

# Activity 2.3.3 CAD Material Appearance and Analysis

## PLTW

### CAD MATERIAL APPEARANCE AND ANALYSIS

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☰ Choosing Materials in CAD

☰ Creating a New Material in CAD

☰ Interference Testing

☰ Conclusion

# Choosing Materials in CAD

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GOALS	RESOURCES
<ul style="list-style-type: none"><li>• Explain how design criteria and constraints (cost, performance, safety, risk, aesthetics, environmental impact) often limit the material choices available for a given design.</li><li>• Create a computer model or simulation to represent an object or conceptual idea and inform design decisions.</li></ul>	
GOALS	RESOURCES
<ul style="list-style-type: none"><li>• <a href="#"><u>Effective Research</u></a></li><li>• <a href="#"><u>Activity 2.3.3. CAD Material Appearance and Analysis (Downloadable PDF)</u></a></li></ul>	

Knowing a material's properties is essential when selecting one for use in prototyping and manufacturing. Properties such as density, yield strength, and thermal conductivity can be defined for a material in a virtual space to harness the power of computers as analytical tools. Simulations based on applying a specific material to a 3D model of an object can virtually test a component's performance under specified conditions.

In this activity, you will learn how to:

- Assign a material to a component
- Create a new material given its parameters
- Run an interference test between two components in a CAD environment

## Exploring CAD Materials

When you performed a structural analysis of your consumer product in Activity 2.2.4 Structural Analysis and Product Disassembly, you were asked to identify each component's material of construction to complete the Product Disassembly Chart. However, when you created a 3D model a default material was assigned with its associated appearance in CAD. This default material may not accurately represent your design intent. Fortunately, both the physical material and its appearance can be modified. Most CAD packages have a robust materials library containing commonly used materials.

Both the appearance and properties of a material are defined by [parameters](#). Appearance parameters include color, texture, reflectiveness, translucency, and luminescence. Material properties that can be used to describe a material include density, thermal properties (such as thermal conductivity and specific heat) and mechanical properties (such as Young's modulus and yield strength). You may experimentally determine a property of a material, or perform academic research to find parameter values that will define a material in CAD.

1

Learn how to apply a different material to a component in CAD.



## Appearance versus Physical Properties

For some design contexts, the appearance of an object is critical. When it is important, you can modify the *appearance* properties of a component, body, or face to give the object a realistic look.

In many design contexts, the *physical* properties of the material applied to the object have greater importance. Assigning a physical material to a component or body allows material properties to be used in engineering analysis.

### INSTRUCTION

## Fusion

- In **Product Documentation**, review **Assign material**.

2

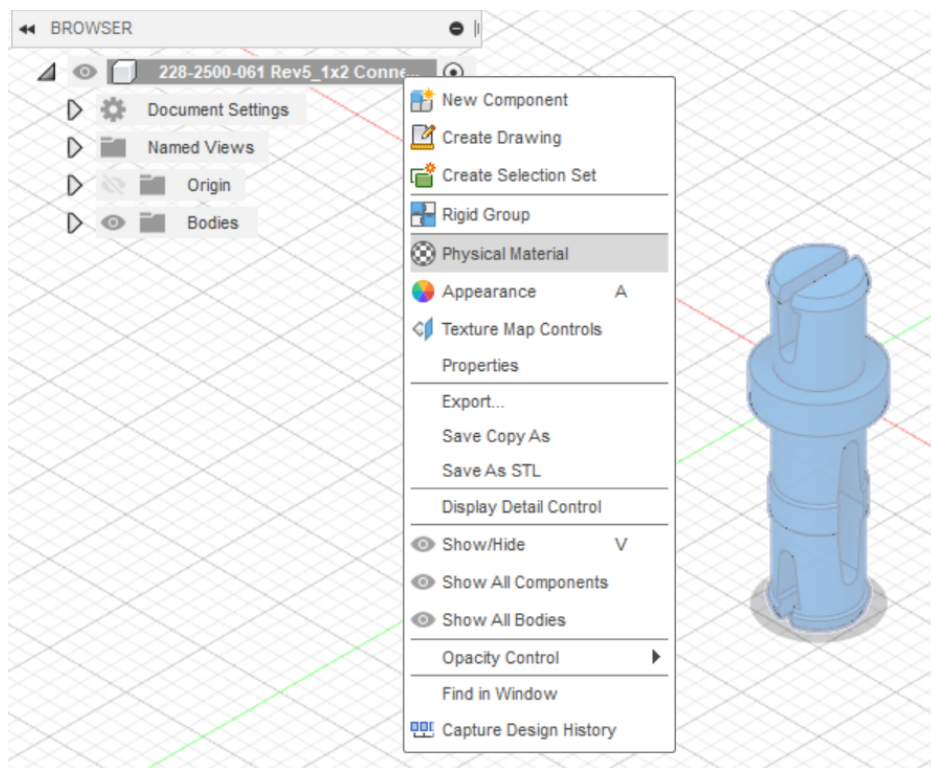
Investigate the materials available to you in CAD.

**NOTE:** Materials are commonly grouped by type; materials in the same group share common physical appearances and material properties.

#### INSTRUCTION

### Fusion

- Open the file containing the model of the commercial product you reverse engineered.
- Select one component from the commercial product model.
- Right-click the component name in the BROWSER bar and select **Physical Material**.
- Review the materials available to you in the Fusion Material Library (default).



3

Review your Product Disassembly Chart for the consumer product you reverse engineered in Activity 2.2.4 Structural Analysis and Product Disassembly.

- Identify the material of construction for each component.
- Select a specific material from the CAD material library for each component.
- Record the name of the material from the CAD material library in the appropriate column of your chart.

- Highlight any component for which you were unable to find an appropriate physical material within the library. Also, note components for which the appearance is not accurately modeled within the software.

## Reflection



What properties are associated with a CAD material?

# Creating a New Material in CAD

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Sometimes, a material that you want to use is not included in the CAD material library or the existing material does not reflect the visual appearance you intend for your component. To realistically represent a component, you may want to create a new material in CAD, defining its appearance and material properties.

Even though many parameters are available to describe a material, you do not have to define all of them to create an acceptable representation of the material in CAD. The more parameters you include, the better the model represents the actual component in simulations.

But remember that the complexity of your model depends on the purpose of your model. For instance, if your 3D model will be used only to provide a visual representation of the design or to print a plastic prototype to check fit, you will not need to worry about the physical properties. But if you will use the model to simulate structural testing of the object, you'll need to define important physical properties such as Young's Modulus, yield strength, and others.

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Define a new material in CAD for polylactic acid (PLA), a plastic commonly used in 3D printing.

**HINT:** Instead of creating a brand new material, it is more time efficient to create a copy of a material that is similar in appearance and structure. For example, ABS Plastic is similar to PLA in appearance and material properties.

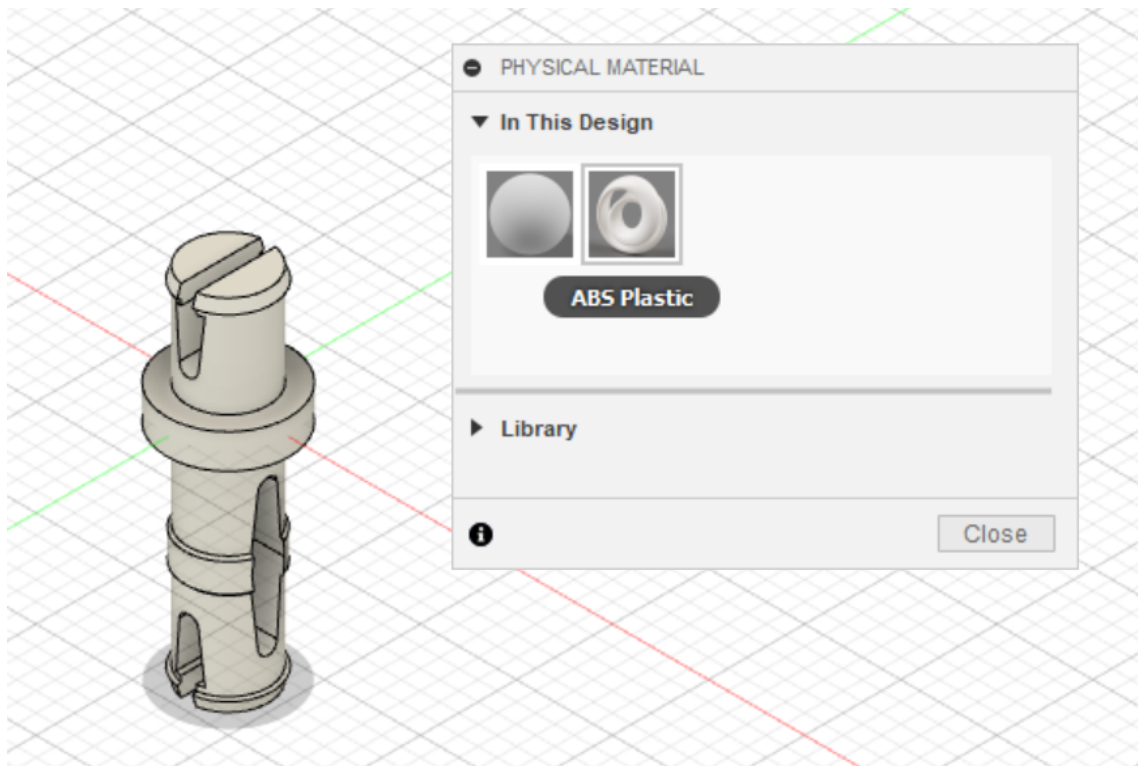
INSTRUCTION

MATERIAL NAMING

PARAMETERS

## Fusion

- In **Product Documentation**, review **Manage physical materials**, focusing on the Manage Materials section. When you are done, navigate back to your open component in Fusion.
- From the Physical Material menu, define your component as ABS Plastic from the Plastic folder. The icon for ABS Plastic appears in the In This Design section.



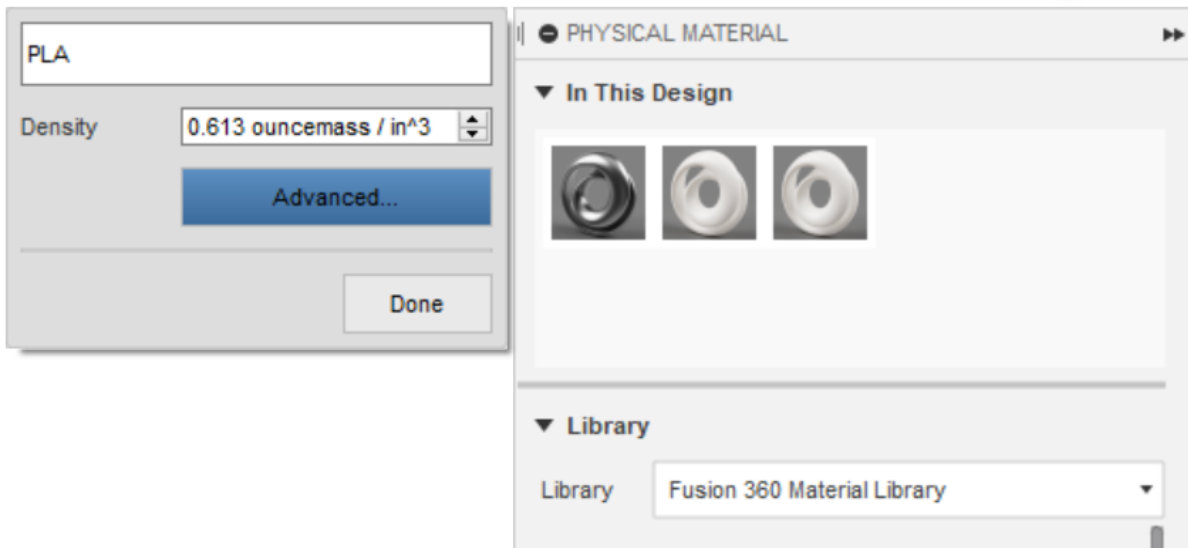
INSTRUCTION

MATERIAL NAMING

PARAMETERS

- Right-click the icon and select **Duplicate**.
- Right-click the new icon (labeled ABS Plastic (1)) and select **Edit**.
- In the pop-up menu, name your material “PLA” and select **Advanced**.

**NOTE:** If you are using mm as your document units, then density units will be g/mm<sup>3</sup>.

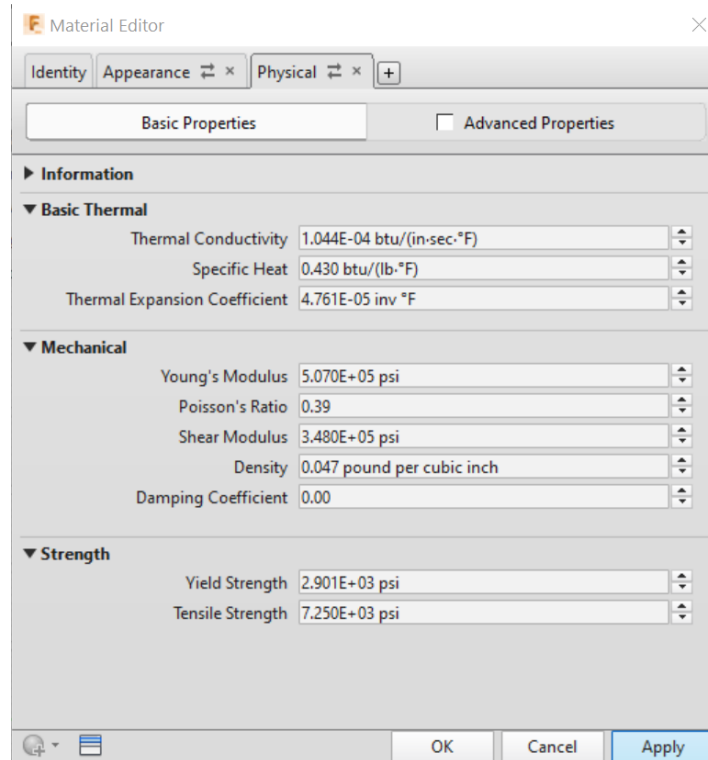


INSTRUCTION

MATERIAL NAMING

PARAMETERS

- Under the **Identity** tab, enter “Polylactic Acid” in the Description box; leave the Type as Plastic.
- Under the **Appearance** tab, enter “PLA” in the Name box, “Polylactic Acid” in the Description box, and “PLA” in the Keywords box. Change the Color parameter to a color of your choice.
- Under the **Physical** tab, enter “PLA” in the Name box, “Polylactic Acid” in the Description box, and “PLA” in the Keywords box. Enter the parameter values for the Basic Thermal, Mechanical, and Strength properties as the following:
  - **Basic Thermal**
    - **Thermal Conductivity:** 1.044E - 04 btu/(in • sec • °F)
    - **Specific Heat:** 0.430 btu/(lb • °F)
    - **Thermal Expansion Coefficient:** 4.761E - 05 inv °F
  - **Mechanical**
    - **Young's Modulus:** 5.070E + 05 psi
    - **Poisson's Ratio:** 0.39
    - **Shear Modulus:** 3.480E + 05 psi
    - **Density:** 0.047 pound per cubic inch
    - **Damping Coefficient:** 0.00
  - **Strength**
    - **Yield Strength:** 2.901E + 03 psi
    - **Tensile Strength:** 7.250E + 03 psi
- Select **Apply** and close the Material Editor. The icon for PLA changes to its newly defined appearance



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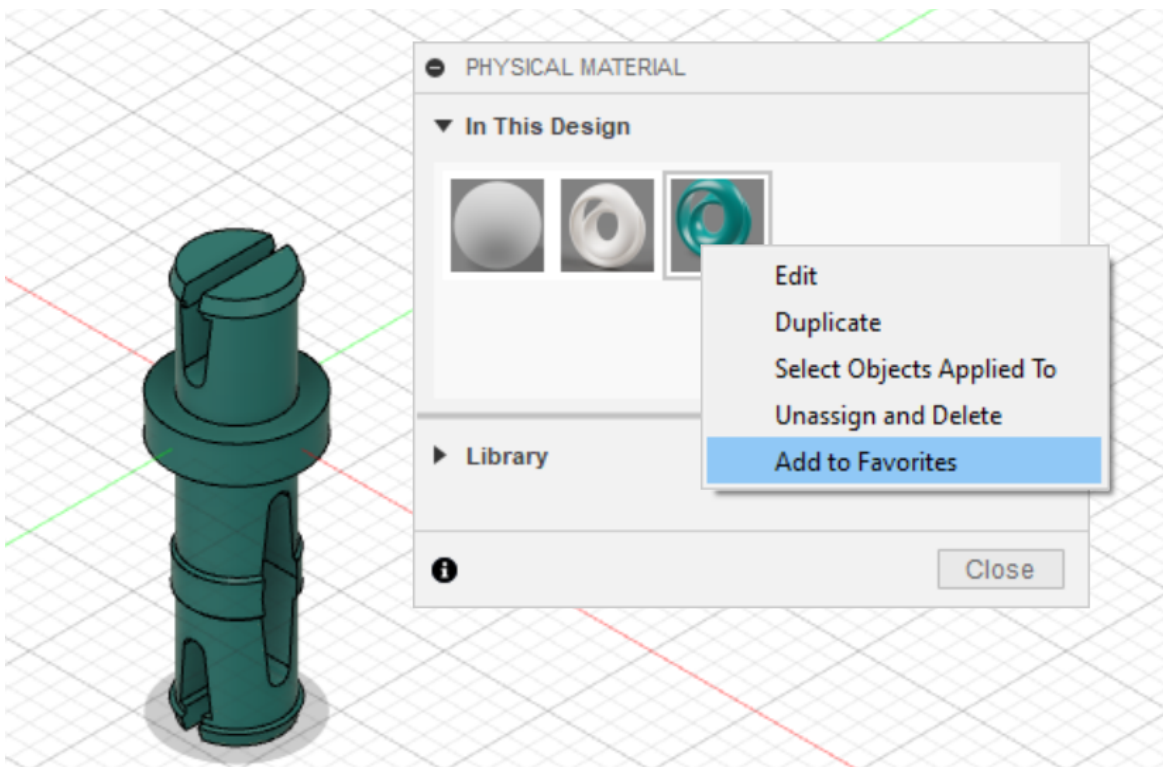
Save the new material to a Favorites folder or a common materials library for use across designs.

**NOTE:** CAD packages often group materials into materials libraries. The materials in those libraries are available to everyone using the software in any design; however, if you create a new material and don't save it into one of those shared libraries, it will not be available to you in other designs.

## INSTRUCTION

### Fusion

- In the Physical Material window, right-click on the PLA icon.
- Select **Add to Favorites**.
- In the Library subsection, change the Library to Favorites. Verify that your PLA material is in the folder.



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Create a new material in CAD that you can use to define a component from your commercial product.

- Include your initials after the name of your new material to distinguish it as a material you have created.
- To identify parameters to use in defining the new material, revisit materials you have tested previously, if appropriate. At a minimum, include density and Young's Modulus.

**Effective Research:** It is important to use reputable sources when you identify material parameters. Review the [Effective Research](#) resource for tips on how to evaluate the validity of a source.

- Adjust the visual appearance of the material within the CAD environment to reflect the true appearance of the material in the consumer product.

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Assign a material to each component of your commercial product. Use your custom material where appropriate.



**IMPORTANT:** If you are having trouble changing the component material, make sure you have the solid activated and not a sketch.

# Interference Testing

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A common simulation that CAD programs can perform is an interference test. An [interference](#) test shows the places where two or more components exist in the same space. This is commonly called “overlap” and can result in errors when converting the CAD model into manufacturing machine code.

8

Investigate how to run an interference test in the CAD software that you are using.

## INSTRUCTION

### Fusion

In **Product Documentation**, review **Interference dialog box**.

9

Run an interference test between the consumer product and your integrated accessory from Project 2.2.8

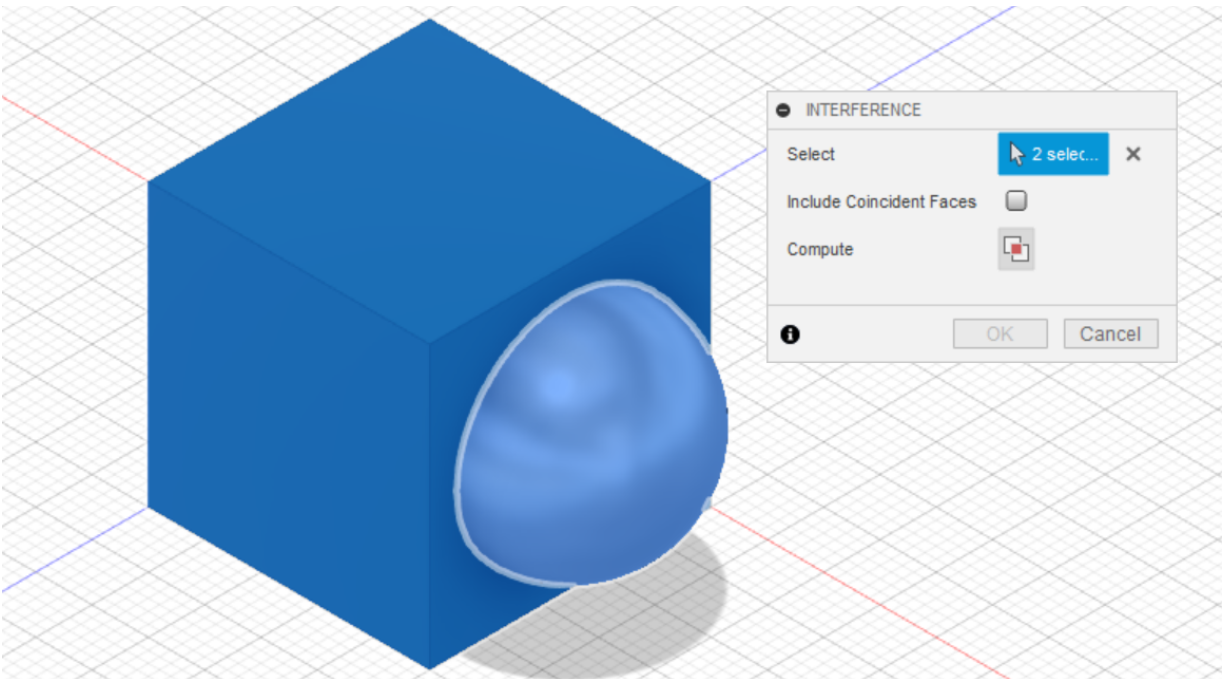
## Design an Integrated Assembly.

INSTRUCTION

VOLUME

### Fusion

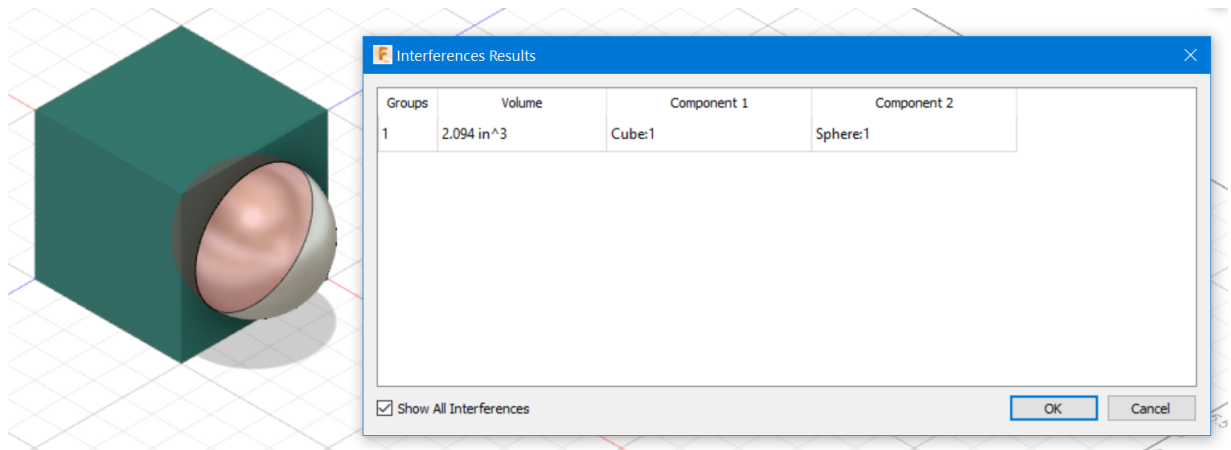
- Open your assembly from Project 2.2.8 Design an Integrated Assembly.
- From the **Inspect** menu, select **Interference**.
- Select at least two components to run the test. The number of selected components will show in Select.
- Click **Compute**.



## INSTRUCTION

## VOLUME

- Each component used in the test will show along with the volume of the interference. You will also be able to see the interference highlighted in red on your solid model.



CAD and simulation software are evolving to perform sophisticated testing of designs. However, these tools are only as good as the information provided. If erroneous material property information is input to the software, the errors may propagate and produce erroneous results. Therefore, simulation and physical testing work together to provide engineers a complete understanding of the performance of a component or assembly.

# Conclusion

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## Question 1

Even if you don't know the exact material of a component, why could it be useful to change the appearance?

## Question 2

Why is it important to frequently check for interference when creating an assembly?