



Curriculum-in-a-Box | Lesson Plan 2

MANIPULATING GEOMETRY

This lesson is designed to begin a student's journey into understanding what makes up 3D geometry in a traditional Digital Content Creation (DCC) Application. We'll first look at our concept of X, Y, and Z dimensions, and then start to break down the building blocks of geometry. This lesson will explore what these elements are named in Houdini, but the concepts will be able to be used in any 3D DCC. We will also look at a couple of ways that people create 3D models, so students will be aware of the strengths and limitations of each method.

As an instructor, it is recommended that you first complete the "Foundations" Learning Path on [Houdini Insight](#) or through the SideFX website. That knowledge, along with this document and supplemental materials, will allow you to craft more compelling classroom experiences for your students. Please feel free to adjust anything found in these materials so that they fit your needs. We will strive to make our teaching methods clear through these materials, so that you feel empowered to do the same in your classroom.

Sections of the "Foundations" book will be packaged along with this document. If you would like digital access to the entire book you can follow this link: sidefx.com/tutorials/foundations-book/

PREREQUISITES

Some suggested prerequisites include:

- *Lesson 1: Let's Play with Houdini*
- Understand the basics of navigating the Houdini UI | **Houdini**
- Plotting (x,y) data on a graph | **Mathematics**
- Have a general understanding of polygonal geometry | **Mathematics**
- A good understanding of how to use computers and their file systems | **Computer Basics**

LEARNING OBJECTIVES

- Students will learn about the basics of the world of 3D computer graphics.
- Students will have an understanding of the different levels of geometry in Houdini.
- Students will be able to make and modify simple geometric shapes to create more interesting final models.

LECTURE

During the lecture portion of the lesson, we recommend that the students are "hands off" the computer, and just listening/watching the teacher. Questions are encouraged, but there will be time for them to work with the software in the next portion of the lesson.

In order to get students up to speed with how geometry is and how it's manipulated, we have provided a Powerpoint presentation that you can use to enhance your classroom activities as you see fit. During the lecture portion of your lesson, we suggest that you address the following topics:

- Introduce students to the X, Y, & Z coordinate space
- Explore the elements of geometry

- Points, Vertices, Polygons, etc.
- What are other types of geometry used in 3D applications?
- NURBS, Volumes, etc.
- Discuss types of modeling
 - Box, Subdivision, Procedural, etc.
- Analyze 3D shapes
 - Breaking down objects into simplified geometric representations
 - Tubes, Spheres, Cubes, etc.

GUIDED WORK

Students are now asked to follow-along with the teacher as they build something in Houdini. For this lesson, our students will follow along as we create a simple 3D model from scratch. There are five options to choose from: a coffee cup, a vase, a logo, a building, and a crate. Each of these options use a slightly different method, and therefore you may want to choose the one that you feel is most appropriate for your students.

While the students will be creating a model during this exercise, the most important part of the process is for them to experience what it's like to manipulate geometry in Houdini. If you'd like to enhance this guided work, you could have your students follow the rendering steps from the end of Lesson 1. This would give them a final image of their model.

For this portion of the lesson there are three pieces of material:

- A video that demonstrates our thought process for teaching this lesson
- A PDF document that outlines the step-by-step process that the class will follow together
 - This could be helpful for the instructor to become familiar with the steps, or it could be distributed to the students to reinforce the directions
- A HIP file that shows the end product of the activity, along with HIP files to use for each section of the lesson (if students get lost along the way)

INDEPENDENT WORK

For this section of our lesson, we recommend letting students work independently. This can be assigned as a lab exercise or as homework, depending on the structure of your course/school and the availability of suitable computers in your students' homes.

For one part of this lesson's independent work, we will have our students create a soccer ball model following the first two sections of [Houdini Foundations | Model, Render, Animate](#), or pages 51-55 of the [Houdini Foundations Book](#). Your students could use one or both of these elements to complete the task, as you see fit.

Another part of this lesson's independent work is to find several real-world objects and explain what type of modeling would be best to describe them in a CG environment. You may want to have the students give short descriptions of why they think each type of modeling would be useful. Keep in mind that there isn't always a black-and-white way to model an object, and the purpose of this exercise is to get the students thinking of the physical world around them in a different way.

QUIZ

For instructors that are looking for an element of assessment during this lesson, we've provided a quiz PDF that could be given to students. This will test their understanding of the concepts introduced throughout the course of exercises outlined above.

SUPPLEMENTAL MATERIALS

In order to better understand the concepts of this lesson, please refer to the following supplemental materials:

- [Houdini Foundations PDF](#)
 - Pgs. 14-17

STANDARDS MAPPINGS

[CSTA Standards](#)

3A-DA-11

Create interactive data visualizations using software tools to help others better understand real-world phenomena.

3A-AP-13

Create prototypes that use algorithms to solve computational problems by leveraging prior student knowledge and personal interests.

3A-AP-17

Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.

3A-AP-18

Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.

3B-AP-13

Illustrate the flow of execution of a recursive algorithm.

[ISTE Standards](#)

1.2.c Intellectual Property

Students demonstrate an understanding of and respect for the rights and obligations of using and sharing intellectual property.

1.5.d Algorithmic Thinking

Students understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.

1.6.b Original and Remixed Works

Students create original works or responsibly repurpose or remix digital resources into new creation.

1.6.c Models and Visualizations

Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations.