Creating Solidworks Model for SCME Pressure Sensor

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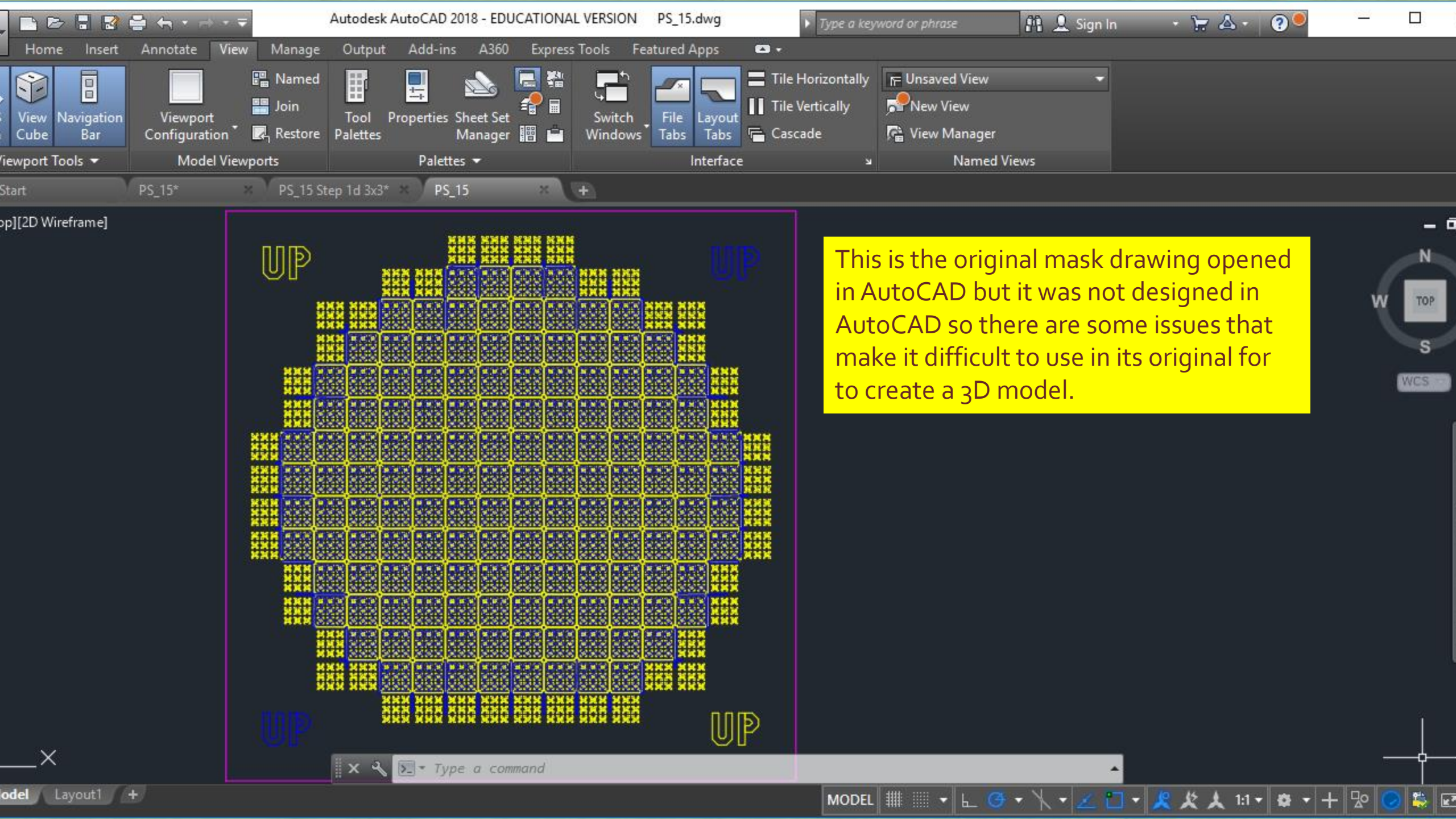
Ivy Tech Community College

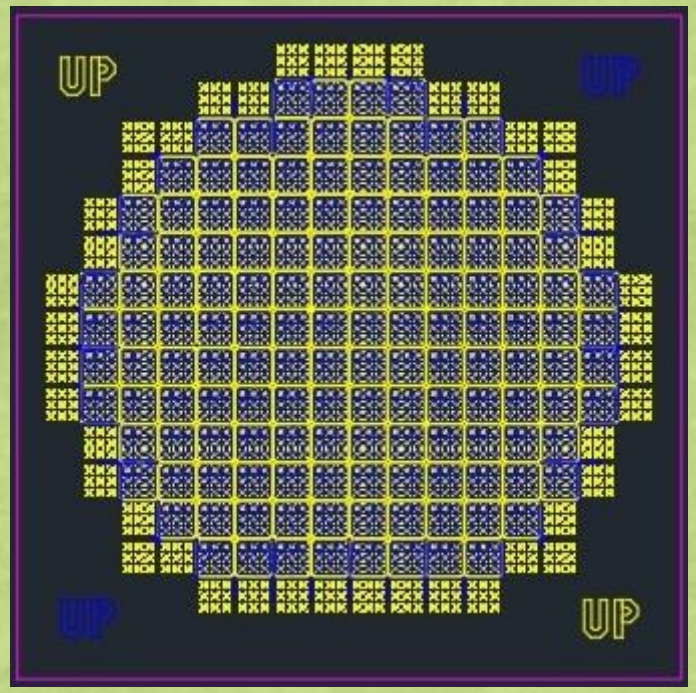
3D Models help student visualize the device

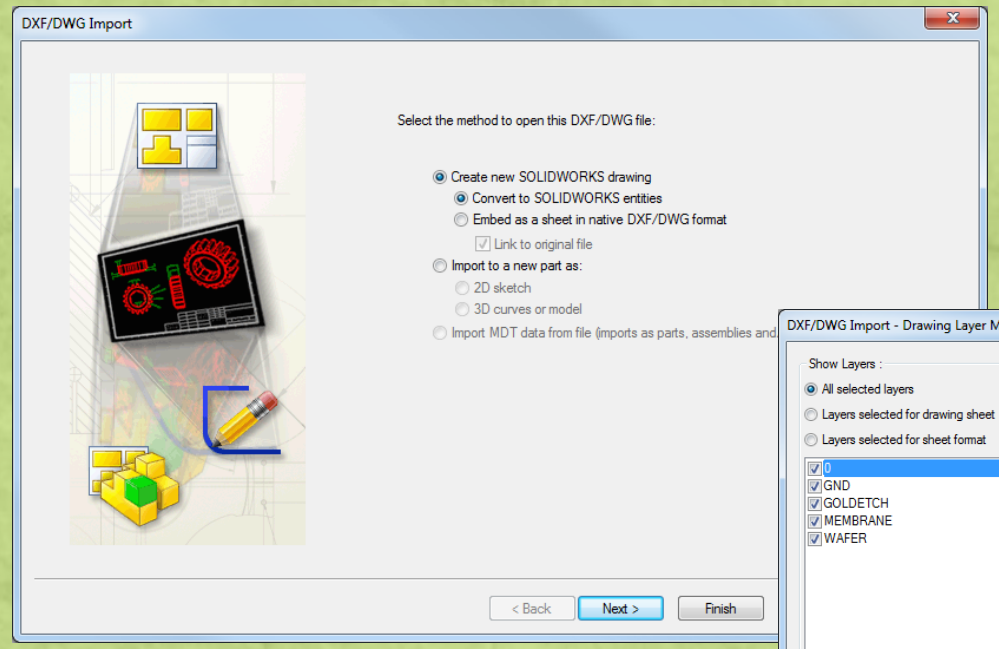
- To visualize a part it is often helpful to use a 3D model
- The SCME Pressure Sensor model is pretty straight forward but we could better used a model to understand its construction.
- Can we use Solidworks (a popular 3D modeling tool) and the mask to create a model?

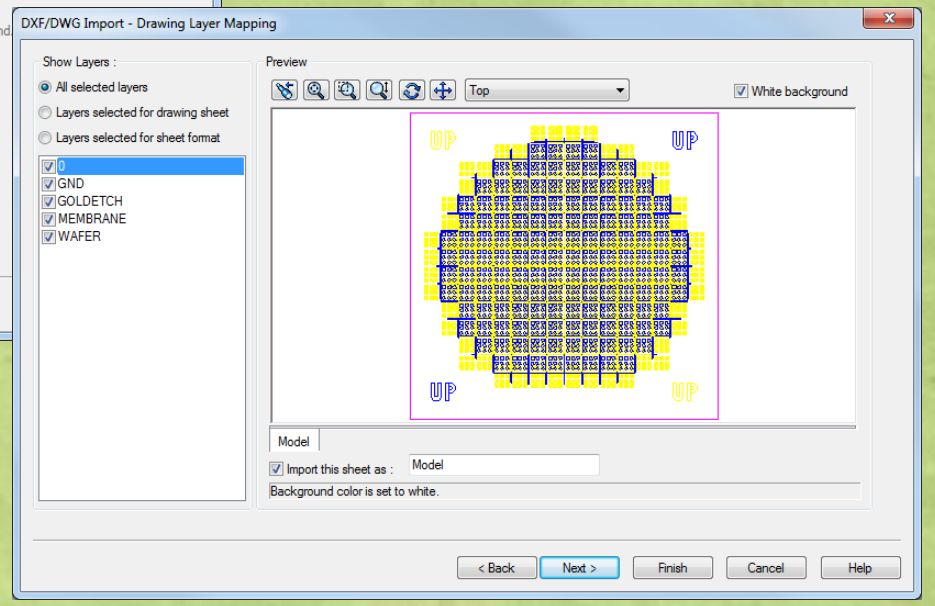

Autodesk AutoCAD 2018 - EDUCATIONAL VERSION PS_15.dwg
Type a keyword or phrase
Sign In
Home Insert Annotate View Manage Output Add-ins A360 Express Tools Featured Apps
View Cube
Navigation Bar
Viewport Configuration
Named
Join
Restore
Tool Palettes
Properties
Sheet Set Manager
Switch Windows
File Tabs
Layout Tabs
Tile Horizontally
Tile Vertically
Cascade
Unsaved View
New View
View Manager
Viewport Tools
Model Viewports
Palettes
Interface
Named Views
Start
PS_15*
PS_15 Step 1d 3x3*
PS_15
op][2D Wireframe]
UP
UP
UP
UP
This is the original mask drawing opened in AutoCAD but it was not designed in AutoCAD so there are some issues that make it difficult to use in its original for to create a 3D model.
N
W
TOP
S
WCS
Type a command
odel
Layout1
MODEL
1:1

Step 1 – Import the mask into Solidworks

- Solidworks can open a DWG file.







SOLIDWORKS File Edit View Insert Tools Window Help PS_15 Step 1 - Model Search files and models

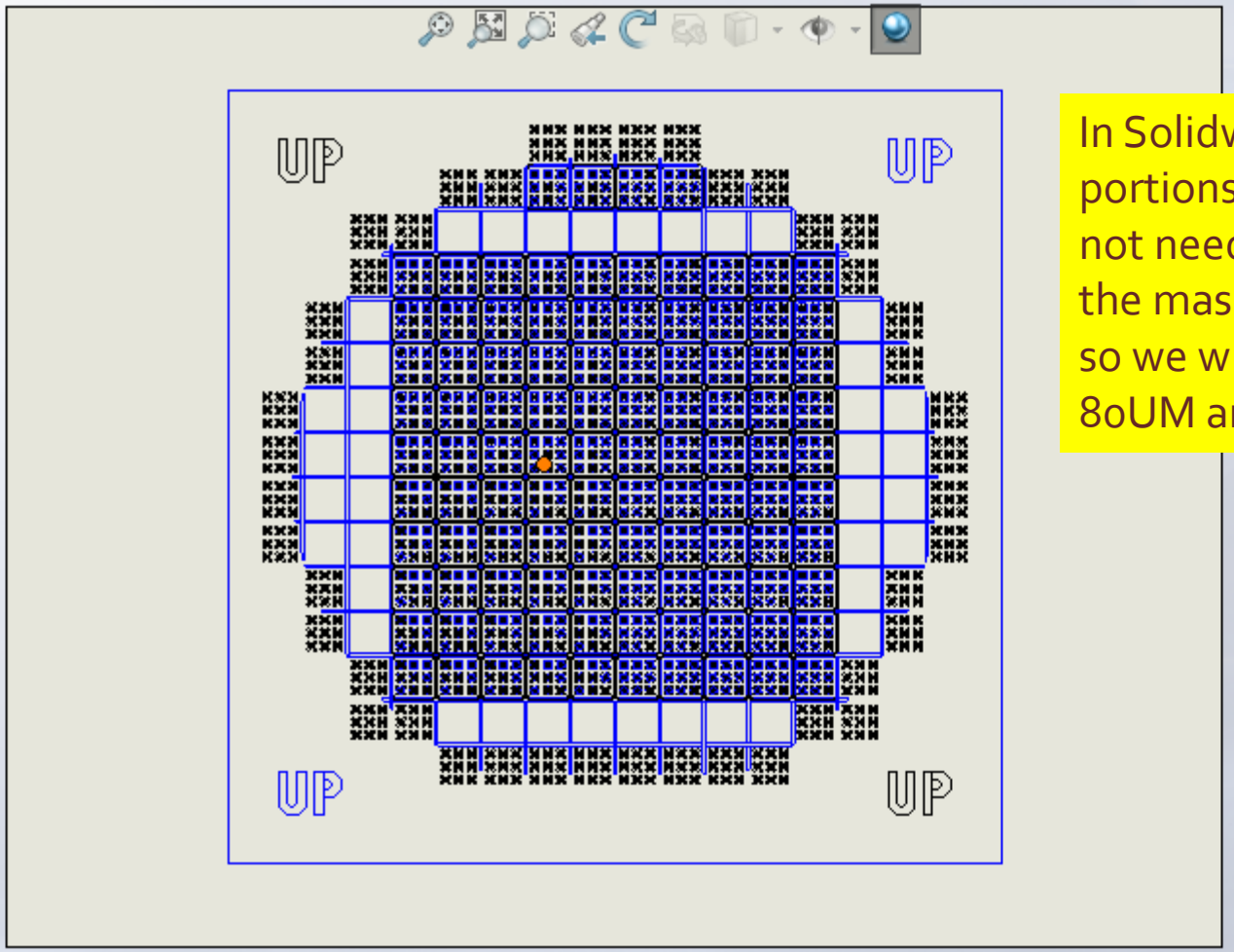
MBRANE

Model Items | Spell Checker | Format Painter | Note | Linear Note Pattern | Balloon | Auto Balloon | Magnetic Line | Surface Finish | Weld Symbol | Hole Callout | Geometric Tolerance | Datum Feature | Datum Target | Blocks | Center Mark | Centerline | Area Hatch/Fill | Revision Symbol | Revision Cloud | Tables

ayout | Annotation | Sketch | Evaluate | SOLIDWORKS Add-Ins | Sheet Format

25400 50800 76200 101600 127000 152400 177800 203200 228600 254000 279400 304800 330200 355600 381

PS_15 Step 1
- Blocks
  - 20UM
  - 80UM
  - 40UM
  - 60UM
  - 9UP60UM
  - 9UP40UM
  - 9UP20UM
  - 9UP80UM
  - ALIGNMENTMARK
  - INNER_SNAPLINES
- Annotations
- Model



In Solidworks delete the portions of the mask you do not need. In our case part of the mask contains “block: so we will delete the 20UM, 80UM and 40uM blocks

Model

ORKS Education Edition - Instructional Use Only | Automatic Solve Mode Off | Editing Model | 1 : 1 | Custom

SOLIDWORKS File Edit View Insert Tools Window Help PS_15 Step 1a - Model Search files and models

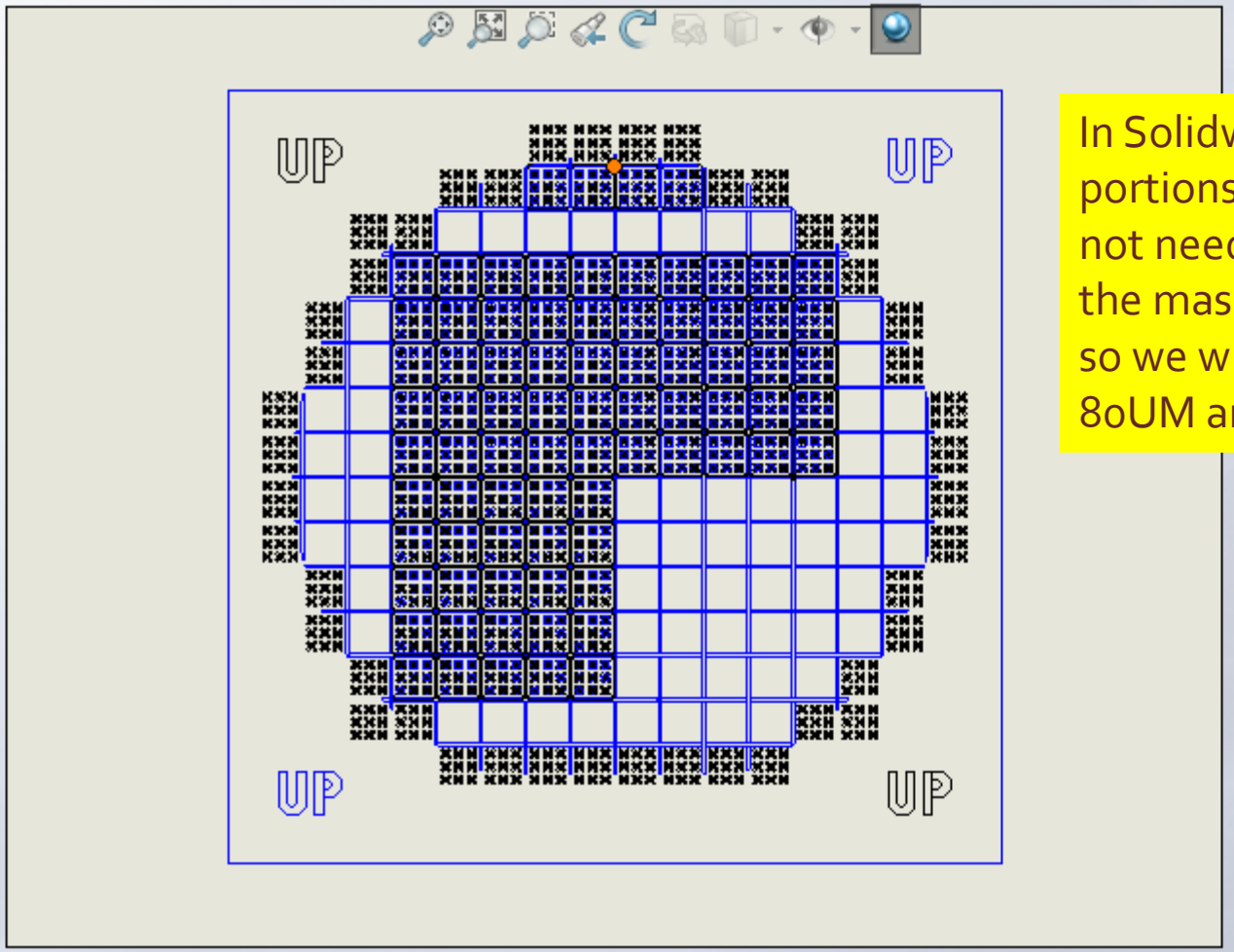
MBRANE

Model Items | Spell Checker | Format Painter | Note | Linear Note Pattern | Balloon | Auto Balloon | Magnetic Line | Surface Finish | Weld Symbol | Hole Callout | Geometric Tolerance | Datum Feature | Datum Target | Blocks | Center Mark | Centerline | Area Hatch/Fill | Revision Symbol | Revision Cloud | Tables

ayout | Annotation | Sketch | Evaluate | SOLIDWORKS Add-Ins | Sheet Format

25400 50800 76200 101600 127000 152400 177800 203200 228600 254000 279400 304800 330200 355600 381

PS_15 Step 1a
- Blocks
  - 20UM
  - 80UM
  - 40UM
  - 60UM
  - 9UP60UM
  - 9UP20UM
  - 9UP80UM
  - ALIGNMENTMARK
  - INNER_SNAPLINES
- Annotations
- Model



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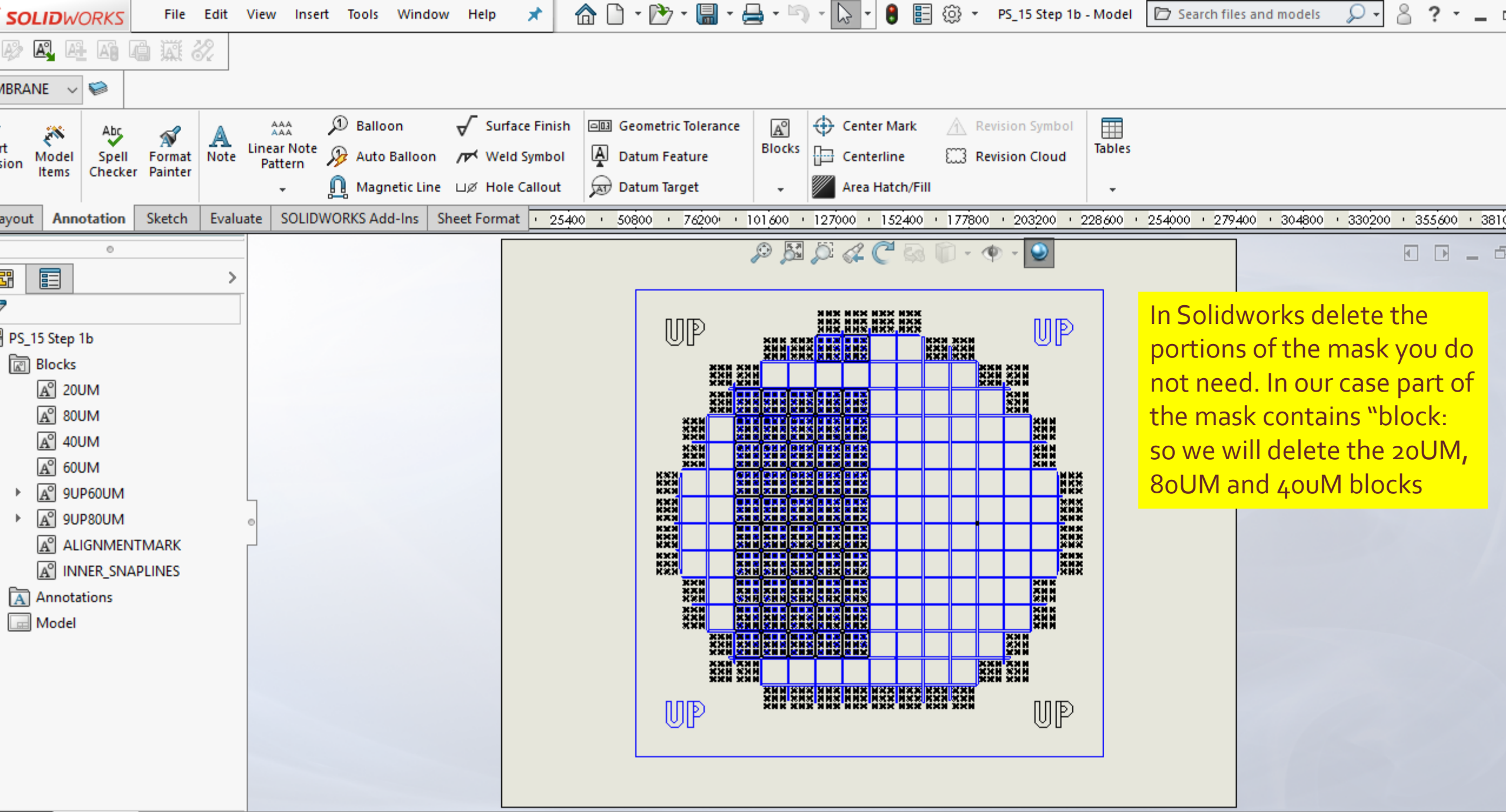
Model

ORKS Education Edition - Instructional Use Only

Automatic Solve Mode Off | Editing Model | 1 : 1 | Custom


SOLIDWORKS
File Edit View Insert Tools Window Help
PS_15 Step 1b - Model
Search files and models
Model Items
Spell Checker
Format Painter
Note
Linear Note Pattern
Balloon
Auto Balloon
Magnetic Line
Surface Finish
Weld Symbol
Hole Callout
Geometric Tolerance
Datum Feature
Datum Target
Blocks
Center Mark
Centerline
Area Hatch/Fill
Revision Symbol
Revision Cloud
Tables
Annotation
Sketch
Evaluate
SOLIDWORKS Add-Ins
Sheet Format
PS_15 Step 1b
Blocks
20UM
80UM
40UM
60UM
9UP60UM
9UP80UM
ALIGNMENTMARK
INNER_SNAPLINES
Annotations
Model
UP
UP
UP
UP
In Solidworks delete the portions of the mask you do not need. In our case part of the mask contains “block: so we will delete the 20UM, 80UM and 40uM blocks
Model
Editing Model
Custom

SOLIDWORKS File Edit View Insert Tools Window Help PS_15 Step 1c - Model Search files and models

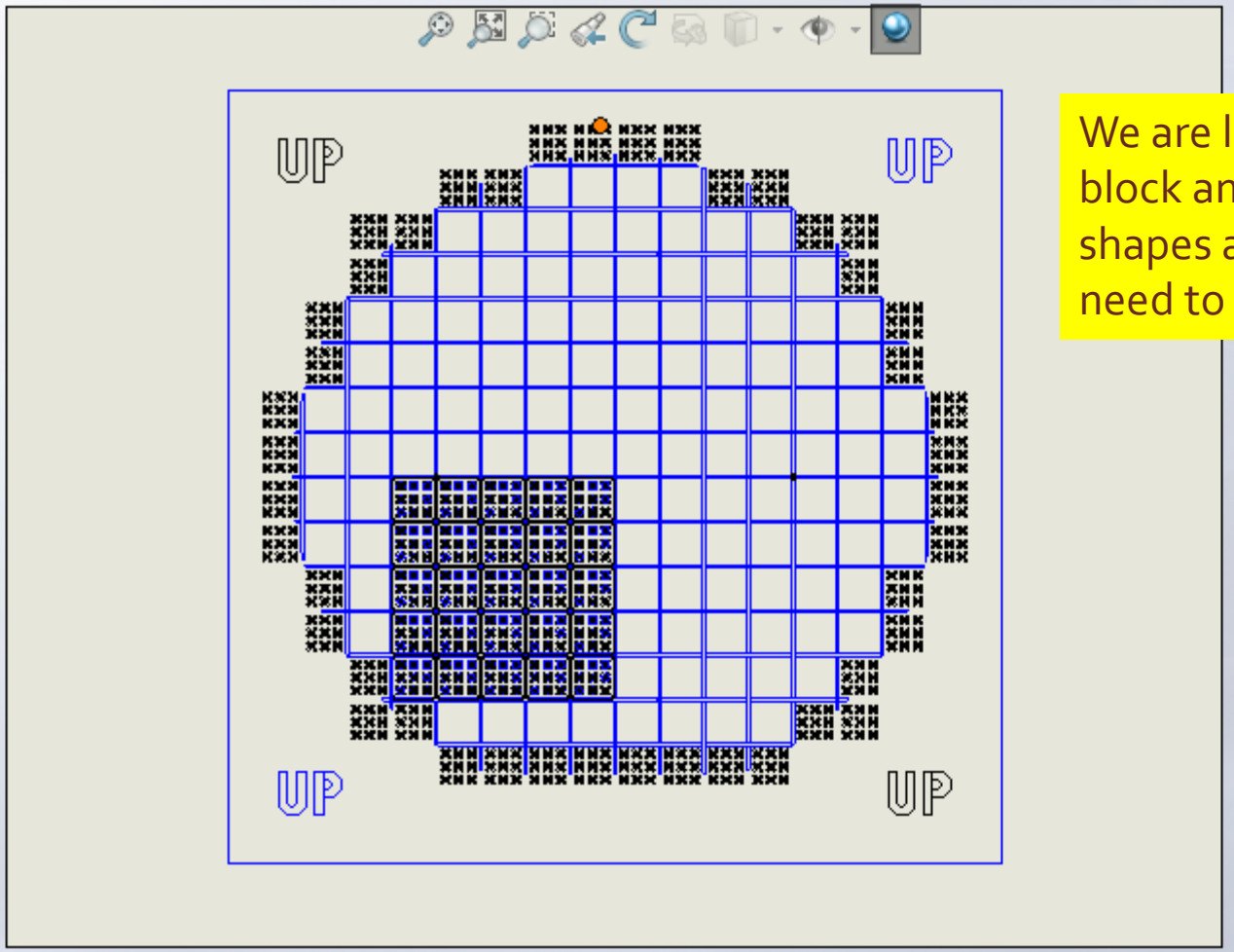
MBRANE

Model Items | Spell Checker | Format Painter | Note | Linear Note Pattern | Balloon | Auto Balloon | Magnetic Line | Surface Finish | Weld Symbol | Hole Callout | Geometric Tolerance | Datum Feature | Datum Target | Blocks | Center Mark | Centerline | Area Hatch/Fill | Revision Symbol | Revision Cloud | Tables

ayout | Annotation | Sketch | Evaluate | SOLIDWORKS Add-Ins | Sheet Format

25400 50800 76200 101600 127000 152400 177800 203200 228600 254000 279400 304800 330200 355600 381

PS_15 Step 1c
Blocks
Annotations
Model



We are left with the 60UM block and some other shapes and lines that we need to whittle down still

Model

ORKS Education Edition - Instructional Use Only 322419.232um 69904.2073um 0um Automatic Solve Mode Off Editing Model 1 : 1 Custom

SOLIDWORKS File Edit View Insert Tools Window Help PS_15 Step 1d 3x3 - Mo... Search files and models

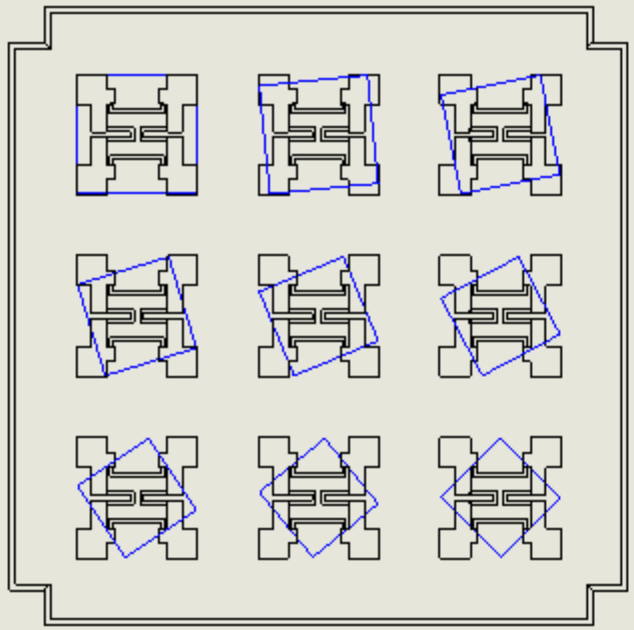
MBRANE

Model Items | Spell Checker | Format Painter | Note | Linear Note Pattern | Balloon | Auto Balloon | Magnetic Line | Surface Finish | Weld Symbol | Hole Callout | Geometric Tolerance | Datum Feature | Datum Target | Blocks | Center Mark | Centerline | Area Hatch/Fill | Revision Symbol | Revision Cloud | Tables

ayout | Annotation | Sketch | Evaluate | SOLIDWORKS Add-Ins | Sheet Format

152400

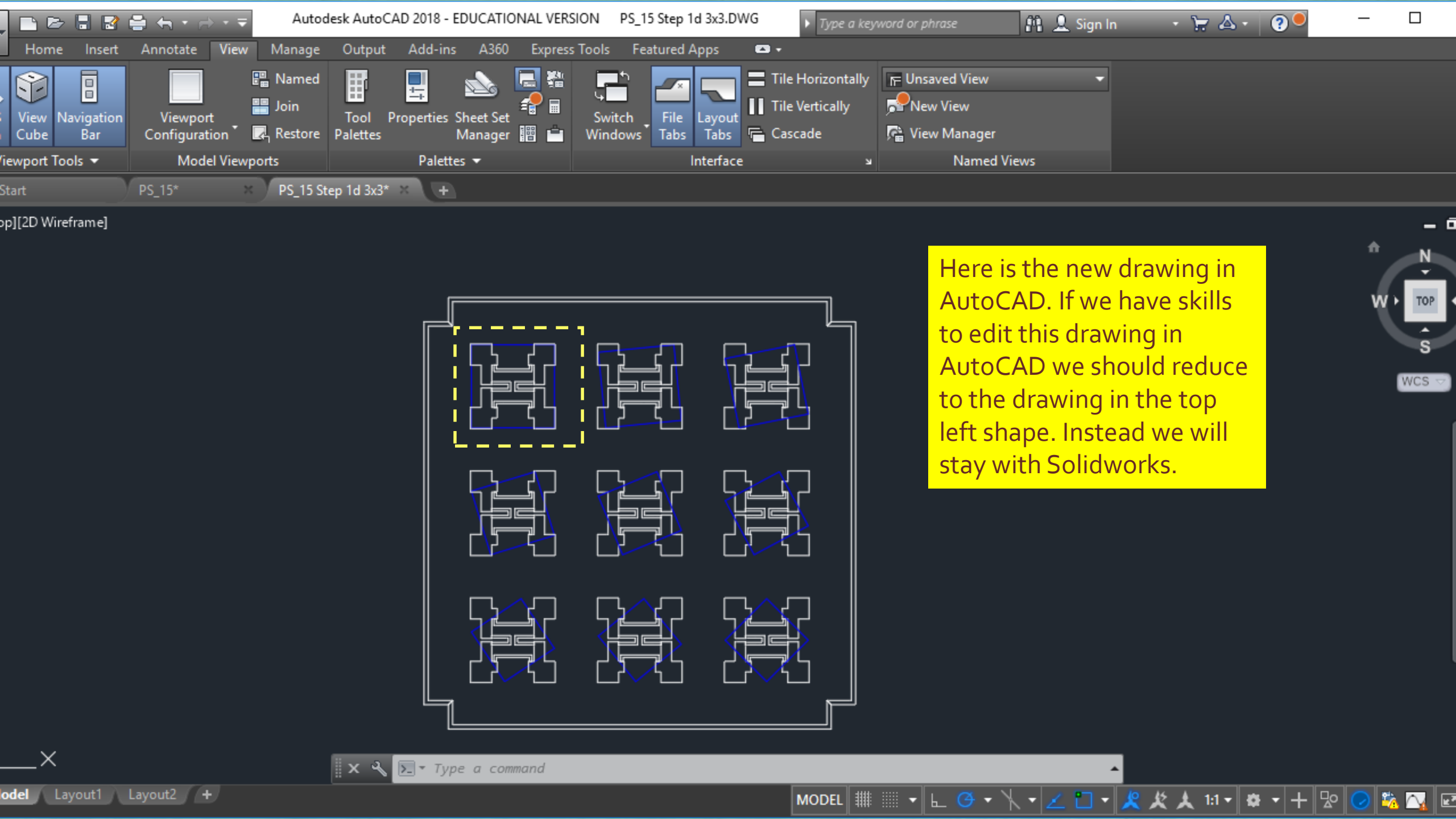
PS_15 Step 1d 3x3
- Blocks
  - 9UP60UM
    - 60UM
    - 9UP
- Annotations
- Model



Finally we have something smaller we can work with and actually save as a DWG and/or SLDDWG.

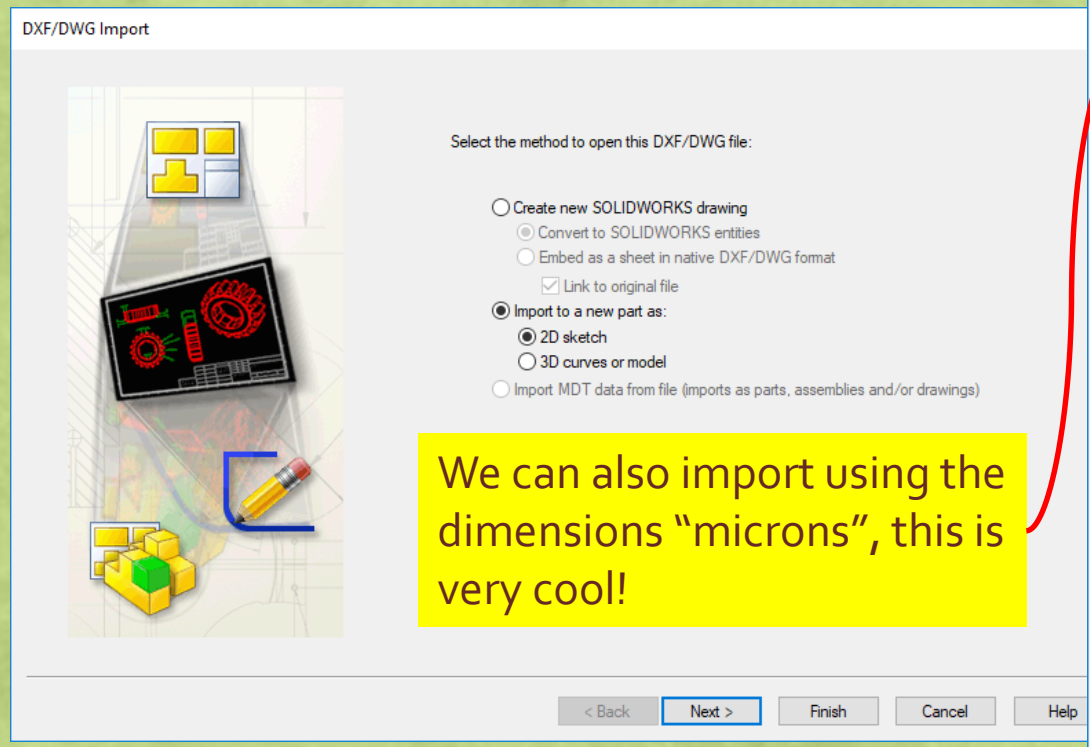
Model

ORKS Education Edition - Instructional Use Only 119370.7233um 107816.1701um 0um Automatic Solve Mode Off Editing Model 1 : 1 Custom

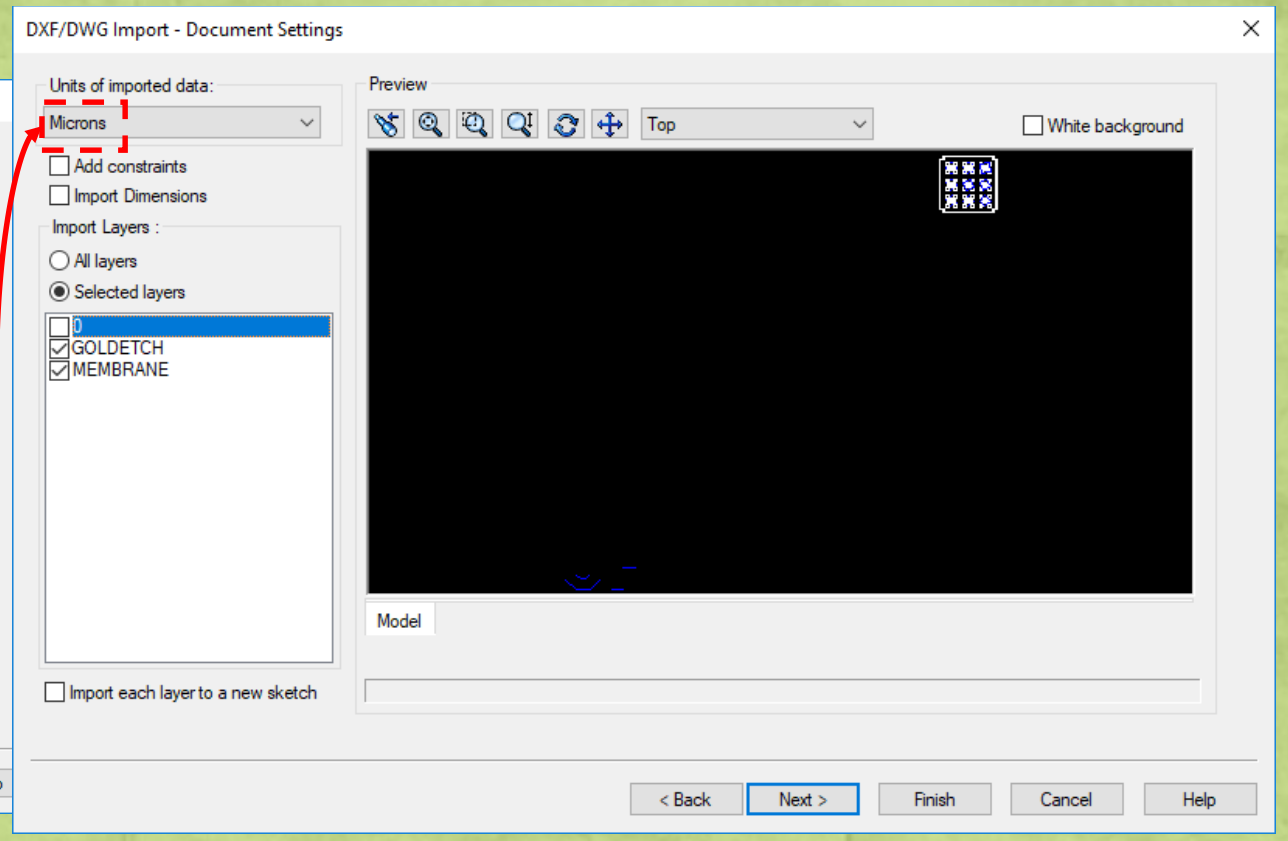

Autodesk AutoCAD 2018 - EDUCATIONAL VERSION PS_15 Step 1d 3x3.DWG
Type a keyword or phrase
Sign In
Home Insert Annotate View Manage Output Add-ins A360 Express Tools Featured Apps
View Cube
Navigation Bar
Viewport Configuration
Named
Join
Restore
Tool Palettes
Properties
Sheet Set Manager
Switch Windows
File Tabs
Layout Tabs
Tile Horizontally
Tile Vertically
Cascade
Unsaved View
New View
View Manager
Viewport Tools
Model Viewports
Palettes
Interface
Named Views
Start
PS_15*
PS_15 Step 1d 3x3*
op][2D Wireframe]
Here is the new drawing in AutoCAD. If we have skills to edit this drawing in AutoCAD we should reduce to the drawing in the top left shape. Instead we will stay with Solidworks.
N
W
TOP
S
WCS
Type a command
odel
Layout1
Layout2
MODEL
1:1

Step 2 – Import again into Solidworks

- Change to import a new 2D part and select only the GOLDETCH and MEMBRANE layers

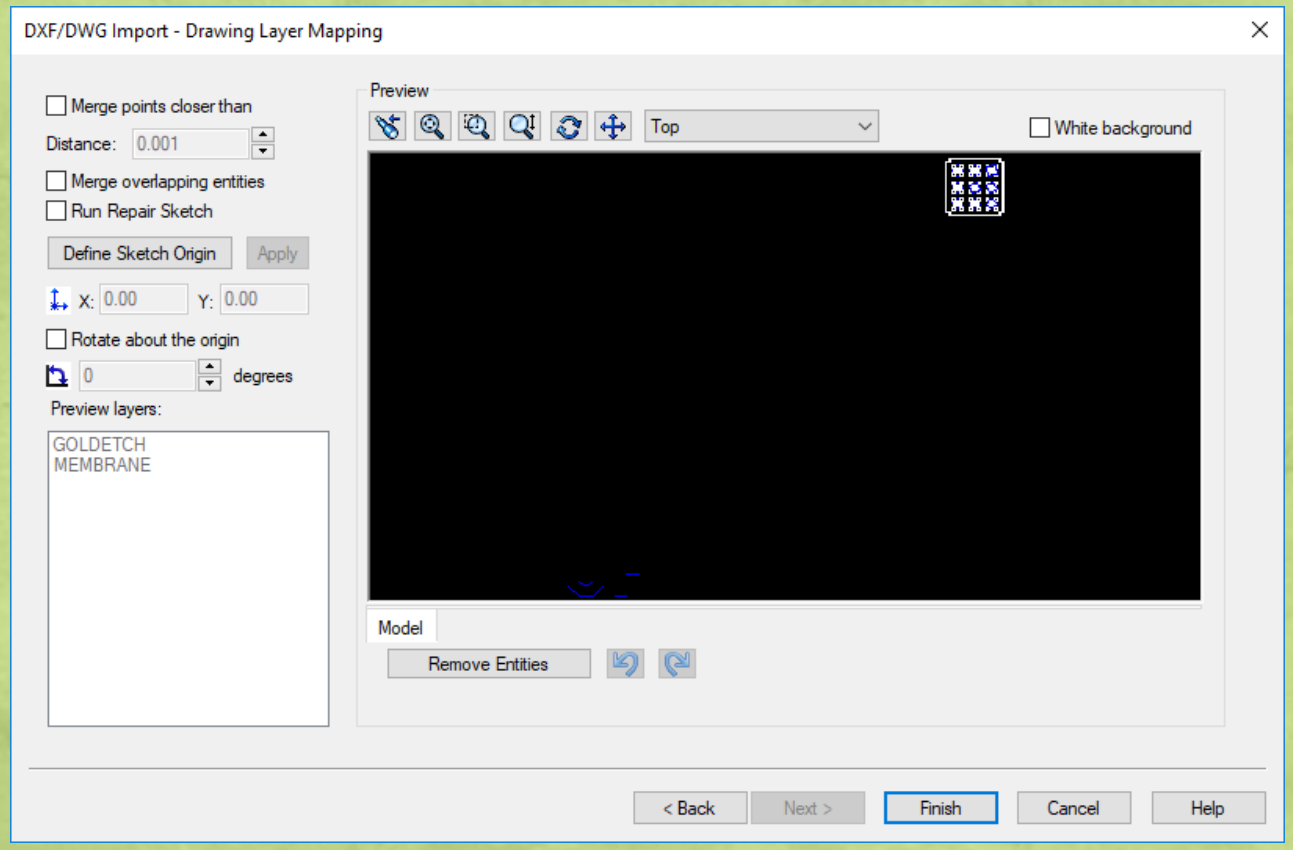


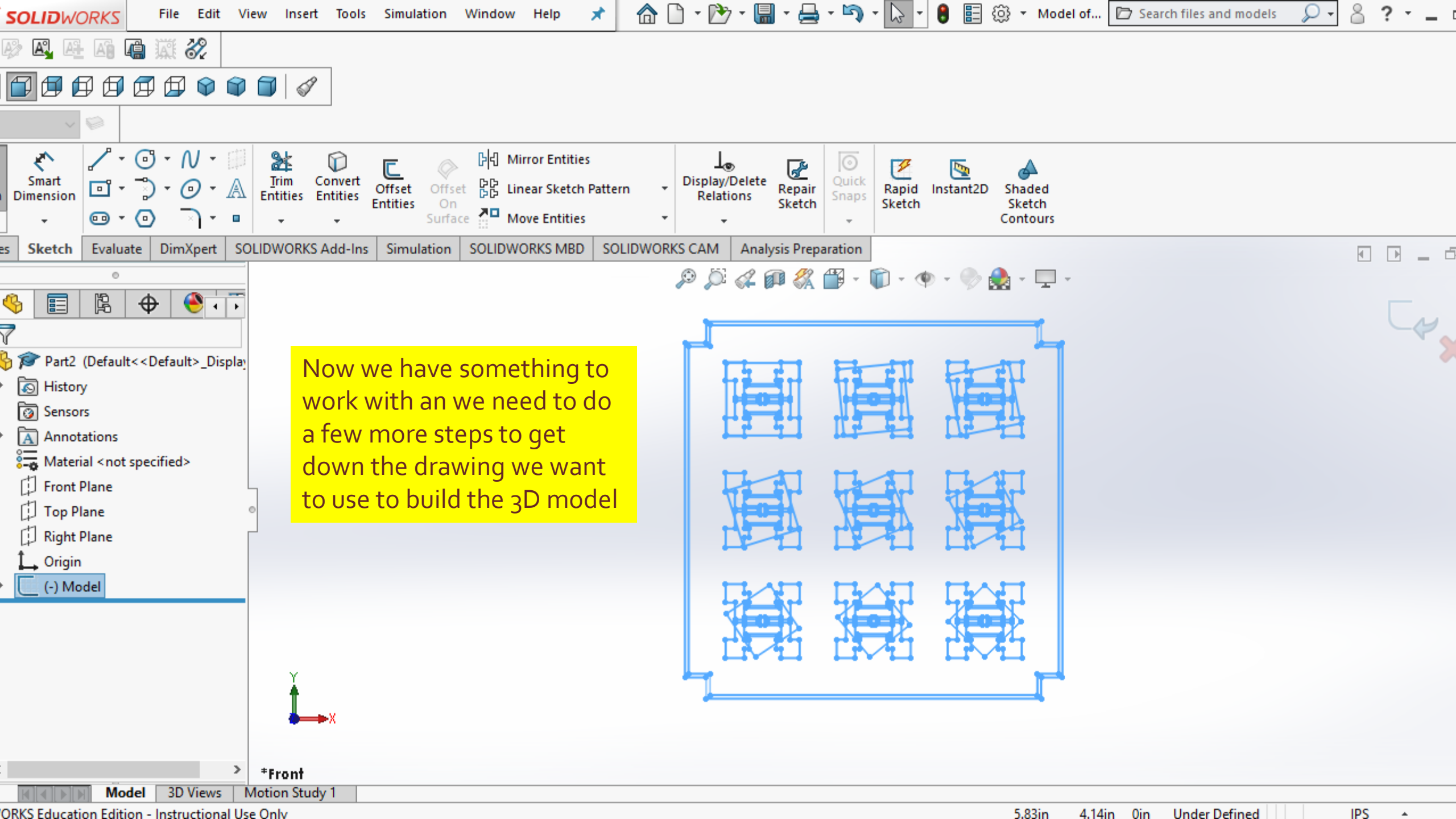
We can also import using the dimensions "microns", this is very cool!

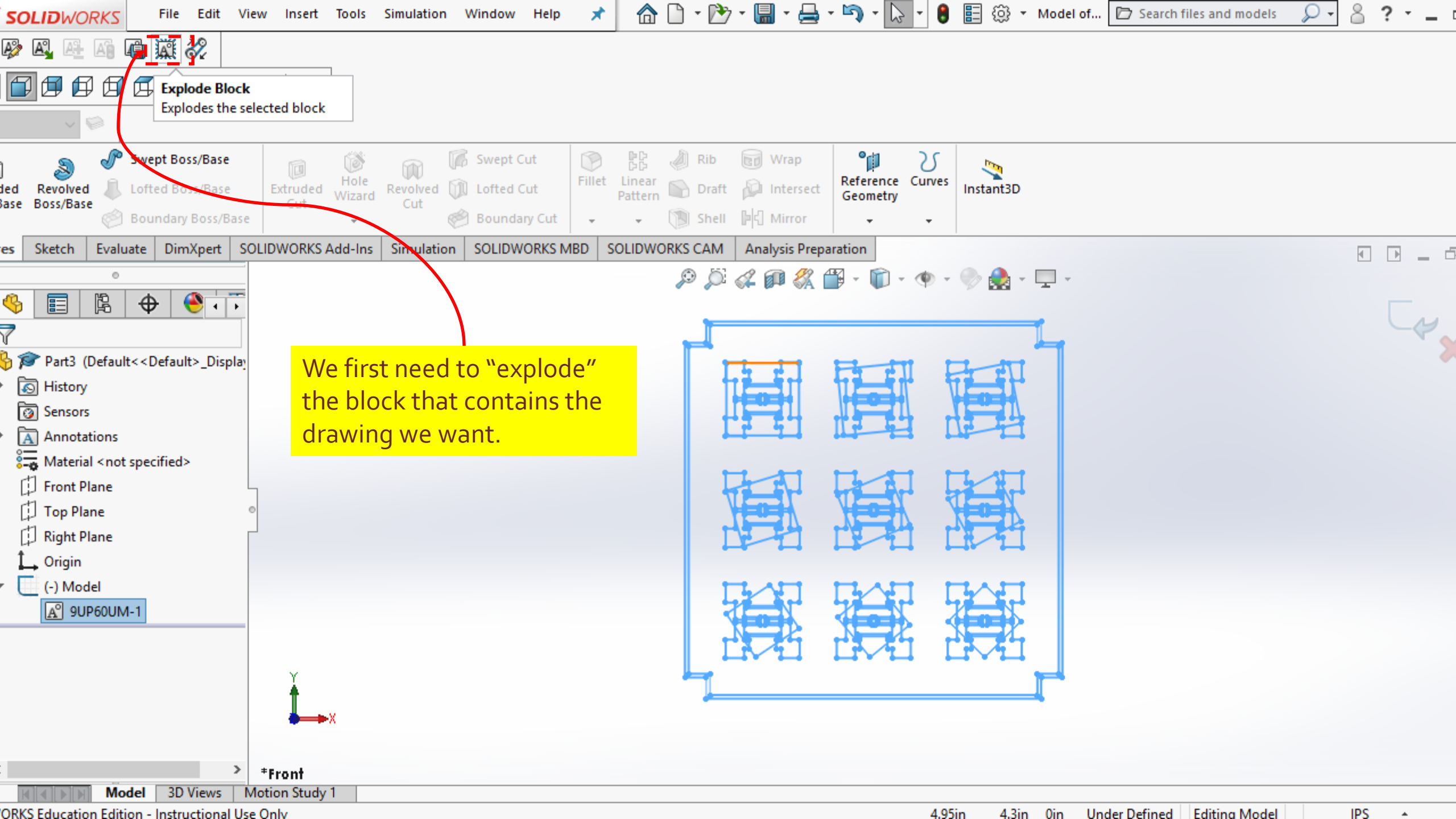


Step 2 – Import again into Solidworks

- Also deselect the "Merge points"



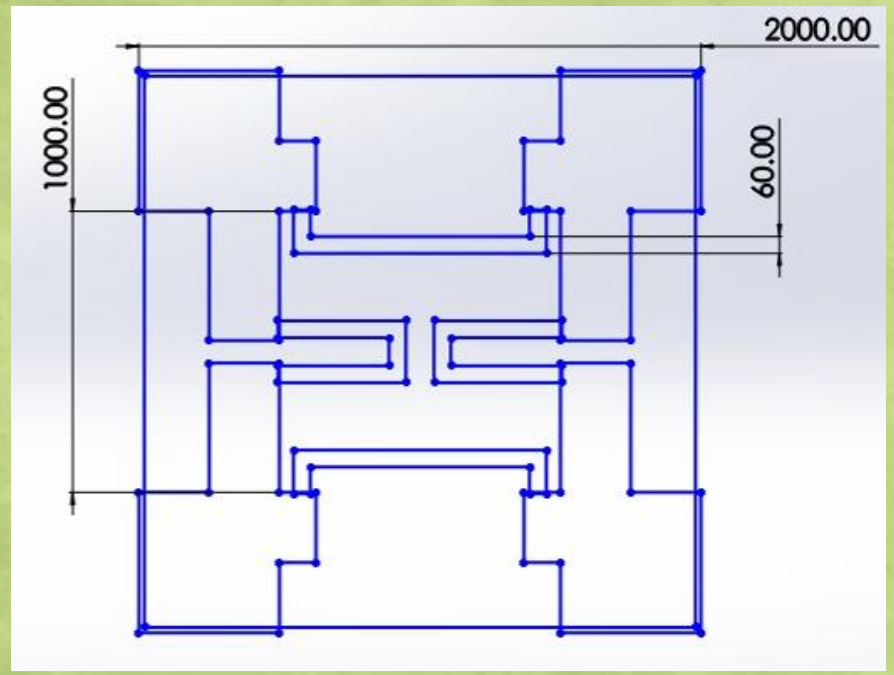

SOLIDWORKS
File Edit View Insert Tools Simulation Window Help
Model of...
Search files and models
Smart Dimension
Trim Entities
Convert Entities
Offset Entities
Offset On Surface
Mirror Entities
Linear Sketch Pattern
Move Entities
Display/Delete Relations
Repair Sketch
Quick Snaps
Rapid Sketch
Instant2D
Shaded Sketch Contours
Sketch Evaluate DimXpert SOLIDWORKS Add-Ins Simulation SOLIDWORKS MBD SOLIDWORKS CAM Analysis Preparation
Part2 (Default<<Default>_Displa
History
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
(-) Model
Now we have something to work with an we need to do a few more steps to get down the drawing we want to use to build the 3D model
Y
X
*Front
Model 3D Views Motion Study 1
ORKS Education Edition - Instructional Use Only
5.83in 4.14in 0in Under Defined IPS

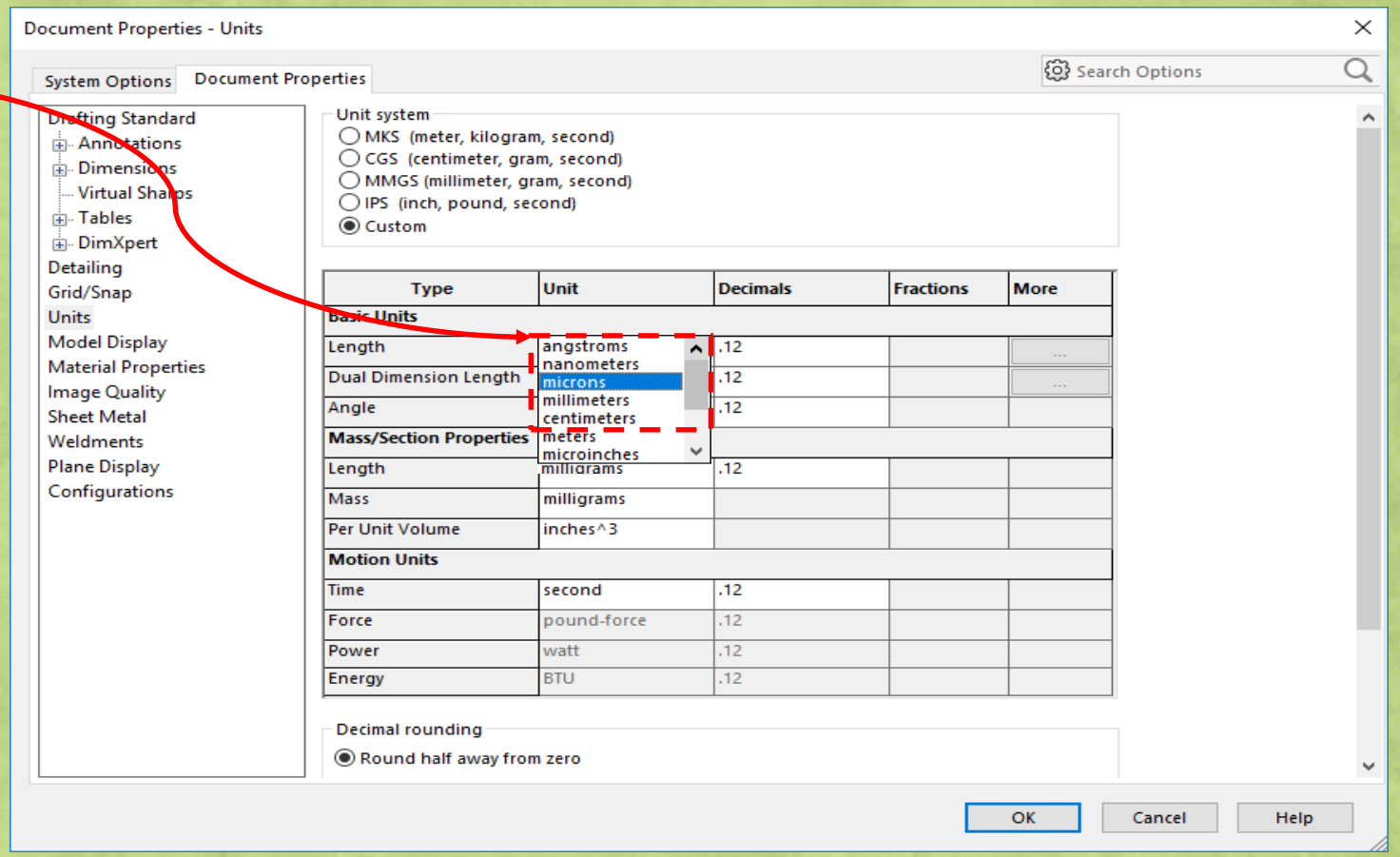

SOLIDWORKS
File Edit View Insert Tools Simulation Window Help
Model of...
Search files and models
Explode Block
Explodes the selected block
Swept Boss/Base
Revolved Boss/Base
Lofted Boss/Base
Boundary Boss/Base
Extruded Cut
Hole Wizard
Revolved Cut
Swept Cut
Lofted Cut
Boundary Cut
Fillet
Linear Pattern
Rib
Draft
Shell
Wrap
Intersect
Mirror
Reference Geometry
Curves
Instant3D
Sketch
Evaluate
DimXpert
SOLIDWORKS Add-Ins
Simulation
SOLIDWORKS MBD
SOLIDWORKS CAM
Analysis Preparation
Part3 (Default<<Default>_Display
History
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
(-) Model
9UP60UM-1
We first need to "explode" the block that contains the drawing we want.
*Front
Model
3D Views
Motion Study 1
4.95in
4.3in
0in
Under Defined
Editing Model
IPS

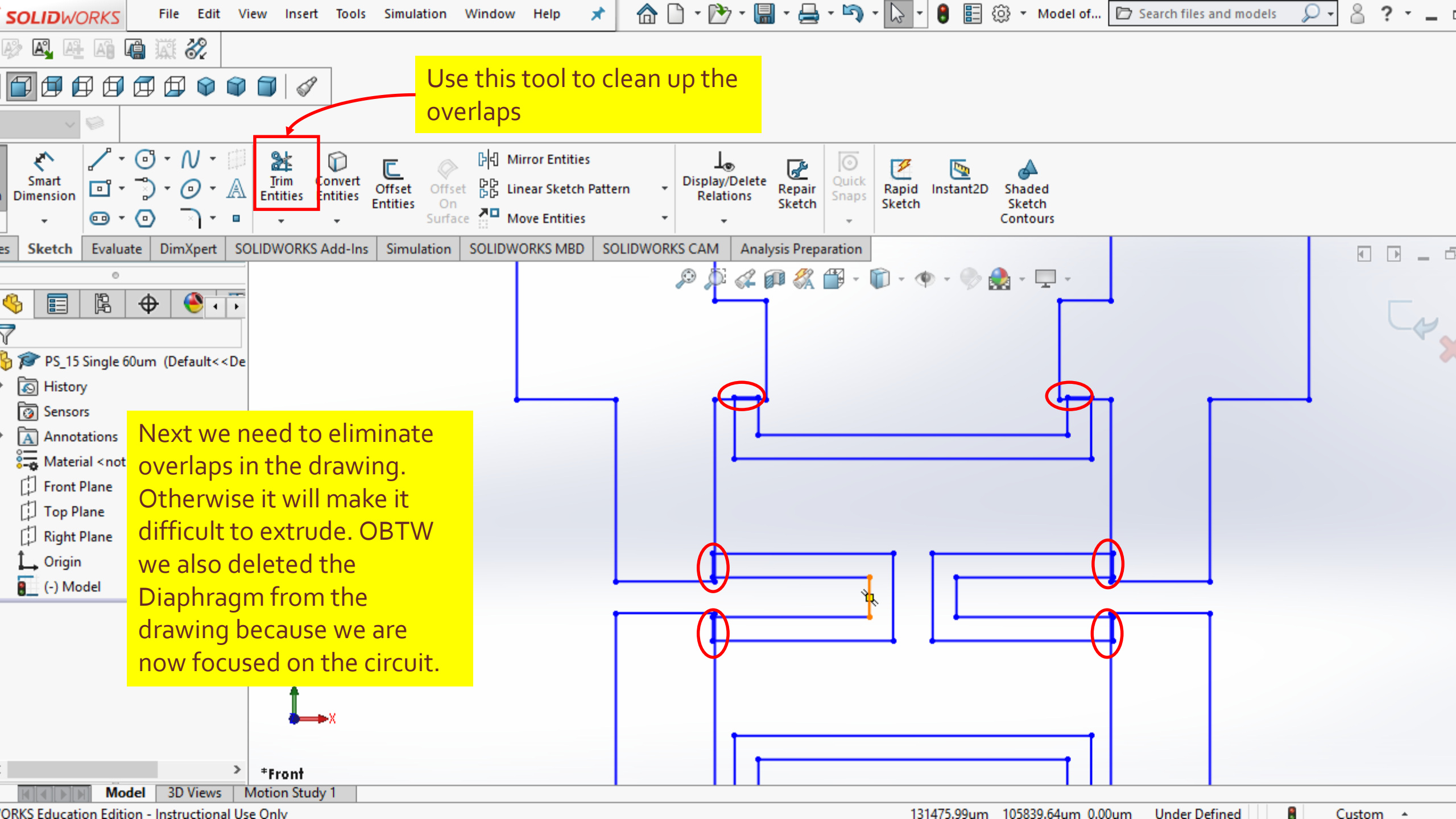
Step 3 – Change the Units to "microns"

- Change the units to microns using the "custom" option

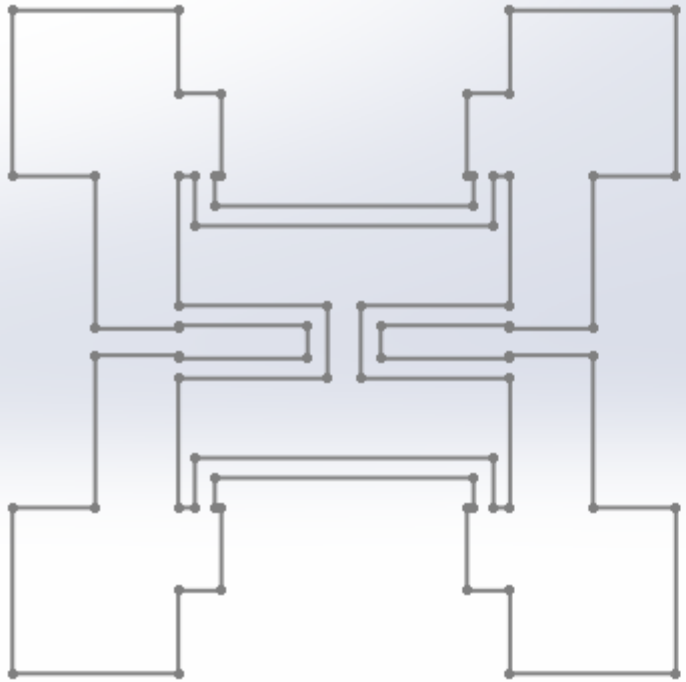
We can also use "microns" as our unit of measure.

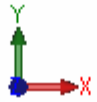





Use this tool to clean up the overlaps
Trim Entities
Convert Entities
Offset Entities
Offset On Surface
Mirror Entities
Linear Sketch Pattern
Move Entities
Display/Delete Relations
Repair Sketch
Quick Snaps
Rapid Sketch
Instant2D
Shaded Sketch Contours
Smart Dimension
Sketch
Evaluate
DimXpert
SOLIDWORKS Add-Ins
Simulation
SOLIDWORKS MBD
SOLIDWORKS CAM
Analysis Preparation
PS_15 Single 60um (Default<<De
History
Sensors
Annotations
Material <not
Front Plane
Top Plane
Right Plane
Origin
(-) Model
Next we need to eliminate overlaps in the drawing. Otherwise it will make it difficult to extrude. OBTW we also deleted the Diaphragm from the drawing because we are now focused on the circuit.
*Front
Model
3D Views
Motion Study 1

We can now build (extrude) the ***circuit***, In this example we will extrude 5UM





*Front

SOLIDWORKS File Edit View Insert Tools Simulation Window Help

PS_15 Sin... Search files and models

Measure | Mass Properties | Section Properties | Sensor | Performance Evaluation | Check | Geometry Analysis | Import Diagnostics | Deviation Analysis | Zebra Stripes | Curvature | Draft Analysis | Undercut Analysis | Parting Line Analysis | Symmetry Check | Thickness Analysis | Compare Documents | Check Active Document | 3DEXPERIENCE Simulation Connector | SimulationXpress Analysis Wizard | FloXpress Analysis Wizard | DFMXpress Analysis Wizard

Sketch | Evaluate | DimXpert | SOLIDWORKS Add-Ins | Simulation | SOLIDWORKS MBD | SOLIDWORKS CAM | Analysis Preparation

- PS_15 Single 60um circuit (Defau
  - History
  - Sensors
  - Annotations
  - Material <not specified>
  - Front Plane
  - Top Plane
  - Right Plane
  - Origin
  - Boss-Extrude1

In an isometric view the ***circuit*** looks good, next we do the "***diaphragm***" and it will be 1UM, also we will make it 2200UM square, i.e. A little bit bigger than the circuit.

*Trimetric

Model | 3D Views | Motion Study 1

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Custom

SOLIDWORKS File Edit View Insert Tools Simulation Window Help

Sketch1 ... Search files and models

Smart Dimension | Trim Entities | Convert Entities | Offset Entities | Offset On Surface | Mirror Entities | Linear Sketch Pattern | Move Entities | Display/Delete Relations | Repair Sketch | Quick Snaps | Rapid Sketch | Instant2D | Shaded Sketch Contours

Sketch | Evaluate | DimXpert | SOLIDWORKS Add-Ins | Simulation | SOLIDWORKS MBD | SOLIDWORKS CAM | Analysis Preparation

PS_15 Single 60um diaphr...

Boss-Extrude1

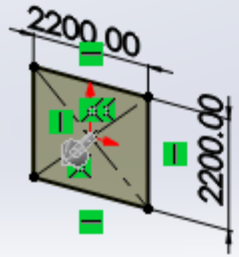
From
Sketch Plane

Direction 1
Blind
1.00um
Draft outward

Direction 2

Selected Contours

In an isometric view the ***diaphragm*** looks good, next we do the "***wafer***" and it will be 500UM



*Trimetric

Model | 3D Views | Motion Study 1

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-15548.97um -2269.60um 0.00um Fully Defined Custom

SOLIDWORKS File Edit View Insert Tools Simulation Window Help Sketch1 ... Search files and models

Smart Dimension | Trim Entities | Convert Entities | Offset Entities | Offset On Surface | Mirror Entities | Linear Sketch Pattern | Move Entities | Display/Delete Relations | Repair Sketch | Quick Snaps | Rapid Sketch | Instant2D | Shaded Sketch Contours

Sketch | Evaluate | DimXpert | SOLIDWORKS Add-Ins | Simulation | SOLIDWORKS MBD | SOLIDWORKS CAM | Analysis Preparation

PS_15 Single 60um wafer ...

Boss-Extrude1

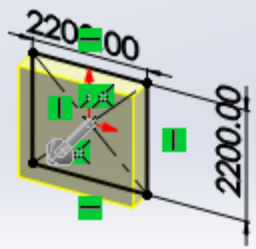
From
Sketch Plane

Direction 1
Blind
500.00um
Draft outward

Direction 2

Selected Contours

In an isometric view the ***wafer*** looks good but now we need to add the ***cavity*** through the wafer so that the angle between the bottom of the wafer and the cavity wall is 54.7 degrees.

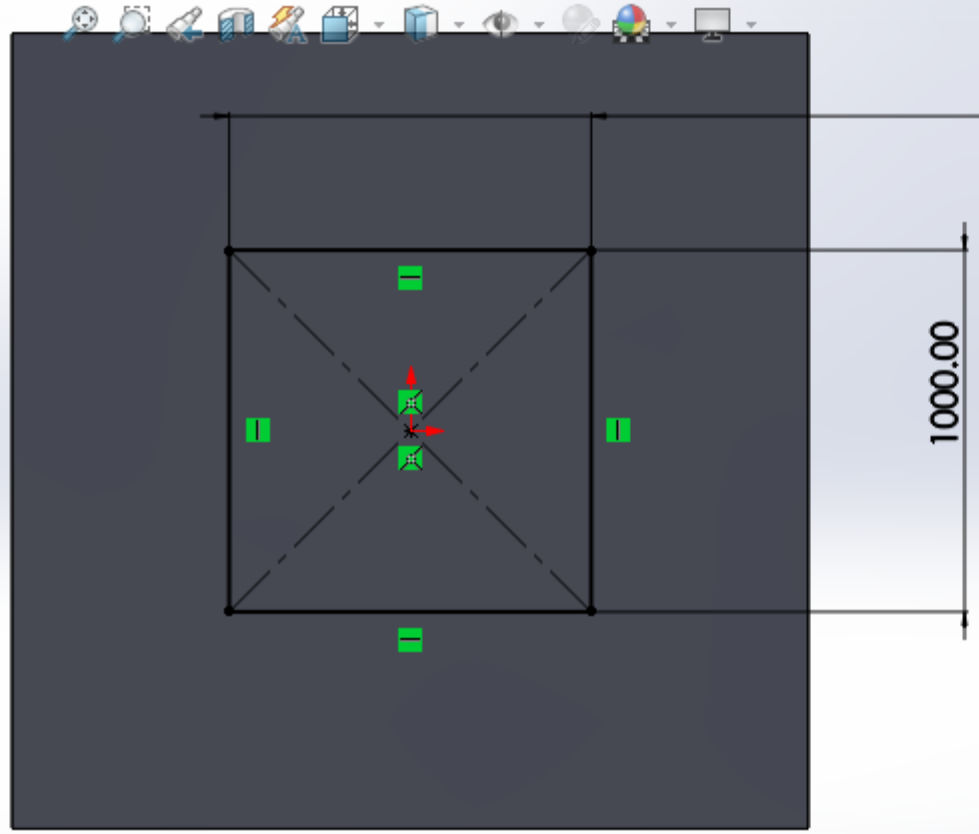


*Trimetric

Model | 3D Views | Motion Study 1

ORKS Education Edition - Instructional Use Only -10901.59um -54.92um 0um Fully Defined Custom

Draw the top of the ***cavity*** as a 1000UM square centered at the center of the ***wafer***



SOLIDWORKS File Edit View Insert Tools Simulation Window Help Sketch2 ... Search files and models

Smart Dimension | Trim Entities | Convert Entities | Offset Entities | Offset On Surface | Mirror Entities | Linear Sketch Pattern | Move Entities | Display/Delete Relations | Repair Sketch | Quick Snaps | Rapid Sketch | Instant2D | Shaded Sketch Contours

Sketch | Evaluate | DimXpert | SOLIDWORKS Add-Ins | Simulation | SOLIDWORKS MBD | SOLIDWORKS CAM | Analysis Preparation

PS_15 Single 60um wafer ...

Cut-Extrude1

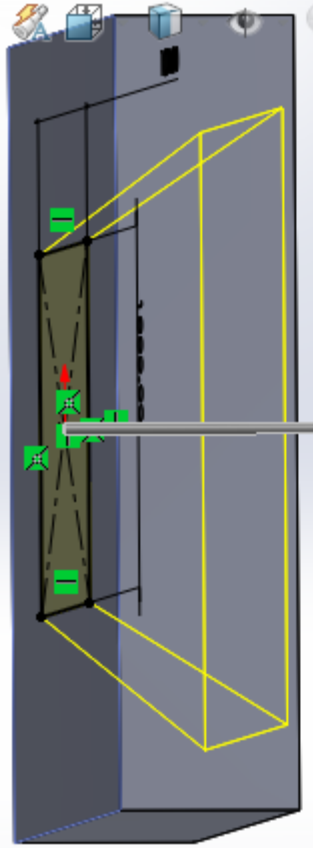
From
Sketch Plane

Direction 1
Through All
Flip side to cut
35.30deg
Draft outward

Direction 2

Selected Contours

The do a extrude cut at 90-54.7 – 35.3 outward, through all



Model | 3D Views | Motion Study 1

handle to modify parameters -8231.84um 384.49um 0um Fully Defined Editing Sketch2 Custom

SOLIDWORKS File Edit View Insert Tools Simulation Window Help

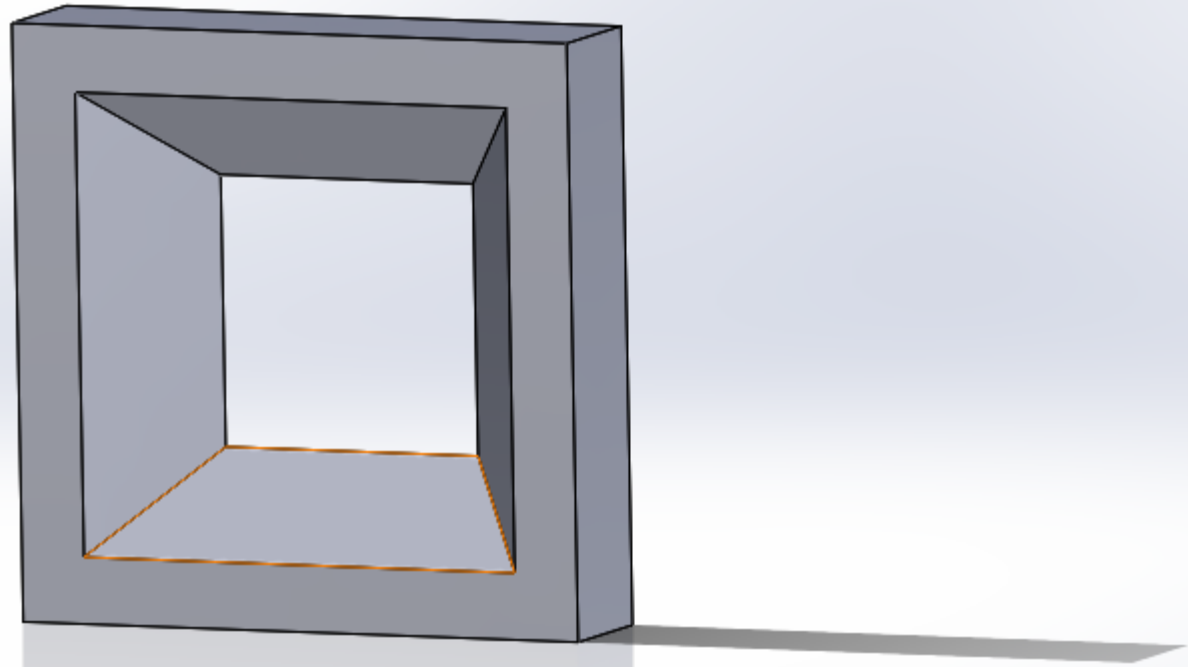
PS_15 Sin... Search files and models

Swept Boss/Base
Lofted Boss/Base
Boundary Boss/Base
Revolved Boss/Base
Extruded Cut
Hole Wizard
Revolved Cut
Swept Cut
Lofted Cut
Boundary Cut
Fillet
Linear Pattern
Rib
Draft
Shell
Wrap
Intersect
Mirror
Reference Geometry
Curves
Instant3D

Sketch | Evaluate | DimXpert | SOLIDWORKS Add-Ins | Simulation | SOLIDWORKS MBD | SOLIDWORKS CAM | Analysis Preparation

PS_15 Single 60um wafer (Default
History
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
Boss-Extrude1
Cut-Extrude1
Sketch2

This is what it looks like.



Model | 3D Views | Motion Study 1

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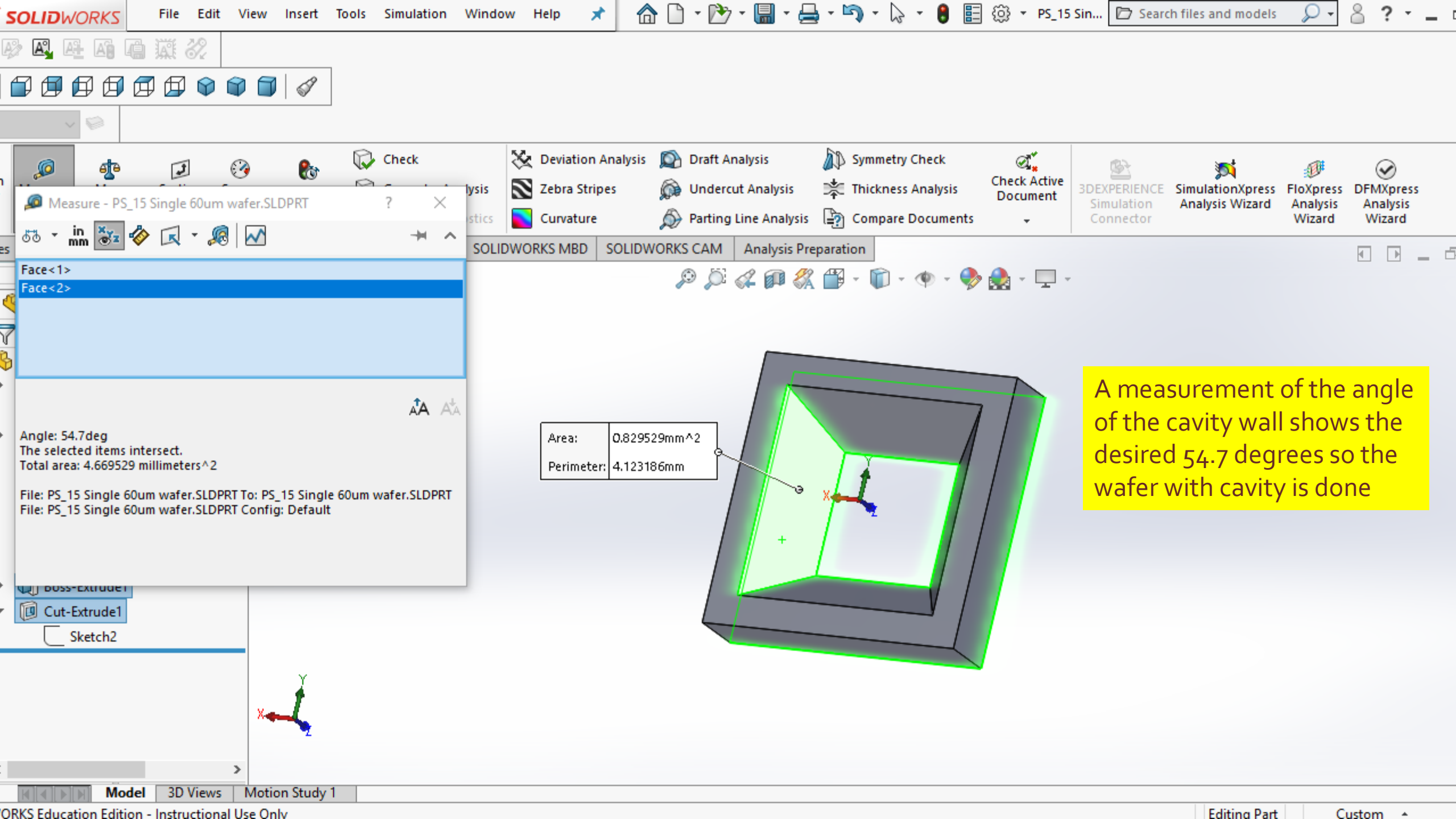
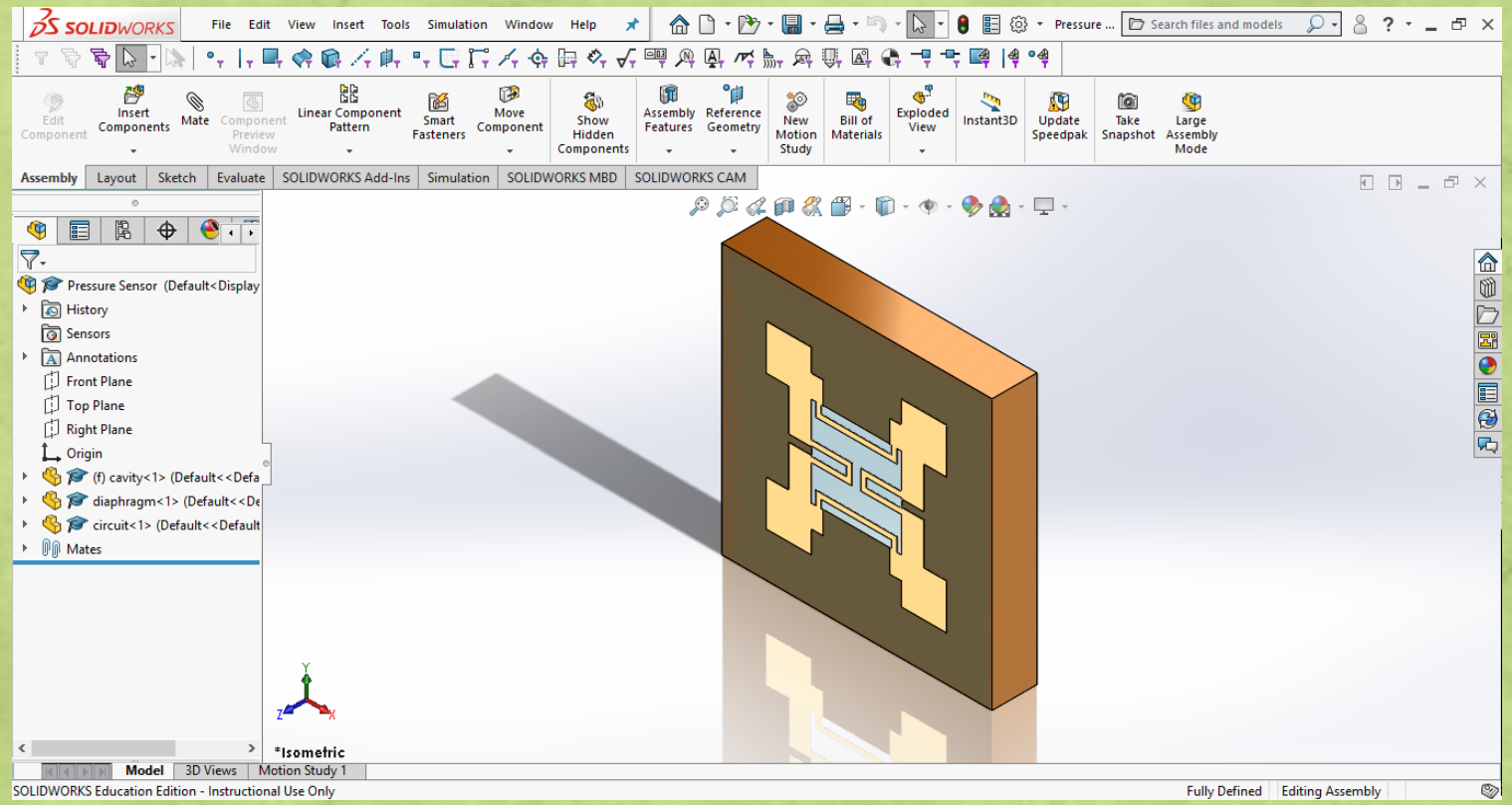
Editing Part | Custom


SOLIDWORKS
File Edit View Insert Tools Simulation Window Help
Search files and models
Check
Deviation Analysis
Draft Analysis
Symmetry Check
Check Active Document
Zebra Stripes
Undercut Analysis
Thickness Analysis
Curvature
Parting Line Analysis
Compare Documents
3DEXPERIENCE Simulation Connector
SimulationXpress Analysis Wizard
FloXpress Analysis Wizard
DFMXpress Analysis Wizard
SOLIDWORKS MBD
SOLIDWORKS CAM
Analysis Preparation
Measure - PS_15 Single 60um wafer.SLDPRT
Face<1>
Face<2>
Angle: 54.7deg
The selected items intersect.
Total area: 4.669529 millimeters^2
File: PS_15 Single 60um wafer.SLDPRT To: PS_15 Single 60um wafer.SLDPRT
File: PS_15 Single 60um wafer.SLDPRT Config: Default
Area: 0.829529mm^2
Perimeter: 4.123186mm
Cut-Extrude1
Sketch2
A measurement of the angle of the cavity wall shows the desired 54.7 degrees so the wafer with cavity is done
Model
3D Views
Motion Study 1
Editing Part
Custom

3D Models help student visualize the device

- At this point the hard work is done. An Assembly can be colored, created and parts mated to create the 3D model of the SCME Pressure Sensor.



3D Models help student visualize the device

Questions?

http://scme-support.org/
http://www.ivytech-mems.org/
http://faculty.ivytech.edu/~abell118/

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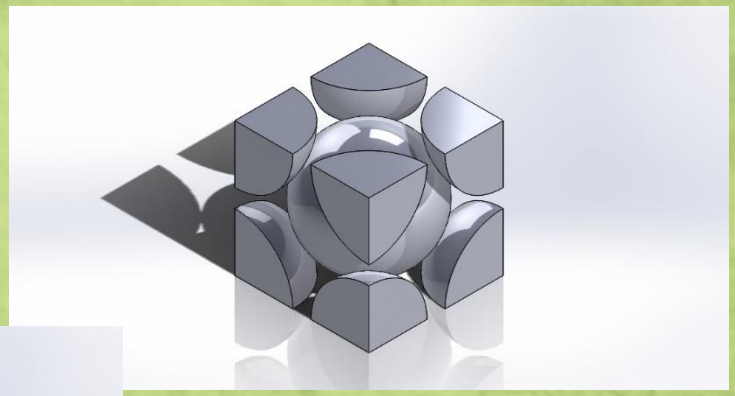
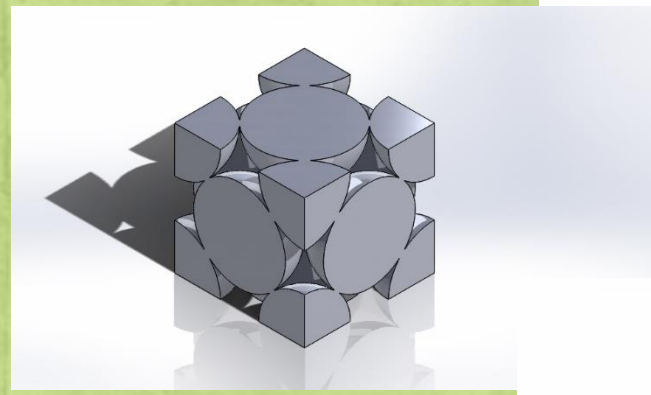
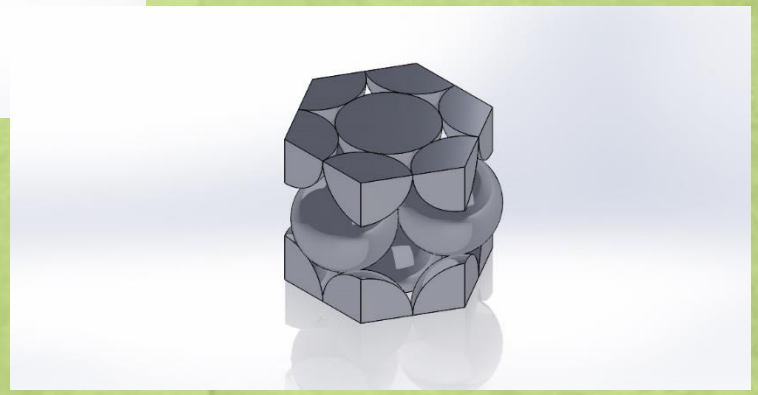


BCC Unit Cell



FCC Unit Cell



HCP Unit Cell