

NANYANG
TECHNOLOGICAL
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CZ2003 Computer Graphics and
Visualization

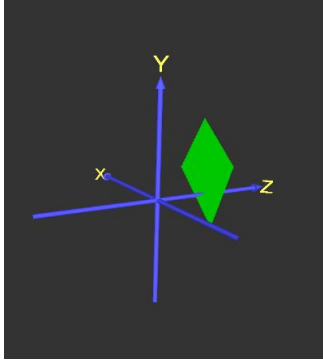
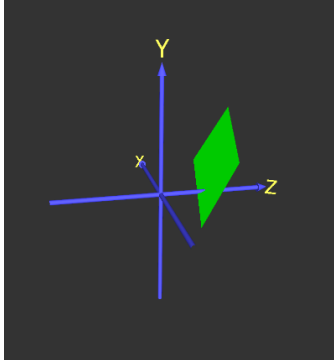
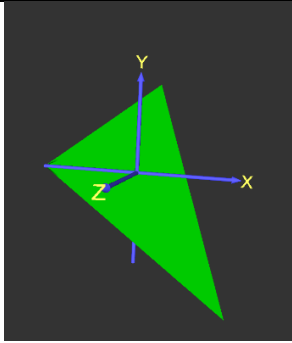
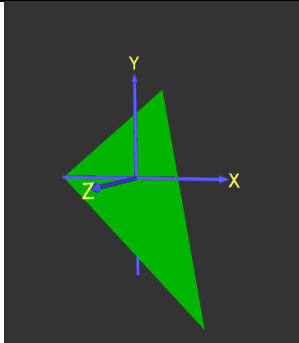
Lab 3: Parametric Surfaces and Solids

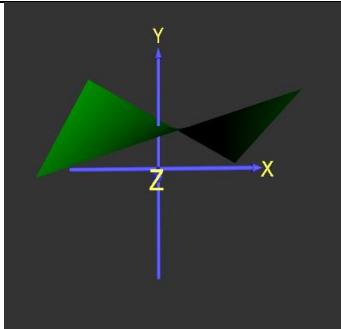
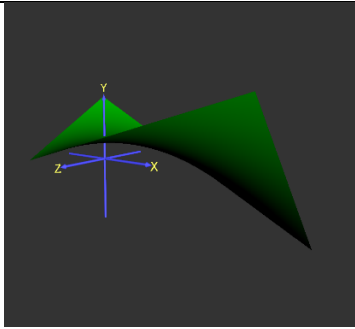
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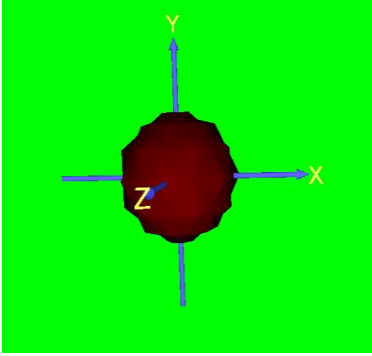
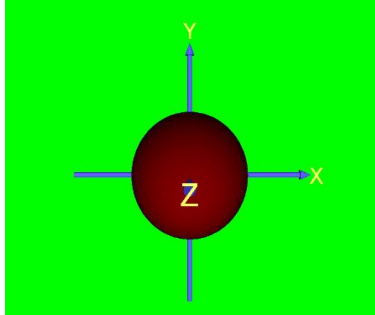
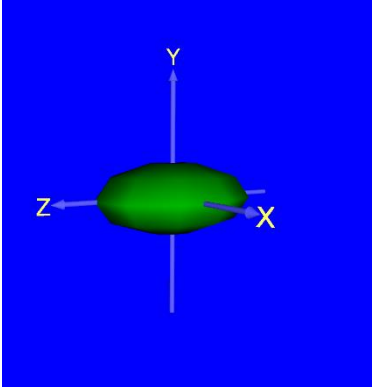
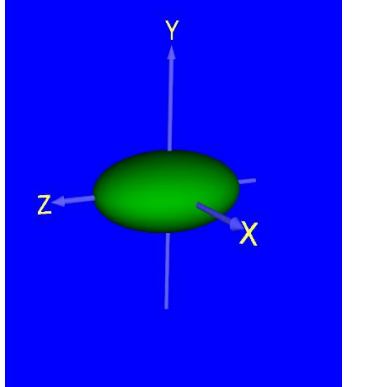
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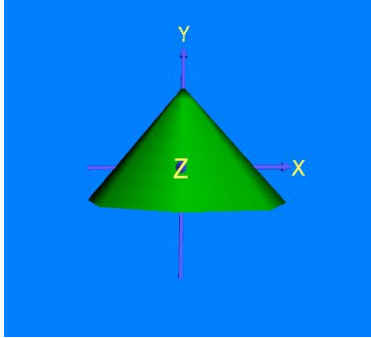
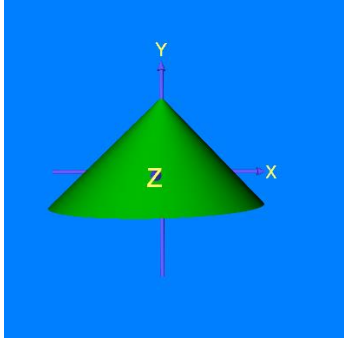
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Surfaces:

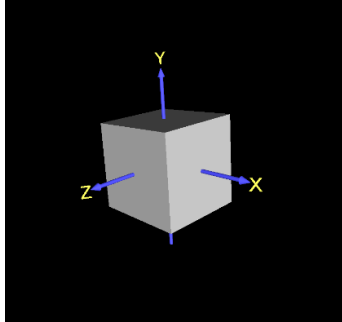
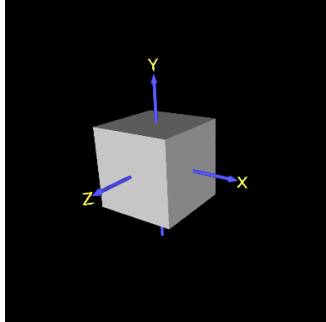
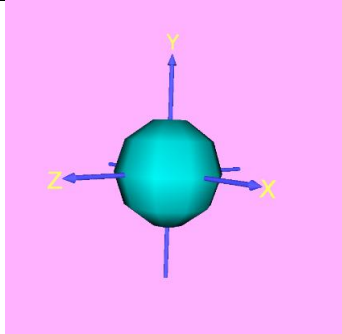
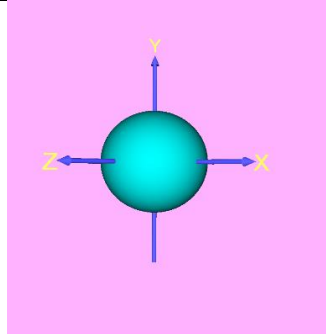
Shape	Figure 1	Figure 2	Notes
3D Plane	 <p>Above is a snapshot of “Plane 1.wrl” with the following properties:</p> <p><u>Parametric Equation:</u> $x = -0.3 + 0.4*u + 0.6*v$ $y = -0.2 + 0.4*u + 0.4*v$ $z = 0.3 + 0.5*u + 0.1*v$</p> <p><u>Domain:</u> [0 1 0 1]</p> <p><u>Resolution:</u> [10 10]</p>	 <p>Above is a snapshot of “Plane 2.wrl” with the following properties:</p> <p><u>Parametric Equation:</u> $x = -0.3 + 0.4*u + 0.6*v$ $y = -0.2 + 0.4*u + 0.4*v$ $z = 0.3 + 0.5*u + 0.1*v$</p> <p><u>Domain:</u> [0 1 0 1]</p> <p><u>Resolution:</u> [100 100]</p>	<p>Decreasing the sampling resolution doesn’t have a great effect on the smoothness of the image we see. However, the number of points sampled is lesser.</p> <p>Changing the domain changes the size of the plane.</p> <p>Increasing the domain increases the size of the plane and decreasing the domain decreases the size of the plane.</p>
Triangular Polygon	 <p>Above is a snapshot of “3D Triangle 1.wrl” with the following properties:</p>	 <p>Above is a snapshot of “3D Triangle 2.wrl” with the following properties:</p>	<p>The figure is obtained by setting $P_3 = P_4$ in the equation of bilinear surface. Just like the 3D Plane, decreasing the sampling resolution doesn’t affect the 3D Triangle and changing the domain size changes the size of the 3D Triangle.</p>

	<p><u>Parametric Equation:</u> $x = u - v - u*v$ $y = 1 - 2*u - v + 2*u*v$ $z = -1 + 2*u + v - 2*u*v$</p> <p><u>Domain:</u> [0 1 0 1]</p> <p><u>Resolution:</u> [10 10]</p>	<p><u>Parametric Equation:</u> $x = u - v - u*v$ $y = 1 - 2*u - v + 2*u*v$ $z = -1 + 2*u + v - 2*u*v$</p> <p><u>Domain:</u> [0 1 0 1]</p> <p><u>Resolution:</u> [100 100]</p>	
Bilinear surface	 <p>Above is a snapshot of “Bilinear Surface 1.wrl” with the following properties:</p> <p><u>Parametric Equation:</u> $x = -1 + 2*u$ $y = 1 - u - v + 1.5*u*v$ $z = -1 + 2*v$</p> <p><u>Domain:</u> [0 1 0 1]</p> <p><u>Resolution:</u> [10 10]</p>	 <p>Above is a snapshot of “Bilinear Surface 2.wrl” with the following properties:</p> <p><u>Parametric Equation:</u> $x = -1 + 2*u$ $y = 1 - u - v + 1.5*u*v$ $z = -1 + 2*v$</p> <p><u>Domain:</u> [0 2 0 1]</p> <p><u>Resolution:</u> [100 100]</p>	<p>Decreasing the sampling resolution to [10 10] doesn’t change the surface drastically. However, if the resolution is decreased to as little as [1 1] or [2 2] the surface loses its smoothness and looks like a paper fold. Increasing the domain increases the size of the bilinear surface;</p>

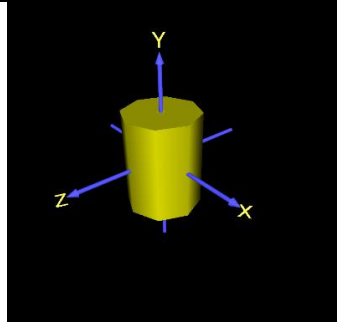
<h2>Sphere</h2>	 <p>Above is a snapshot of “Sphere 1.wrl” with the following properties:</p> <p><u>Parametric Equation:</u> $x=0.5*\cos(2*\pi*u) * \sin(\pi*v)$ $y=0.5*\sin(2*\pi*u)$ $z=0.5*\cos(2*\pi*u) * \cos(\pi*v)$</p> <p><u>Domain:</u> [0 1 0 2]</p> <p><u>Resolution:</u> [7 7]</p> <p><u>Colour:</u> $r = (1 - 0.5*v)/2$ $g = 0$ $b = 0$</p>	 <p>Above is a snapshot of “Sphere 2.wrl” with the following properties:</p> <p><u>Parametric Equation:</u> $x=0.5*\cos(2*\pi*u) * \sin(\pi*v)$ $y=0.5*\sin(2*\pi*u)$ $z=0.5*\cos(2*\pi*u) * \cos(\pi*v)$</p> <p><u>Domain:</u> [0 1 0 1]</p> <p><u>Resolution:</u> [75 75]</p> <p><u>Colour:</u> $r = (1 - 0.5*v)/2$ $g = 0$ $b = 0$</p>	<p>A sphere is created by rotational sweeping of the circular curve about any of the axes that it not orthogonal to it.</p> <p>Decreasing the sampling resolution decreases the smoothness of the surface and it becomes rather pointed. This is because lesser number of points are sampled.</p> <p>Increasing the domain doesn’t have much effect as you are essentially overdrawing the sphere.</p> <p>By decreasing the domain to [0 1 0 0.5] we get a hemisphere.</p>
<h2>Ellipsoid</h2>	 <p>Above is a snapshot of “Ellipsoid 1.wrl” with the following properties:</p> <p><u>Parametric Equation:</u> $x=0.5*\cos(2*\pi*u) * \sin(\pi*v)$ $y=0.3*\sin(2*\pi*u)$ $z=0.7*\cos(2*\pi*u) * \cos(\pi*v)$</p> <p><u>Domain:</u> [0 1 0 1]</p>	 <p>Above is a snapshot of “Ellipsoid 2.wrl” with the following properties:</p> <p><u>Parametric Equation:</u> $x=0.5*\cos(2*\pi*u) * \sin(\pi*v)$ $y=0.3*\sin(2*\pi*u)$ $z=0.7*\cos(2*\pi*u) * \cos(\pi*v)$</p> <p><u>Domain:</u> [0 1 0 1]</p>	<p>An ellipsoid is created by rotational sweeping of and elliptic curve about any of its axes that is not orthogonal to it.</p> <p>Just like the sphere, decreasing the sampling resolution reduces the smoothness of the surface and it becomes pointy and rough.</p> <p>Increasing the domain doesn’t do much as the ellipsoid is overdrawn then.</p> <p>The figure is defined by variable colour.</p>

	<u>Resolution:</u> [10 10] <u>Colour:</u> $r = 0$ $g = 0.6 + u/3$ $b = 0$	<u>Resolution:</u> [75 75] <u>Colour:</u> $r = 0$ $g = 0.6 + u/3$ $b = 0$	
Cone	 <p>Above is a snapshot of “Cone 1.wrl” with the following properties:</p> <p><u>Parametric Equation:</u> $x = u \cdot \sin(2 \cdot \pi \cdot v)$ $y = -1 \cdot u + 0.7$ $z = u \cdot \cos(2 \cdot \pi \cdot v)$</p> <p><u>Domain:</u> [0 1 0 1] <u>Resolution:</u> [8 8]</p>	 <p>Above is a snapshot of “Cone 2.wrl” with the following properties:</p> <p><u>Parametric Equation:</u> $x = u \cdot \sin(2 \cdot \pi \cdot v)$ $y = -1 \cdot u + 0.7$ $z = u \cdot \cos(2 \cdot \pi \cdot v)$</p> <p><u>Domain:</u> [0 1 0 1] <u>Resolution:</u> [100 100]</p>	<p>A cone is created by rotational sweeping of a line segment about any of the coordinate axes.</p> <p>Decreasing the sampling resolution gives the cone a Polygon-like base and the smoothness decreases.</p> <p>Increasing the domain doesn't affect the surface as it will get overdrawn.</p>

Solids:

Shape	Figure 1	Figure 2	Notes
Solid Box	 <p>Above is a snapshot of "Solid Box 1.wrl" with the following properties:</p> <p><u>Parametric Equation:</u> $x = -0.5 + u$ $y = -0.5 + v$ $z = -0.5 + w$</p> <p><u>Domain:</u> [0 1 0 1 0 1] <u>Resolution:</u> [15 15 15]</p>	 <p>Above is a snapshot of "Solid Box 2.wrl" with the following properties:</p> <p><u>Parametric Equation:</u> $x = -0.5 + u$ $y = -0.5 + v$ $z = -0.5 + w$</p> <p><u>Domain:</u> [0 1 0 1 0 1] <u>Resolution:</u> [100 100 100]</p>	<p>Decreasing the sampling resolution doesn't have any effect on the Solid Box. This is because very few points are needed to draw the Box.</p> <p>Increasing the domain changes the dimensions of the Box.</p> <p>Changing the domain from [0 1 0 1 0 1] to [0 1 0 1 0 2] changes the shape of the box from a Cube to a Cuboid.</p>
Solid Sphere	 <p>Above is a snapshot of "Solid Sphere 1.wrl" with the following properties:</p> <p><u>Parametric Equation:</u> $x = 0.5 * w * \cos(2 * \pi * u) * \sin(\pi * v)$ $y = 0.5 * w * \sin(2 * \pi * u)$ $z = 0.5 * w * \cos(2 * \pi * u) * \cos(\pi * v)$</p> <p><u>Domain:</u> [0 1 0 1 0 1] <u>Resolution:</u> [10 10 10]</p>	 <p>Above is a snapshot of "Solid Sphere 2.wrl" with the following properties:</p> <p><u>Parametric Equation:</u> $x = 0.5 * w * \cos(2 * \pi * u) * \sin(\pi * v)$ $y = 0.5 * w * \sin(2 * \pi * u)$ $z = 0.5 * w * \cos(2 * \pi * u) * \cos(\pi * v)$</p> <p><u>Domain:</u> [0 1 0 1 0 1] <u>Resolution:</u> [75 75 75]</p>	<p>A solid sphere is created by rotational sweeping of a circular disk (circular surface) by π radians about any axis that is not orthogonal to its surface.</p> <p>Decreasing the sampling resolution decreases the smoothness of the solid and it looks very rough.</p> <p>Increasing the domain doesn't have any effect as the solid sphere gets overdrawn.</p>

Solid Cylinder



Above is a snapshot of “**Solid Cylinder 1.wrl**” with the following properties:

Parametric Equation:

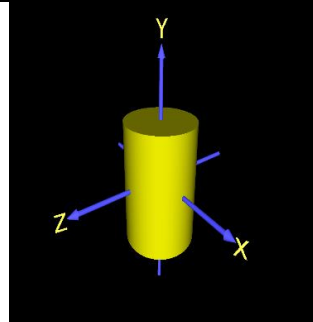
$$x = 0.4 * w * \sin(2 * \pi * u)$$

$$y = -0.5 + v$$

$$z = 0.4 * w * \cos(2 * \pi * u)$$

Domain: [0 1 0 1 0 1]

Resolution: [8 8 8]



Above is a snapshot of “**Solid Cylinder 2.wrl**” with the following properties:

Parametric Equation:

$$x = 0.4 * w * \sin(2 * \pi * u)$$

$$y = -0.5 + v$$

$$z = 0.4 * w * \cos(2 * \pi * u)$$

Domain: [0 1 0 1 0 1]

Resolution: [75 75 75]

A Solid Cylinder is created by translational sweeping of a circular disk (circular surface) about an axis orthogonal to its surface.

Decreasing the sampling resolution to [8 8 8] gives the cylinder an octagonal base and the cylinder loses its smoothness. Increasing the domain increases the size of the cylinder.

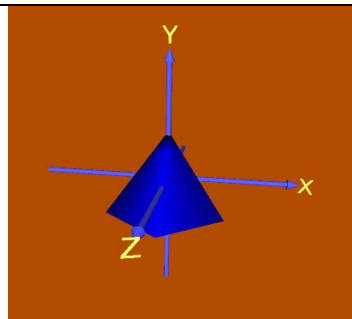
Note:

u -> controls how much of the cylinder we see.

v -> controls height of cylinder.

w -> controls radius of cylinder.

Solid Cone



Above is a snapshot of “**Solid Cone 1.wrl**” with the following properties:

Parametric Equation:

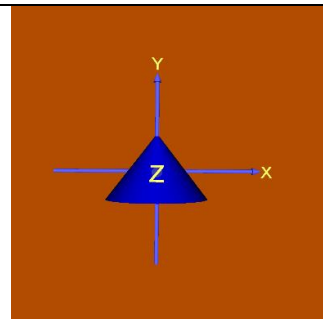
$$x = (1-w) * 0.5 * u * \sin(2 * \pi * v)$$

$$y = 0.7 * w - 0.3$$

$$z = (1-w) * 0.5 * u * \cos(2 * \pi * v)$$

Domain: [0 1 0 1 0 1]

Resolution: [5 5 5]



Above is a snapshot of “**Solid Cone 2.wrl**” with the following properties:

Parametric Equation:

$$x = (1-w) * 0.5 * u * \sin(2 * \pi * v)$$

$$y = 0.7 * w - 0.3$$

$$z = (1-w) * 0.5 * u * \cos(2 * \pi * v)$$

Domain: [0 1 0 1 0 1]

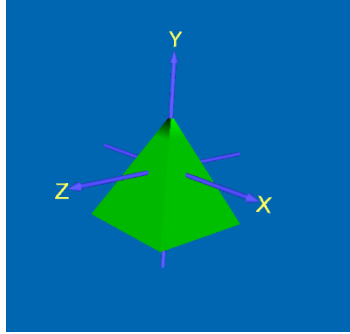
Resolution: [75 75 75]

A solid cone can be created from the equation of a solid cylinder by changing the constant radius to the variable radius decreasing as one parameter increases. Here the factor (1-w) controls the radius of the cone and is decreases linearly. Decreasing the sampling resolutions decreases the smoothness of the cone and changing the domain changes the size of the cone.

Note:

A solid cone can be created by rotational sweeping of a triangular polygon.

Triangular Pyramid



Above is a snapshot of
“**Triangular Pyramid 1.wrl**”
with the following properties:

Parametric Equation:

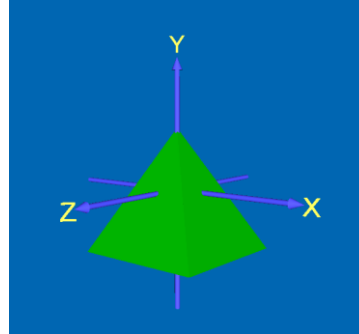
$$x = (1-w) * (-0.5+u)$$

$$y = -0.5 + w$$

$$z = (1-w) * (-0.5+v)$$

Domain: [0 1 0 1 0 1]

Resolution: [5 5 5]



Above is a snapshot of
“**Triangular Pyramid 2.wrl**”
with the following properties:

Parametric Equation:

$$x = (1-w) * (-0.5+u)$$

$$y = -0.5 + w$$

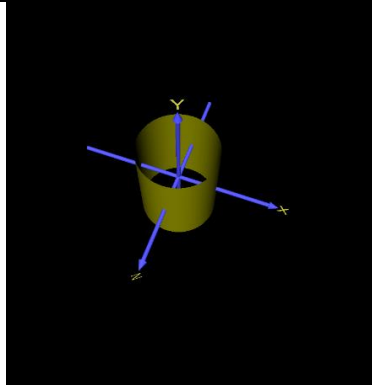
$$z = (1-w) * (-0.5+v)$$

Domain: [0 1 0 1 0 1]

Resolution: [100 100 100]

A Triangular Pyramid can be created from the equation of a solid box. The only change is that we decrease the length and breadth (x and z values) linearly as the height increases. On decreasing the sampling resolution, we see little to no difference in the appearance of the figure. The only noticeable change is that the tip of the pyramid becomes darker. Changing the sampling resolution changes the size of the pyramid.

Convert a Cylindrical Surface into a Solid Cylinder:



Above is a snapshot of
“**Cylinder.wrl**” with the
following properties:

Parametric Equation:

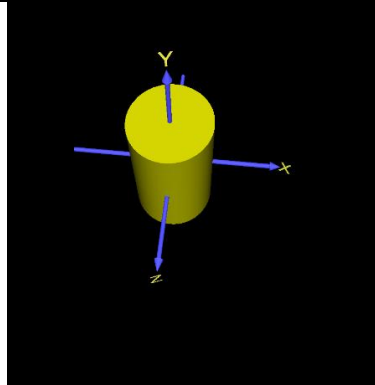
$$x = 0.4 * \sin(2 * \pi * u)$$

$$y = -0.5 + v$$

$$z = 0.4 * \cos(2 * \pi * u)$$

Domain: [0 1 0 1]

Resolution: [75 75]



Above is a snapshot of
“**Solid Cylinder 2.wrl**” with the
following properties:

Parametric Equation:

$$x = 0.4 * w * \sin(2 * \pi * u)$$

$$y = -0.5 + v$$

$$z = 0.4 * w * \cos(2 * \pi * u)$$

Domain: [0 1 0 1 0 1]

Resolution: [75 75 75]

A Cylindrical Surface is created by translational sweeping of a circular curve and a Solid Cylinder is created by translational sweeping of a circular surface.

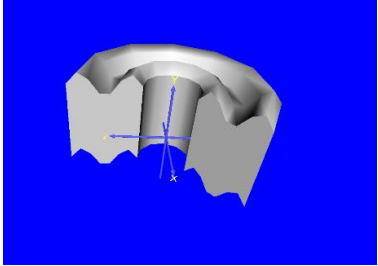
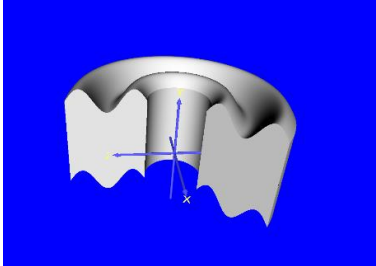
The Cylindrical Surface can be converted to a Solid Cylinder by introducing a third parameter ‘w’.

The effect of this is to fill in the missing space inside the hollow Cylindrical Surface.

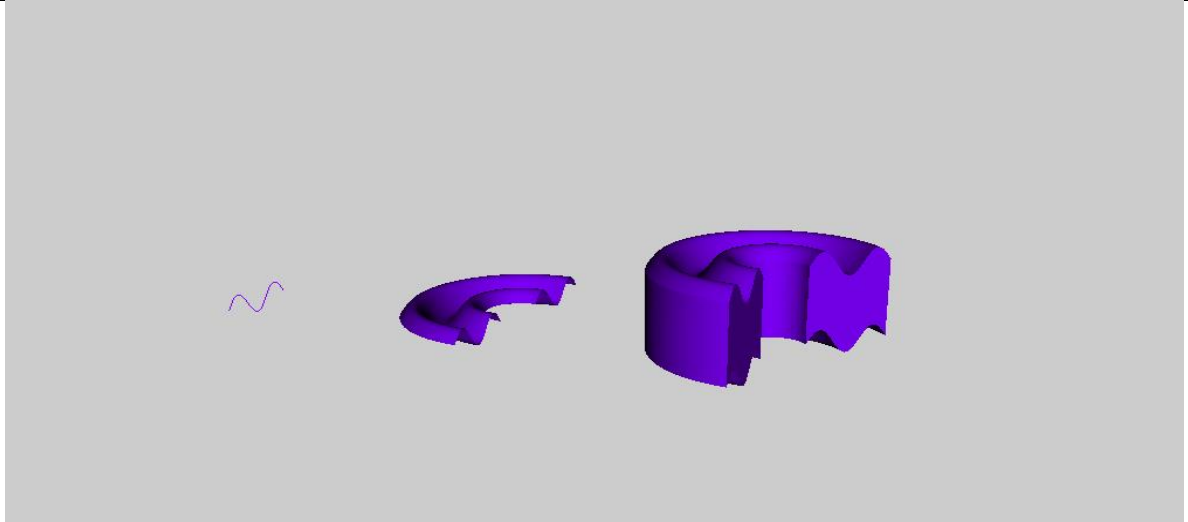
The general idea is that a surface has 2 degrees of freedom and a solid has 3 degrees of freedom.

Therefore, any surface can be converted to a solid by including a 3rd parameter (example: w) to give it another degree of freedom.

Rotational and Translational Sweeping on a Sine curve:

 <p>Above is a snapshot of "Sine curve sweeping 1.wrl" with the following properties:</p> <p><u>Parametric Equation:</u> $x = (0.5 + 1.25*u) * \sin(1.25*\pi*v)$ $y = 0.2*\sin(3*\pi*u) - 0.5 + 1.5*w$ $z = (0.5 + 1.25*u) * \cos(1.25*\pi*v)$</p> <p><u>Domain:</u> [0 1 0 1 0 1]</p> <p><u>Resolution:</u> [7 7 7]</p>	 <p>Above is a snapshot of "Sine curve sweeping 2.wrl" with the following properties:</p> <p><u>Parametric Equation:</u> $x = (0.5 + 1.25*u) * \sin(1.25*\pi*v)$ $y = 0.2*\sin(3*\pi*u) - 0.5 + 1.5*w$ $z = (0.5 + 1.25*u) * \cos(1.25*\pi*v)$</p> <p><u>Domain:</u> [0 1 0 1 0 1]</p> <p><u>Resolution:</u> [75 75 75]</p>	<p>The figure is created by translational and rotational sweeping of a sine curve.</p> <p>As we reduce the sampling resolution the sine curve loses its smoothness and therefore, the entire solid becomes rather rough and pointy.</p> <p>Changing the domain changes the size of the solid.</p> <p><u>Note:</u></p> <p>Effect of parameters u-> controls length of sine curve. v-> rotational sweeping of the sine curve. w->translational sweeping of the sine curve.</p>
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Rotational and Translational Sweeping on a Sine curve with Animation:



Above is a snapshot of “**Sine curve sweeping with animation.wrl**”. It explains rotational and translational sweeping with animations.

The first figure is a curve defined by:

$$x = 0$$

$$y = 0.2 \sin(3\pi u) - 0.5$$

$$z = 0.5 + 1.25u$$

It is a sine curve that travels along the positive Z direction with an amplitude of 0.2.

The second figure is a surface defined by:

$$x = (0.5 + 1.25u) \sin(-1.25\pi v t)$$

$$y = 0.2 \sin(3\pi u) - 0.5$$

$$z = (0.5 + 1.25u) \cos(-1.25\pi v t)$$

It is formed by rotational sweeping of the first figure by 1.25π radians starting from positive Z axis along the clockwise direction. Time variable t was used to demonstrate **rotational sweeping**.

The third figure is a solid defined by:

$$x = (0.5 + 1.25u) \sin(-1.25\pi v)$$

$$y = 0.2 \sin(3\pi u) - 0.5 + 1.5w t$$

$$z = (0.5 + 1.25u) \cos(-1.25\pi v)$$

It is formed by translation sweeping of the second figure by 2 units along the Y axis.

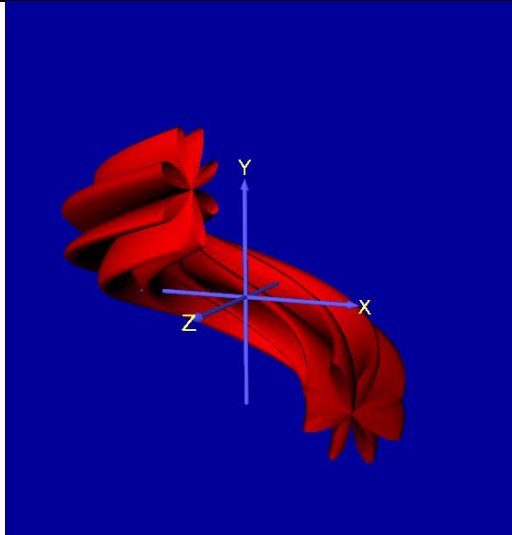
Time variable t was used to demonstrate **translational sweeping**.

Note:

The figure can also be created by applying translational sweeping followed by rotational sweeping.

Extra Surfaces and Solids

The following figures can be found in the “**Lab3_Extras**” folder in the Lab3 folder.



Above is a snapshot of
“**surface 1.wrl**” with the following properties:

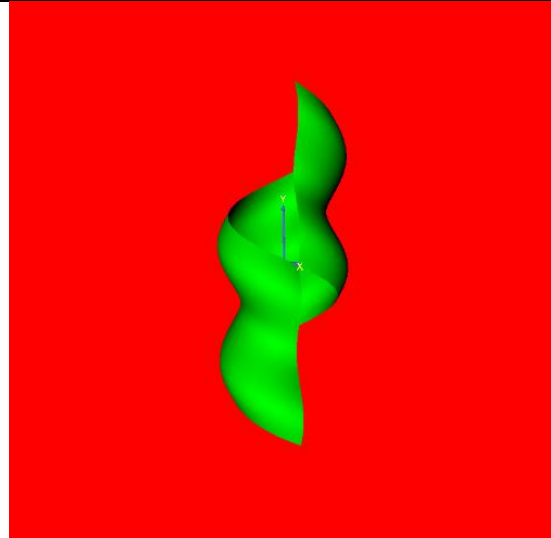
Parametric Equation:

$$\begin{aligned}x &= (0.5 \sin(8\pi u) \cos(2\pi u) + 1) \sin(1.5\pi v + 0.5\pi) \\y &= 0.5 \sin(8\pi u) \sin(2\pi u) - 1 + 2v \\z &= (0.5 \sin(8\pi u) \cos(2\pi u) + 1) \cos(1.5\pi v + 0.5\pi)\end{aligned}$$

Domain: [0 1 0 1]

Resolution: [75 75]

The figure describes rotational sweeping by 1.5π radians starting from positive X axis and terminating at positive Z axis travelling counter-clockwise and translational sweeping by 2 units along the Y axis of a “polar rose” defined in polar coordinates by $r = 0.5\sin(4\alpha)$ where $\alpha \in [0, 2\pi]$.



Above is a snapshot of
“**surface 2.wrl**” with the following properties:

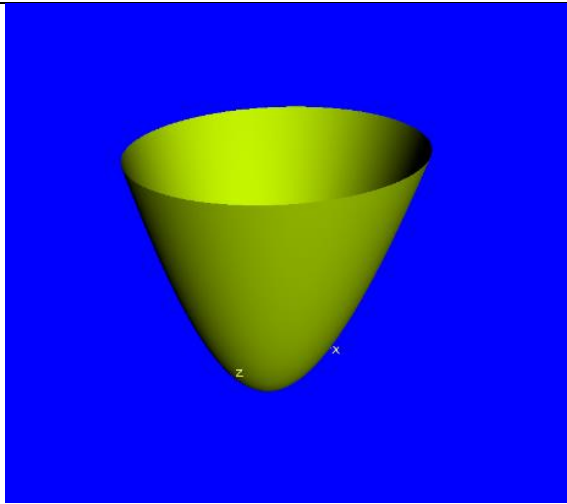
Parametric Equation:

$$\begin{aligned}x &= (0.2 \sin(3\pi u) + 1) \sin(2\pi v + 0.5\pi) \\y &= -3 + 3u + 3v \\z &= (0.2 \sin(3\pi u) + 1) \cos(2\pi v + 0.5\pi)\end{aligned}$$

Domain: [0 1 0 1]

Resolution: [75 75]

The figure describes rotational sweeping of one counter-clockwise rotational about the Y axis and translational sweeping by 3 units in the positive Y direction of a sinusoidal curve defined by $x = 0.2\sin(y) + 1$.



Above is a snapshot of
“surface 3.wrl” with the following properties:

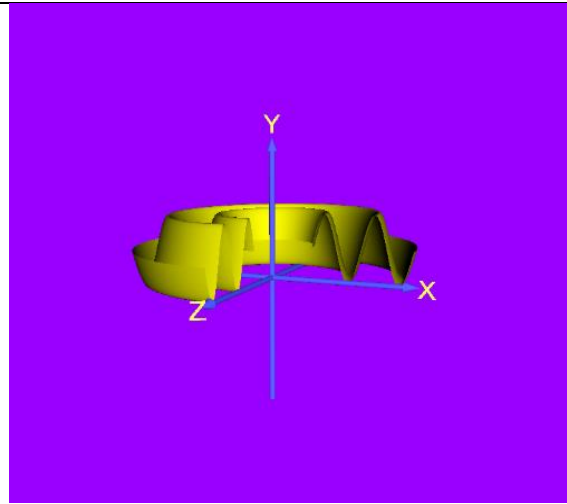
Parametric Equation:

$$\begin{aligned}x &= (-2+4*u) * \sin(2*\pi*v) \\y &= (-2+4*u)^2 - 1 \\z &= (-2+4*u) * \cos(2*\pi*v)\end{aligned}$$

Domain: [0 1 0 1]

Resolution: [75 75]

The figure describes rotational sweeping of a parabola defined by the explicit function $y = x^2 - 1$, where $x \in [-2, 2]$ by π radians about the Y axis.



Above is a snapshot of
“surface 4.wrl” with the following properties:

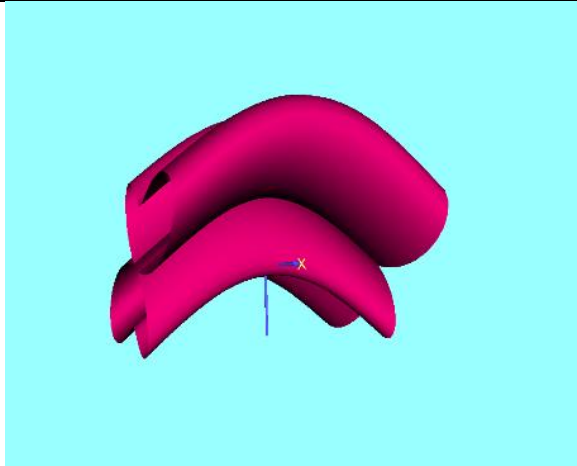
Parametric Equation:

$$\begin{aligned}x &= (0.3+0.7*u) * \sin(-1.5*\pi*v) \\y &= 0.25*\sin(4*\pi*u) + 0.25 \\z &= (0.3+0.7*u) * \cos(-1.5*\pi*v)\end{aligned}$$

Domain: [0 1 0 1]

Resolution: [75 75]

The figure describes rotational sweeping of a sinusoidal curve defined by the equation $x(u) = 0.3+0.7u$ and $y(u) = 0.25\sin(4\pi u)$ about the Y axis by 1.5π radians.



Above is a snapshot of
“surface 5.wrl” with the following properties:

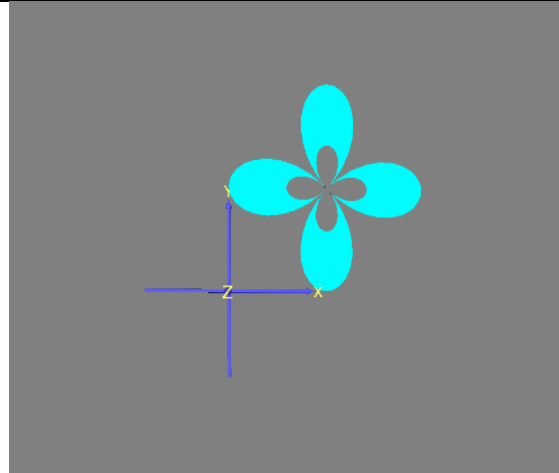
Parametric Equation:

$$\begin{aligned}x &= (1 + \cos(2\pi u) \sin(6\pi u)) \cos(2\pi u) \\y &= (1 + \cos(2\pi u) \sin(6\pi u)) \sin(2\pi u) + \sin(\pi v) \\z &= -2 + 4v\end{aligned}$$

Domain: [0 1 0 1]

Resolution: [75 75]

The figure describes a surface created by sweeping a curve defined in polar coordinates by $r = 1 + \cos(\alpha)\cos(3\alpha)$ where $\alpha \in [0, 2\pi]$ along another curve which is located in the YZ plane defined by $y = \sin(\alpha)$ where $\alpha \in [0, \pi]$ and spanning from $z = -2$ to $z = 2$.



Above is a snapshot of
“surface 6.wrl” with the following properties:

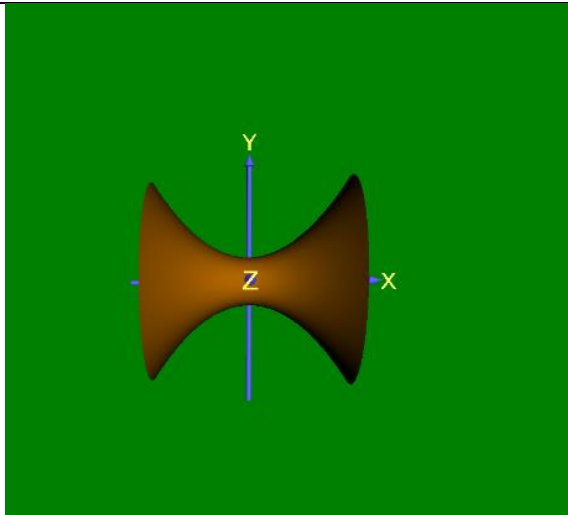
Parametric Equation:

$$\begin{aligned}x &= (0.5 + 0.7u) \sin(4\pi v - 0.5\pi) \cos(2\pi v) + 1.2 \\y &= (0.5 + 0.7u) \sin(4\pi v - 0.5\pi) \sin(2\pi v) + 1.2 \\z &= 0\end{aligned}$$

Domain: [0 1 0 1]

Resolution: [75 75]

The figure describes a surface created from the curves $r_1 = 0.5\sin(2\alpha - 0.5\pi)$ and $r_2 = 1.2\sin(2\alpha - 0.5\pi)$ where the value of r linearly changes from r_1 to r_2 .



Above is a snapshot of
“surface 7.wrl” with the following properties:

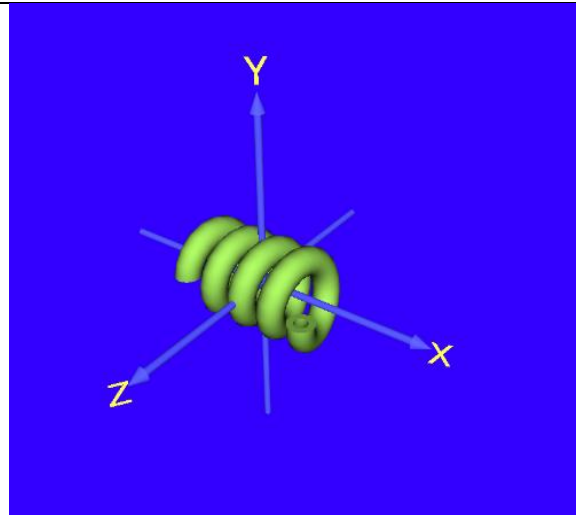
Parametric Equation:

$$\begin{aligned} x &= -0.8 + 1.6 * u \\ y &= ((-0.8 + 1.6 * u)^2 + 0.2) * \cos(2 * \pi * v) \\ z &= ((-0.8 + 1.6 * u)^2 + 0.2) * \sin(2 * \pi * v) \end{aligned}$$

Domain: [0 1 0 1]

Resolution: [75 75]

The figure describes rotational sweeping about the X axis of a parabola defined by the explicit function $y = x^2 + 0.2$.



Above is a snapshot of
“solid 1.wrl” with the following properties:

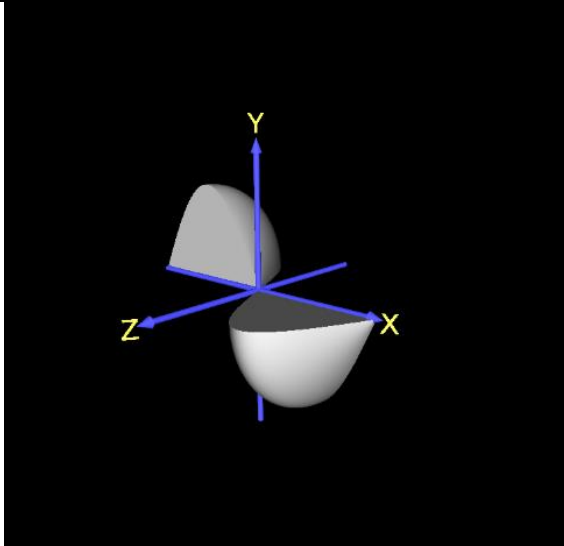
Parametric Equation:

$$\begin{aligned} x &= (0.04 + 0.04 * u) * \sin(2 * \pi * v) - 0.4 + 0.8 * w \\ y &= ((0.04 + 0.04 * u) * \cos(2 * \pi * v) + 0.2) * \cos(-8 * \pi * w + 0.5 * \pi) \\ z &= ((0.04 + 0.04 * u) * \cos(2 * \pi * v) + 0.2) * \sin(-8 * \pi * w + 0.5 * \pi) \end{aligned}$$

Domain: [0 1 0 1 0 1]

Resolution: [75 75 75]

The figure describes a solid helical spring which makes 4 revolutions about the X axis with inner radius $r = 0.04$ and outer radius $R = 0.08$. It is also translated along the X axis by 0.8 units.



Above is a snapshot of
“solid 2.wrl” with the following properties:

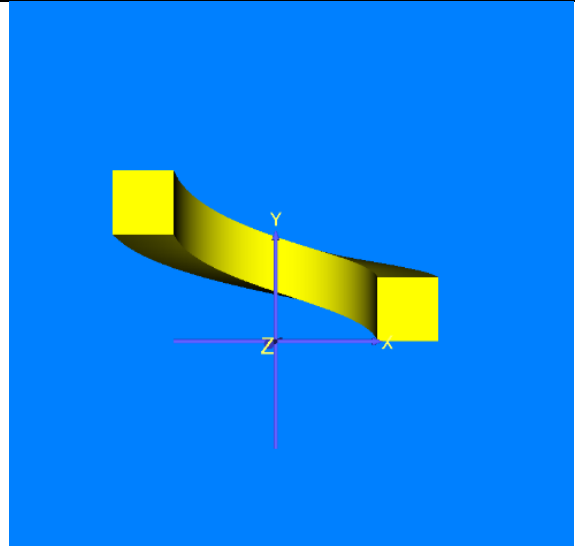
Parametric Equation:

$$\begin{aligned}x &= -1 + 2*u \\y &= (0.7*v*\sin(2*\pi*u)) * \cos(-0.5*\pi*w) \\z &= (0.7*v*\sin(2*\pi*u)) * \sin(-0.5*\pi*w)\end{aligned}$$

Domain: [0 1 0 1 0 1]

Resolution: [75 75 75]

The figure describes a solid formed by rotational sweeping of a sinusoidal surface about the X axis by 0.5π radians.



Above is a snapshot of
“solid 3.wrl” with the following properties:

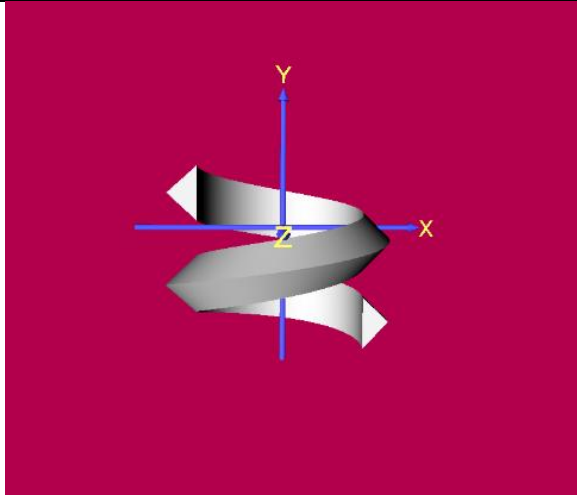
Parametric Equation:

$$\begin{aligned}x &= (1 + 0.6*u) * \sin(\pi*w + 0.5*\pi) \\y &= 0.6*v + w \\z &= (1 + 0.6*u) * \cos(\pi*w + 0.5*\pi)\end{aligned}$$

Domain: [0 1 0 1 0 1]

Resolution: [75 75 75]

The figure describes a solid object created by rotational and translational sweeping of a square polygon with size 0.6×0.6 .



Above is a snapshot of
“solid 4.wrl” with the following properties:

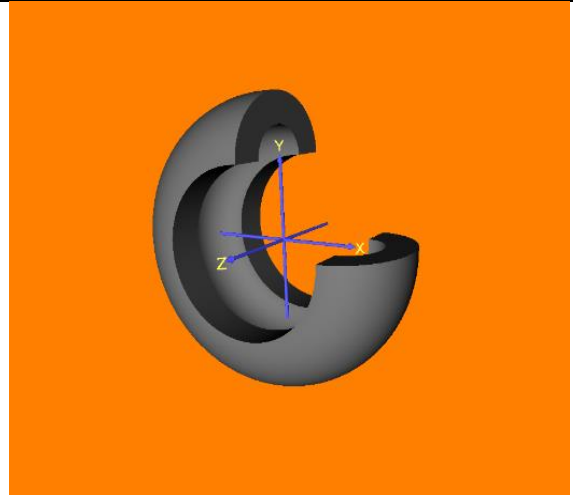
Parametric Equation:

$$\begin{aligned}x &= (0.6+0.2*u) * \sin (0.5*\pi+3*\pi*w) \\y &= (-0.2+0.4*v) * (1-u) - 0.75 + w \\z &= (0.6+0.2*u) * \cos (0.5*\pi+3*\pi*w)\end{aligned}$$

Domain: [0 1 0 1 0 1]

Resolution: [75 75 75]

The figure describes a solid generated by rotational and translational sweeping of a triangular polygon about the Y axis.



Above is a snapshot of
“solid 5.wrl” with the following properties:

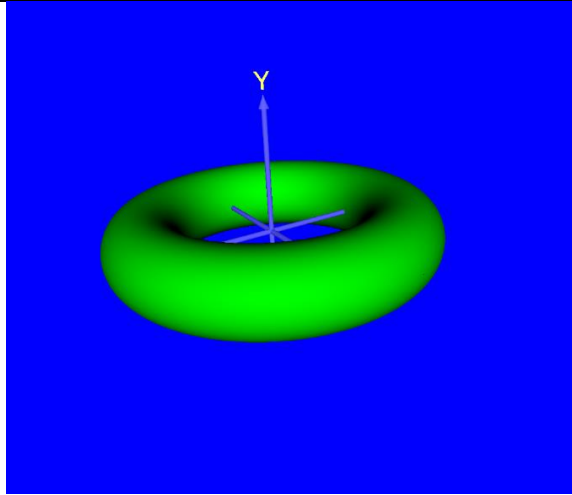
Parametric Equation:

$$\begin{aligned}x &= (1+(0.4+0.4*u) * \sin(\pi*v)) * \cos(-1.5*\pi*w) \\y &= (1+(0.4+0.4*u) * \sin(\pi*v)) * \sin(-1.5*\pi*w) \\z &= (0.4+0.4*u) * \cos(\pi*v)\end{aligned}$$

Domain: [0 1 0 1 0 1]

Resolution: [75 75 75]

The figure describes a solid created by rotational sweeping of a surface defined by $r = 0.4+0.4u$, $x(u, v) = 1+rsin(\pi v)$, $y(u, v) = 0$, $z(u, v) = 1+rcos(\pi v)$ about the Z axis (clockwise) by 1.5π radians.



Above is a snapshot of
"solid 6.wrl" with the following properties:

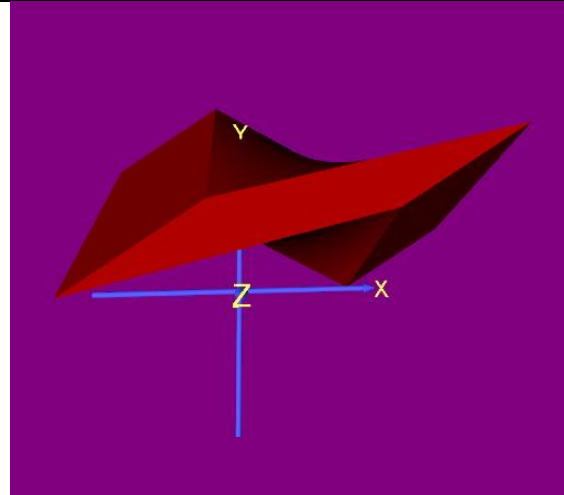
Parametric Equation:

$$\begin{aligned}x &= ((0.1+0.2*u) * \cos(2*\pi*v) + 1) * \sin(2*\pi*w) \\y &= (0.1+0.2*u) * \sin(2*\pi*v) \\z &= ((0.1+0.2*u) * \cos(2*\pi*v) + 1) * \cos(2*\pi*w)\end{aligned}$$

Domain: [0 1 0 1 0 1]

Resolution: [100 100 100]

The figure describes a toroid whose equation can be derived by rotational sweeping of the circular surface which is displaced about one of its axes.



Above is a snapshot of
"solid 7.wrl" with the following properties:

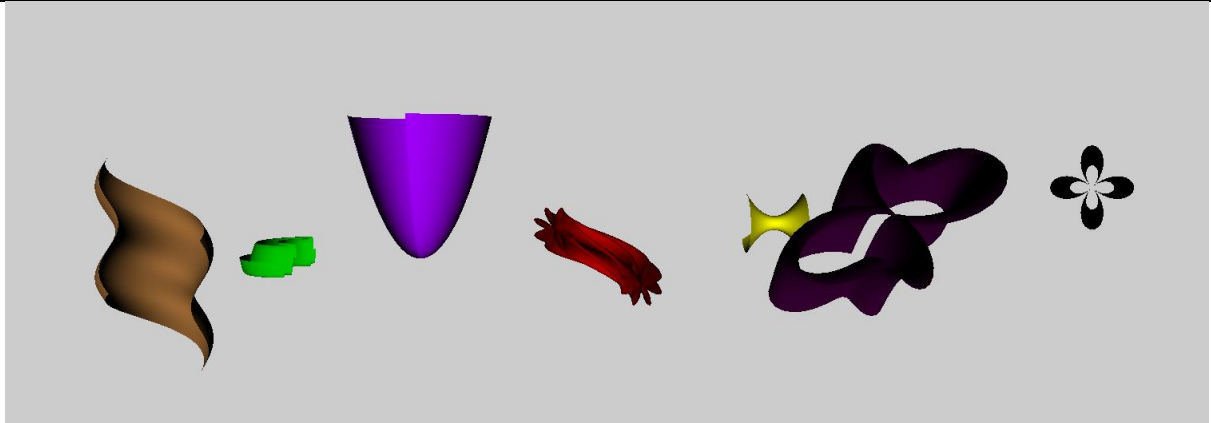
Parametric Equation:

$$\begin{aligned}x &= (-1 + 2*u) + 0.8*w \\y &= 1 - u - v + 1.5*u*v + 0.5*w \\z &= (-1 + 2*v) + 0.3*w\end{aligned}$$

Domain: [0 1 0 1 0 1]

Resolution: [50 50 50]

The figure describes translational sweeping of a bilinear surface along the vector [0.8 0.5 0.3].



Above is a snapshot of “**Sweeping with Animation (Surfaces).wrl**”. It contains all the extra surfaces mentioned above.

All the surfaces in the file use **time parameter** t to illustrate the effect of sweeping.

Example:

The definition of the surface defined in “**surface 1.wrl**” was changed to

$$x = (0.5 * \sin(8 * \pi * u) * \cos(2 * \pi * u) + 1) * \sin(1.5 * \pi * v * t + 0.5 * \pi)$$

$$y = 0.5 * \sin(8 * \pi * u) * \sin(2 * \pi * u) - 1 + 2 * v * t$$

$$z = (0.5 * \sin(8 * \pi * u) * \cos(2 * \pi * u) + 1) * \cos(1.5 * \pi * v * t + 0.5 * \pi)$$

This file also contains surfaces whose colour changes with time.

Example:

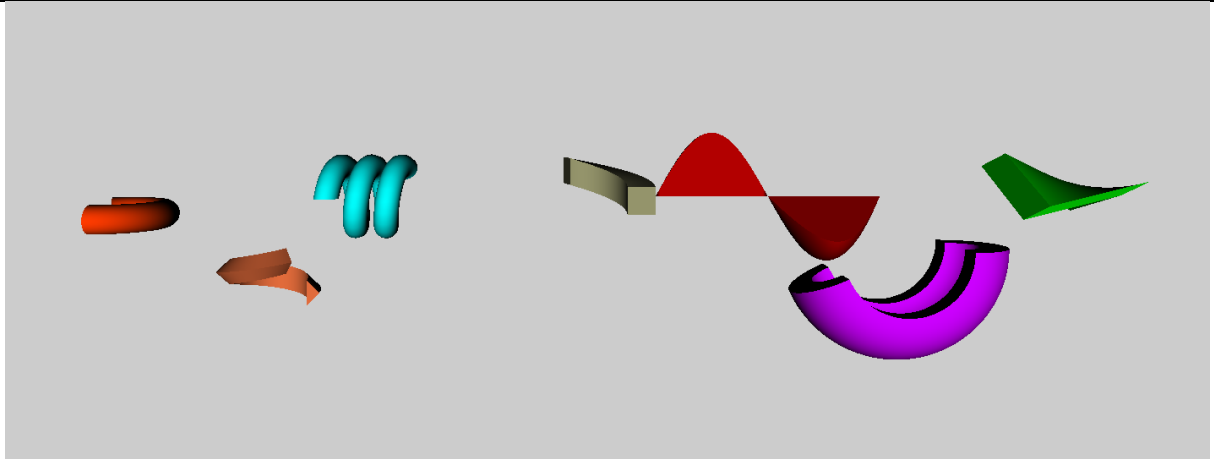
The colour definition of the surface defined in “**surface 3.wrl**” was changed to

$$r = t$$

$$g = 0$$

$$b = 1$$

The colour of this surface uniformly changes from blue to pink.



Above is a snapshot of “**Sweeping with Animation (Solids).wrl**”. It contains all the extra solids mentioned above.

All the solids in the file use **time parameter** t to illustrate the effect of sweeping

Example:

The definition of the solid defined in “**solid 5.wrl**” was changed to

$$x = (1 + (0.4 + 0.4 * u) * \sin(\pi * v)) * \cos(-1.5 * \pi * w * t)$$

$$y = (1 + (0.4 + 0.4 * u) * \sin(\pi * v)) * \sin(-1.5 * \pi * w * t)$$

$$z = (0.4 + 0.4 * u) * \cos(\pi * v)$$

The file also contains solids whose colour changes with time

Example:

The colour definition of the solid defined in “**solid 3.wrl**” was changed to

$$r = t$$

$$g = t$$

$$b = 1 - t$$

The colour of this solid changes uniformly from blue to yellow