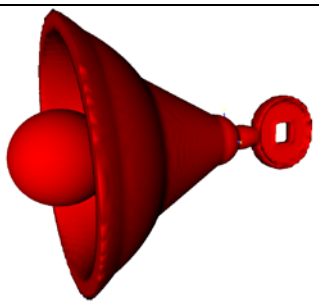
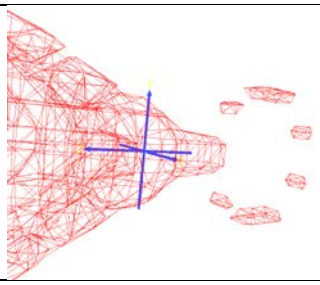
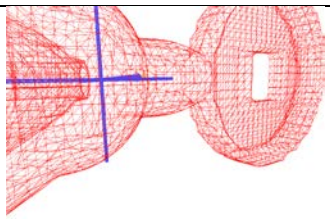
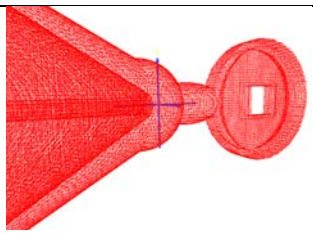
16	Combine Step 15 and 4		Max(Max(1^2-(x/0.5)^2 - (y/0.5)^2 - (z+0.7)^2, Max(Max(Min(Min(1.5^2-(y)^2-(3+z)^2,0.1-x,0.1+x),- Min(1.5^2-(y)^2-(3+z)^2,0.1-x,0.1+x)), Min (Min(1.6^2-(y)^2-(3+z)^2,0.3-x,0.3+x),-1.4^2-(y)^2-(3+z)^2)), Min(Min(-z-2.5, z+3.5, 0.5-y, 0.5+y, 0.2-x, 0.2+x),- Min(z-2.6,z+3.4,0.4-y,0.4+y)))), Max(Min(z,4-z, (x)^2 + (y)^2 -(((z)*0.5)+0.7)^2)), Min(z,4-z, (x)^2 + (y)^2 - (((z)*0.5)+0.7)^2)));
17	Create Sphere for Bell Shape		5^2-(x)^2 - (y)^2 - (z-8.5)^2 >= 0;
18	Cut-Off Point For Sphere		Min(-z+6,5^2-(x)^2 - (y)^2 - (z-8.5)^2) >= 0
19	Repeat similar step for 17 and 18		Min(4.2^2-(x)^2 - (y)^2 - (z-7)^2, -z+6) >= 0

20	Combine Step 19 and 18 and 16		Max(Min(4.2^2-(x)^2 - (y)^2 - (z-7)^2, -z+6), Min(-z+6,5^2-(x)^2 - (y)^2 - (z-8.5)^2), Max(Max(1^2-(x/0.5)^2 - (y/0.5)^2 - (z+0.7)^2, Max(Max(Min(Min(1.5^2-(y)^2-(3+z)^2,0.1-x,0.1+x),- Min(1.5^2-(y)^2-(3+z)^2,0.1-x,0.1+x)), Min (Min(1.6^2-(y)^2-(3+z)^2,0.3-x,0.3+x),-1.4^2-(y)^2-(3+z)^2)), Min(Min(-z-2.5, z+3.5, 0.5-y, 0.5+y, 0.2-x, 0.2+x),- Min(z-2.6,z+3.4,0.4-y,0.4+y)))), Max(Min(z,4-z, (x)^2 + (y)^2 -(((z)*0.5)+0.7)^2)), Min(z,4-z, (x)^2 + (y)^2 - (((z)*0.5)+0.7)^2)));) >= 0
21	Create Inner Cone		Min(z,7-z, (x)^2 + (y)^2 - (((z-1)*0.6)+0.7)^2) >= 0;

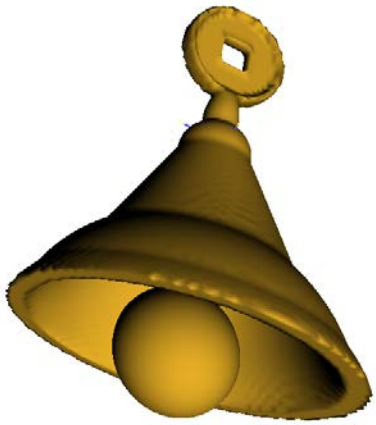
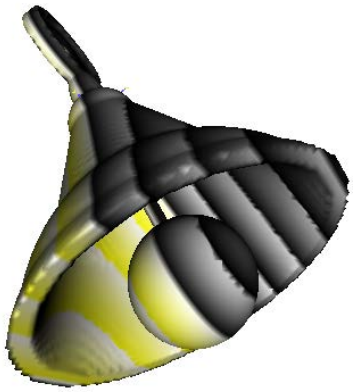
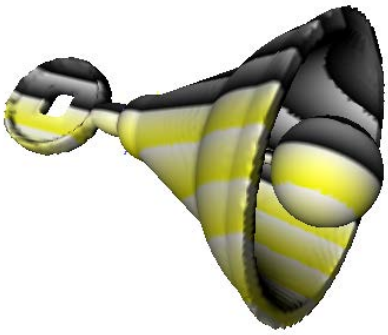
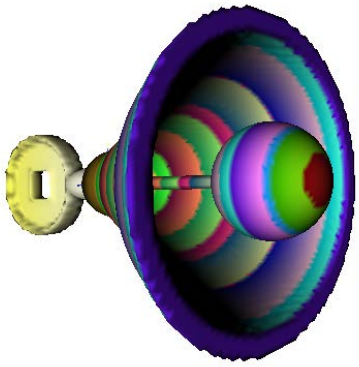
22	Negate Step 21 with Step 20, to create a hollow cone space		Min(Max(Min(4.2^2-(x)^2 - (y)^2 - (z-7)^2, -z+6), Min(-z+6,5^2-(x)^2 - (y)^2 - (z-8.5)^2), Max(Max(1^2-(x/0.5)^2 - (y/0.5)^2 - (z+0.7)^2, Max(Max(Min(Min(1.5^2-(y)^2-(3+z)^2,0.1-x,0.1+x),- Min(1.5^2-(y)^2-(3+z)^2,0.1-x,0.1+x)), Min (Min(1.6^2-(y)^2-(3+z)^2,0.3-x,0.3+x),-1.4^2-(y)^2-(3+z)^2)), Min(Min(-z-2.5, z+3.5, 0.5-y, 0.5+y, 0.2-x, 0.2+x),- Min(z-2.6,z+3.4,0.4-y,0.4+y)))), Max(Min(z,4-z, (x)^2 + (y)^2 -(((z)*0.5)+0.7)^2)), Min(z,4-z, (x)^2 + (y)^2 - (((z)*0.5)+0.7)^2)));),- Min(z,7-z, (x)^2 + (y)^2 - (((z-1)*0.6)+0.7)^2)) >= 0;
23	Similarly, create a sphere and inside the bell		Max(1.5^2-(x)^2 - (y)^2 - (z-6)^2, Min(Max(Min(4.2^2-(x)^2 - (y)^2 - (z-7)^2, -z+6), Min(-z+6,5^2-(x)^2 - (y)^2 - (z-8.5)^2), Max(Max(1^2-(x/0.5)^2 - (y/0.5)^2 - (z+0.7)^2, Max(Max(Min(Min(1.5^2-(y)^2-(3+z)^2,0.1-x,0.1+x),- Min(1.5^2-(y)^2-(3+z)^2,0.1-x,0.1+x)), Min (Min(1.6^2-(y)^2-(3+z)^2,0.3-x,0.3+x),-1.4^2-(y)^2-(3+z)^2)), Min(Min(-z-2.5, z+3.5, 0.5-y, 0.5+y, 0.2-x, 0.2+x),- Min(z-2.6,z+3.4,0.4-y,0.4+y)))), Max(Min(z,4-z, (x)^2 + (y)^2 -(((z)*0.5)+0.7)^2)), Min(z,4-z, (x)^2 + (y)^2 - (((z)*0.5)+0.7)^2)));),- Min(z,7-z, (x)^2 + (y)^2 - (((z-1)*0.6)+0.7)^2)) >= 0;) >= 0;

25	Similarly, create a cylinder with to support the sphere of the bell		Max(min(0.2^2-x^2-y^2,z,6-z), Max(1.5^2-(x)^2 - (y)^2 - (z-6)^2, Min(Max(Min(4.2^2-(x)^2 - (y)^2 - (z-7)^2, -z+6), Min(-z+6,5^2-(x)^2 - (y)^2 - (z-8.5)^2), Max(Max(1^2-(x/0.5)^2 - (y/0.5)^2 - (z+0.7)^2, Max(Max(Min(Min(1.5^2-(y)^2-(3+z)^2,0.1-x,0.1+x),- Min(1.5^2-(y)^2-(3+z)^2,0.1-x,0.1+x)), Min (Min(1.6^2-(y)^2-(3+z)^2,0.3-x,0.3+x),-1.4^2-(y)^2-(3+z)^2)), Min(Min(-z-2.5, z+3.5, 0.5-y, 0.5+y, 0.2-x, 0.2+x),- Min(z-2.6,z+3.4,0.4-y,0.4+y)))), Max(Min(z,4-z, (x)^2 + (y)^2 -(((z)*0.5)+0.7)^2)), Min(z,4-z, (x)^2 + (y)^2 - (((z)*0.5)+0.7)^2)));),- Min(z,7-z, (x)^2 + (y)^2 - (((z-1)*0.6)+0.7)^2)) >= 0;)) >= 0

Resolution

Resolution Value	50, 50, 50 (Low)	150, 150 ,150 (Med)	300, 300 ,300 (High)
View			
WireFrame			
Rendering	Almost Instant	Take a few seconds	Take longer than 5 seconds
Observation	The lack of resolution results in features not able to form properly as shown.	The resolution is sufficient to render all polygons as intended.	The resolution is high but may not be necessary for gaming applications. More feasible for the movie-related application. The edges are smoother and refine
Source	FShape_Composite _low_res.wrl	FShape_Composite.wrl	FShape_Composite _high_res.wrl

Color Variation

Color	View	Source
Gold R = 90.2% G = 68.24% B = 14.51%		FShape_Composite_ Color_Gold.wrl
Gradient All with variable U		FShape_Composite_ ColorGradientU.wrl
Gradient All with variable V		FShape_Composite_ ColorGradientV.wrl
RGB Gradiant with all variable W With R = 90.2% G = 68.24% B = 14.51%		FShape_Composite_ ColorGradientW.wrl

- Notice that the color of gradient changes in different directions depending on X,Y,Z axis. From here we can conclude that it is corresponding with U,V,W respectively.