THE ADDITIVE PROJECT
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CUSTOM KEYCHAIN PROJECT

This facilitator guide is a companion to the step-by-step directions for **The Custom Keychain Project**. It is intended to guide the facilitator through setting up, introducing some basic concepts of 3D design, guiding participants through the project, and debriefing the experience at the end. This is the first lesson in The Additive Project's curriculum in which participants are actually creating a printable object themselves. As such, it can be offered as a stand alone immersion in 3D printing or immediately following the introductory lesson also available on TheAdditiveProject.org.

The Custom Keychain Project familiarizes participants with working in 3D space and introduces some basic skills needed to work in 123D Design. Some fundamental tools necessary for creating objects in the program are also introduced.

LEARNING OBJECTIVES

- What is 123D Design
- Basic Navigation of the Program
- How to Use the Text Tool
- How to Extrude an Object
- How to Move + Scale
- How to Merge + Subtract
- How to Export for Print

PROJECT OVERVIEW

- Introduction
- Overview of Prototyping and Uses of Customization (Optional)
- Skills Lesson
- Project Work Round
- OR Tools Lesson
- Guided Project Work Round
- Debrief + Class Summary

SKILLS OVERVIEW

This project was developed for use with Autodesk 123D Design. The following skills will be learned through the introduction and/or repeated use of the relevant tools, available for view in the Tutorials + Tool Tips sections included in the step-by-step. Optional educational activities can be incorporated based on their relevance to the required steps for the project.

PROGRAM BASICS

OPENING 123D DESIGN   Open Autodesk 123D Design to work on new projects
- Open 123D Design

OPENING A 123D FILE   Accessing a saved 123D file
- Opening a 123D File

DELETING ITEMS   Discard unwanted pieces from the workspace
- Deleting Objects

VIEWING + MOVING

CAMERA ROTATION TOOL   Make adjustments in the camera view.
- Using the Orientation Tool

ZOOM   View objects close up or at a distance.
- Zoom Tool

VIEWING + HIDING SKETCH   Choose to view a sketch template or hide it.
- Show/Hide Tool

OBJECT INSERTION + MANIPULATION

INSERTING OBJECTS   Create text in the 3D space
- Entering text
- Inserting Files

MANIPULATING OBJECTS   Changing + moving objects relative to one another
- Extruding Text
- Moving Objects
- Merging Objects
- Subtracting Objects

PREP + MATERIALS

CLASSROOM RESOURCES

COMPUTER ACCESS:

Each participant should have his or her own computer for the duration of the project.

PRESENTATION + LECTURING:

Ideally, you should be able to play the Tool Tips videos and walk the class through each Module by demonstration on a projector that all participants can see.

SOFTWARE REQUIREMENTS:

This project requires each computer to have Autodesk 123D Design installed and available.

TEMPLATE REQUIREMENT:

This project requires each student to have the ability to access and open The Additive Project Keychain, a 123D file. This can be done via the internet from The Additive Project site if access is available. Alternatively, you may download the file and preload it onto computers where the participants will have access.

PRINTING REQUIREMENT:

Currently, this project outlines the process for printing using the MakerBot Printer.

TIME

The lesson is designed to take 45m-1h, depending on:
- The inclusion of the introduction
- Time spent on going over skills training
- Time spent on optional learning activities
- Time spent debriefing

PRINT TIME

The Keychain Project has been tested to create a viable object with a print time of 20m or less. This can be done at the end of the lesson or during another class period. The size and duration of the print is flexible and based on your access to printers.

SUGGESTED PROCESS

INTRODUCTION
Play the introductory project video showing the class what they will be making and discussing the skills they will acquire in the process.

OVERVIEW OF THE PROTOTYPING + THE USES OF CUSTOMIZATION (OPTIONAL)
Play the video or show the slides related to prototyping and customization and present the associated talking points.

PROJECT OVERVIEW
Direct participants to the project website. Introduce or review the project page components they can use as reference, showing them the step-by-step instructions, the location of the Required Files (refer them to their desktops if previously installed), and point out the Tool Tips + Tutorials section.

PROJECT FACILITATION
OPTION 1: With groups that do well independently, you may choose to begin the session by giving an overview of the Keychain Project learning objectives, as well as the tools needed to complete the project. Additionally, you might identify the goals, play the Tutorials videos, and let participants follow the step-by-step on the site.

OPTION 2: Alternatively, you may also break the session up into smaller segments or Modules, which each include several steps involving particular skills and allow for break points to check in with participants and teach the following Module's new skills before progressing. Play Tool Tips videos and allow participants to follow the steps on the Additive site, play Tutorials videos, or demonstrate the steps to the class using projection. There are additional learning modules that are called out within the project flow, which can be investigated or ignored depending upon the amount of time you have for the project as a whole.

MODULE 1: 123D BASICS
Step 1. Opening 123D and beginning to familiarize participants with it; using basic movement tools. Ensure all participants have completed this step before proceeding.

MODULE 2: CREATING DIMENSIONAL TEXT
Steps 2-4. Inserting text; creating 3D lettering. Ensure all participants have completed this step before proceeding.

SUGGESTED PROCESS (cont.)

MODULE 3: CHOOSING A KEYCHAIN

Steps 5-7. Select the keychain from available choices; import text. Ensure all participants have completed this step before proceeding.

MODULE 4: SCALING+ ALLIGNMENT

Steps 8-10. Instruct students in non-uniform scaling techniques. Ensure all participants have grasped and completed these steps before proceeding.

MODULE 5: MERGING + SUBTRACTING

Steps 11-12. Merging + subtracting to reach the final, printable object. In 123D, pasted objects appear on top of the original and must be moved. Ensure all participants have completed this step before proceeding.

CLASS REGROUP + SUMMARY

We recommend regrouping as a class to discuss challenges and successes, and to offer feedback, both among the participants and about the curriculum itself.

FACILITATOR STEP-BY-STEP

MODULE 1: INTRODUCTION (OPTIONAL)

3D printing has created the ability to do on demand customization. This has alleviated some of the need to create in mass customized souvenirs and large wasteful production runs. It also means that none needs to suffer ever again through the pain of not having his or her name available for purchase.

The fact is that traditional prototyping can require a large initial investment, making the process of moving from idea to reality that much more difficult for people with limited resources. Also, commercial manufacturing tends to operate on cost to volume analyses, meaning that creating the infrastructure for a product line becomes more profitable the larger the production output. So when you see a cool nameplate belt buckle and want one of your own, you might not be able to find one that features your personal moniker. It's not that nobody ever thought a "Freshtastic" buckle wouldn't be a great idea, it's just that they'd have to produce so many that it wouldn't be practical. With access to a 3D printer, however, you can now create your own.

MODULE 2: LET'S GET STARTED

GOAL

Open + Begin to Navigate 123D Design

TALKING POINTS

Today we are going to create a customized Keychain. We will be designing text as a 3D object, choosing a shape, assembling the pieces and, time permitting, printing. We will have several break points to regroup and go over the skill sets required in each section. You will also be able to reference step-by-step instructions, videos of the Keychain Project, and Tool Tips on The Additive Project website.

MEDIA

Using your projection screen, direct students to TheAdditiveProject.org website and the Keychain Project page.

TALKING POINTS

- All of the resources you will need can be found at this URL
- You can see here what your final printed Keychain will look like
- The **Step-by-Step tab** provides step-by-step instructions to follow for the whole project
- The **Required Files tab** has the Keychain file you need to download for the project
- OR If you have installed the file on the computers ahead of time, point participants to the location of the file

FACILITATOR STEP-BY-STEP

- The **Tool Tips + Tutorials tab** contains videos of the tools and functions you will be using (Tool Tips), and project-specific videos on each of the steps (Tutorials).

MEDIA

- Play the Tutorial: *Navigating 123D Design*
- **OR** Demonstrate opening 123D and manipulating the camera view
- **OR** Play Tool Tips video: *Using the Orientation Tools*

TALKING POINTS

- For this project we are going to use Autodesk 123D Design, a free 3D modelling program.
- First, let's open 123D Design.
- Here you can see the grid plane. This grid represents the X + Y axes and helps us keep track of the objects we are placing in 3D space.
- **Q:** Does anyone know what the X + Y Axes represent?
- **Q:** What is the other Axis in 3D space?
- Most of the orientation tools are along the right side of the screen.
- Notice the Pan Tool at the top of the vertical toolbar (it looks like a crosshairs). This allows you to move the whole grid plane while holding down the left mouse button. Left click to release the tool - this is standard for all tools.
- The Orbit Tool, just below Pan, lets you move the grid plane for custom views. Left click to release.
- Zoom is below that and allows you to zoom in while holding down the let mouse button and moving the mouse forward, and zoom out by moving it back.
- In the top right corner, you will see a cube with its faces labelled 'left, front + top.' This cube corresponds to the grid plane we see on the screen and will help you keep track of where you are.
- The Home icon will return you to the original view of the grid plane.
- Try manipulating the cube by clicking on the faces, the arrows and by dragging and turning it manually to achieve different views.
- Hit the Home icon to return to the original view.

MODULE 3: CREATING 3 DIMENSIONAL TEXT

GOAL

Place 2D Text on the Grid Plane + Extrude to 3D

MEDIA

- Play Tutorial: *Creating 3 Dimensional Text*
- **OR** Demonstrate using the Text Tool to create text on the grid plane

FACILITATOR STEP-BY-STEP

TALKING POINTS

- The first thing we'll attempt is creating some text for our Keychain.
- Find the Text Tool on the horizontal toolbar at the top—it looks like a upper case T.
- This tool will allow you to type text directly onto the grid plane. Once you have it selected, you can see the dashboard allows you to select the size, font etc. Keep the text in the default size for now.
- For this project, you should stick with simpler fonts. The more ornate the font, the more difficult it is to create small scale 3D lettering.
- *Instruct participants to stop after completing steps 1 + 2.*
- *Walk around and make sure everyone is able to orient the inserted text before proceeding.*

MEDIA

- Play Tutorial: *Extrude the Text*
- **OR** Demonstrate extruding text

TALKING POINTS

- The text you have placed on the grid plane is 2 dimensional, essentially a line drawing, so we now have to make it 3 dimensional through a technique called extruding.
- Extrusion is simply forcing material—hypothetical material at this point—through the area enclosed by lines on a plane to make a 3D object. Think of the edges of a cookie cutter through which you force play dough. We can do this with letters when the typed characters on our grids have ample width to sustain a print.
- Select the Construct Tool on the top toolbar and choose the first option, Extrude. Then select the text you've typed in and drag the letters upward using the arrow that appears. Extrude to 2mm.
- You may have to zoom in to extrude by smaller increments than 5mm. Alternatively, type 2mm into the extrude popup tool.
- *Walk around the room as participants extrude. In addition to perhaps needing the tighter zoom to extrude to smaller depths, you might also point out to students that they can type 2mm into the extrude menu bar.*
- *One common issue that may arise is that once the letters are extruded, 123D treats them as separate objects. Participants may inadvertently move one or more of their newly extruded letters. Remind them of the Undo option on the top toolbar next to the 123D logo.*
- *Ensure everyone has been able to successfully extrude their letters before proceeding.*

MEDIA

- Play Tutorial: *Hide Sketch, Group Text + Save Your File*
- **OR** Demonstrate hiding the sketch, grouping letters and saving

FACILITATOR STEP-BY-STEP

- **OR** Play Tool Tips videos: Show/Hide Tool; Grouping Objects

TALKING POINTS

- On the toolbar on the right, find the Show/Hide Tool (it looks like an eye) and select Hide Sketches to get rid of the underlying lettering.
- Now that the letters have been extruded, 123D considers them all individual objects. For the sake of ease of movement and manipulation, it is best to group them together as a single object.
- Highlight one letter and then hold down the shift key as you highlight the others. Find the Grouping Tool in the toolbar at the top and select Group. Now the letters are linked together, almost as a single piece, as far as the software is concerned.
- Save the file using the dropdown menu under the 123D logo.
- *Walk around to ensure participants progress through all parts of this step.*
- *Always remember the Undo Tool.*
- *If someone hides the wrong elements they can simply go back to the menu and show them again.*
- *If only some of the letters are grouped, the new partial group can be joined with left over individual letters following the same instructions.*

MODULE 4: CHOOSING A KEYCHAIN

GOAL

Choose a Keychain Backing and Import Text

MEDIA

- Play Tutorial: *Insert Keychain File*
- **OR** Demonstrate downloading and inserting the Keychain file from Additive

TALKING POINTS

- Now that you have created the text, we can choose an object for the text to sit on to complete the final object.
- Minimize 123D for a moment and navigate to the Keychain Project on the Projects page and then to the Required Files on TheAdditiveProject.org. Download and save the Keychain Template file.
- Back in 123D, go to the drop down menu under the logo and choose Insert. Choose Browse My Computer in the popup window and the Browse button. Navigate to the Keychain Template.
- The file should have four objects—three Keychain shapes and one small cylinder which we will disregard for the moment.

FACILITATOR STEP-BY-STEP

MEDIA

- Play Tutorial: *Delete Objects*
- **OR** Demonstrate deleting objects

TALKING POINTS

- Decide which of the shapes you would like and then highlight and delete the others.
- *Walk around to ensure all participants have completed this step before proceeding.*
- *Ctrl + Z to undo any mistakes.*

MODULE 5: UNIFORM + NON-UNIFORM SCALING

GOAL

To place the letters on the Keychain

MEDIA

- Play Tutorials: *Move Text; Scale Lettering; Place Cutout Object*
- **OR** Demonstrate moving and scaling the letters
- **OR** Play Tool Tips videos: *Uniform Scaling; Moving an Object*

TALKING POINTS

- To move the letters so that they are touching the Keychain, select the letter object and choose the Move Tool. Use the Orientation Cube to change your view to the side so that you can line the two object up properly.
- Move the letters object by dragging it upwards from the grid plane so that it would over-lap but stick out above the Keychain. Then move it over to and on top of the Keychain object.
- Next, we will scale the letters to fit onto the Keychain. Objects can be scaled up or down making them larger or smaller.
- To scale an object you highlight the object, select scale on the pop up toolbar and either grasp + drag the scaling arrow or by input a specific scaling factor or number.
- When scaling, the default settings are to uniform, giving you only one arrow to manipulate and one numerical input field. This type of scaling will change the size of the object in all directions.
- When scaling the letters to fit, you may have to move the scaled object to realign the object to the Keychain. To do this you can either select the object and drag it the new location or you can use the move tool to move it using the arrows or input numbers.
- *Walk around to ensure all participants are able to complete this step before proceeding.*
- Move the small cylinder, which will become the cutout for the key ring, into position in a corner or edge of the Keychain.

FACILITATOR STEP-BY-STEP

MODULE 6: MERGING + SUBTRACTING

GOAL

To merge all elements of the Keychain

MEDIA

- Play Tutorial: *Merge the Lettering + Keychain*
- **OR** Demonstrate merging components
- **OR** play Tool Tips video: *Merging Objects*

TALKING POINTS

- Previously, we <u>combined</u> the letters to let ourselves work with them as a single unit. <u>Merging</u> actually makes two contiguous or overlapping objects into a single object. This is what we have to so with the letters and Keychain in order to have a printable piece.
- Make any adjustments to depth that are needed before merging the components. To do this, remain in Home view and highlight the letters and select the move tool. Move the letters up or down as needed to achieve the desired depth.
- Locate the Combine Tool on the top toolbar and select Merge. Highlight the letters as the Target Mesh/Object and then the Keychain as Source and hit enter to complete the merge.

MEDIA

- Play Tutorial: *Subtract Keychain Opening*
- **OR** Demonstrate subtracting the key ring opening object
- **OR** Play Tool Tips: *Subtracting Objects*

TALKING POINTS

- Locate the Combine Tool again but select Subtract.
- When using the subtract tool, remember that the first option selected—the Target Solid—is the target to be subtracted from, in this case the Keychain. The Source is the object that represents the material to be taken away, the key ring opening cylinder. Select the Keychain first, then the cylinder and hit enter to complete.

MODULE 7: EXPORT + PRINT

GOAL

To successfully print the Keychain

MEDIA

- Play Tutorials: *Export for Print*; *Scale + Prep for Print*
- **OR** Demonstrate exporting and prepping for print

FACILITATOR STEP-BY-STEP

TALKING POINTS

- In the 123D drop down menu, select Export STL.
- Save the file to an accessible place or directly to an SD card.
- Scale and Prep For Print
- Open MakerBot software, access the Keychain file, place it on the print bed.
- To make final adjustments before printing, select the Export tab in the top menu. A pop up will appear showing the file being prepared for print. When this is complete, the file is ready for export. The window will expand to include a Print Preview option and will indicate the estimated time to print and amount of filament used.
- For our purposes, a 20 minute print time is ideal.
- If the print time of your object is longer than 20 minutes or so, cancel out of Export and return to Scale.
- Once you have the right print time, click Export Now and save the file.
- *Refer to the 3D Printing 101 Step-by-Step or Facilitation Guide for detailed instructions on printer prep and SD cards.*

MODULE 8: DEBRIEF (OPTIONAL)

GOAL

Make sure any work in progress is saved. Discuss and answer any questions related to the project.

TALKING POINTS

- What do you think about the 3D design process?
- What is the most interesting thing you learned today?
- What was the most challenging part of this project?