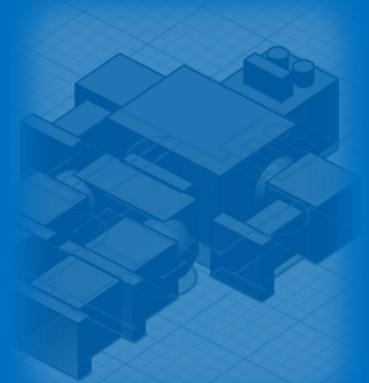


This facilitator guide is a companion to the step-by-step directions for **Robot Project One**. It is intended to guide the facilitator through setting up, introducing the historical and cultural significance of robots, guiding participants through the project, and debriefing the experience at the end. The project also contains several optional activities that can be tied to math and science learning objectives. This project can stand alone or be offered as part of a larger curriculum that will provide some prerequisite skills as well as further stepped learning.

**Robot Project One: Building A Robot** develops familiarity with and introduces the use of primitive shapes, uniform and non-uniform scaling and copying + pasting objects. The project also reinforces merging and subtracting.

This project can be immediately followed by **Robot Project Two: Customizing Your Robot** to build upon the object, extend the project duration, allow for broader creative expression and exploration, and build further skills.



---

## LEARNING OBJECTIVES

- Learn Building with Primitives; Basic Geometric Shapes
- Learn Copy and Paste to Replicate Objects
- Reinforce Moving and Manipulating in 3 Dimensions
- Reinforce Camera Move Abilities
- Reinforce Scaling Objects; Uniform and Non-Uniform Scaling

---

## PROJECT OVERVIEW

- Introduction
  - Overview of Robotics in Industry and Society (Optional)
  - Skills Lesson 1
  - Project Work Round 1
  - Skills Lesson 2
  - Project Work Round 2
  - Debrief + Class Summary
-

# SKILLS OVERVIEW

This project was developed for use with Autodesk 123D Design. The following skills will be learned or reinforced through the introduction and/or repeated use of the relevant tools, available for view in the 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.

## VIEWING + MOVING

### ORTHOGRAPHIC + PERSPECTIVE VIEW

View 3D objects in 2D (orthographic) or in the more realistic (perspective) views.

- [Orthographic View on the Template](#)

### CAMERA ROTATION TOOL

Make adjustments in the camera view.

### ZOOM

View objects close up or at a distance.

### VIEWING + HIDING SKETCH

Choose to view a sketch template or hide it.

## OBJECT INSERTION + MANIPULATION

### BUILDING WITH PRIMITIVES

Use basic geometric shapes, create complex objects.

- [Sphere Placement on the Template](#)
- [Box Placement on the Template](#)

### SELECT + MULTI-SELECT

Choose one or more components to manipulate.

- [Scaling Arms with Multi-Select](#)

### MOVE OBJECT

Move objects in 3D space.

- [Moving Hands on the Template](#)

### SCALING OBJECTS

Uniform + Non-Uniform

Increase or decrease the size of an object in height, width + depth uniformly, or in selected dimensions.

- [Scaling the Head on the Template](#)
- [Scaling the Body on the Template](#)
- [Scaling Hands on the Template](#)

### COPY + PASTE

Copy + paste objects to ensure uniformity.

- [Copying + Pasting Hands on the Template](#)

# SKILLS OVERVIEW (cont.)

## OBJECT INSERTION + MANIPULATION (cont.)

### MERGE + SUBTRACT

Combine objects or subtract one object's volume from another.

- [Subtracting the Mouth on the Template](#)
- [Merging All Components on the Template](#)

### PRINTING (optional)

#### SAVING FOR PRINT

Refer to The Additive Project website for instructions on how to save, scale, export, position and print the group's Robots on your printer model.

#### POSITIONING ON BED

#### SCALING FOR PRINT TIME

[www.theadditiveproject.org](http://www.theadditiveproject.org)

#### EXPORTING FOR PRINT

#### PRINTING

## SUPPLEMENTAL LEARNING

### DECIMALS

### SCALING

### PROPORTION

# 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 projects requires each student to have the ability to access and open The Additive Project Robot Template, 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-1.5h, depending on:

- The inclusion of the cultural and historical introduction
- Time spent on going over skills training
- Time spent on optional learning activities
- Time spent debriefing

## PRINT TIME

The Robot Project has been tested to create a viable object with a 20m per Robot print time. 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.

# INTRODUCTION: ROBOTS

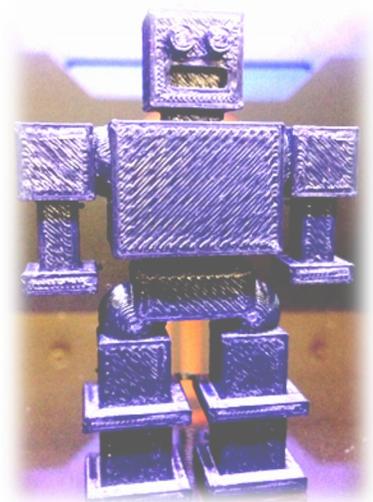
The idea of mechanical helpers has been around seemingly since the dawn of human kind ('If only I had a machine that could skin this wooly mammoth for me...') and appears in ancient Greek, Jewish, Indian and Chinese mythology to name but a few. Over the centuries, people designed increasingly complex automata—machines able to perform functions based on predetermined instructions. Among these were Su Song's Cosmic Engine (China, 1088), Al-Jazari's musicians (modern Turkey, 1206), and Leonardo da Vinci's knight (Italy, c. 1495).

As the Industrial Revolution unfolded in the 18th and 19th centuries, the field of mechanical sciences expanded rapidly, paving the way for the programmable machines, capable of performing complex functions, that we generally refer to today as robots. By the middle of the 20th century, industry was more and more mechanized resulting in greater demand for more autonomous machines capable of difficult, precise, or dangerous tasks.



Today, Robots are widely used in manufacturing, assembly, packing and packaging, transport, earth and space exploration, surgery, weaponry, laboratory research, safety, and the mass production of consumer and industrial goods. Chances are, your clothes, car, computer, phone, even some of the food you ate today, were made in part by robots. In fact, the machine that you will use to print your Additive Project Robot, the 3D printer, is itself a robot.

As for the Additive Project Robot, s/he is humanoid in appearance, like C3PO from *Star Wars*, Bender from *Futurama*, Sheriff Not-A-Robot from *The Lego Movie*, or—going a bit further back —the *Terminator* franchise. As you build your Robot in this project, start thinking about how you can use these skills and tools to create your own robot. Will it be a purely functional robot built to perform specific tasks, or will it be endowed with intelligence to make decisions about design, defense, or dance moves?



# SUGGESTED PROCESS

## INTRODUCTION MODULE (OPTIONAL)

Play the introductory project video showing the class what they will be making and discussing the skills they will acquire in the process. Play the video or show the slides related to the history of robots and present the associated talking points.

## PROJECT FACILITATION

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 Template (refer them to their desktops if previously installed), and point out the Tool Tips section.

**OPTION 1:** With groups that do well independently, you may choose to begin the session by giving an overview of the Robot Project learning objectives, as well as the tools needed to complete the project. Additionally, you might identify the goals, play the general Tool Tips videos (as opposed to the project specific 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 general skill Tool Tips and allow participants to follow the steps on the Additive site, play project-specific Tool Tips, 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: SETUP

Step 1. Downloading or opening the Robot Template file. Ensure all participants have completed this step before proceeding.

### MODULE 2: ORIENTING THE TEMPLATE

Step 2. Orienting the camera and setting it to orthographic view. Ensure all participants have completed this step before proceeding.

### MODULE 3: INSERTING BASIC GEOMETRIES

Steps 3-4. Help participants identify and place basic geometric shapes. Ensure all participants have completed this step before proceeding.

# SUGGESTED PROCESS (cont.)

## **MODULE 4: UNIFORM + NON-UNIFORM SCALING**

Steps 5-10. Instruct students in uniform scaling, non-uniform scaling techniques. Ensure all participants have grasped and completed these steps before proceeding.

## **MODULE 5: COPYING + PASTING**

Steps 11-12. Copying + pasting results in identical objects. In 123D, pasted objects appear on top of the original and must be moved. Ensure all participants have completed this step before proceeding.

## **MODULE 6: POPULATE THE TEMPLATE**

Step 13. Scale + place all remaining objects on the template. Ensure all participants have completed this step before proceeding.

## **MODULE 7: ADJUSTING DEPTH**

Step 14. Depth and its correlation to the Z axis; moving objects so they align properly with each other. Ensure all participants have completed this step before proceeding.

## **MODULE 8: SCALING DEPTH**

Steps 15-18. Scale depth on the Z axis; scaling more than one object simultaneously using multi-select. Ensure all participants have completed these steps before proceeding.

## **MODULE 9: MERGING + SUBTRACTING**

Steps 19-20. Merging and subtracting objects. Ensure all participants have complete this step before proceeding to print.

## **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

## INTRODUCTION MODULE (OPTIONAL)

### MEDIA

Show the Slideshare: [History of Robots Overview](#)

### TALKING POINTS

- Today we are going to build a printable Robot. We will be using basic geometric shapes as building blocks which we'll then copy, paste, scale, merge and subtract. We will have several break points to regroup and go over the skill sets requires in each section. You will also be able to reference step-by-step instructions, videos of the Robot Project, and Tool Tips on The Additive Project website.
- Slide Show Talking Points by Slide:
  - ⇒ Slide 1: Robots go back all the way to Greek mythology. Hephaestus, the god of fire created gold automated "robots" including mechanical dogs and automated tables that brought their owners food and drink.
  - ⇒ Slide 2: Some of the first automated machines were water powered machines that had automated figurines that acted out scenes.
  - ⇒ Slide 3: Other early automated machines were water powered clocks. An early example in China played music and could be "reprogrammed" by moving pegs around that caused the machine to play different notes.
  - ⇒ Slide 4: During the Islamic Golden Age, Al-Ajazari invented many automated machines including an automated band that played from a boat.
  - ⇒ Slide 5: In the West, Renaissance master Leonardo Da Vinci invented a humanoid mechanism built inside a suit of armor that could be controlled by ropes that mimiced many human movements.
  - ⇒ Slide 6: One of the first automated humanoid robots was exhibited at the annual exhibition of the Model Engineers Society. The Robot could move it's hand and head and be controlled by remote or voice control.
  - ⇒ Slide 7: Robots began to make a huge difference in industry. The first robot used in manufacturing was Unimate, which was used in a General Motors Factory in New Jersey.
  - ⇒ Slide 8: One of the most famous humanoid robots, and one of the first to truly start to mirror humanoid, movements is Asimo.
  - ⇒ Slide 9: Space exploration has long been one of the truly pioneering fields in robotics, as can be seen by one of its most famous robots, the Mars Rover.
  - ⇒ Slide 10: The actual phrase Robot was coined in the play *R.U.R.* (Rossum's Universal Robots) by the Czech writer Karel Čapek (Tcha' pek). According to Čapek, the word was created by his brother Josef from the Czech "robotá" meaning servitude. This view mirrors that of the very first non-fiction reference to what we would call robots by Aristotle in his *Politics*: "There is only one condition in which we can imagine managers not needing subordinates, and masters not needing slaves. This condition would be that each instrument could do its own work, at the word of command or by intelligent anticipation, like the statues of Daedalus or the tripods made by Hephaestus, of which Homer relates that 'Of their own motion they entered the conclave of Gods on Olympus,' as if a shuttle should weave of itself, and a plectrum should do its own harp playing." *Pol. I.4*
  - ⇒ Slide 11: The first "robot" to be dramatized in film was Maria in Fritz Lang's 1927 movie *Metropolis*.
  - ⇒ Slide 12: One of the pioneers of the use of robots in science fiction writing was Isaac Asimov who wrote

# FACILITATOR STEP-BY-STEP

many books incorporating robots including the famous book of short stories *iRobot*.

- ⇒ Slide 13: One of the most iconic early depictions of robots was Robbie the Robot who starred in film in *Forbidden Planet*. The character was one of the most famous robots in early television appearing in different shows throughout history.
- ⇒ Slide 14: Robots have obviously gone on to permeate media and technology. What are some of your favorite robots?

## MODULE 1: LET'S GET STARTED

### GOAL

Open the Template file

### MEDIA

- Play Tutorial: *Open Robot Sketch File*
- **OR** Demonstrate downloading the file and opening the file

### TALKING POINTS

- For this project we are going to use a template outline of the final robot to help us lay out the component parts.
- Download the file from the web-site to your desktop.
- Open 123D Design.
- Navigate to Open on the main menu of 123D.
- Navigate to the file on your desktop titled RobotTemplate.123dx and open.

## MODULE 2: ORIENTING THE TEMPLATE

### GOAL

Set up proper orientation and view to proceed with the project

### MEDIA

- Play Tutorial: *Orient Camera to Top View*
- **OR** Demonstrate orthographic view; top view orientation; using the fit to screen button

### TALKING POINTS

- First, we should adjust our view of the 3D space to simplify things.
- Perspective view attempts to mimic the way the human eye sees the world, making things in the foreground appear larger and things in the background appear smaller.
- Orthographic view removes the changes to scale in the perspective view, making it harder to view depth but easier to view relative placement and scale.
- We are using orthographic view for this project so that we can easily see how things line up with each other and are relatively sized.

# FACILITATOR STEP-BY-STEP

- The view orientation cube allows you to quickly jump to specific camera views at the major viewing angles, ensuring your alignment with a specific axis.
- For working with this template, it is best that we are perfectly aligned looking down on the template, so we will use the orientation cube to set the camera on the “top” view.
- An easy way to zoom out the camera to include all of the existing objects in the scene on the screen is to use the fit tool. It is a great tool for reorienting yourself if you find yourself off center or zoomed in too close to an object.
- *Instruct participants to follow steps 1 to 2 and stop.*

## STEPS COVERED IN MODULE 2

Participants should have completed the following steps when you are ready to move on:

**Step 2. Orient Camera to Top View:** Orthographic view on; locate Orientation Cube; achieve top view; fit/zoom

## MODULE 3: INSERTING BASIC GEOMETRIES

### GOAL

Place basic geometric shapes in the appropriate places

### MEDIA

- Play Tutorials: *Add Sphere Object Joints; Add Shoulders and Legs*
- **OR** Demonstrate inserting a sphere and cube on the template

### TALKING POINTS

- One method for building 3D models is to assemble them from basic building blocks. Think of it as putting together a Lego set.
- The basic shapes available in 123D are a cube, a sphere, a cylinder, a cone, and a ring, which can be located in the primitives menu in the top tool bar.
- For this project we will be using the cube, sphere, and cylinder.
- When you place objects in 123D, they will naturally try to snap to the grid or align with other objects. You will notice the objects jump into place during these steps.
- Place the spheres for the shoulder + hip joints and the cubes for the shoulders + legs.
- If during these steps you have placed the object but it does not align, you can simply click and hold the object to drag it into place, use the move tool to drag the directional arrows, or input specific numbers into the directional fields.
- **Tip** If you accidentally select and move the wrong object you can undo your last action by pressing control (or command) + Z.
- **Tip** If you have selected the wrong object simply click into empty space to deselect and then attempt to select the desired object again.

# FACILITATOR STEP-BY-STEP

## STEPS COVERED IN MODULE 3

Participants should have completed the following steps when you are ready to move on:

**Step 3. Add Sphere Object Joints:** Locate primitives; review basic shapes; place spheres; learn snap-to behavior

**Step 4. Add Shoulders + Legs:** Select box; place box objects

## MODULE 4: UNIFORM + NON-UNIFORM SCALING

### MEDIA

- Play Tutorial: *Add Head Component*
- **OR** Demonstrate inserting a cube and scale it for the head

### TALKING POINTS

- Objects can be scaled up or down making them larger or smaller.
- When an object is scaled you can either scale it uniformly, meaning that it grows or shrinks equally in all directions, or non-uniformly, meaning you can scale it in one of the major axis directions which will in effect distort the object.
- To scale an object you highlight the object, select scale on the pop up tool bar 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 head to fit the head template area you may have to move the scaled object to realign the object to the template. 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.
- *If the wrong number is input, be sure that the user undoes (command + z) the scaling; any future scaling will be done relative to the new size.*

### Supplemental Learning

- *Optionally you can discuss the math behind the numbers, or factors, and how it relates to scaling; i.e. 1 means 100% of original size resulting in no scaling while a 2 means 200% of original size or double the original size and a .5 means 50% of original size of half the original size.*
- *You can also apply fractions to the units of the background grid, the size of the initial object, and the number of units desired for the final object either as a whole or related to each side of the object. The default area of the face of the cube is 4x4 units. The head is 5x5. To make the box 5x5, enter a factor of 1.25 (125% or 1 1/4 of its default size).*

# FACILITATOR STEP-BY-STEP

- *Extend this lesson as far as you would like by translating numbers to percentages or fractions, and by challenging participants to use multiplication and algebra related to percentages and fractions.*

## MEDIA

- Play Tutorial: *Add Body Component; Scale the Body Component*
- **OR** Demonstrate inserting a cube and scaling the body

## TALKING POINTS

- When you select non-uniform scaling you will be presented with arrows pointing in all of the core axis directions and the option to enter a numerical value into the x, y, or z fields.
- When you scale the body you will want to scale it differently in both the x and y axis to make it fit the template. You can do this by pulling on each of the different arrows or entering the unique value into the appropriate field.
- When scaling the body to fit the body template area you may have to move the scaled object to realign the object to the template. 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.
- **Q:** What factors do we enter to arrive at the correct proportions? (The body is 8 units tall, a factor of X:2, and 9 units wide, a factor of Y:2.25.)

**Note:** Similarly to the non-uniform scaling tool, all three dimensions are represented in the tool, though we only see two from top view. You can quickly switch back to home view before returning to top view to check this out.

## STEPS COVERED IN MODULE 4

Participants should have completed the following steps when you are ready to move on:

**Step 5. Add Head Component**

**Step 6. Scale Head:** Select object; Scale Tool; verify Uniform; drag arrows/type 1.25

**Step 7. Add Body Component**

**Step 8. Scale Body:** Select object; Scale Tool; change to Non-Uniform; drag arrows/type X:2, Y:2.25

## MODULE 5: COPYING + PASTING

### GOAL

Successfully replicate objects to maintain uniformity

## MEDIA

# FACILITATOR STEP-BY-STEP

- Play Tutorials: *Copy Hand; Move Duplicate Hand*
- **OR** Demonstrate copying, pasting and moving the copied object for the hand

## TALKING POINTS

- In many cases you will want replicate an object that has already been modified. In 123D it is as simple as using Command + C to copy and then Command + V to paste (you can do this as many times as you like).
- Add a cube for the hand and scale. Copy + paste.
- Once you have pasted the object it will sit directly on top of the copied item and already be selected with the move tools highlighted.
- You can then simply move the item to the desired place using the arrows or by entering the number value for where you would like to move it.
- *Walk around and make sure everyone is able to successfully copy and paste the hand item.*

## STEPS COVERED IN MODULE 5

Participants should have completed the following steps when you are ready to move on:

### **Step 9. Add Hand**

**Step 10. Scale Hand:** Select object; Scale Tool; change to Non-Uniform; drag arrows/type

**Step 11. Copy Hand:** Select; ctrl + c; ctrl + v

**Step 12. Move Duplicate Hand:** Grab + drag to position; type in distance in Move Tool; grid units = 5mm x 5mm

## MODULE 6: POPULATE THE TEMPLATE

### GOAL

Complete the placement of the remaining components independently

### MEDIA

- Play Tutorial: *Insert Remaining Objects*
- **OR** Demonstrate placing remaining objects
- **OR** Let participants loose to proceed

## TALKING POINTS

- You now have all the skills you need to populate all of the remaining items of the robot so go ahead and do so.
- **Hint:** For the eyes, select and scale the sphere or try a new primitive—the cylinder. Copy + paste + drag the second eye into place.

# FACILITATOR STEP-BY-STEP

- **Hint:** After copying + pasting + placing the knees, SHIFT + CLICK to highlight both knees, then copy + paste + place the pair to create the feet.
- **Note:** The mouth will begin as a solid object placed on top of the head.
- *This is a good point to circulate, offering assistance to anyone needing it, and see how the class as a whole is responding to the information, pace, terminology etc.*
- *Keep challenging students to identify ratios, fractions, + percentages as they scale. The next Module includes making final adjustments before the merge.*
- *If you plan on printing, check that the printer is on and warming up.*

## STEPS COVERED IN MODULE 6

Participants should have completed the following steps when you are ready to move on:

**Step 13. Insert Remaining Components:** Review of previous steps + techniques

## MODULE 7: ADJUSTING THE DEPTH (Z AXIS) OF COMPONENTS

### GOAL

Create appropriate alignment + depth for all components relative to each other

### MEDIA

- Play Tutorial: *Align Components*
- **OR** Demonstrate camera move to side view

### TALKING POINTS

- With all the components in place, we can adjust the depth of the objects to create the right alignment along the Z axis.
- To do this, move the camera to the side view with the orientation cube.
- You may notice some of the objects ended up on top of other objects or suspended in space, usually the pelvis and eyes.
- Use the move tool to line them up with each other correctly.
- The amount of overlap of the mouth object and the head will determine the size of the mouth opening.
- *Some variance may be present in the placement of participants' objects.*

## STEPS COVERED IN MODULE 7

Participants should have completed the following steps when you are ready to move on:

**Step 14. Align Components:** Change camera to side view; Move Tool to move objects along Z axis; partial overlap of mouth object

# FACILITATOR STEP-BY-STEP

## MODULE 8: SCALING THE DEPTH (Z AXIS) OF COMPONENTS

### GOAL

Create appropriate proportion of all limbs + extremities

### MEDIA

- Play Tutorial: *Remove Template Sketch*
- **OR** Demonstrate hiding the sketch

### TALKING POINTS

- Now that everything is aligned, we can remove the sketch which we don't need anymore and which can be confusing when selecting multiple objects for scaling.
- To do this, return to home view on the orientation cube. Then find the Show/Hide tool on the tool bar on the right and select Hide Sketch.

### MEDIA

- Play Tutorials: *Scale Chest Component; Scale the Arms; Proportion Your Robot*
- **OR** Demonstrate scaling limbs with multi-select (shift + click)

### TALKING POINTS

- With the sketch gone, we can create the appropriate proportions in the legs, arms etc.
- To make sure components like the arms are exactly the same, we can scale them at the same time. To do this, select one arm, then hold shift and select the other, just like in copying + pasting the knees and feet. Then continue with non-uniform scaling, only adjusting the Z axis arrow or number.

### STEPS COVERED IN MODULE 8

Participants should have completed the following steps when you are ready to move on:

**Step 15. Remove Template Sketch:** Show/Hide Tool; Hide Sketch option

**Step 16. Scale Chest:** Home view; non-uniform scaling; scale on z axis only

**Step 17. Scale Arms:** Select arm; shift + click to multi-select; non-uniform scaling; scale on z axis only

**Step 18. Proportion Your Robot**

## MODULE 9: MERGING + SUBTRACTING

### GOAL

Combine all elements to create a finished, printable Robot

### MEDIA

- Play Tutorial: *Create Mouth Opening*
- **OR** Demonstrate subtracting the mouth object

### TALKING POINTS

- We are now able to subtract the mouth and combine all the components to create the printable Robot. First, though, **save your file** so you can make modifications later and use it for the customized Robot section later.
- Make any final adjustments to the depth of the mouth object now, as the area of overlap between it and the head will be the size of the mouth opening.
- 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 head. The Source is the object that represents the material to be taken away, the mouth object.

### MEDIA

- Play Tutorial: *Combine Components into One Object*
- **OR** Demonstrate merging all components (using shift + click)

### TALKING POINTS

- Now you can merge the remaining pieces of the Robot. Select an item and shift + click to select components which touch, one by one, until the whole Robot is selected and merge.
- If pieces are not touching or overlapping, the pieces will not combine. Try to highlight the whole Robot to check this. You may need to zoom in pretty close to see the small gaps left during the placement steps.
- *Walk through the room, checking that participants are able to merge. If there is only a small gap between groups of pieces, merge the groups first and then move the larger, combined units into place.*

### STEPS COVERED IN MODULE 9

Participants should have completed the following steps when you are ready to move on:

**Step 19. Create Mouth Opening:** Save the file; Combine Tool; Subtract option; select head, then mouth

**Step 20. Combine Components:** Combine Tool; Merge option; shift + click to select all objects; check merge

## MODULE 10: PRINT

### MEDIA

Refer to The Additive Project site for printing instructions for your printer model.