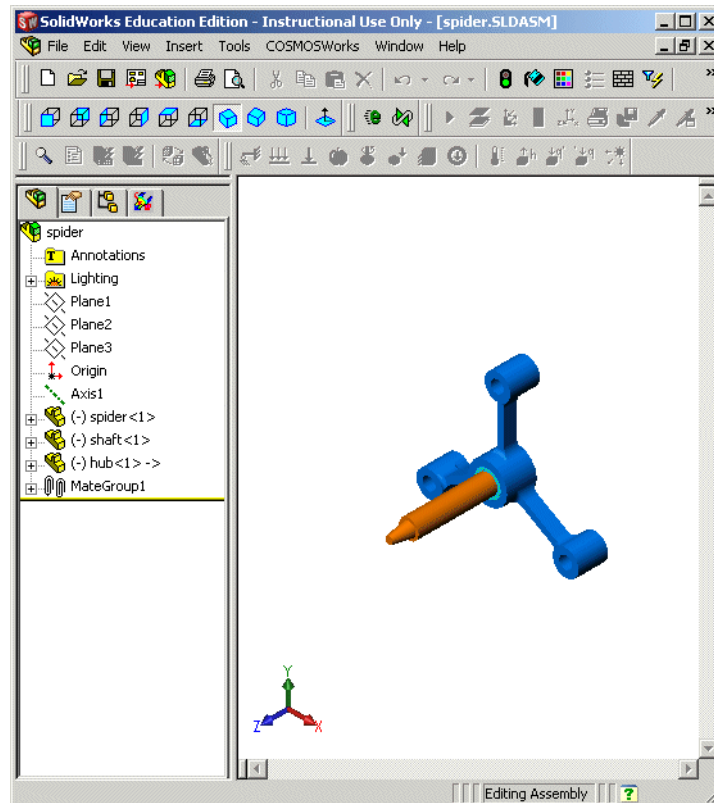


## Lesson 1: Basic Functionality of COSMOSWorks

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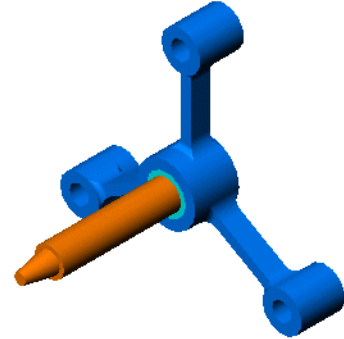
Upon successful completion of this lesson, you will be able to understand the basic functionality of COSMOSWorks and perform static analysis to the following assembly.




## Active Learning Exercise — Performing Static Analysis

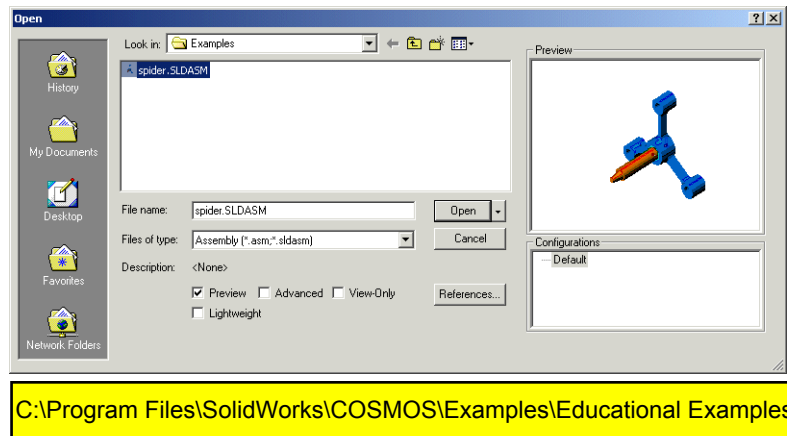
Use COSMOSWorks to perform static analysis on the Spider.SLDASM assembly shown to the right.

The step-by-step instructions are given below.



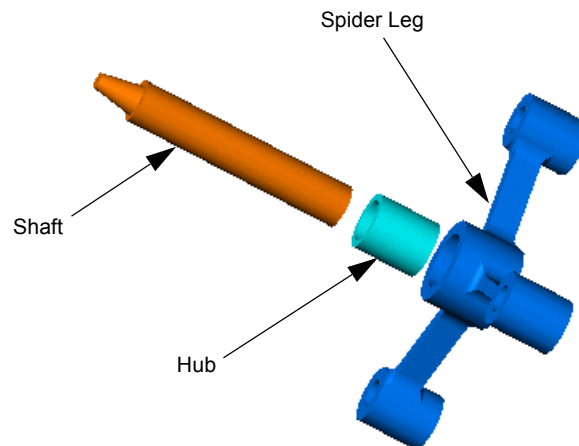
### Opening the Spider.SLDASM Document

- 1 Click **Open**  on the Standard toolbar. The **Open** dialog box appears.
- 2 Navigate to the **Examples** folder in the COSMOSWorks' installation directory.
- 3 Select Spider.SLDASM.
- 4 Click **Open**.



The spider.SLDASM assembly opens.

The spider assembly has three components: the shaft, hub, and spider leg. The following exploded view of the assembly shows these components.



## Checking the COSMOSWorks Menu

If COSMOSWorks is properly installed, the COSMOSWorks menu appears on the SolidWorks' menu bar. If not:




- 1 Click **Tools, Add-Ins**.

The **Add-Ins** dialog box appears.

- 2 Check **COSMOSWorks**. If COSMOSWorks is not in the list, you need to install COSMOSWorks.

- 3 Click **OK**.

The COSMOSWorks menu appears on the SolidWorks' menu bar. Also, the COSMOSWorks Manager tab  appears at the top of the left pane.

## Saving the Assembly to a Temporary Directory

We recommend that you save the assembly to a temporary directory to save the original copy for repeated use.

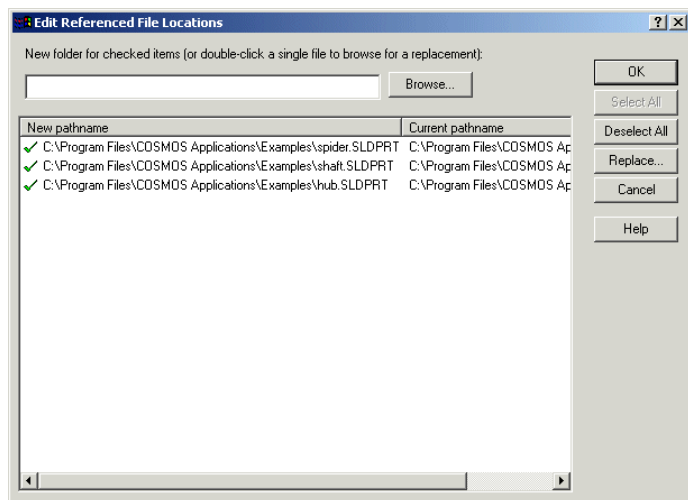
- 1 Create a temporary directory named **temp** in the **Examples** folder.

- 2 Click **File, Save As**.

The **Save As** dialog box appears.

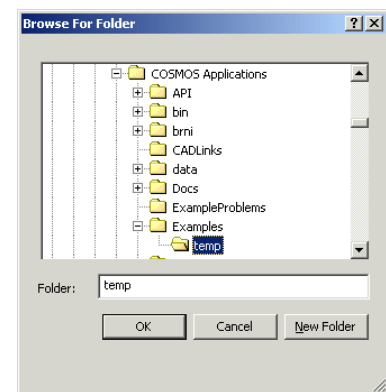
- 3 Click **References**.

The **Edit Referenced File Locations** dialog box appears.



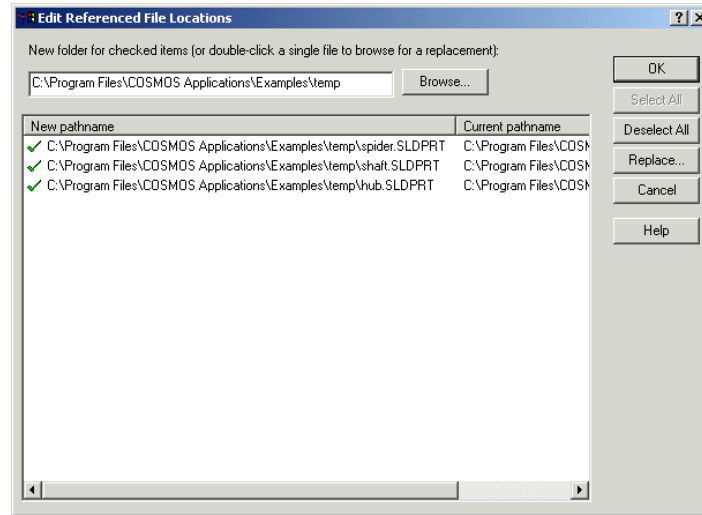
- 4 Check the three part files named `spider.SLDPRT`, `shaft.SLDPRT`, and `hub.SLDPRT`.

- 5 Click **Browse**. The **Browse for Folder** dialog box appears.




- 6 Navigate to the **temp** directory created in step 1 and click **OK**. The full path to the new location of the assembly and the associated part files appears at the top of the **Edit Referenced File Locations** dialog box as shown in the next figure.

## Lesson 1: Basic Functionality of COSMOSWorks



- 7 Click **OK**.
- 8 In the **Save As** dialog box, navigate to the `temp` directory and click **Save** to save the assembly file `spider.SLDASM`. SolidWorks creates another copy of the assembly file along with associated part files in the `temp` directory.

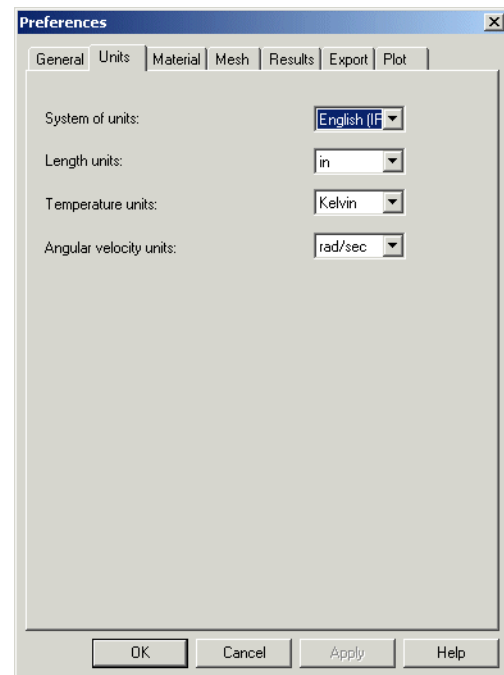
### Switching to COSMOSWorks Manager

Switch to COSMOSWorks by clicking the COSMOSWorks Manager tab  at the top of the left pane.

### Setting the Analysis Units

Before we start this lesson, we will set the analysis units.

- 1 Click **COSMOSWorks**, Options .  
The Options dialog box appears.
- 2 Click the **Units** tab.
- 3 Click **SI** in the **System of units** list.
- 4 Click **in** in the **Length units** list.
- 5 Click **OK**.

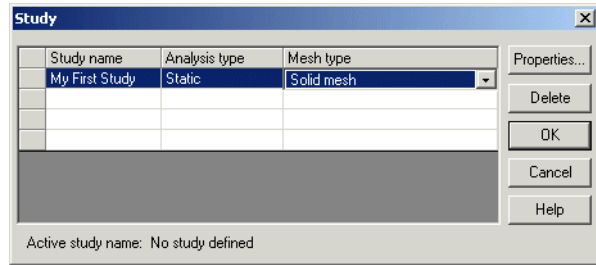


### Step 1: Creating a Study

The first step in performing analysis is to create a study.

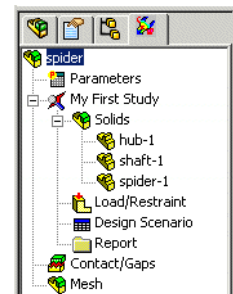
- 1 Right-click the spider icon and click **Study**, or click **COSMOSWorks, Study**.

The **Study** dialog box appears.



- 2 Under **Study name**, type My First Study.
- 3 Under **Analysis type**, select **Static**.
- 4 Under **Mesh type**, select **Solid mesh**.
- 5 Click **OK**. (the green tick)

COSMOSWorks creates a representative tree for the study in the COSMOSWorks Manager.



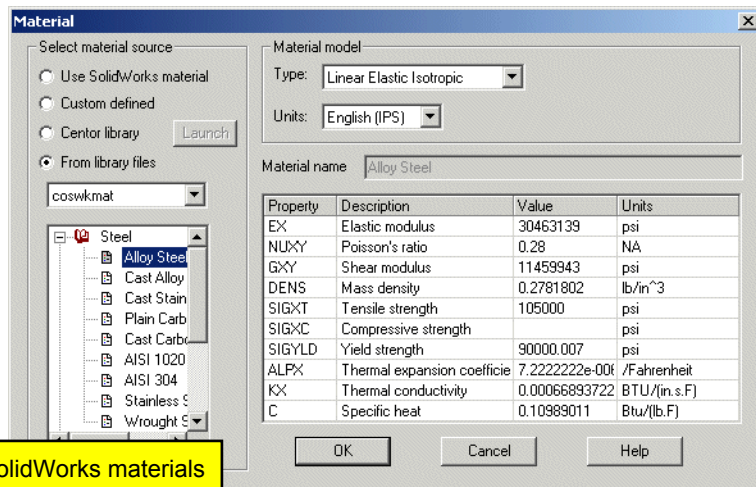
### Step 2: Assigning Material

All assembly components are made of Alloy Steel.

#### Assign Alloy Steel to All Components

- 1 In the COSMOSWorks Manager tree, right-click the **Solids** folder and click **Apply Material to All**.

The **Material** dialog box appears.



- 2 Under **Select material source**, do the following:
  - a) Click **From library files**.
  - b) Select **coswkmnt** from the menu.
  - c) Click the plus sign  $\oplus$  next to the **Steel** material category and select **Alloy Steel**.

**Note:** The mechanical and physical properties of Alloy Steel appear in the table to the right.

- 3 Click **OK**.

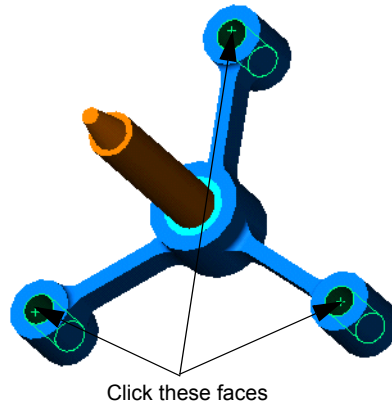
Alloy steel is assigned to all components of the assembly and a check mark appears on each component's icon. Note that the name of the assigned material appears next to the component's name.



### Step 3: Applying Restraints

We will fix the three holes.

- 1 Use the **Arrow** keys to rotate the assembly as shown in the figure.

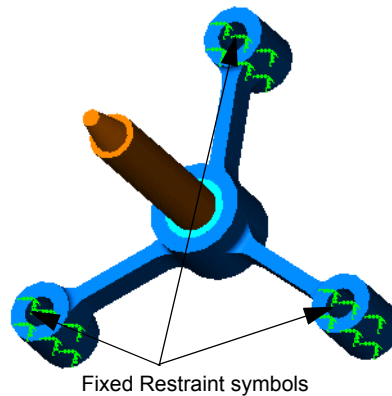


- 2 In the COSMOSWorks Manager tree, right-click the **Load/Restraint** folder and click **Restraints**.

The **Restraint** PropertyManager appears.

- 3 Make sure that **Type** is set to **Fixed**.
- 4 In the graphics area, click the faces of the three holes.  
Face<1>, Face<2>, and Face<3> appear in the **Selected entities** list box.
- 5 Click **OK** .


The **Fixed** restraint is applied and its symbols appear on the selected faces.



Also, a restraint icon (Restraint-1) appears in the Load/Restraint folder in the COSMOSWorks Manager tree.

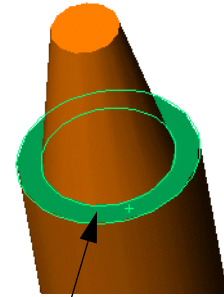
### Step 4: Applying Loads

We will apply a **2500N** force normal to the face shown in the figure.




- 1 Click **Zoom to Area**  on the View toolbar and zoom into the tapered part of the shaft.
- 2 In the COSMOSWorks Manager tree, right-click the **Load/Restraint** folder and click **Force**.

The **Force** PropertyManager appears.

- 3 Under **Type**, click **Apply normal force**.
- 4 In the graphics area, click the face shown in the figure.  
Face<1> appears in the **Selected entities** list box.



Click this face

- 5 Make sure that **Units** is set to **English (IPS)**.
- 6 In the **Normal Force/Torque (Per entity)**  box, type **2500**.
- 7 To view the force before it is applied, click **Preview** .
- 8 Click **OK** .

COSMOSWorks applies the force to the selected face and a Force-1 icon appears in the Load/Restraint folder.

#### To Hide Restraints and Loads Symbols

In the COSMOSWorks Manager tree, right-click the **Load/Restraint** folder and click **Hide All**.

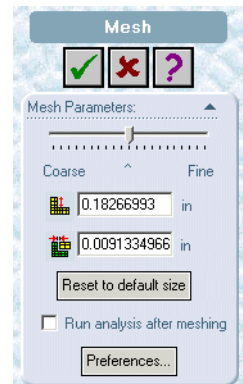
### Step 5: Meshing the Assembly

Meshing divides your model into smaller pieces called elements. COSMOSWorks suggests an element size for convenience.

- 1 In the COSMOSWorks Manager tree, right-click the **Mesh** icon and click **Create**.

The **Mesh** PropertyManager appears.

- 2 Click **Preferences**.




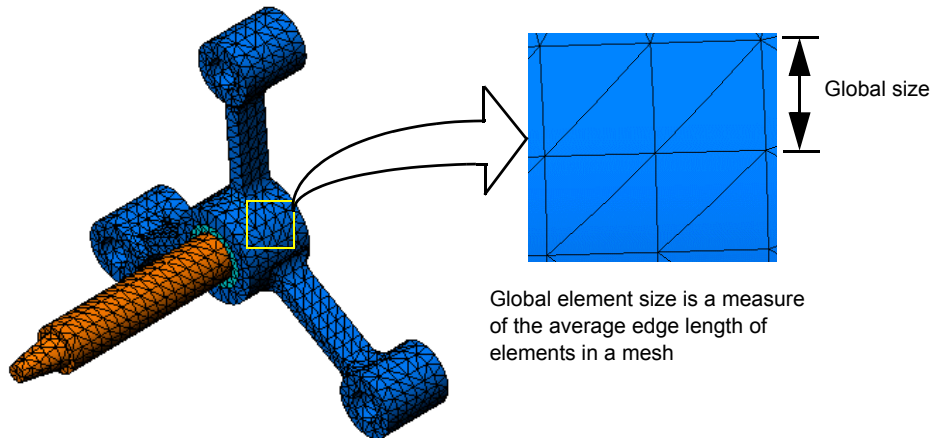
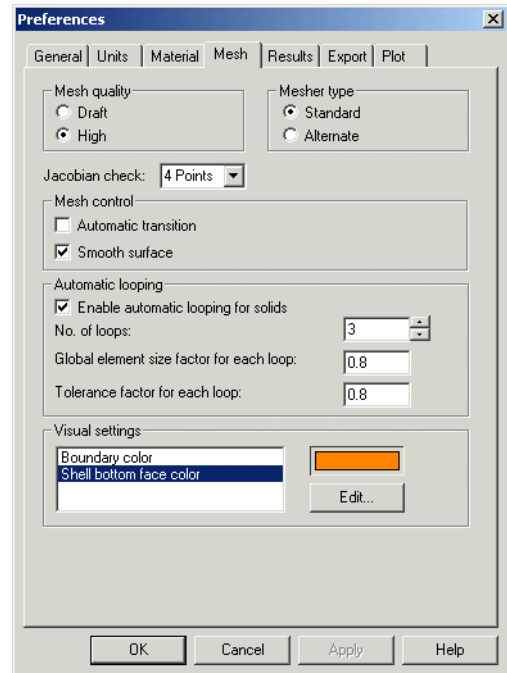
The **Preferences** dialog box appears with the **Mesh** tab selected.

- 3 Under **Mesh quality**, click **High**.
- 4 Under **Mesher type**, click **Standard**.
- 5 Select **4 Points** from the **Jacobian check** menu.
- 6 Under **Mesh Control**, click **Smooth Surface**. Make sure that **Automatic transition** is not checked.
- 7 Click **OK**.

You will return to the **Mesh PropertyManager**.

- 8 Accept the default **Global Size**  and **Tolerance**  suggested by the program and click **OK** .

Meshing starts. When meshing is completed, a check mark appears on the Mesh icon  and the mesh is displayed in the graphics area.



### Step 6: Running the Analysis

In the COSMOSWorks Manager tree, right-click the **My First Study** icon and click **Run**.

Analysis starts. When analysis is completed, COSMOSWorks creates result folders automatically in the COSMOSWorks Manager tree.

### Step 7: Visualizing the Results

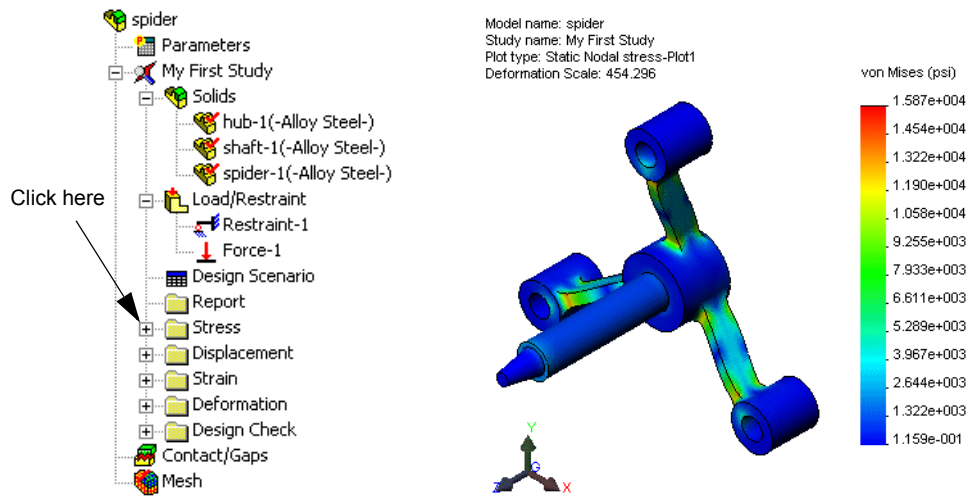
#### von Mises stress

- 1 Click the plus sign  beside the **Stress** folder.

**Plot1** icon appears.

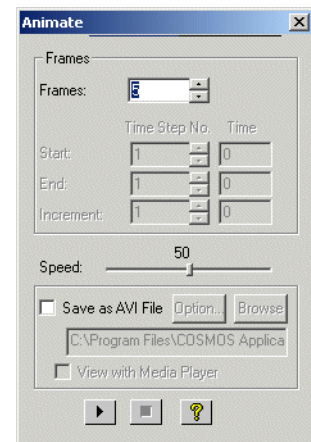
- 2 Double-click **Plot**.

Von Mises stress plot is displayed.



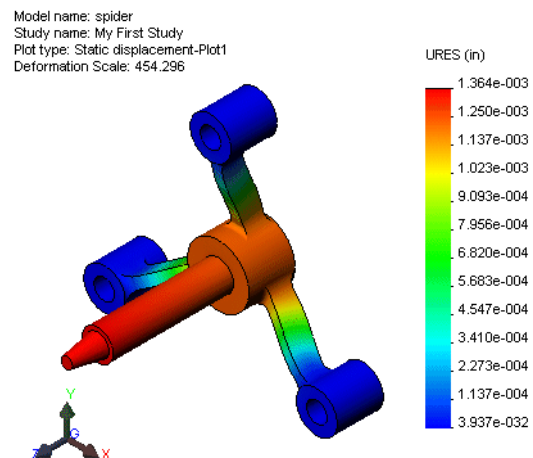
### Animating the Plot

- 1 Right-click **Plot1** and click **Animate**.  
The **Animation** dialog box appears.
- 2 Check **Save as AVI File**, then click **Browse** and select a destination folder to save the AVI file.
- 3 Click to play the animation.
- 4 Click to stop the animation.
- 5 Click to close the **Animation** dialog box.



### Visualizing Resultant Displacements

- 1 Click the plus sign beside the **Displacement** folder.  
**Plot1** icon appears.
- 2 Double-click **Plot1**.  
Resultant displacement plot is displayed.



## Is the Design Safe?

The **Design Check Wizard** can answer this question for you. We will use the wizard to estimate the factor of safety at every point in the model. In the process, you need to select a failure criterion.

- 1 Click the plus sign  $\oplus$  beside the **Design Check** folder.

**Plot1** appears.

- 2 Right-click the **Plot1** icon and select **Edit Definition**.

**Design Check Wizard Step 1 of 3** dialog box appears.

- 3 Under **Criterion**, click **Maximum von Mises stress**.

**Note:** Several criteria are available. The von Mises criterion is usually used to check the failure of ductile materials.

- 4 Click **Next**.

**Design Check Wizard Step 2 of 3** dialog box appears.

- 5 Under **Set stress limit**, click to **Yield strength**.

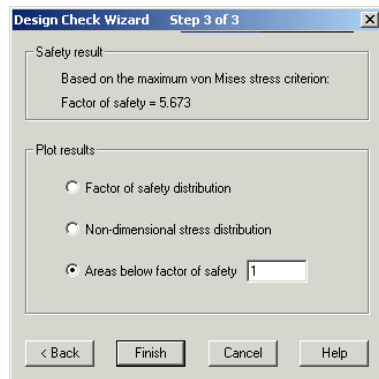
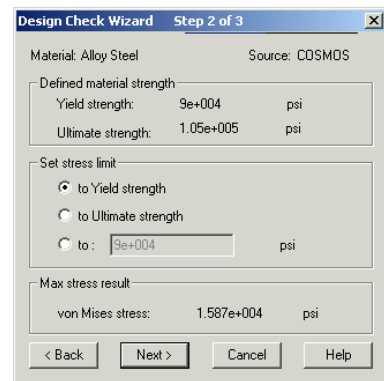
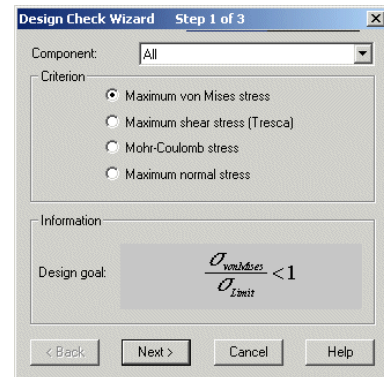
**Note:** When a material yields, it continues to deform even if the load is not increased.

- 6 Click **Next**.

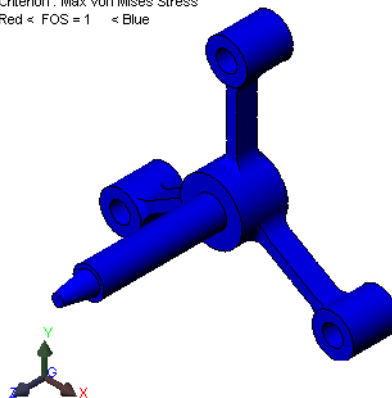
**Design Check Wizard Step 3 of 3** dialog box appears.

- 7 Under **Plot results**, click **Areas below factor of safety** and enter **1**.

- 8 Click **Finish**. The plot is generated.



Model name: spider  
 Study name: My First Study  
 Plot type: Design Check-Plot1  
 Criterion : Max von Mises Stress  
 Red < FOS = 1 < Blue



Rotate the model and look for unsafe areas shown in red. The plot is free from the red color indicating that all locations are safe.

## How Safe is the Design?

- 1 Right-click the **Design Check** folder in the analysis tree and click **Define**.

**Design Check Wizard Step 1 of 3** dialog box appears.

- 2 Click **Next**.

**Design Check Wizard Step 2 of 3** dialog box appears.

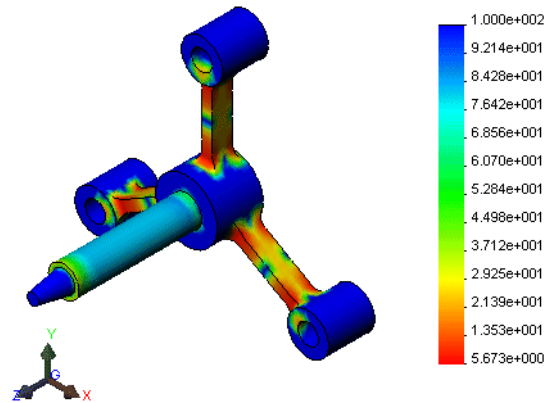
- 3 Click **Next**.

**Design Check Wizard Step 3 of 3** dialog box appears.

- 4 Under **Plot results**, click **Factor of safety distribution**.

- 5 Click **Finish**.

Model name: spider  
Study name: My First Study  
Plot type: Design Check-Plot2  
Criterion: Max von Mises Stress  
Factor of safety distribution: Min FOS = 5.7



The generated plot shows the distribution of the factor of safety. The smallest factor of safety is approximately 5.7.

---

**Note:** A factor of safety of 1.0 at a location means that the material is just starting to yield. A factor of safety of 2.0, for example, means that the design is safe at that location and that the material will start yielding if you double the loads on the model

---

## Saving All Generated Plots

Right-click **My First Study** icon and click **Save all plots as JPEG files**.

The program saves all result plots in the following directory:

“\work\reports\spider-My First Study” inside the COSMOSWorks’ installation directory.

## Generating a Study Report

The **Report** utility helps you document your work quickly and systematically for each study. The program generates structured, Internet-ready reports (HTML files) that describe all aspects related to the study.

- 1 Right-click the **Report** icon and click **Define**.

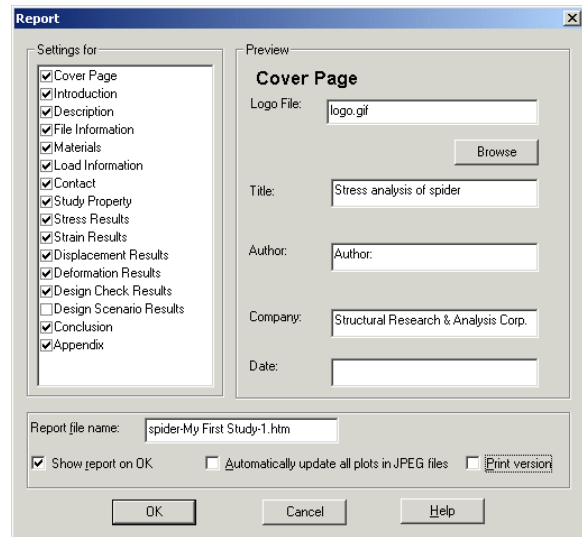
The **Report** dialog box appears.

The **Settings for** list box lists the sections to be included in the report. To include a section, make sure that it is checked. To exclude a section, clear it from the list.

- 2 In the **Logo File** box, browse to the location of your company’s logo file. Admissible formats are: **JPEG Files (\*.jpg)**, **GIF Files (\*.gif)**, or **Bitmap Files (\*.bmp)**.
- 3 In the **Title** box, type a title for your report.

## Lesson 1: Basic Functionality of COSMOSWorks

- 4 Supply the rest of information (**Author**, **Company**, and **Date**) in their respective fields.
- 5 Select the **Show report on OK** check box.
- 6 To edit the contents of a section, highlight it in the **Settings for** box. The **Preview** box lets you enter the desired information in the report.
- 7 Highlight **Conclusion** in the **Settings for** list and enter a conclusion of your study in the box to the right.
- 8 Click **OK**.




The report opens in your default internet browser.

Also, the program creates an icon in the Report folder in the COSMOSWorks Manager tree.

To edit any section of the report, right-click the report icon and click **Edit Definition**. Modify the section and click **OK** to replace the existing report.

## Save Your Work and Exit SolidWorks

- 1 Click  on the Standard toolbar or click **File, Save**.
- 2 Click **File, Exit** on the Main menu.

## 5 Minute Assessment

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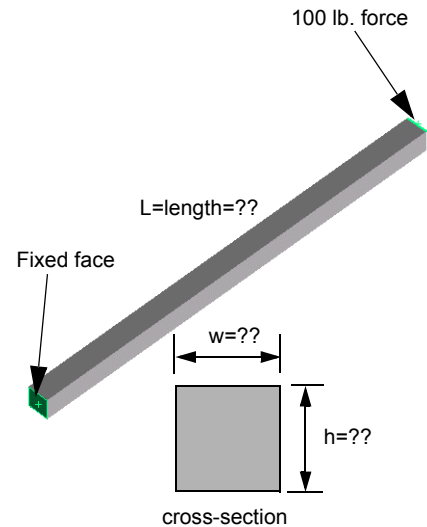
- 1 How do you start a COSMOSWorks session?  
\_\_\_\_\_  
\_\_\_\_\_
- 2 What do you do if COSMOSWorks menu is not on the SolidWorks' menu bar?  
\_\_\_\_\_  
\_\_\_\_\_
- 3 What types of documents can COSMOSWorks analyze? \_\_\_\_\_  
\_\_\_\_\_
- 4 What is analysis? \_\_\_\_\_  
\_\_\_\_\_
- 5 Why analysis is important? \_\_\_\_\_  
\_\_\_\_\_
- 6 What is an analysis study? \_\_\_\_\_  
\_\_\_\_\_
- 7 What types of analysis COSMOSWorks can perform? \_\_\_\_\_  
\_\_\_\_\_
- 8 What does static analysis calculate? \_\_\_\_\_  
\_\_\_\_\_
- 9 Why static analysis is important? \_\_\_\_\_  
\_\_\_\_\_
- 10 What is stress? \_\_\_\_\_  
\_\_\_\_\_
- 11 What are the main steps in performing analysis? \_\_\_\_\_  
\_\_\_\_\_
- 12 How can you change the material of a part? \_\_\_\_\_  
\_\_\_\_\_
- 13 What tool do you use to check the safety of your design? \_\_\_\_\_  
\_\_\_\_\_
- 14 The Design Check Wizard shows a factor of safety of 0.8 at some locations. Is your design safe? \_\_\_\_\_  
\_\_\_\_\_

## Projects — Deflection of a Beam Due to an End Force

Some simple problems have exact answers. One of these problems is a beam loaded by a force at its tip as shown in the figure. We will use COSMOSWorks to solve this problem and compare its results with the exact solution.

### Tasks

- 1 Open the `cantilever.sldprt` file located in the `Examples` folder of the COSMOSWorks installation directory.
- 2 Measure the width, height, and length of the cantilever.
- 3 Save the part to another name.
- 4 Switch to the COSMOSWorks Manager tree.
- 5 Create a static study.
- 6 Assign `Alloy Steel` to the part. What is the value of the elastic modulus in psi?  
**Answer:** \_\_\_\_\_
- 7 Fix one of the end faces of the cantilever.
- 8 Apply a downward force to the upper edge of the other end face with magnitude of 100 lb.
- 9 Mesh the part and run the analysis.
- 10 Plot the displacement in the Y-direction. The Y-direction is the same as dir 2 of Plane1. What is the maximum Y-displacement at the free end of the cantilever?



- 11 Calculate the theoretical vertical displacement at the free end using the following relation:  
**Answer:** \_\_\_\_\_
- 12 Calculate the error in the vertical displacement using the following relation:

$$UY_{Theory} = \frac{4FL^3}{Ewh^3}$$

**Answer:** \_\_\_\_\_  
\_\_\_\_\_

$$ErrorPercentage = \left( \frac{UY_{Theory} - UY_{COSMOS}}{UY_{Theory}} \right) 100$$

**Answer:** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Lesson 1 Vocabulary Worksheet**

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Name \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

*Fill in the blanks with the proper words.*

- 1 The sequence of creating a model in SolidWorks, manufacturing a prototype, and testing it: \_\_\_\_\_
- 2 A *what-if* scenario of analysis type, materials, restraints, and loads: \_\_\_\_\_
- 3 The method that COSMOSWorks uses to perform analysis: \_\_\_\_\_
- 4 The type of study that calculates displacements, strains, and stresses: \_\_\_\_\_
- 5 The process of subdividing the model into small pieces: \_\_\_\_\_
- 6 Small pieces of simple shapes created during meshing: \_\_\_\_\_
- 7 Elements share common points called: \_\_\_\_\_
- 8 The force acting on an area divided by that area: \_\_\_\_\_
- 9 The sudden collapse of slender designs due to axial compressive loads: \_\_\_\_\_
- 10 A study that calculates how hot a design gets: \_\_\_\_\_
- 11 A number that provides a general description of the state of stress: \_\_\_\_\_
- 12 Normal stresses on planes where shear stresses vanish: \_\_\_\_\_
- 13 The frequencies that a body tends to vibrate in: \_\_\_\_\_
- 14 The type of analysis that can help you avoid resonance: \_\_\_\_\_

## Lesson 1 Quiz

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Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

*Directions: Answer each question by writing the correct answer or answers in the space provided.*

- 1 How do you switch between the COSMOSWorks Manager and the FeatureManager? \_\_\_\_\_  
\_\_\_\_\_
- 2 You test your design by creating a study. What is a study? \_\_\_\_\_  
\_\_\_\_\_
- 3 What types of analyses can you perform in COSMOSWorks? \_\_\_\_\_  
\_\_\_\_\_
- 4 After obtaining the results of a study, you changed the material, loads, and/or restraints. Do you have to mesh again? \_\_\_\_\_  
\_\_\_\_\_
- 5 After meshing a study, you changed the geometry. Do you need to mesh the model again? \_\_\_\_\_  
\_\_\_\_\_
- 6 How do you create a new static study? \_\_\_\_\_  
\_\_\_\_\_
- 7 What is a mesh? \_\_\_\_\_  
\_\_\_\_\_
- 8 In an assembly, how many icons you expect to see in the Solids folder? \_\_\_\_\_