Intermediate 3D Design

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1. Sign-in + Review

- If you already have a Tinkercad account, sign in at [http://www.tinkercad.com/](http://www.tinkercad.com/)
- If you don’t have a Tinkercad account, go to the same page [http://www.tinkercad.com/](http://www.tinkercad.com/) and sign up
- The Tinkercad right side menu has lots of the buttons you need for designing objects.
- 6 Shortcuts at the top let you quickly open different groups of buttons, otherwise, you can scroll up and down through the group labels. Click each section label once to open and again to close. Left to right: Helpers, Geometric, Holes, Letters, Numbers, Favorites.
- If you have any shapes you use all the time, you can click the star in the upper right corner of a shape to add it to the Favorites menu.

- Import allows you to bring in pre-made 3D files to add to a design or modify using Tinkercad.

- Shape generators are fancy custom shape builders made by the Tinkercad community. These help make gears, mountains, and other advanced shapes.

- Helpers includes a ruler tool to measure design parts and the workplane tool to change the surface where objects are initially placed.
- Components includes shapes for designing robots.

- Geometric has basic shapes such as boxes, cylinders, pyramids, and more.
- Holes has two premade holes (a box and a cylinder), although any shape can be turned into a hole in Tinkercad.
- Letters has pre-made ABC…XYZ letter shapes.
- Numbers has pre-made 0123456789 number shapes.
- Symbols has shapes including @&! and a few others.
- Extras has a few extra shapes like eggs.
- These premade shapes are called primitives.
2. Insert shapes and copying

- We’re designing a model of the library today!
- To start, let’s insert 2 green roofs
- To insert them, click into the Geometric section of the right side menu.
- Single left click on the green roof. Move your mouse over onto the light blue grid workplane, and then single click to place the roof. Select the first green roof and use the shortcuts ctrl+c and ctrl+v to copy a second green roof.

3. Rotating multiple shapes

- The green roofs are not the proper orientation for how we’re going to use them in our library model! Have no fear! We can rotate them.
- Select both green roofs by dragging your mouse over both.
- Use the rotation handles to rotate the roofs up 90° as shown in picture 2 below.
- To do fast 22.5° rotations, rotate your mouse on the inside of the circle that appears. To do 1° rotations, move your mouse outside the circle and then rotate.

*You will probably have to change the view to find the correct rotation handle. More on changing the view in a few minutes. For now, right click anywhere and drag until you can see 3 curved arrows on your green roof.

![Picture 1](image1.png) ![Picture 2](image2.png) ![Picture 3](image3.png)

4. Raising and lowering multiple shapes

- When we rotated the green roofs, they wound up half underneath the bottom of the workplane. That’s not where we want them!
- Select both green roofs again, and then use the black triangle above it to raise it by 5 millimeters, so it’s even with the workplane base.

*The z axis handle will be in the middle of your two green roofs.*
5. Movement workplane tip
- We’re using the green roofs and the red box to make the middle section of the library.
- To move shapes, we simply click and drag them.
- Let’s put the green roofs right next to each other.
- Use the darker light blue workplane grid lines as guides. Each grid square is 10 x 10mm.
- You may need to zoom in to be precise enough.

6. View shortcut
- Review:
  - Arrows rotate around the current center
  - Home goes to the default view
  - Square button zooms in on selected shape(s)
  - + / - zoom in/out, you can also use your mouse scroll wheel
  - Right click and drag rotate around current center position
  - Shift+right click and drag pan left/right/up/down
  - A diagonal view is usually best to see multiple shape sides.
- If you don’t like the right click and drag movement control, try ctrl+left click and drag.

7. Advanced resizing
- We need to change the size of the green roofs to 19 mm wide x 25 mm deep x 15 mm tall.
- Keep them exactly next to each other in the middle.
- Click on either green roof. Use the black resize handles on the opposite side of the other roof to change the width sizes.
- Use the top black resize handle by the point to increase the depth.
- Remember, use the resize handles strategically to make creating your object easiest.

8. Grouping review
- Even though our two green roofs hardly intersect, we can group them together.
- Drag your mouse over both green roofs. Click the Group button above the Inspector.
- Grouping these shapes together allows us to align other shapes relative to the group.
9. Aligning

- Insert another green roof, and **move it** to point between our grouped shape. It won’t be perfect—**we’ll fix it soon**.
- You will need to **rotate the roof up** as before and raise it to be even with the workplane.
- Resize it to be **19 mm wide and 15 mm tall**. Picture 1.
- Drag your mouse over **all the green roofs**. Picture 2.
- Release your click. If successful, it looks like Picture 3.
- Click the **Adjust button**, then **Align**… Picture 4.
- This alignment tool allows us to perfectly align parts of our designs together without having to worry about our **Snap grid** settings or anything else. The **Alignment tool just does it perfectly for us**.
- A bunch of large black circle handles will appear around our selection. **Hover** over a few of them to see what they will do. Pictures 5-8.
- You may need to **zoom in and/or rotate** around to see exactly what each alignment option does. Pictures 5-7.
- If the text “**Aligned**” appears when you hover over any of the circle handles, that means your parts are already perfectly aligned in that axis. Picture 6.
- Click the circle handle that aligns the 3rd roof as shown in Pictures 8-9.
- **Aligning is especially useful when creating holes and symmetric designs, but is also useful in cases like this**.
- To dismiss the alignment tool either **click in any blank space** or press the X by **Dismiss Align Tool**.

10. Move shapes by resizing

- **Repeatedly resizing shapes can “move” them highly precisely**.
- Select the **newest green roof** and drag its **front black resize handle** so it is even with the back edge of the grouped roofs.
- That’s **Part 1** of our “move”. We temporarily increased depth.

**Part 2**: Drag the **newest green roof’s back black resize handle** to decrease its depth back to **25 mm**, which should align it perfectly with the front two points of the **grouped roofs**. Rotate around to check you’ve got it right.
11. Workplane tool

- Remember your high school geometry?
  *The workplane, the light blue grid, is a geometric plane, or a “flat, two-dimensional surface that extends infinitely far. A plane is the two-dimensional analogue of a point (zero dimensions), a line (one dimension), and three-dimensional space.”* [https://en.wikipedia.org/wiki/Plane_(geometry)]

- The workplane tool allows us to move the workplane to any of the surfaces of our design. After that, any new shapes we insert will automatically be placed flat on that new plane.

- Now we’re going to do the curved back and two sides of the library.

- From the **right side menu**, in the **Helpers** menu, click on **Workplane**.

- Drag your mouse in to the design area on the left.

- You can use any of the edges of your design as new workplanes.

- Let’s use the back. Once the workplane tool looks like this picture, single left click.

- From the **right side menu**, in the **geometric** section, insert a **rounded roof**.

- Resize its “height” (which in this view looks like length or depth) to be **15 mm**.

- Reposition the workplane to the right side of our model.

- From the **geometric** section of the **right side menu**, insert a **red box** even with the front corner of the library. Use the resize handles to make this box **15 mm “tall”**, **20 mm wide** (no change), and **25 mm deep** (looks like height).
• Reposition the **workplane** to the left side of our model before we go on.

12. Importing

• We’ve pre-made the other side of the library for you to demo **Importing**.
• From the **right side menu**, open the **Import** section.
• Click **Choose File**, and use the window that appears to find **east-wing-b.stl** on the **Desktop** of your computer. Click **Open**.
• After you’ve done that, **No file chosen** will change to **east-wing-b.stl**. Click **Import**.
• Unfortunately, the **Import** function ignores the workplane. Huge bummer :( We’ll fix it.

13. Review exercise

• Use any of the methods we’ve taught today or in the basic 3D design class to position the imported shape against the open edge of our library model. Some suggested methods:
  o Use the **up arrow height tool** (which looks sideways since we changed the **workplane**) and move the imported shape until it is even (0.00mm) with the **orange workplane**.
  o Use the **black square resize handles** on either side to move the imported shape by resizing it. (The imported shape is about ~40.00mm deep overall.)
  o Or maybe use the **rotation handle** which is flat with the original **workplane** to change the angle of the imported shape a bit.
  o Watch the **workplane gridlines** as reference points to make sure you’re resizing and moving the imported shape.
  o Regularly use the **rotation controls** or **rotation keyboard shortcuts** to check yourself.
• Let us know if we can help you.
14. Mirroring

- Uh oh. Anybody notice the mistake we made?
- Yep. We designed the library exactly backwards.
- That’s ok! There’s a tool to fix this.
- **Drag your mouse over all of our shapes** to select all.

- Click into the **Adjust** menu and click **Mirror**...
- **Hover over the black double sided arrows.** Use the **orange previews** to figure out which **mirroring arrow handle** fixes the problem.

- Once you’ve found the correct **mirroring arrow handle**, single left click it.

- To dismiss the alignment tool either **click in any blank space** or press the X by **Dismiss Mirroring Tool**.
15. 3D print preview in LulzBot Cura

- Ela Library 3D printers are the Mini model made by LulzBot.
- LulzBot provides a free program called Cura to preview prints.
  - You can download and install this software on your desktop or laptop computer at home.
  - Go here: [https://www.lulzbot.com/cura](https://www.lulzbot.com/cura) to download. The first time you open Cura, it will ask you questions. Set it up for a LulzBot Mini. We already have this software installed already.
  - On a Mac computer, do the keyboard shortcut Command+space bar and then type in Cura and press enter to open Cura up. On a PC, click the Windows key and then click the Cura icon.
  - In the upper left corner, click Load model.
  - Find the file called bad-design.stl from the desktop, click on it, and then click Open.
  - We could print it at this orientation with supports. Supports are mini removable structures designed by Cura to hold up suspended parts of designs. Click the checkbox next to Print support structure.
  - Click the Normal or View mode button in the upper right corner. This displays different available views. Within all the views, click on Layers. A slider appears in the lower right corner of the interface.
  - Drag this slider up and down. The supports are teal green. This design is “bad” because the curved back of the library was unsupported before we enabled supports. It won’t print cleanly – you’ll have to rip off the supports and potentially sand that part of the model.
  - Click the Layers button in the upper right corner, and click back into the normal view.
  - Click on the model itself. In the lower left corner, options to Rotate or Scale it appear.
  - Click on Rotate. Hover over the three circles that appear around your design. Use yellow circle to rotate the bad design 90° in either direction.
  - Now click on the model again and click on the Scale button. Maybe we want to make the model a bit bigger. You can change the dimensions by Scale at the top or by millimeter dimensions at the bottom. If you use the Scale or millimeter dimension scaling options, you may accidentally scale your model too big. If your model turns dark gray, it’s too big for us to 3D print. Click the max size button if you want the design to be as large as possible at its current proportions.
  - Once you’ve got your design exactly how you want it in Cura, you can see estimates of how long it will take to print and how much the finished product will weigh. 3D prints cost $.10/gram. You can do the math and figure out how much your print job will cost. Submit 3D print jobs at [http://eapl.org/create/forge/3d-print-job-submission](http://eapl.org/create/forge/3d-print-job-submission).
Recommended Additional Resources:

Other technology classes
Go to http://www.eapl.org/events to view and signup for other computer classes.

Class handouts
Go to http://eapl.org/events/computer-programs/class-handouts to download handouts and exercise files.

Librarians, Computer Aides, and Makerspace Assistants
We are glad to help you out at the second floor reference desk or in the Makerspace as best we can while helping others. Makerspace assistants are typically available to help on nights and weekends.

Help appointments
Ela Library cardholders can schedule one-on-one appointments with librarians for further help. We can help with our Digital Media Labs or with general technology questions in our areas of expertise. Appointments last up to one hour. Paper appointment request forms are available at the 2nd floor reference desk. You can also request appointments online:


Tech Tutoring
The last Wednesday of some months, a tech savvy librarian is available for six 30 minute tech tutoring appointments. Bring a list of questions and we’ll help with as many as possible. Limit one tutoring appointment per month per patron. First registered first served, no library card required. Go to http://www.eapl.org/events to register for a session.

Databases
The Library offers card holders access to many premium databases. These include:

- Gale Courses offers a wide range of highly interactive, instructor led courses that you can take entirely online. As an Ela Area Public Library card holder in good standing, you are entitled to these courses at no cost. Courses run for six weeks and new session begin every month.
- Lynda.com offers technology training with over 20,000 training videos on over 300 topics with exercise files included. The Library pays for you card holders in good standing to access this resource, however you will be required to create a free account. *Please remember to log out when done.*

Access both of these databases from the library Research page: http://www.eapl.org/resources

Books

- **3D modeling and printing with Tinkercad: create and print your own 3D models** by James F. Kelly
  Call Number: 006.686 TINKERCAD

- **3D printing with AutoDesk 123D, Tinkercad, and Makerbot** by Lydia Sloan Cline
  Call Number: 621.988 CLI

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