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Navigating around the space

- Refer to the C4D Interface handout.
- Open Cinema 4D.
- Go to top menu bar to the Object Creation section. Left click on the cube icon, then select a cube. This is a primitive/parametric object.
- Observe that the Object Manager now has a Cube in it. Also observe the information about the cube in the Attribute Manager and Coordinate Manager.
- **Save** your c4d file and give it a name.
- The **undo** and **redo** buttons are the first buttons on the top menu bar.
- Observe the axes: red is x -axis, blue is z -axis and green is y -axis. This is the standard orientation for 3D visualization, but is the reverse orientation of the axes from math classes.
- Practice moving around in space.
 - Hold 1 and left click: allows you to move in the three spatial dimensions.
 - Hold 2 and left click: allows you to zoom in and out. (The wheel on the mouse also lets you zoom.) The zoom is in the direction of the cursor. (See if you can fly inside the cube.)
 - Hold 3 and left click: allows you to rotate your viewpoint. The rotation is centered on the spot your cursor is when you begin rotating.
- Practice moving an object in space. First select the object (right now this is a cube). Look at the Navigation Tools on the left of the top menu bar.
 - Click on the symbol that looks like xy -axes (the **Move Tool**). Then click on your object and move it in any of the three spatial dimensions. Look at the numbers in the Coordinate Manager (bottom right of the view-port). You can precisely place objects by editing these numbers. See if you can shift the cube up 20 cm and move it 50 cm in the z -axis direction.

- Click on the next symbol along from the move tool. This is the **Scale Tool**. You'll notice the axes end with squares, not arrows. Scale the cube up and down in size. Look at the numbers in the Coordinate Manager (bottom right of your window). Scale your cube to have side length 10cm. Zoom in so you can see it clearly.
- Click on the next symbol along from the scale tool. This is the **Rotate Tool**. Practice rotating the cube in various directions. Use the undo buttons to return the square to its usual orientation.

Basic commands

- Change the cube from a primitive object to an editable object. Click on top button on the left hand menu, the **Make Editable** button. (This looks like two spheres with an arrow.)
- Look at the Object manager. To the right of the word Cube is a picture of a cube. After clicking the Make Editable button, the picture changes from a cube to a triangle shape.
- The Modes Icon Palette is found on the menu on the left. There are 4 useful modes: **Model mode** (directly below the Make Editable button), **Point mode** (a cube with two points highlighted), **Edge mode** (a cube with an edge highlighted), and **Polygon mode** (a cube with a face highlighted). Each of these modes allows you edit the various properties of the cube (points, edges, faces).
 - On the top menu in the Navigation tools, click on the **Live Selection** button with an arrow in a round circle. This lets you select various objects and parts of objects.
 - Now experiment with each of the modes and see what happens.
 - Note that you can change the size of the circle you see with Live Selection. Under the Attribute Manager, simply increase or decrease the radius.

TIP: Forget what the various buttons do on the top and side menus? Simply hover the mouse over the button. The name, and keyboard shortcut commands will appear.

TIP: Cinema 4D keeps track of which tools you are using. There is a **Short Cut** button located at the right side of the Navigation Tools on the top menu, but to the left of the button which has an X in a red circle. This button has some symbol on it (exactly which one changes with what you have selected), with a black arrow in the bottom right corner. Left click (and hold) this **Short Cut** button down. You will see a display of all the tools you have recently used. This menu serves as useful shortcut to find tools after you have first used them.

Mesh repair

Cinema 4D can be used to repair meshes of objects you would like to 3D print.

1. Open a new Cinema 4D file.
2. Left click (and hold) on the Cube button in the Object Creation menu. Select a cube.
3. Go to the Attribute Manager, under Object increase the number of segments for X , Y and Z to 3 for each of them.
4. Click on the Make Editable button. The cube now has a 3×3 grid on each face.
5. Click on the **Model Mode** on the left Modes Icon Palette. You can use the Coordinate Manager (bottom right of the window) to precisely fix the size and position of the object.
6. Click on the **Point Mode** on the left Modes Icon Palette. Notice that the vertices of the cube are shown as small black dots
7. Click on the **Live Selection** button from the top menu. Notice that when the circle moves over a vertex, it turns orange.
8. Select a vertex on the interior of one of the faces. Press the **Delete** key. The vertex, and the edges and faces adjacent to it have all been deleted.
9. Go to the **Mesh** menu found on the top just above the Rotate Tool. Go to **Create Tools**, then select **Close Polygon Hole**.
10. Move the tool over the gap on the cube. The outline of the hole is shown in white. Clicking here fills the hole with a polygonal face.
11. To add in edges, go to **Mesh** → **Create Tools** → **Line Cut**. Once the **Line Cut** Tool has been selected, click on the object at the start point of the new edge, then click again at the endpoint. The tool creates a sequence of edges, the start point of the next edge is the end point of the previous one. Once you have finished adding in one (or more) edge(s), click on the **Live Selection** button. (Or indeed any other tool.) This turns off the tool.
12. Bring up the **Line Cut** tool again. (Recall that you can click on the **Short Cut** button to find it quickly.) Note that the start and end points of the new edges can be located precisely by hovering over edges or vertices. These turn white when the tool is over them. Vertices turn green when selected.

13. An edge may also be removed from a mesh. Click on the **Edge Mode** on the left Modes Icon Palette, and click on the **Live Selection** button. Edges are highlighted in white when the cursor is over them. After selecting an edge, press the **Delete** key to delete it and the vertices and faces adjacent to it.
14. A polygonal face may also be removed from a mesh. Click on the **Polygon Mode** on the left Modes Icon Palette, and click on the **Live Selection** button. Faces are highlighted in white. Faces turn orange once they have been selected.

TIP: These mesh editing tips only work once your object has been made editable. If you start with a parametric object, make sure you click on the **Make Editable** button before proceeding.

TIP: To fix meshes, I have found it most useful to add and subtract polygonal faces while in **Polygon Mode**. Cinema 4D has other mesh editing tools — go experiment!

Fixing normal vectors

Objects can only be 3D printed if the normal vectors to the surface are pointing outwards.

1. Open a new Cinema 4D file.
2. Left click (and hold) on the Cube button in the Object Creation menu. Select a cube.
3. Click on the Make Editable button.
4. Click on the **Polygon Mode** on the left Modes Icon Palette.
5. Select all of the cube. Do this by holding down the **Control** and **a** key, or by going to the **Select** menu at the top (above the Move Tool), and clicking on **Select All**.
6. The entire cube is an orange color. This means the normal vectors are the correct way around.
7. Go to **Mesh** → **Normals** → **Reverse Normals**. The cube is now a blue color. This means the normal vectors are the wrong way around (and the object will not be 3D printable). Reverse the normal vectors again.
8. The **Align Normals** command, above Reverse Normals, is useful for fixing normal vectors on more complex models.

Importing and Exporting files

Importing *Mathematica* files

1. Create your shape in *Mathematica*, and label it.
 - For example, the volume bounded by the planes $z = 0$, $x = 1$, $y = 1 - x$, and $z = 1 - x^2$ can be found as follows:
$$n = \text{RegionPlot3D}[0 \leq x \leq 1 \ \&\& \ 0 \leq y \leq 1 - x \ \&\& \ 0 \leq z \leq 1 - x^2, \{x, 0, 1\}, \{y, 0, 1\}, \{z, 0, 1\}, \text{Mesh} \rightarrow \text{None}, \text{PlotPoints} \rightarrow 300, \text{Axes} \rightarrow \text{None}]$$
 - The shape has been labeled “n”.
 - Note that the large number of PlotPoints means that *Mathematica* may take a few minutes to generate the shape.
2. Still in *Mathematica*, type `Export["Graphics3D.stl", n]`. You can choose your own name instead of Graphics3D.
3. Your model will be saved as “Graphics3D.stl” on your computer.
4. In *Mathematica*, click on **open file directory** found below the output from the Export command. This will open the folder where your object file is saved. From here you can move it to your desired folder.
5. In Cinema 4D, click **File** → **Open** and select your .stl file.

Creating a .stl file

Once you are satisfied with your model, you can create a .stl file that a 3D printer can use.

- At the top left of the view-port go to **File** → **Export** → **.STL (*.stl)**.
- Keep the scale as “1 Centimeter”.
- Save your .stl file.