3D SolidWorks Tutorial

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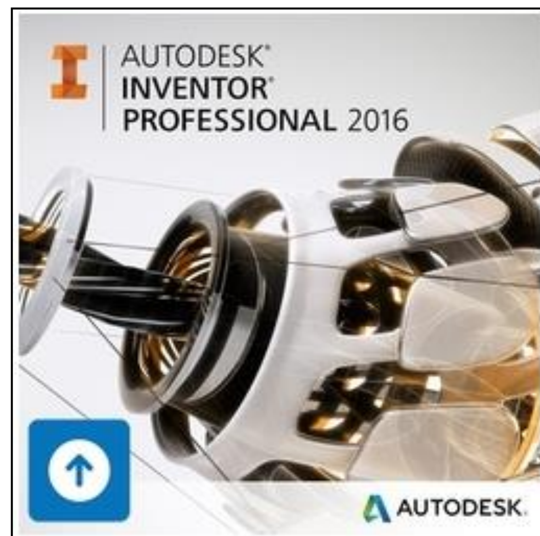
2-11-16 3D_SolidWorks_Tutorial.pptx

INTRODUCTION - 3D DESIGN SOFTWARE

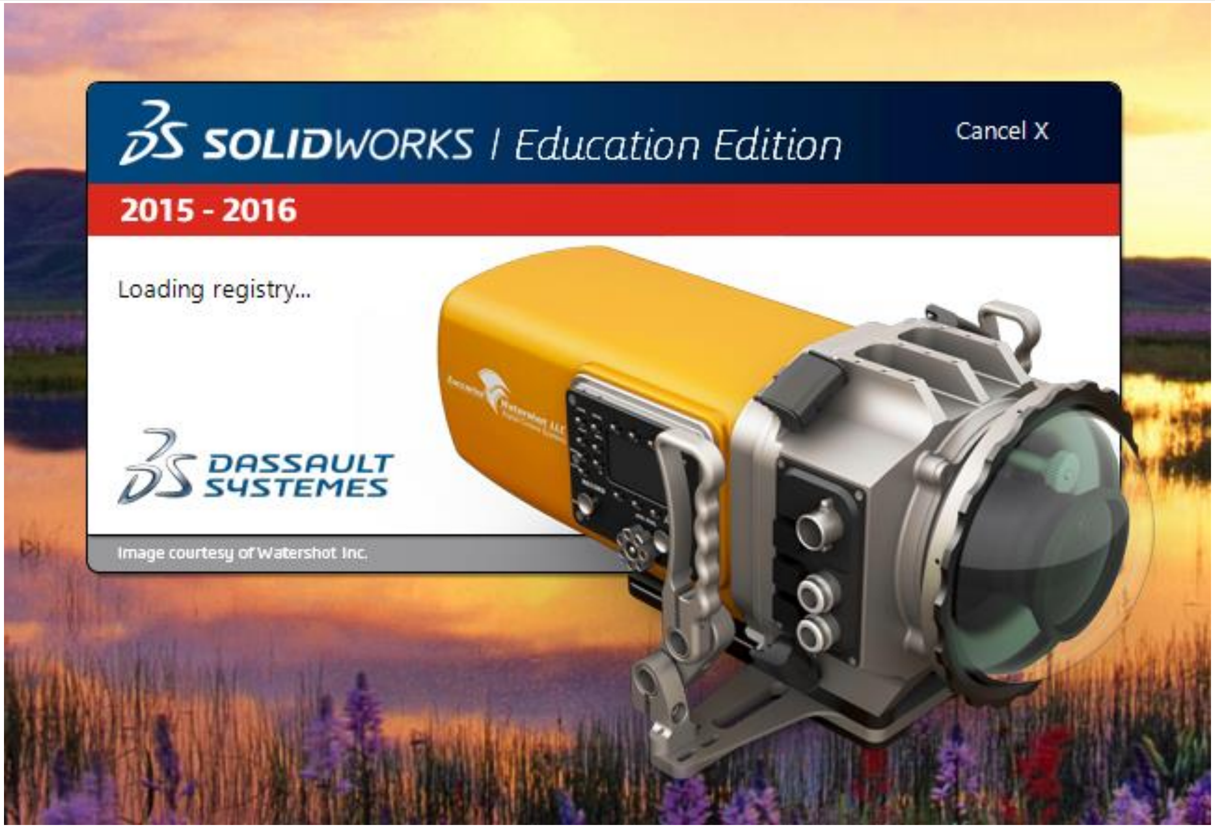
There are a few different kinds of 3D design software available for use by RIT students. The preferred software for compatibility with the 3D printers is Inventor. This software can be downloaded for free by students from the internet. SolidWorks is another software that can be found on RIT computers in Mechanical Engineering. Both of these programs use similar vocabulary and functions, so after learning one software, it is not difficult to transition to another. The basic operations are either identical or very similar with only minor nuances between programs.

SOLIDWORKS



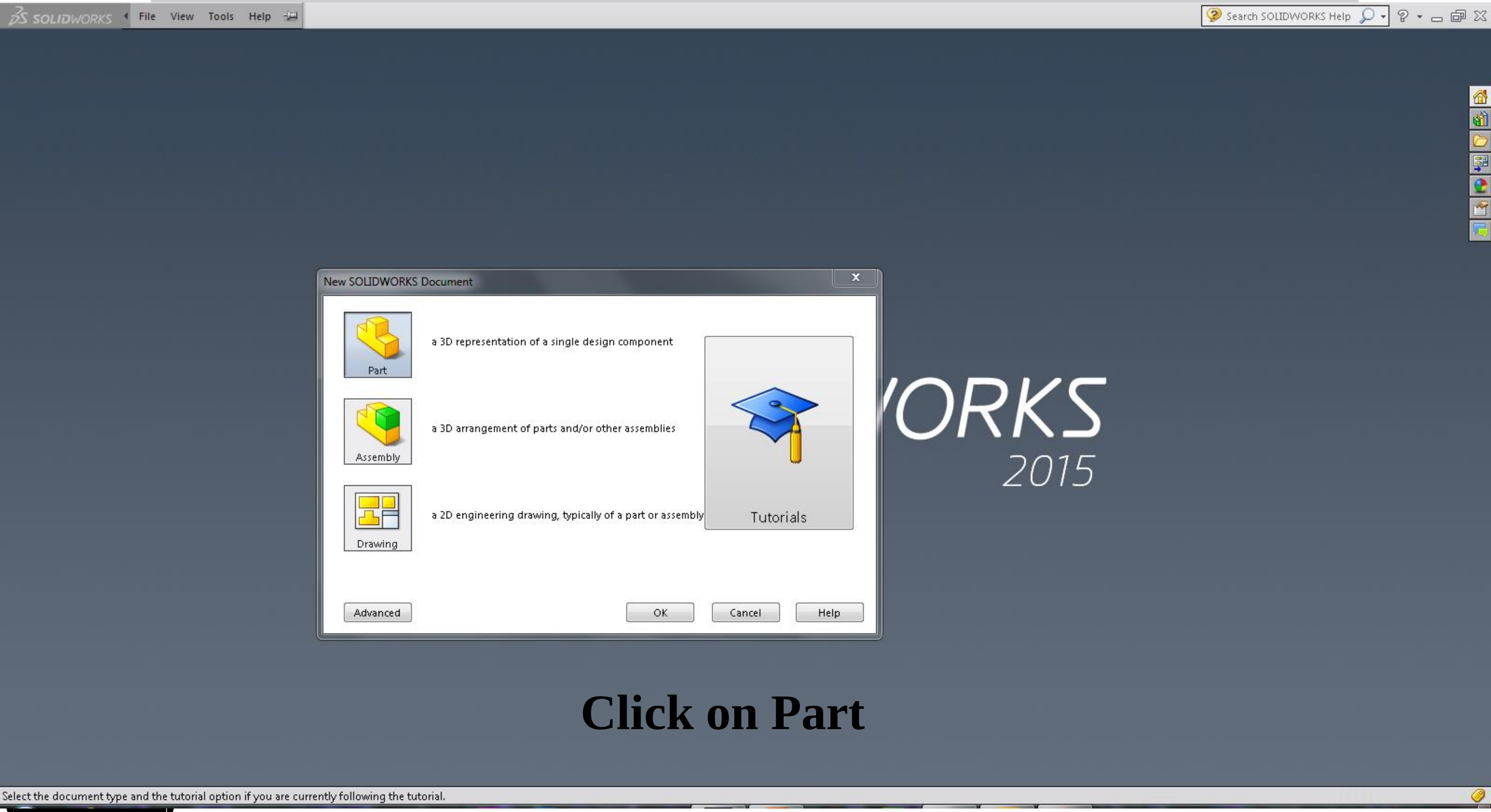
Above graphics from software websites.

SOLIDWORKS EDUCATION EDITION



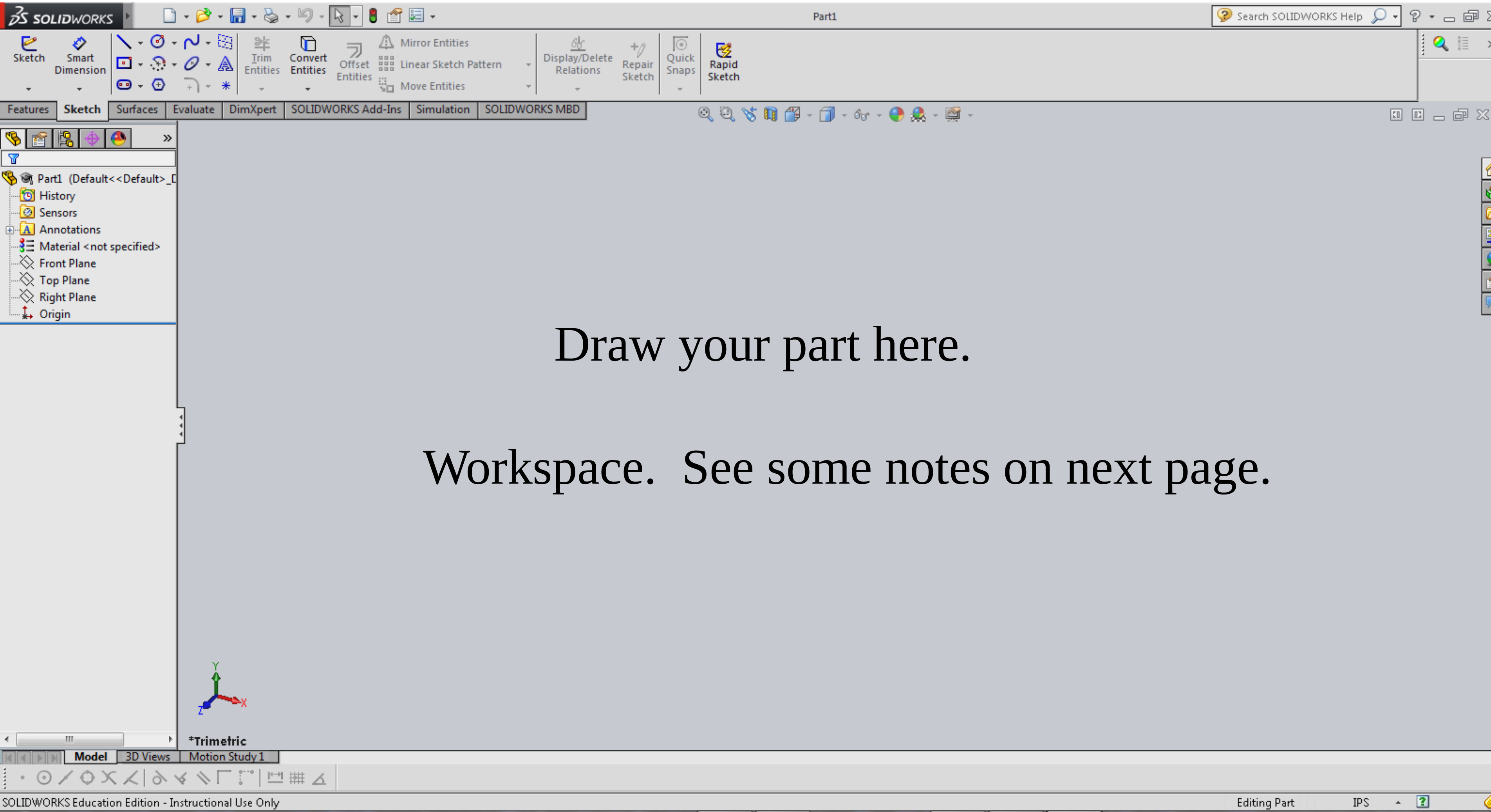
Software is available in the PC labs owned by the Mechanical Engineering Department. You can use these PC's (except sometimes when a class/lab is being taught). You can sign on with your RIT user account and password. PC labs in GLE-2260 and ENG-1535.

SOLID WORKS SOFTWARE



Click on Part

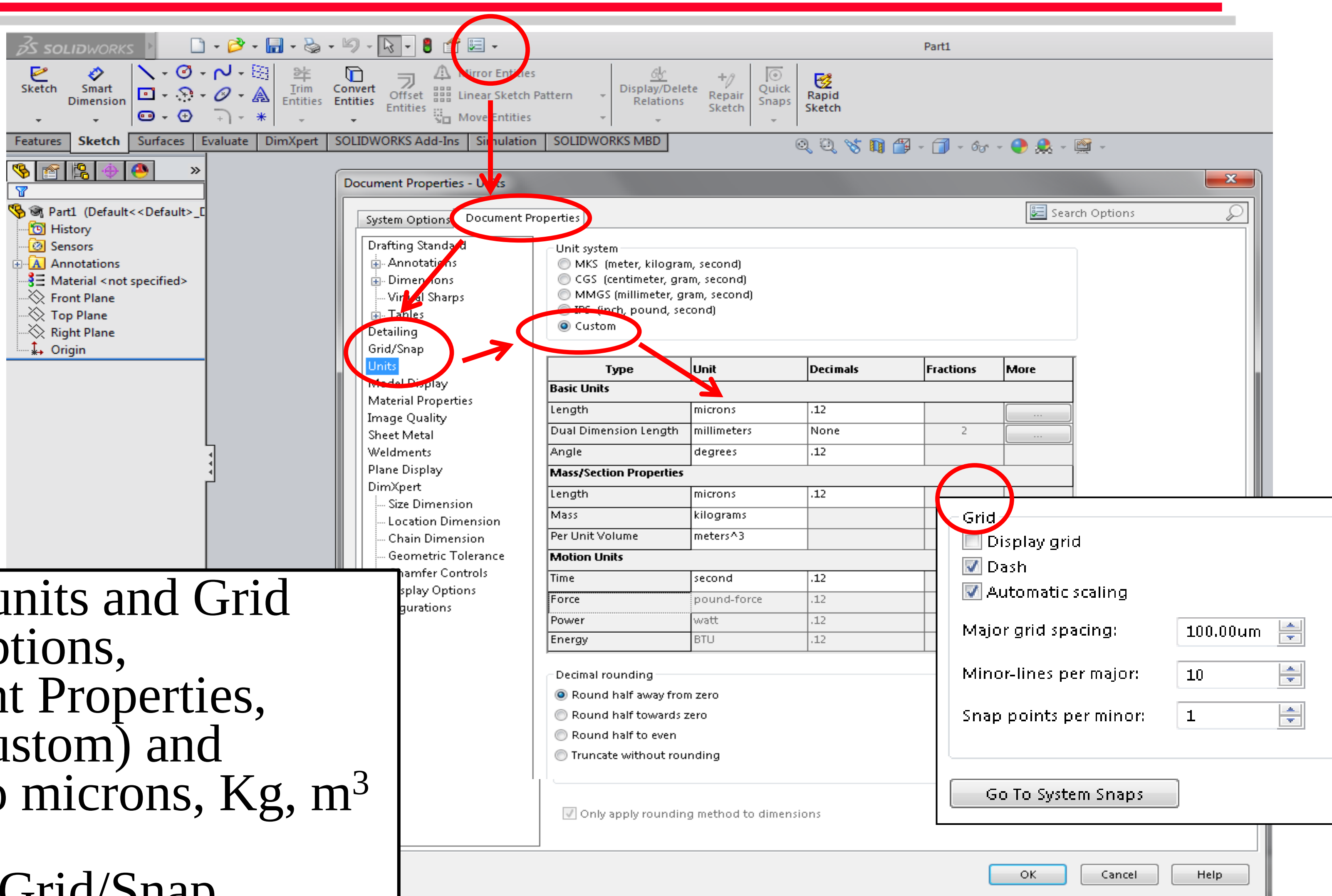
WORKSPACE



Draw your part here.

Workspace. See some notes on next page.

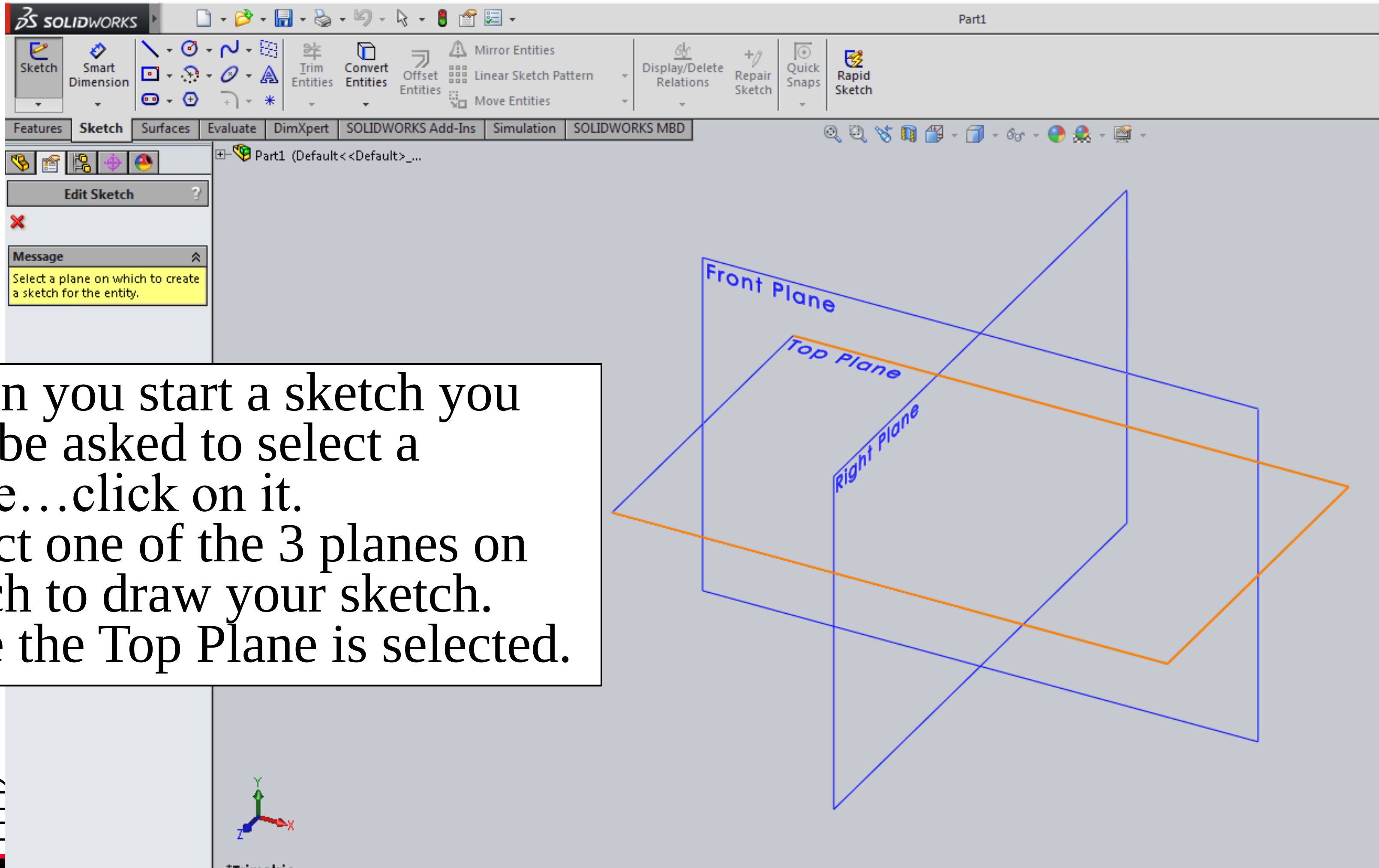
SET UNITS AND GRID



First set units and Grid
Select Options,
Document Properties,
Units (Custom) and
change to microns, Kg, m^3

Then set Grid/Snap

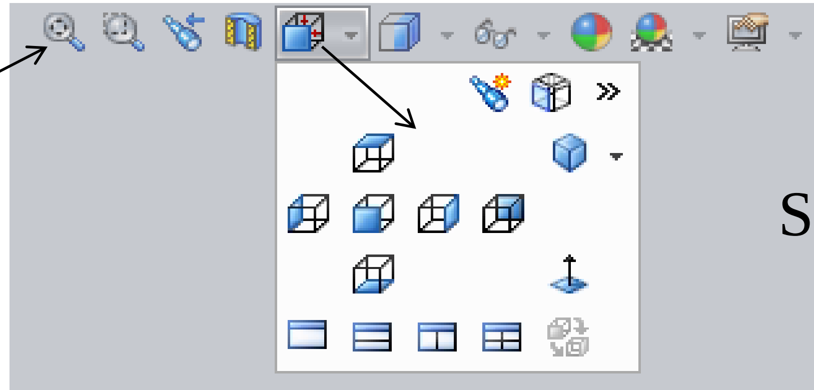
SELECT PLANE… START SKETCH



When you start a sketch you will be asked to select a plane…click on it.
Select one of the 3 planes on which to draw your sketch.
Here the Top Plane is selected.

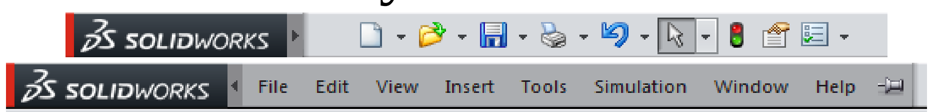
CHANGE VIEWS AND BANNERS

Fit to view

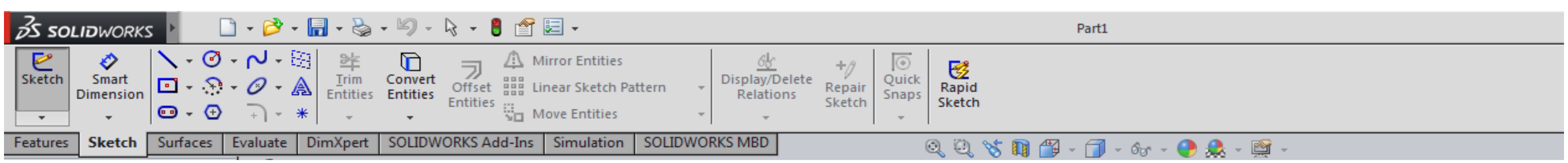


Select different views

Middle mouse button lets you zoom in/out and rotate the view

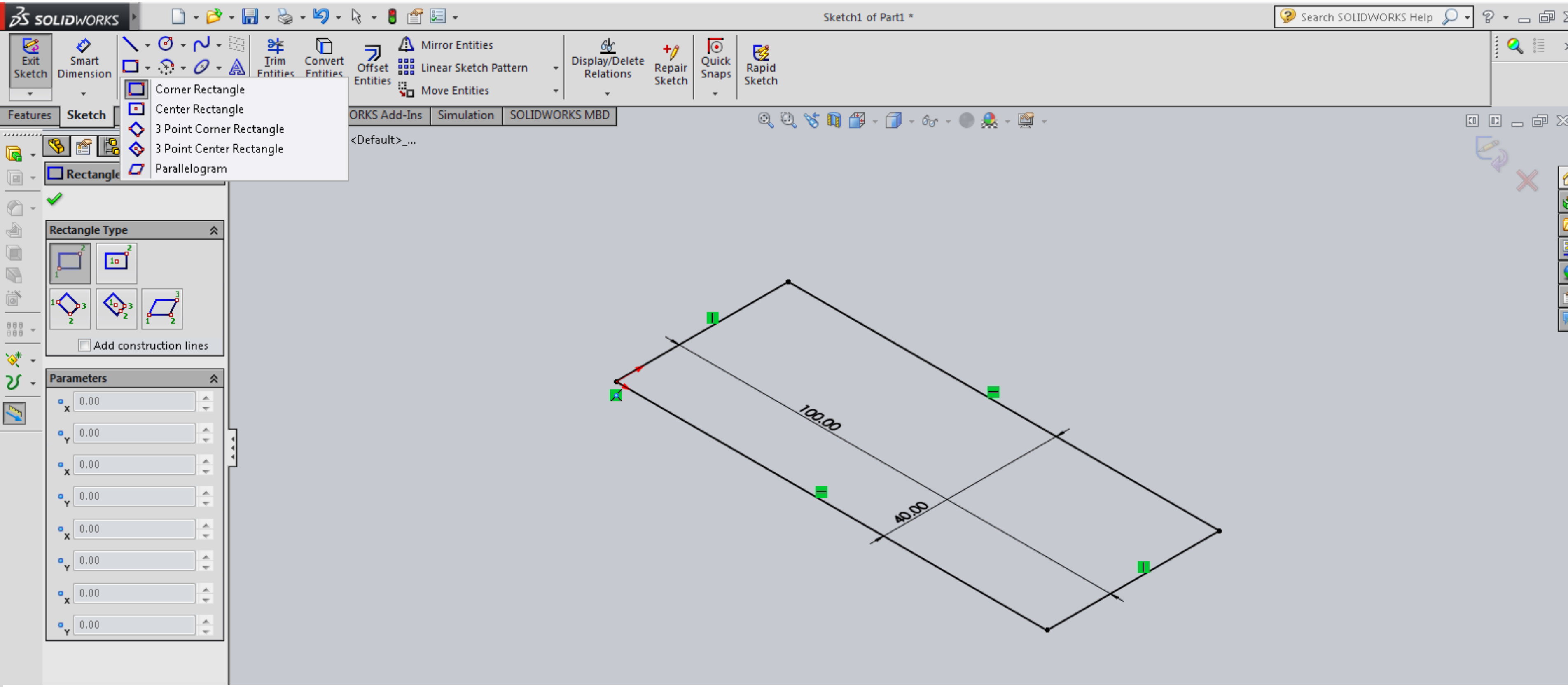


Top banner can be symbols or tabs, click on small arrow on left



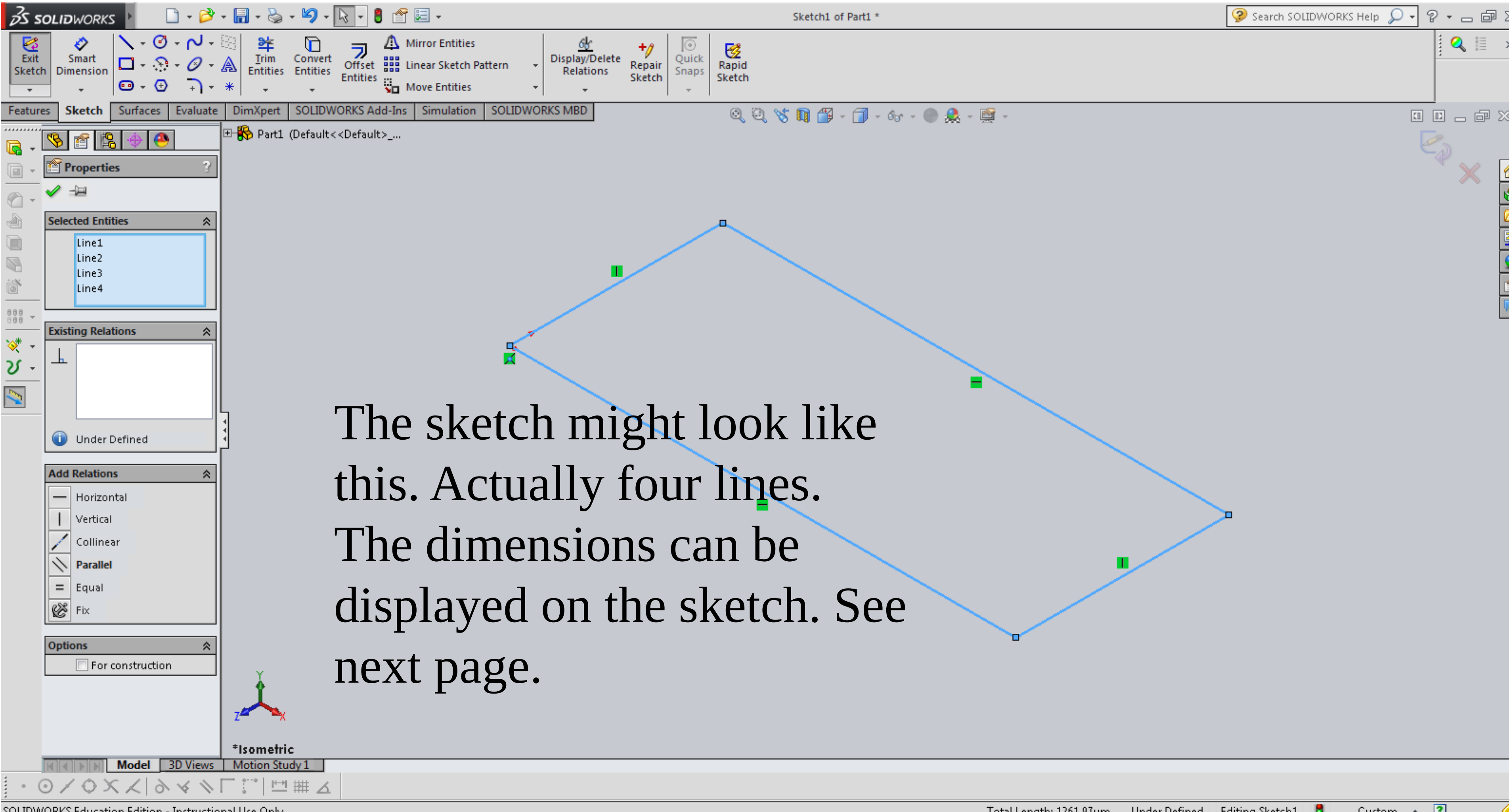
Tools banner is shown under top banner.
Note: you can select visible tabs by right clicking on any of the existing tabs and selecting the tabs you want shown.

EXAMPLE SKETCH USING CORNER RECTANGLE



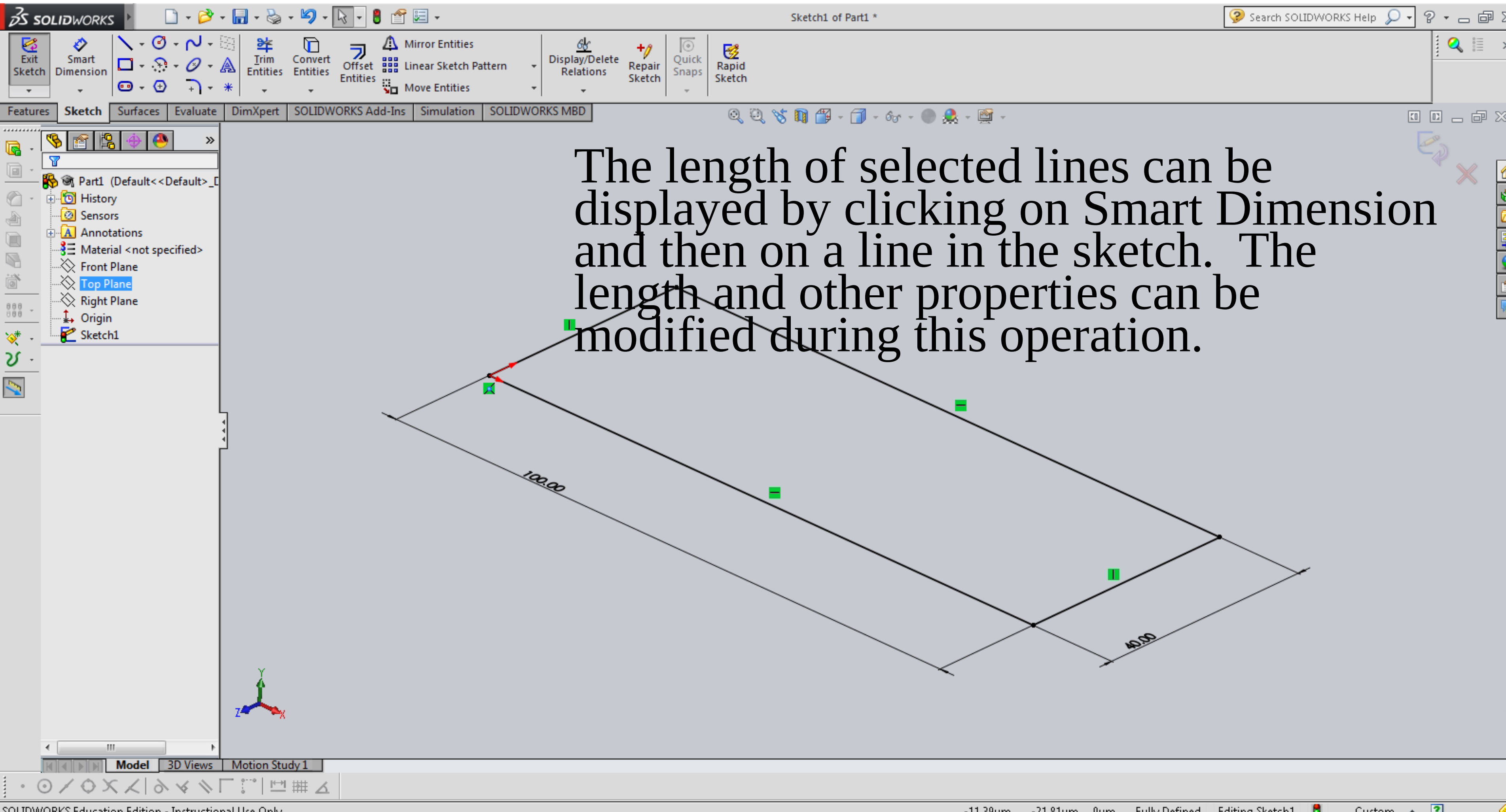
To draw a 100um by 40um rectangle. Click Sketch and Corner Rectangle. Then zoom in on the origin symbol using the middle mouse button (roll towards you) so that the 100um size rectangle can be seen once defined. Then click on the dot at the origin and drag to the other corner (approximate dimensions). The exact dimensions can be set in the parameters box on the left. When that object is correct click on the green check mark.

SKETCH



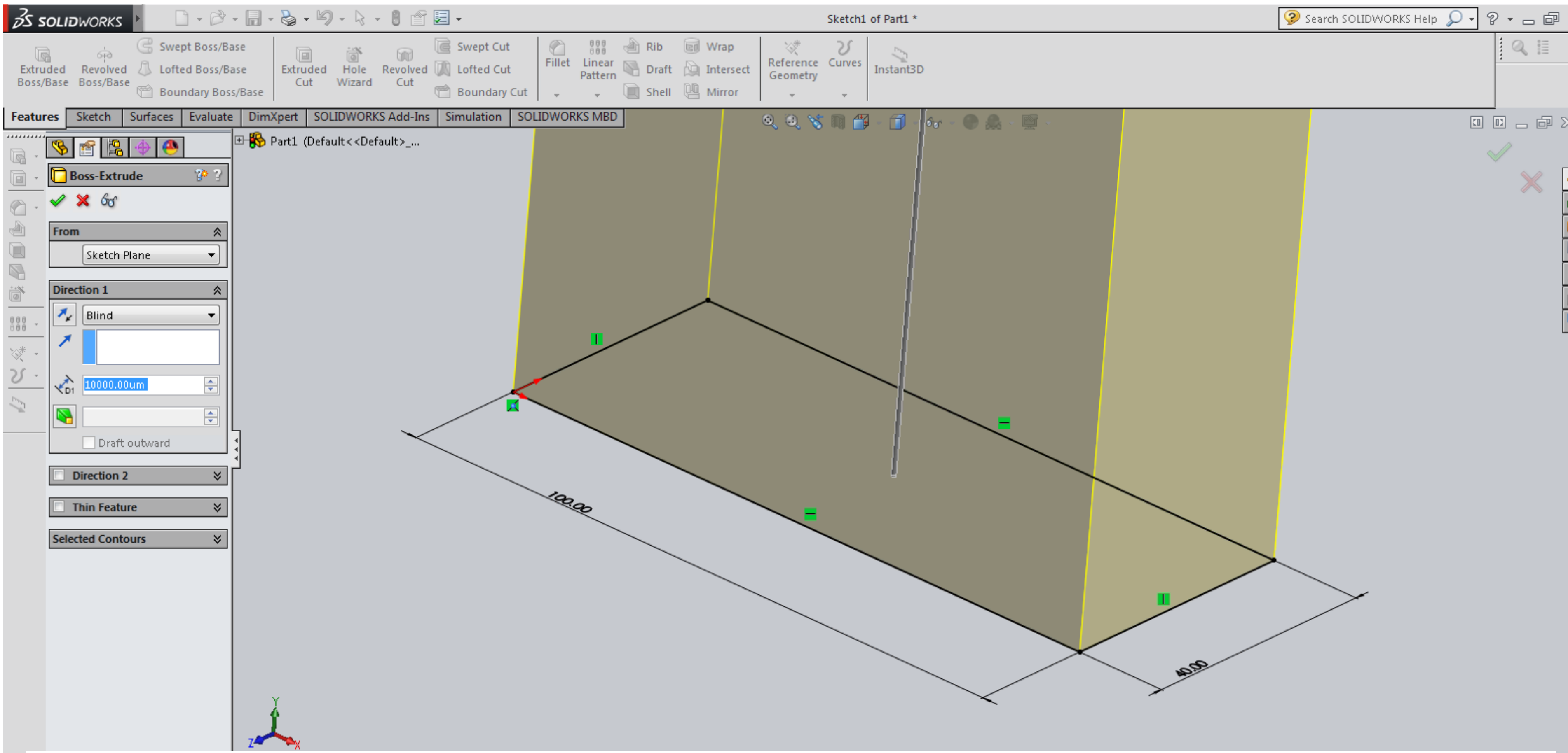
The sketch might look like this. Actually four lines. The dimensions can be displayed on the sketch. See next page.

SMART DIMENSION



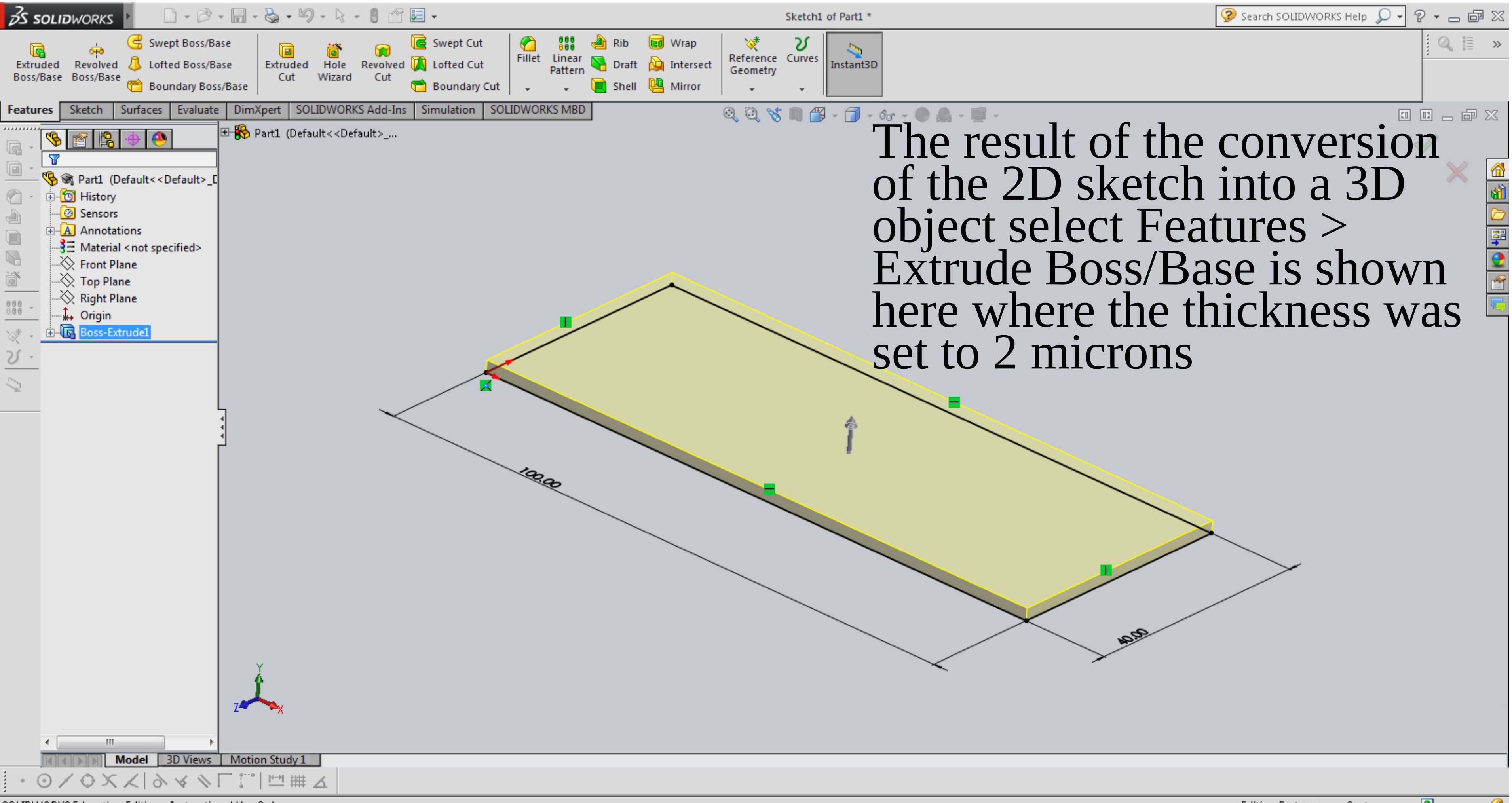
The length of selected lines can be displayed by clicking on Smart Dimension and then on a line in the sketch. The length and other properties can be modified during this operation.

EXTRUDE 2D SKETCH TO MAKE 3D OBJECT



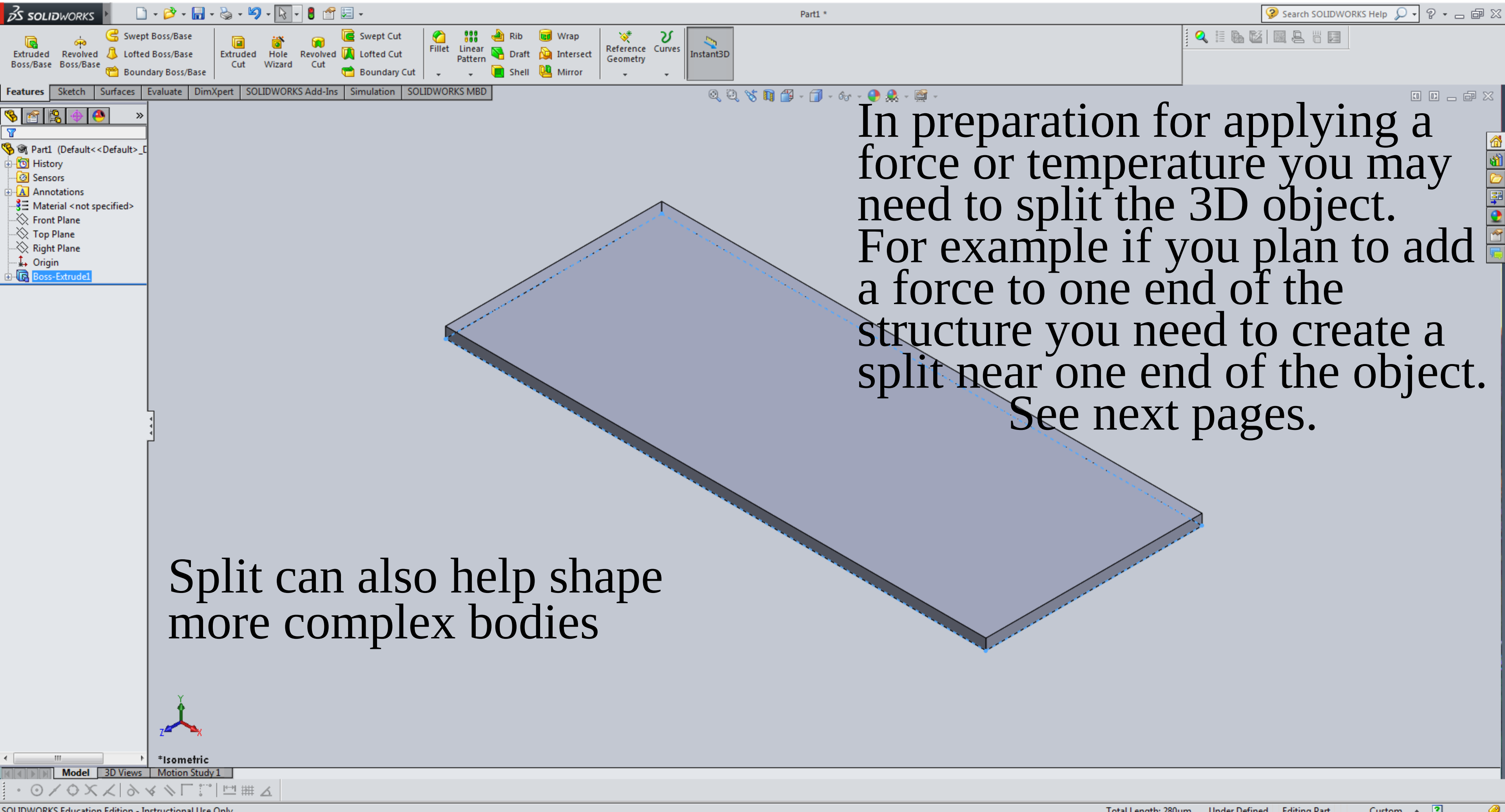
To convert the 2D sketch into a 3D object select Features > Extrude Boss/Base. Set the height in the properties box on the left. Click on the green check box when done.

2D EXTRUDE TO 3D AND Y DIMENSION SET TO 2um



The result of the conversion of the 2D sketch into a 3D object select Features > Extrude Boss/Base is shown here where the thickness was set to 2 microns

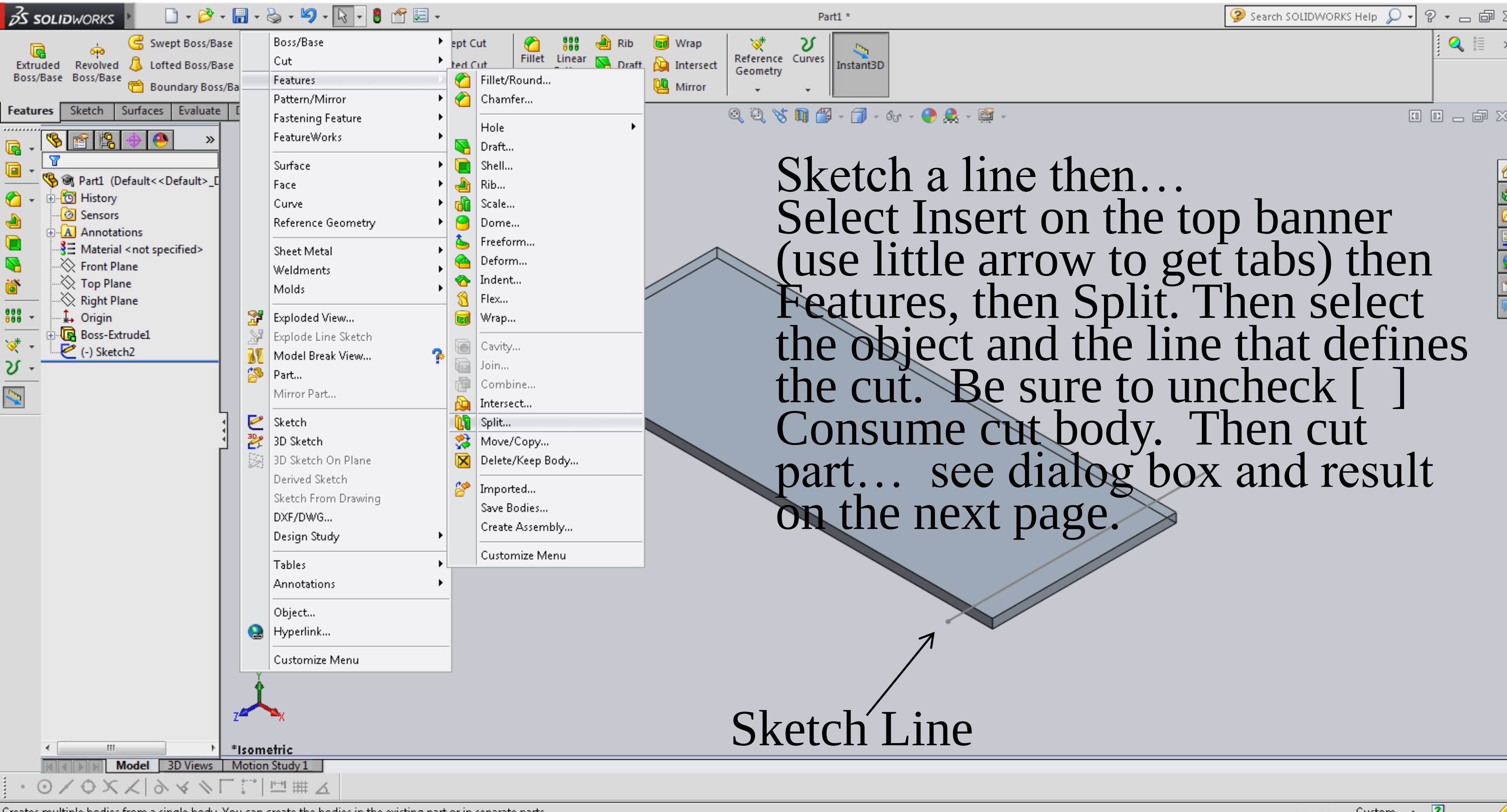
INSERTING A SPLIT



In preparation for applying a force or temperature you may need to split the 3D object. For example if you plan to add a force to one end of the structure you need to create a split near one end of the object. See next pages.

Split can also help shape more complex bodies

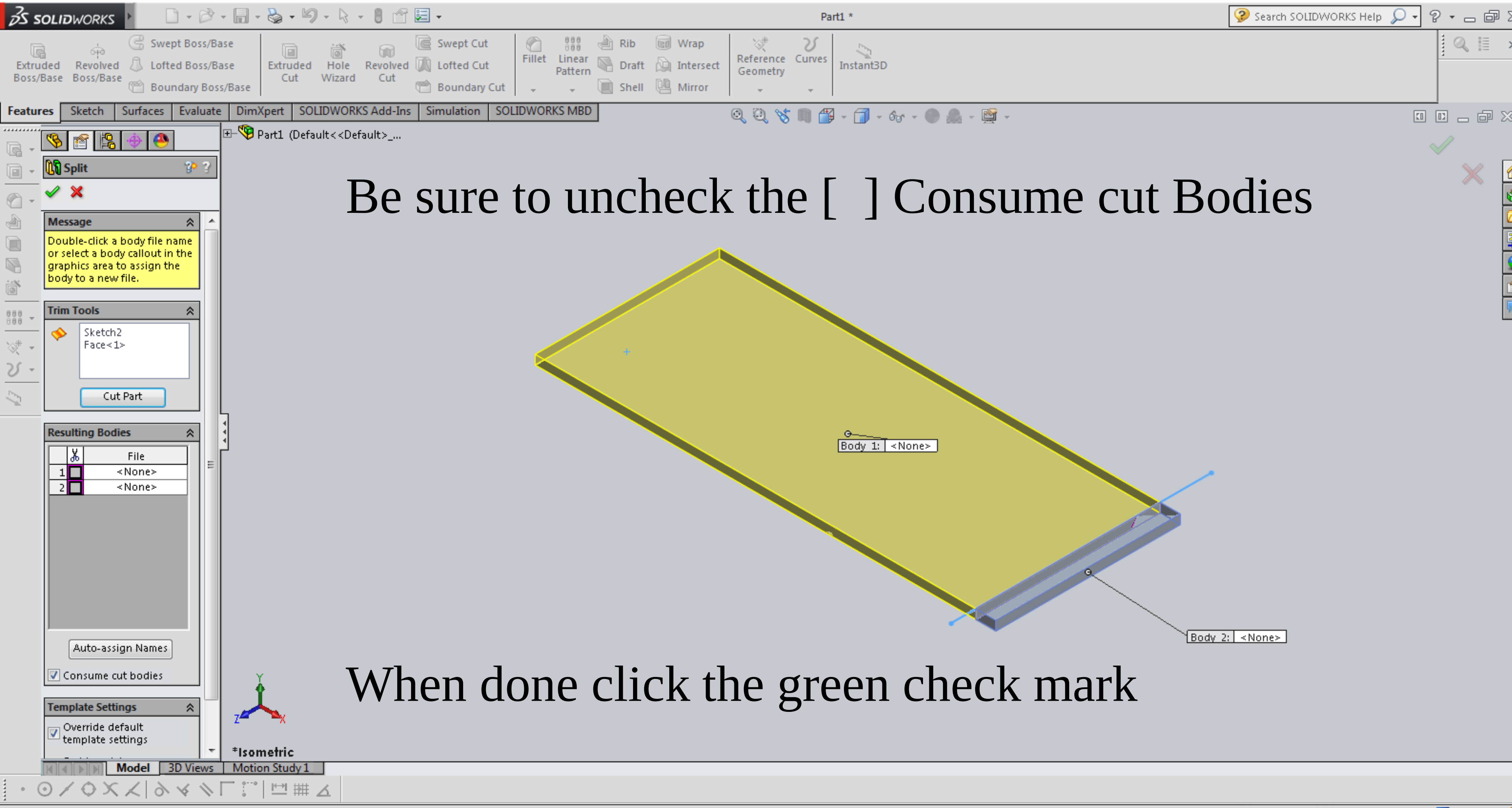
SPLIT



Sketch a line then…
Select Insert on the top banner (use little arrow to get tabs) then Features, then Split. Then select the object and the line that defines the cut. Be sure to uncheck [ ] Consume cut body. Then cut part… see dialog box and result on the next page.

Sketch Line

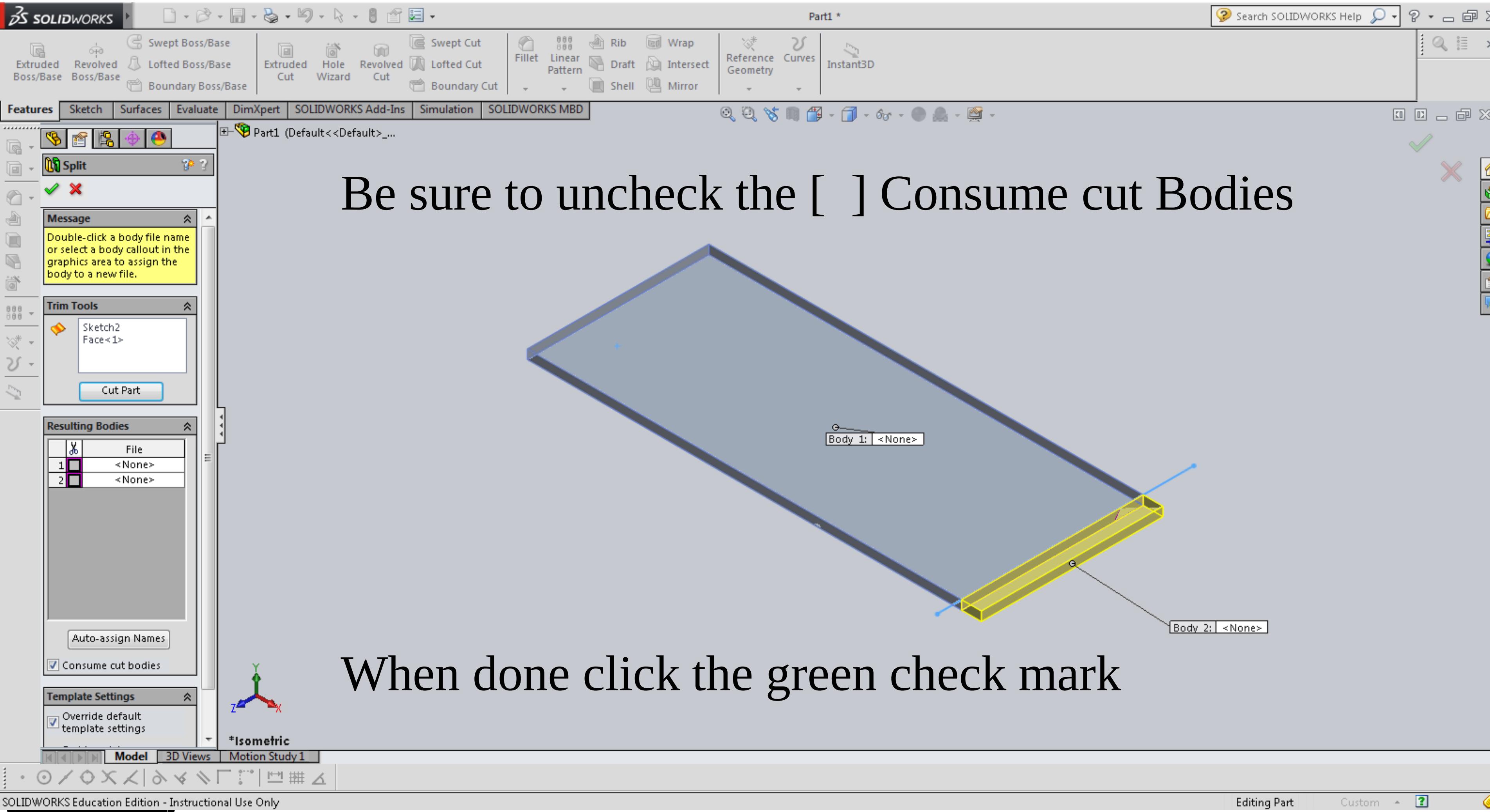
VIEW OF BODY 1 AFTER SPLIT



Be sure to uncheck the [ ] Consume cut Bodies

When done click the green check mark

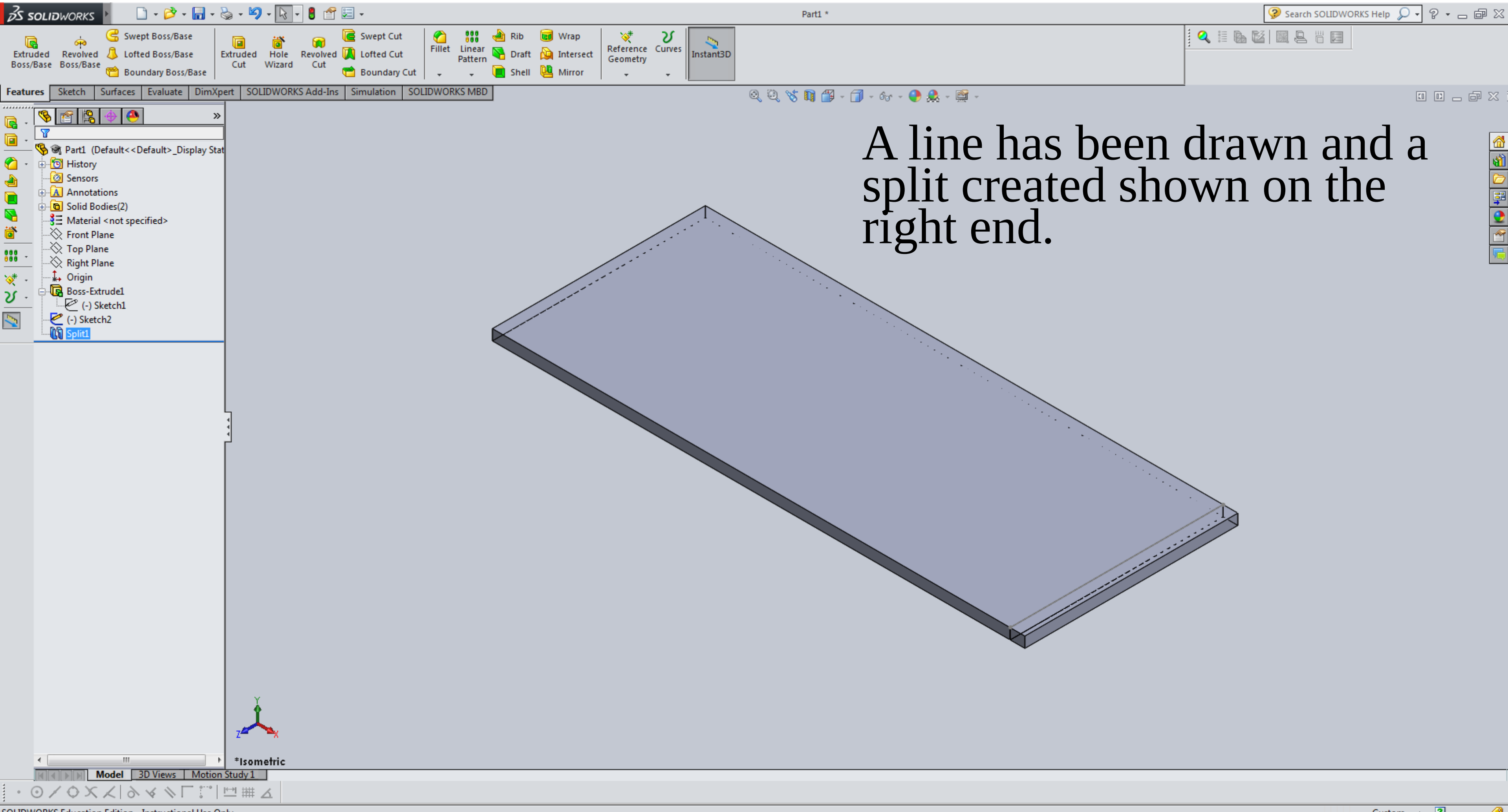
VIEW OF BODY 2 AFTER SPLIT



Be sure to uncheck the [ ] Consume cut Bodies

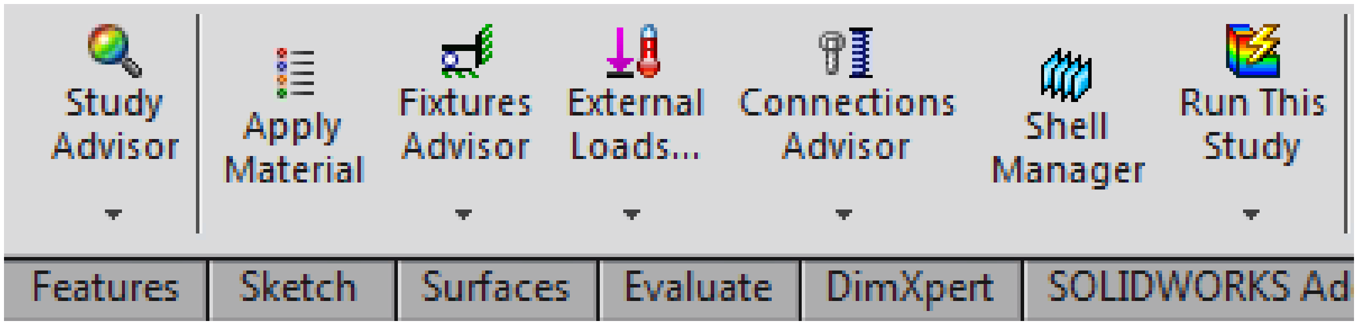
When done click the green check mark

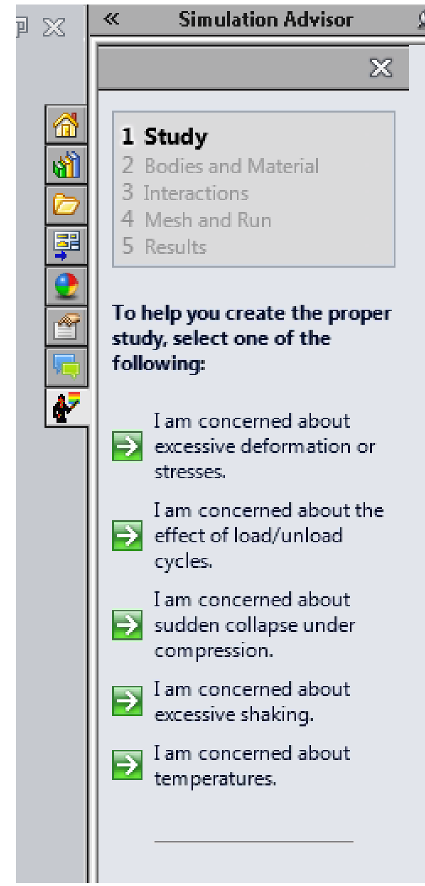
COMPLETED SPLIT



A line has been drawn and a split created shown on the right end.

STUDY (SIMULATION)





Apply Material
Fixtures to support structure
External Loads
.
.
Create Mesh
Run This Study

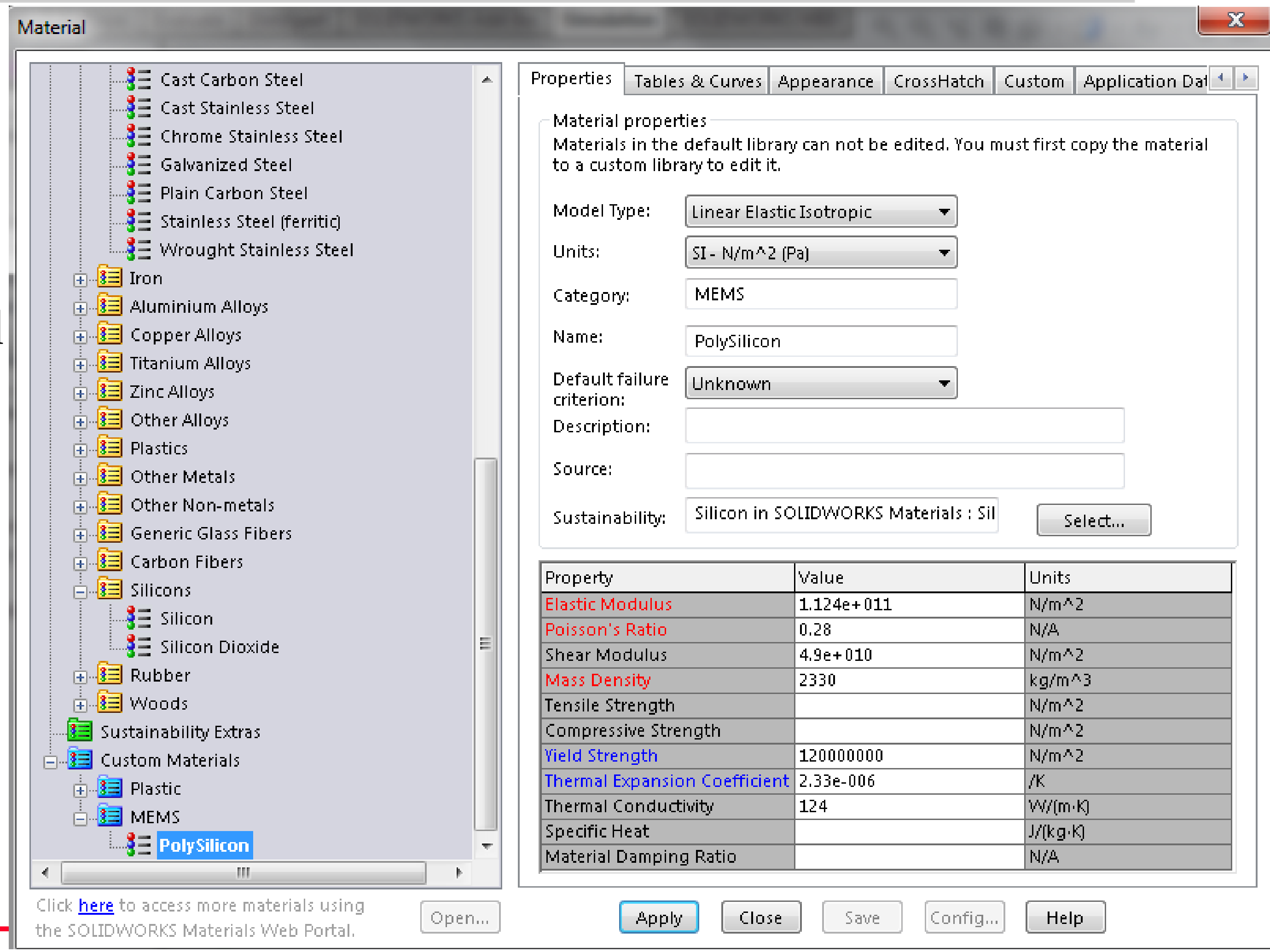
PROPERTIES OF SI, Al, SiO2, Si3N4

	Silicon	Aluminum	SiO2	Si3N4
Density (g/cm3)	2.33	2.7	2.5	3.1
Thermal Expansion (E-6/(°C)	2.6			
Thermal Conductivity (w/(m°C)	149			
Young's Modulus (GPa)	112	68	73	385
Shear Modulus (GPa)	70			
Poisson Ratio	0.28			
Yield Strength (GPa)	12			
Tensile Strength (GPa)	14			
More				
.				
.				

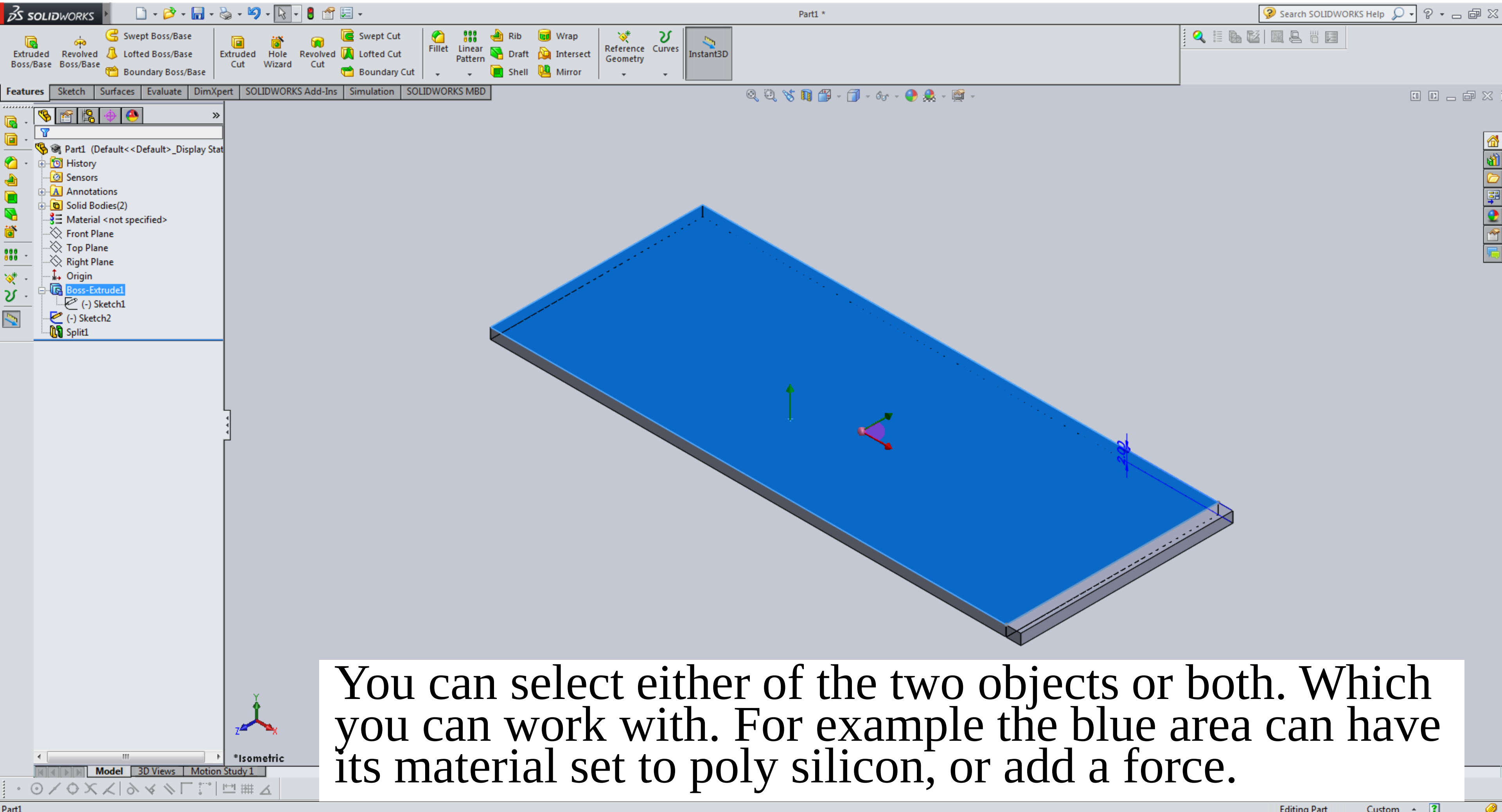
still working on these entries

CREATING A CUSTOM MATERIAL

Create a new folder (such as MEMS) in the Custom Materials folder.
Copy Silicon from the Silicons folder and put it the folder created and name it Polysilicon
Click on Polysilicon, enter Thermal Coefficient of expansion 2.33E-6/°K
Apply
Close

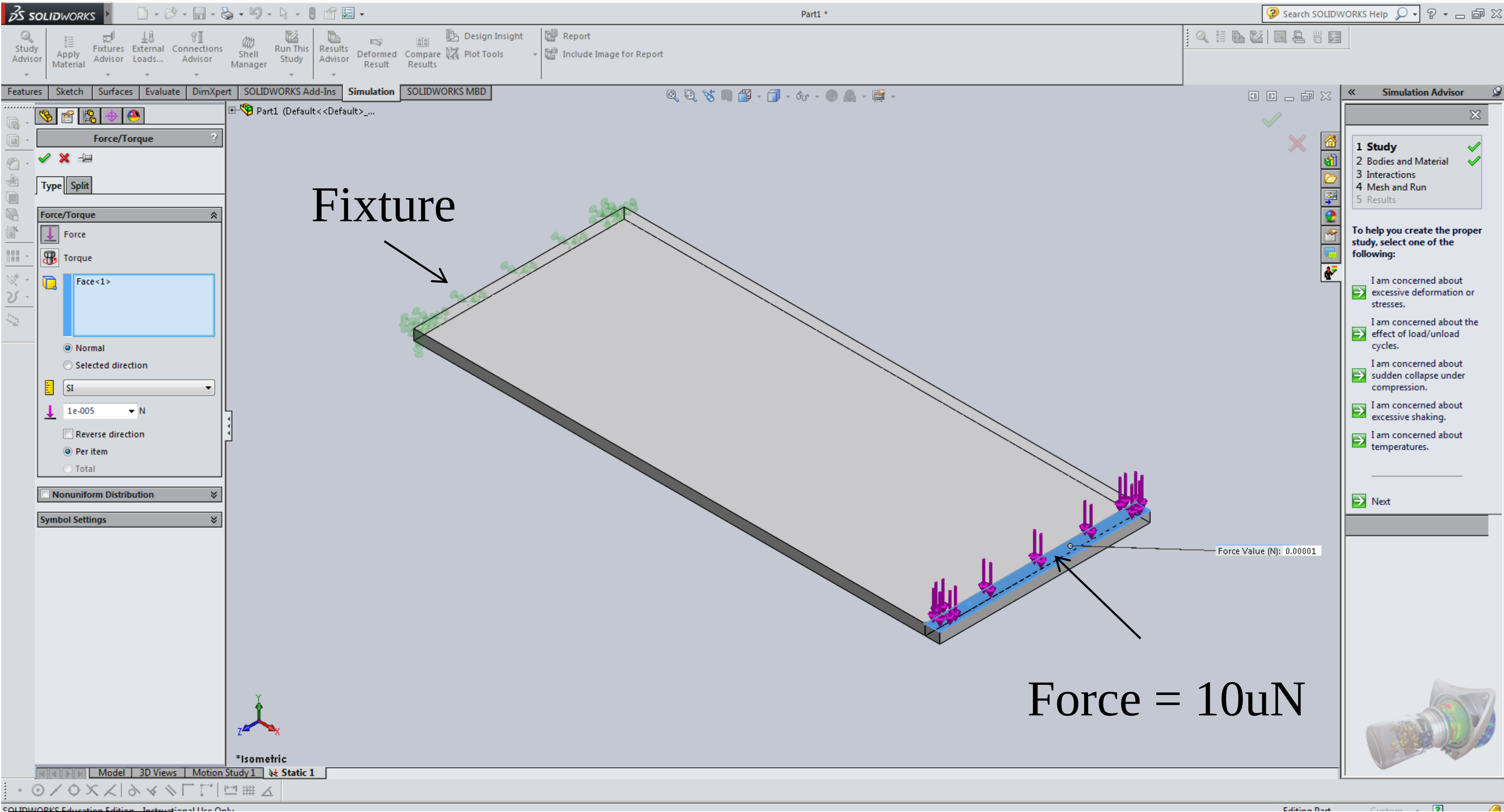


SELECT SPLIT BODIES

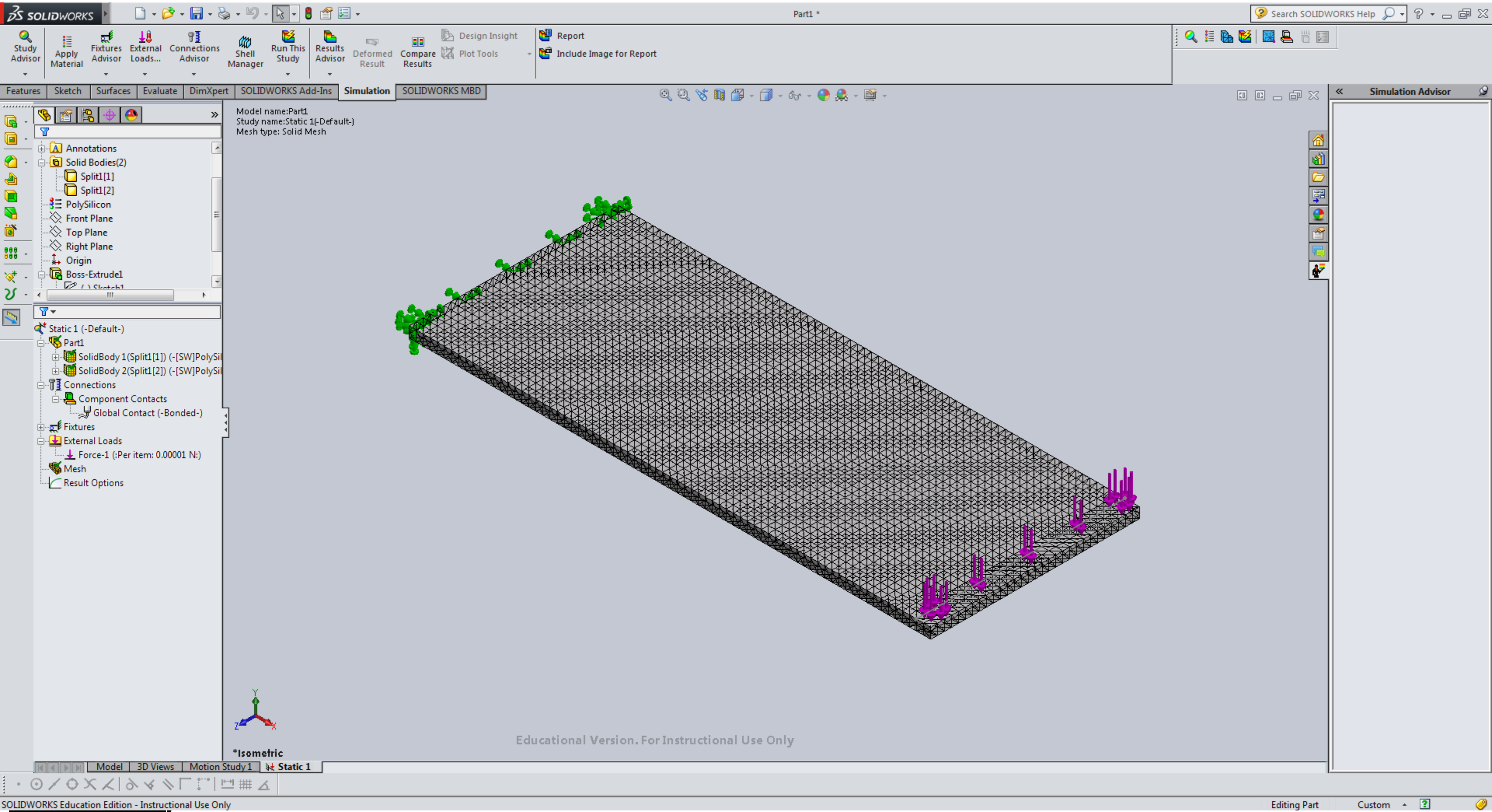


You can select either of the two objects or both. Which you can work with. For example the blue area can have its material set to poly silicon, or add a force.

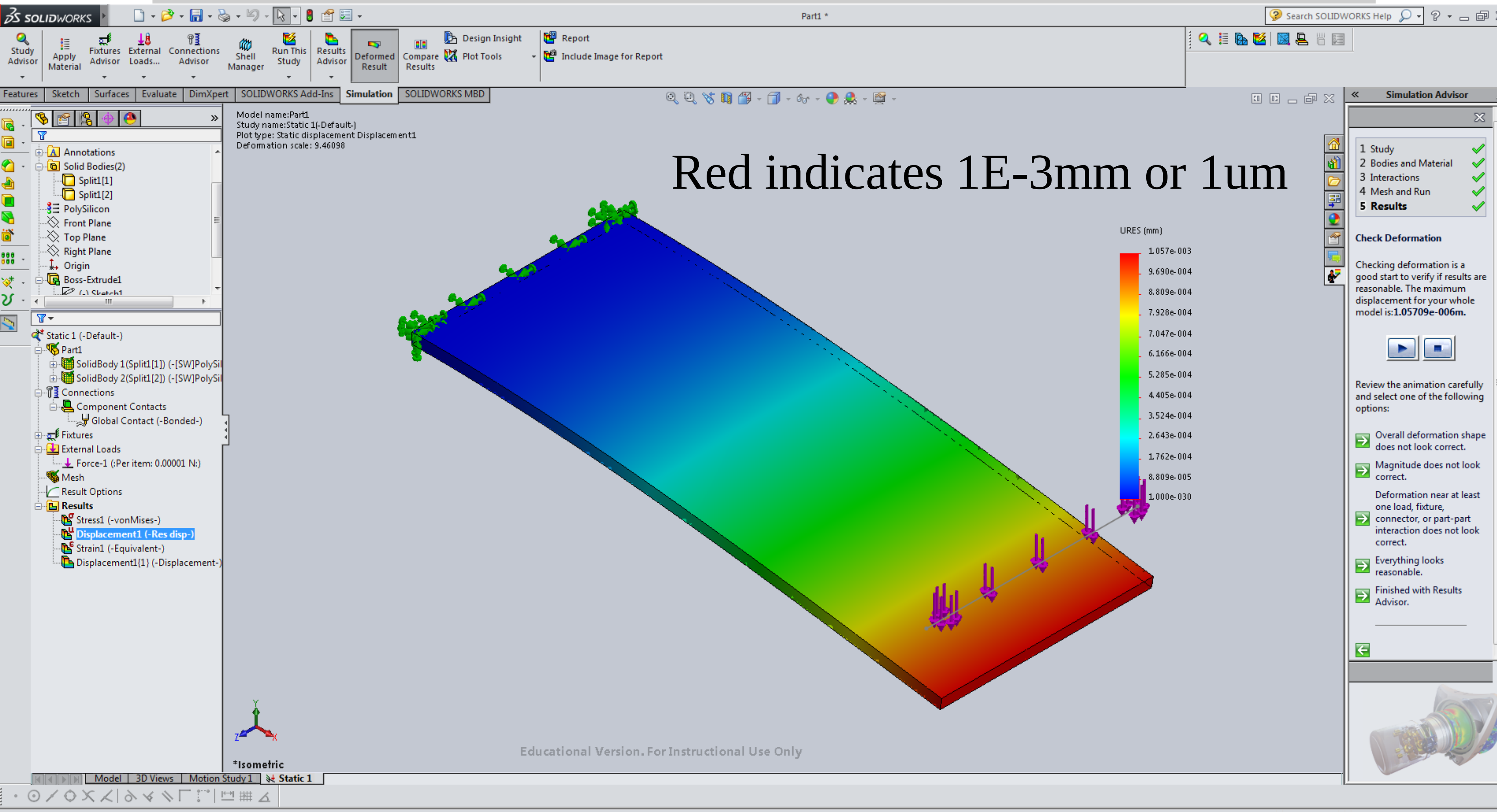
ADDING FORCE TO A SURFACE AND FIXTURE



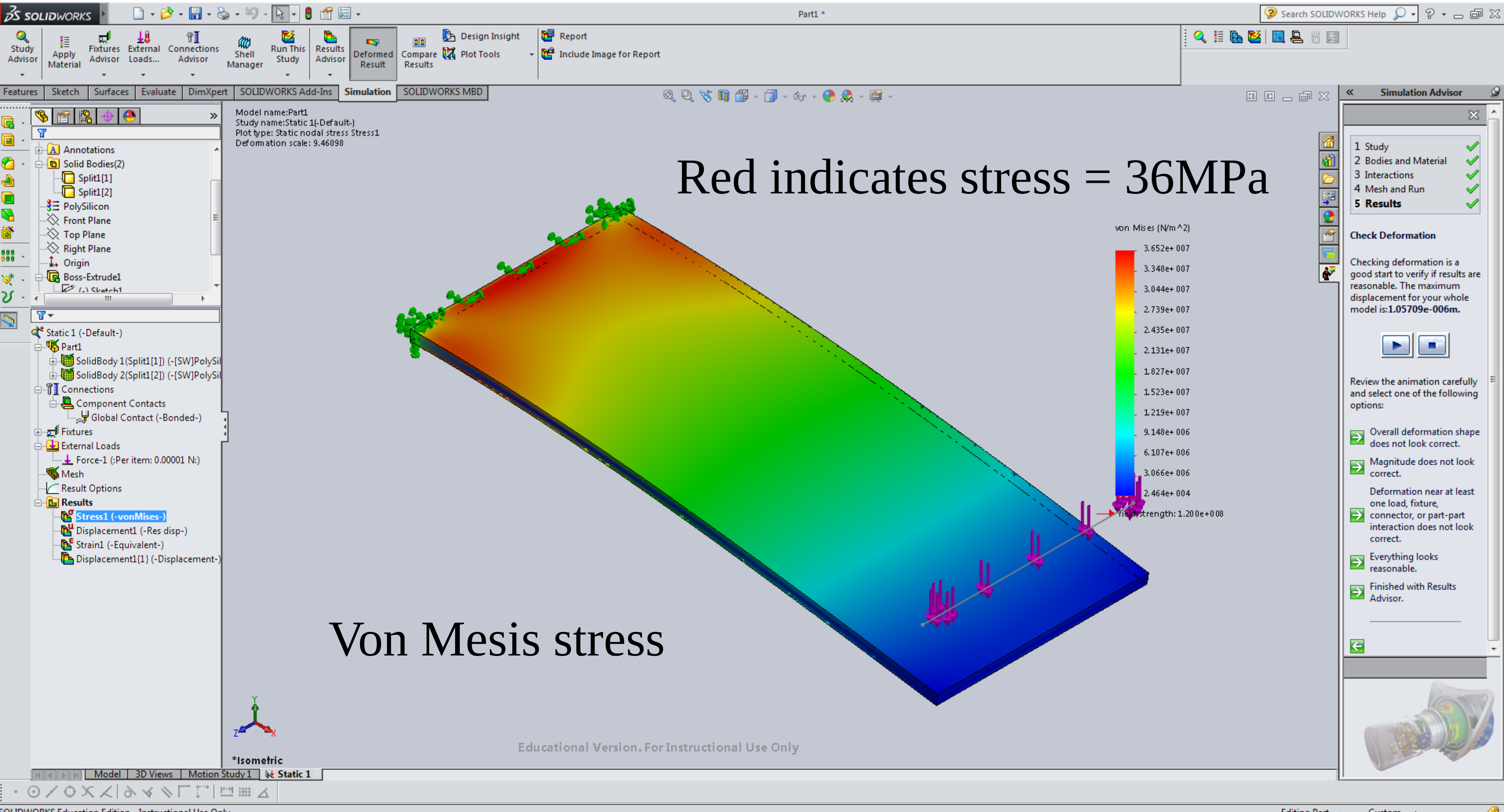
CREATE FINITE ELEMENT ANALYSIS (FEA) MESH



DISPLACEMENT SOLUTION

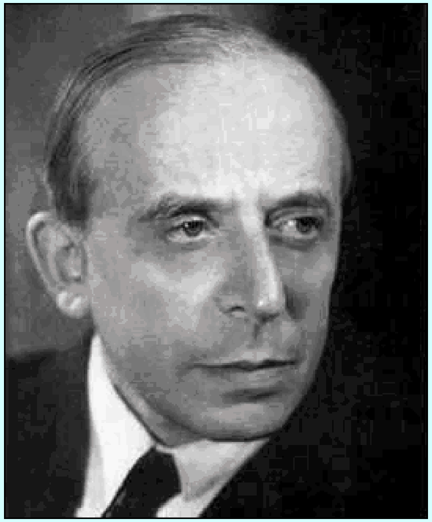


Von Mesis - STRESS RESULTS



Richard von Mises

von Mises, von Mises Yield Criterion



Richard von Mises, Austria, U.S.A.
1883 - 1953

von Mises, an applied mathematician forced to leave Germany in 1933, came to Harvard in 1939. He gave the first university course on powered flight in 1913, and made and piloted a 600-horsepower aircraft for the Austrian army.

von Mises developed a criterion for the yield stress of ductile materials that employs the total distortional strain energy in the sample. Originally developed for mathematical convenience, the model provides a better fit to data obtained on ductile samples than the Tresca criterion. Written in terms of the principal stresses this criterion states that yield will occur when:

$\sigma_M = (1/2[(\sigma_1 - \sigma_2)^2 + (\sigma_1 - \sigma_3)^2 + (\sigma_2 - \sigma_3)^2])^{0.5}$.

The value of σ_M can be obtained from a uniaxial yield stress determination since for uniaxial tension $\sigma_1 = \sigma_y$ = yield stress, and $\sigma_2 = \sigma_3 = 0$, so that $\sigma_M = \sigma_y$. The term in the square root is also proportional to the shear stress on the octahedral planes of the coordinate system defined by the principal axes.

CALCULATIONS

Rochester Institute of Technology — 1/17/2016

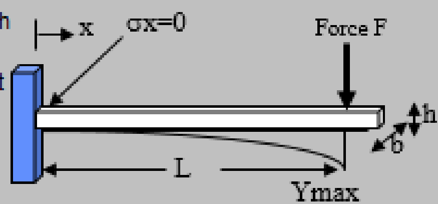
Microelectronic Engineereing — CantileverBasics.xls

Dr. Lynn Fuller

Length L = 100 um

Width b = 40 µm

Height h = 2 µm



E = 1.90E+11 N/m2

Maximum displacement Ymax for given force (F)

$$Y_{max} = F L^3/3EI$$

$$I = bh^3/12$$

F = 1.00E-05 N

2.25E-06 lb-force

Ymax = 6.58E-01 µm

Maximum Stress for given force (F)

$$\sigma_{x=0} = F Lh/2I$$

σ = 3.75E+07 Pa (N/m2)

Strain = Stress / Youngs Modulus — Strain = 1.97E-04 m/m

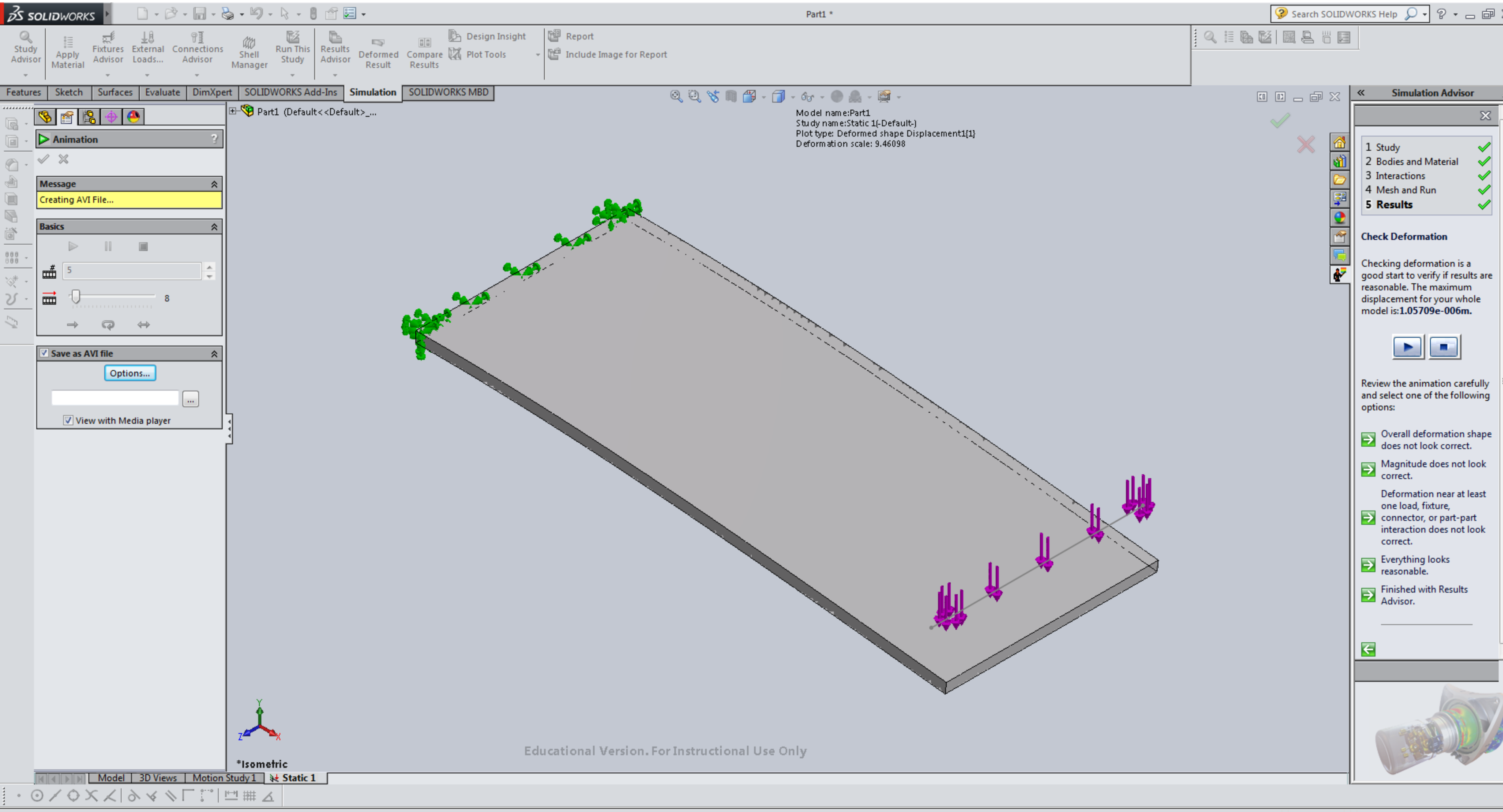
Change in length = Length x Strain — ΔL = 1.97E-02 um

Material Properties

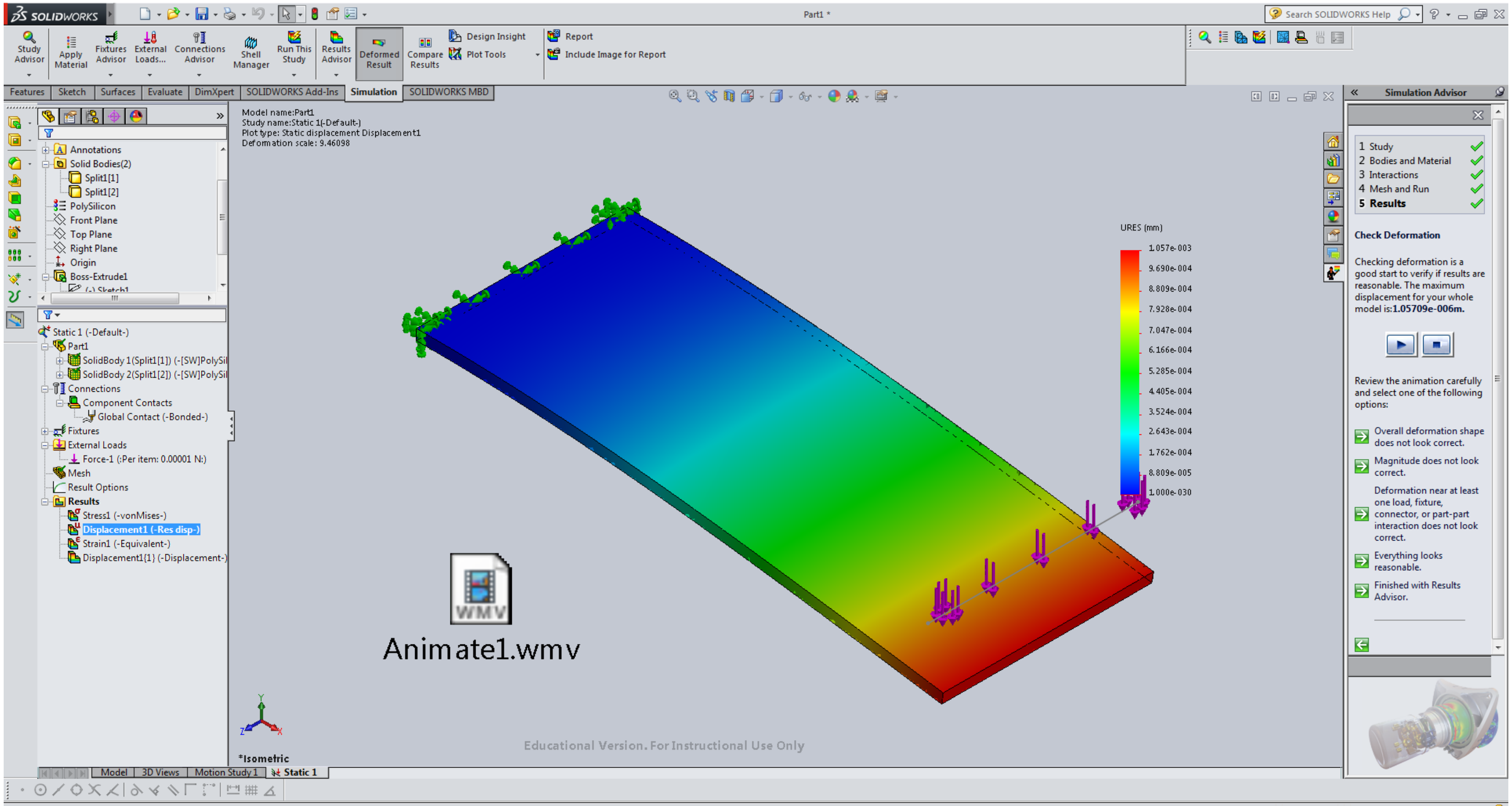
	Silicon	Oxide	Nitride	Aluminum	Units
Youngs Modulus	1.90E+11	7.30E+10	3.85E+11	6.80E+10	N/m2
Density	2.30E+03	2.50E+03	3.10E+03	2.70E+03	Kg/m3
Ultimate Strength	1.40E+10	1.60E+10	2.80E+10		N/m2

Mechanics of Materials, by Ferdinand P. Beer, E. Russell Johnston, Jr., McGraw-Hill Book Co.1981

ADDING ANIMATION

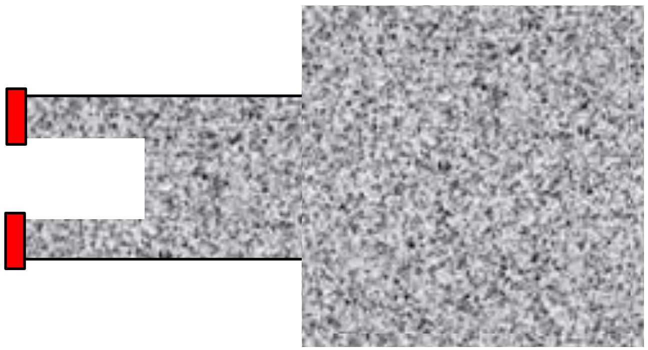


ANIMATION

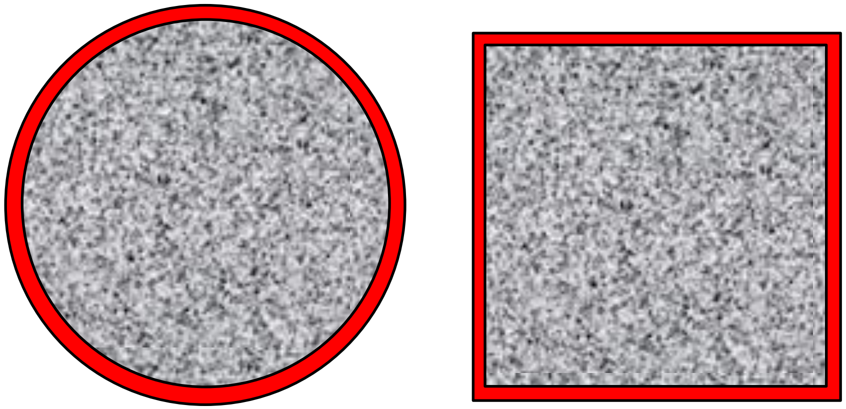


Select Simulate >Plot Tools > Animate

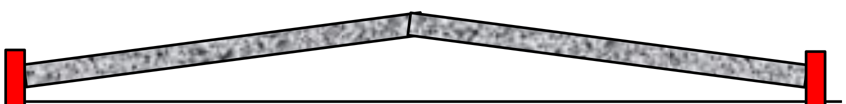
OTHER STRUCTURES OF INTEREST



Complex Cantilever



Diaphragms



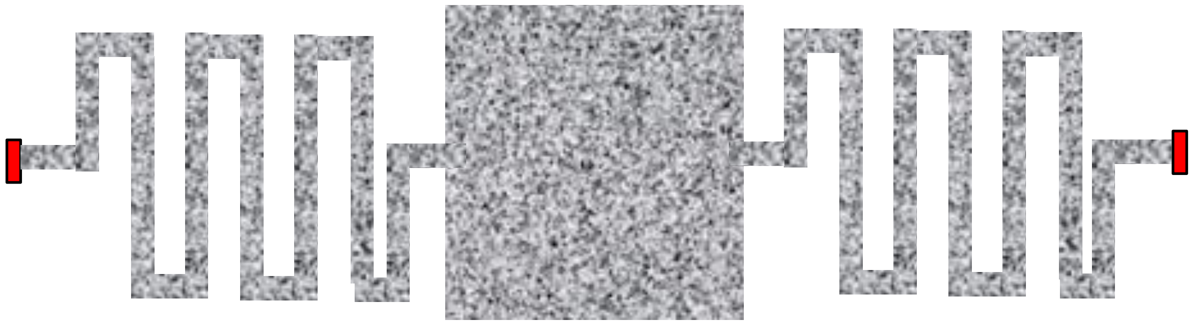
Chevron
Thermal Actuator

Hot Arm

Thermal Actuators

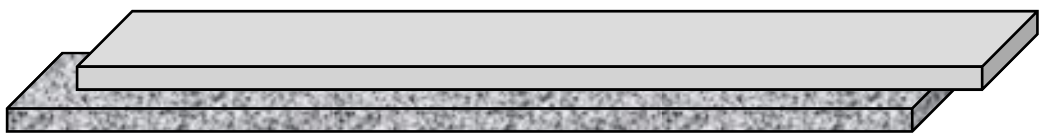
Fixed Points in Red

OTHER STRUCTURES OF INTEREST



Springs

Fixed Points in Red



Multilayer Different Materials

Simple Bridge

REFERENCES

1. Solid Works website help.
2. Dr. Fuller's Tutorial on 3D printing. See webpage

HOMEWORK – SOLID WORKS TUTORIAL

1. Duplicate the drawing and evaluation of a simple cantilever with different dimensions.
2. Draw and evaluate one of the structures on page 30.