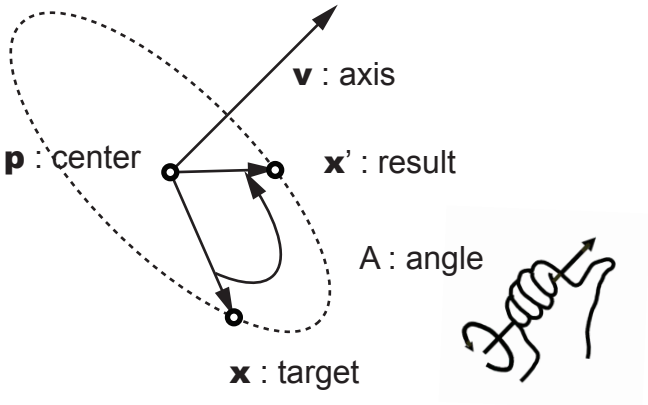
MORPH SEMINAR 2009

MATHEMATICS FOR SYSTEMATIC MODELING

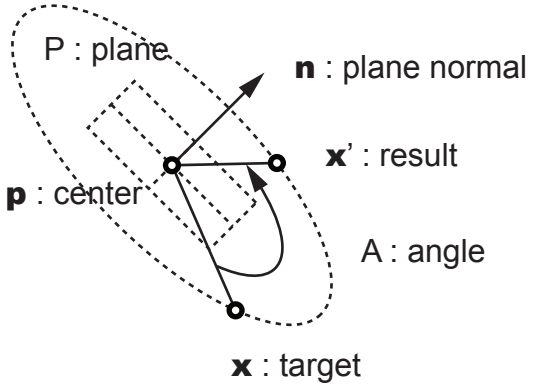
WEEK3 ROTATION AND CIRCLE

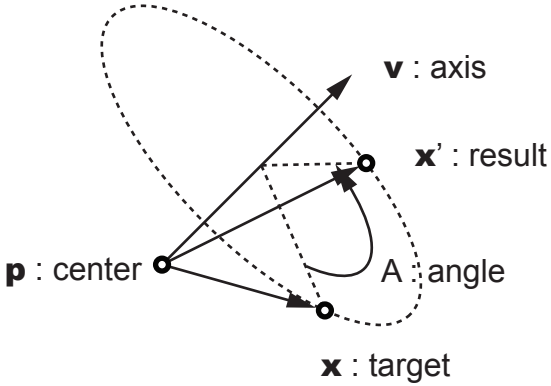
DEFINITION OF ROTATION

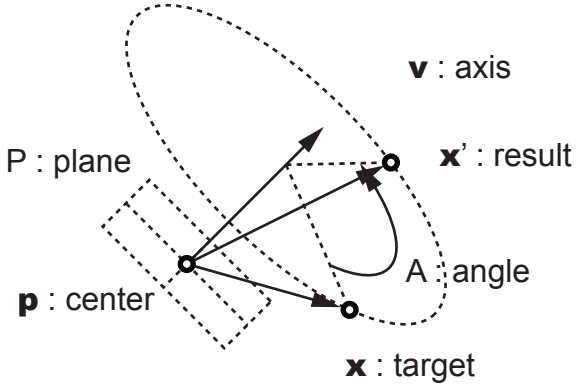
ROTATION BY CENTER + AXIS + ANGLE



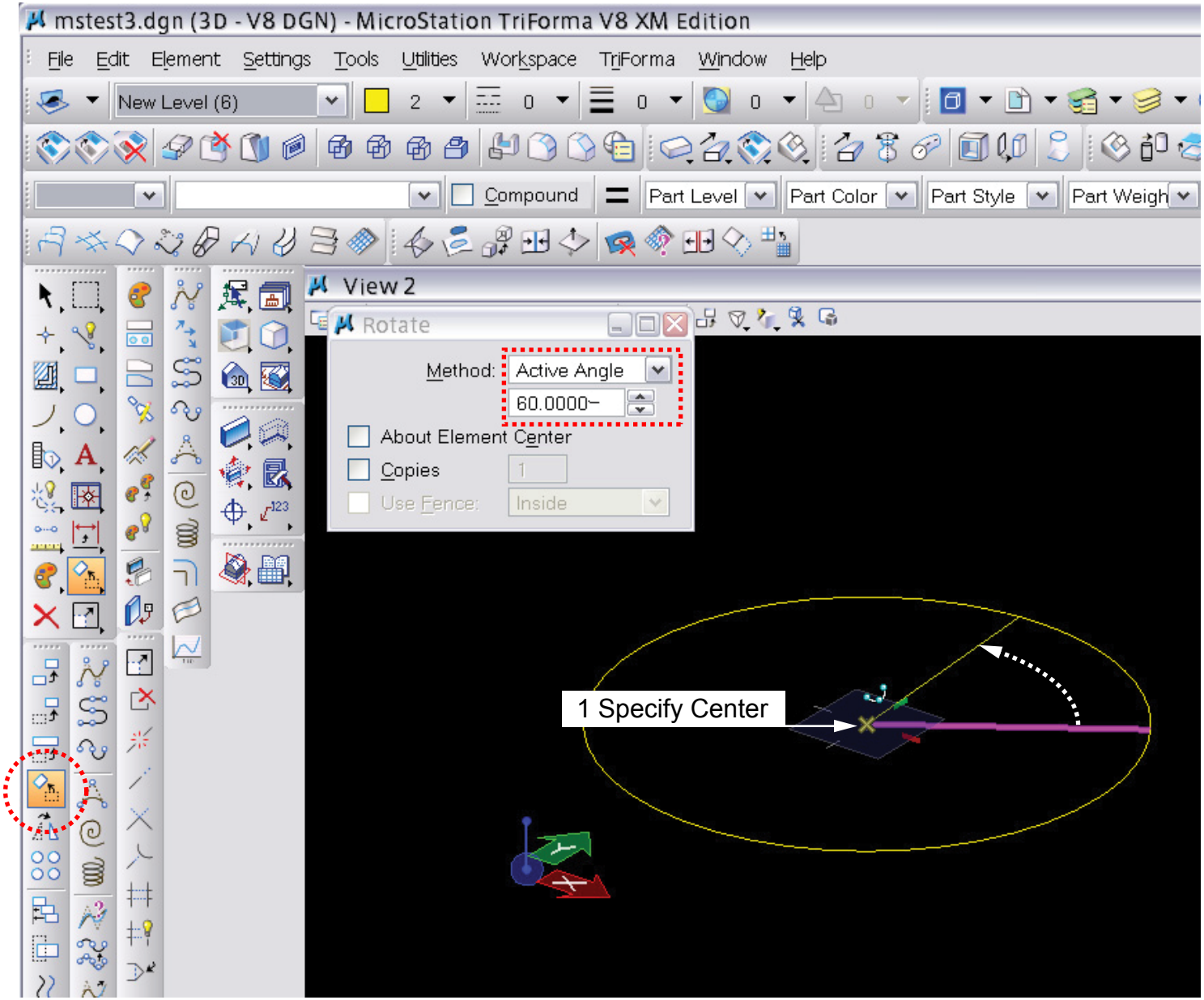
ROTATION BY CENTER + PLANE + ANGLE





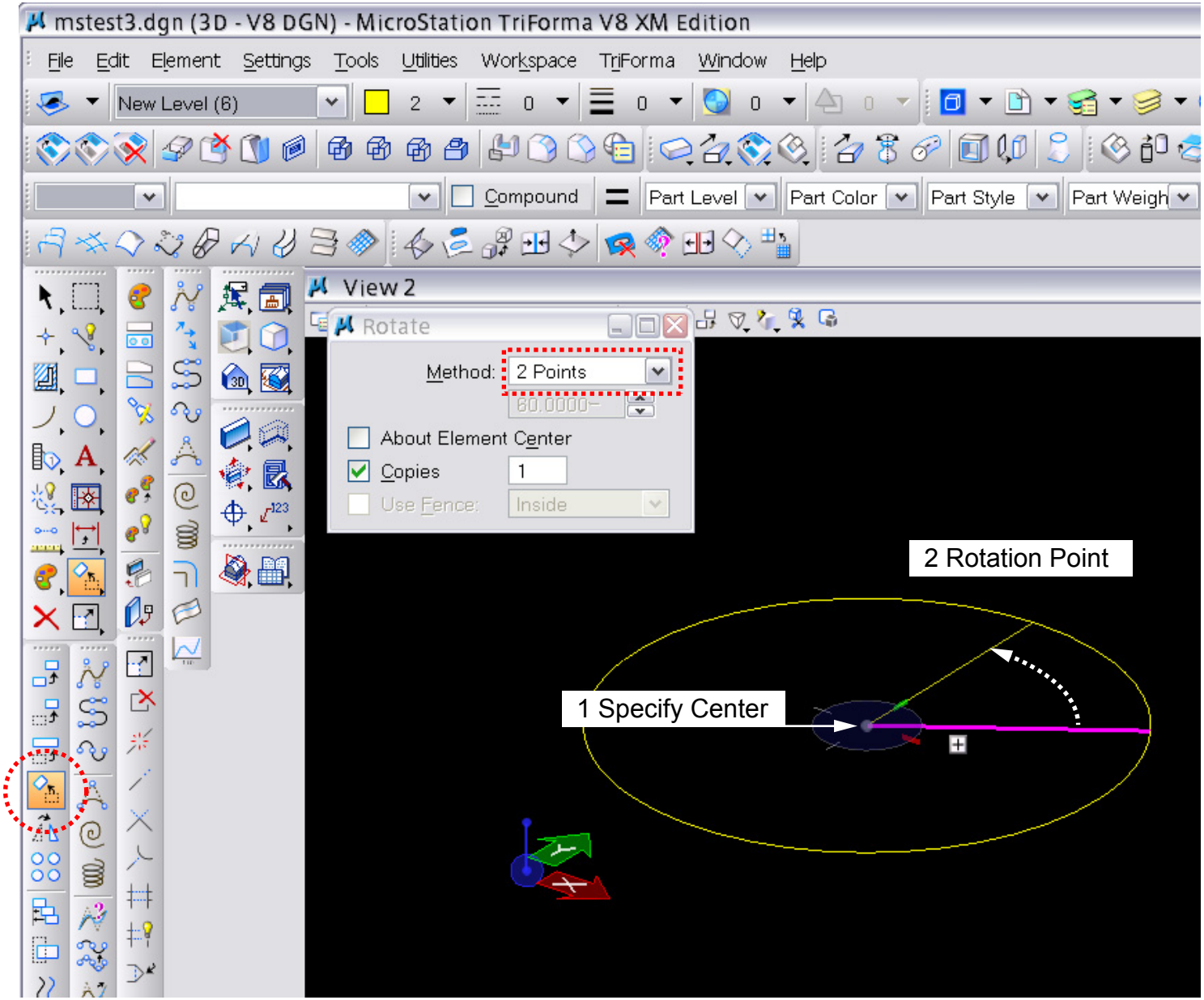


ROTATION: MICROSTATION



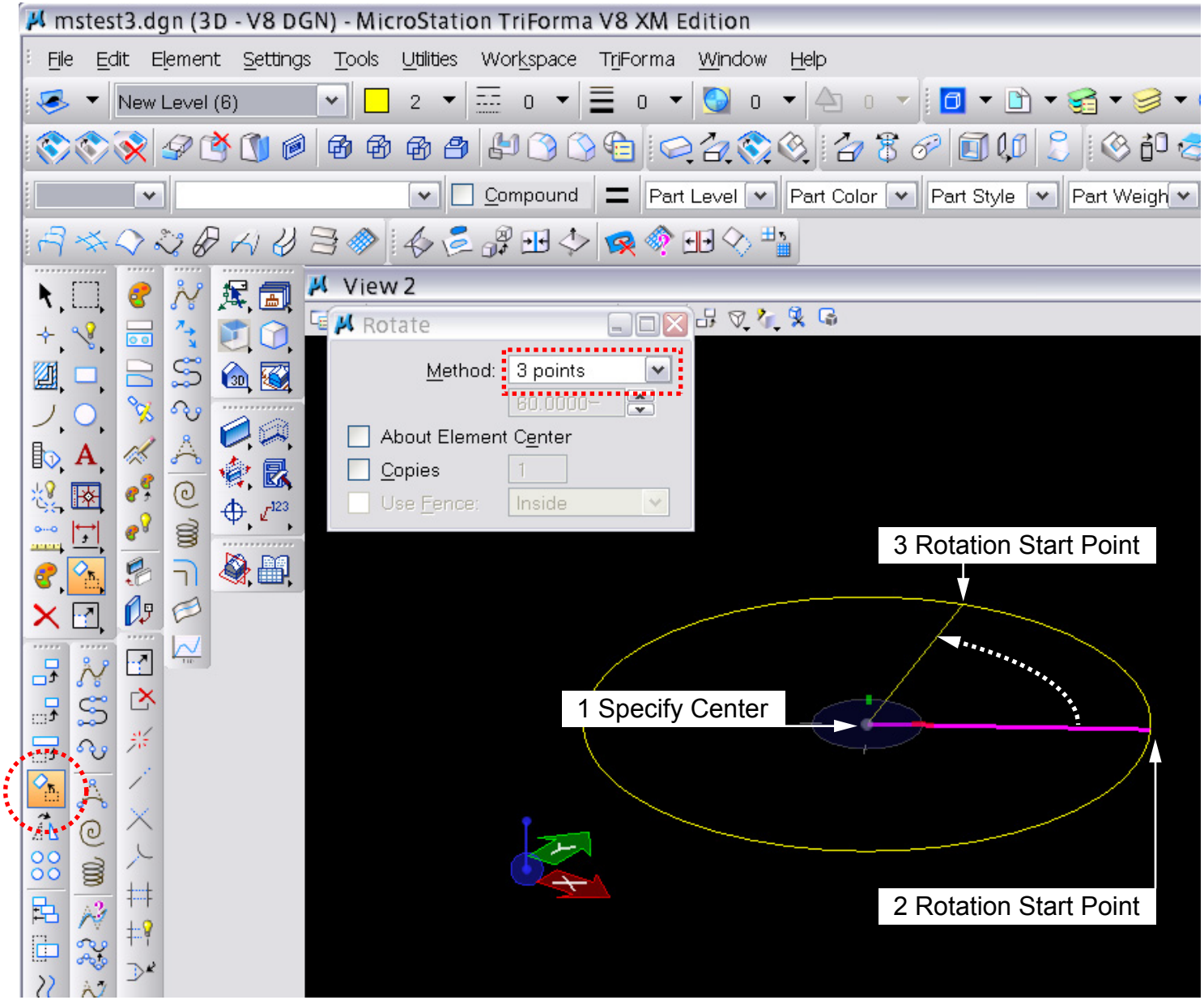
ROTATE WITH ACTIVE ANGLE METHOD

ROTATION: MICROSTATION



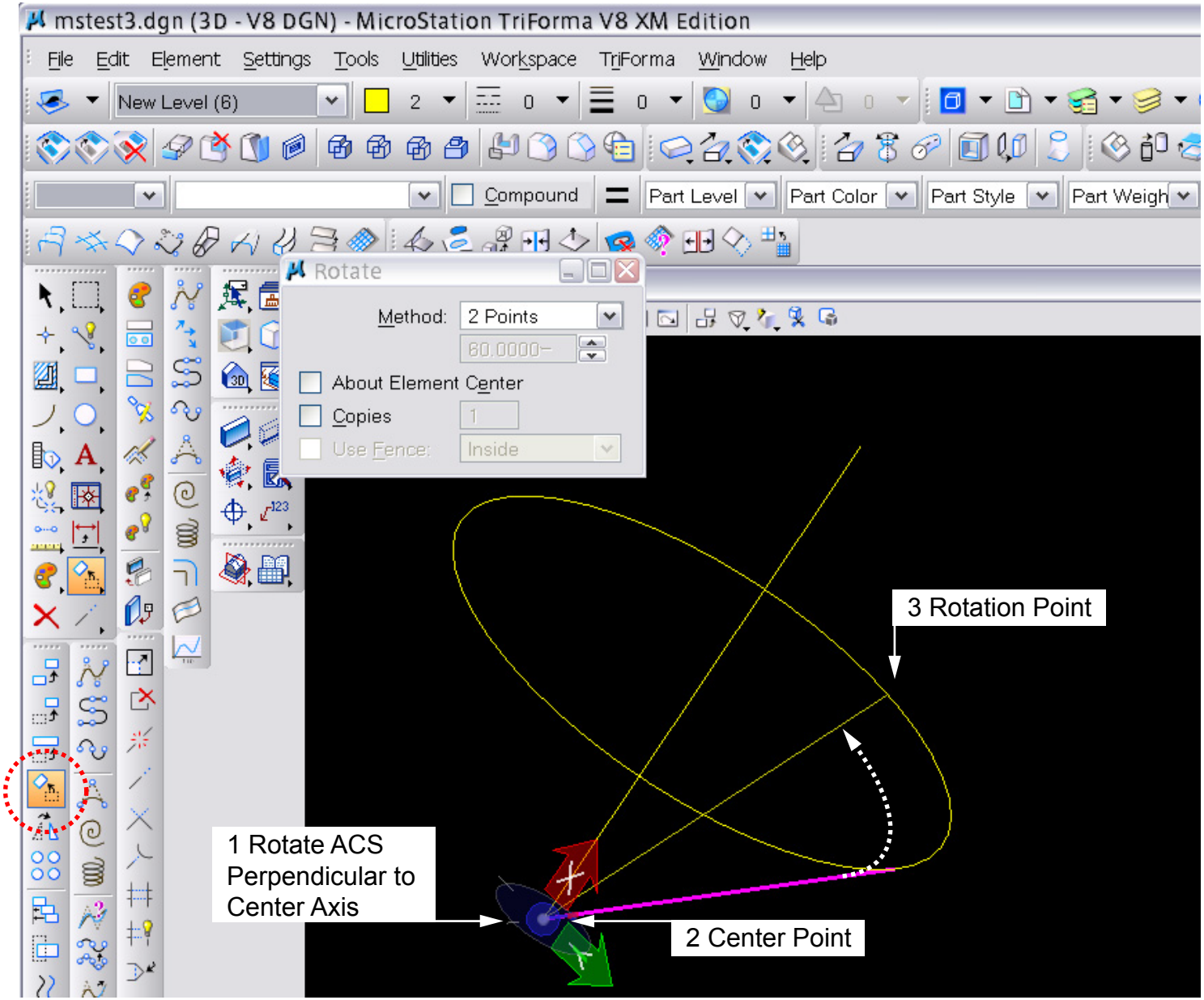
ROTATE WITH 2 POINTS METHOD

ROTATION: MICROSTATION



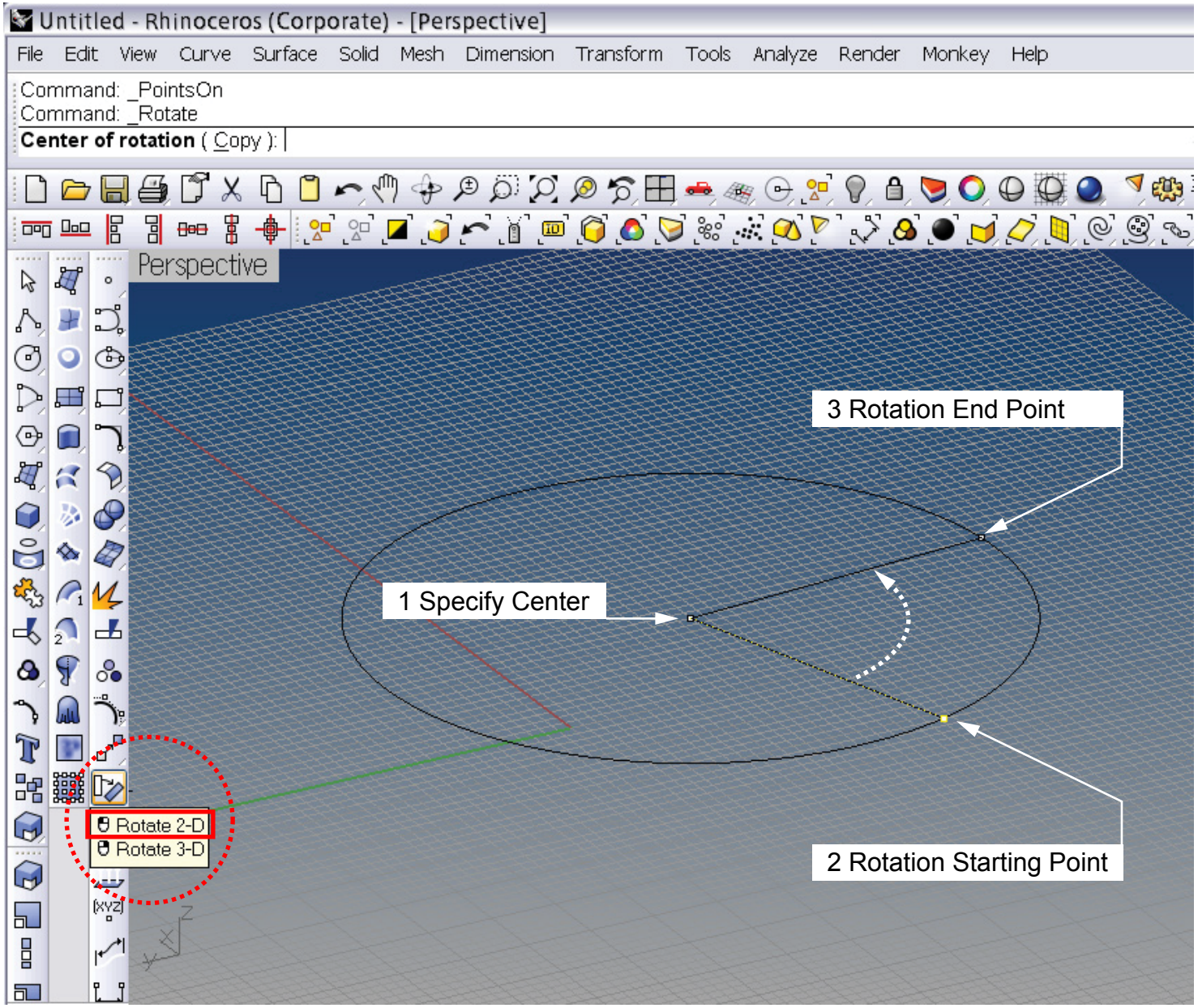
ROTATE WITH 3 POINTS METHOD

ROTATION: MICROSTATION



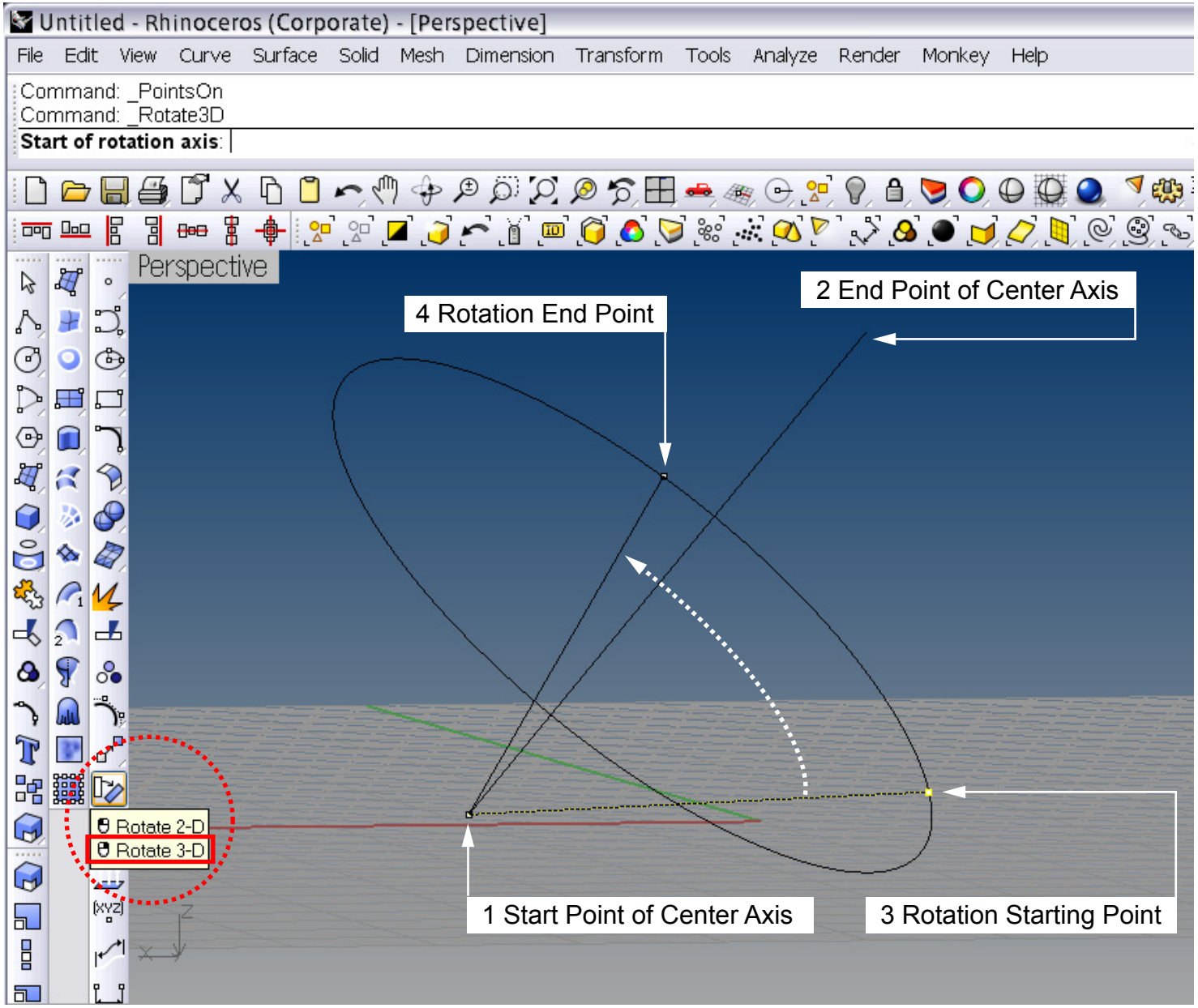
ROTATE WITH 2 POINTS METHOD AFTER SETTING ACS

ROTATION: RHINOCEROS



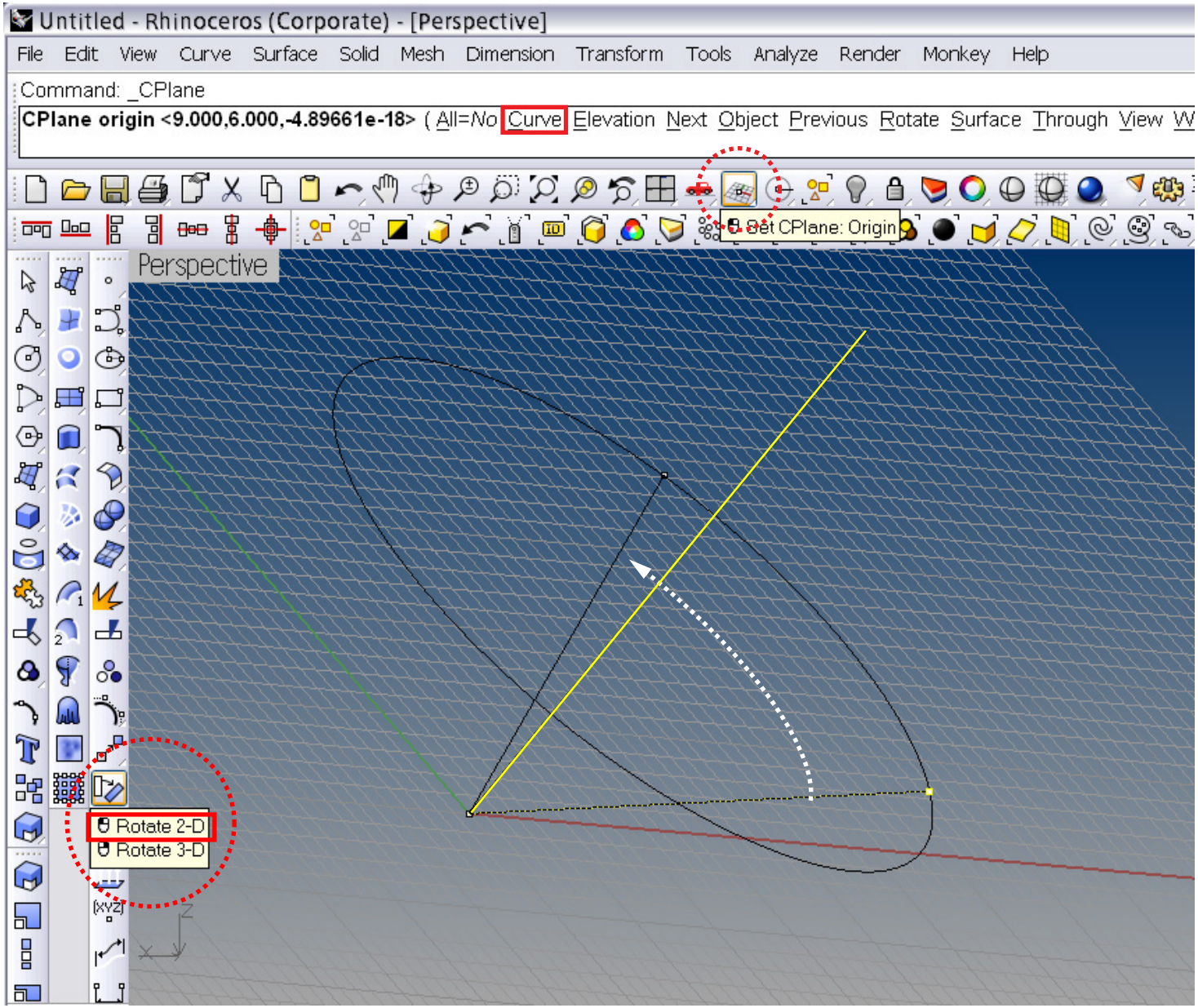
ROTATE 2-D (Left Click)

ROTATION: RHINOCEROS



ROTATE 3-D (Right Click)

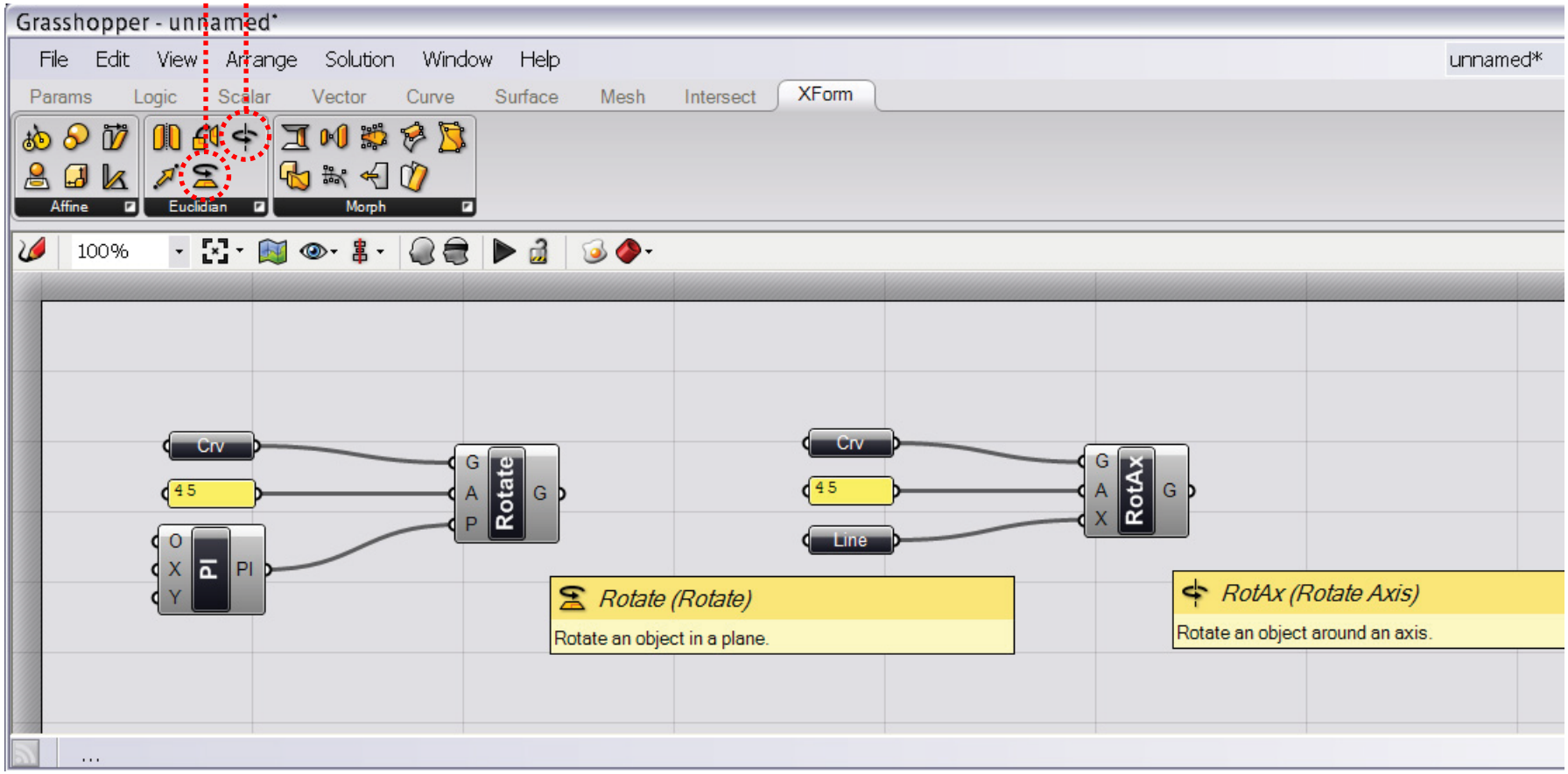
ROTATION: RHINOCEROS



ROTATE 2-D (left click) after changing CPlane with Curve

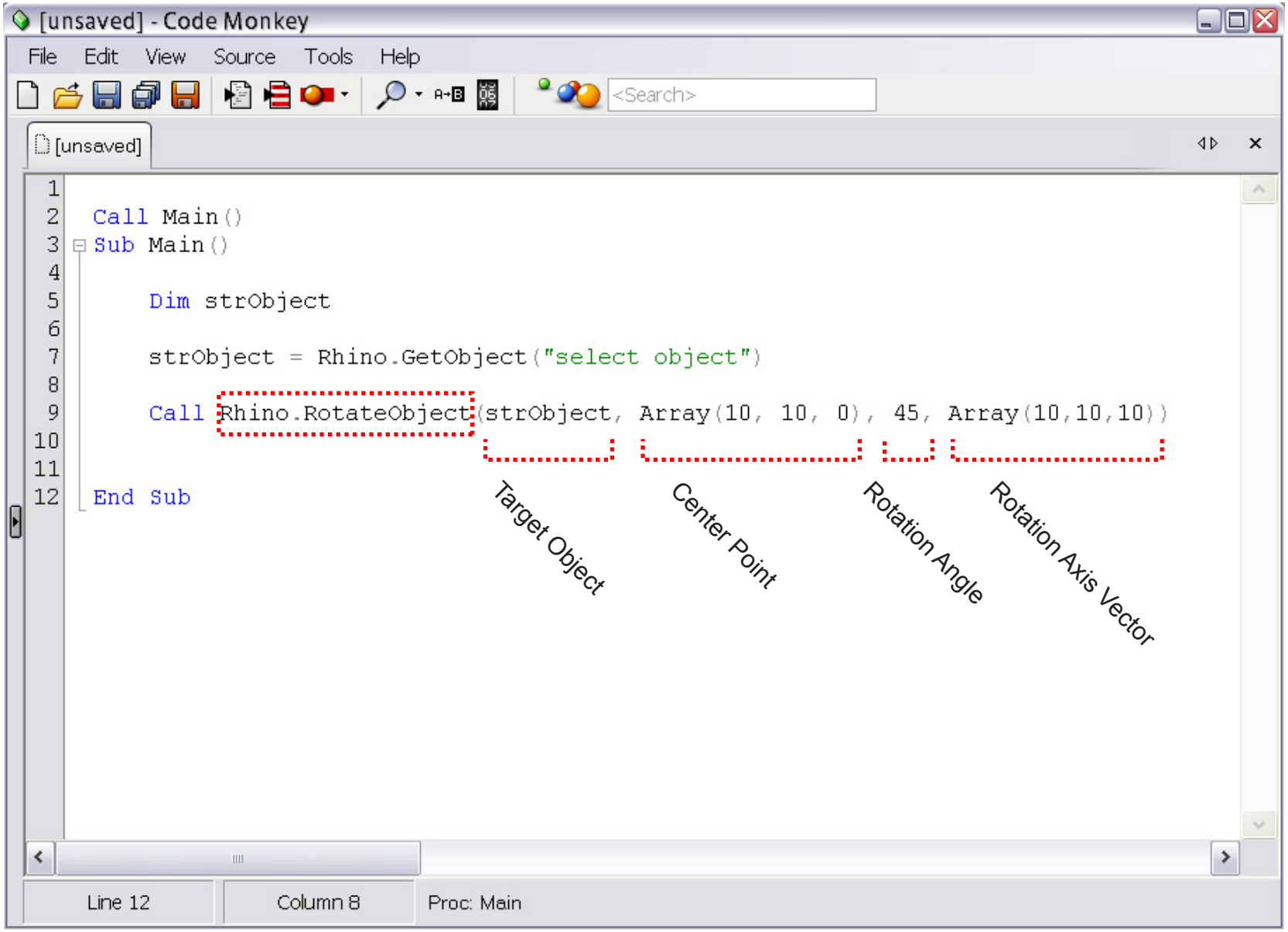
ROTATION: GRASSHOPPER

Rotate in A Plane Rotate around An Axis



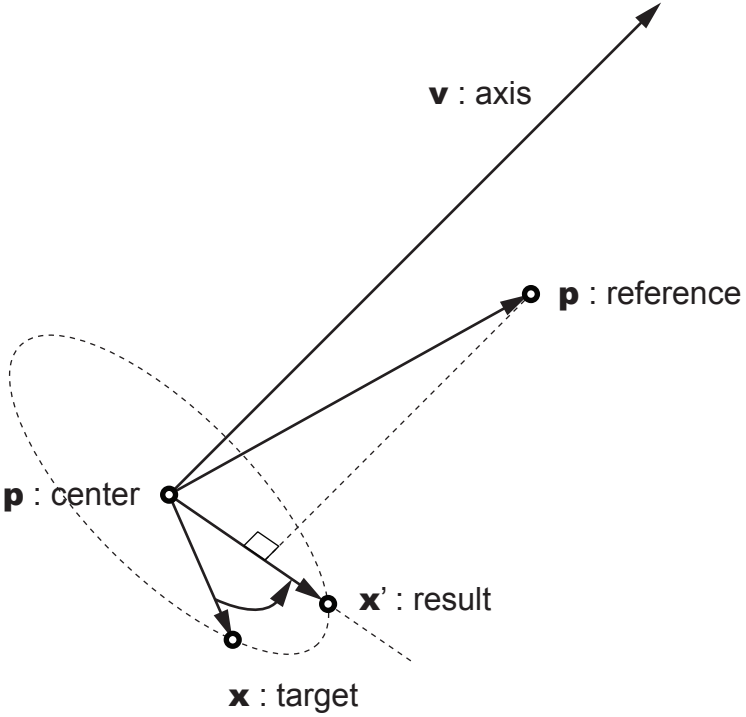
ROTATE IN A PLANE & ROTATE AROUND AN AXIS

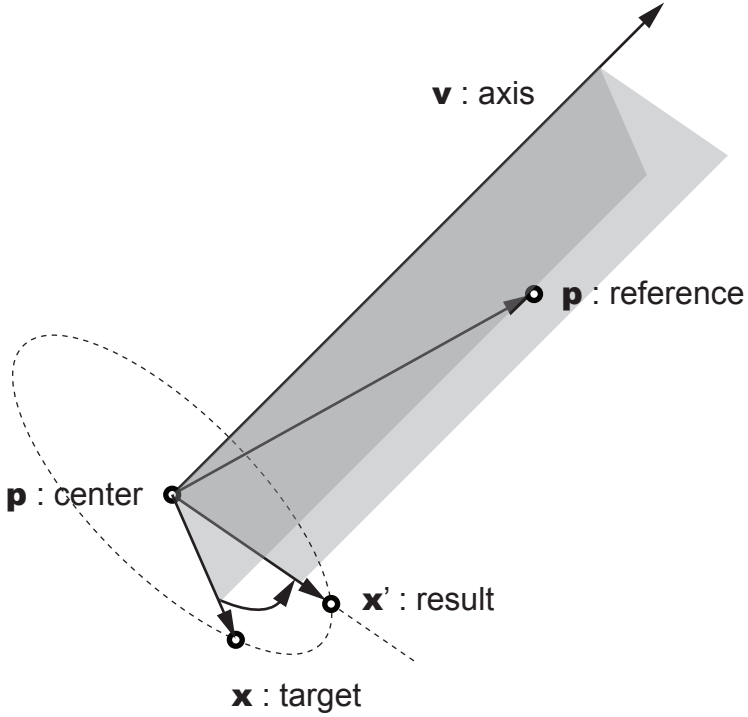
ROTATION: RHINOSCRIPT



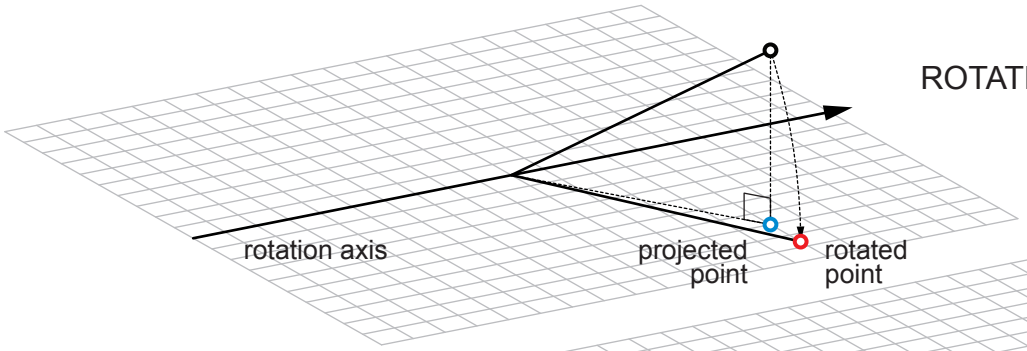
ROTATE OBJECT METHOD

ROTATION TOWARD A POINT

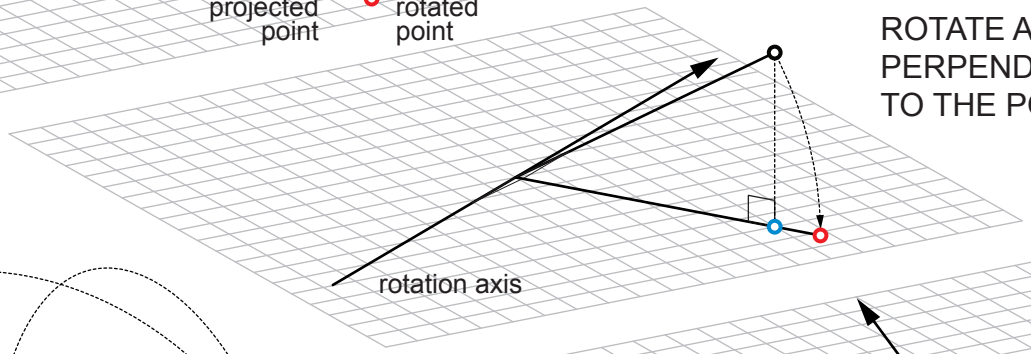




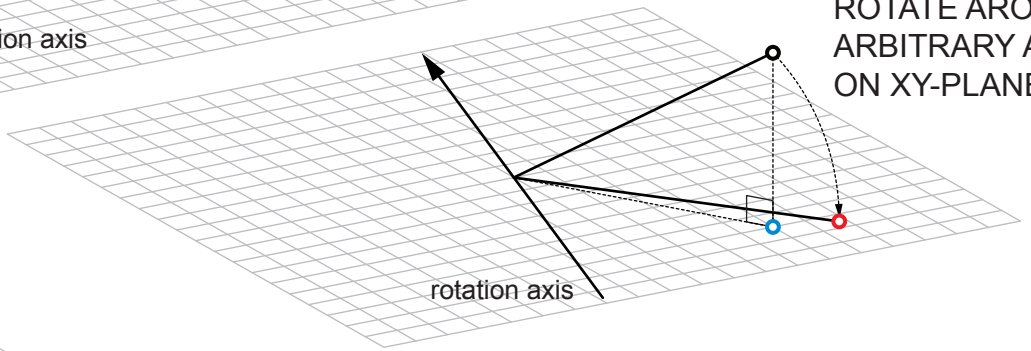
ROTATION VS PROJECTION



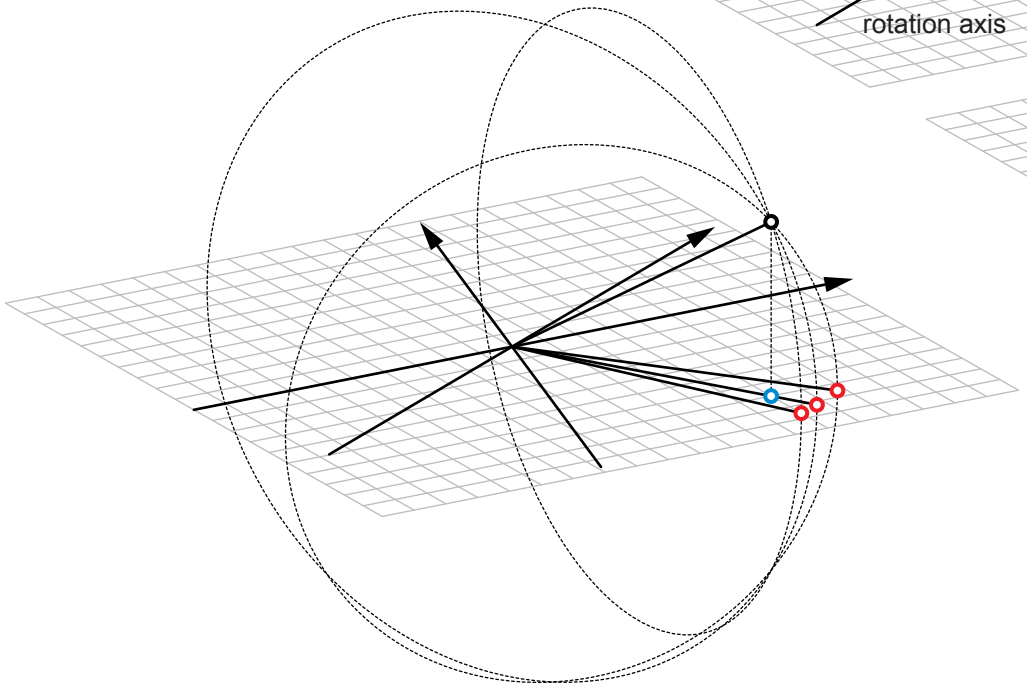
ROTATE AROUND X-AXIS



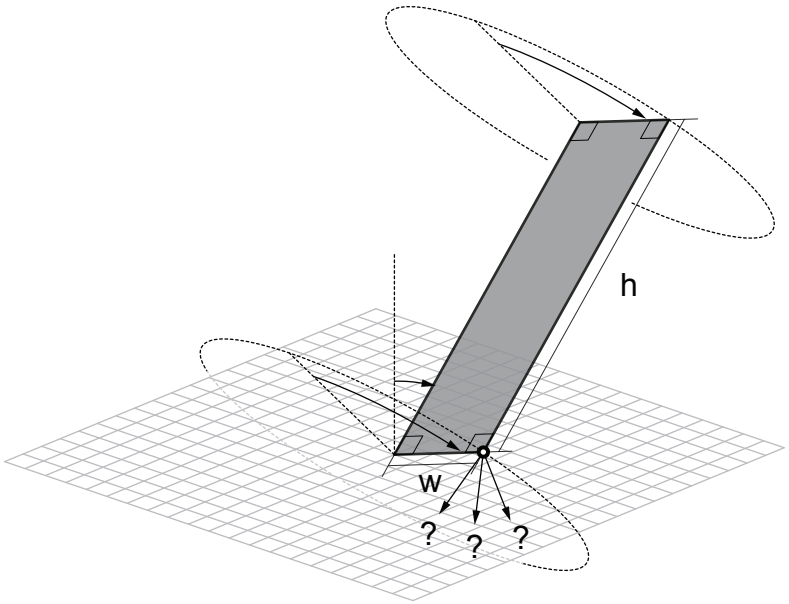
ROTATE AROUND AXIS ON XY-PLANE
PERPENDICULAR TO A VECTOR
TO THE POINT



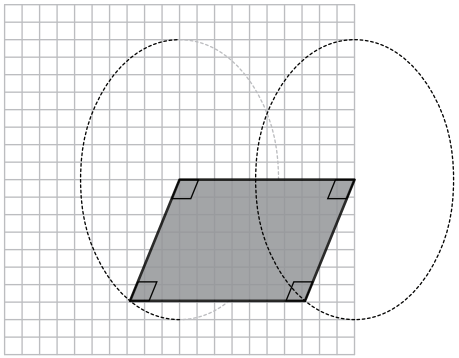
ROTATE AROUND
ARBITRARY AXIS
ON XY-PLANE

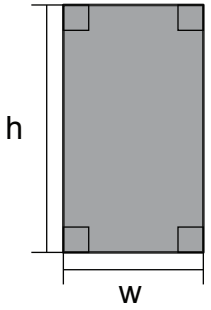


ROTATION / PROJECTION / EXTENSION



PLAN



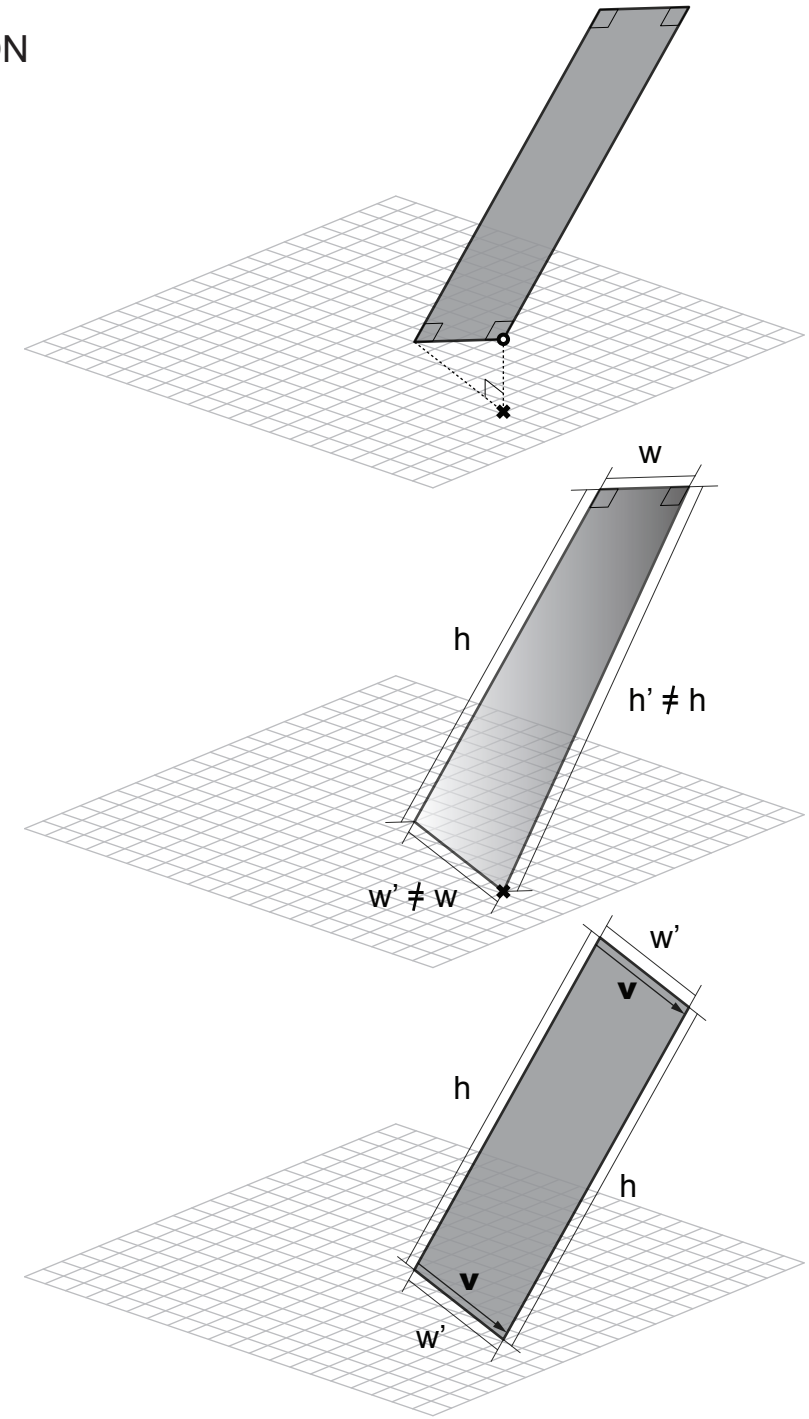


UNFOLDED SHAPE

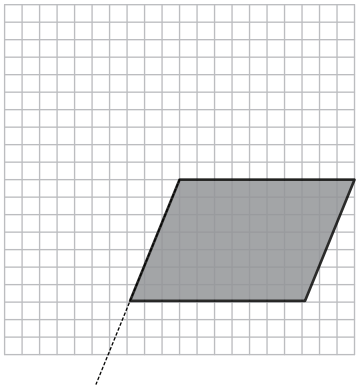
HOW TO MOVE CORNER POINT TO BE ON XY-PLANE?

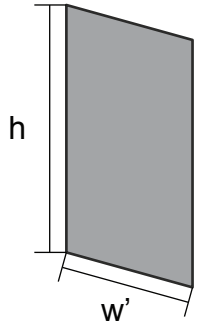
ROTATION / PROJECTION / EXTENSION

PROJECTION



PLAN

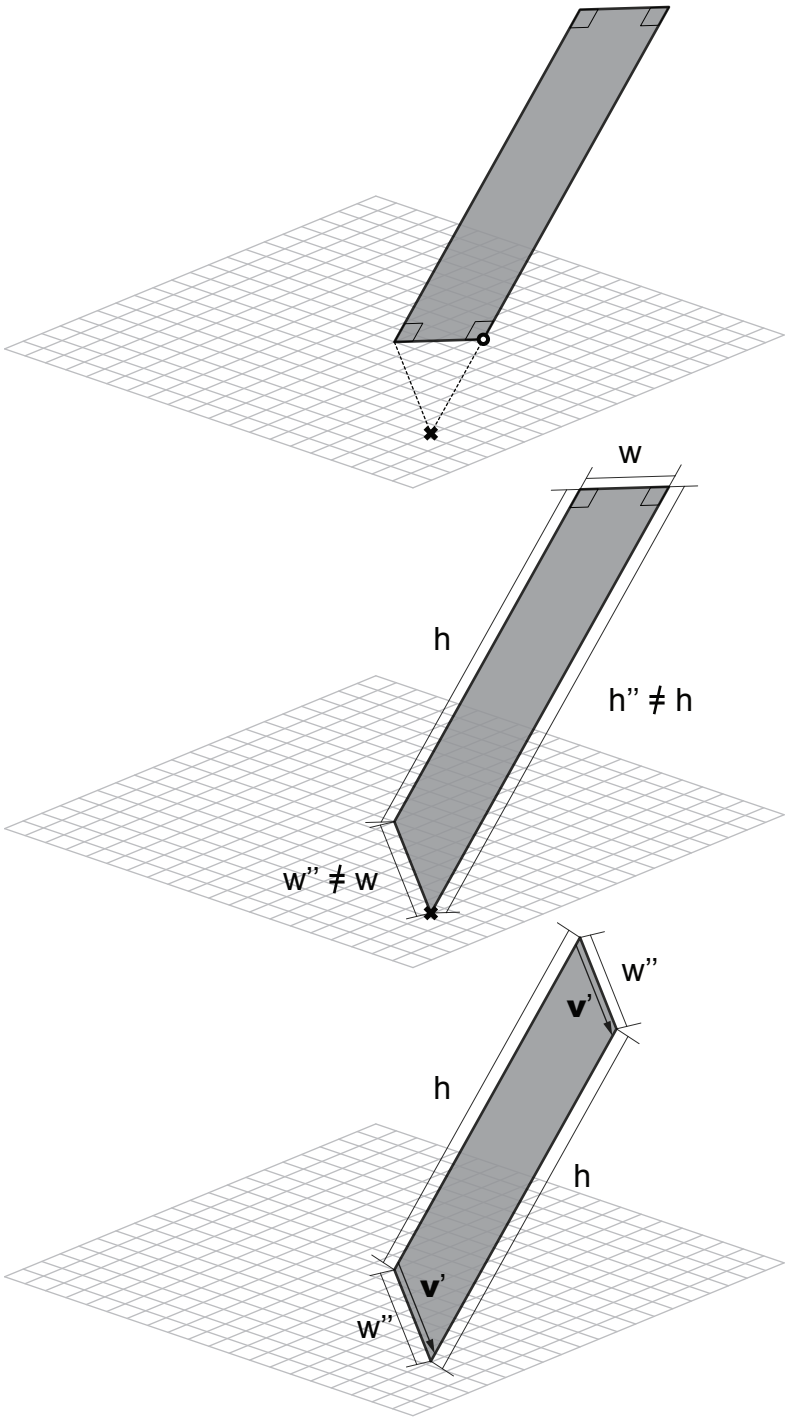




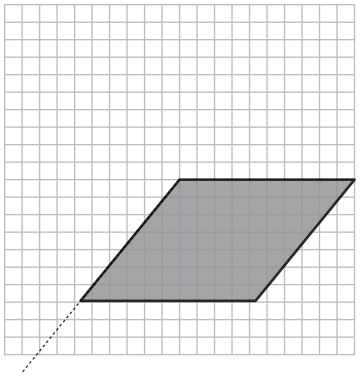
UNFOLDED SHAPE

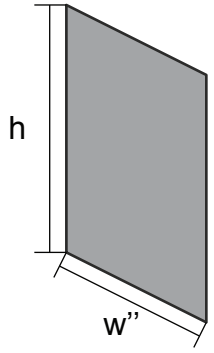
ROTATION / PROJECTION / EXTENSION

EXTENSION



PLAN

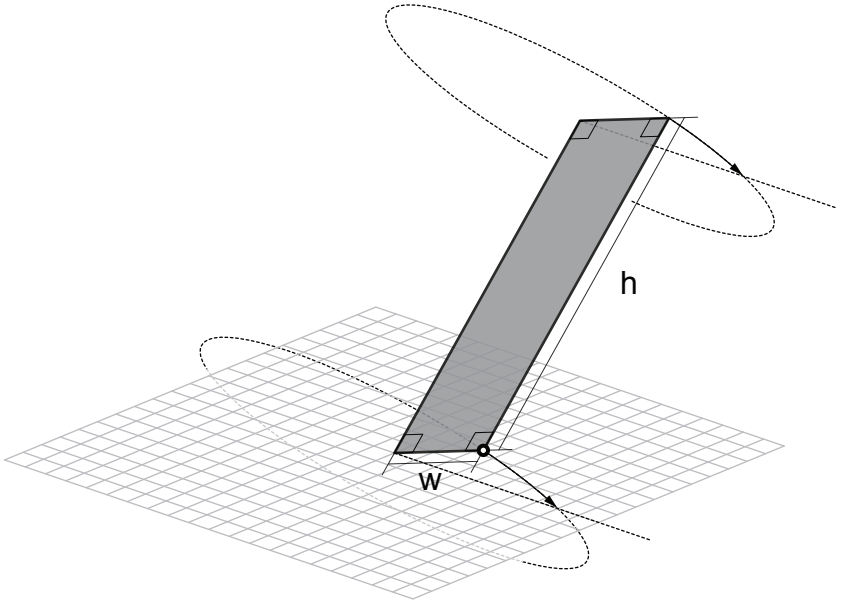




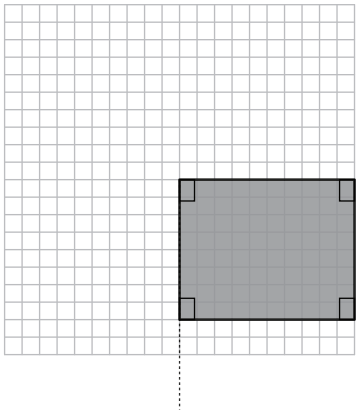
UNFOLDED SHAPE

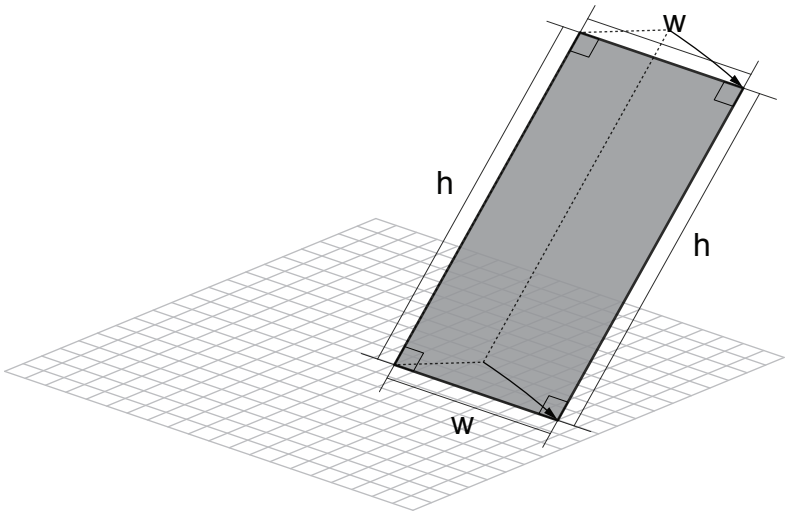
ROTATION / PROJECTION / EXTENSION

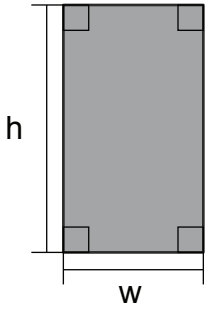
ROTATION



PLAN



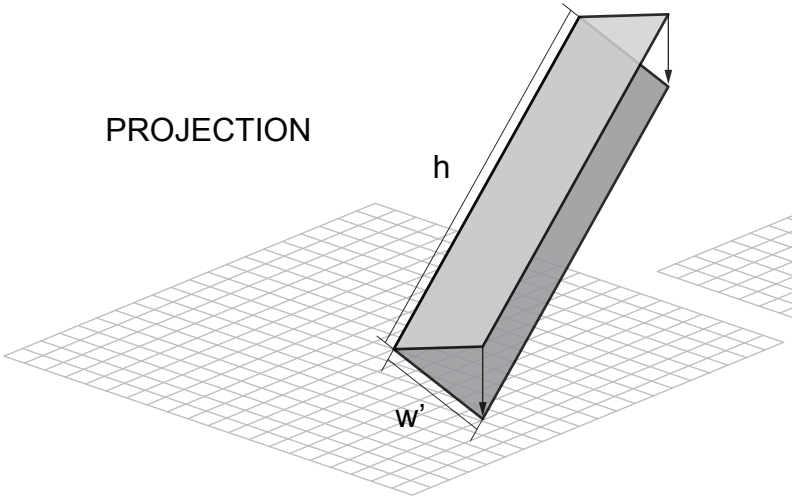




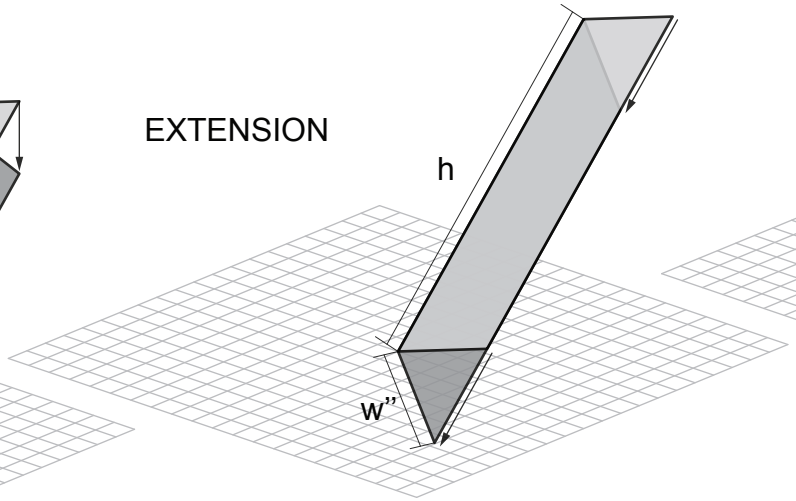
UNFOLDED SHAPE

ROTATION / PROJECTION / EXTENSION

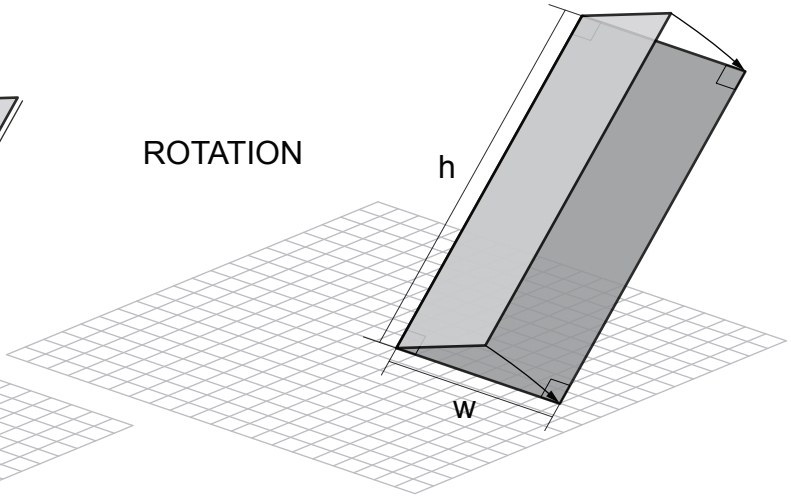
PROJECTION

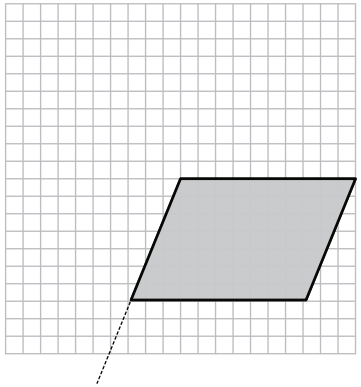


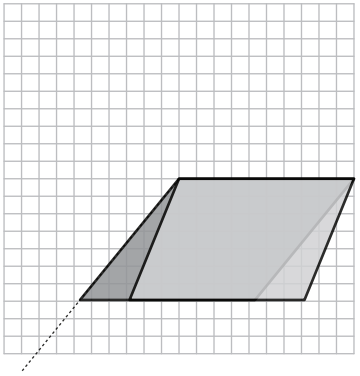
EXTENSION

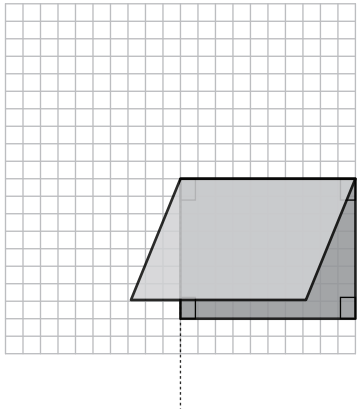


ROTATION

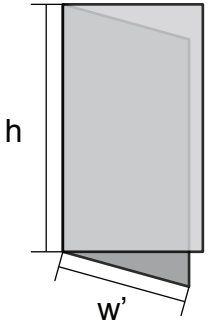


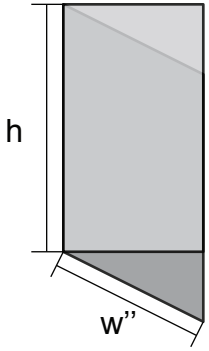


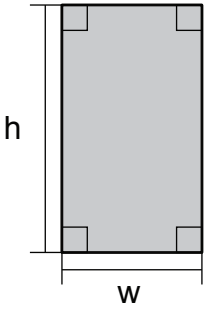




PLAN

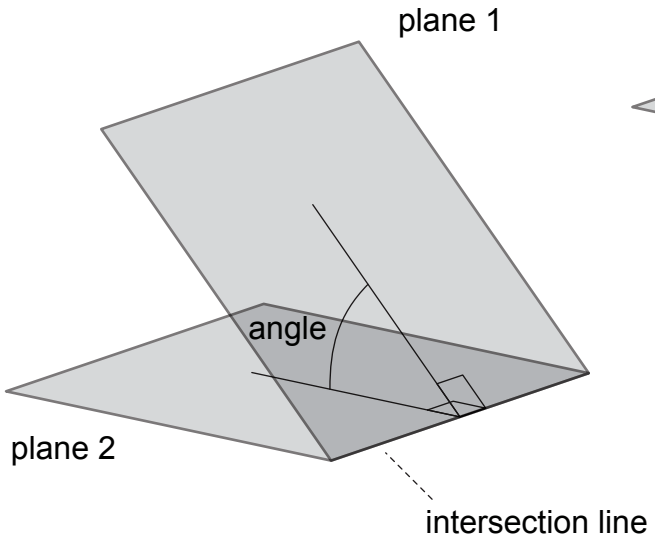




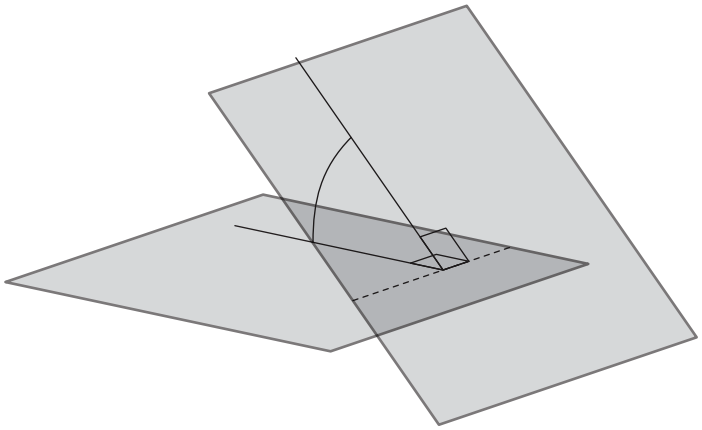


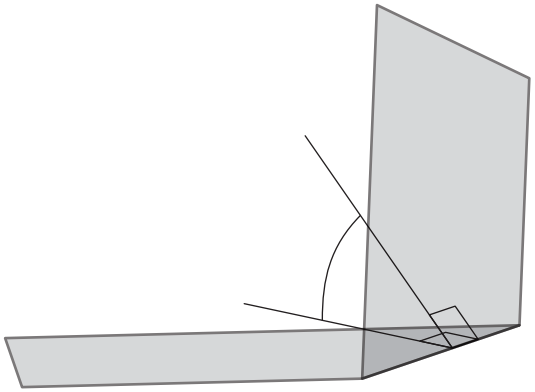
UNFOLDED SHAPE

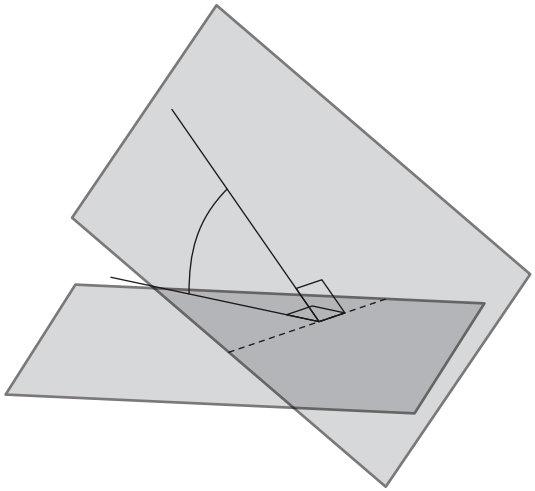
ANGLE OF TWO PLANES

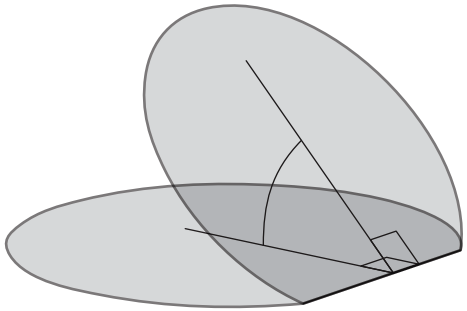


measured by two lines perpendicular
to the intersection line

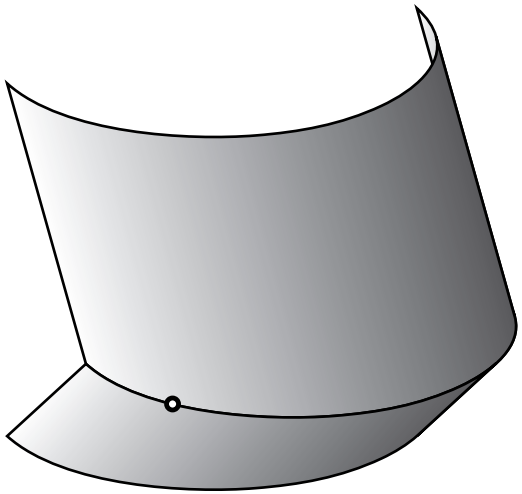




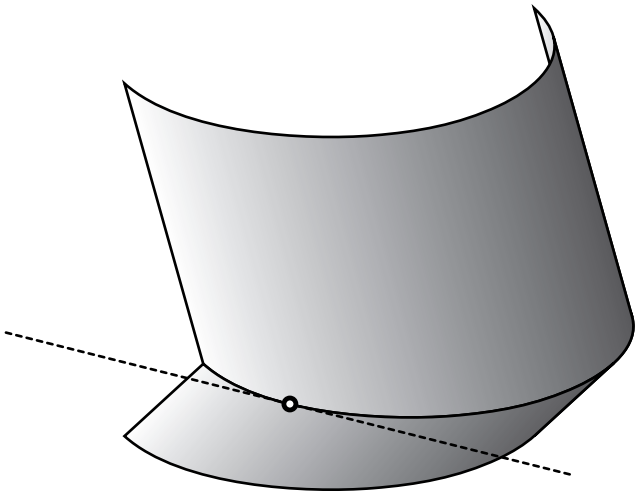




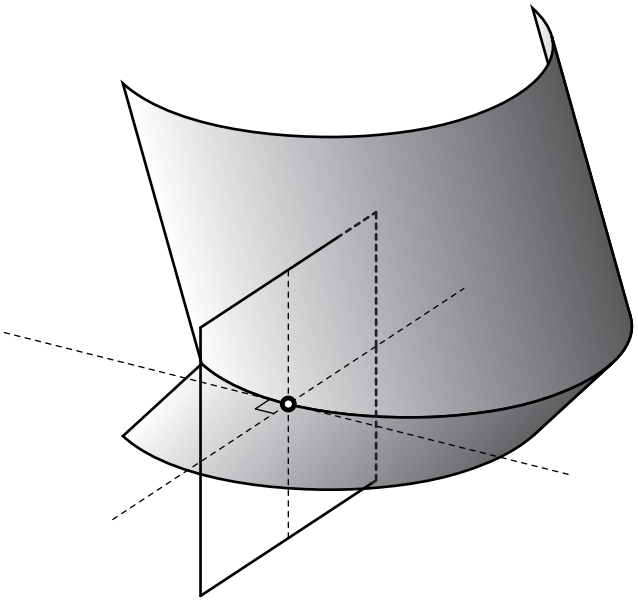
ANGLE OF TWO SURFACE



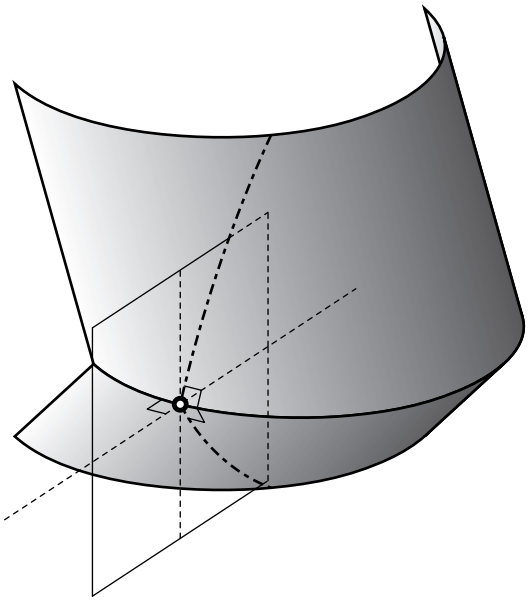
1. Measurement Point



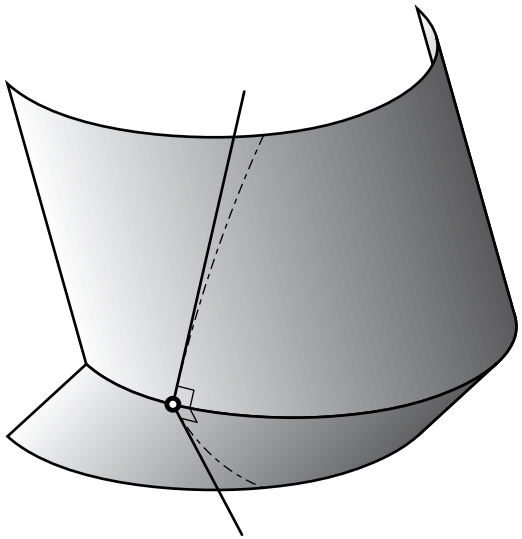
2. Tangent line of the intersection curve



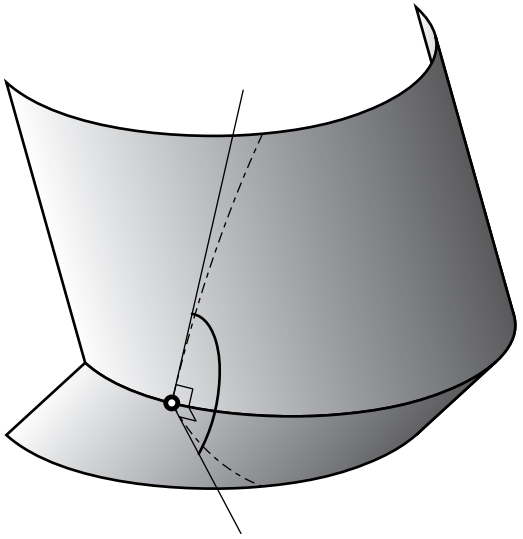
3. Perpendicular plane to tangent line



4. Intersection curves of the plane and the surfaces

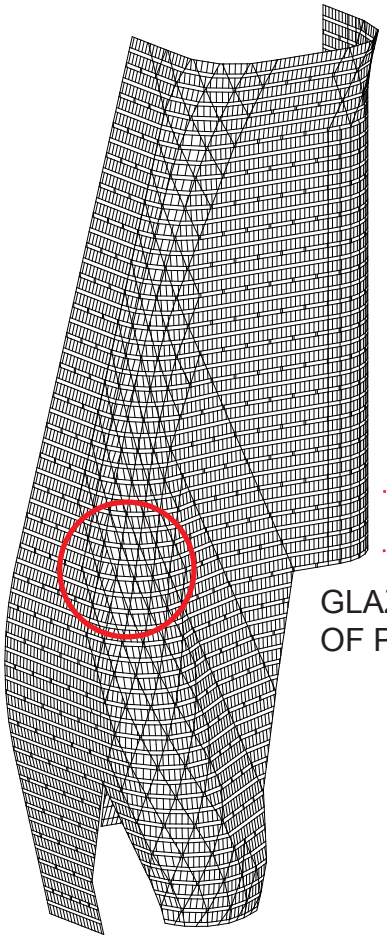


5. Tangent line of the each intersection curve

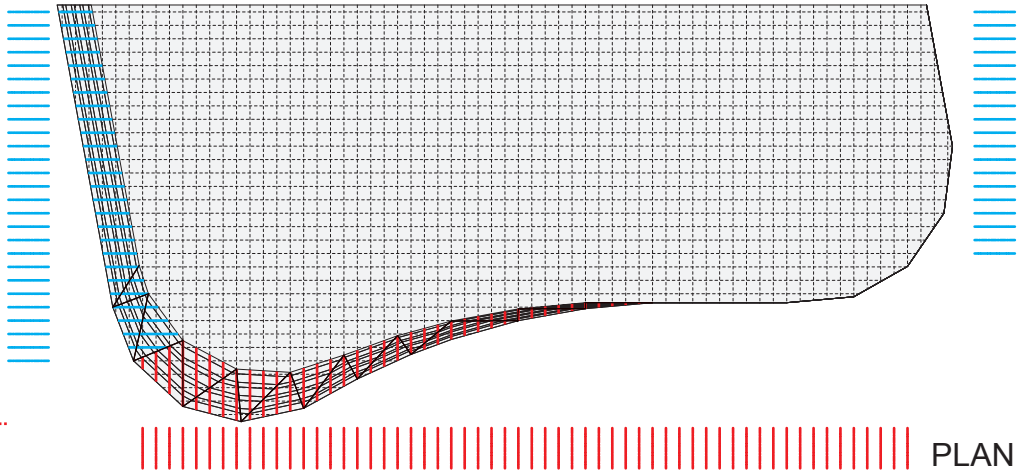


6. Angle of two the tangent lines

ANGLE OF TWO SURFACE : EXAMPLE



GLAZING MULLION
OF PHARE TOWER



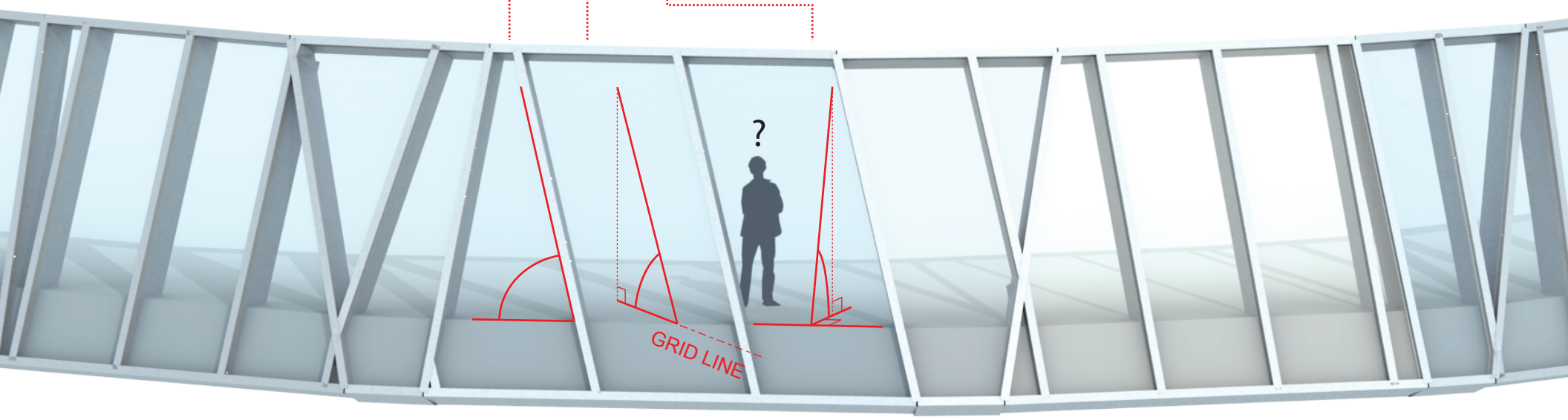
PLAN

Q WHICH IS ANGLE BEWEEN FLOOR SLAB AND GLAZING FACE?

1) SLAB EDGE & MULLION EDGE

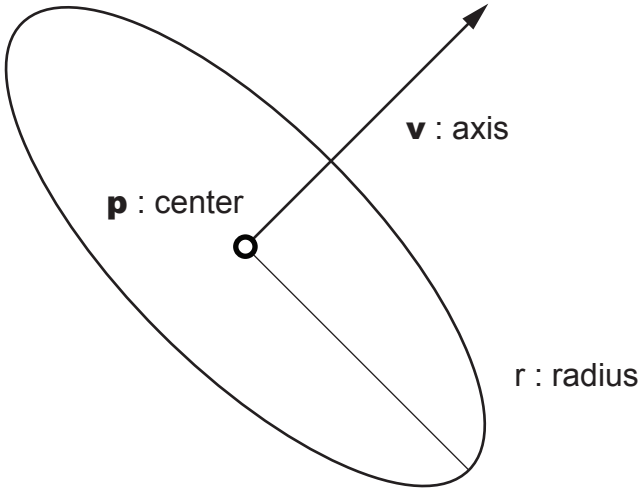
2) GRID LINE & PROJECTED GRID LINE ON GLAZING FACE

3) PERPENDICULAR LINE TO SLAB EDGE AND
PROJECTED LINE ON GLAZING FACE

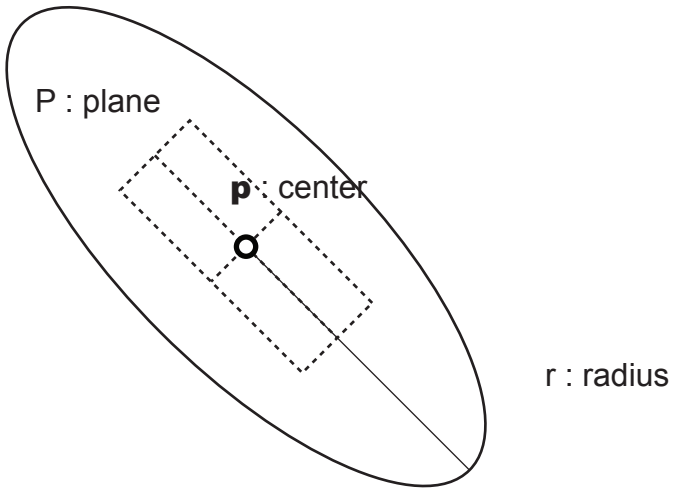


CIRCLE : DEFINITION

CIRCLE BY CENTER + AXIS + RADIUS

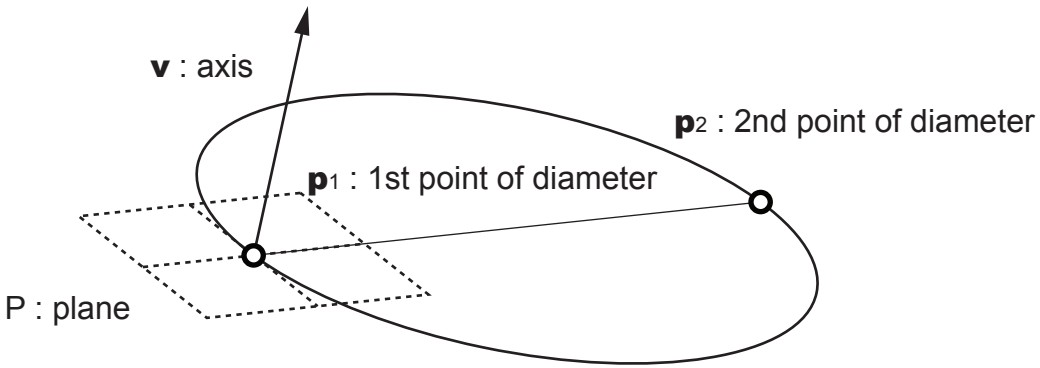


CIRCLE BY CENTER + PLANE + RADIUS

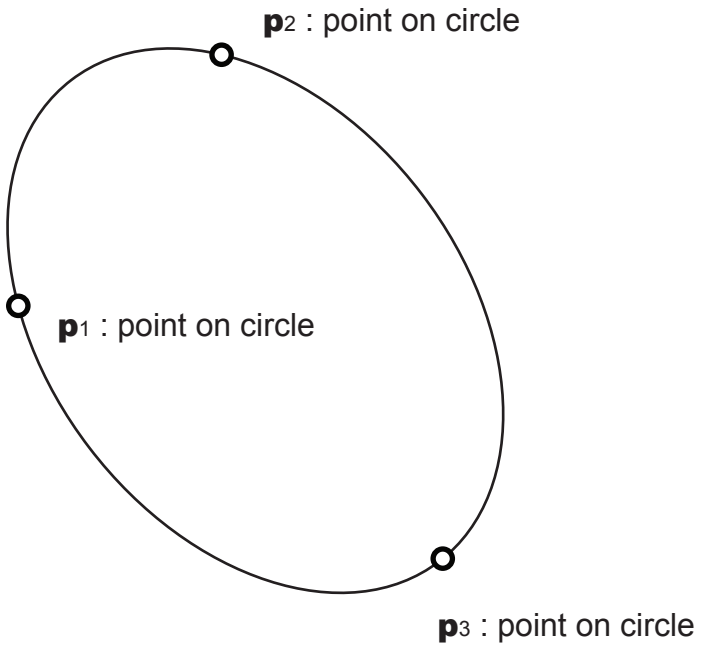


CIRCLE : DEFINITION

CIRCLE BY PLANE (OR AXIS) + DIAMETER

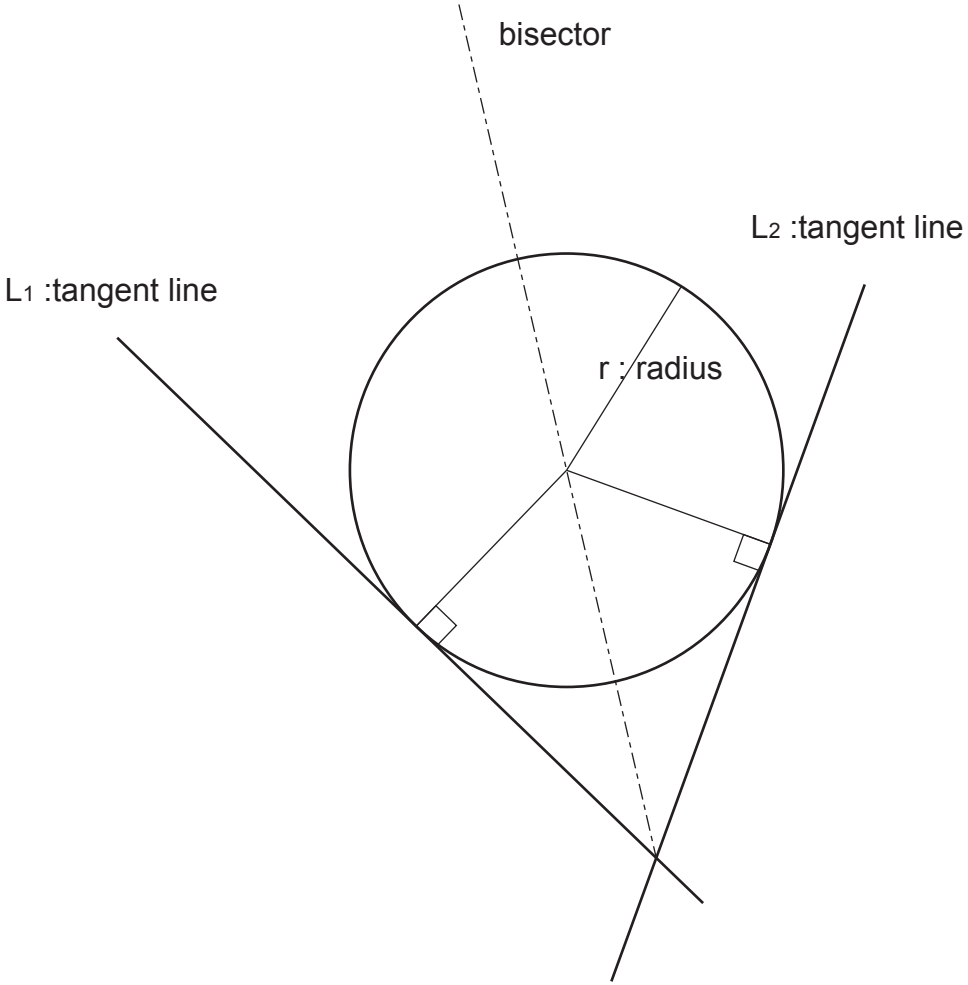


CIRCLE BY 3 POINTS

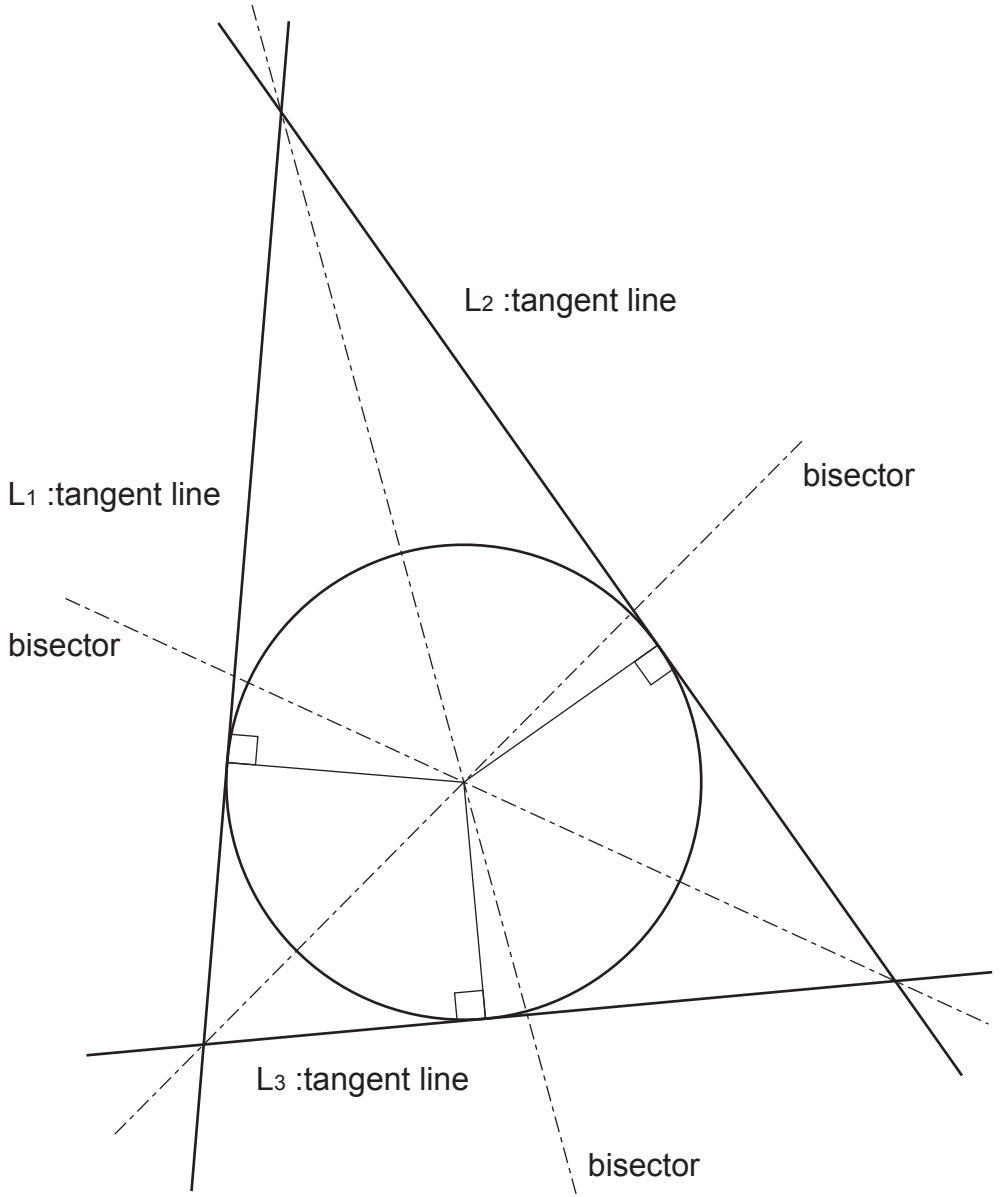


CIRCLE : DEFINITION

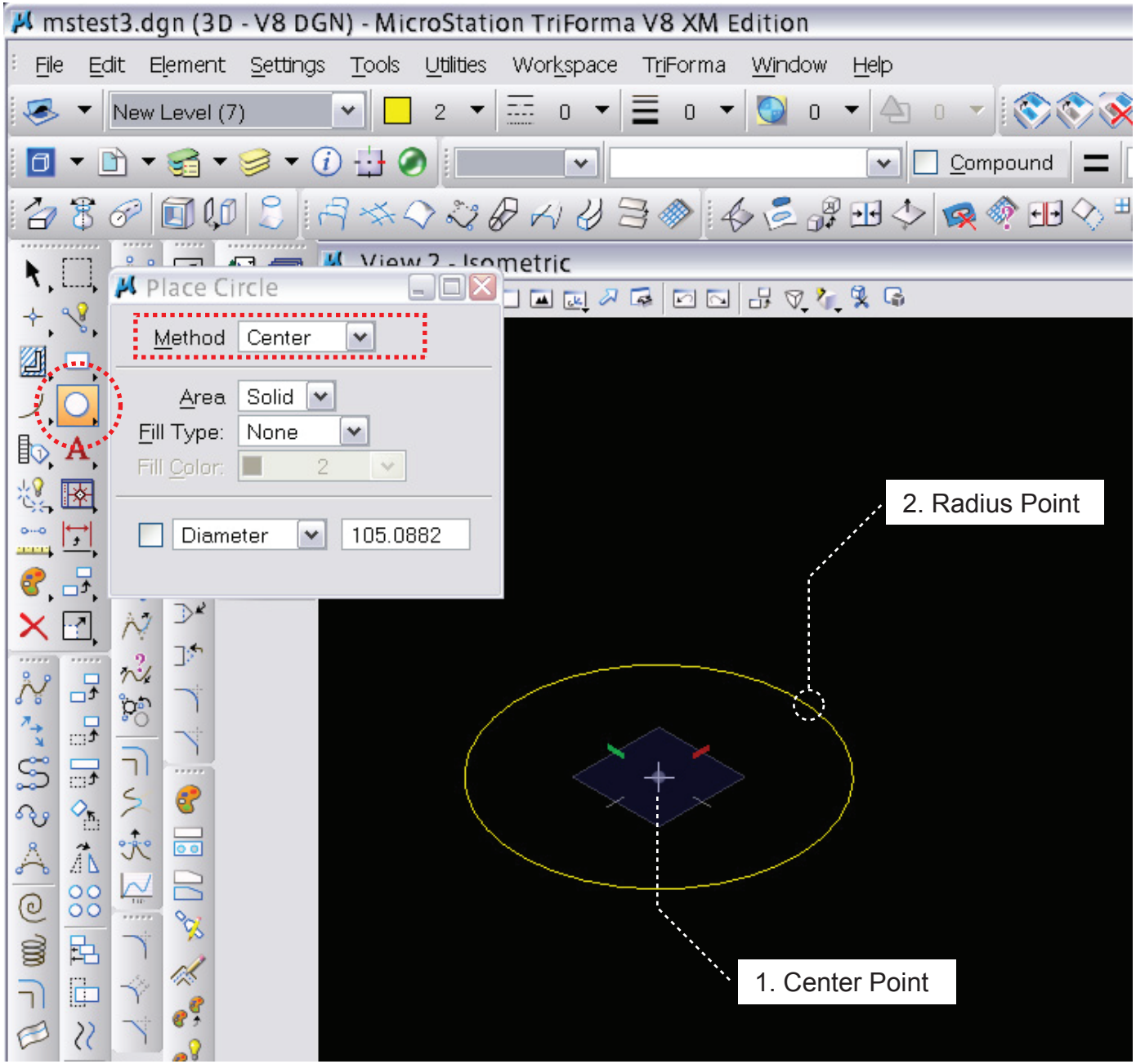
CIRCLE BY 2 TANGENT LINES + RADIUS



CIRCLE BY 3 TANGENT LINES

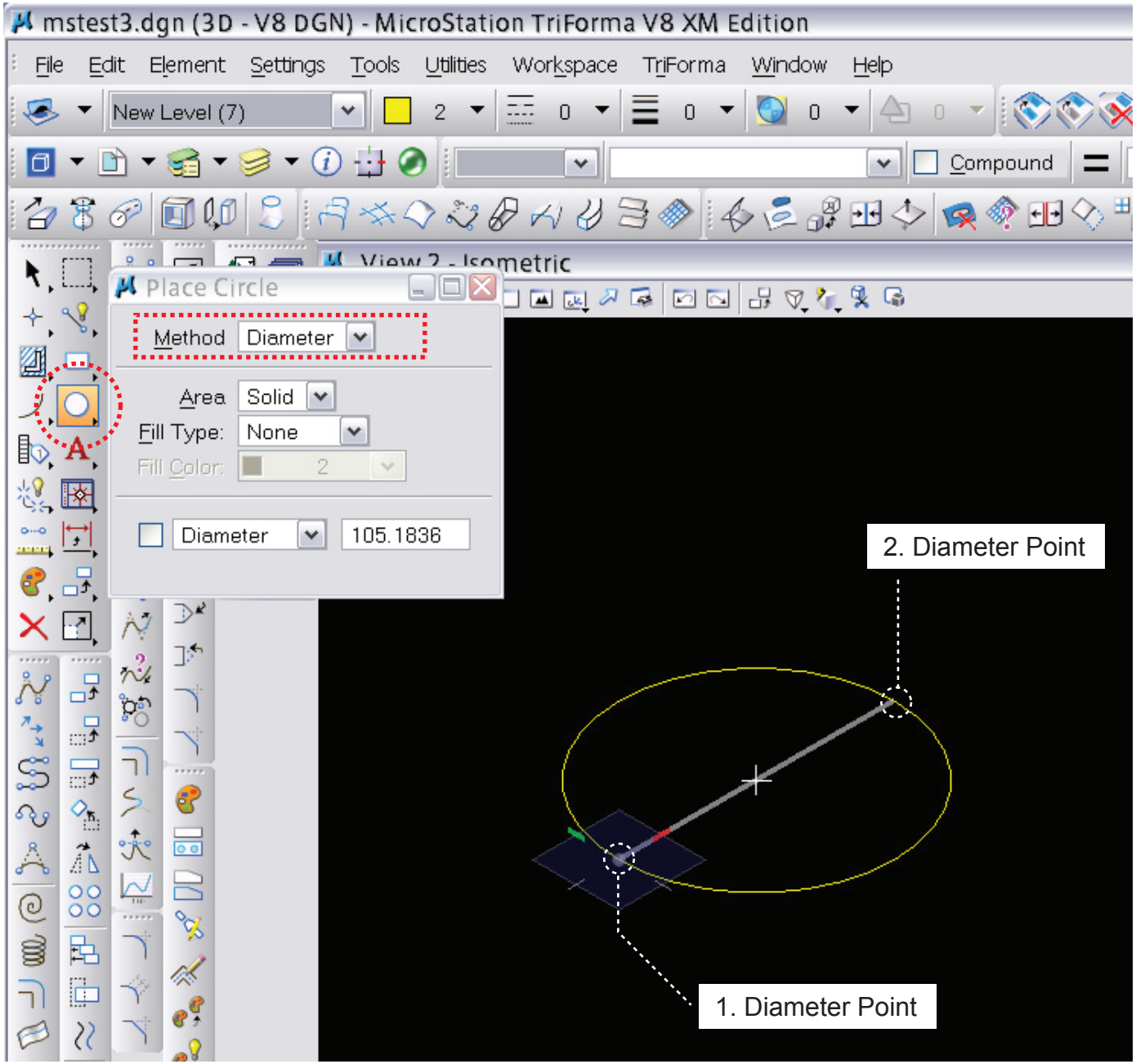


CIRCLE IN MICROSTATION



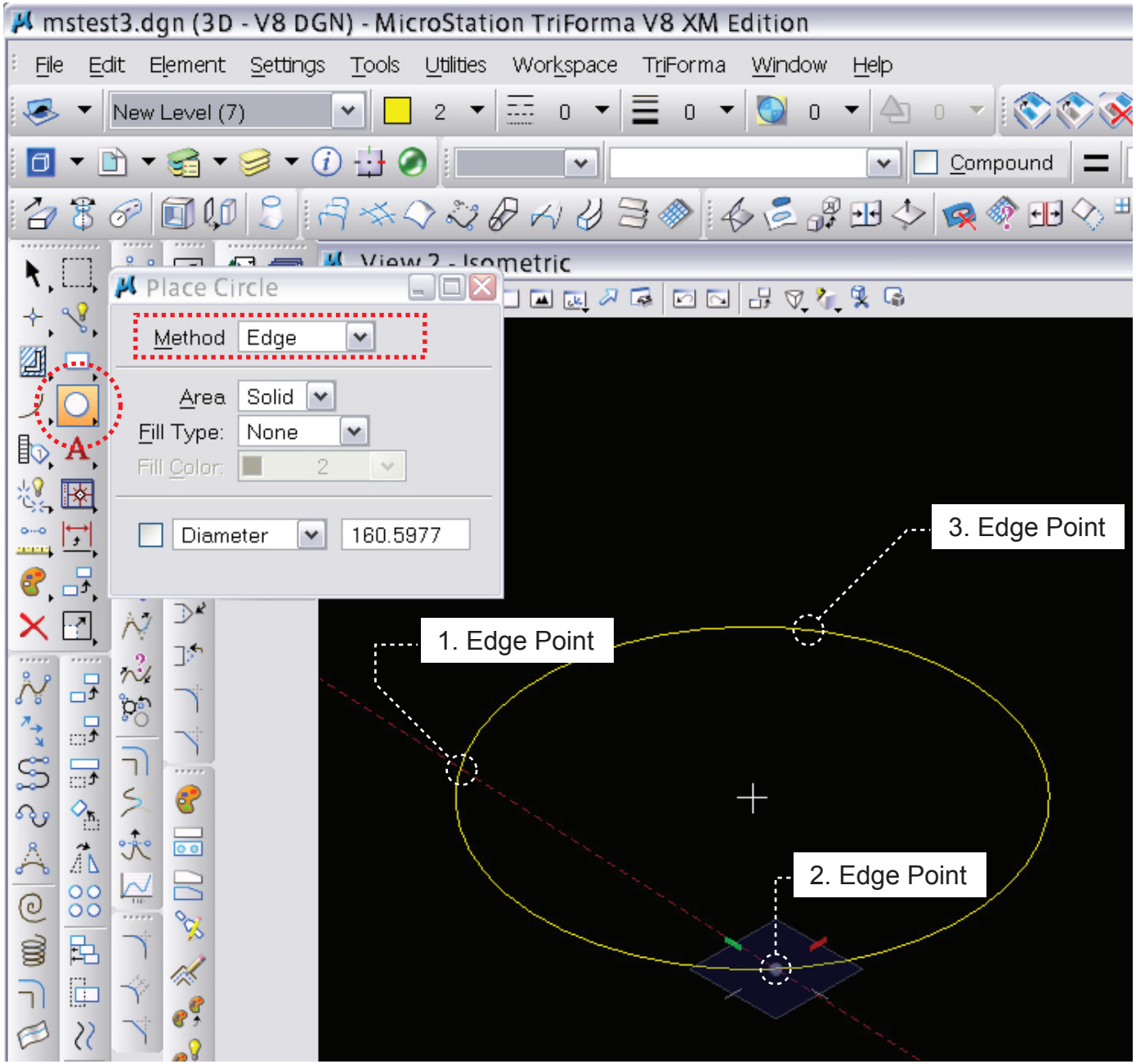
CIRCLE BY CENTER AND RADIUS

CIRCLE IN MICROSTATION



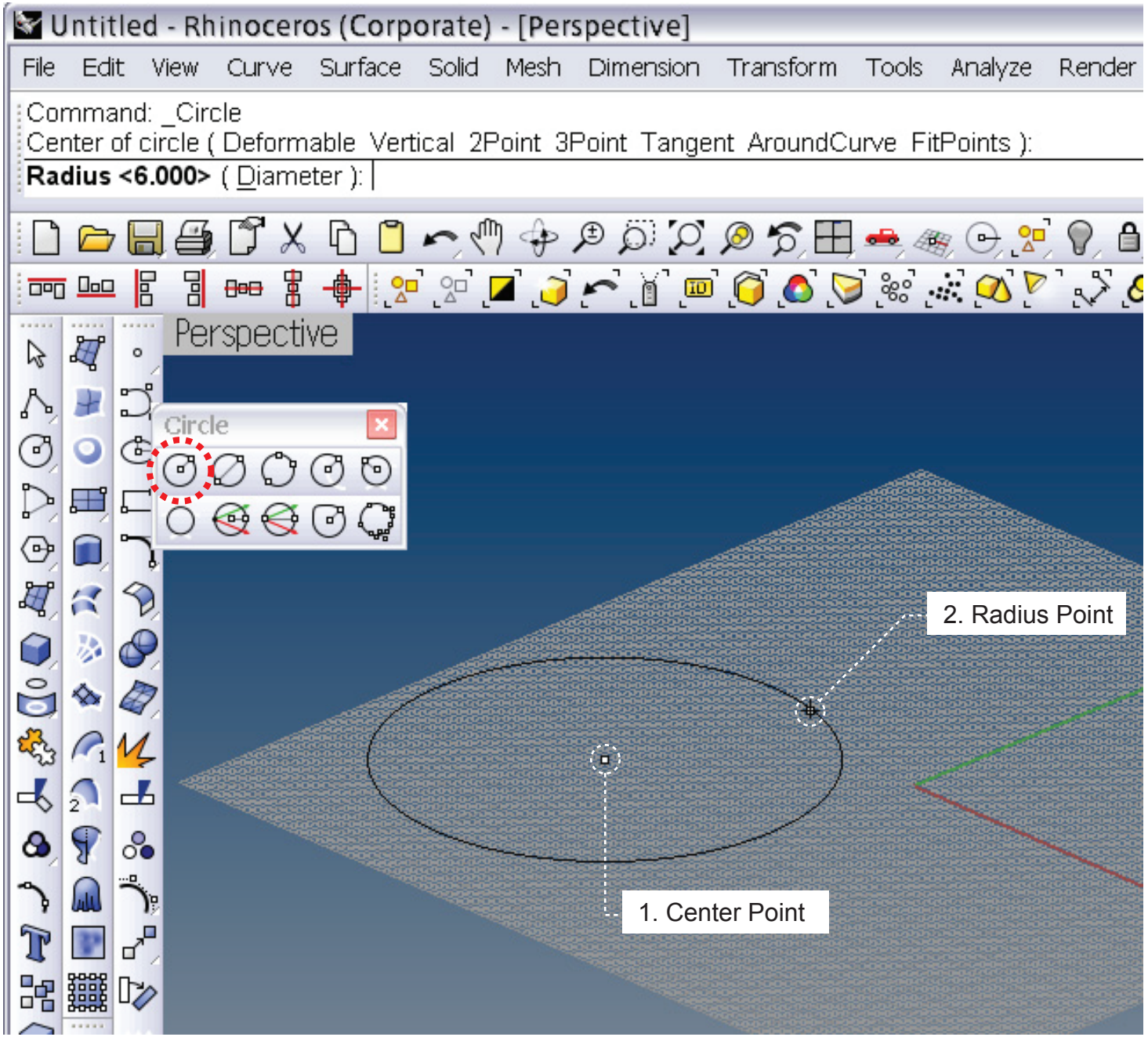
CIRCLE BY DIAMETER

CIRCLE IN MICROSTATION



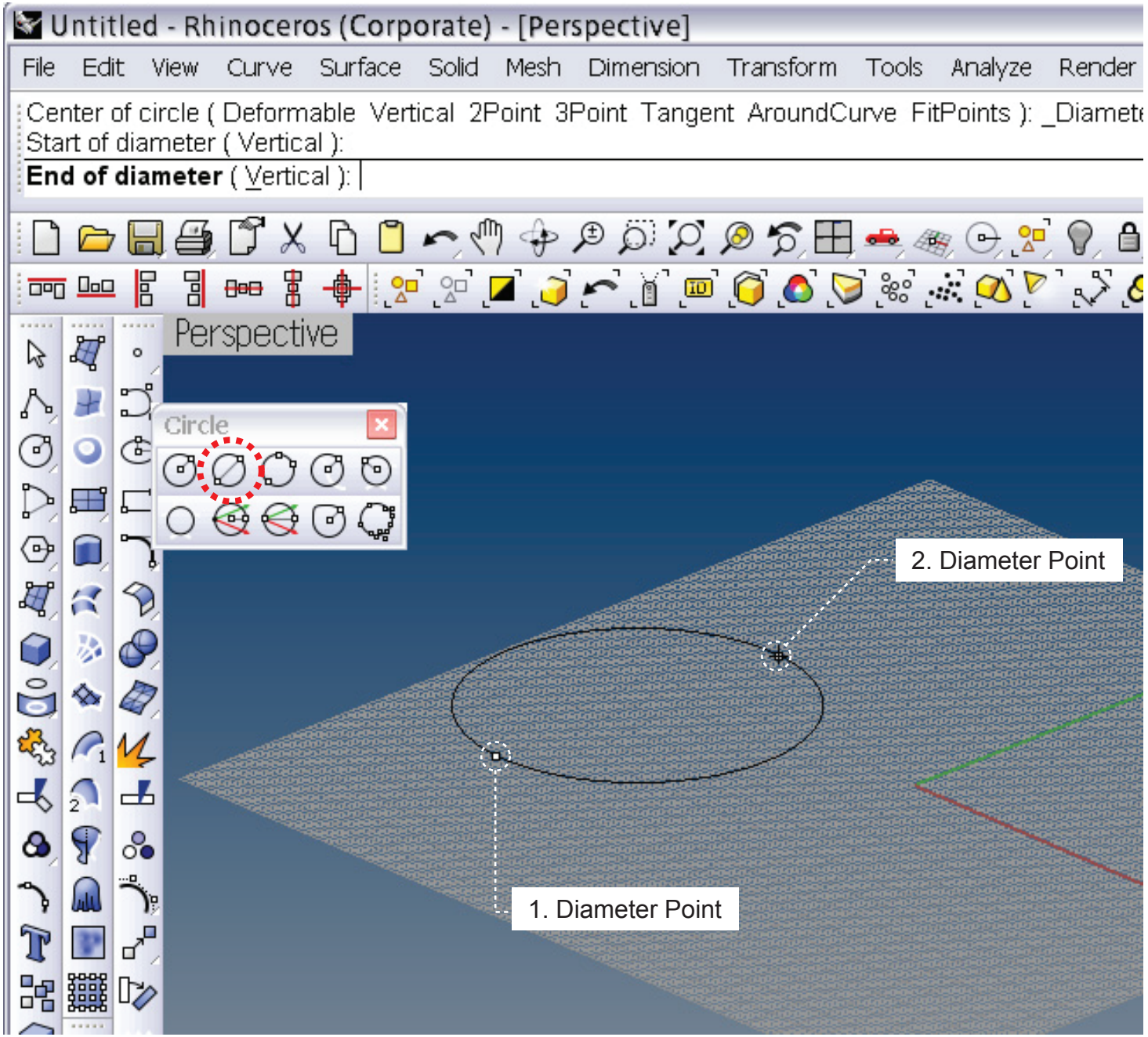
CIRCLE BY 3 POINTS

CIRCLE IN RHINOCEROS



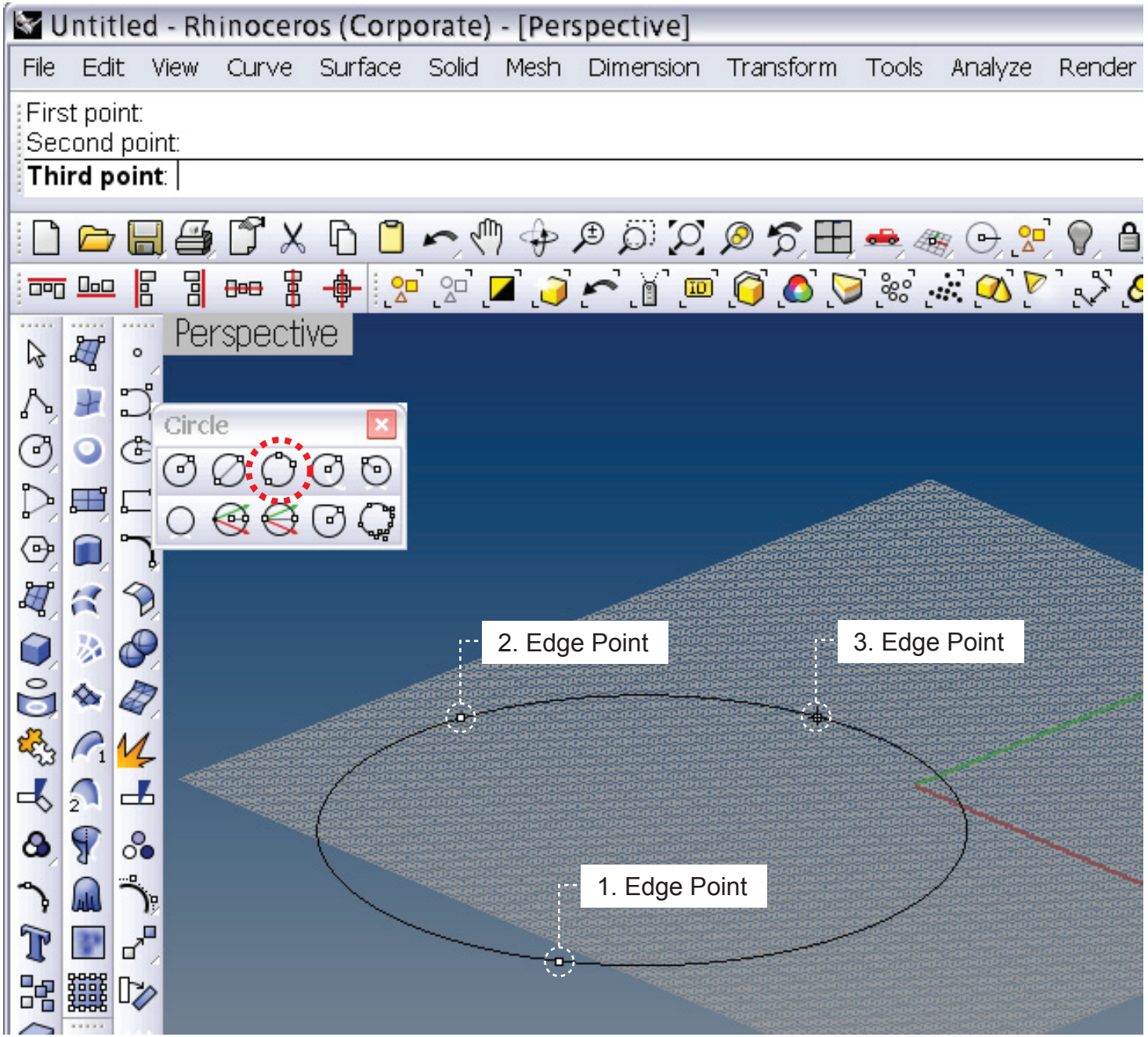
CIRCLE BY CENTER AND RADIUS

CIRCLE IN RHINOCEROS



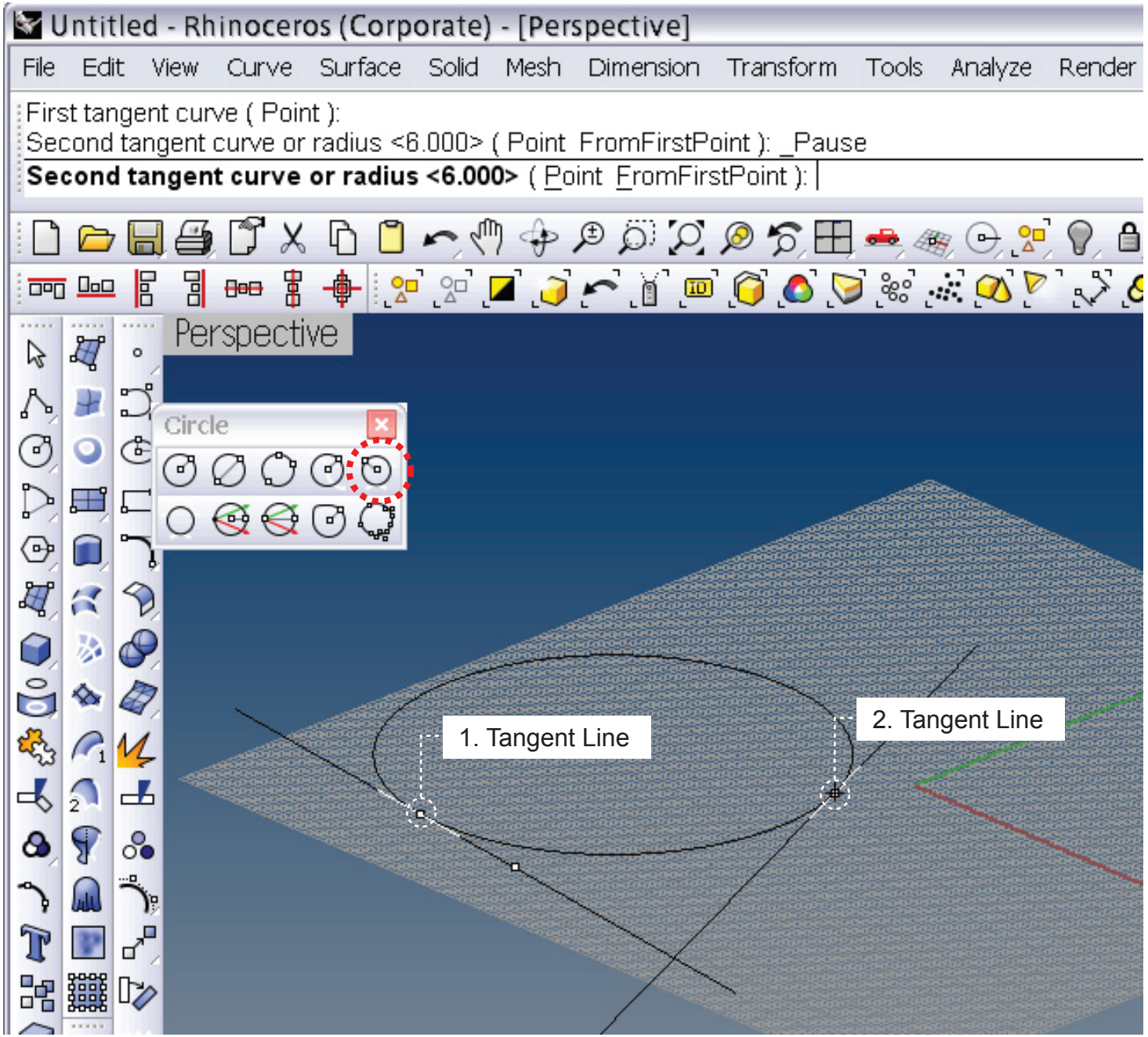
CIRCLE BY DIAMETER

CIRCLE IN RHINOCEROS



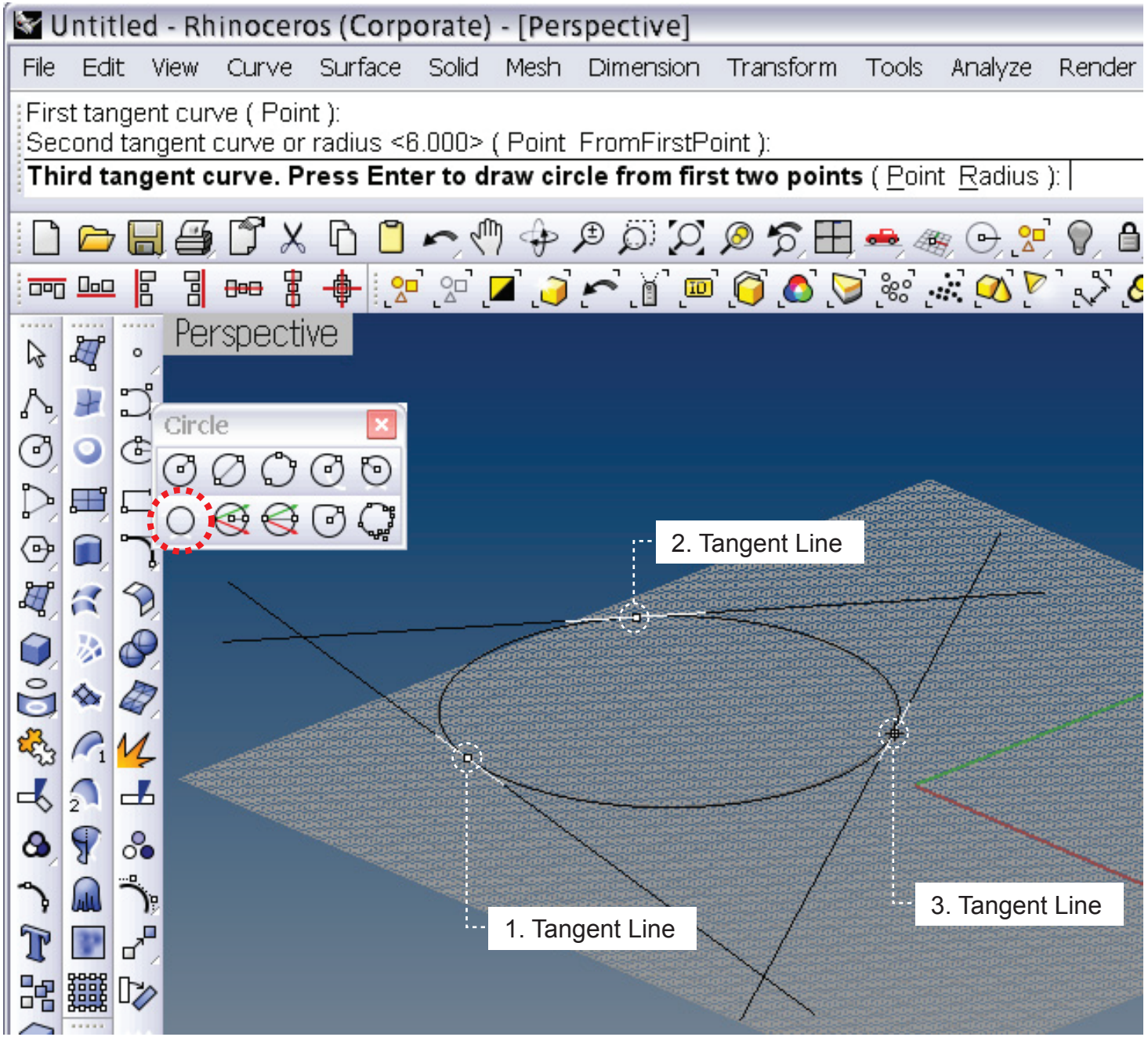
CIRCLE BY 3 POINTS

CIRCLE IN RHINOCEROS



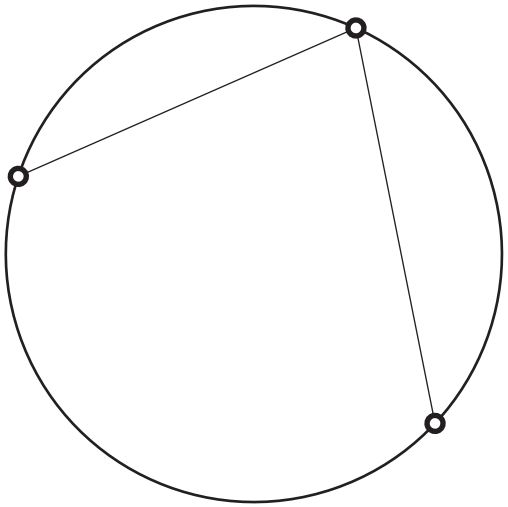
CIRCLE BY 2 TANGENT LINES AND RADIUS

CIRCLE IN RHINOCEROS

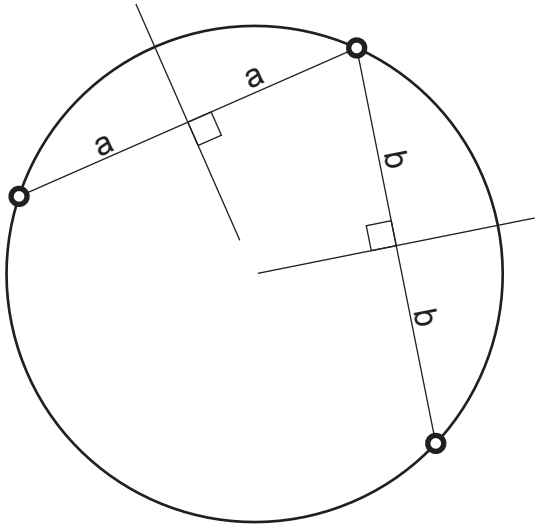


CIRCLE BY 3 TANGENT LINES

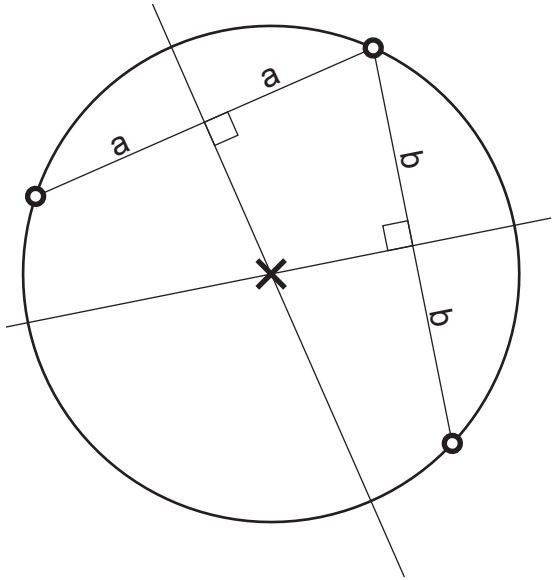
FINDING CENTER OF CIRCLE



Take 3 points on the circle and draw 2 lines between them.

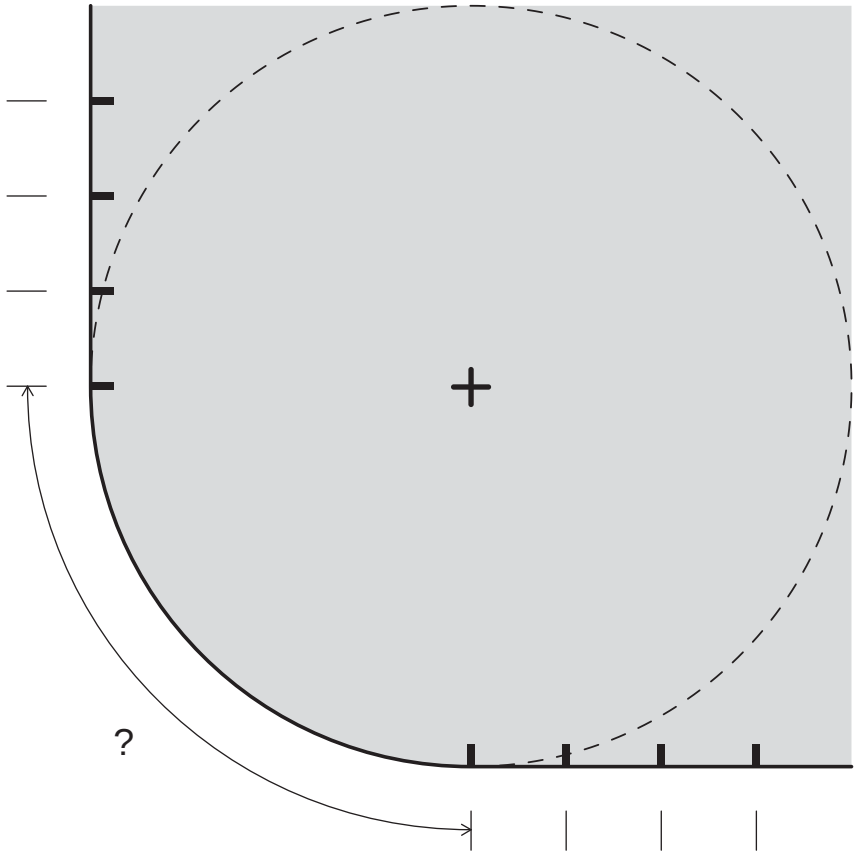


Draw a perpendicular line from a midpoint of each line.

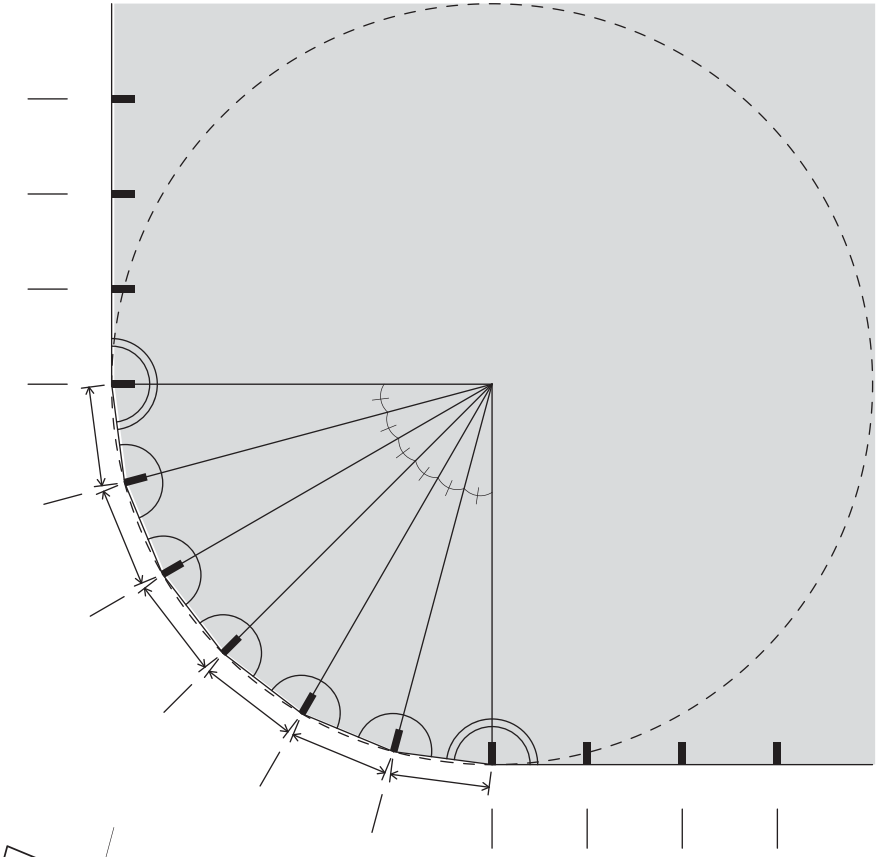


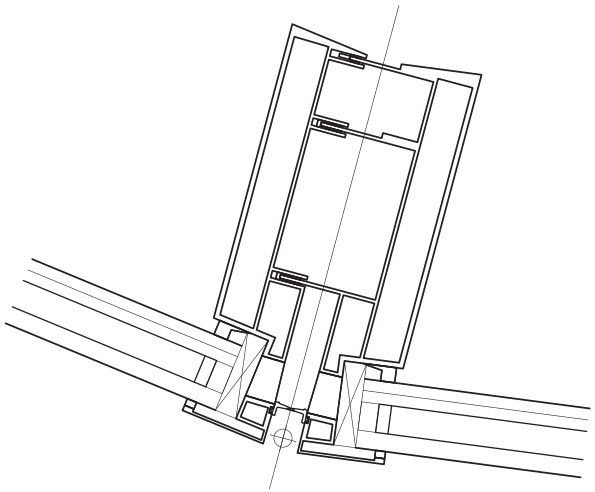
Take an intersection of perpendicular lines and it's the center of the circle.

DIVIDING ARC INTO EQUAL LENGTH / ANGLE

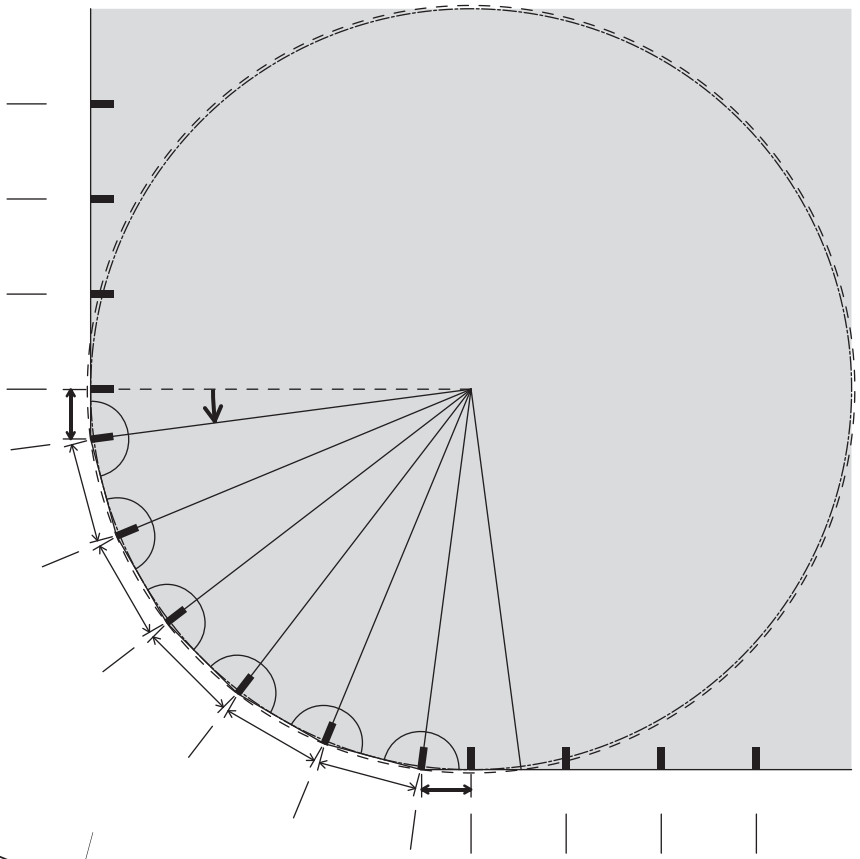


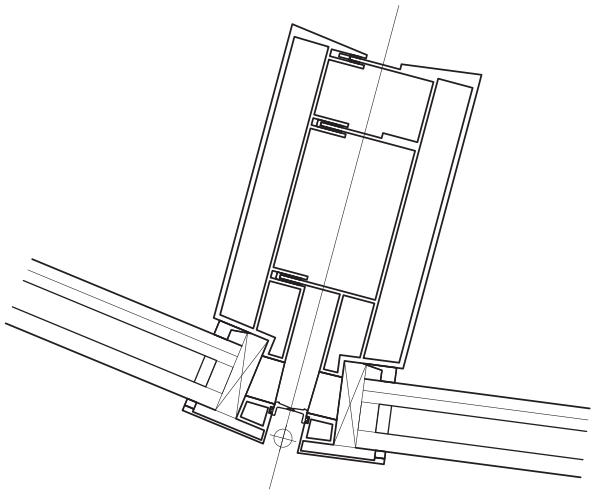
DIVIDING ARC INTO EQUAL LENGTH / ANGLE



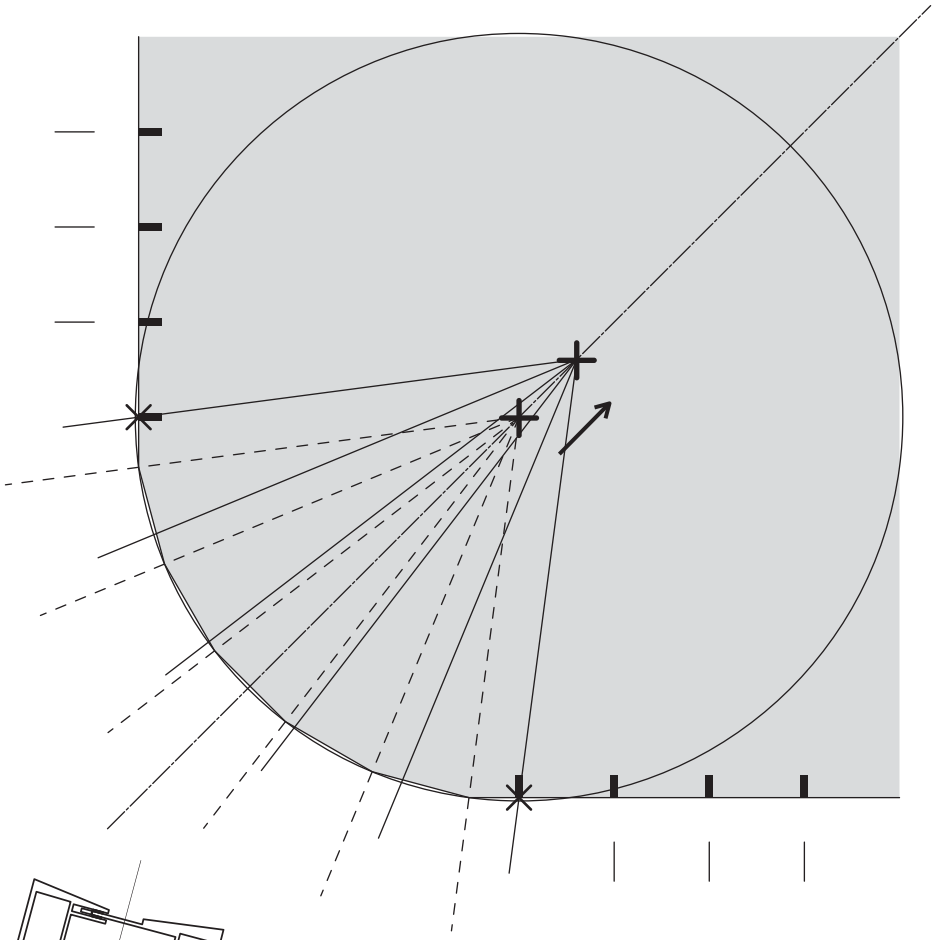


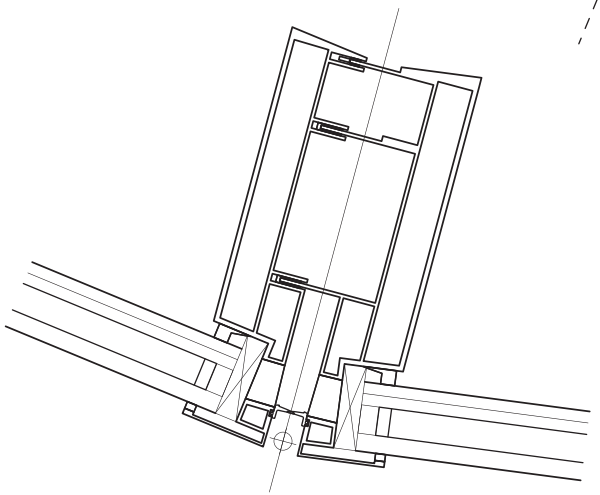
DIVIDING ARC INTO EQUAL LENGTH / ANGLE



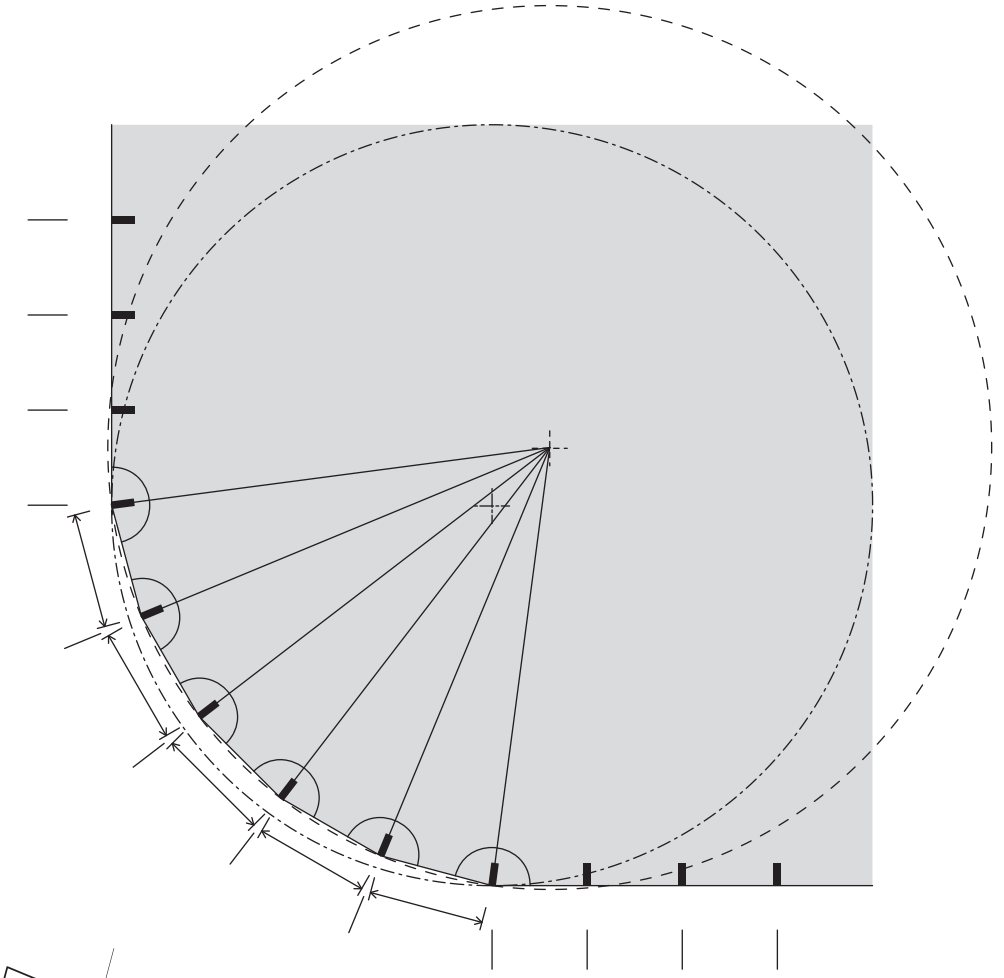


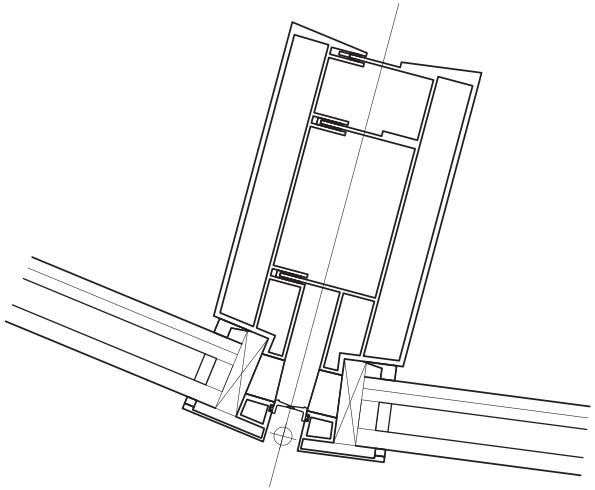
DIVIDING ARC INTO EQUAL LENGTH / ANGLE





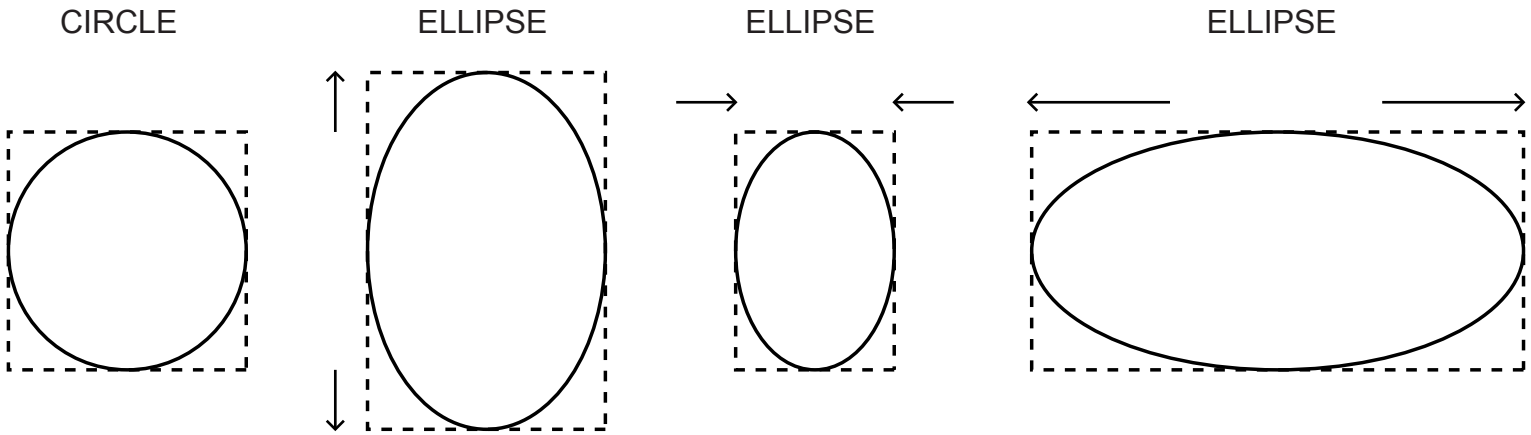
DIVIDING ARC INTO EQUAL LENGTH / ANGLE



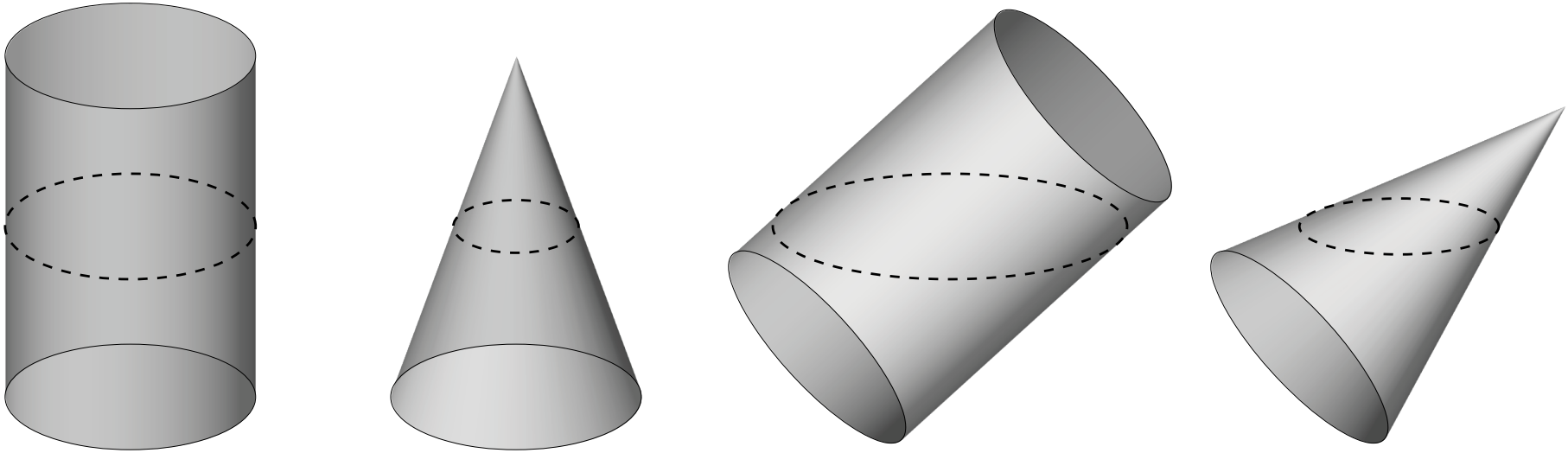


ELLIPSE AND CYLINDER/CONE

RELATIONSHIP BETWEEN CIRCLE AND ELLIPSE BY UNPROPORTIONAL SCALING



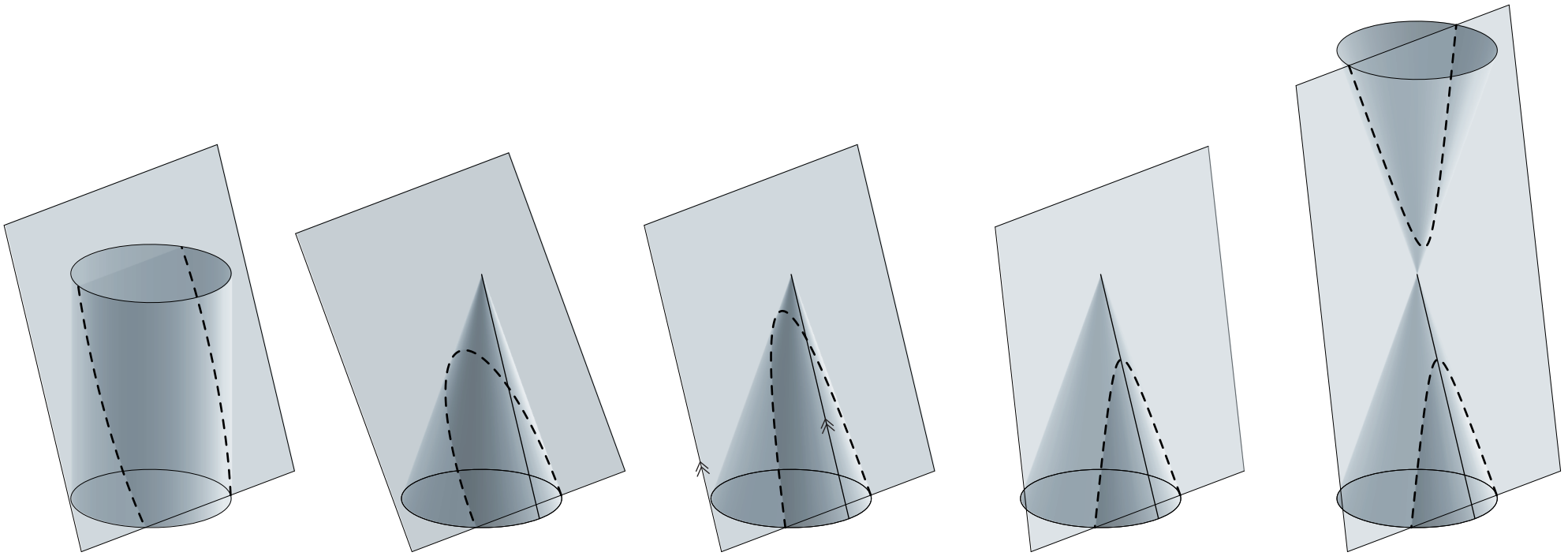
RELATIONSHIP BETWEEN CIRCLE/ELLIPSE AND CYLINDER/CONE BY INTERSECTION



CIRCLE　CIRCLE　ELLIPSE　ELLIPSE

ELLIPSE AND CYLINDER/CONE

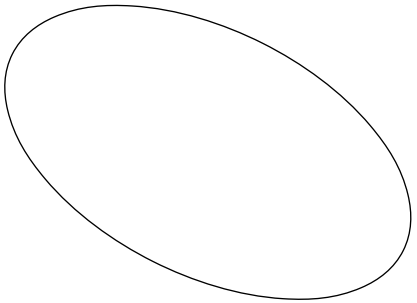
TRIVIA: PARABOLA AND HYPERBOLA

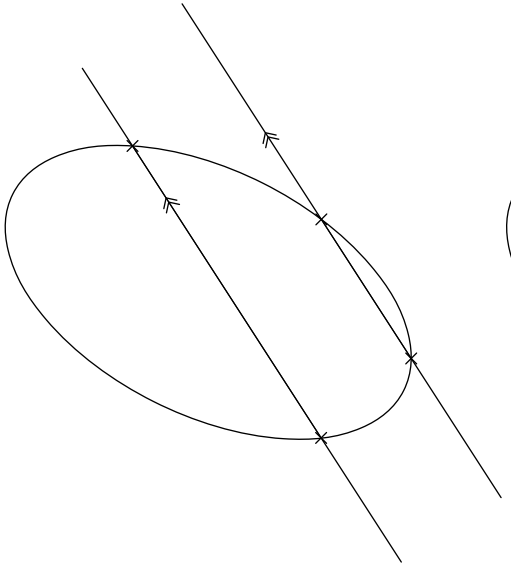


ELLIPSE ELLIPSE PARABOLA HYPERBOLA HYPERBOLA

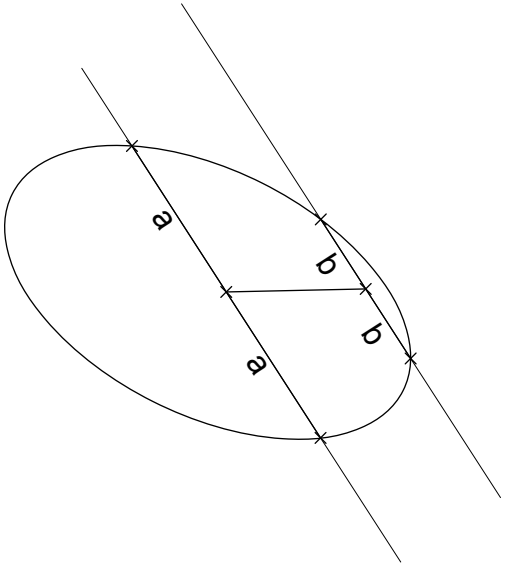
FINDING CENTER AND AXIS OF ELLIPSE

FINDING CENTER

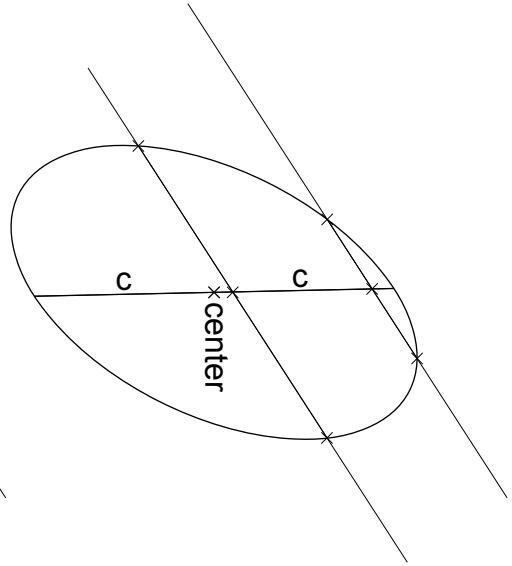




Draw two parallel lines intersecting at 4 points

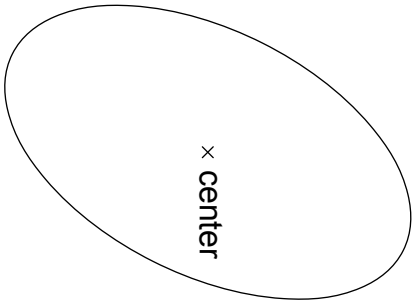


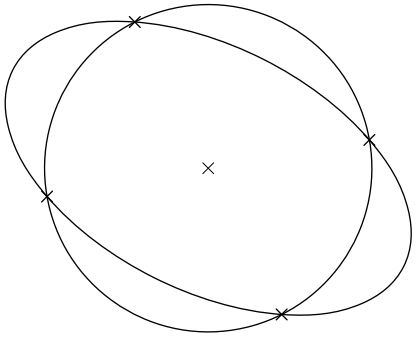
Pick midpoints of each pair of intersections and connect them



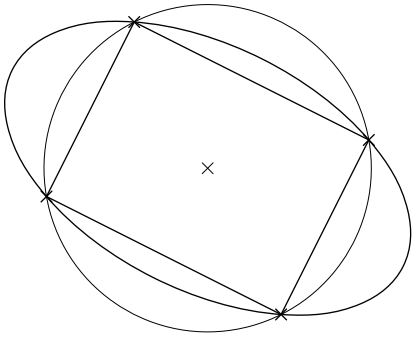
Extend the line to the ellipse and the midpoint of the line is the center

FINDING MAJOR AND MINOR AXES

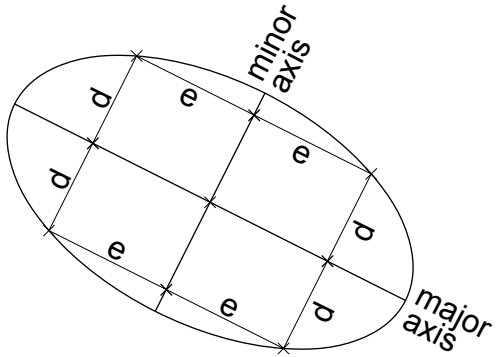




Draw a circle from the center intersecting at 4 points

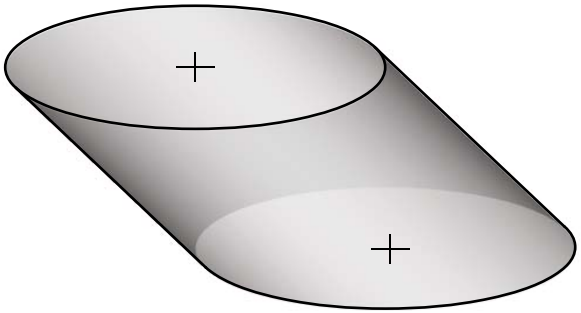


Draw rectangle connecting the 4 intersection points

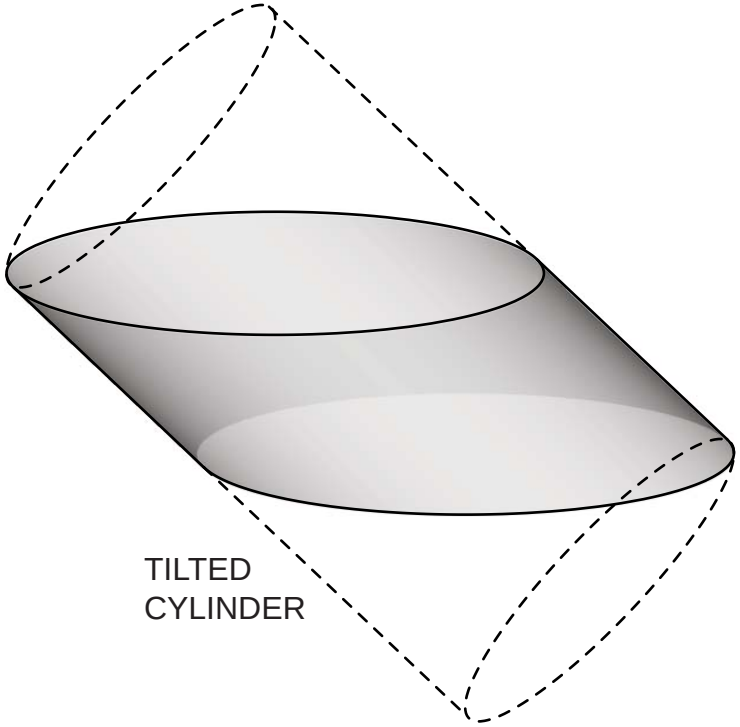


Connection of midpoints of each edge of the rectangle gives you major and minor axes

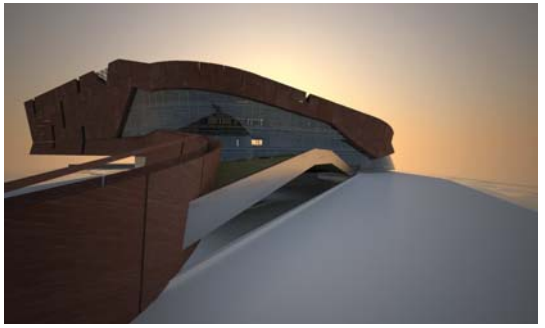
TILTED CYLINDER AND LOFTED CIRCLE

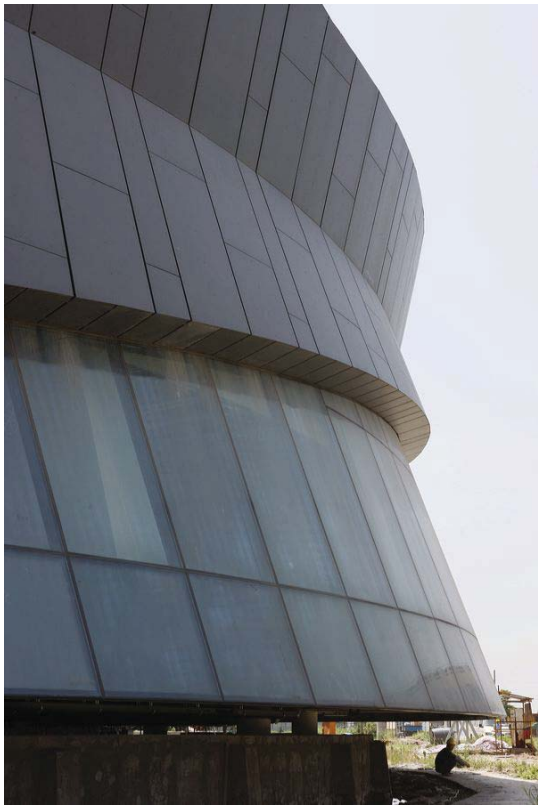


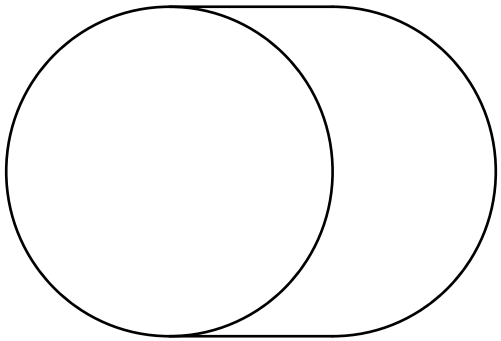
LOFTED SURFACE
BETWEEN CIRCLES



TILTED
CYLINDER

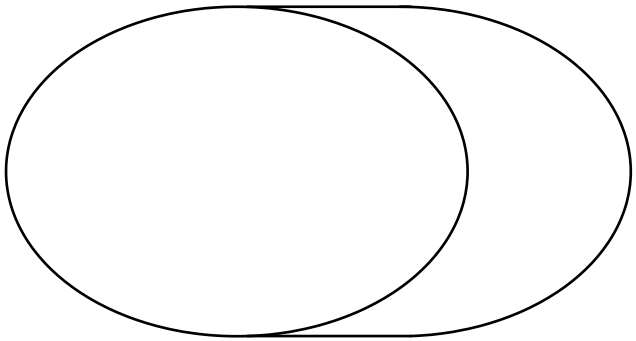






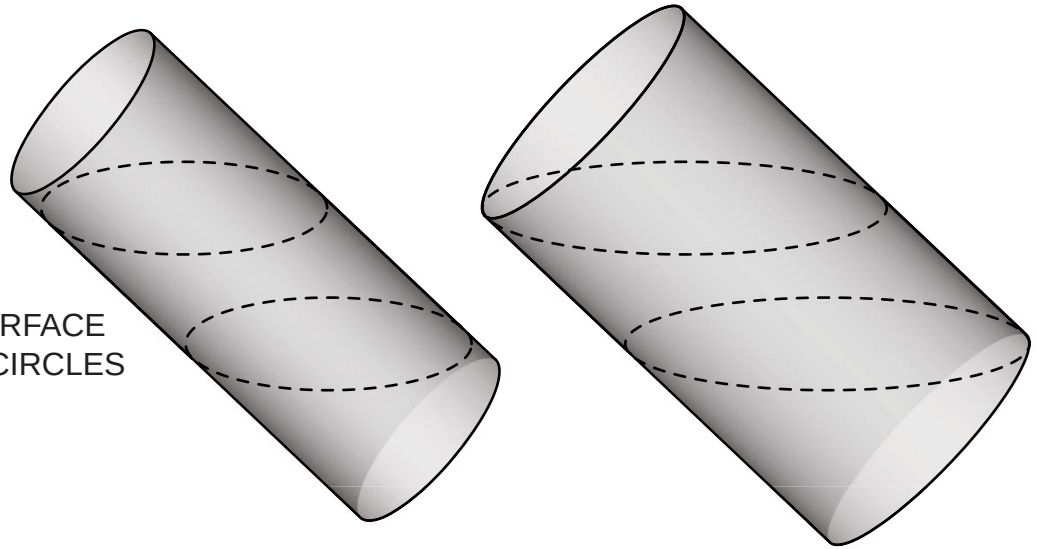
PLAN

CIRCULAR EDGE



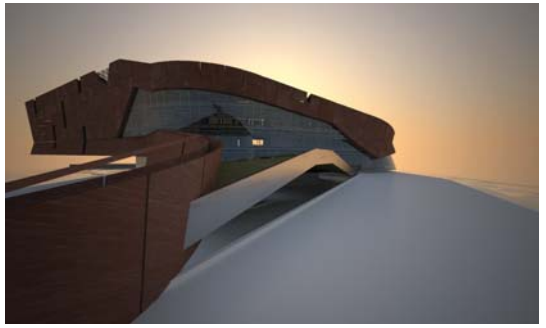
ELLIPTICAL EDGE

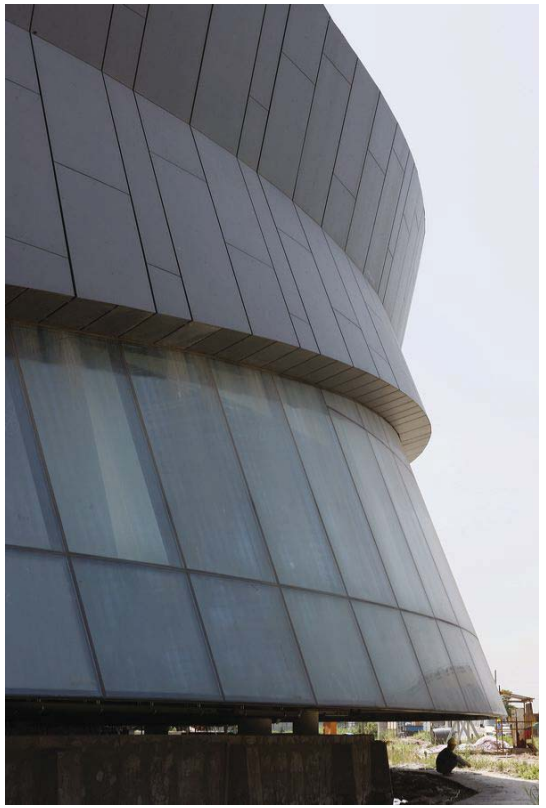
TILTED CYLINDER AND LOFTED CIRCLE

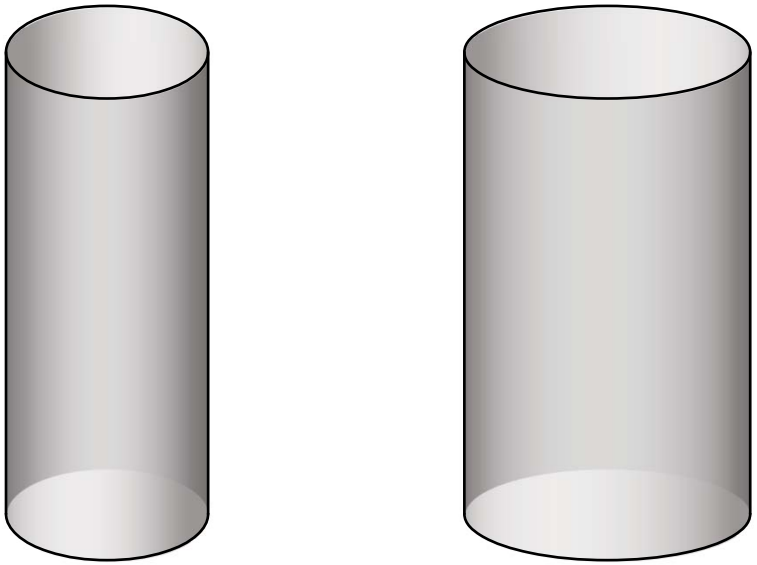


LOFTED SURFACE
BETWEEN CIRCLES

TILTED
CYLINDER



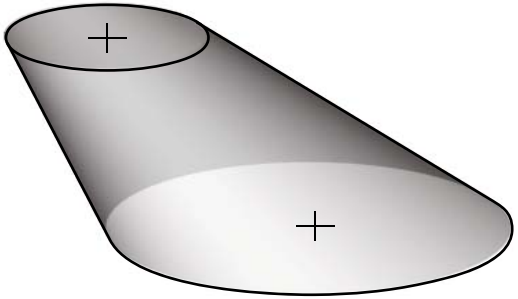




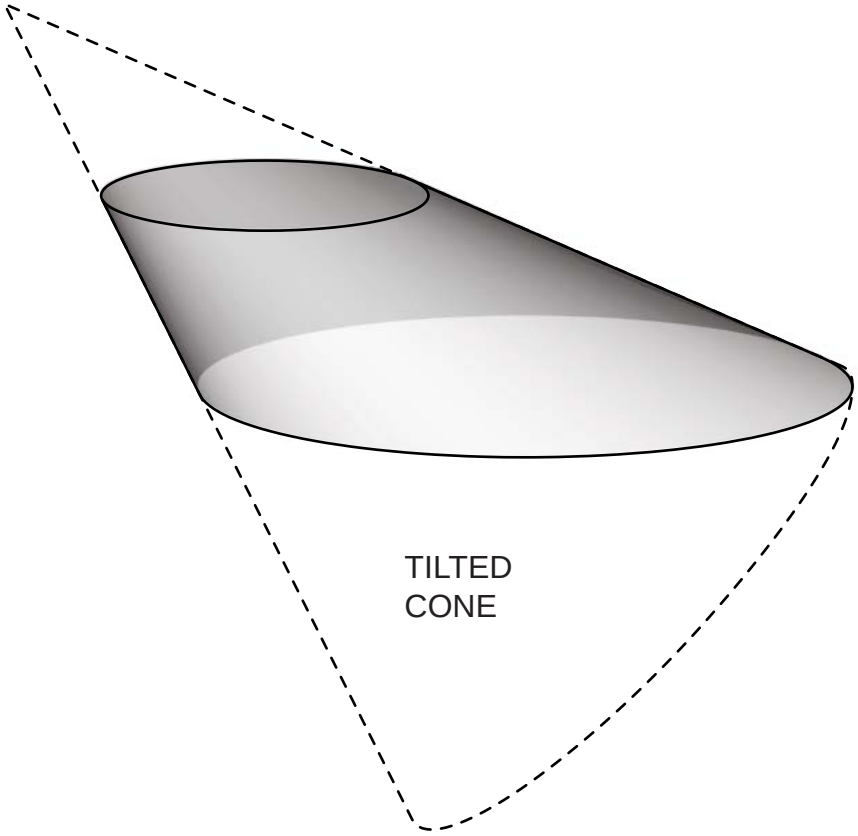
ELLIPTICAL
PROFILE

CIRCULAR
PROFILE

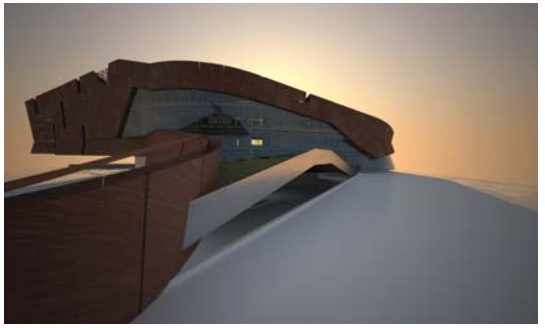
TILTED CONE AND LOFTED CIRCLE

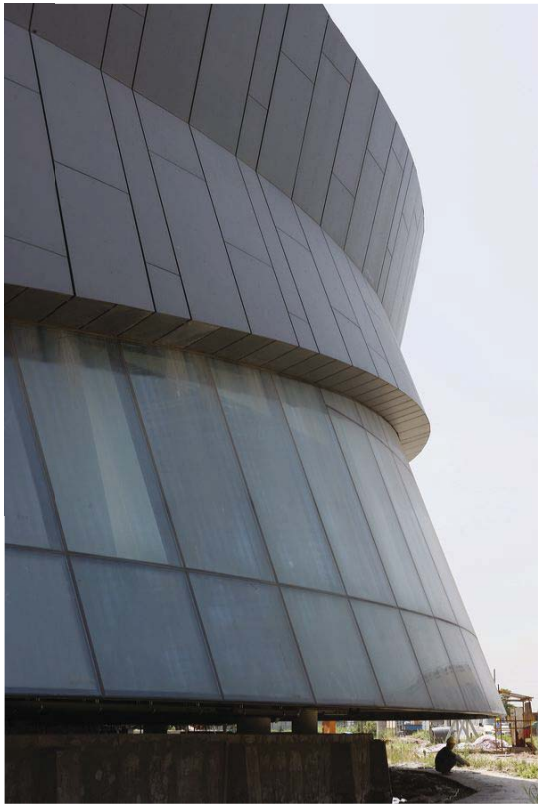


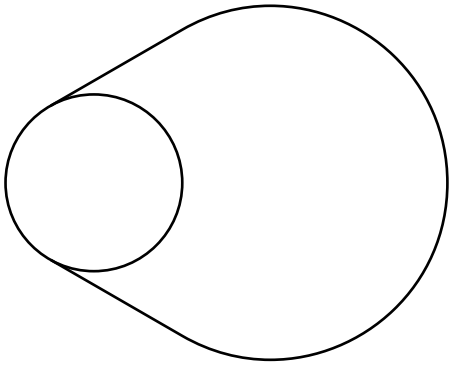
LOFTED SURFACE
BETWEEN CIRCLES



TILTED
CONE

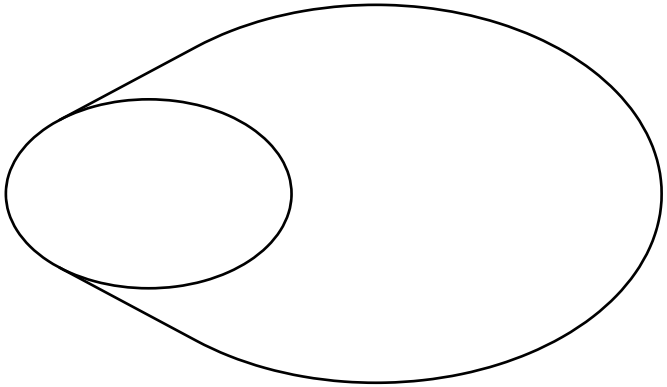






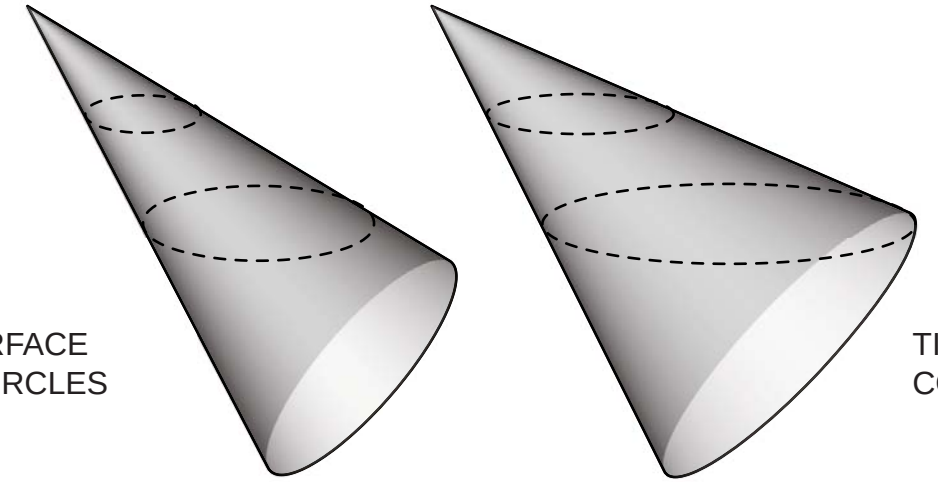
PLAN

CIRCULAR EDGE



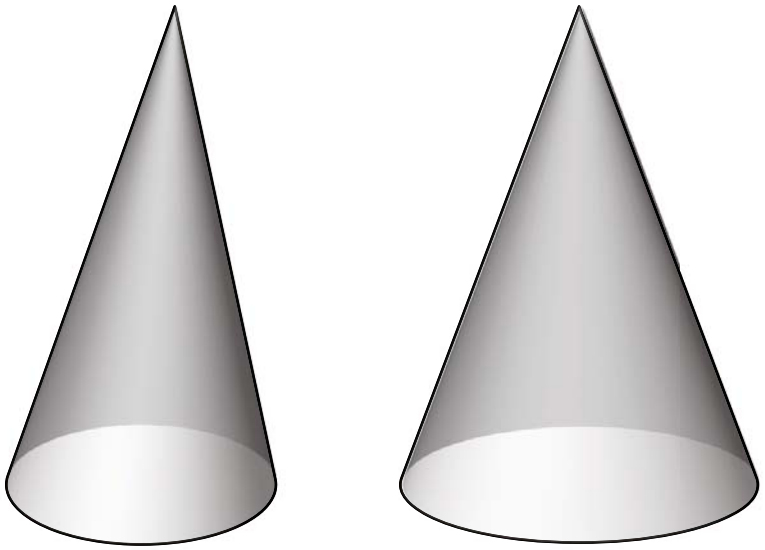
ELLIPTICAL EDGE

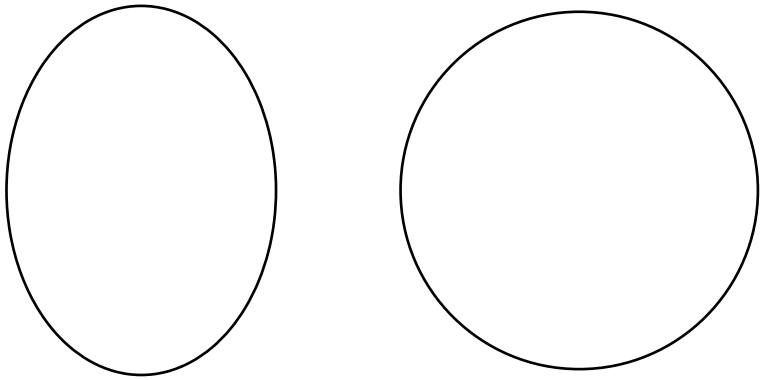
TILTED CONE AND LOFTED CIRCLE



LOFTED SURFACE
BETWEEN CIRCLES

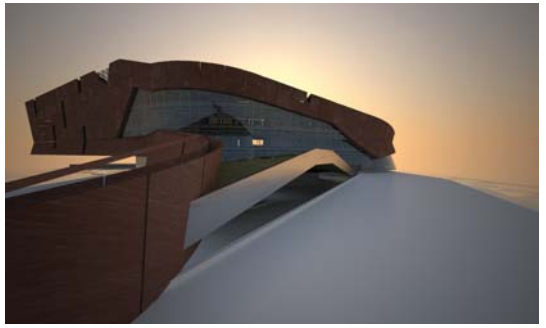
TILTED
CONE

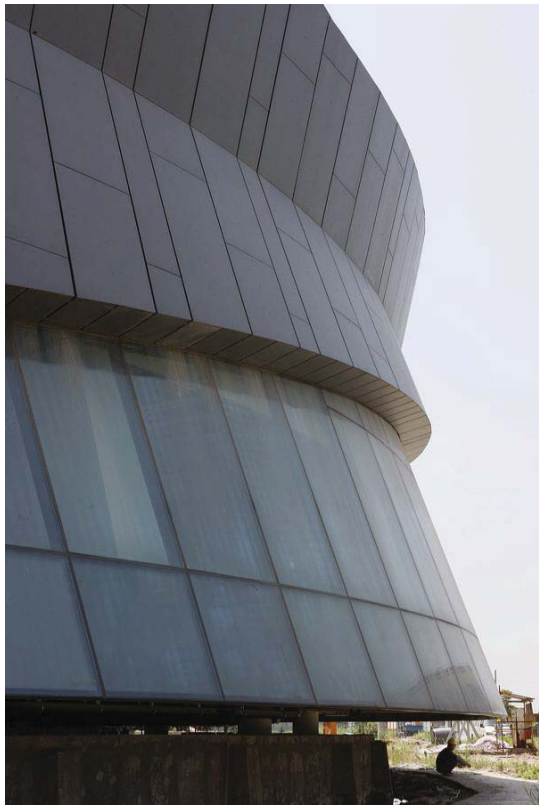




ELLIPTICAL
PROFILE

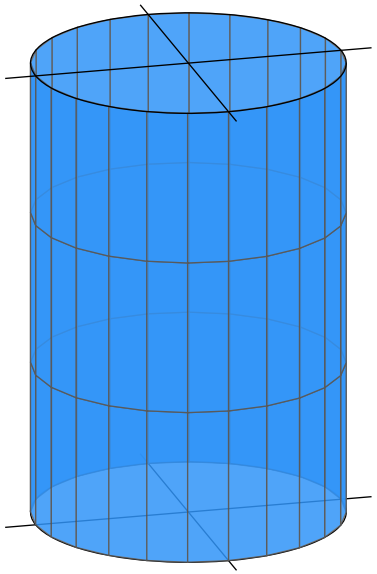
CIRCULAR
PROFILE

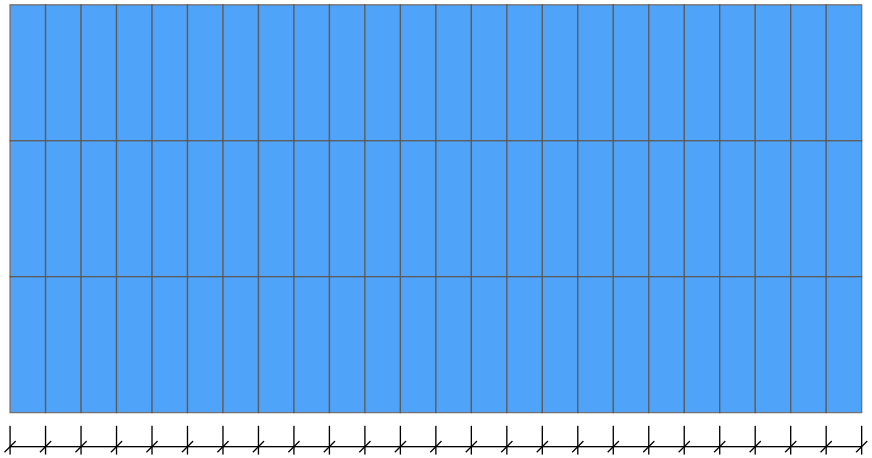




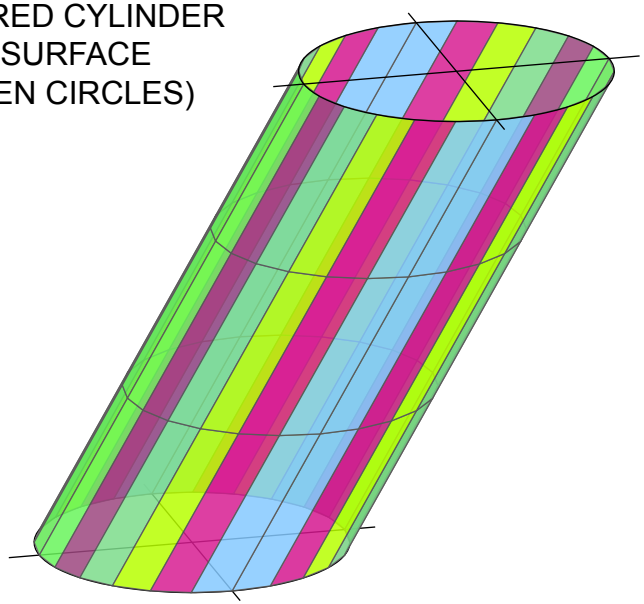
PANELIZATION OF CYLINDER AND CONE

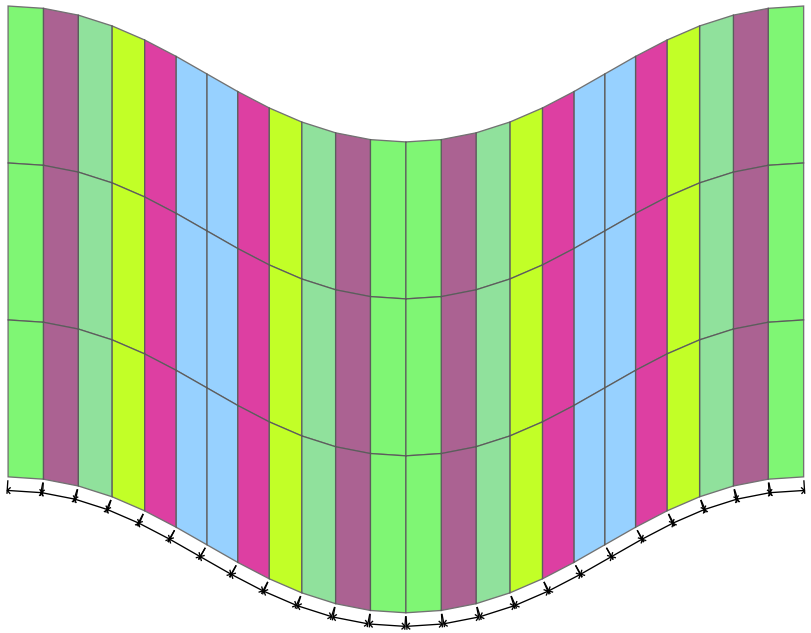
CYLINDER





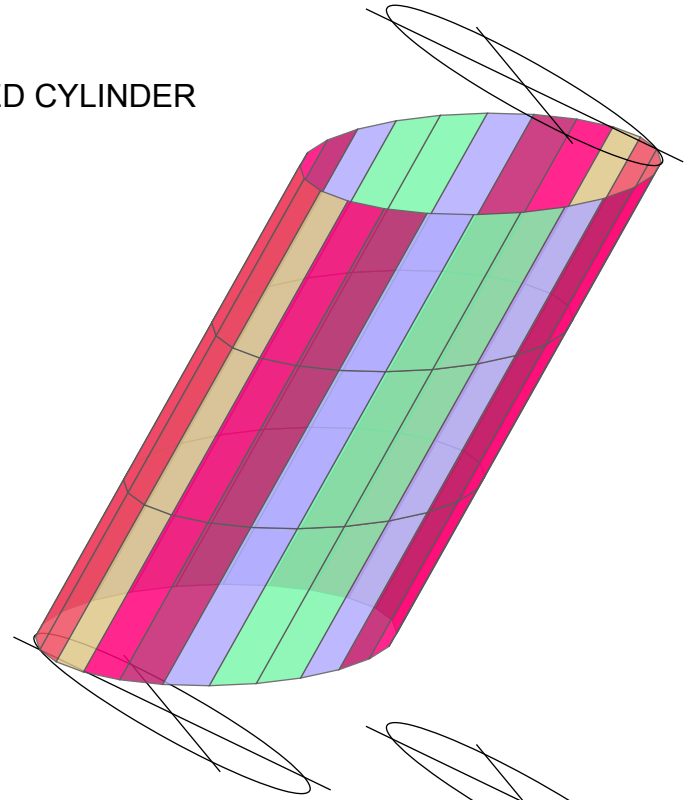
SHEARED CYLINDER
(LOFT SURFACE
BTWEEN CIRCLES)

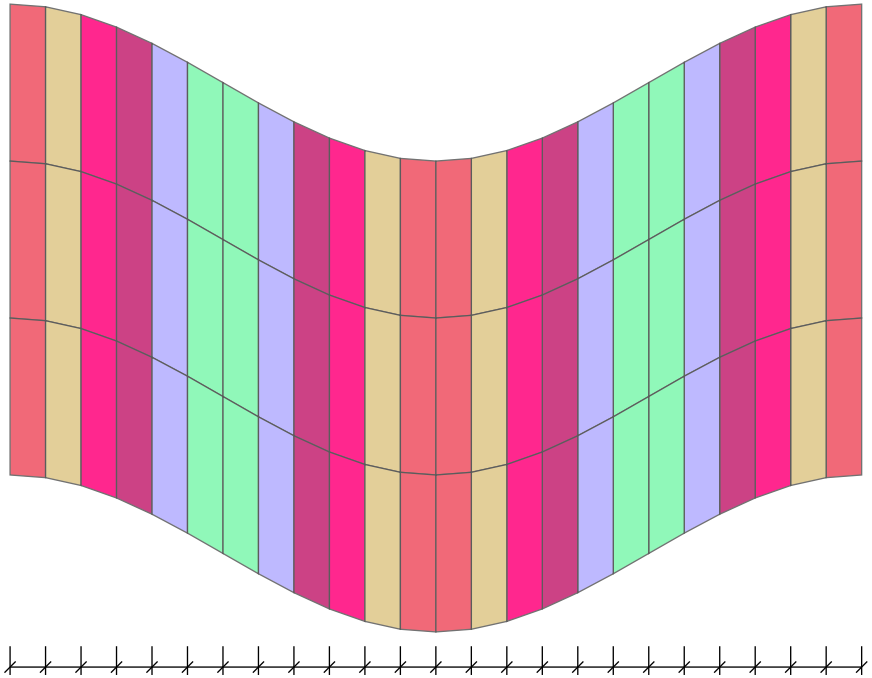




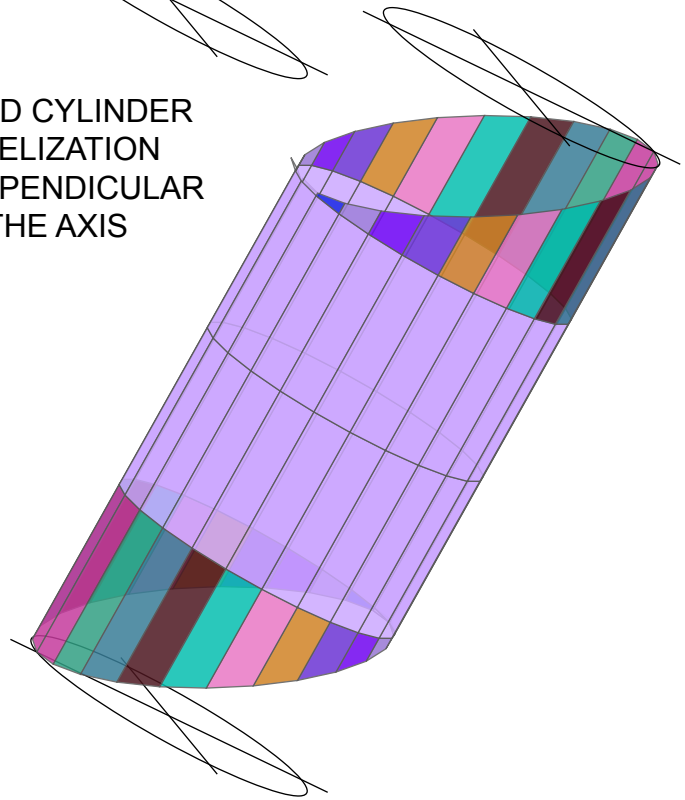
PANELIZATION OF CYLINDER AND CONE

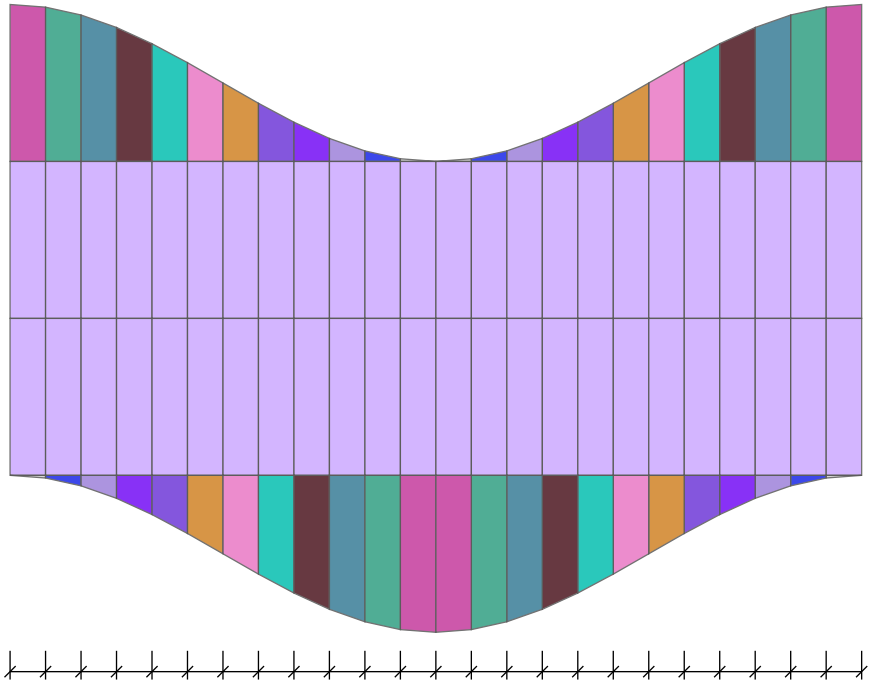
TILTED CYLINDER





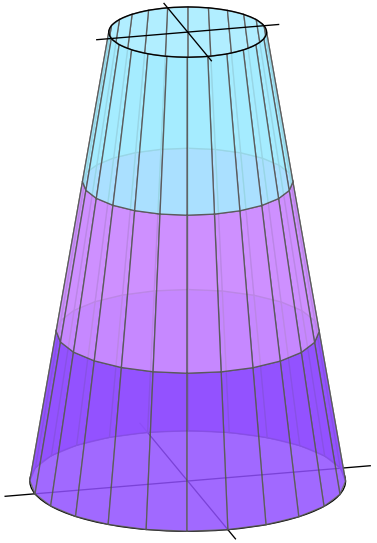
TILTED CYLINDER
- PANELIZATION PERPENDICULAR TO THE AXIS

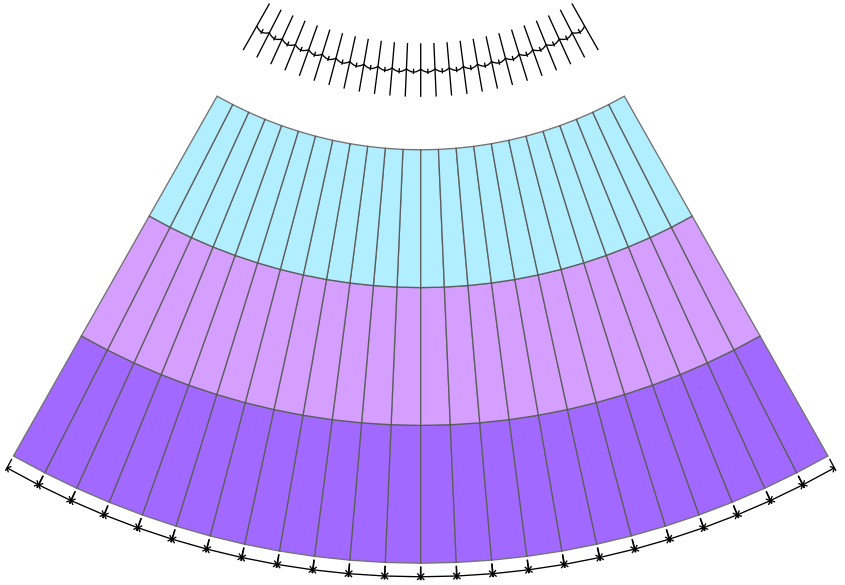




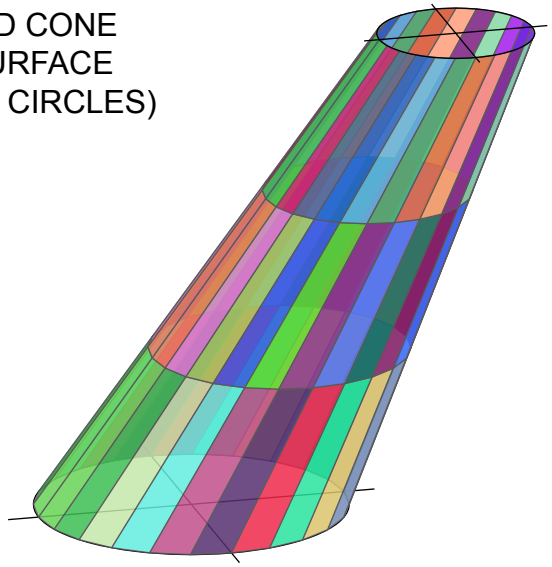
PANELIZATION OF CYLINDER AND CONE

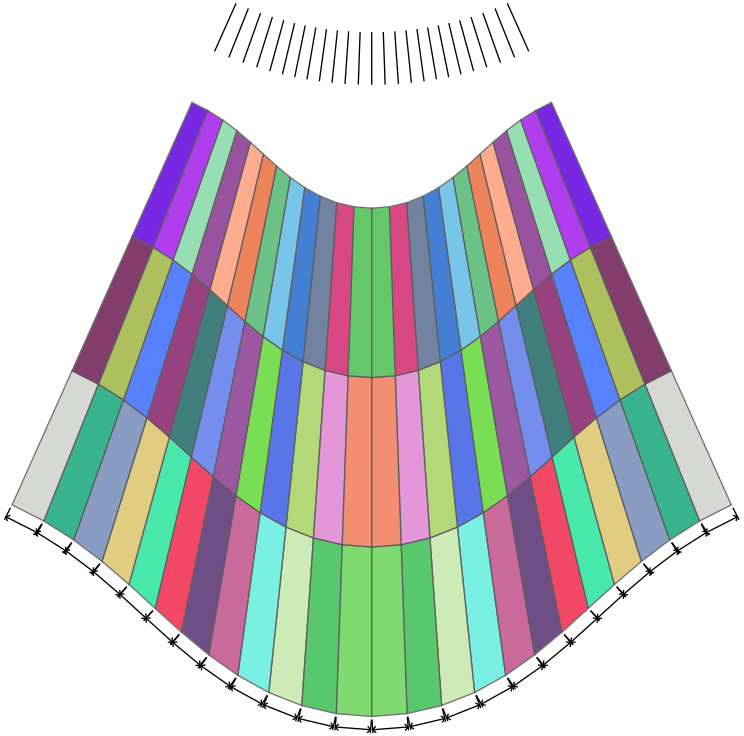
CONE





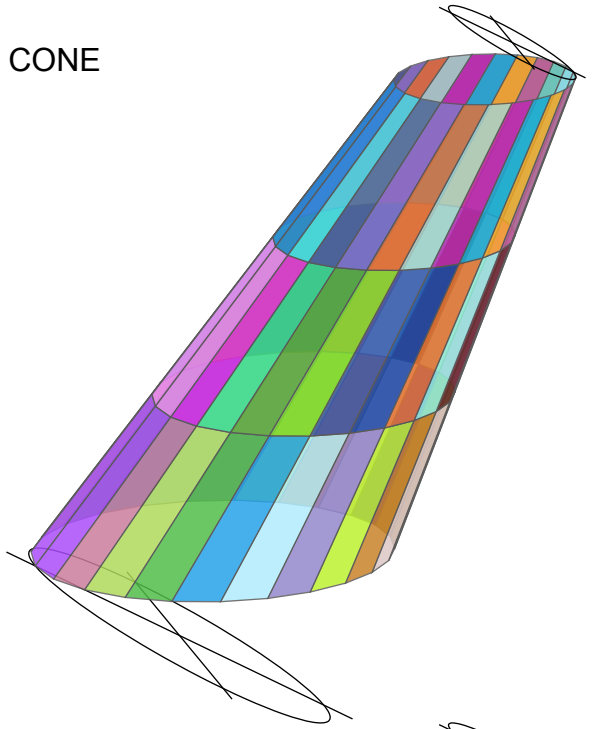
SHEARED CONE
(LOFT SURFACE
BTWEEN CIRCLES)

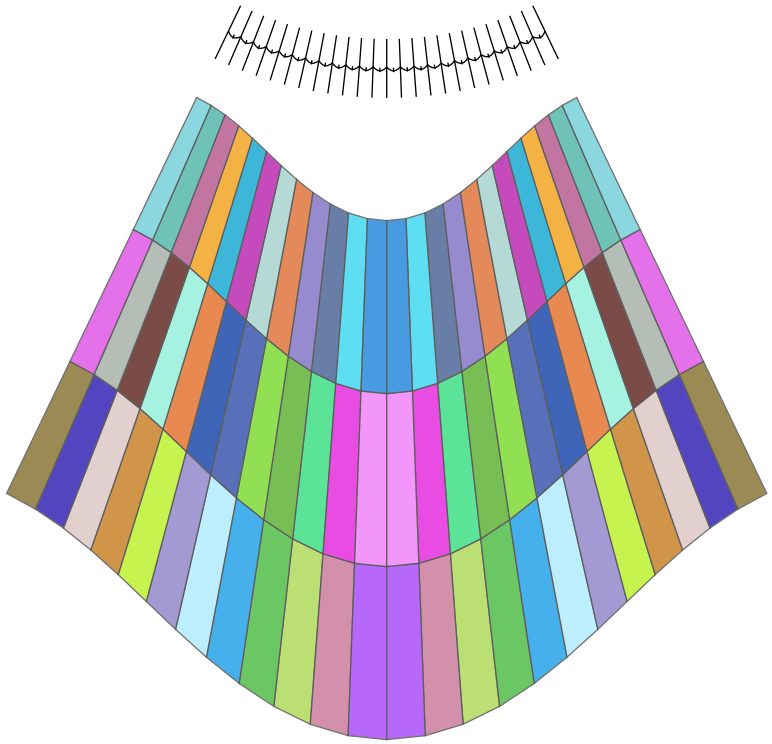




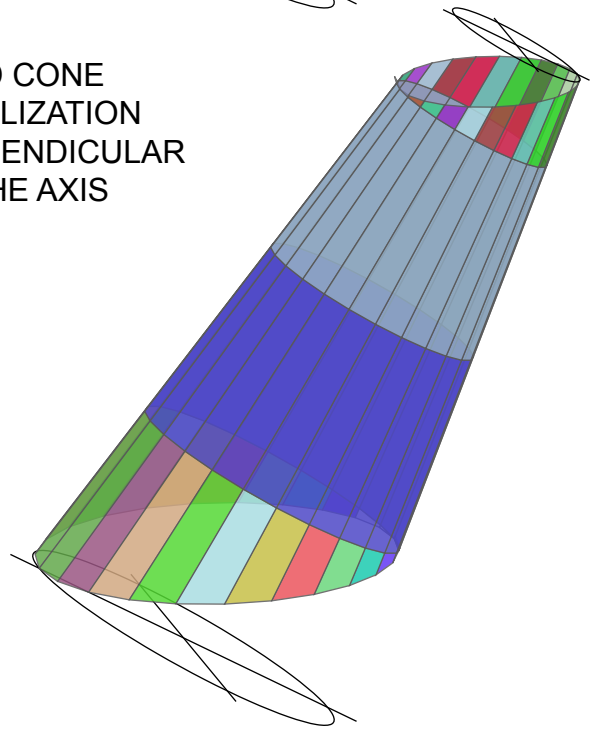
PANELIZATION OF CYLINDER AND CONE

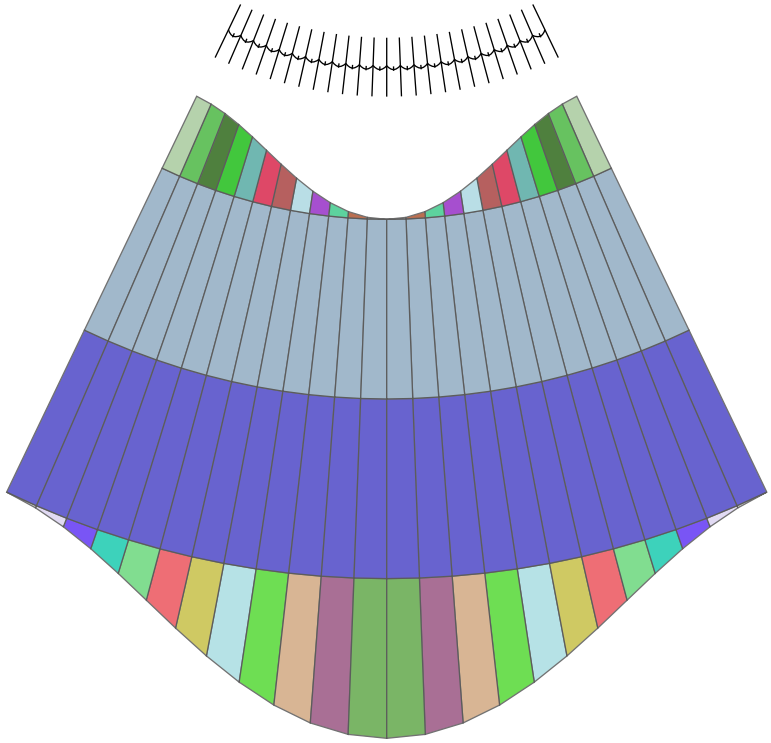
TILTED CONE



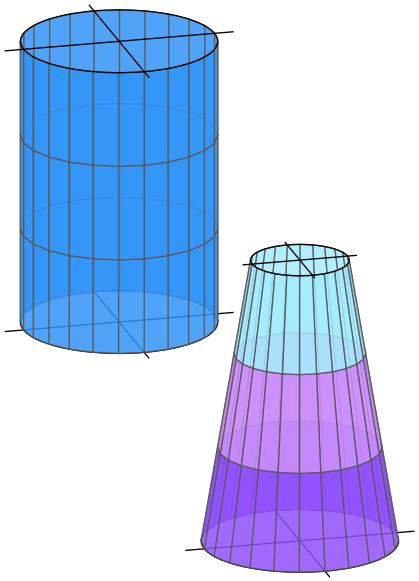


TILTED CONE
- PANELIZATION PERPENDICULAR TO THE AXIS



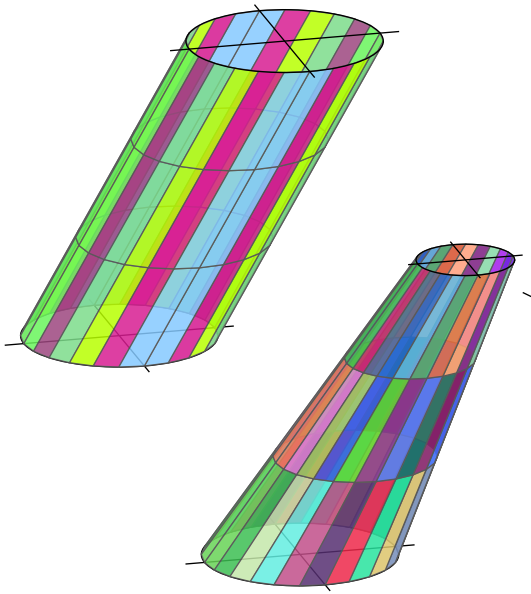


PANELIZATION OF CYLINDER AND CONE



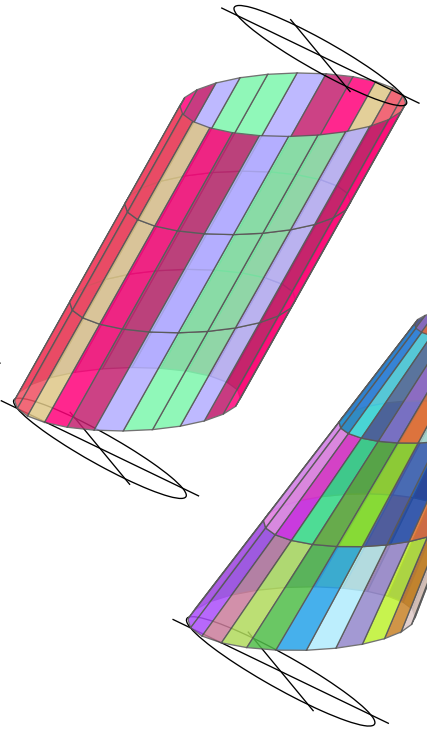
CYLINDER

CONE



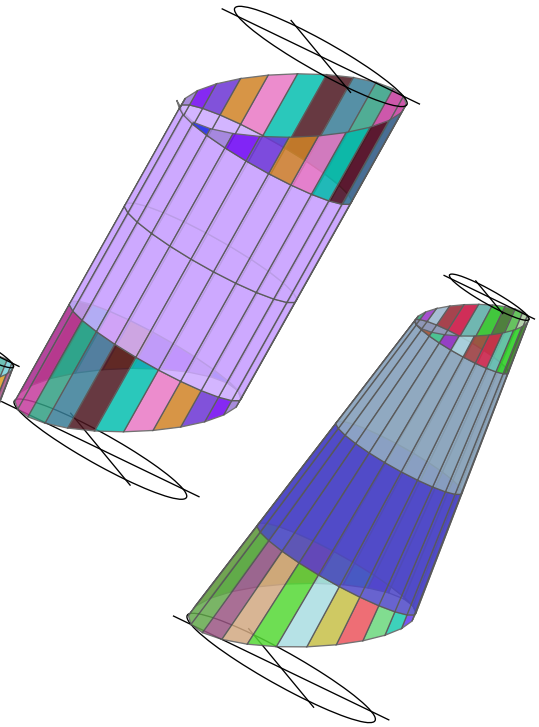
SHEARED CYLINDER

SHEARED CONE



TILTED CYLINDER

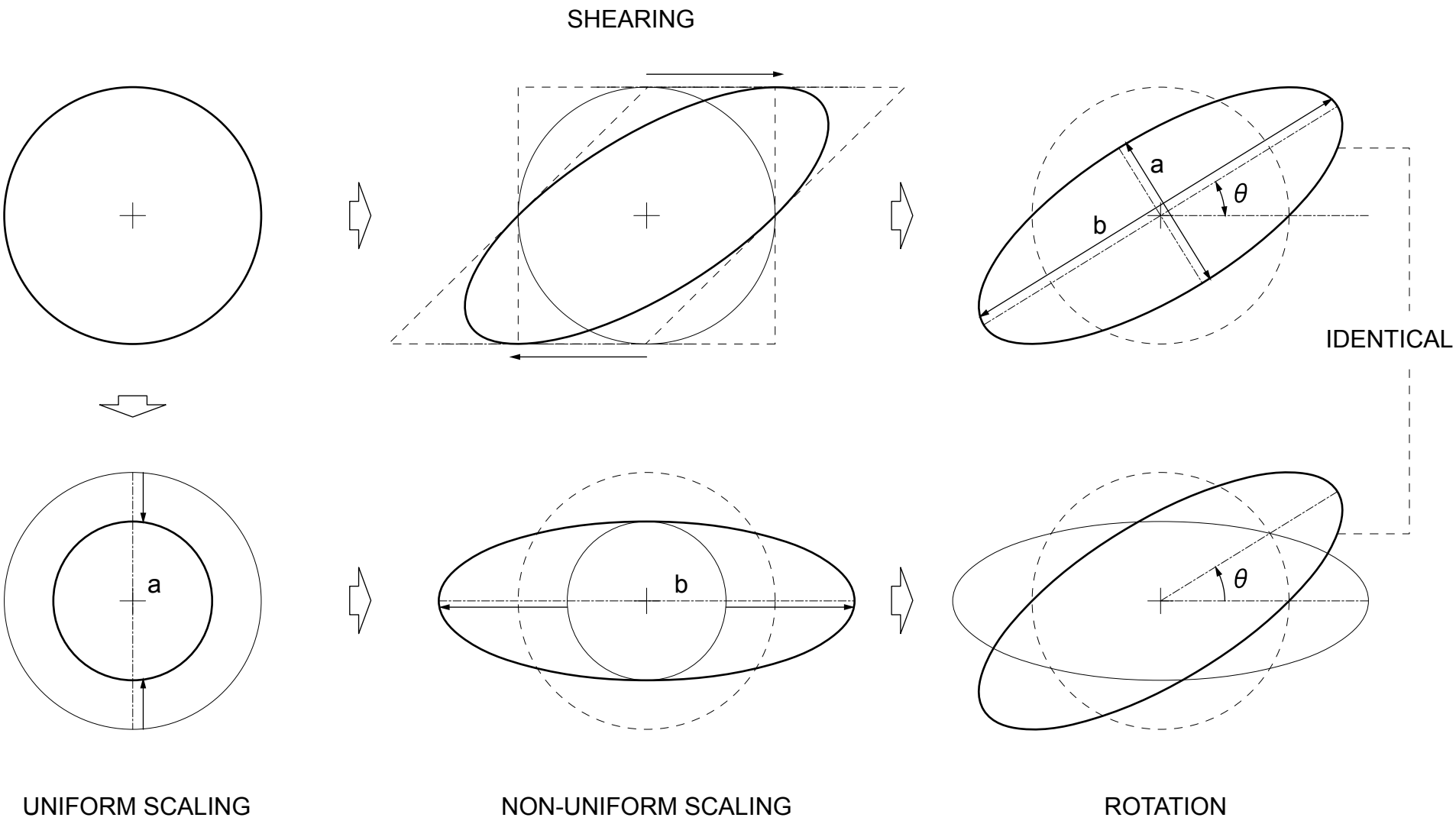
TILTED CONE



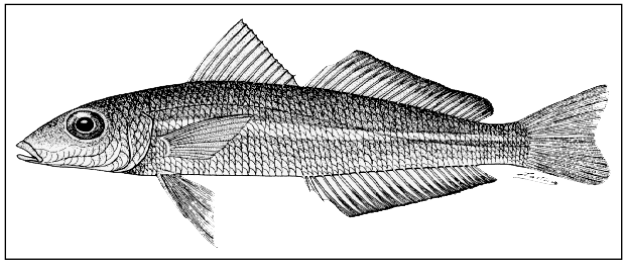
TILTED CYLINDER

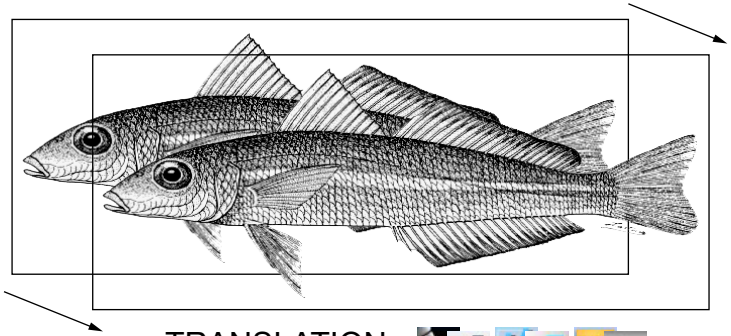
TILTED CONE

TRANSFORMATION OF CIRCLE INTO ELLIPSE

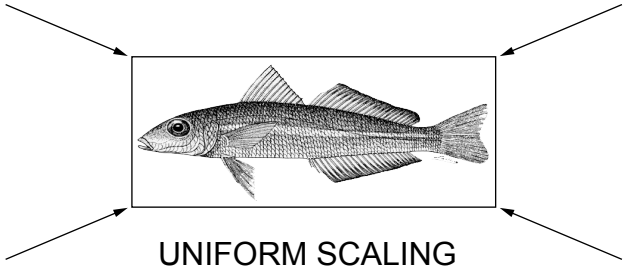


AFFINE TRANSFORMATION

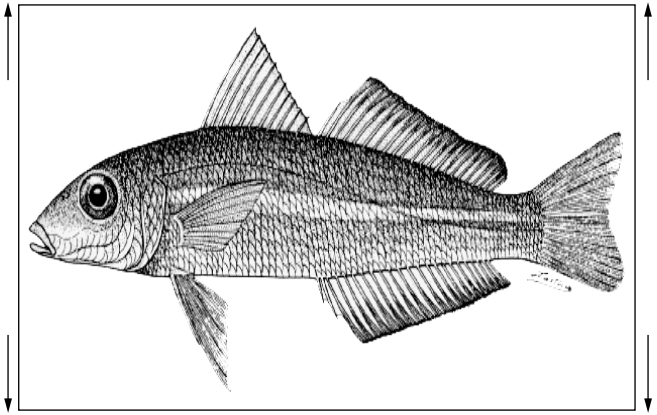




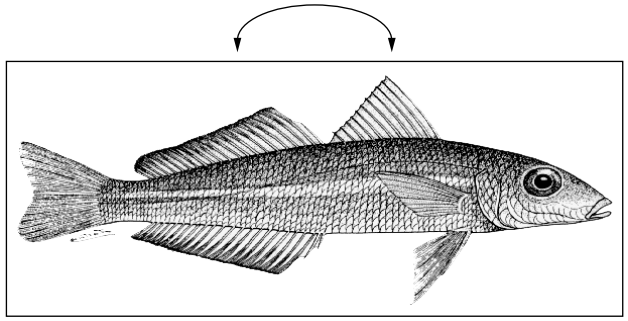
TRANSLATION



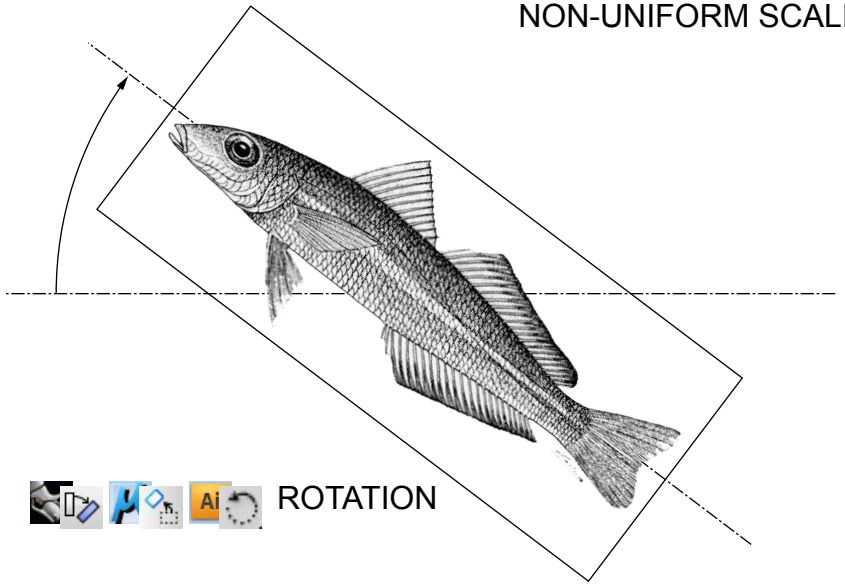
UNIFORM SCALING



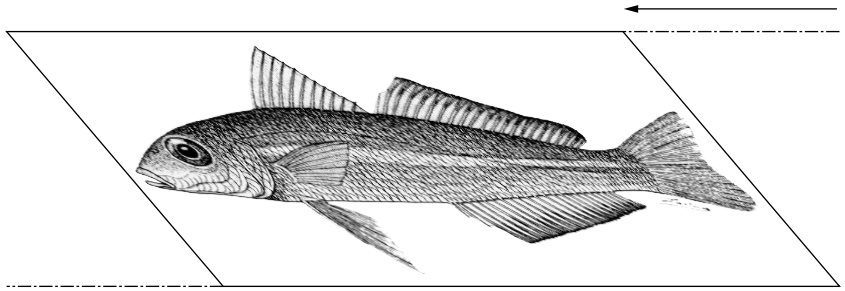
NON-UNIFORM SCALING



REFLECTION

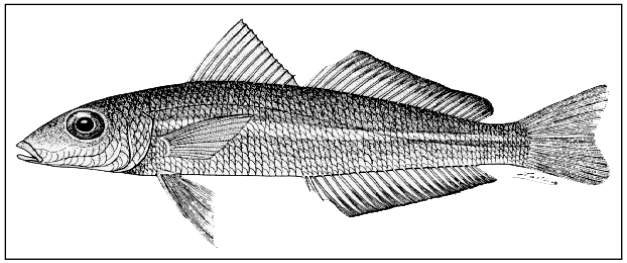


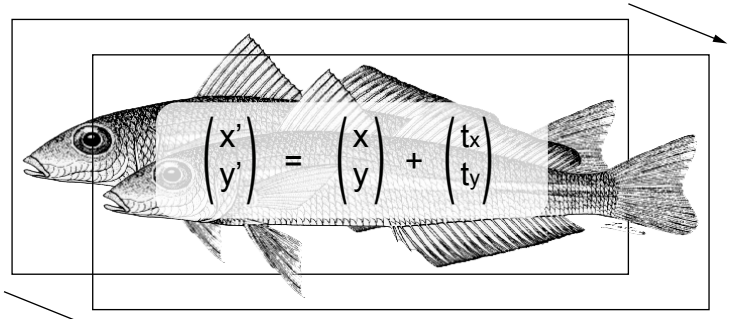
ROTATION



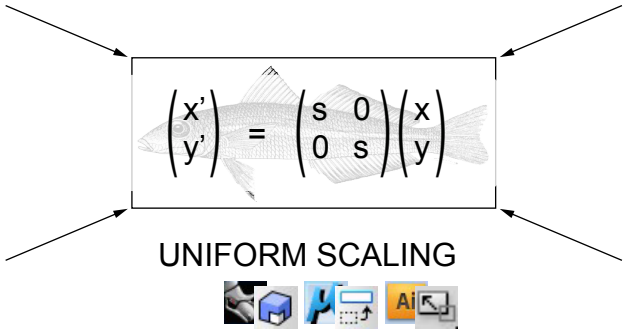
SHEARING

AFFINE TRANSFORMATION

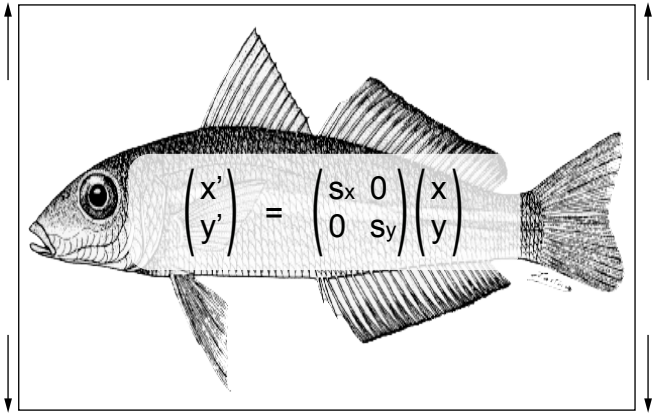




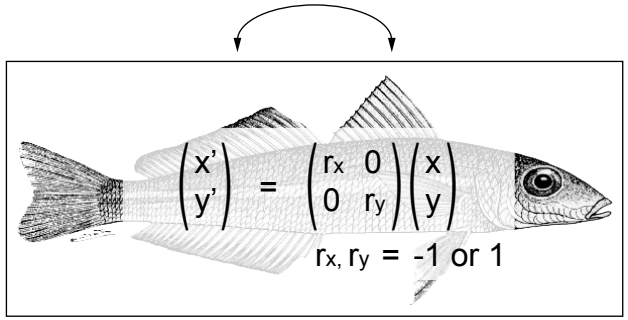
TRANSLATION



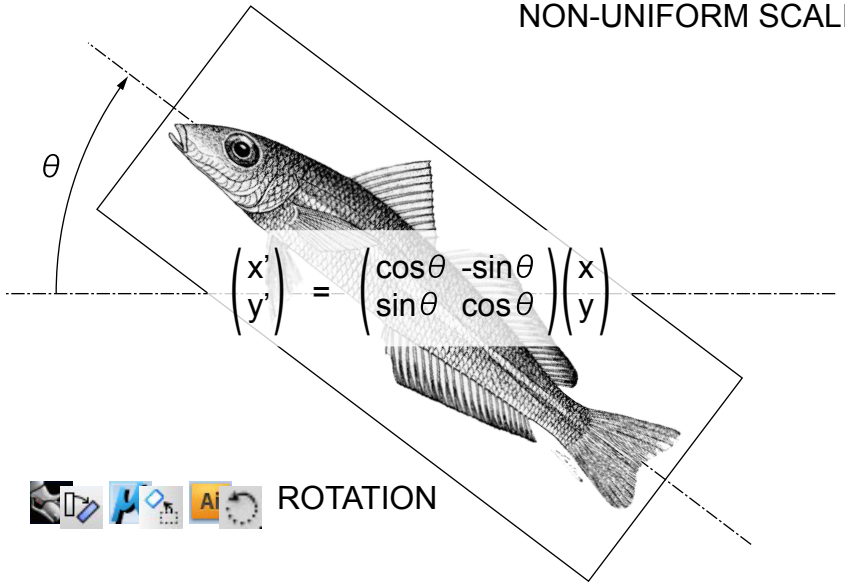
UNIFORM SCALING



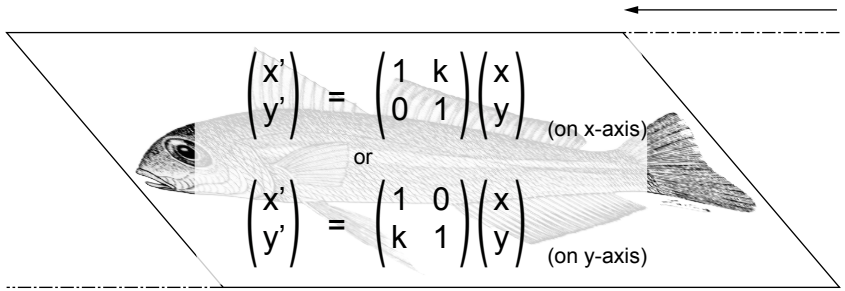
NON-UNIFORM SCALING



REFLECTION



ROTATION



SHEARING

AFFINE TRANSFORMATION

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} a & b \\ c & d \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} + \begin{pmatrix} s \\ t \end{pmatrix}$$

TRANSLATION

$$\begin{pmatrix} x' \\ y' \\ 1 \end{pmatrix} = \begin{pmatrix} a & b & s \\ c & d & t \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ 1 \end{pmatrix}$$

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} s & 0 \\ 0 & s \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

UNIFORM SCALING

$$\begin{aligned} \mathbf{x}' &= M_1\,\mathbf{x} \\ \mathbf{x}'' &= M_2\,\mathbf{x}' \\ \mathbf{x}''' &= M_3\,\mathbf{x}'' \\ &\vdots \\ \mathbf{x}'^{\cdots\prime} &= M_n \cdots M_3\,M_2\,M_1\,\mathbf{x} \end{aligned}$$

$$C = M_n \cdots M_3\,M_2\,M_1\,\mathbf{x}$$

$$\mathbf{x}'^{\cdots\prime} = C\,\mathbf{x}$$

NON-UNIFORM SCALING

CONCATENATION

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} r_x & 0 \\ 0 & r_y \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

r_x, r_y = -1 or 1

REFLECTION

θ

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

ROTATION

$$\begin{pmatrix} x' \\ y' \\ z' \\ 1 \end{pmatrix} = \begin{pmatrix} a & b & c & s \\ d & e & f & t \\ g & h & i & u \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \\ 1 \end{pmatrix}$$

3D

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 1 & k \\ 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$ (on x-axis)

or

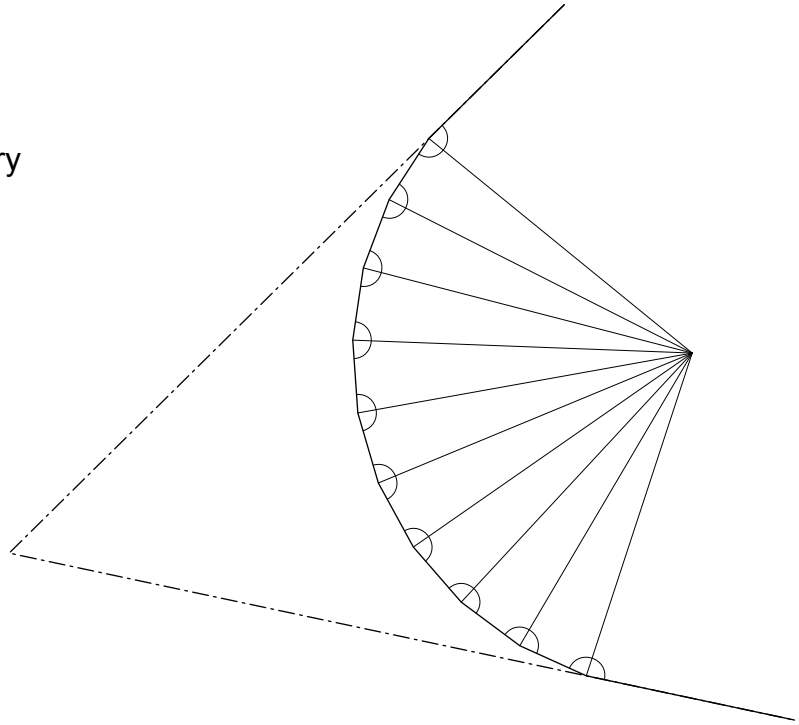
$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ k & 1 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$ (on y-axis)

SHEARING

EXERCISE : FACETING EQUALLY

TASK1. BASIC

Draw corner with an arbitrary angle and draw facet lines whose angles are all equal. Measure the angle to make sure they are equal.



TASK2. ADVANCED

Model tilted faces with the facet lines drawn in task 1 whose unfolded shapes are identical and the angles of faces are all equal.
Measure the angles of faces to check if they are equal and unfold the faces to check if the shapes are identical.

* The angle of tilted faces in 3D is different from the angle on the plan.