

product DESIGN

OIDD 415 / 515

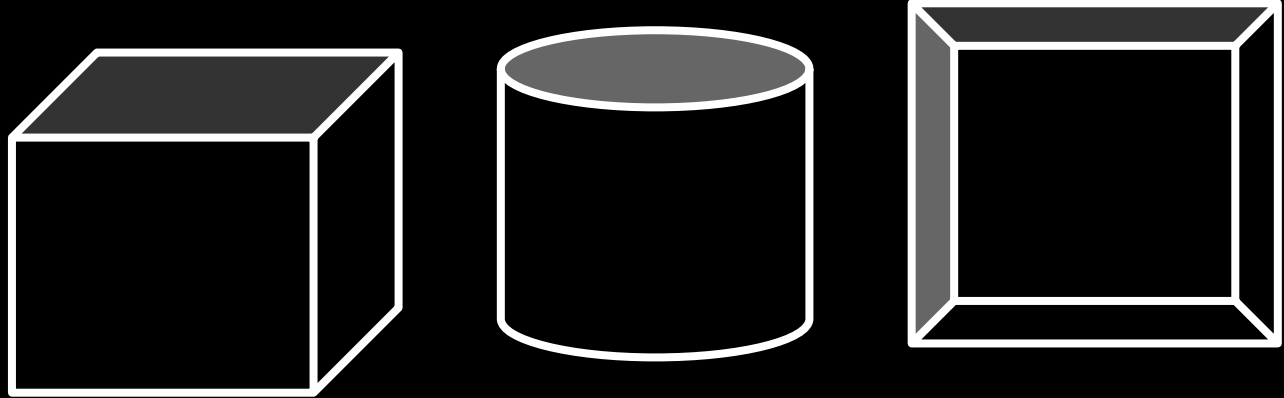
MEAM 415

IPD 515

Prof. Taylor Caputo

Class Agenda

- **CAD Basic Workflows + Important Commands**
- **Live Tutorial**
- **Design Challenge**



one part

(individual project separate from team project)

OnePart Schedule

Due Today

One Part Sketch

Start Lynda
Tutorial

In Studio Today

In Class Live
Tutorial

Spring Break

By March
13th

**Start
Modeling
Object**

**In Studio
March 13th**

In Class Work
Time

Mental Models for CAD Design

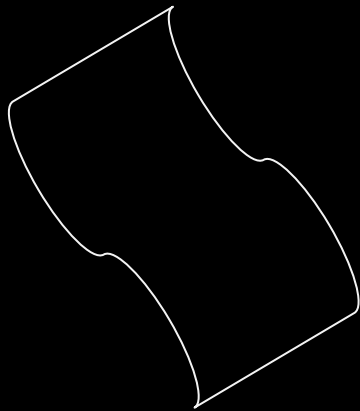
*How to use Rhino,
commands,
troubleshooting,
etc.*



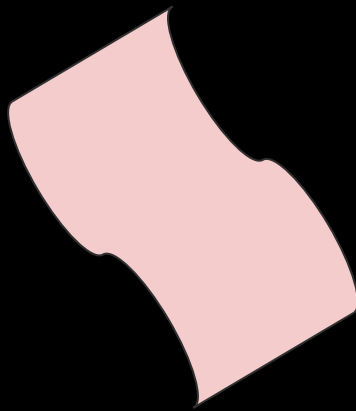
*How to understand
building three
dimensional objects
in Rhino.*

Rhino Basic Workflows

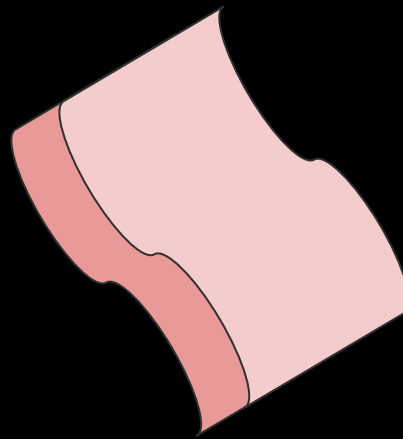
BasicWorkflow



curves



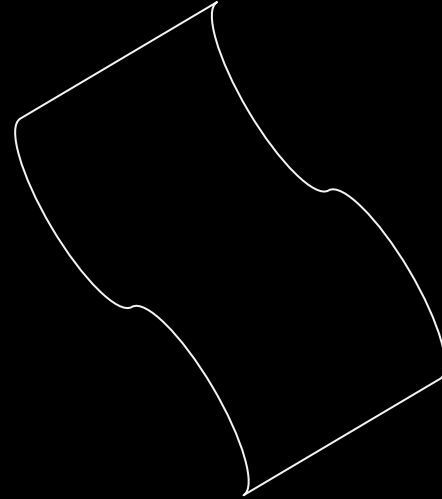
surfaces



solids

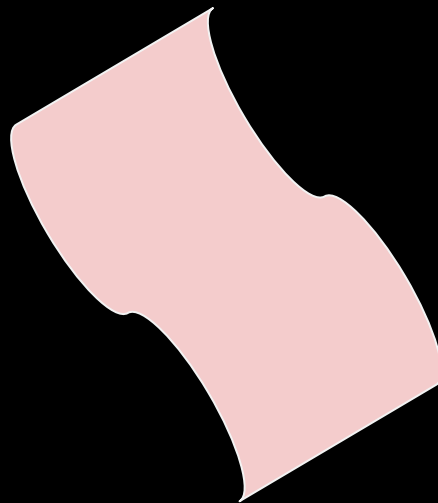
BasicWorkflow

1. Draw curves (doesn't have to be all at once if complex geometry)



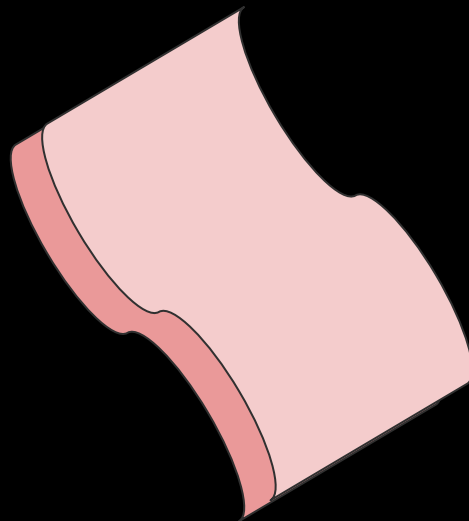
BasicWorkflow

1. Draw curves (doesn't have to be all at once if complex geometry)
2. Create surfaces using commands like Sweep2



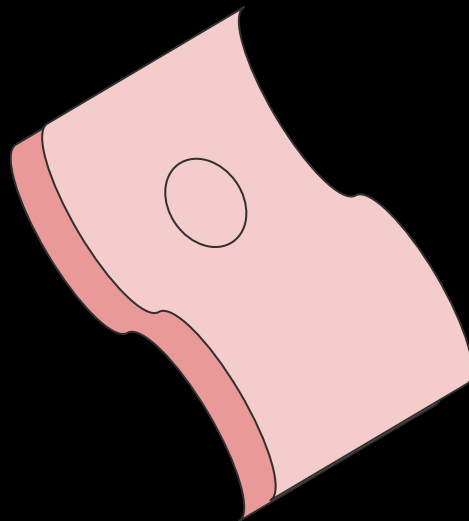
BasicWorkflow

1. Draw curves (doesn't have to be all at once if complex geometry)
2. Create surfaces using commands like Sweep2
3. Create solids with ExtrudeSrf, OffsetSrf



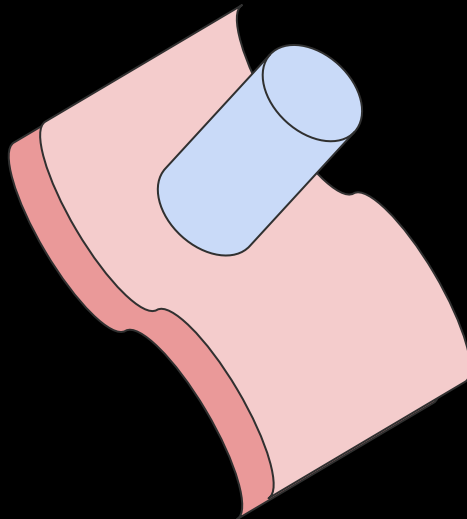
BasicWorkflow

1. Draw curves (doesn't have to be all at once if complex geometry)
2. Create surfaces using commands like Sweep2
3. Create solids with ExtrudeSrf, OffsetSrf
4. Reference edges, surfaces to build off of



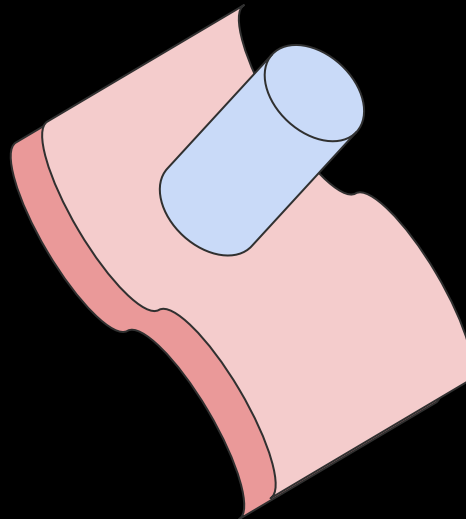
BasicWorkflow

1. Draw curves (doesn't have to be all at once if complex geometry)
2. Create surfaces using commands like Sweep2
3. Create solids with ExtrudeSrf, OffsetSrf
4. Reference edges & surfaces to build off of



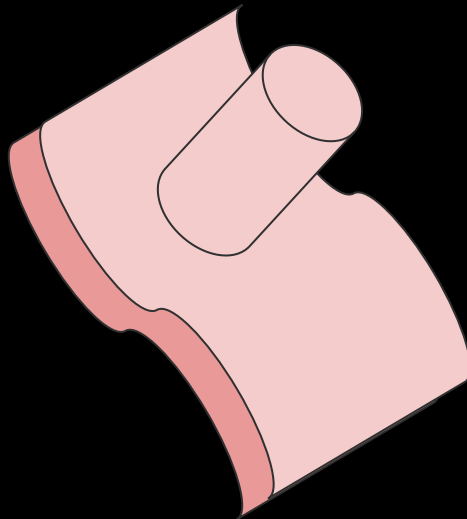
BasicWorkflow

1. Draw curves (doesn't have to be all at once if complex geometry)
2. Create surfaces using commands like Sweep2
3. Create solids with ExtrudeSrf, OffsetSrf
4. Reference edges & surfaces to build off of
5. Use solid manipulation commands (BooleanUnion, BooleanDifference)



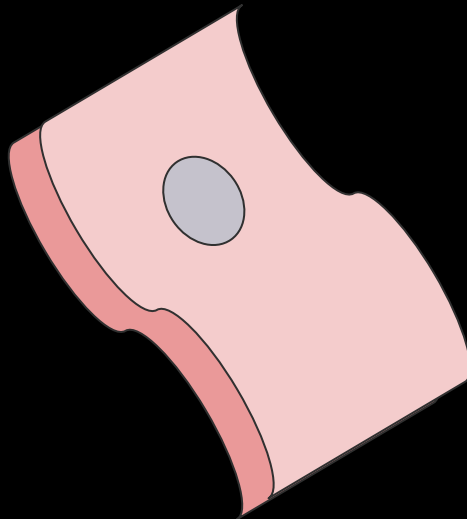
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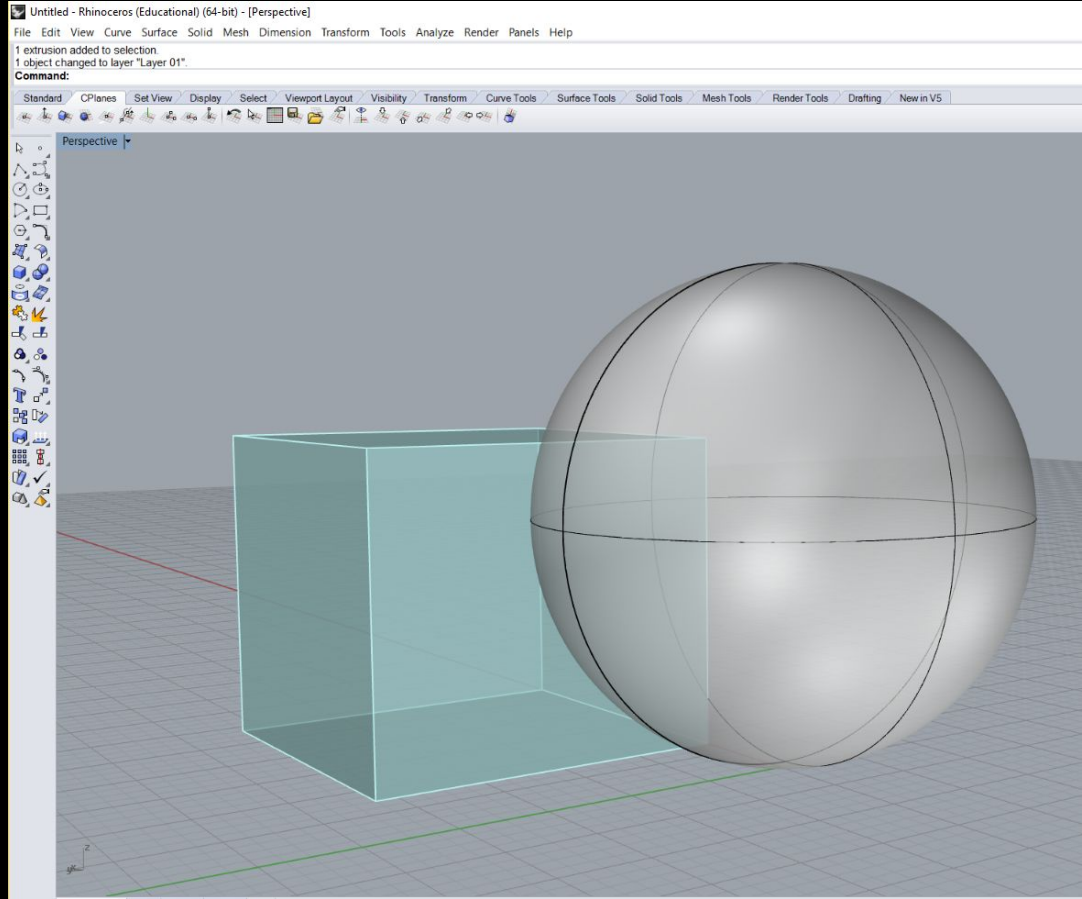
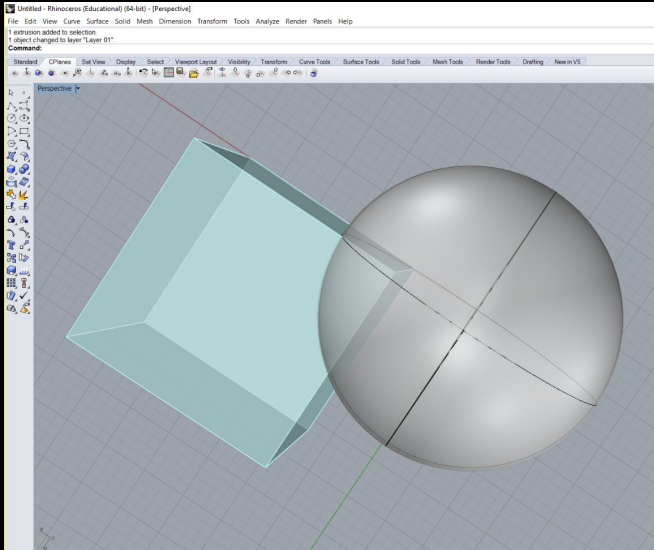
BasicWorkflow

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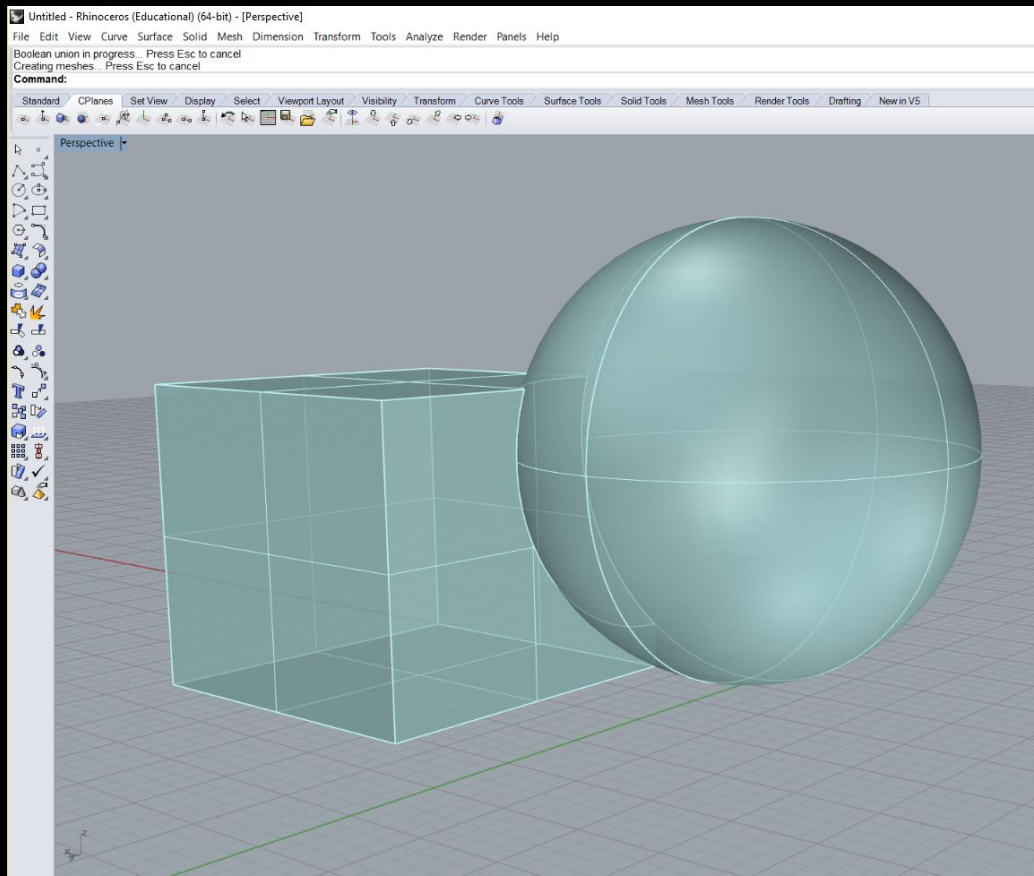
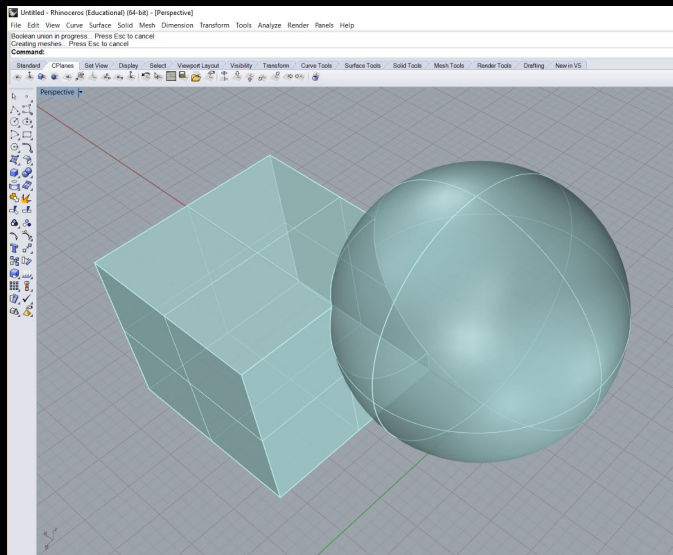
BooleanUnion

- Objects have to be touching/intersecting



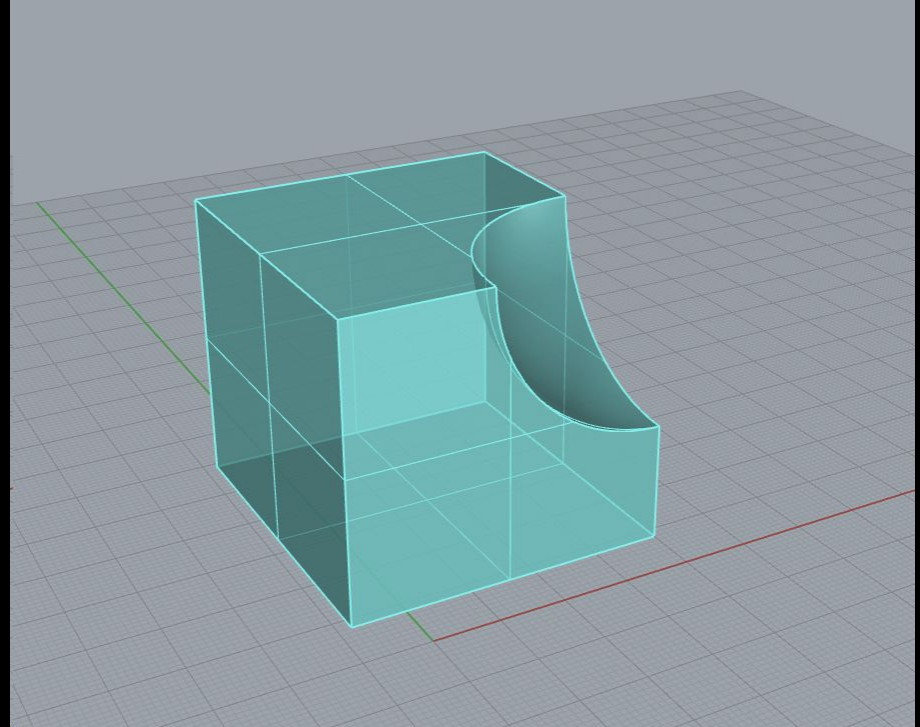
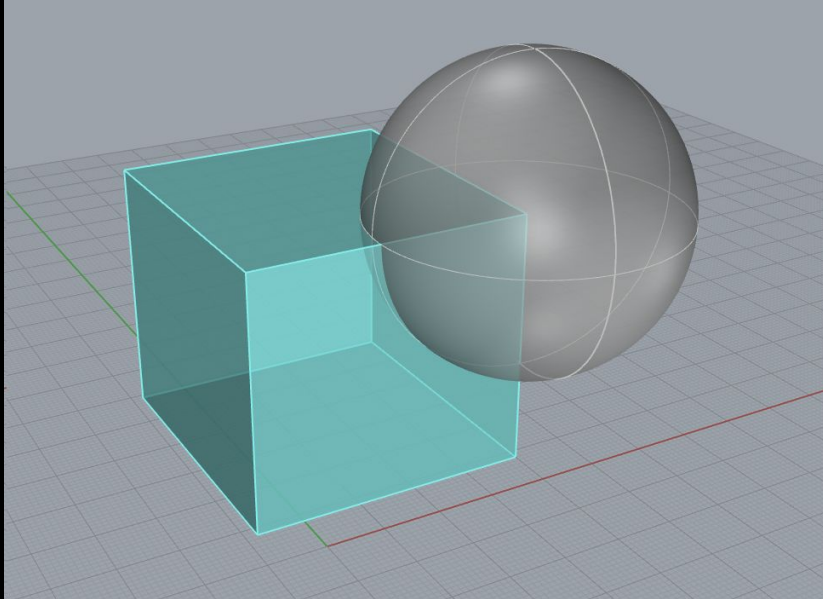
BooleanUnion

- Boolean gets rid of solid intersection.



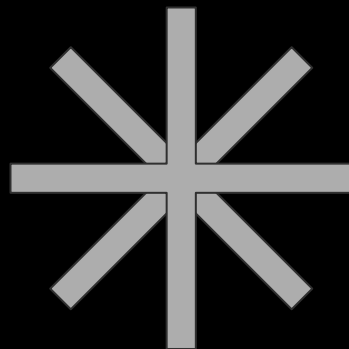
BooleanDifference

- Subtracts one Solid from another



BooleanUnion Troubleshooting

- Don't try to boolean more than ~3 objects at a time
- Boolean smaller parts together, and then boolean these assemblies together
- If it won't boolean, try different combinations
 - Especially true if you're trying to boolean polar arrayed solids

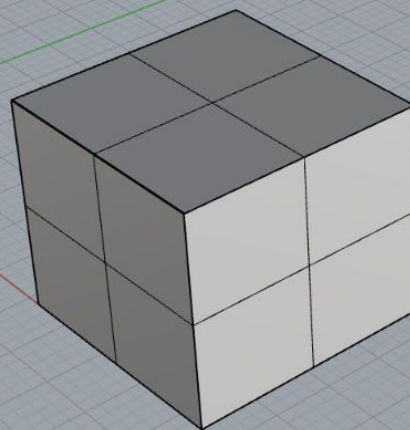
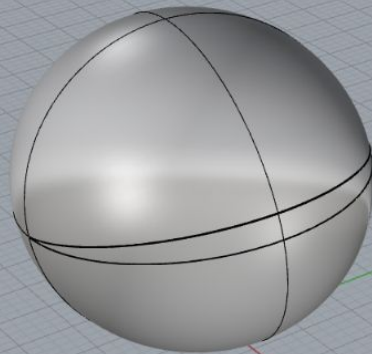


NakedEdges

- Incomplete surfaces or solids (usually very small and hard to see)
- Check using the “ShowEdges” command periodically as you model
 - **If objects won't join, boolean, always check edges first!**
- Repair using “Join 2 Naked Edge Edges” from dropdown menu



Perspective ▾



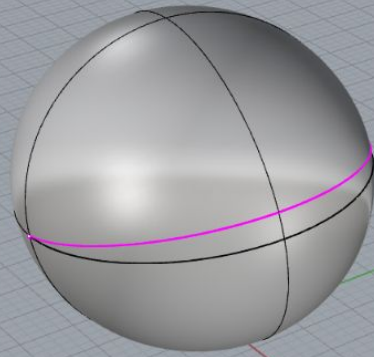
Select surfaces, polysurfaces or meshes for edge display. Press Enter when done:

Found 18 edges total, 6 naked edges, no non-manifold edges.

Command:



Perspective ▾



Edge Analysis

Show

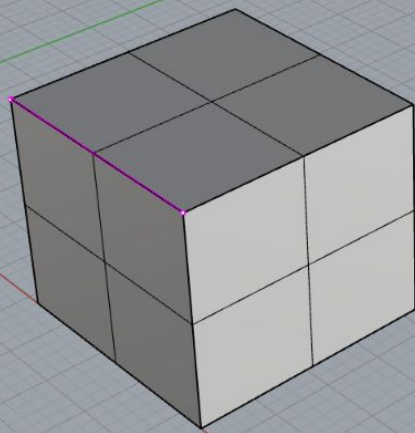
- ☐ All Edges
- ☒ Naked Edges
- ☐ Non-Manifold Edges

Zoom

Edge color

Add Objects

Remove Objects



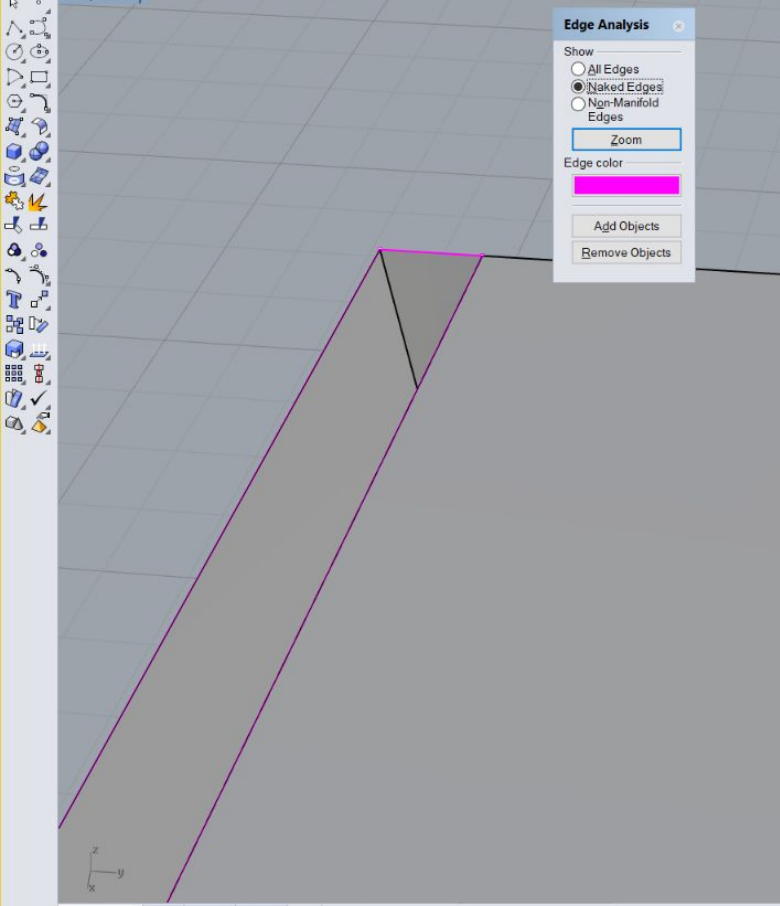
Select surfaces, polysurfaces or meshes for edge display. Press Enter when done:

Found 18 edges total, 6 naked edges, no non-manifold edges.

Command:



Perspective



Edge Analysis

Show

☐ All Edges
☒ Naked Edges
☐ Non-Manifold Edges

Zoom

Edge color

Add Objects

Remove Objects

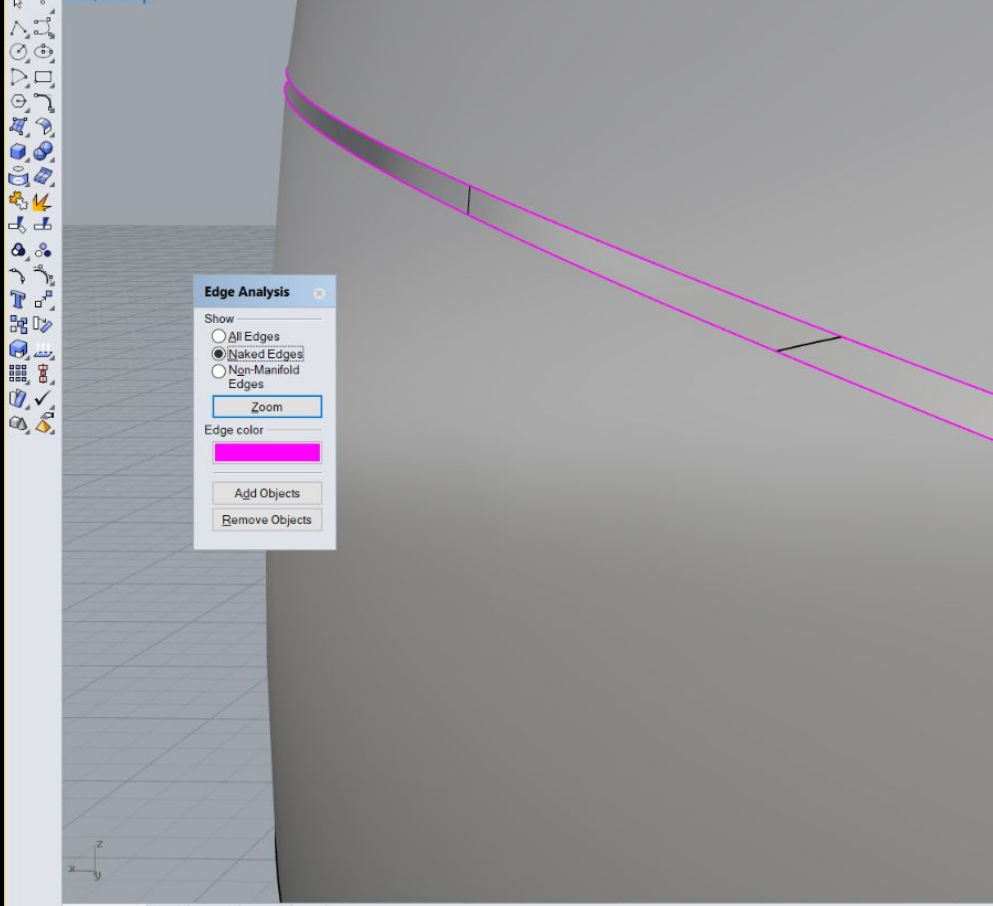
Select surfaces, polysurfaces or meshes for edge display. Press Enter when done:

Found 18 edges total, 6 naked edges, no non-manifold edges.

Command:



Perspective



Edge Analysis

Show

☐ All Edges
☒ Naked Edges
☐ Non-Manifold Edges

Zoom

Edge color

Add Objects

Remove Objects

Found 18 edges total; 6 naked edges, no non-manifold edges.

1 polysurface added to selection.

Command:

Standard CPlanes Set View Display Select Viewport Layout Visibility



Perspective

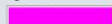
Edge Analysis

Show:

- ☐ All Edges
☒ Naked Edges
☐ Non-Manifold Edges

Zoom

Edge color



Add Objects

Remove Objects

Analyze

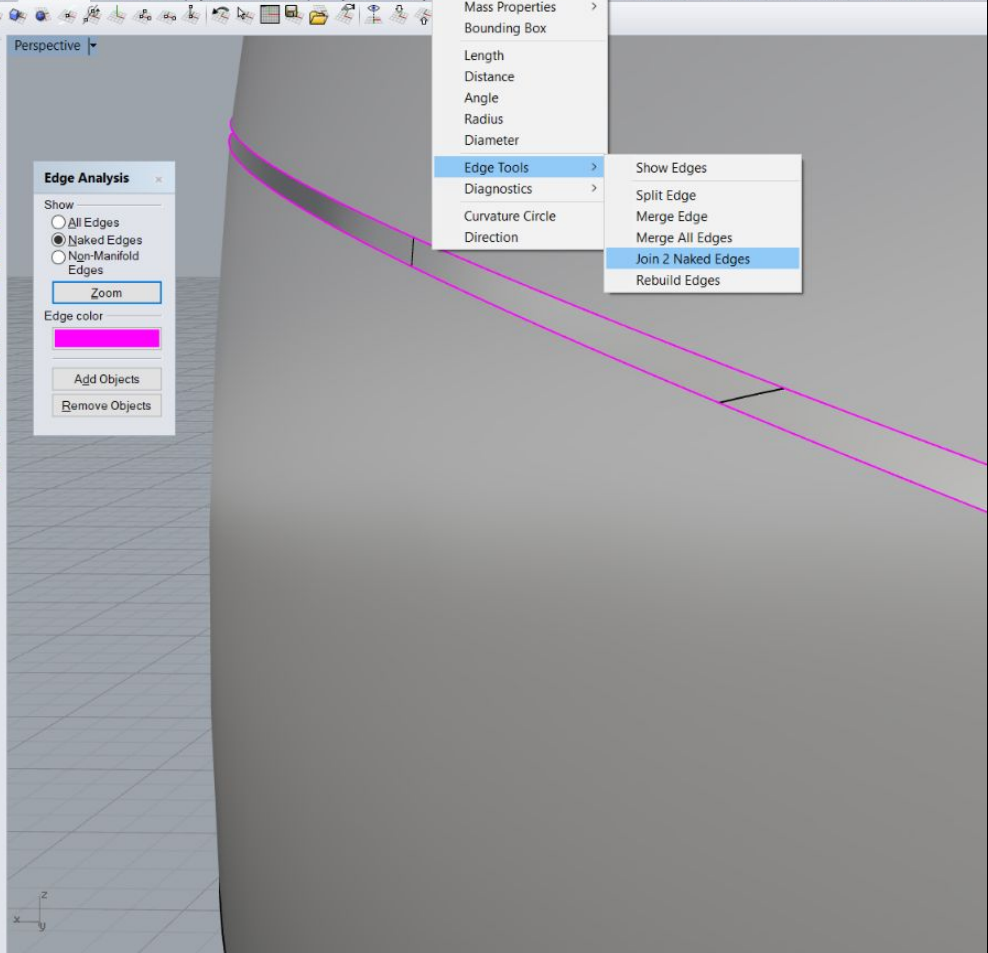
Render Panels Help

- Point
- Curve
- Surface
- Mass Properties
- Bounding Box
- Length
- Distance
- Angle
- Radius
- Diameter

- Edge Tools
- Diagnostics
- Curvature Circle
- Direction

- Show Edges
- Split Edge
- Merge Edge
- Merge All Edges
- Join 2 Naked Edges
- Rebuild Edges

Surface Tools Solid Tools Mesh Tools Render Tools Draft



Select two unjoined edges:

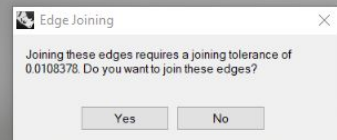
Select two unjoined edges:

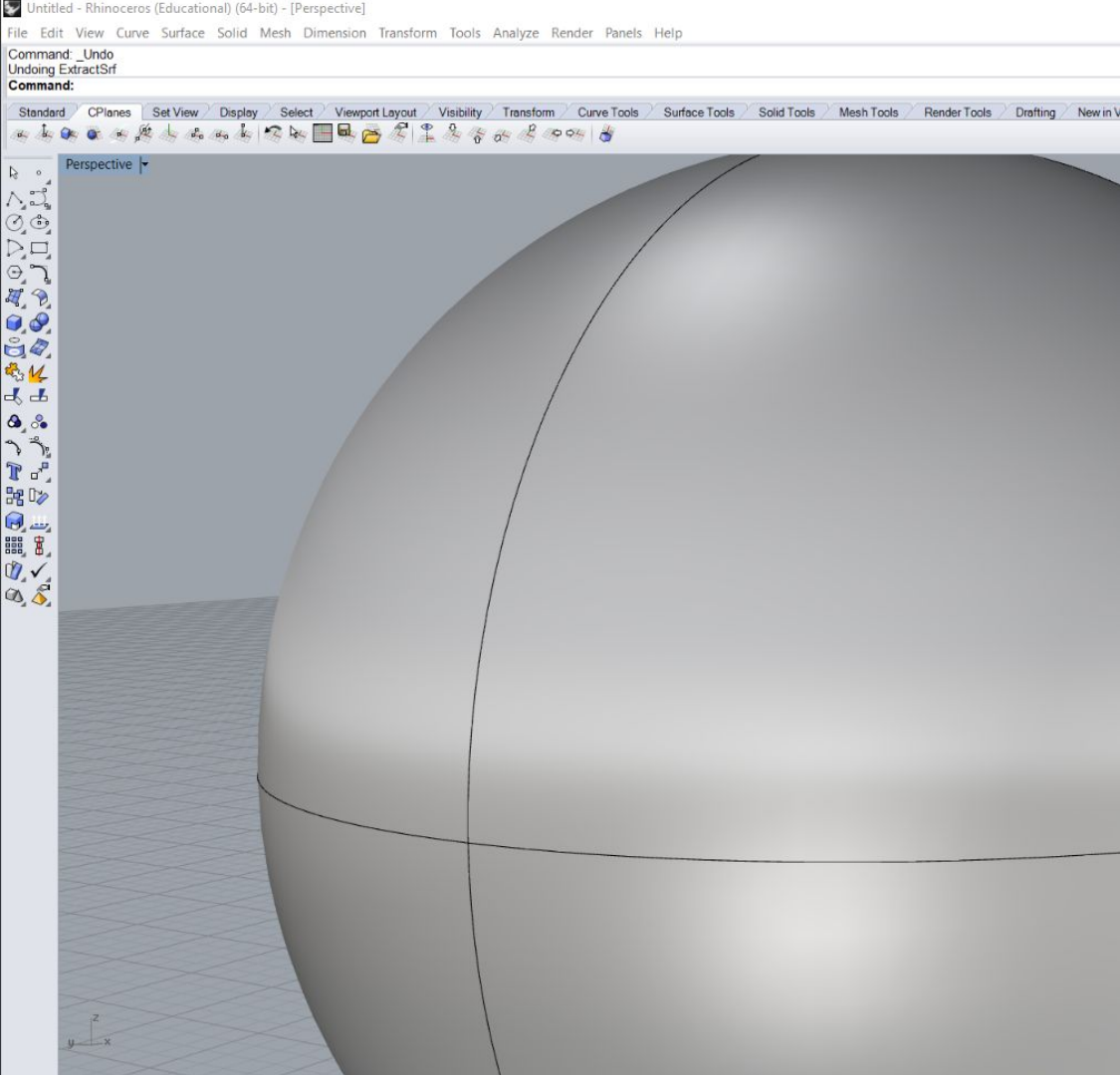
Select two unjoined edges:

Standard CPlanes Set View Display Select Viewport Layout Visibility Transform Curve Tools Surface Tools Solid Tools Mesh Tools Render Tools Dra



Perspective

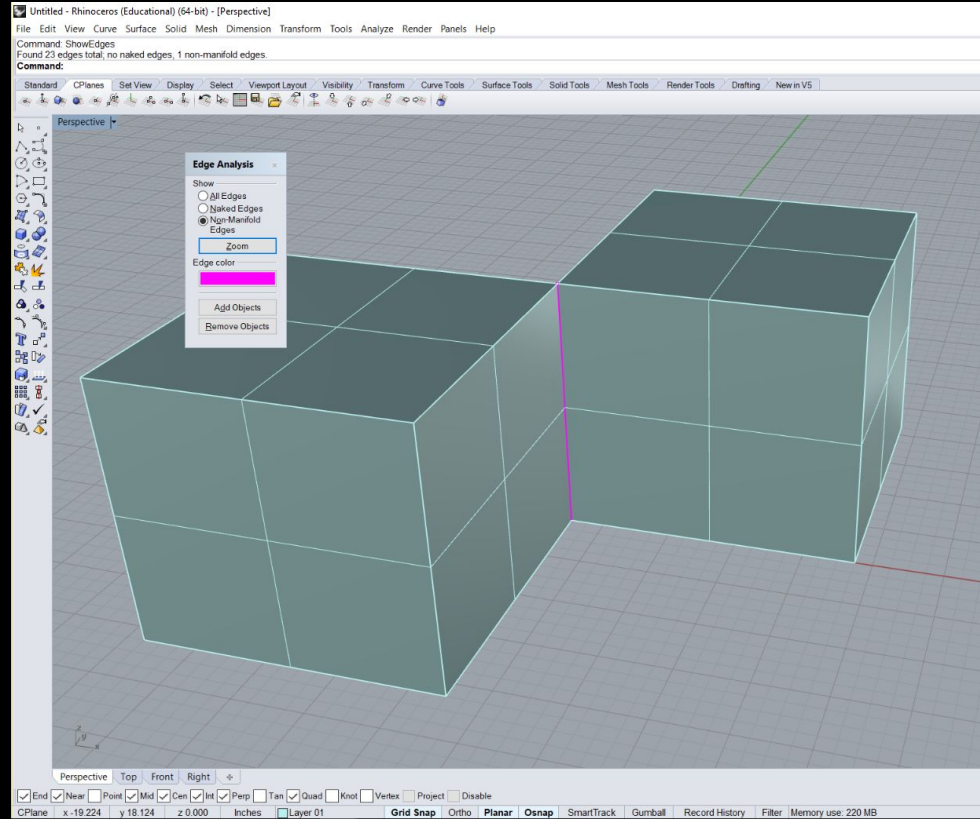




- This only works about 75% of the time
- Otherwise use Sweep1 or Sweep2, Cap, or Patch to try to fill in gaps.

NonManifoldEdges

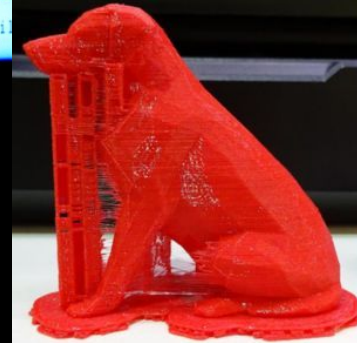
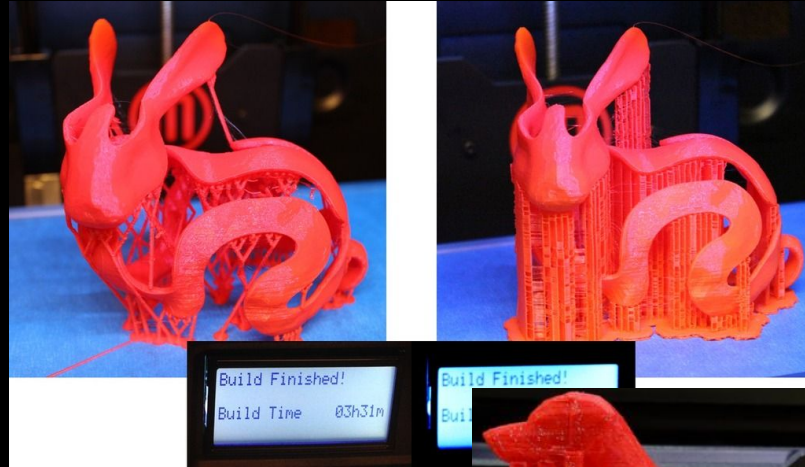
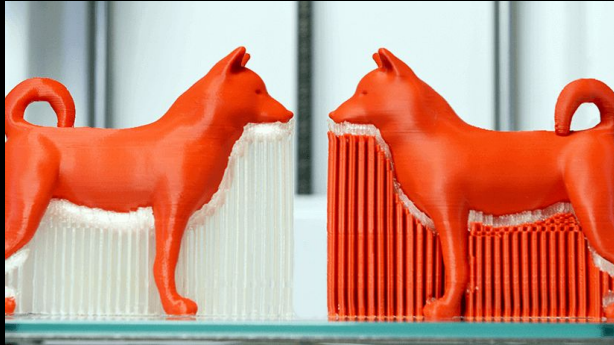
- Where two solids share the same edge (the 3D printer can't understand this transition)
- Unlikely you'll encounter them, but check using same "ShowEdges" command
- To fix this, undo the Boolean and make the solids intersect



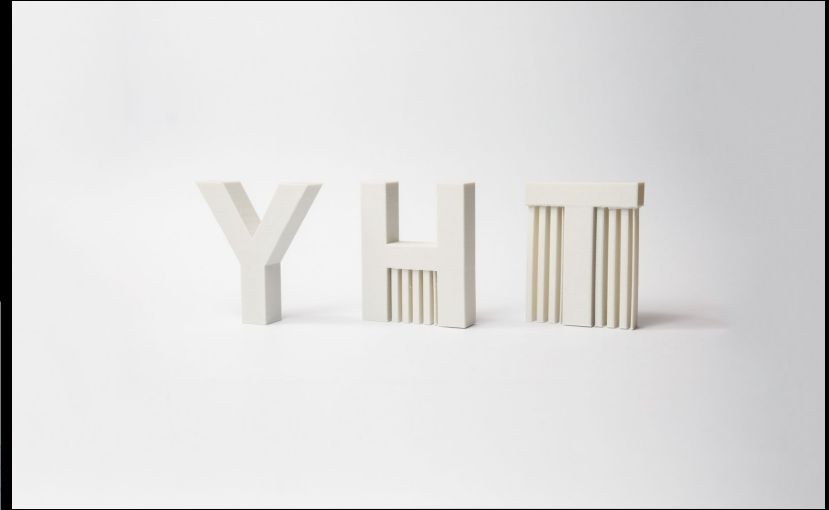
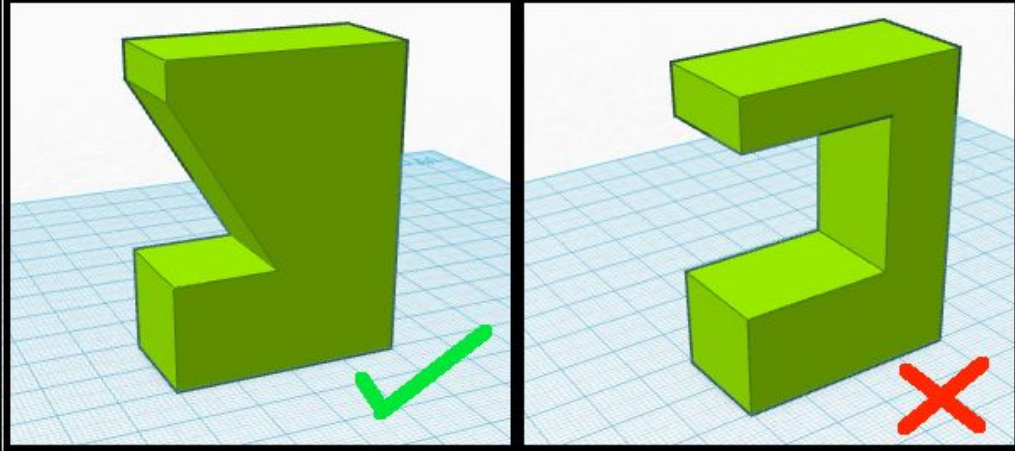
basics designing for 3D printing

minimize unnecessary overhangs
(either by design or orientation)

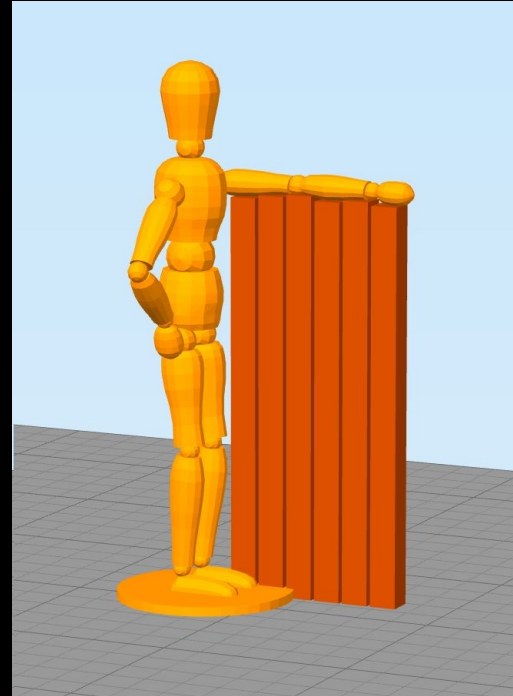
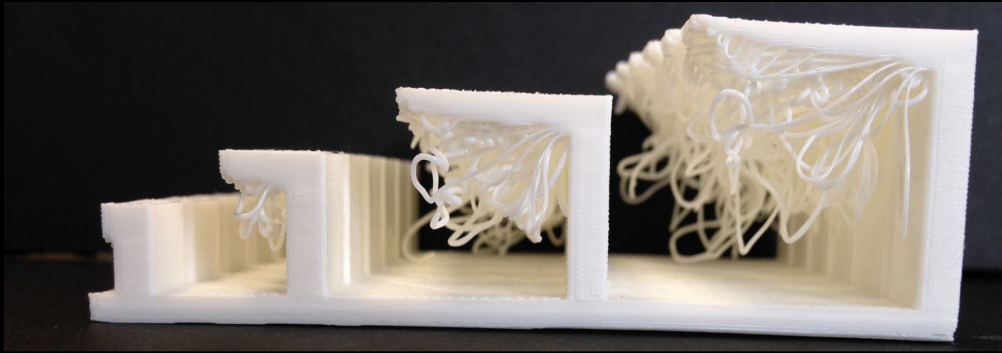
basics designing for 3D printing



basics designing for 3D printing

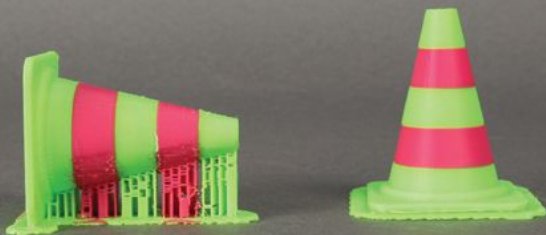


basics designing for 3D printing



basics designing for 3D printing

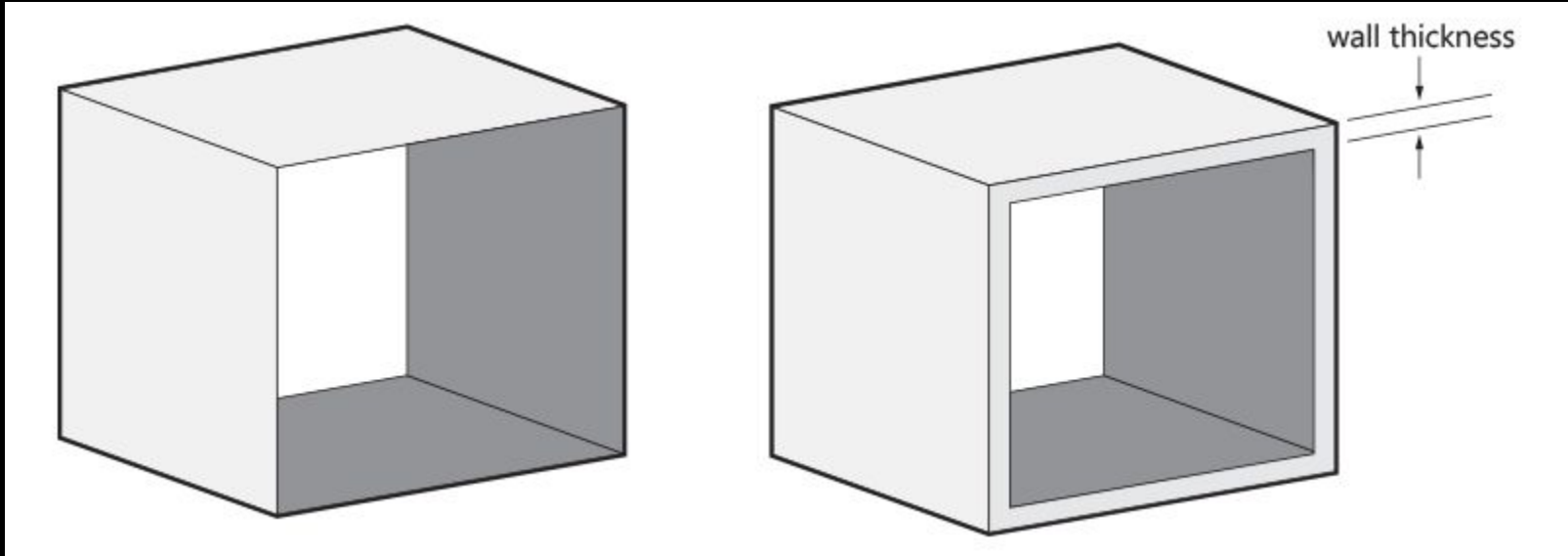
MakerBot
MakerWare 2.3



(I orient your parts for printing
but you should still consider it
while designing!)

Designing for 3D Printing

Minimum Wall thickness: 1-2mm



Mental Models for CAD Design

*How to use Rhino,
commands,
troubleshooting,
etc.*



*How to understand
building three
dimensional objects
in Rhino.*

Mental Models for CAD Design

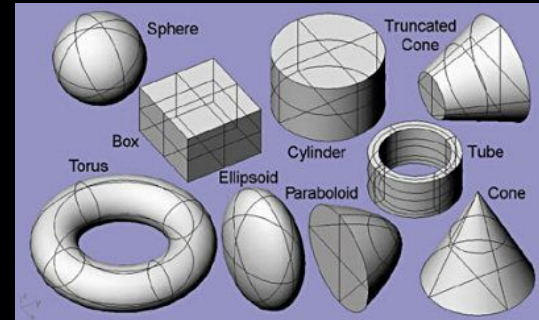
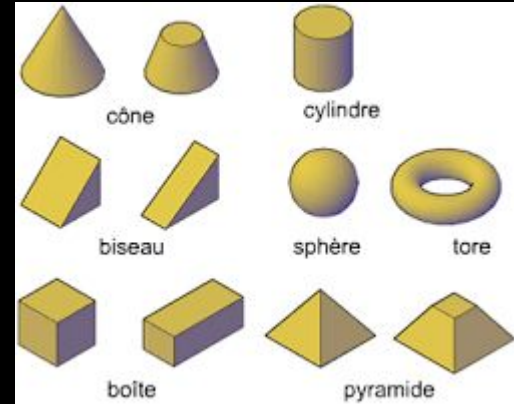
*Break your object you want
to design down to discrete*

Primitive Solids

Mental Models for CAD Design

*Break your object you want
to design down to discrete*
Primitive Solids

Primitives are the building blocks of 3D design—basic geometric forms that you can use as is or modify with transforms and Booleans.

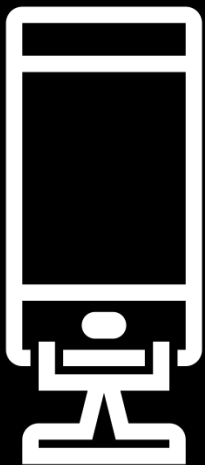


Mental Models for CAD Design

*Break your object you want
to design down to discrete
Primitive Solids*

Primitives are the building blocks of 3D design—basic geometric forms that you can use as is or modify with transforms and Booleans.

***Reference the
handout to
understand how to
build these
primitives.***



Mental Models for CAD Design

*Break your object you want
to design down to discrete*

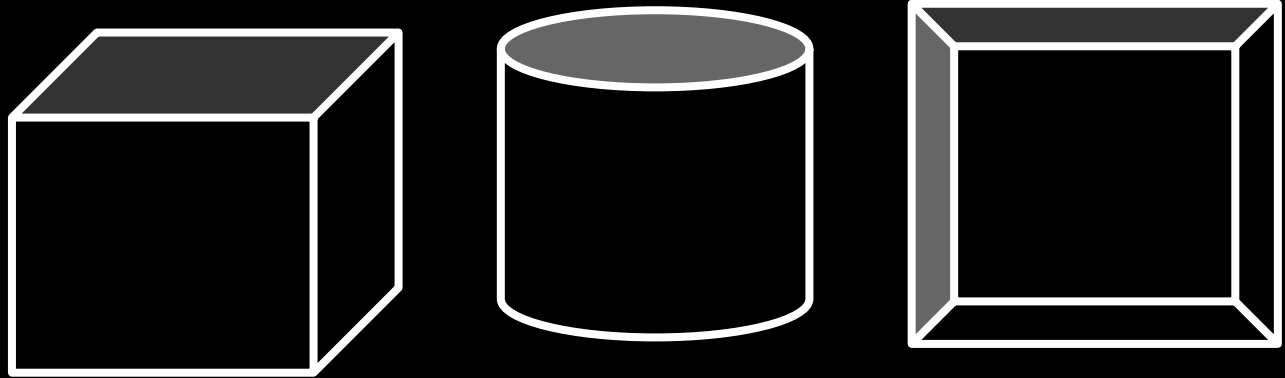
Primitive Solids

Primitives are the building blocks of 3D—basic geometric forms that you can use as is or modify with transforms and Booleans.

***One person from
each table of 4
come up to the
front and choose
an object.***

Mental Models for CAD Design

- Discuss with your team how to break down your object into ***Primitive Solids***.
- Try to model your object in Rhino (don't worry about scale)



Looking Ahead

- Prototype + Testing Assignment Due right after break
- Sustainability + Lifecycle Analysis
- Next Class: Start your rhino file and come ready to work!
 - This is our *only* in class work day!