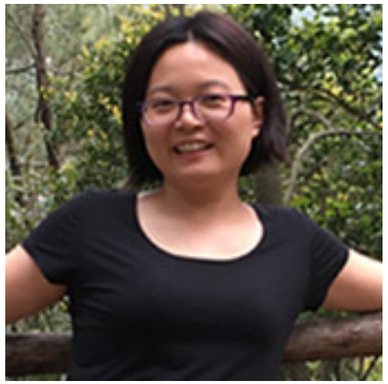
Sheet Metal in Inventor: making top-down design with multiple bodies

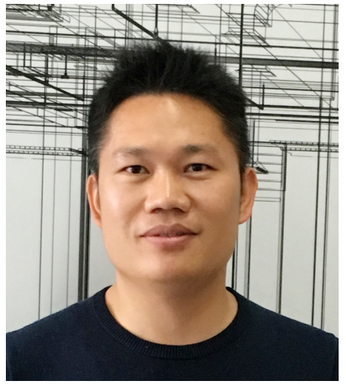
Nina Shao, Principal Experience Designer
River Cai, Senior SQA Engineer

About Speakers



Nina Shao

Major: Mechanical Design and Manufacturing
Job: Principal Experience Designer
Inventor Experiences:
Sheet Metal, Modeling, Sketch, Assembly, BIM Content, Tooling



River Cai

Major: Mechanical Design and Manufacturing
Job: Senior SQA Engineer & Customer Success Engineer
Inventor Experiences:
Sheet Metal, Part/Assembly Modeling, Frame Generator, Tube & Pipe, IDF

Class summary

Learn how to make top-down design with Autodesk Inventor Sheet Metal, using the multiple body and the whole Sheet Metal system to improve the productivity.

Key learning objectives

At the end of this class, you will be able to:

Set up and Manage Inventor Sheet Metal Styles/Rules

Make Sheet Metal Features

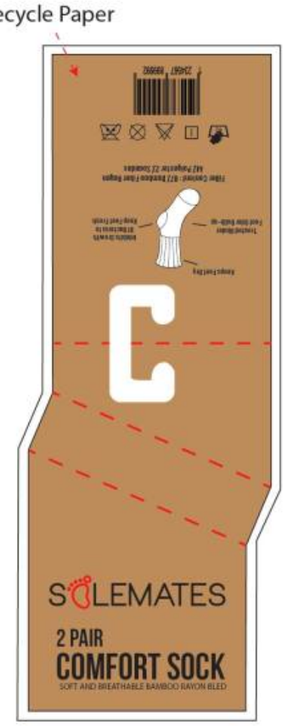
Make Top-down Design with Inventor Sheet Metal

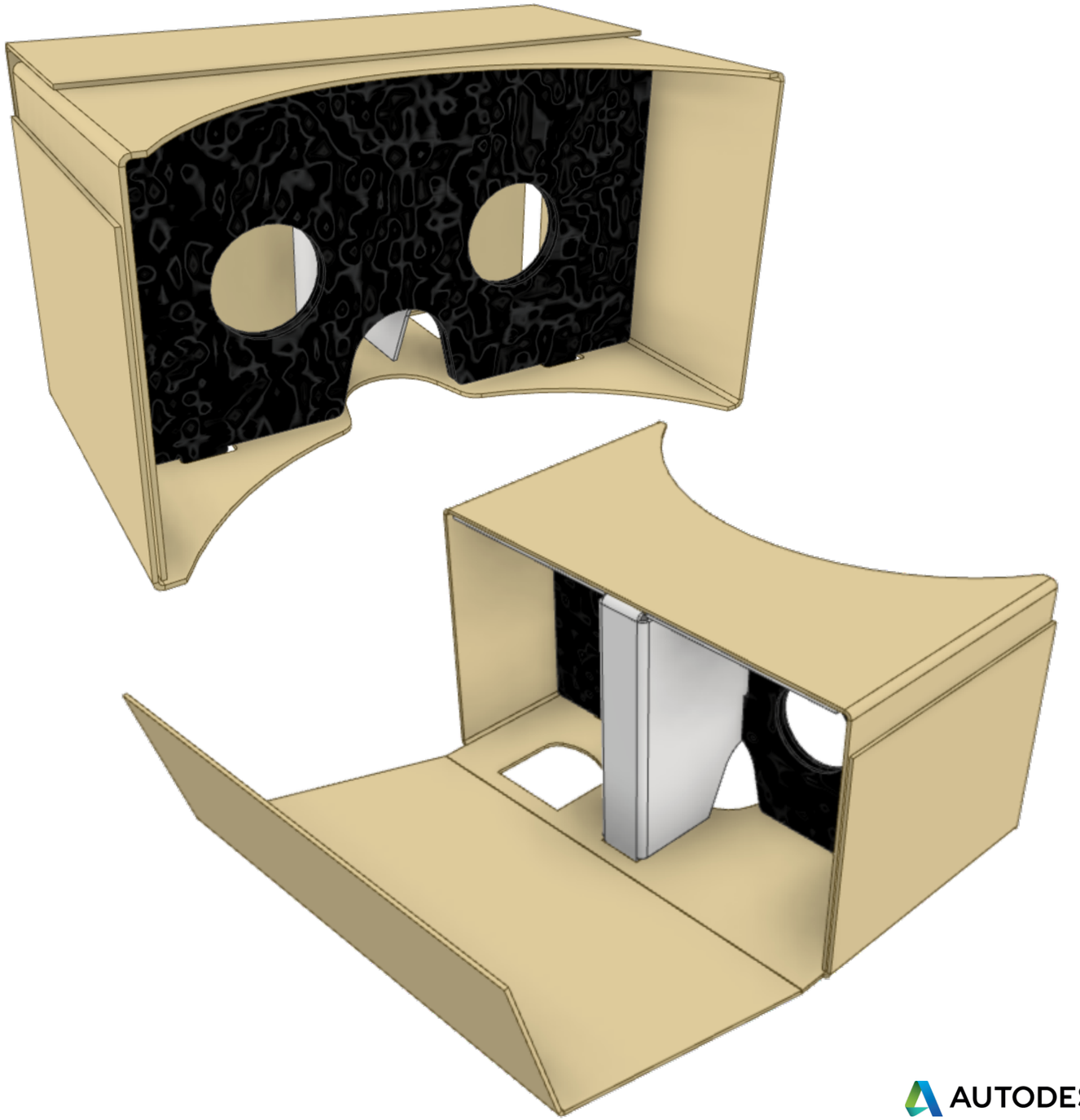
Get Tips to ease your work

Know where to find us

Sheet Metal for Sheet Metal

Sheet Metal for not only Sheet Metal

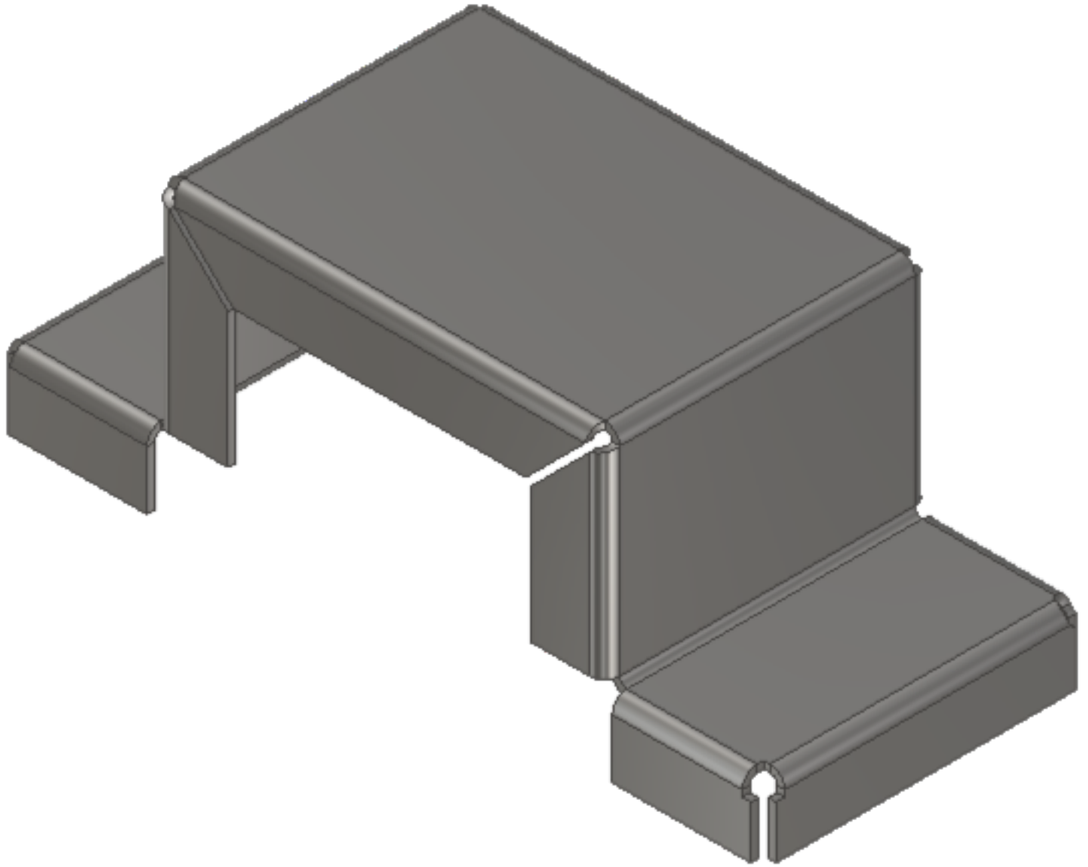




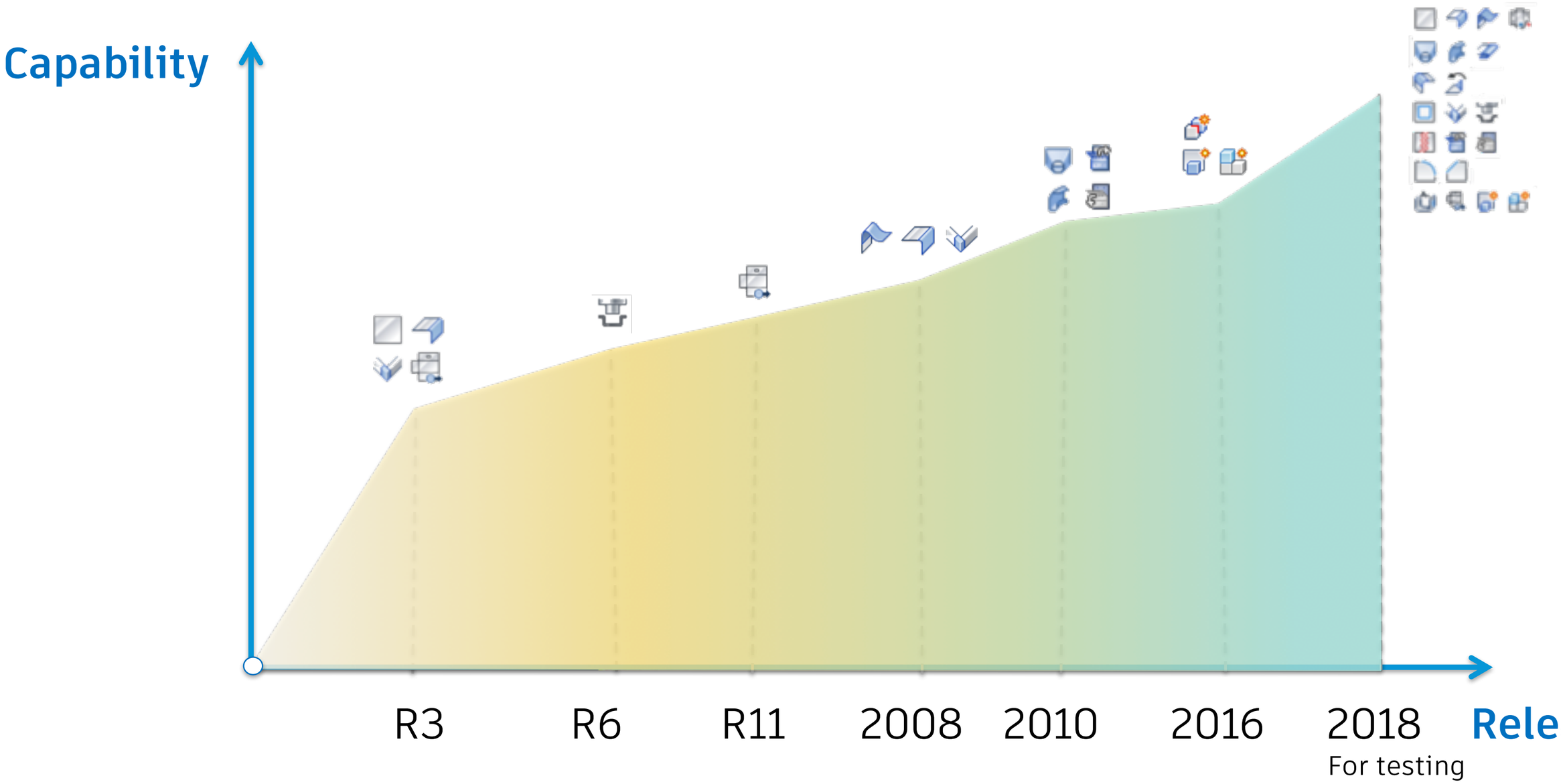
AUTODESK.

Choose Sheet Metal when

- With Uniform Material
- With Uniform Thickness
- Require Bend or Folded



Inventor Sheet Metal Evolution



Inventor Sheet Metal System

Inventor Sheet Metal Styles/Rules

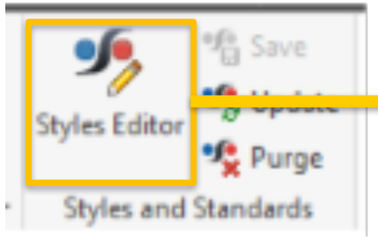
What we will learn?

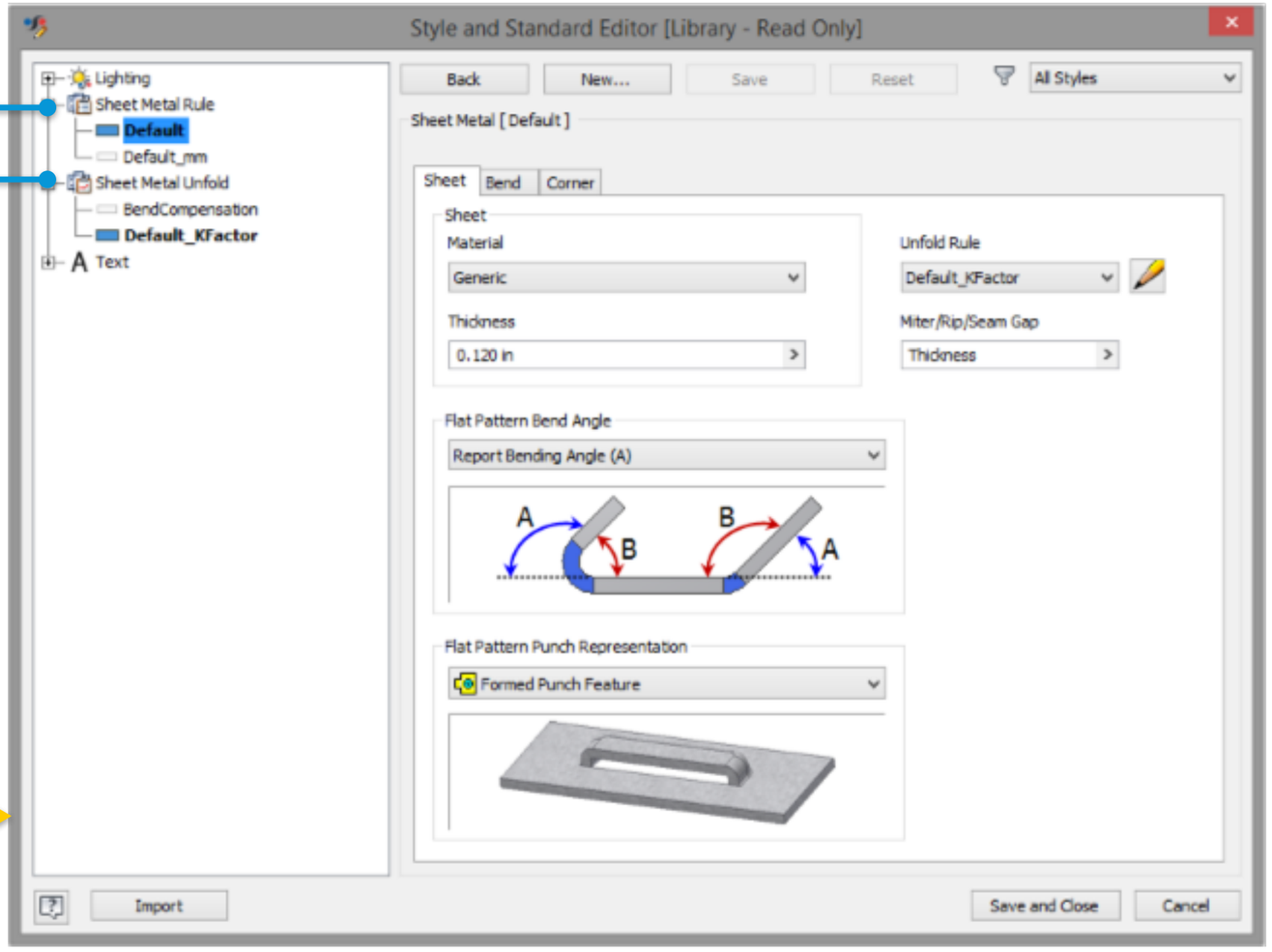
- Set up Sheet Metal Rules
- Define Unfold Rules
- Share Styles/Rules with Templates

Style and Standard Editor

Sheet Metal Rules

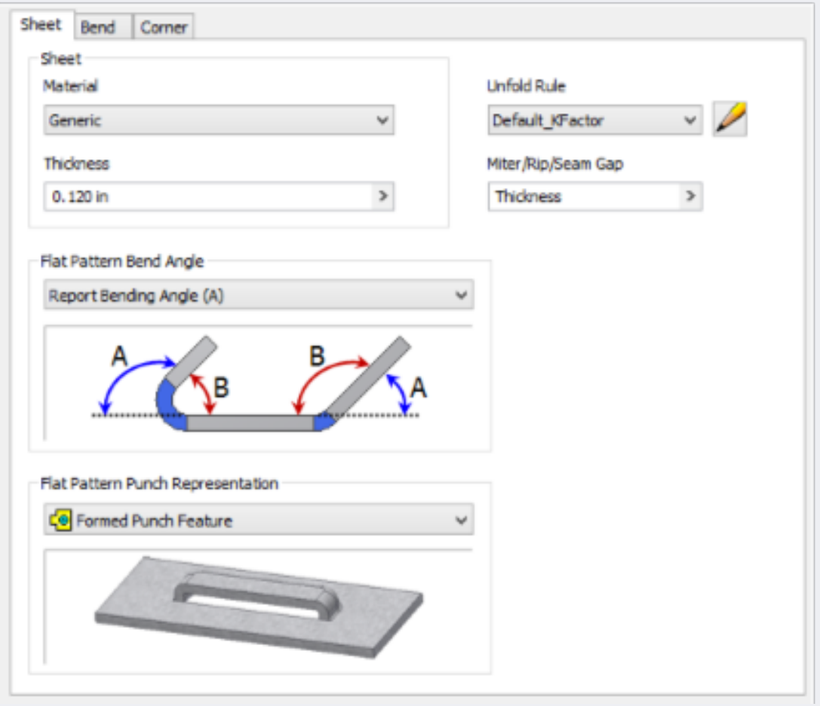
Sheet Metal Unfold Rules



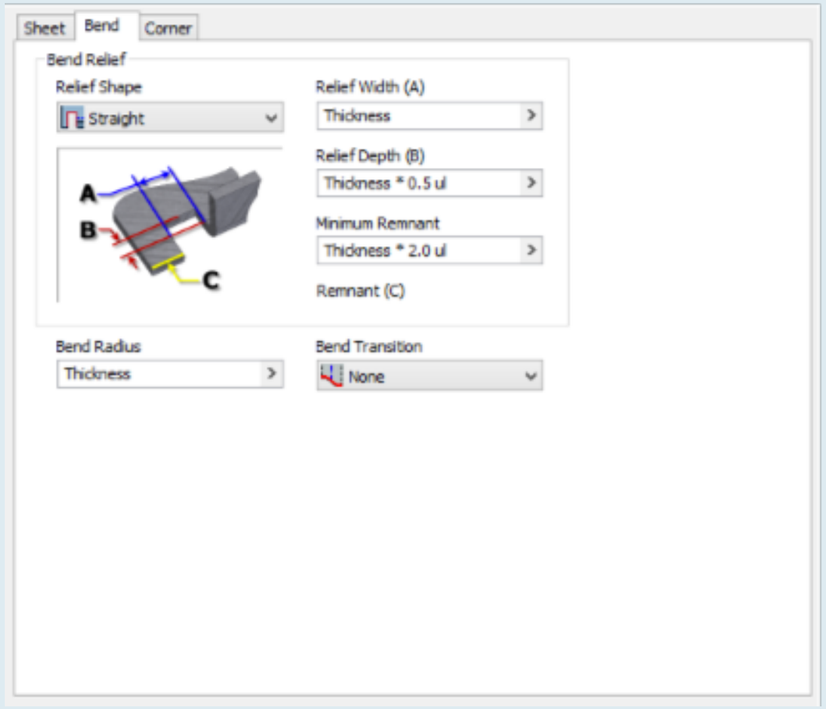


Sheet Metal Rules

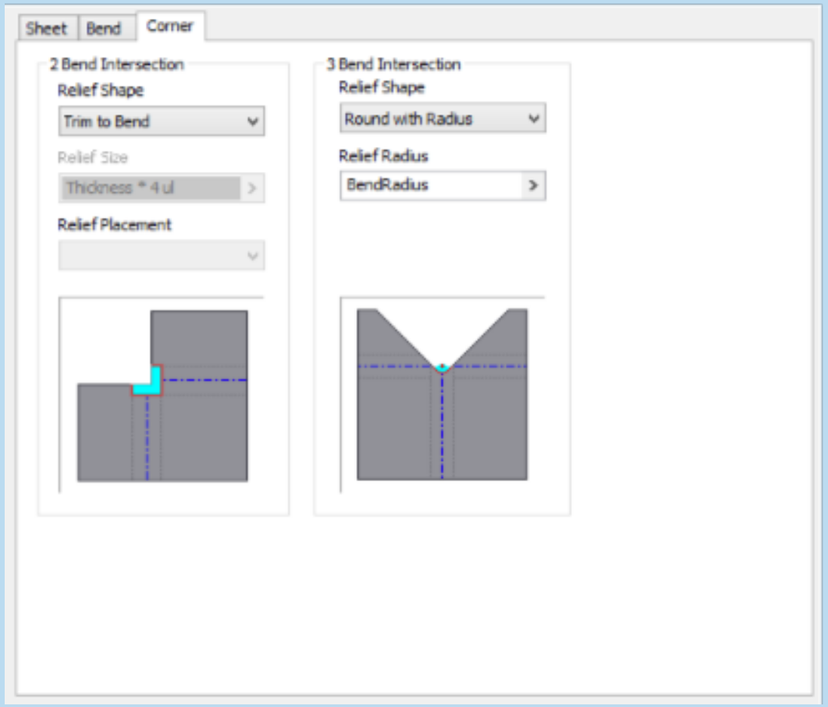
Sheet
- Material
- Thickness
- Unfold Rule



Bend
- Bend Radius
- Bend Relief
- Bend Transition



Corner
- Relief Shape
- Relief Radius
- Relief Placement



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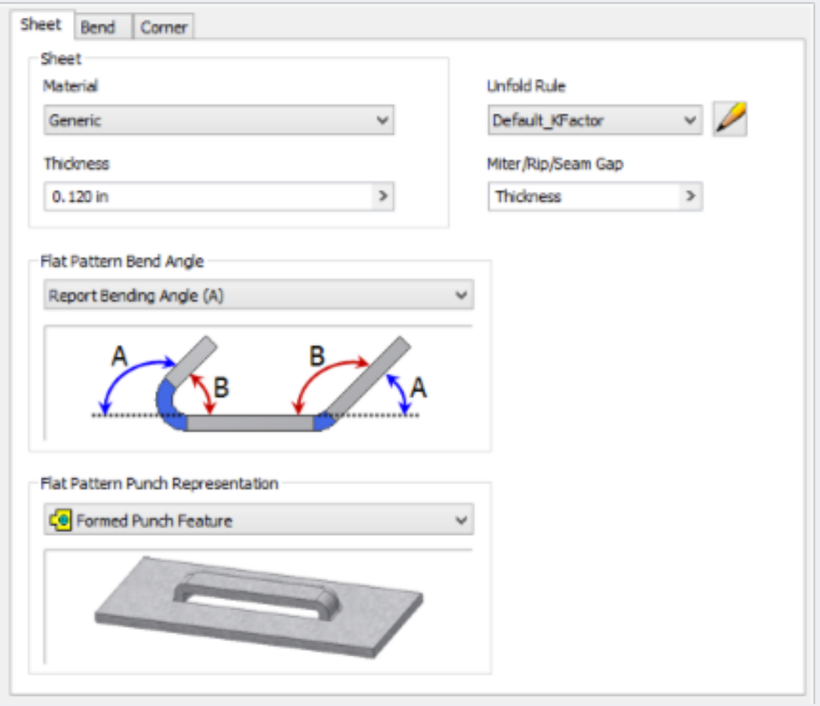
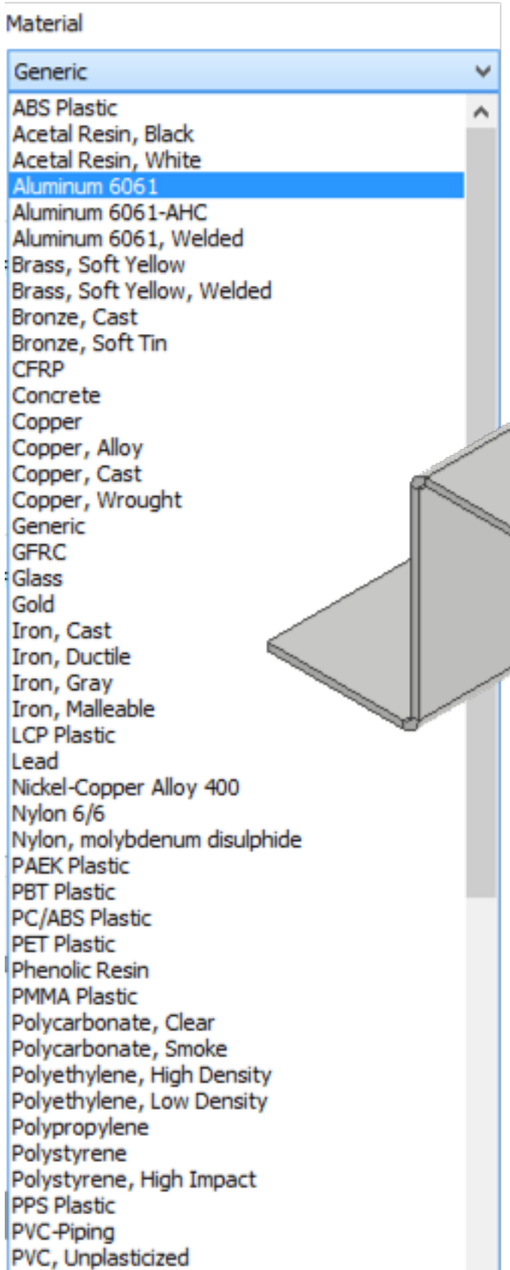
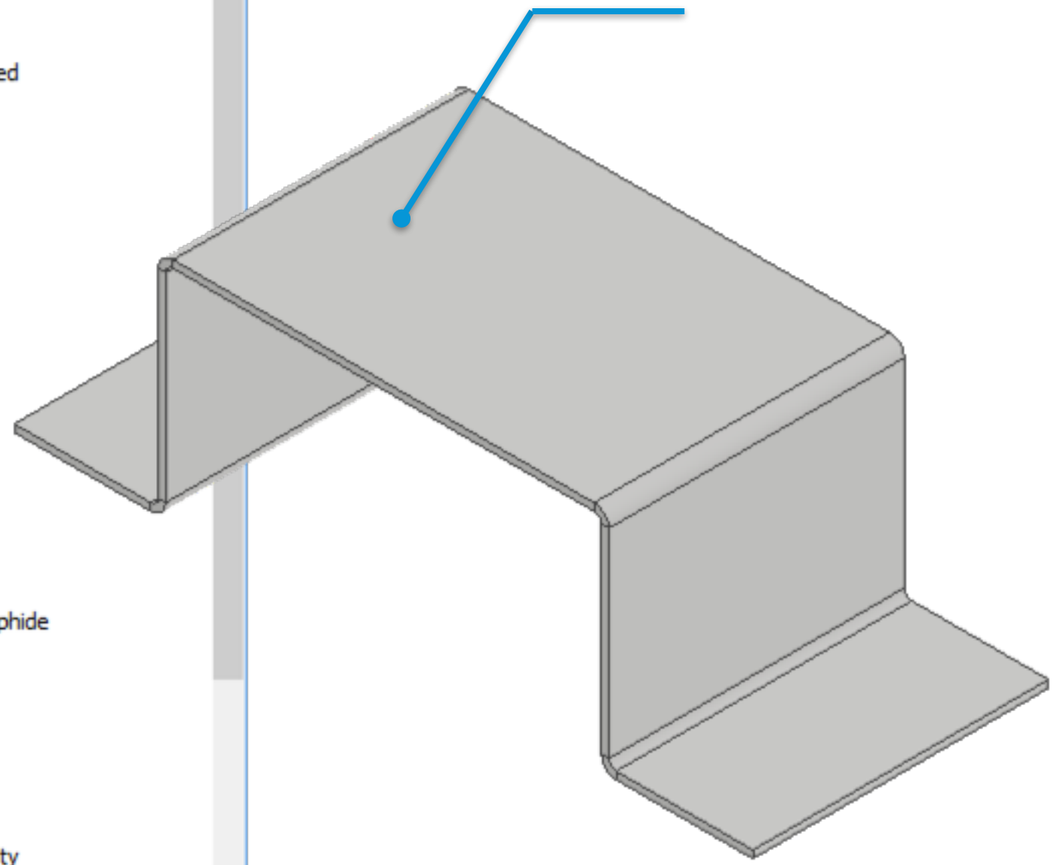
Sheet Metal Rules – Sheet

Sheet
- Material
- Thickness
- Unfold Rule





Stainless Steel 304
Thickness 2 mm

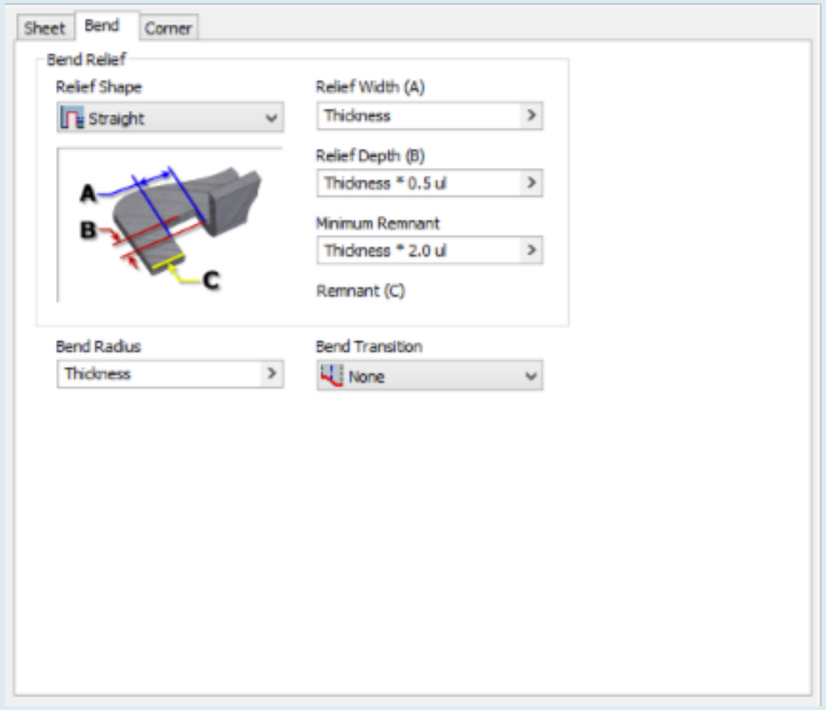


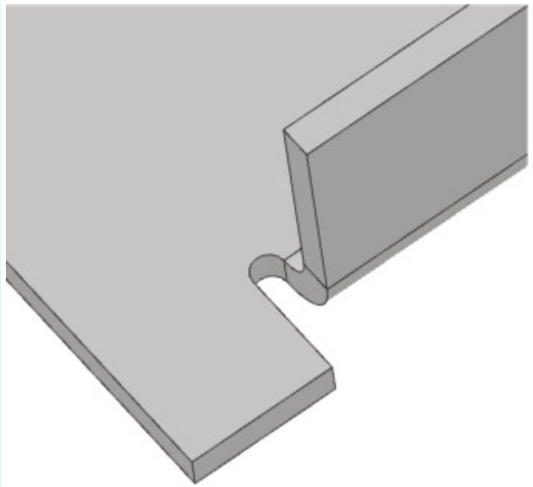
AUTODESK.

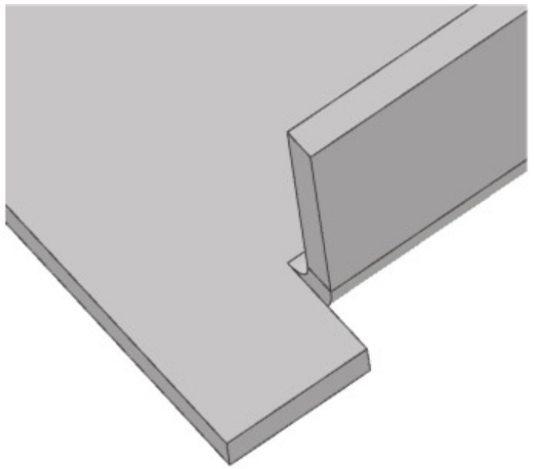
Sheet Metal Rules – Bend

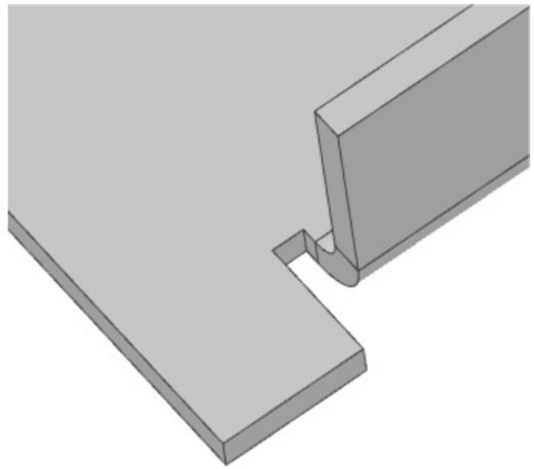
Bend

- Bend Radius
- Bend Relief
- Bend Transition



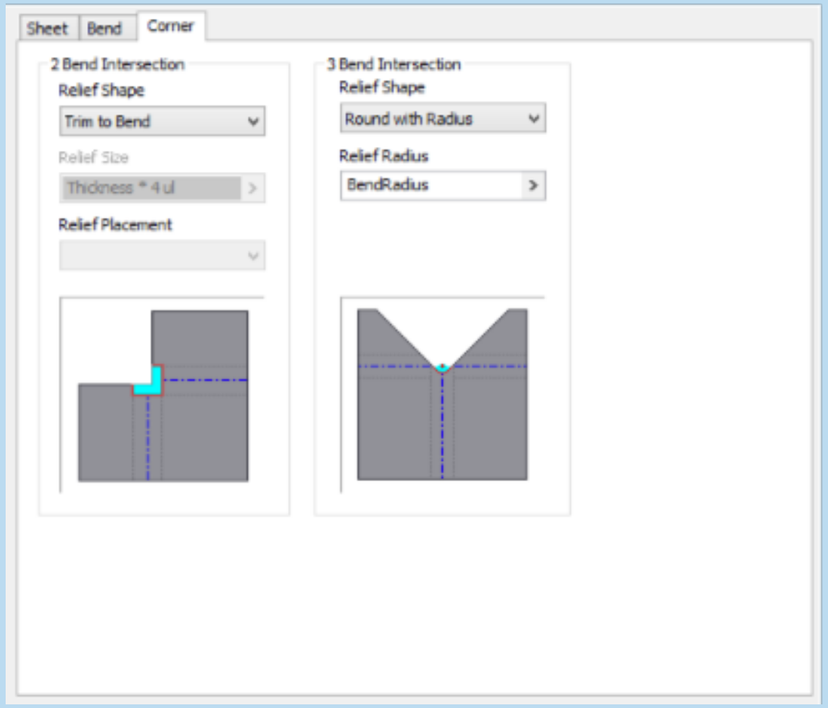


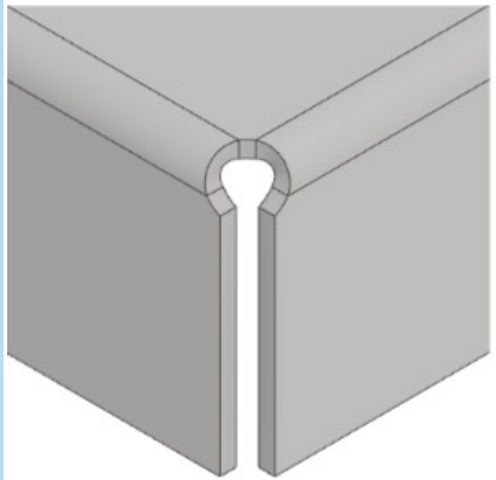


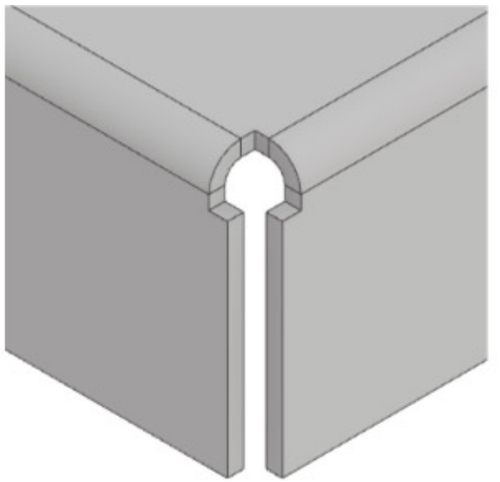


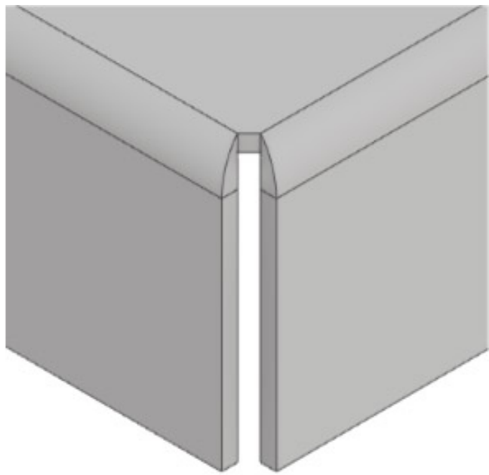
Sheet Metal Rules – Corner

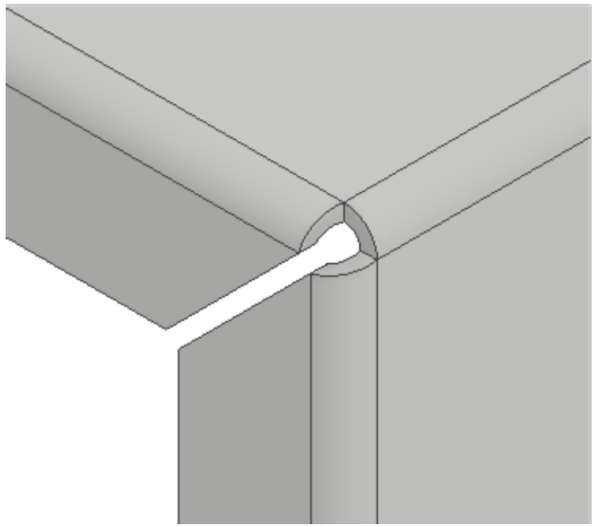
Corner
- Relief Shape
- Relief Radius
- Relief Placement

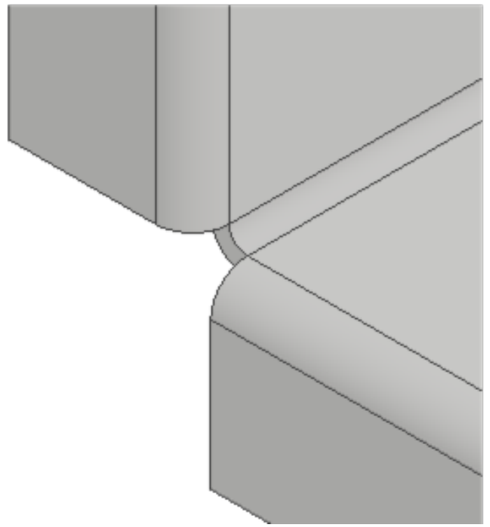






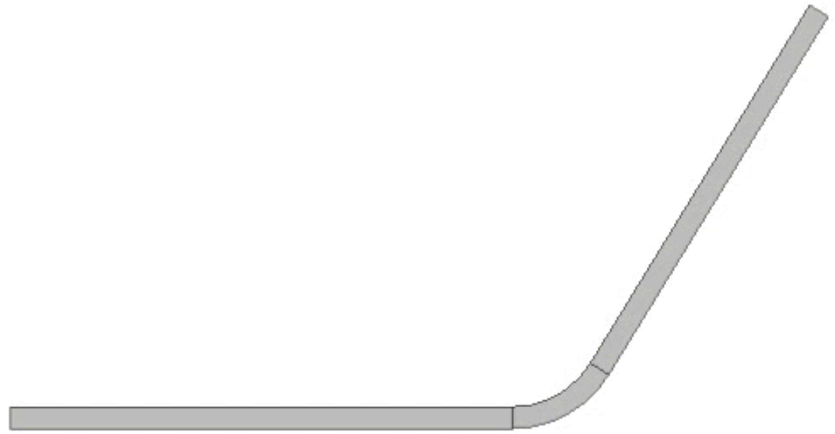


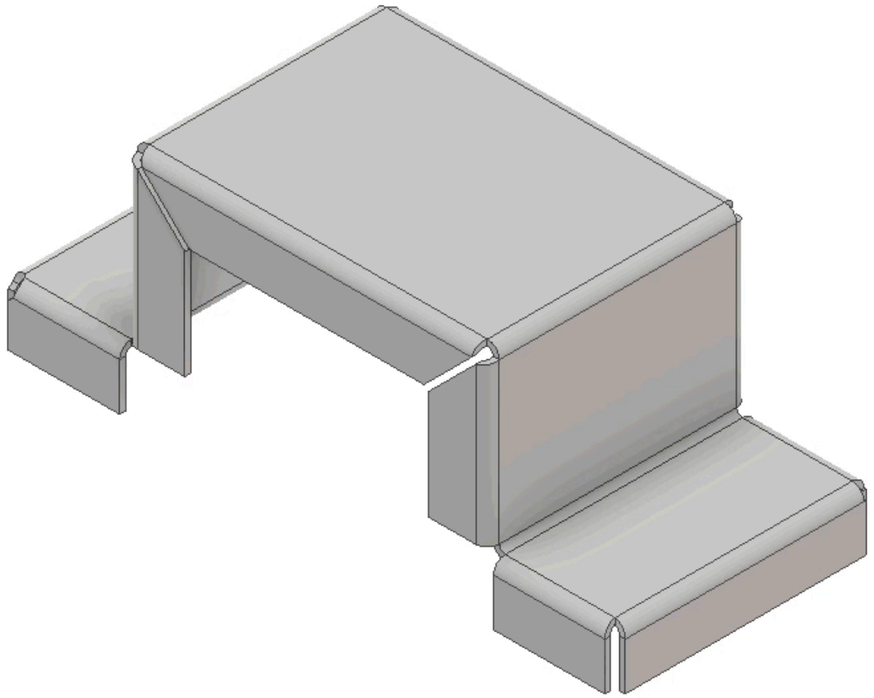




Unfold Rules

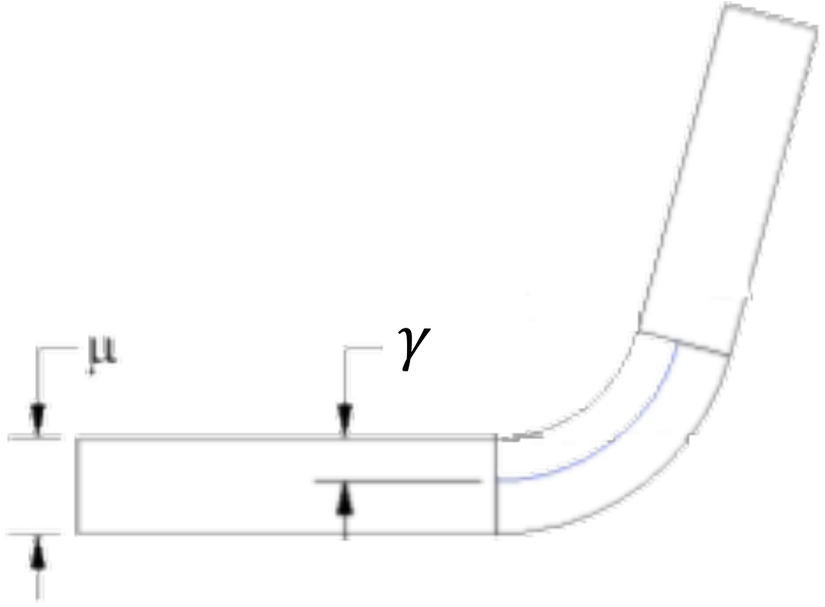
- Linear – KFactor
- Bend Table
- Custom Equation
  - Bend Allowance
  - Bend Compensation
  - Bend Deduction
  - Variable KFactor



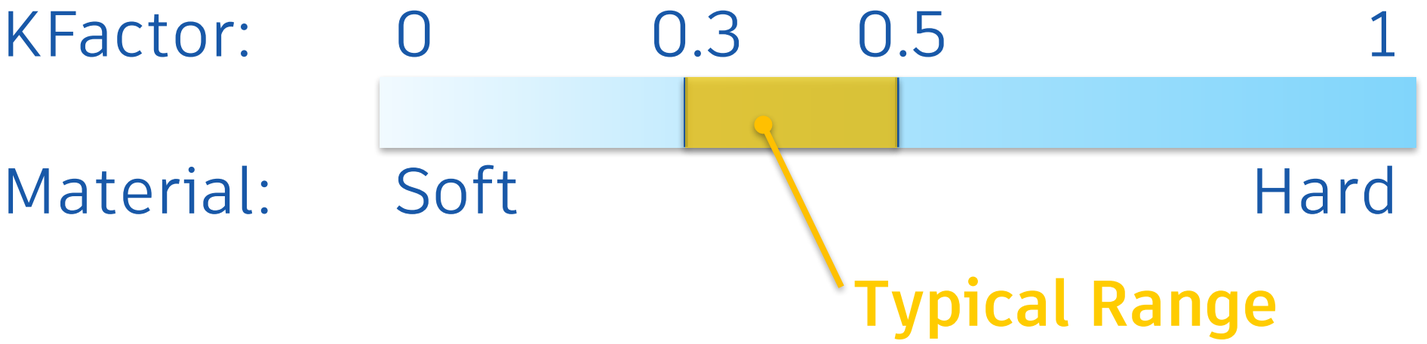


Linear – KFactor

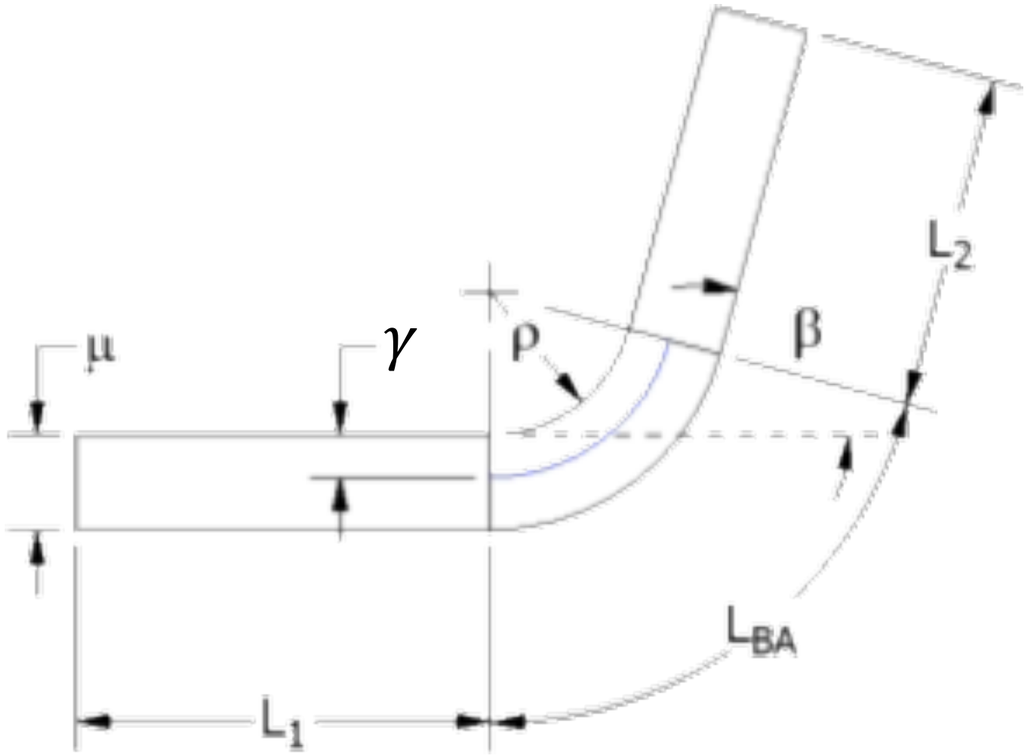
KFactor is a ratio of location of the neutral surface to the material thickness as defined by γ/μ where γ = location of the neutral surface and μ = material thickness. γ is measured from the inside face.



KFactor = γ /μ



Linear – KFactor



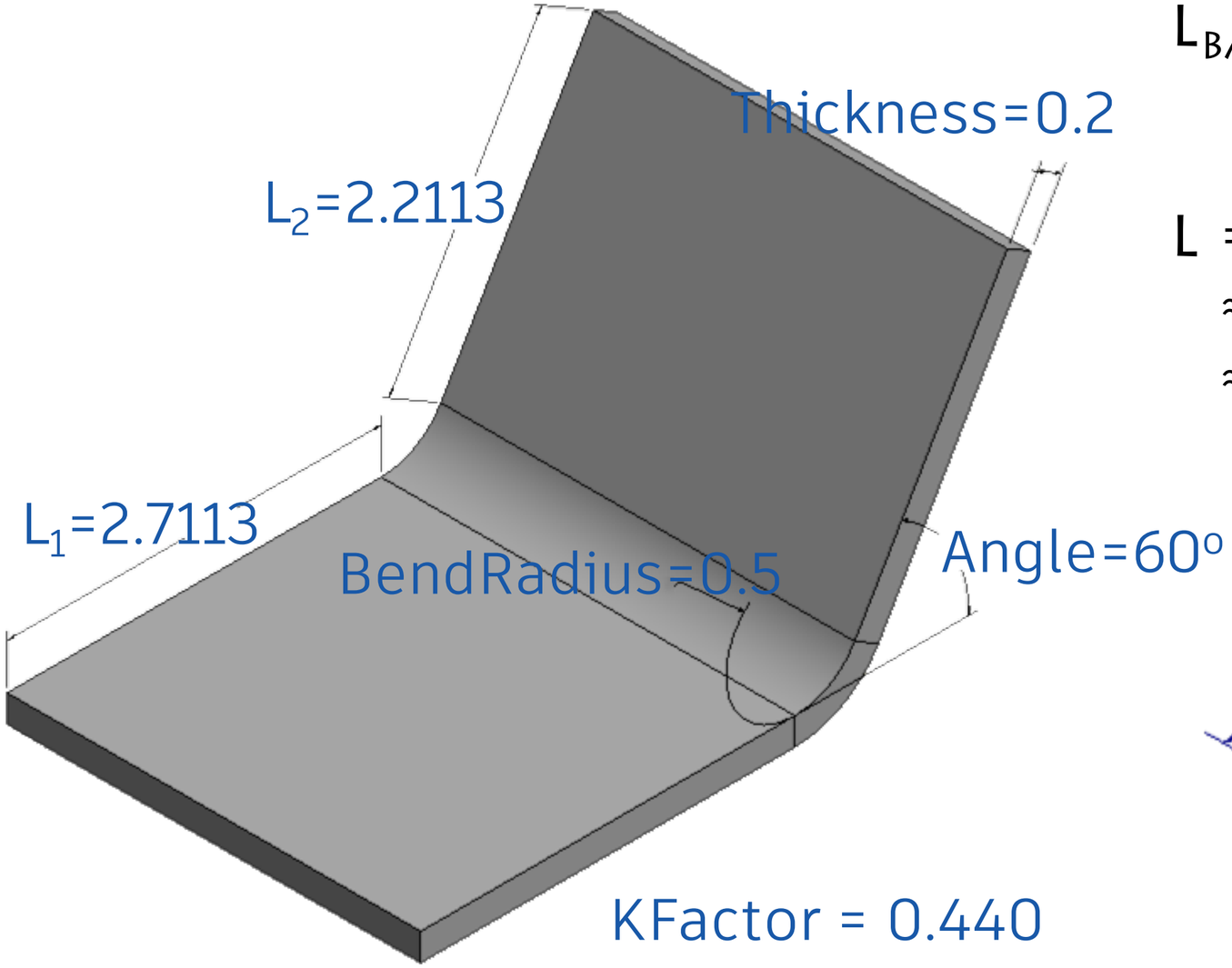
$$L = L_1 + L_{BA} + L_2$$

$$L_{BA} = \pi \cdot \left(\frac{\beta}{180°}\right) \cdot (\rho + K_{Factor} \cdot \mu)$$

L – Developed length

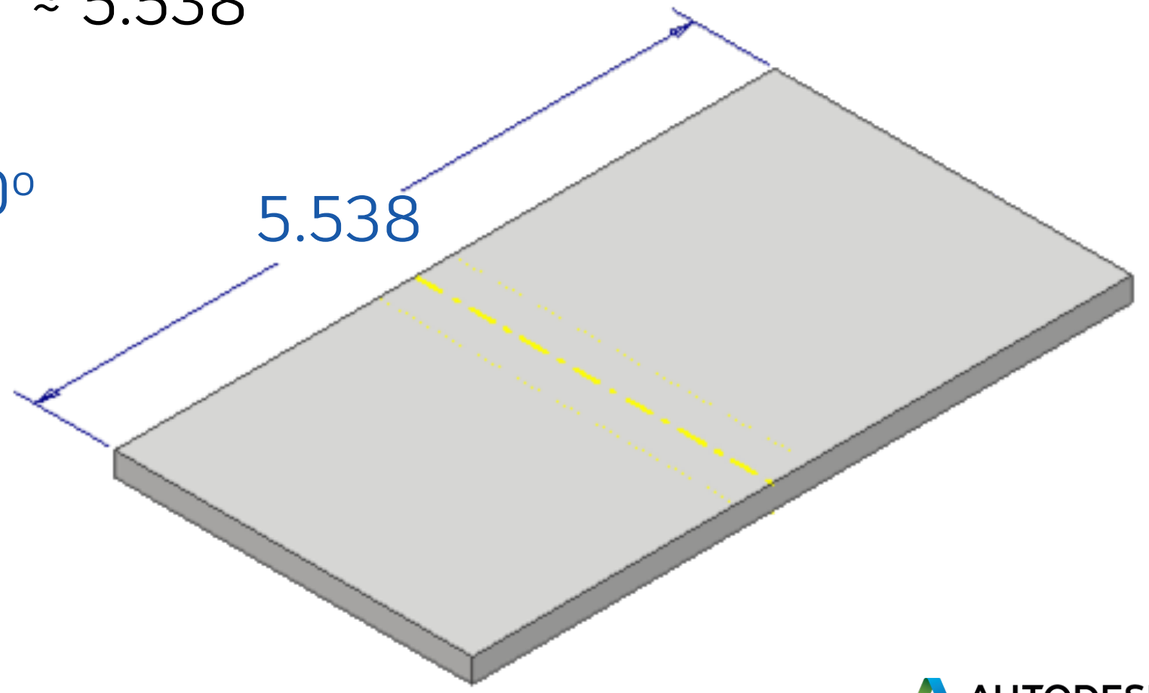
L_{BA} – Bend Allowance

Linear – KFactor



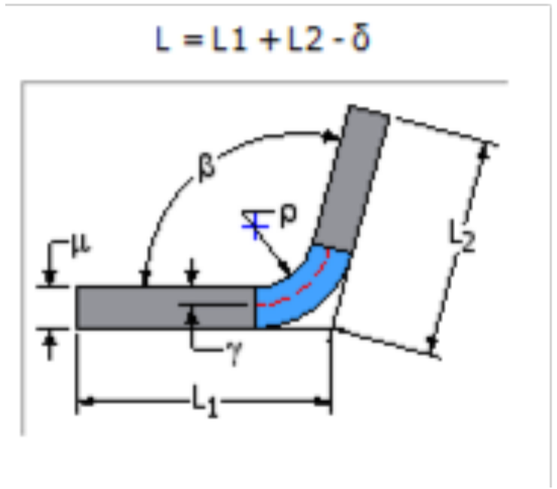
L_{BA} = 3.14x (60/180)x (0.5+0.44x0.2)
= 0.61544

$L = L_1 + L_{BA} + L_2$
≈ 2.7113 +2.2113 + 0.61544
≈ 5.538



Bend Table

Specifies the length correction value for a specified material thickness at specific radii and bend angles for the flat pattern analyzer



Import

Unfold Method

Bend Table

Linear Unit

millimeter (mm)

Thickness

0.500000

2.000000

Click here to add

Backup KFactor Value

0.440 ul

Spline Factor Value

0.500 ul

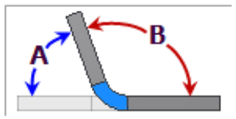
Table Tolerances

Sheet

0.0001

Radii 0.004

Angle 0.004



Bending Angle Reference (A)

Open Angle Reference (B)

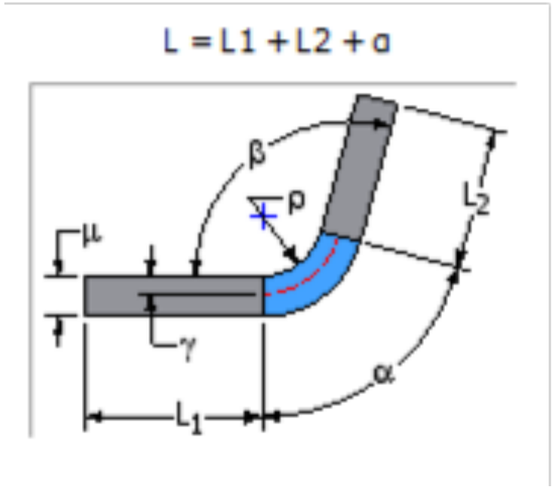
Bending Radii

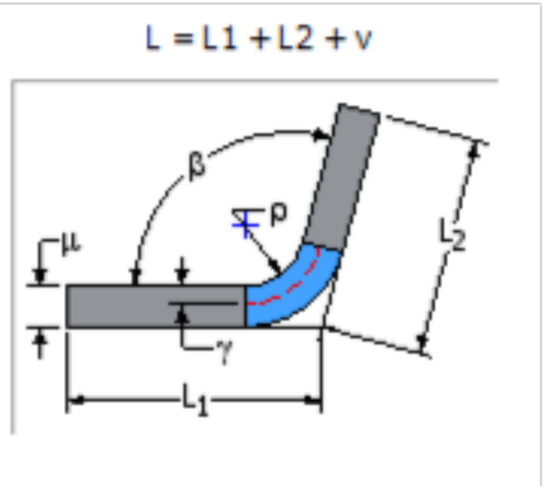
Open Angle (deg)

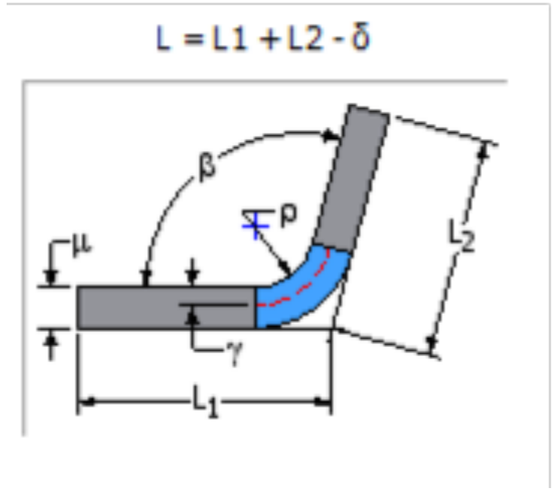
	0.125000	0.500000	1.000000	1.500000	2.000000	3.000000	4.000000	5.000000	6.000000
0.000000	0.583221	-0.081305	-0.770316	-1.410263	-2.030123	-3.240866	-4.431522	-5.611171	-6.783858
1.000000	0.586925	-0.069742	-0.749369	-1.380206	-1.991066	-3.183972	-4.356902	-5.518887	-6.673948
5.000000	0.601742	-0.023491	-0.665585	-1.259978	-1.834841	-2.956398	-4.058424	-5.149750	-6.234307
10.000000	0.620264	0.034323	-0.560854	-1.109693	-1.639560	-2.671929	-3.685326	-4.688328	-5.684755
15.000000	0.638785	0.092137	-0.456123	-0.959408	-1.444279	-2.387461	-3.312229	-4.226907	-5.135203
20.000000	0.657307	0.149951	-0.351392	-0.809123	-1.248998	-2.102992	-2.939131	-3.765485	-4.585652
25.000000	0.675829	0.207765	-0.246661	-0.658837	-1.053717	-1.818524	-2.566033	-3.304064	-4.036100
30.000000	0.694350	0.265579	-0.141930	-0.508552	-0.858435	-1.534055	-2.192935	-2.842643	-3.486549
35.000000	0.712872	0.323393	-0.037199	-0.358267	-0.663154	-1.249587	-1.819837	-2.381221	-2.936997
40.000000	0.731394	0.381207	0.067532	-0.207982	-0.467873	-0.965118	-1.446739	-1.919800	-2.387445
45.000000	0.749915	0.439021	0.172263	-0.057697	-0.272592	-0.680650	-1.073642	-1.458378	-1.837894
50.000000	0.768437	0.496835	0.276994	0.092588	-0.077311	-0.396181	-0.700544	-0.996957	-1.288342
55.000000	0.786959	0.554649	0.381725	0.242873	0.117970	-0.111713	-0.327446	-0.535536	-0.738790
60.000000	0.805480	0.612463	0.486456	0.393158	0.313252	0.172756	0.045652	-0.074114	-0.189239
65.000000	0.824002	0.670277	0.591187	0.543443	0.508533	0.457224	0.418750	0.387307	0.360313
70.000000	0.842524	0.728091	0.695918	0.693728	0.703814	0.741693	0.791848	0.848729	0.909864
75.000000	0.861045	0.785905	0.800649	0.844013	0.899095	1.026161	1.164945	1.310150	1.459416
80.000000	0.879567	0.843719	0.905380	0.994298	1.094376	1.310630	1.538043	1.771572	2.008968
85.000000	0.898089	0.901533	1.010111	1.144583	1.289658	1.595098	1.911141	2.232993	2.558519

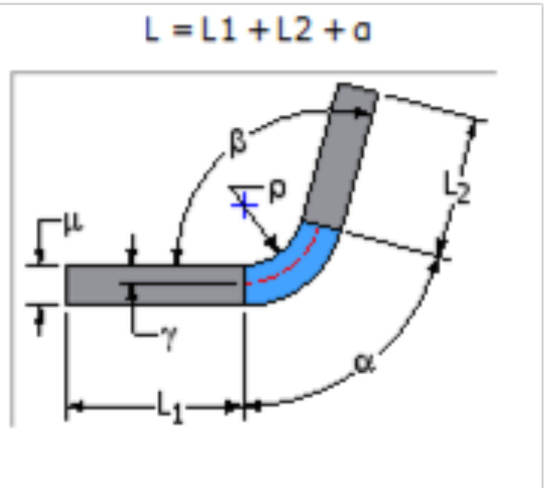
Custom Equation

- Bend Allowance (**α**)
- Bend Compensation(**v**)
- Bend Deduction(**δ**)
- Variable KFactor(**κ**)









Unfold Method

Custom Equation

Equation Type

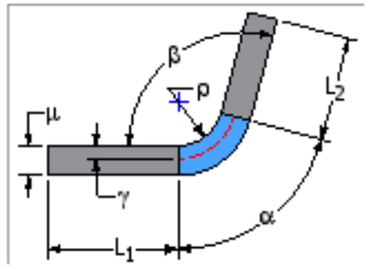
Bend Allowance

Angular Reference(β)

Open Angle

β - Angle
μ - Thickness
ρ - Radius, Inner
π - Pi
γ - Neutral Surface
L - Developed Length

L = L1 + L2 + α



	Custom Equation	Bounding Condition
α =	π * ((180deg - β)/180deg) * (ρ + (μ/2ul) * (0.65ul + 0.5ul * log(ρ/μ))) - 2ul * (ρ + μ)	0 deg≤ β ≤90 deg
α =	π * ((180deg - β)/180deg) * (ρ + (μ/2ul) * (0.65ul + 0.5ul * log(ρ/μ))) - 2ul * (ρ + μ) * tan((180 deg - β)/2ul)	90 deg< β ≤165 deg
α =	0 in	165 deg< β ≤180 deg

Unfold Method

Custom Equation

Equation Type

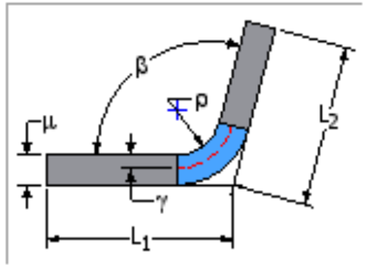
Bend Compensation

Angular Reference(β)

Open Angle

β - Angle
μ - Thickness
ρ - Radius, Inner
π - Pi
γ - Neutral Surface
L - Developed Length

L = L1 + L2 + v



	Custom Equation	Bounding Condition
v =	π * ((180deg - β)/180deg) * (ρ + (μ/2ul) * (0.65ul + 0.5ul * log(ρ/μ))) - 2ul * (ρ + μ)	0 deg≤ β ≤90 deg
v =	π * ((180deg - β)/180deg) * (ρ + (μ/2ul) * (0.65ul + 0.5ul * log(ρ/μ))) - 2ul * (ρ + μ) * tan((180 deg - β)/2ul)	90 deg< β ≤165 deg
v =	0 in	165 deg< β ≤180 deg

Unfold Method

Custom Equation

Equation Type

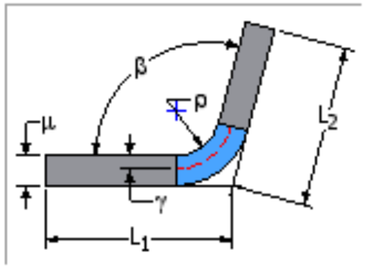
Bend Deduction

Angular Reference(β)

Open Angle

β - Angle
μ - Thickness
ρ - Radius, Inner
π - Pi
γ - Neutral Surface
L - Developed Length

L = L1 + L2 - δ



	Custom Equation	Bounding Condition
δ =	π * ((180deg - β)/180deg) * (ρ + (μ/2ul) * (0.65ul + 0.5ul * log(ρ/μ))) - 2ul * (ρ + μ)	0 deg≤ β ≤90 deg
δ =	π * ((180deg - β)/180deg) * (ρ + (μ/2ul) * (0.65ul + 0.5ul * log(ρ/μ))) - 2ul * (ρ + μ) * tan((180 deg - β)/2ul)	90 deg< β ≤165 deg
δ =	0 in	165 deg< β ≤180 deg

Unfold Method

Custom Equation

Equation Type

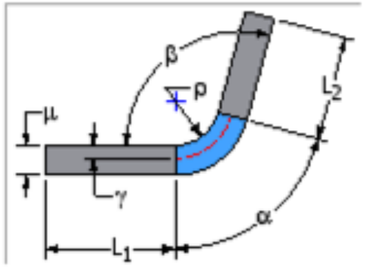
KFactor

Angular Reference(β)

Open Angle

β - Angle
μ - Thickness
ρ - Radius, Inner
π - Pi
γ - Neutral Surface
L - Developed Length
α - Bend Allowance

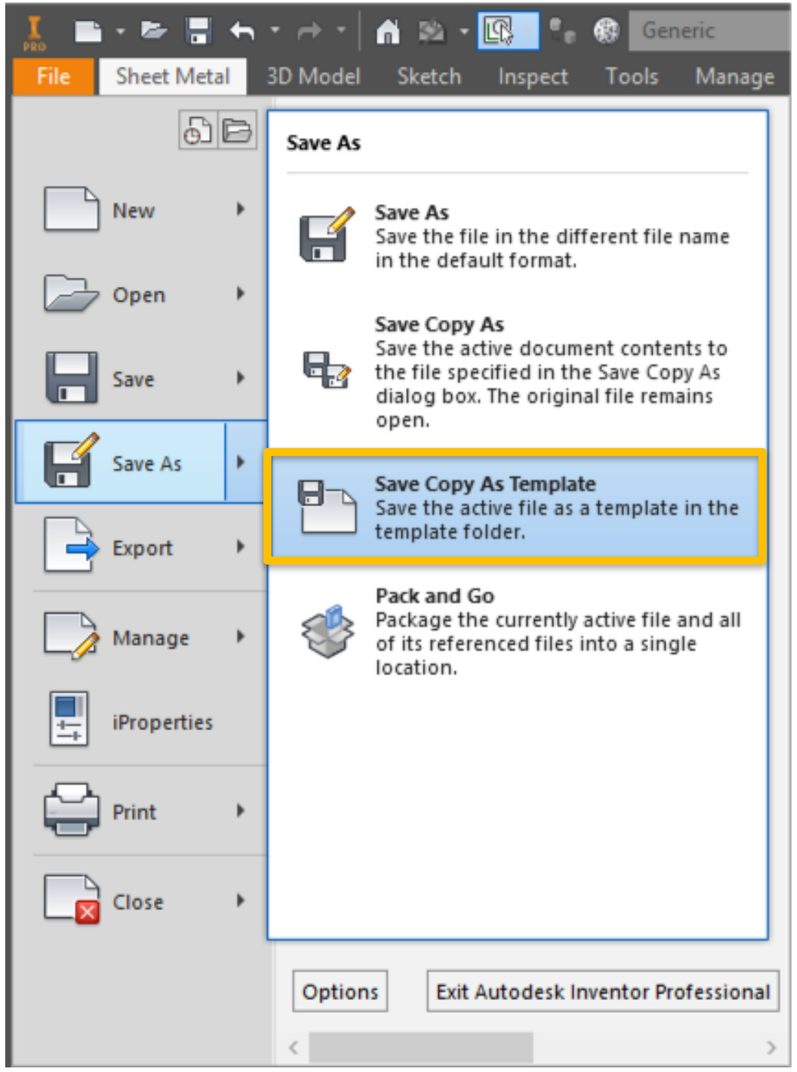
L = L1 + L2 + α

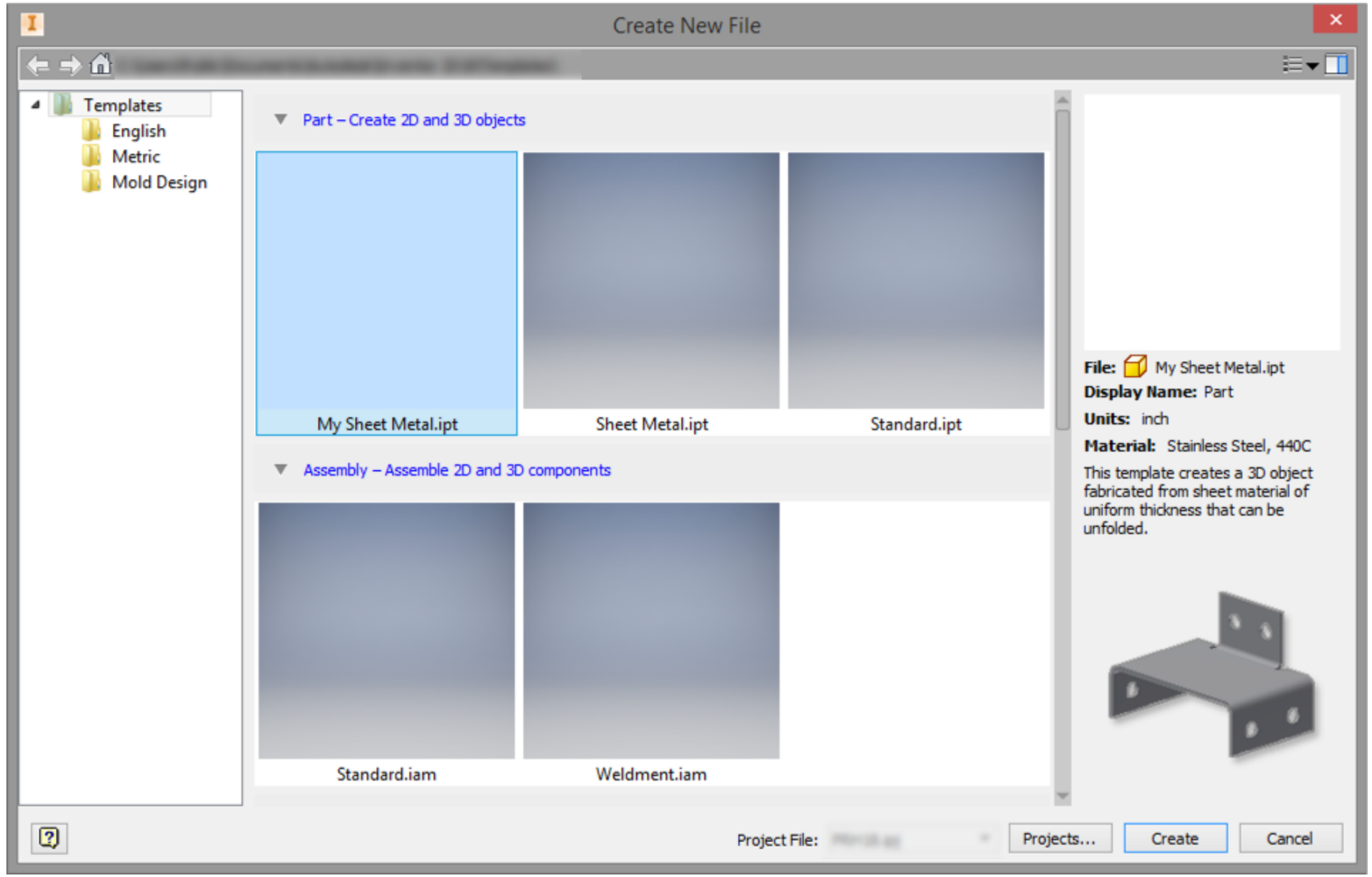


$$\alpha = \pi \bullet (\beta / 180) \bullet (\rho + \kappa \bullet \mu)$$

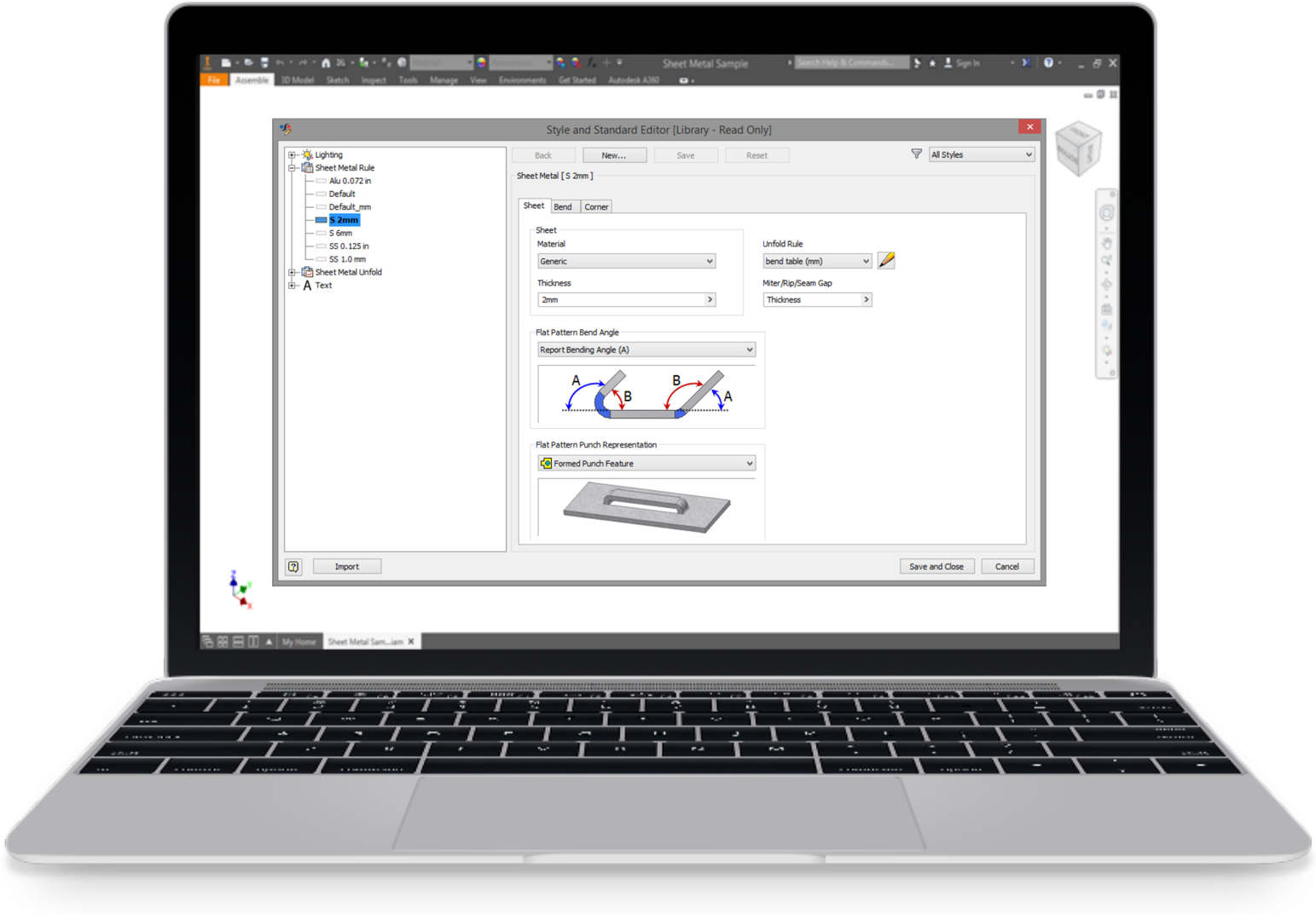
	Custom Equation	Bounding Condition
K =	π * ((180deg - β)/180deg) * (ρ + (μ/2ul) * (0.65ul + 0.5ul * log(ρ/μ))) - 2ul * (ρ + μ)	0 deg≤ β ≤90 deg
K =	π * ((180deg - β)/180deg) * (ρ + (μ/2ul) * (0.65ul + 0.5ul * log(ρ/μ))) - 2ul * (ρ + μ) * tan((180 deg - β)/2ul)	90 deg< β ≤165 deg
K =	0 in	165 deg< β ≤180 deg

Make Template



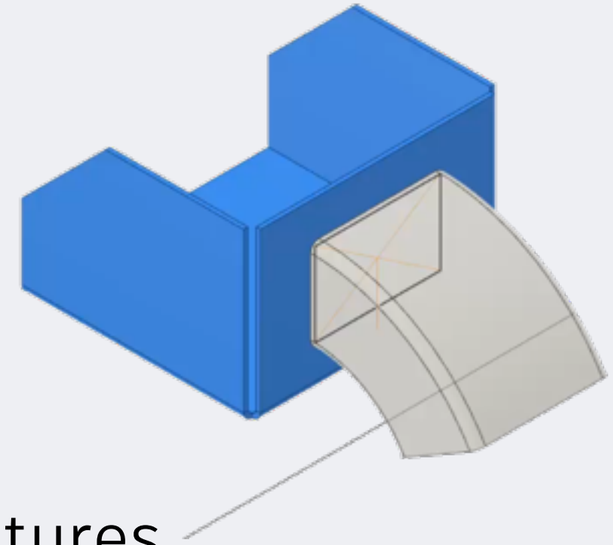


Demo Time

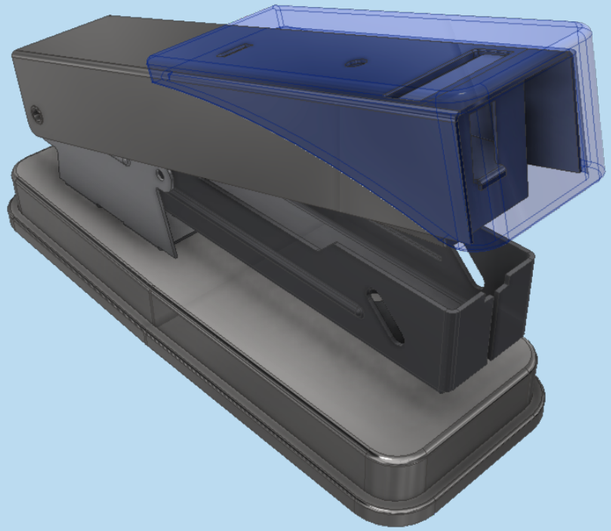

Sheet Metal Sample
Style and Standard Editor [Library - Read Only]
Lighting
Sheet Metal Rule
Alu 0.072 in
Default
Default_mm
S 2mm
S 6mm
SS 0.125 in
SS 1.0 mm
Sheet Metal Unfold
Text
Back
New...
Save
Reset
All Styles
Sheet Metal [S 2mm]
Sheet
Bend
Corner
Material
Generic
Thickness
2mm
Unfold Rule
bend table (mm)
Miter/Rip/Seam Gap
Thickness
Flat Pattern Bend Angle
Report Bending Angle (A)
A
B
B
A
Flat Pattern Punch Representation
Formed Punch Feature
Import
Save and Close
Cancel

Inventor Sheet Metal Features

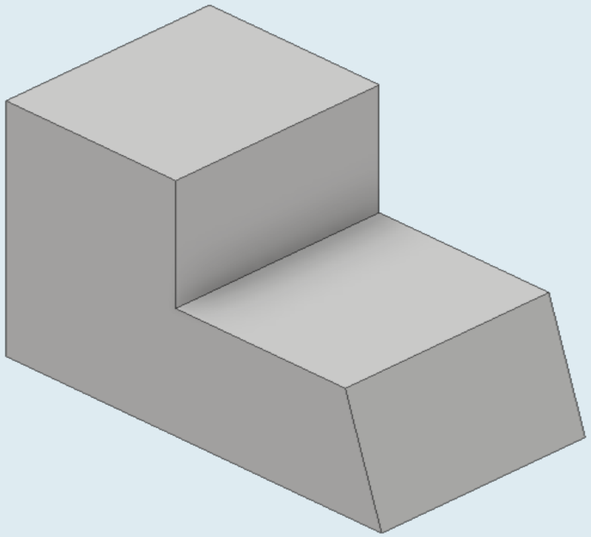
What we will learn?



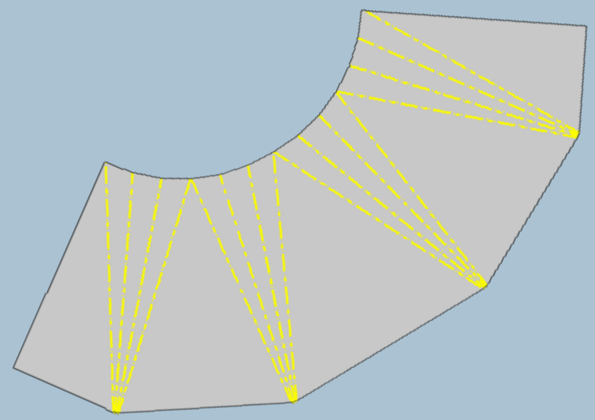
Base Features
Secondary Features



Multiple Body

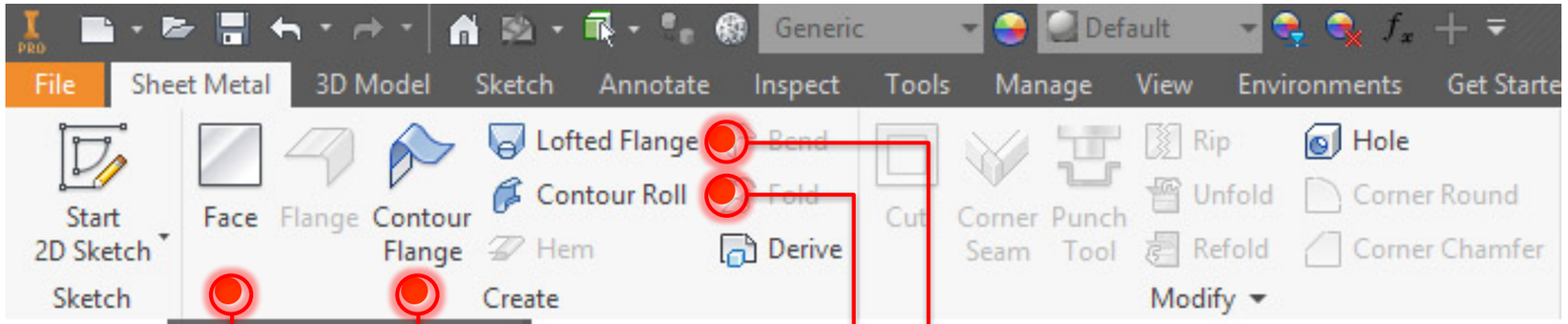


Convert from
Standard Part

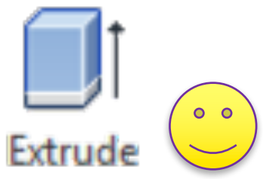


Flat Pattern

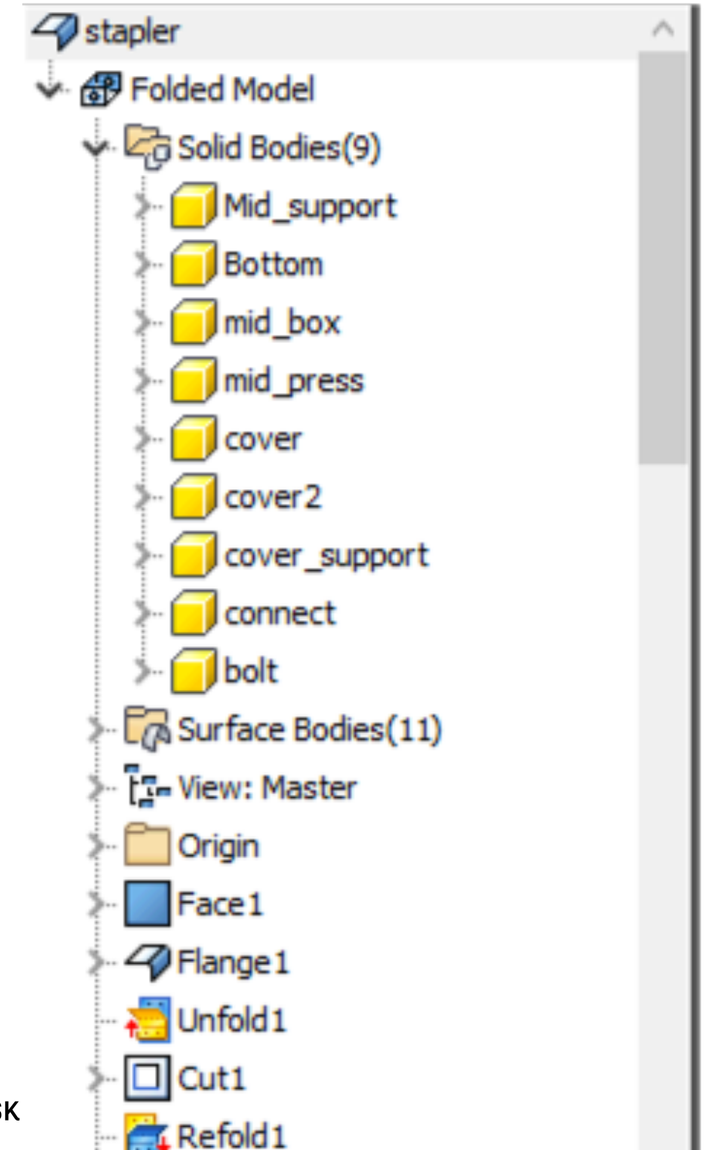
Base Features to new Sheet Metal Solids

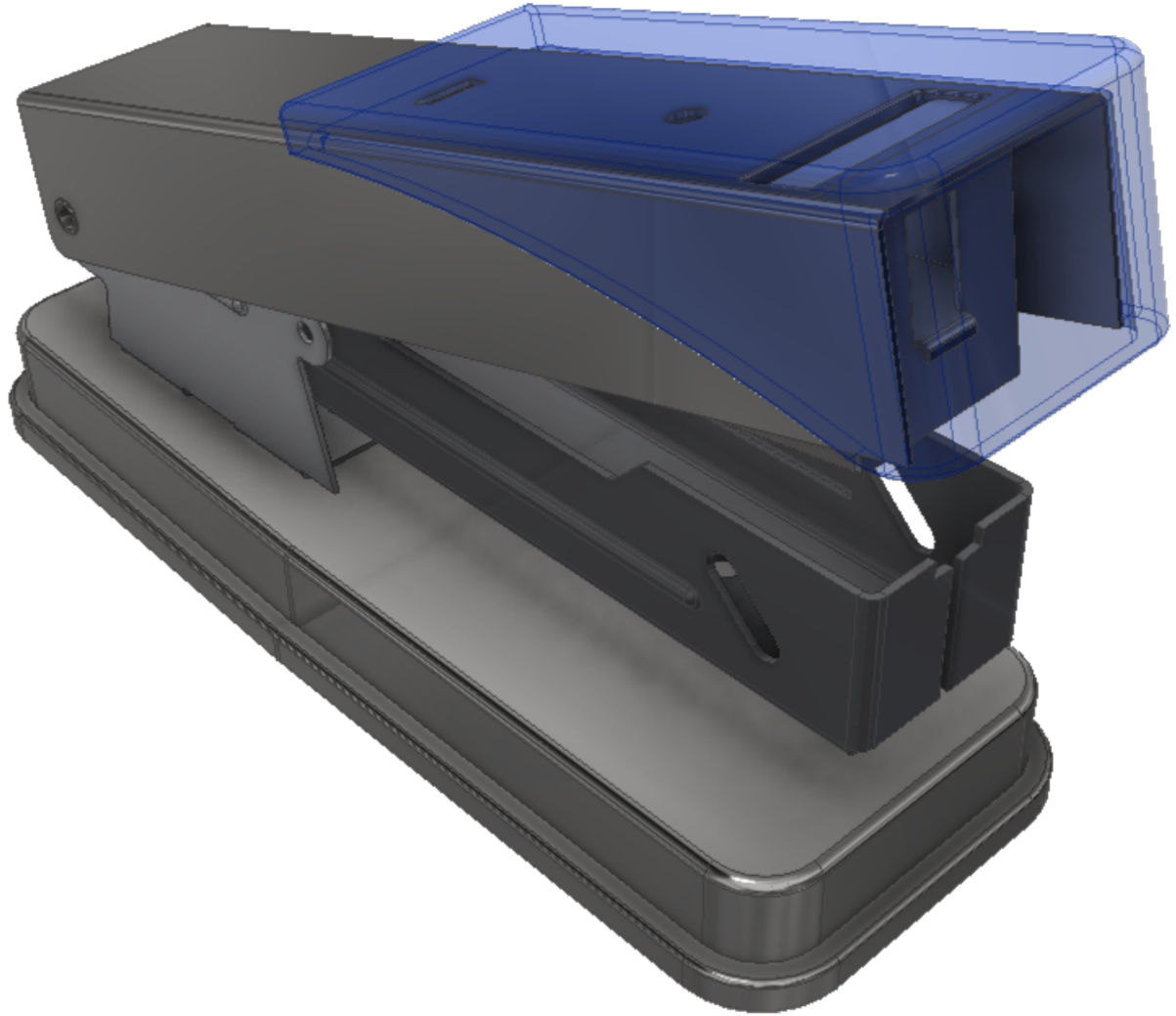


- Face
- Contour Flange
- Contour Roll
- Lofted Flange

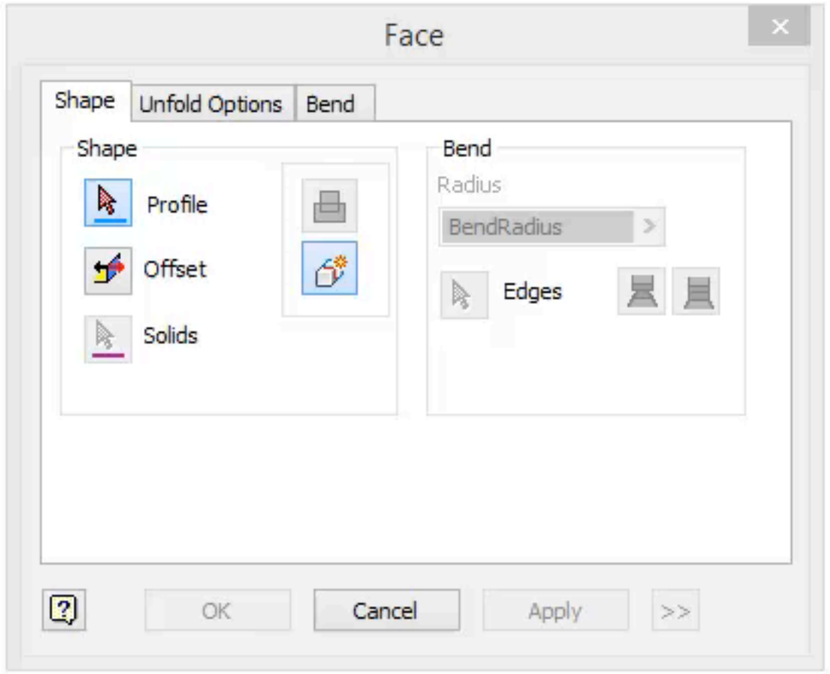


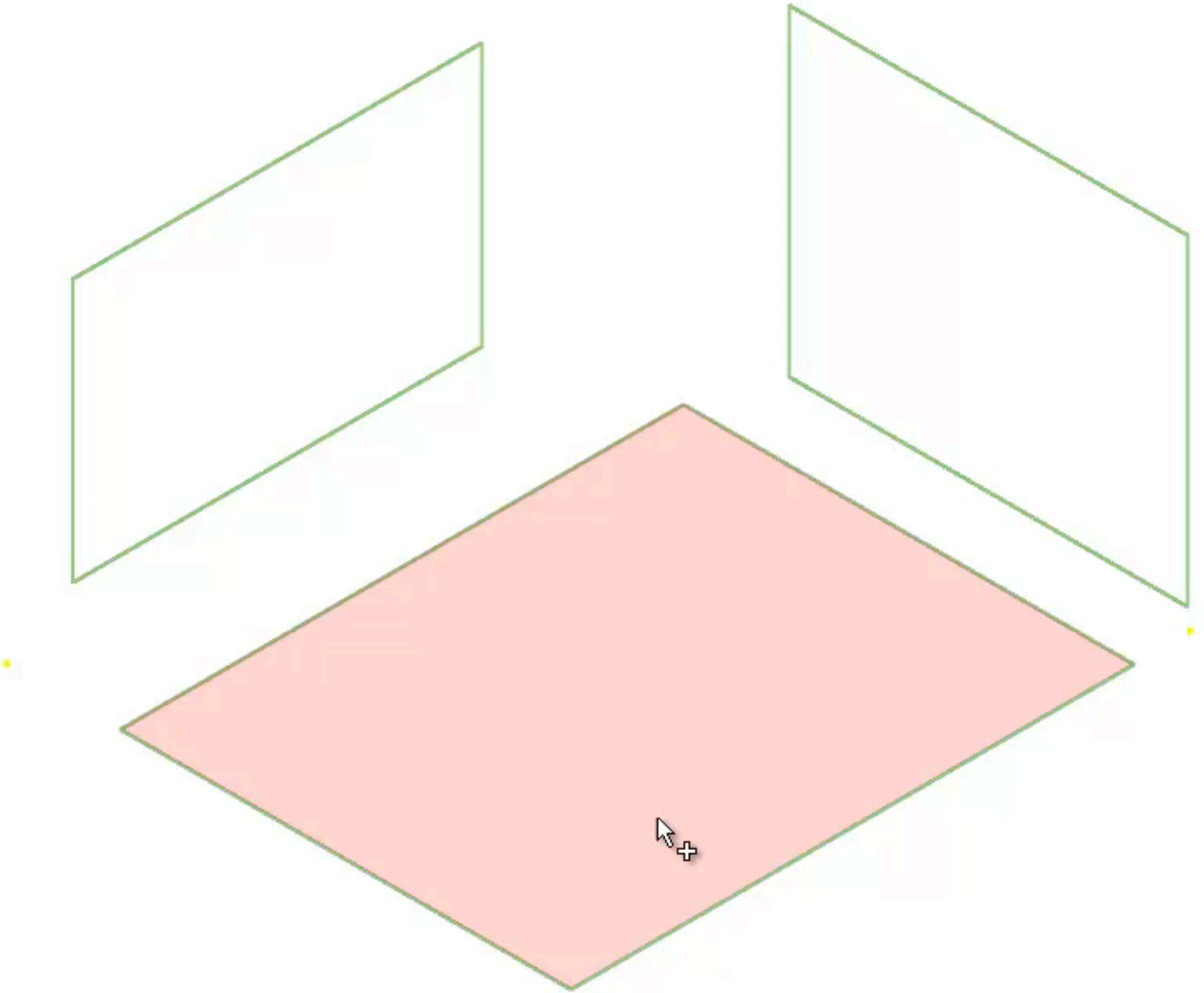
Sheet Metal Multiple Body



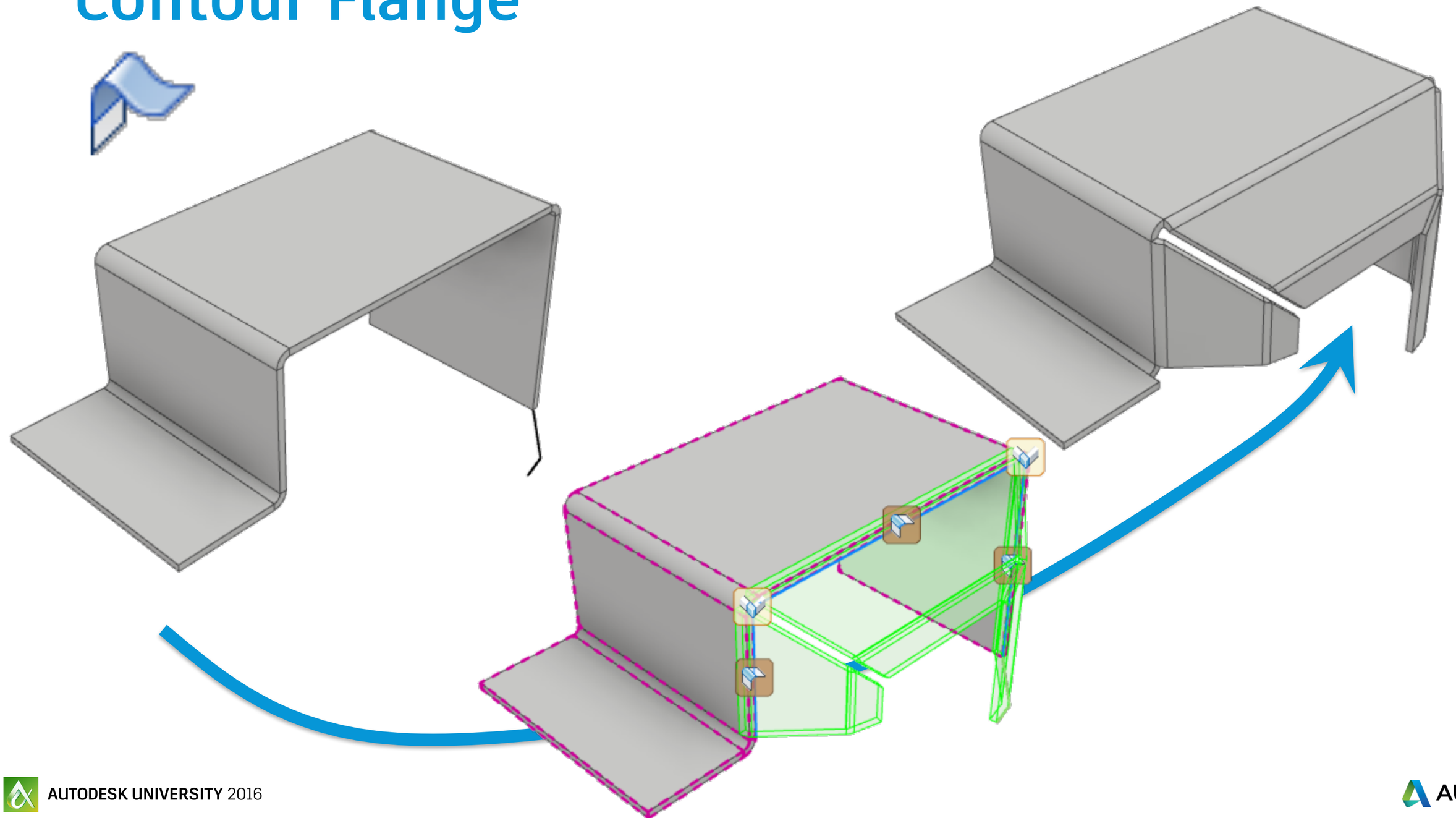


Face

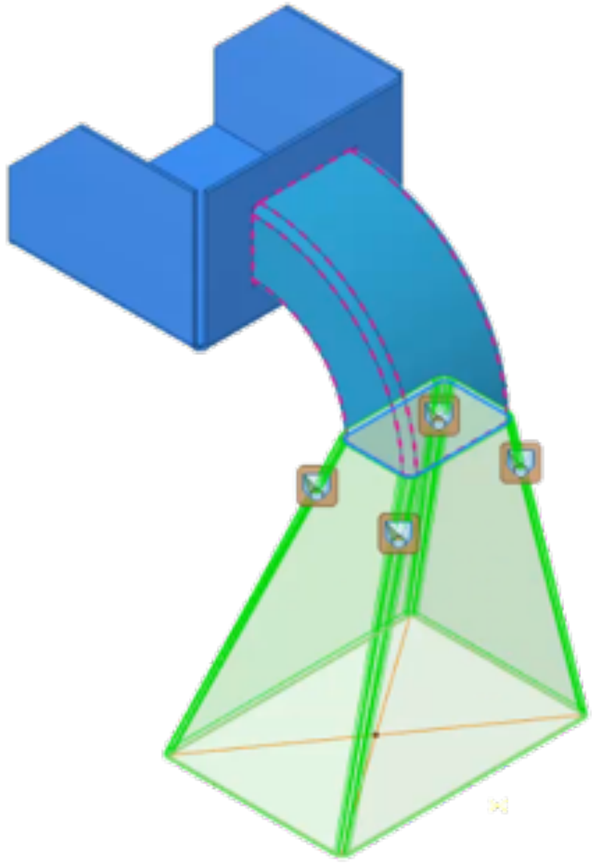

Face
Shape
Unfold Options
Bend
Shape
Profile
Offset
Solids
Bend
Radius
BendRadius
Edges
OK
Cancel
Apply
>>

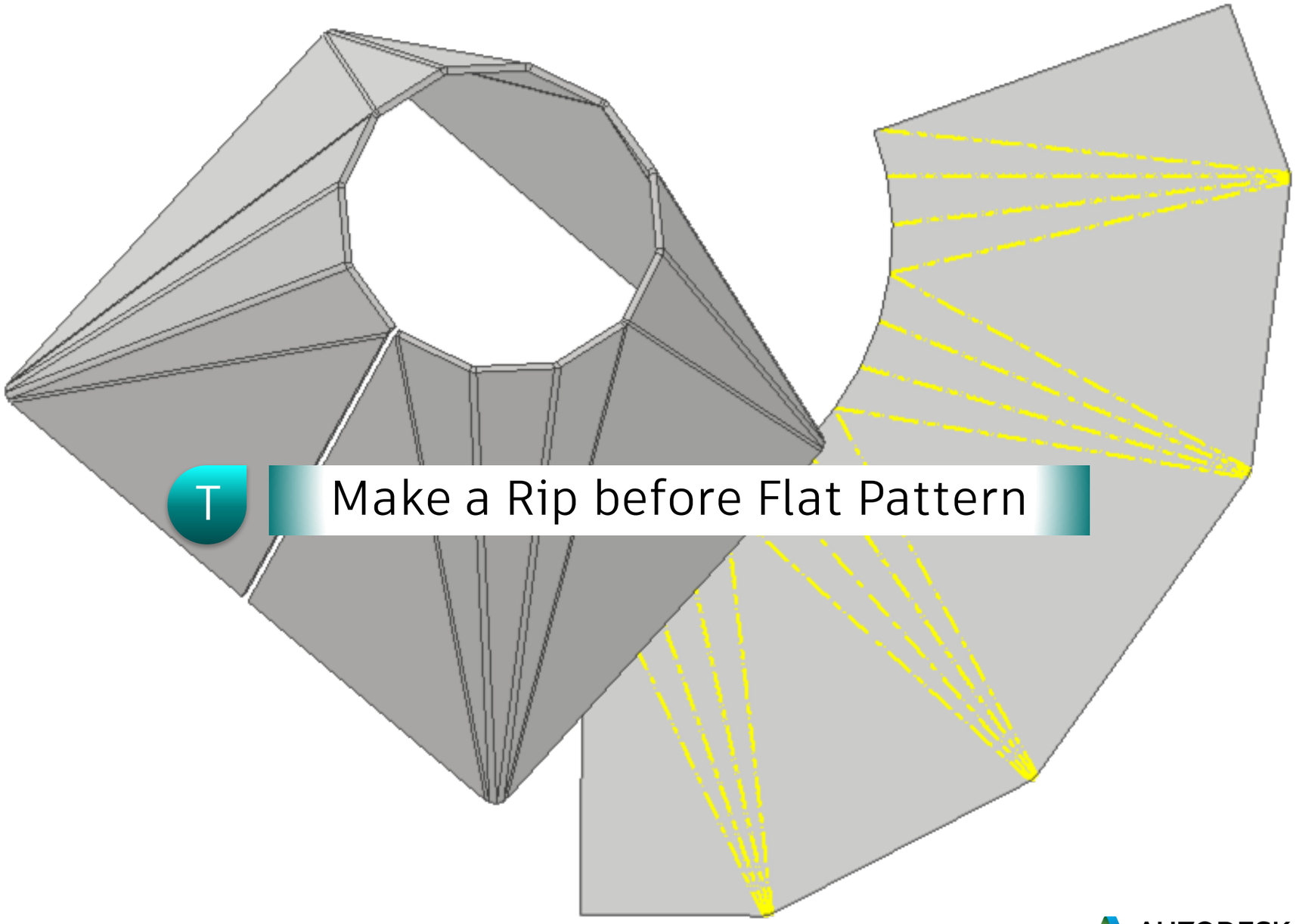


Contour Flange



Lofted Flange

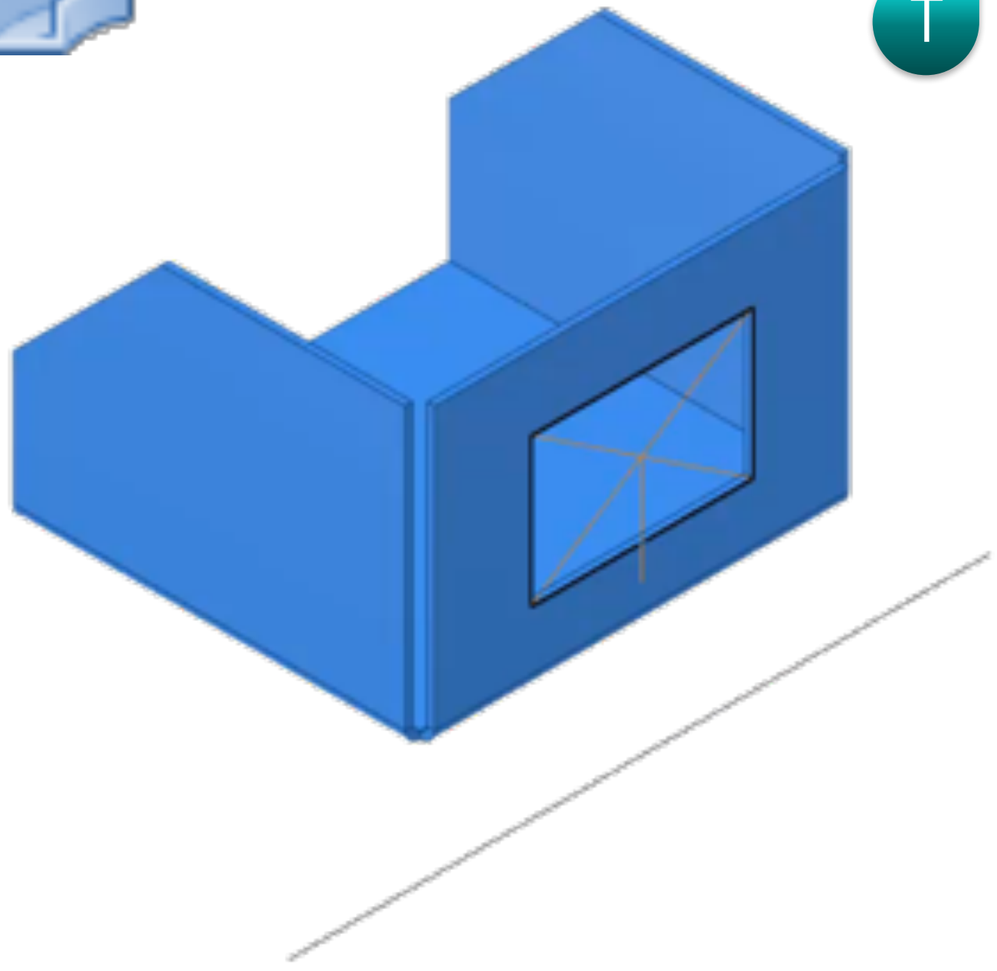


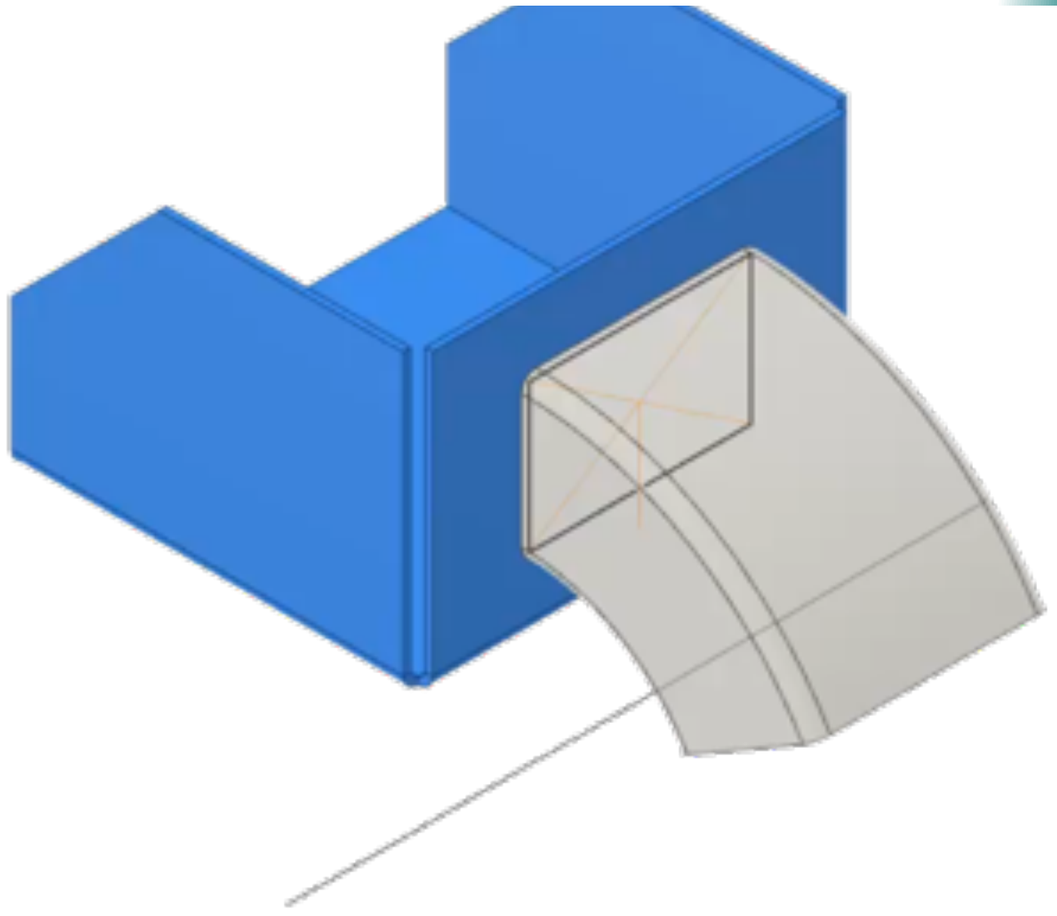


T Make a Rip before Flat Pattern

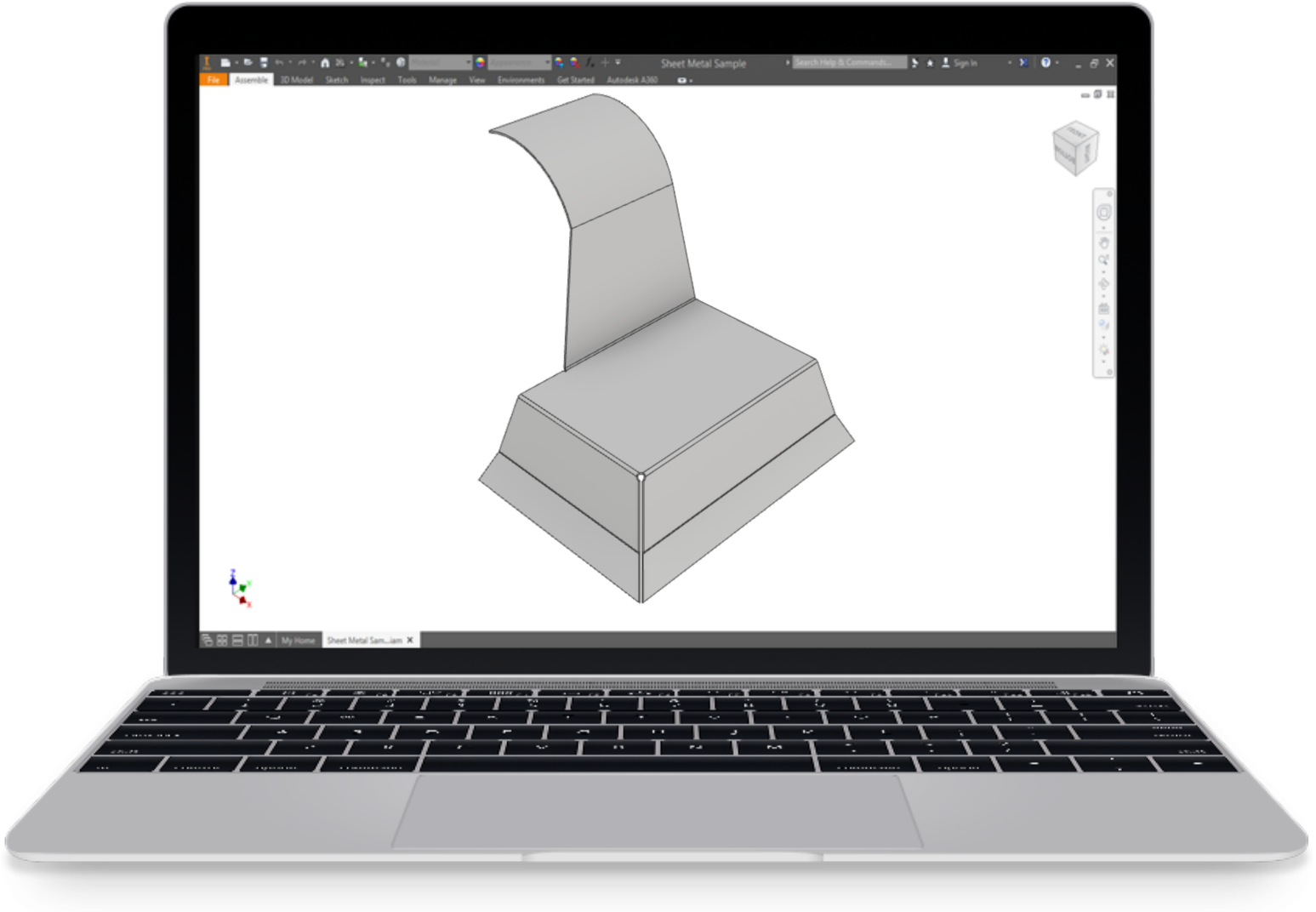
Contour Roll

Make an open profile for Contour Roll



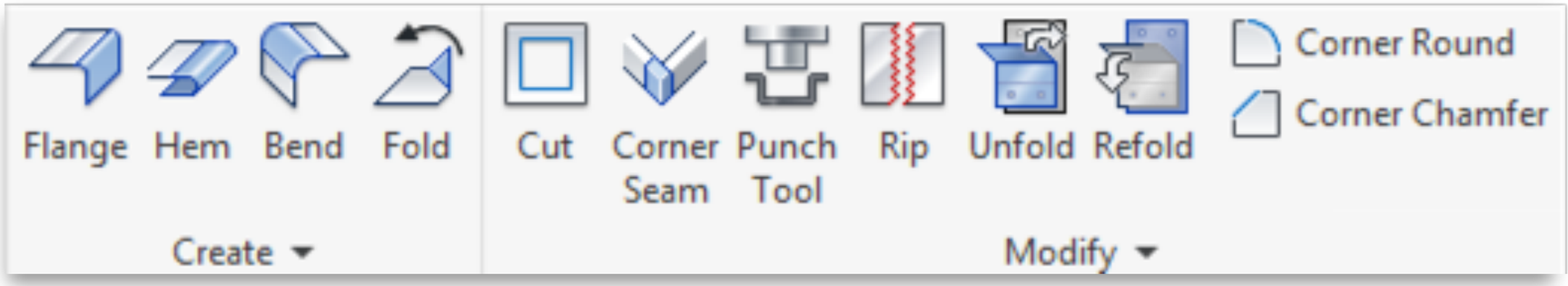


Demo Time

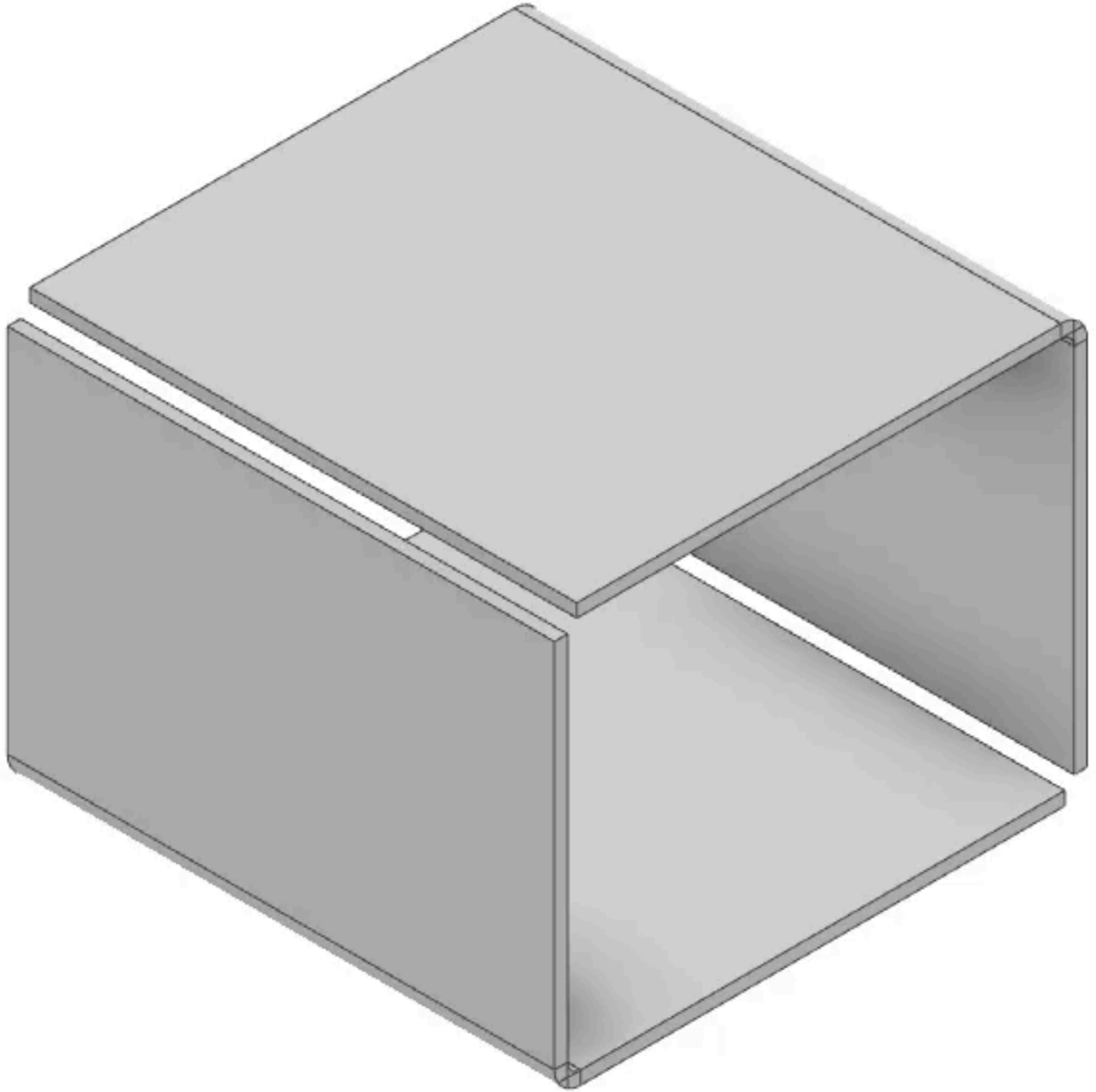

Sheet Metal Sample
File
Assemble
3D Model
Sketch
Inspect
Tools
Manage
View
Environments
Get Started
Autodesk A360
My Home

Secondary Features

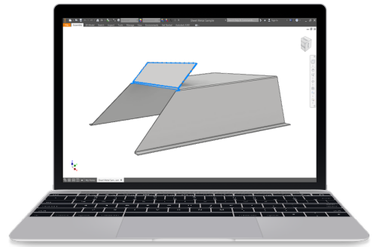
- Flange
- Bend
- Hem
- Fold
- Cut
- Corner Seam
- Punch
- Rip
- Unfold/Refold
- Corner Round and Chamfer



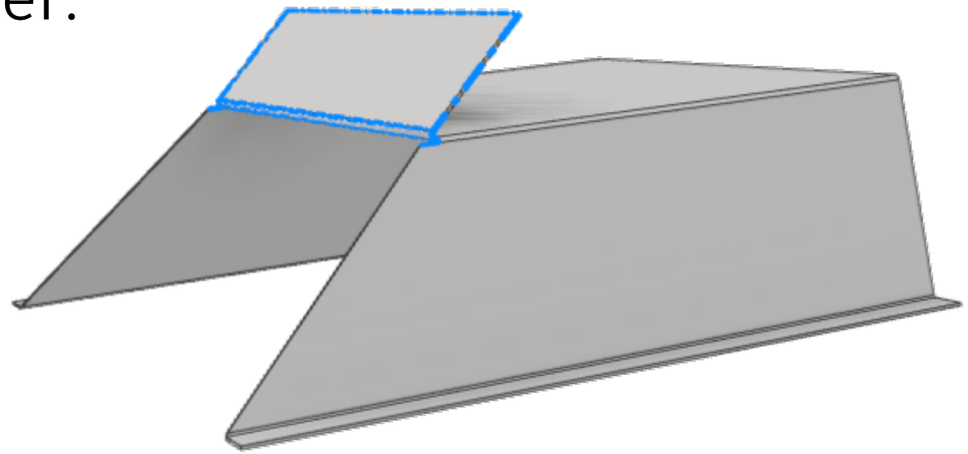
Secondary Features - Flange

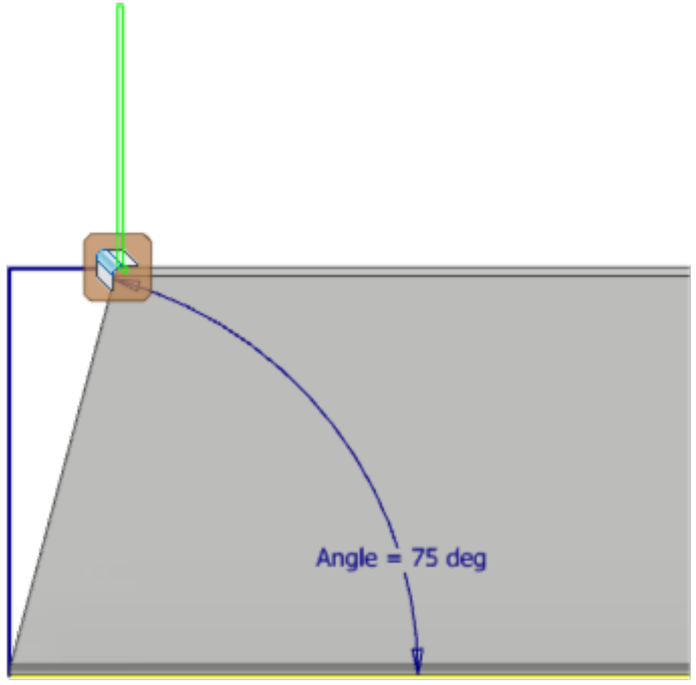


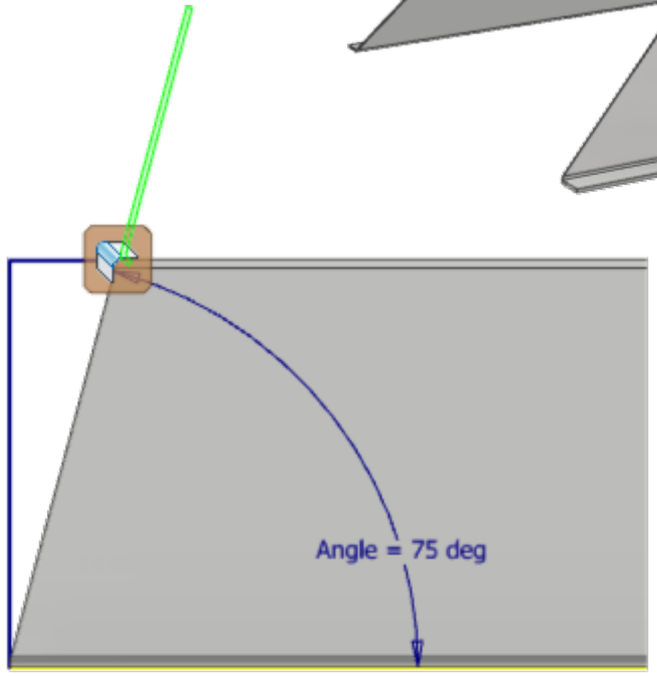
Secondary Features - Flange

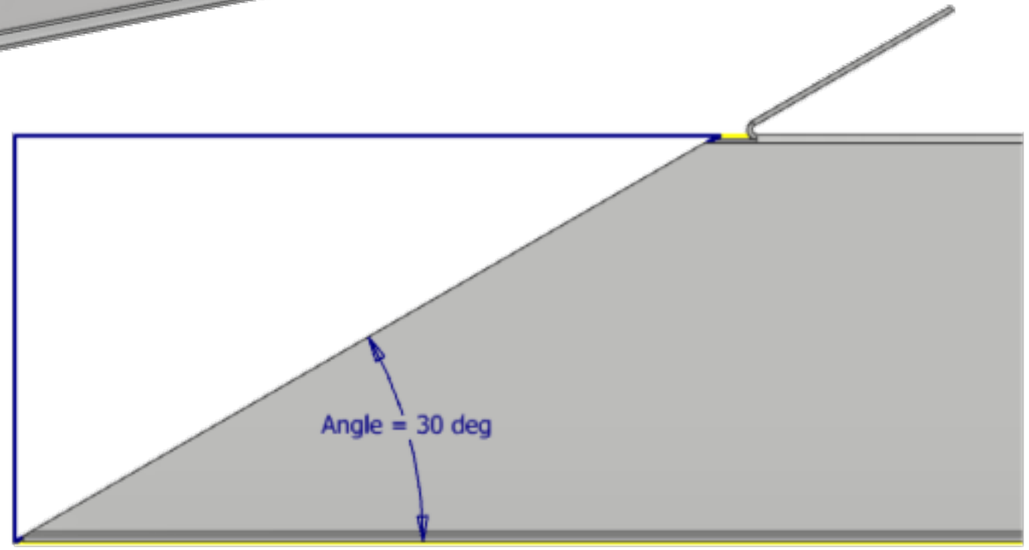


To make a Flange always parallel with an adjacent angled face, please link the angle parameter.

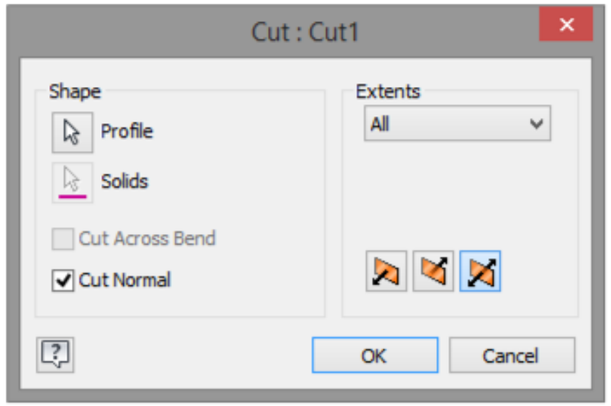




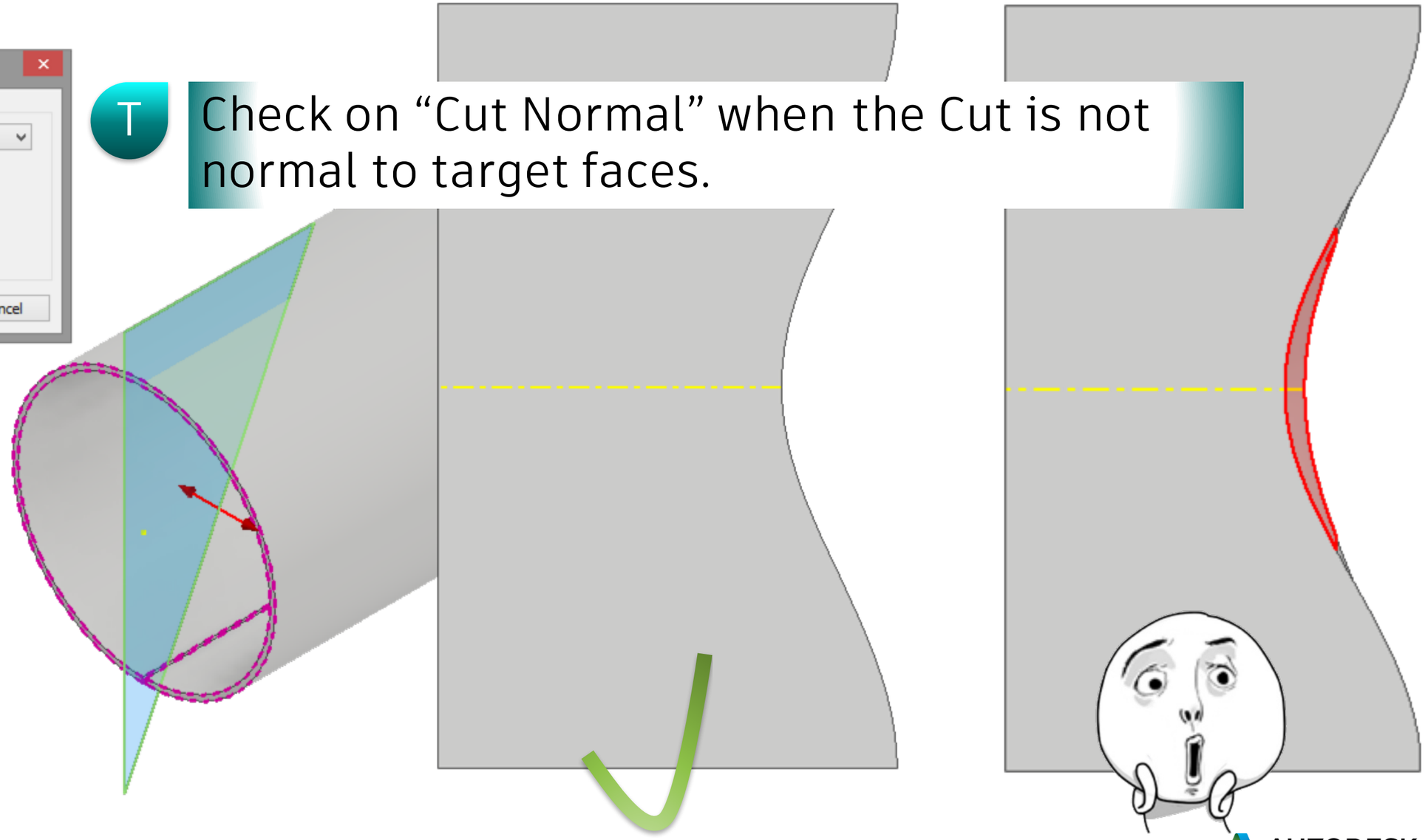




Secondary Features - Cut

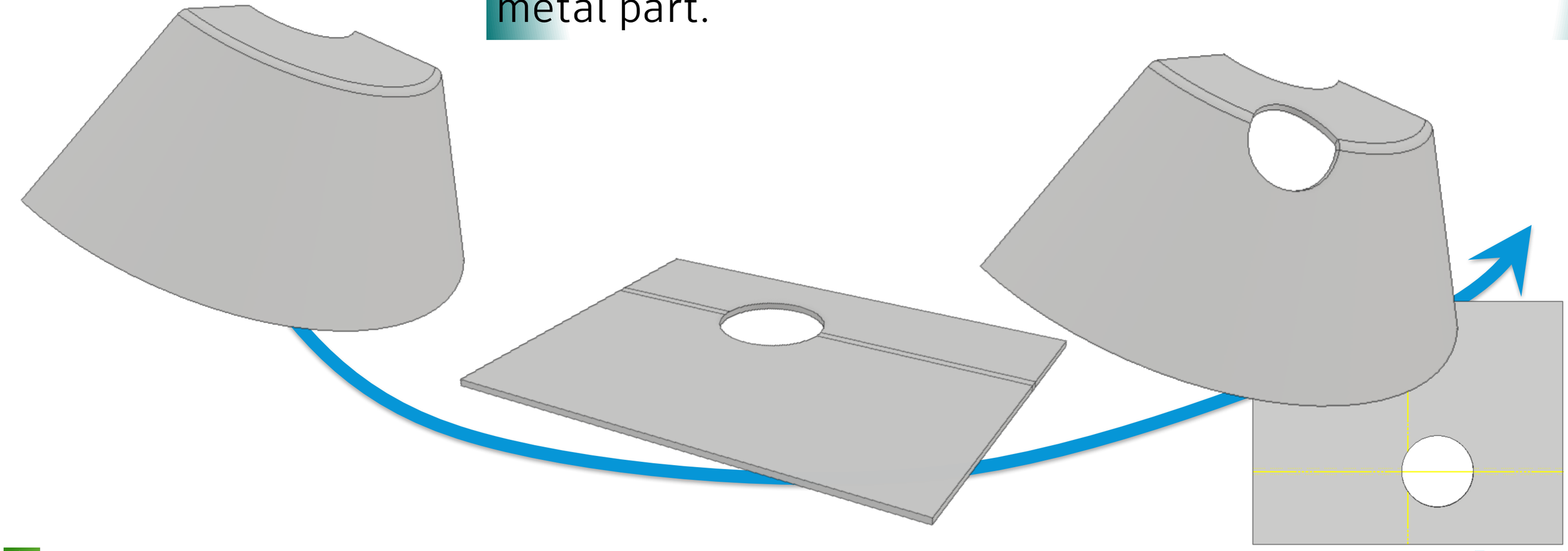


- Check on “Cut Normal” when the Cut is not normal to target faces.

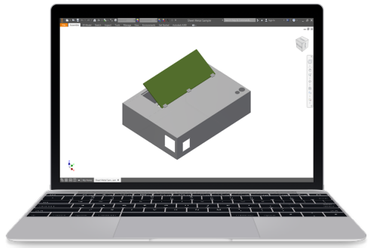


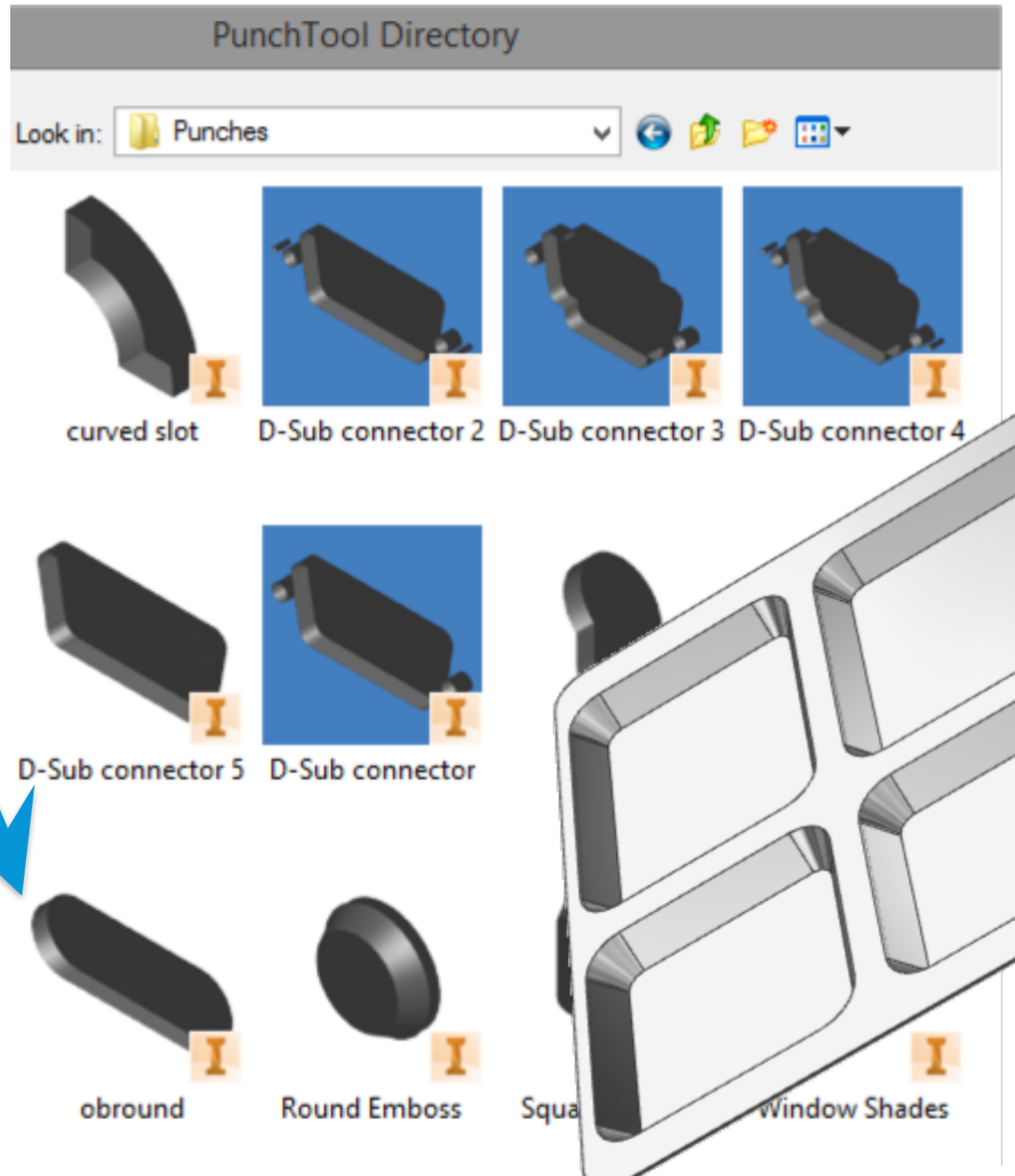
Secondary Features - Cut

To achieve Cut Across Bend, please do Unfold→Cut→Refold, when the target is a rolled sheet metal part.



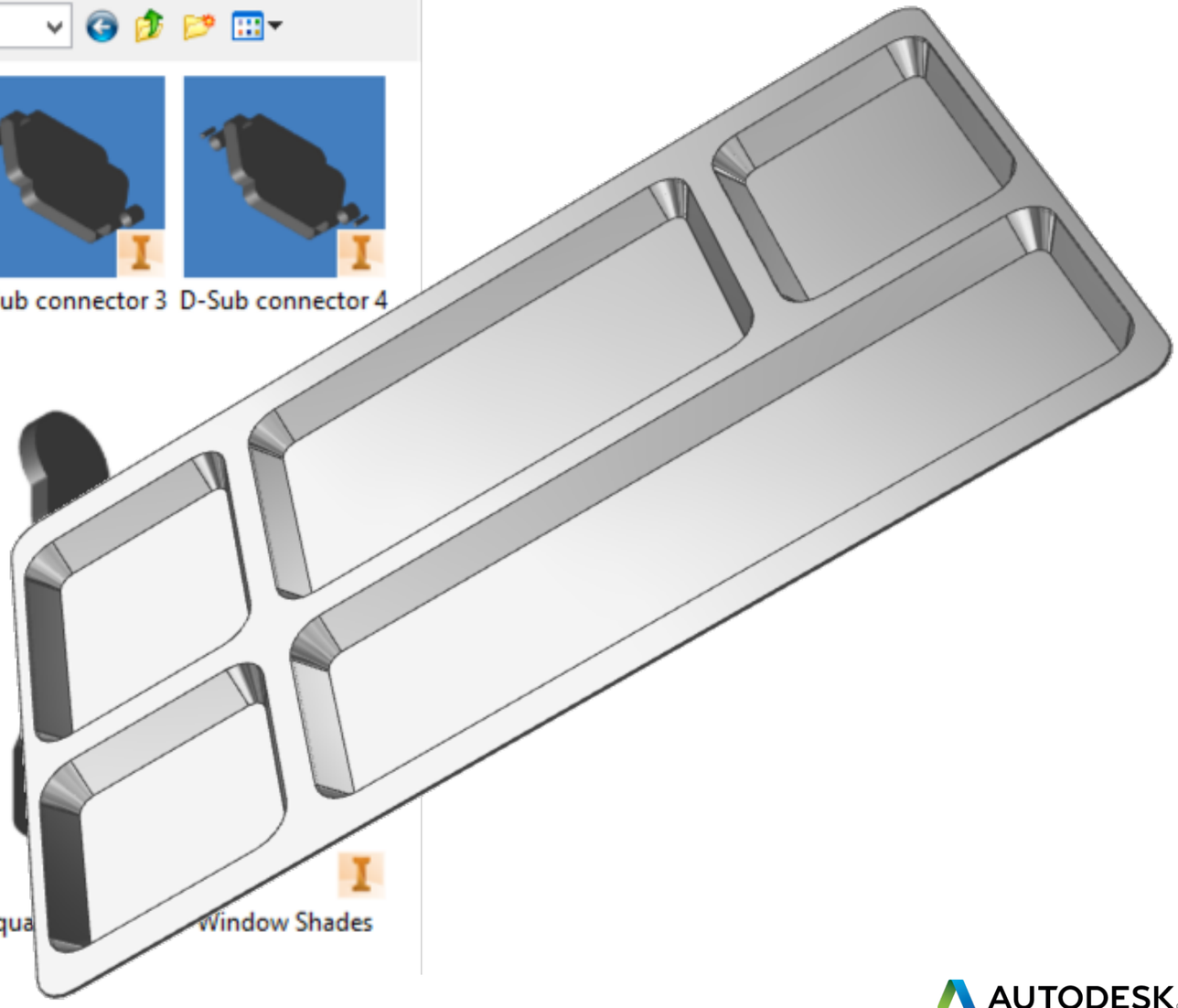
Secondary Features - Punch





Punch Tool

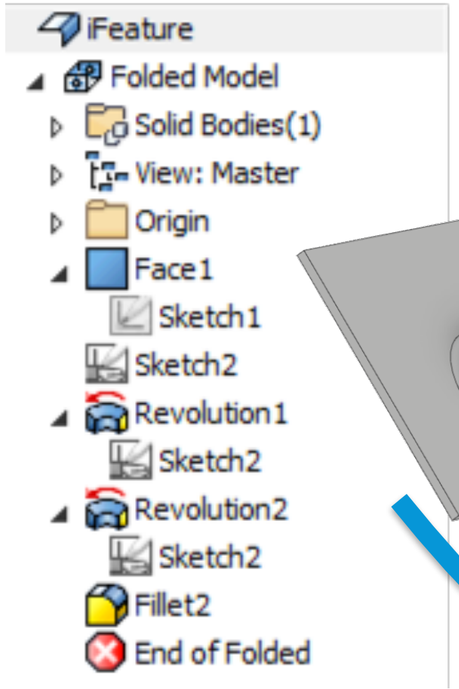
Start 2D Sketch

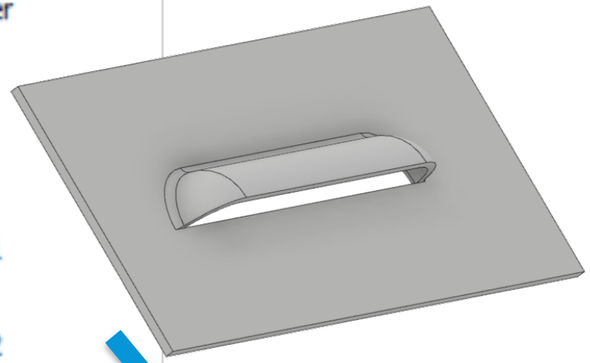


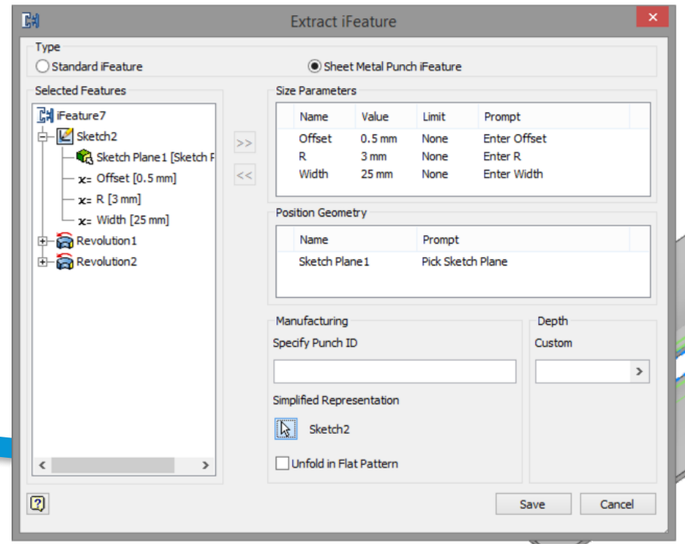
Make Punch iFeature

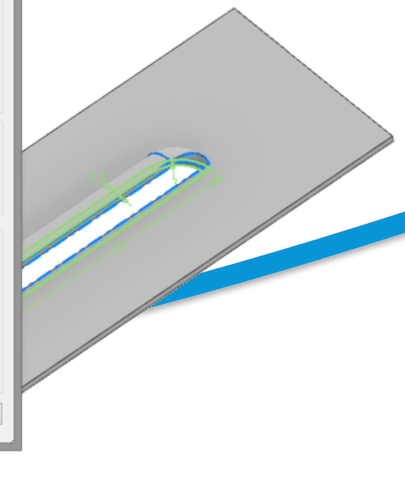
Features supported to create Punch iFeature

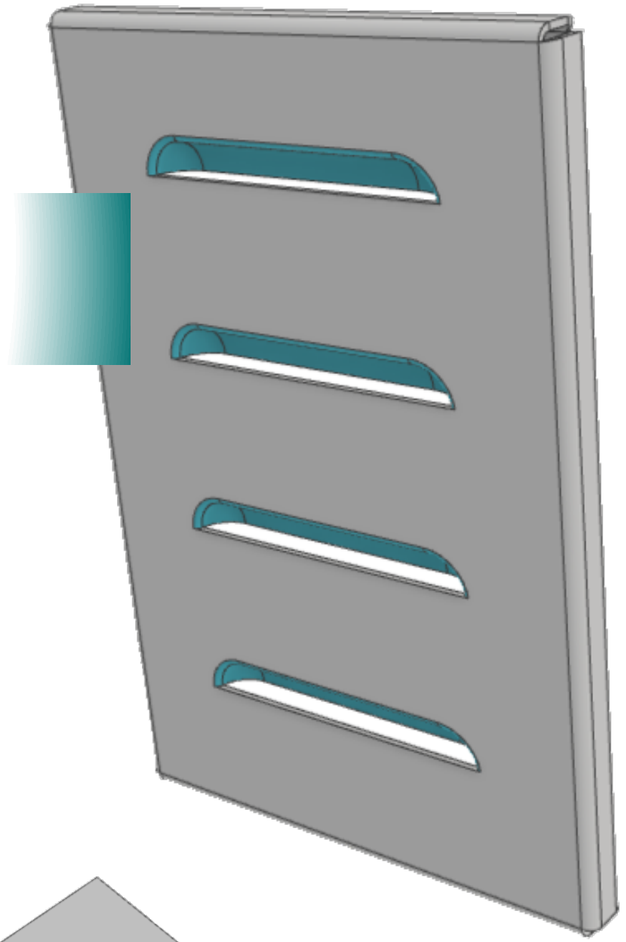
| Cut | Extrude | Revolve | Sweep | Fillet |





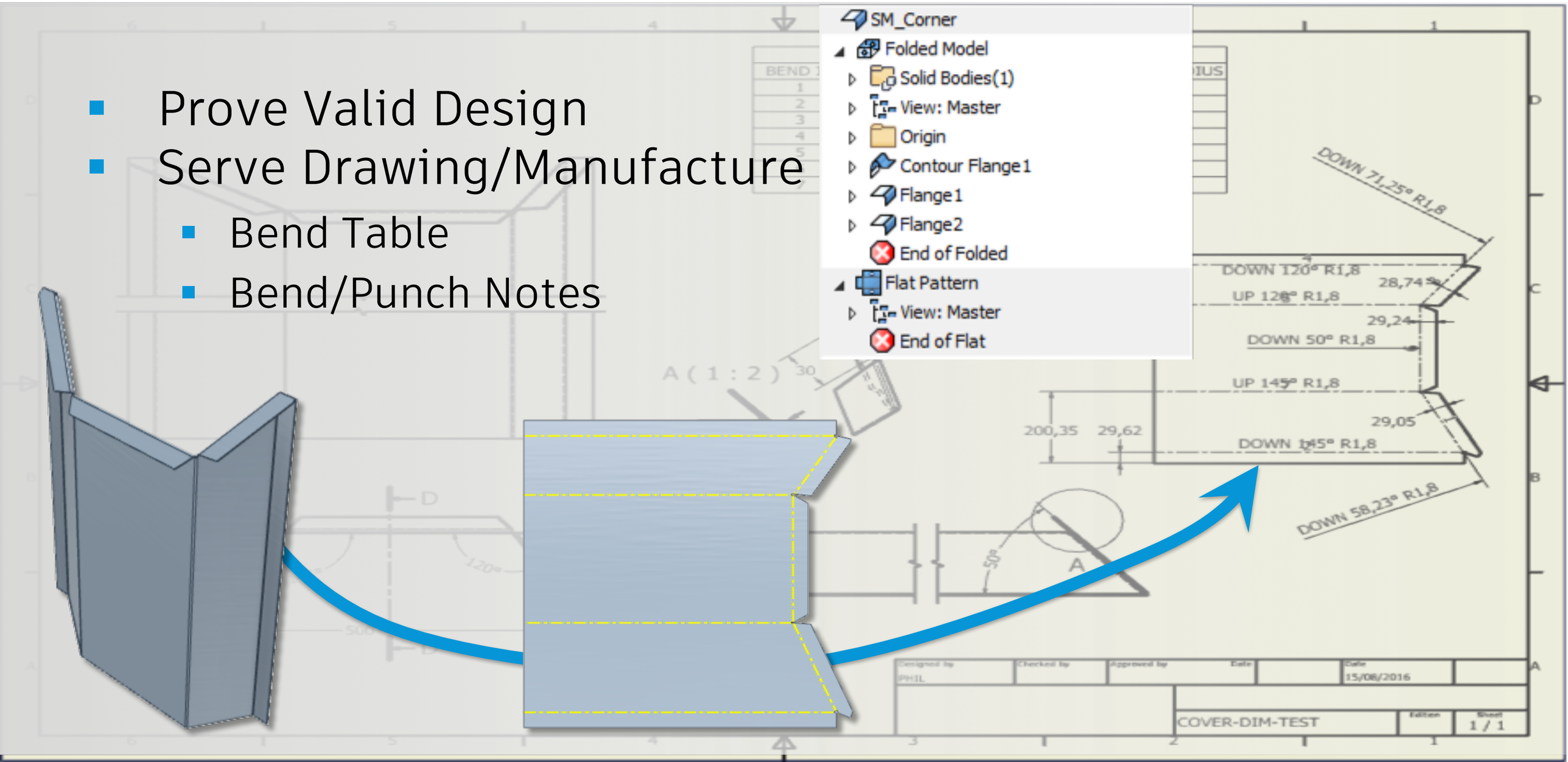






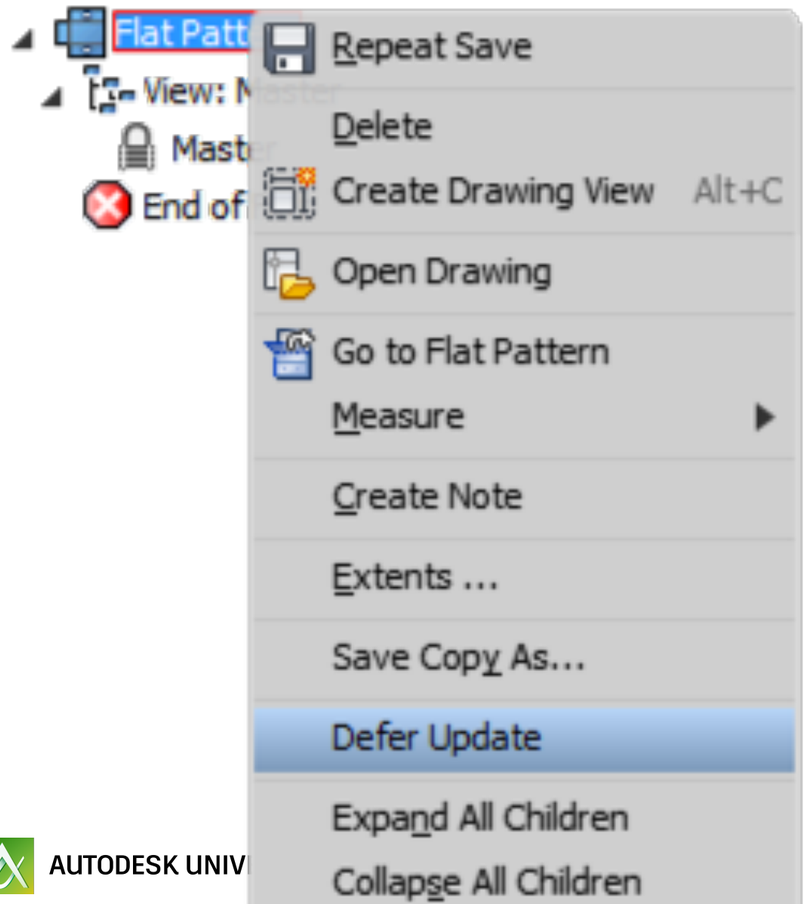
Flat Pattern

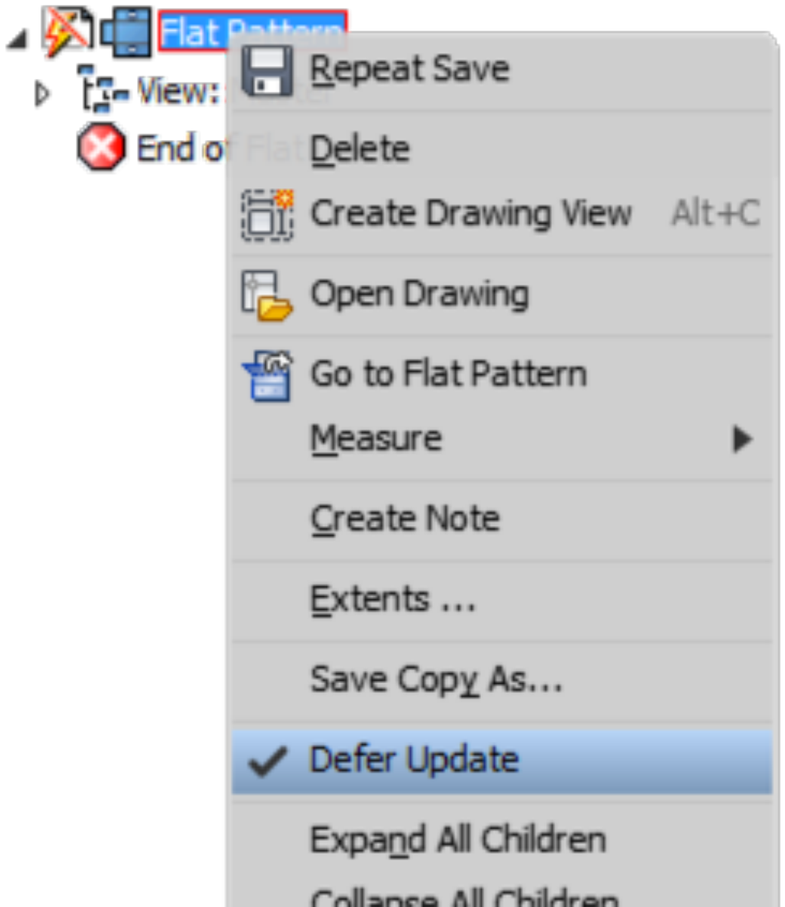
- Prove Valid Design
- Serve Drawing/Manufacture
  - Bend Table
  - Bend/Punch Notes

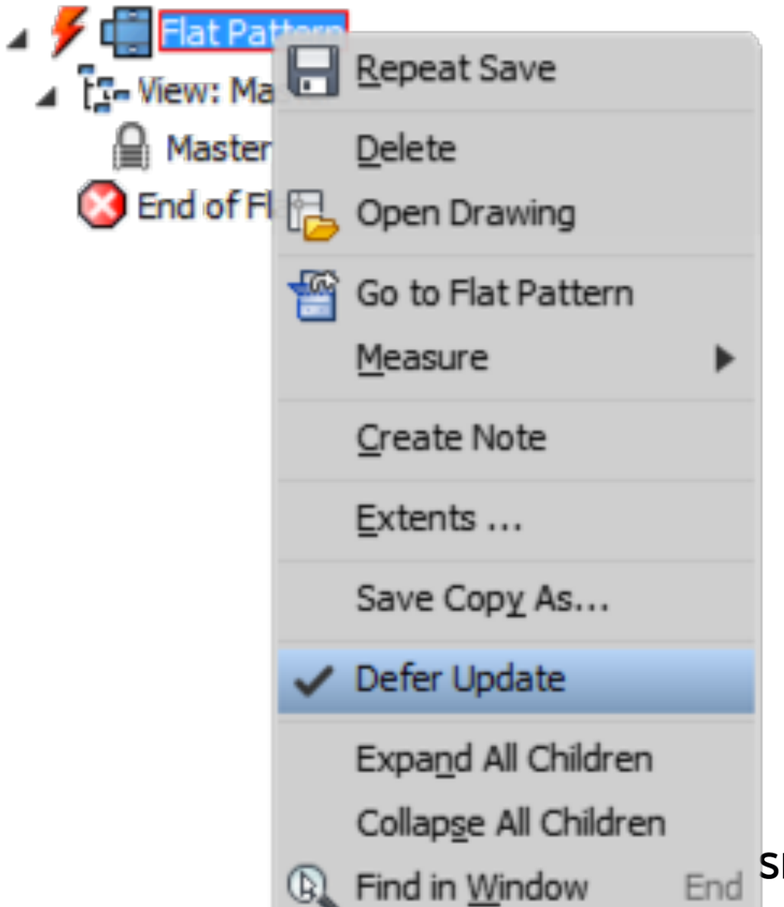


Flat Pattern

Turn on “Defer Update” when the Sheet Metal part becomes complex.

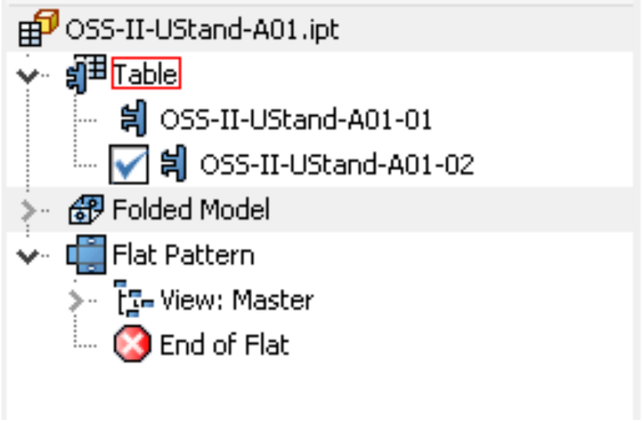


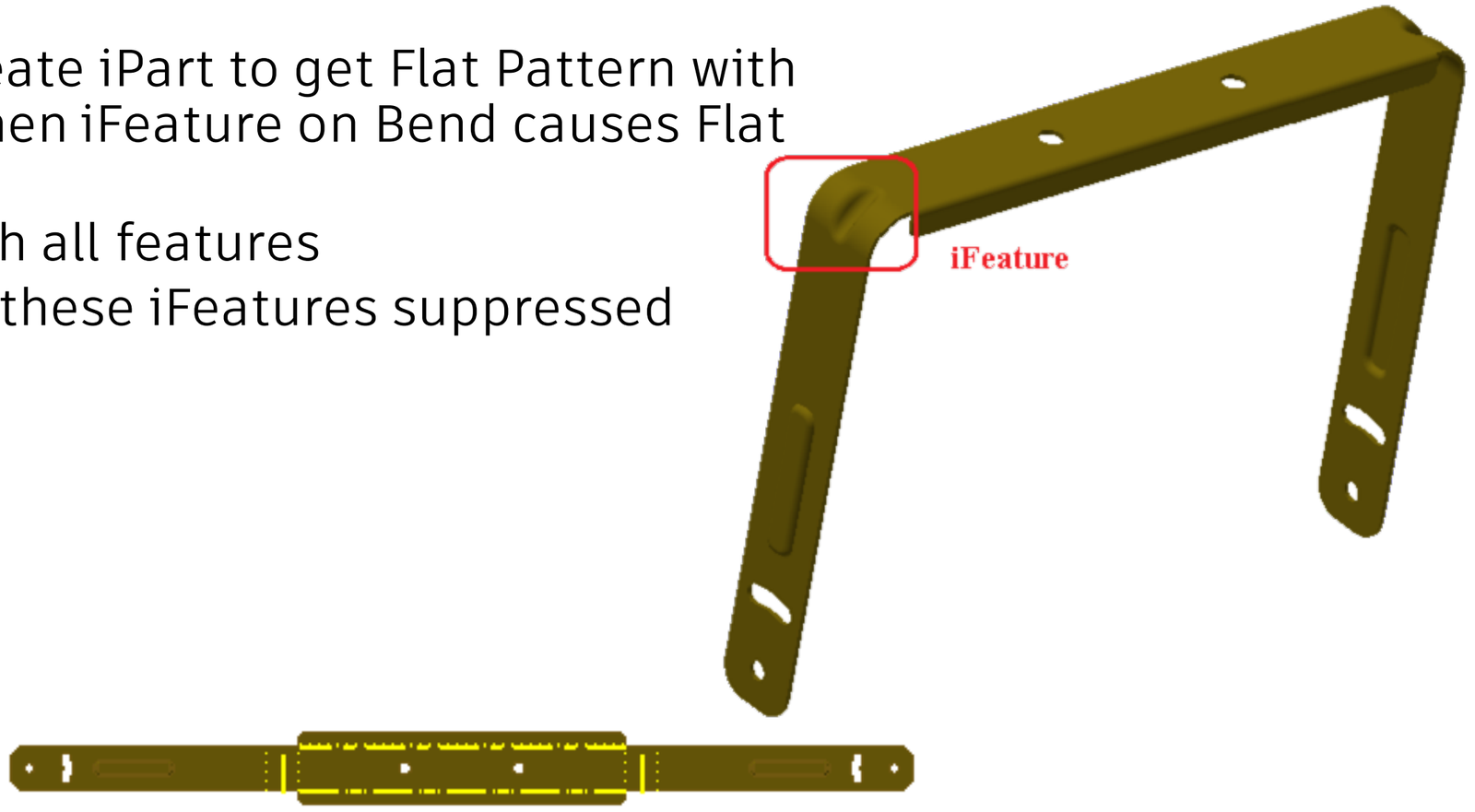




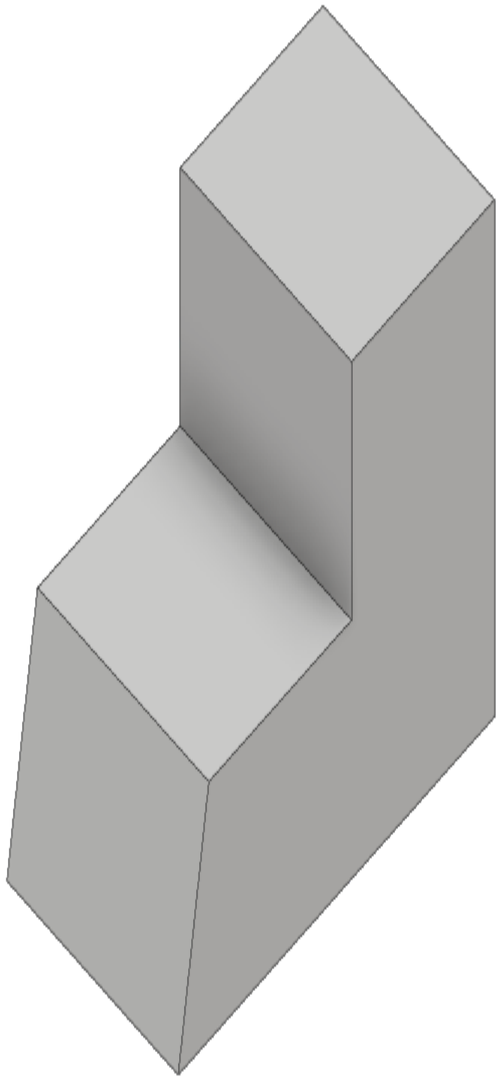
Flat Pattern

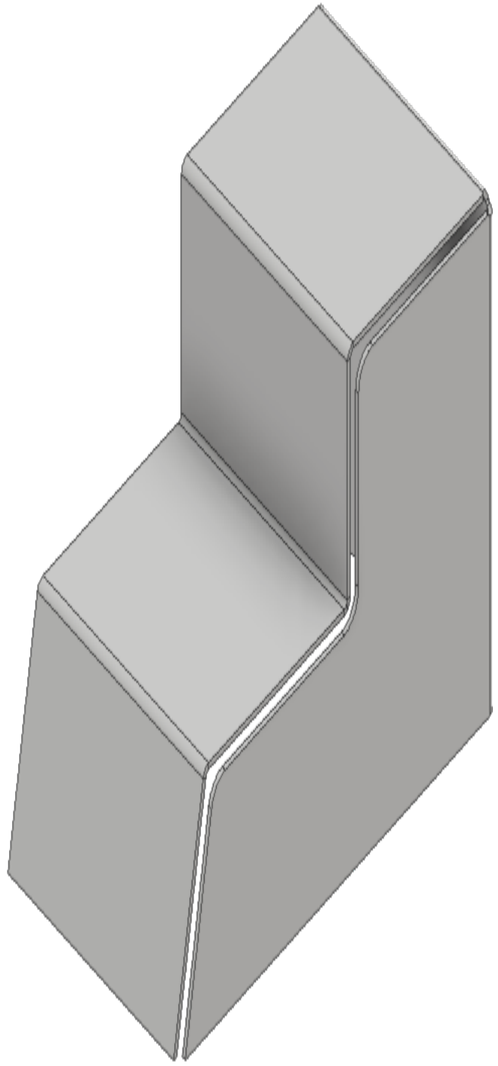
- For single body part, Create iPart to get Flat Pattern with iFeature suppressed, when iFeature on Bend causes Flat Pattern failure.
  - Folded model with all features
  - Flat pattern with these iFeatures suppressed

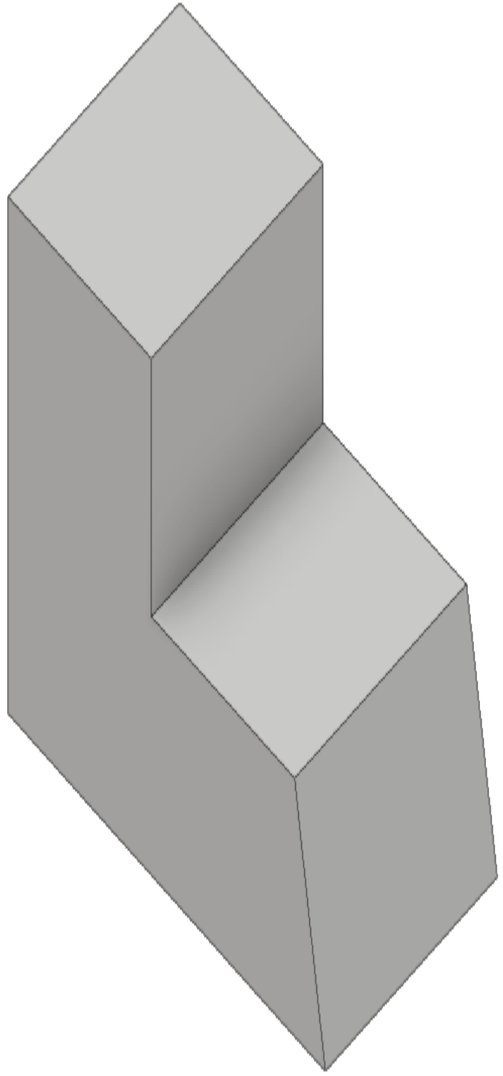


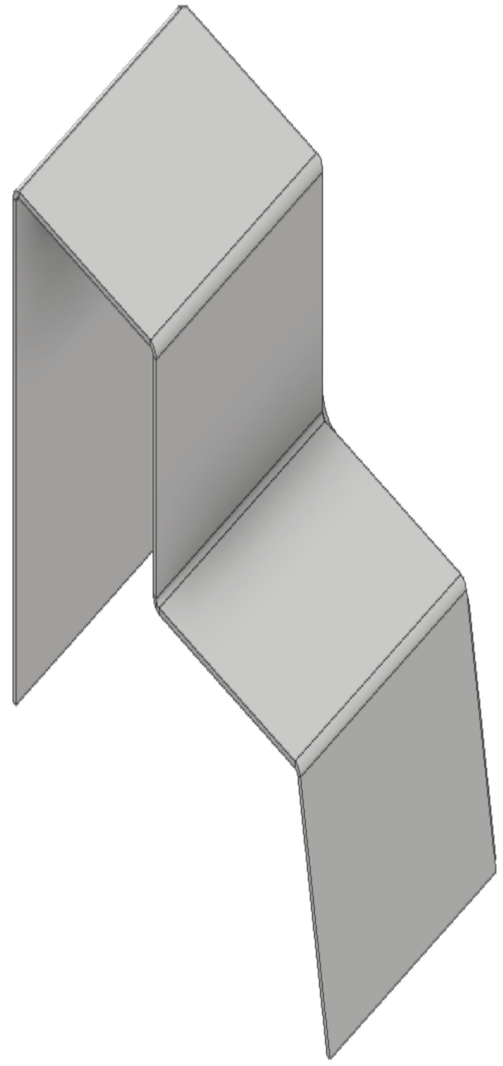


Convert from Standard Part - Solid

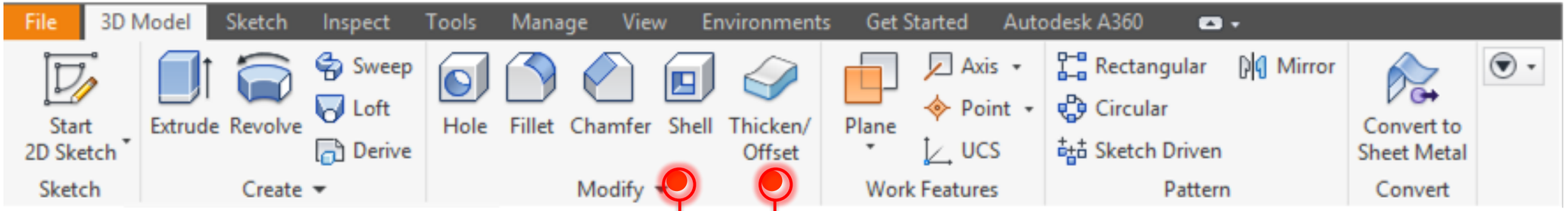








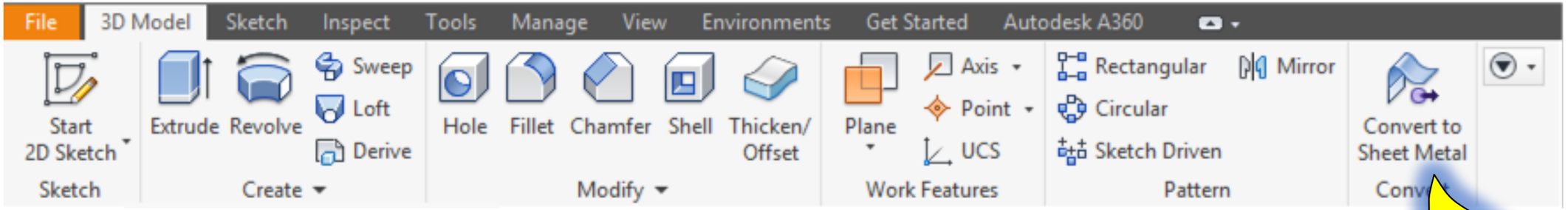
Convert from Standard Part - Solid

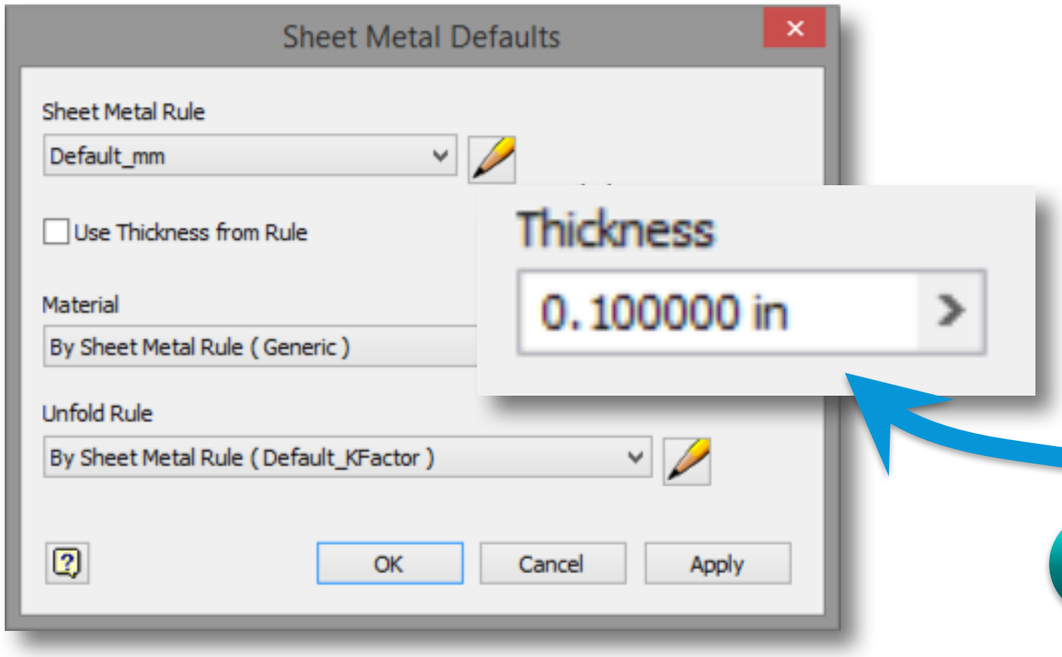


Tools to Extract Sheet from Solid:

- Shell
- Thicken/Offset

Convert from Standard Part - Solid

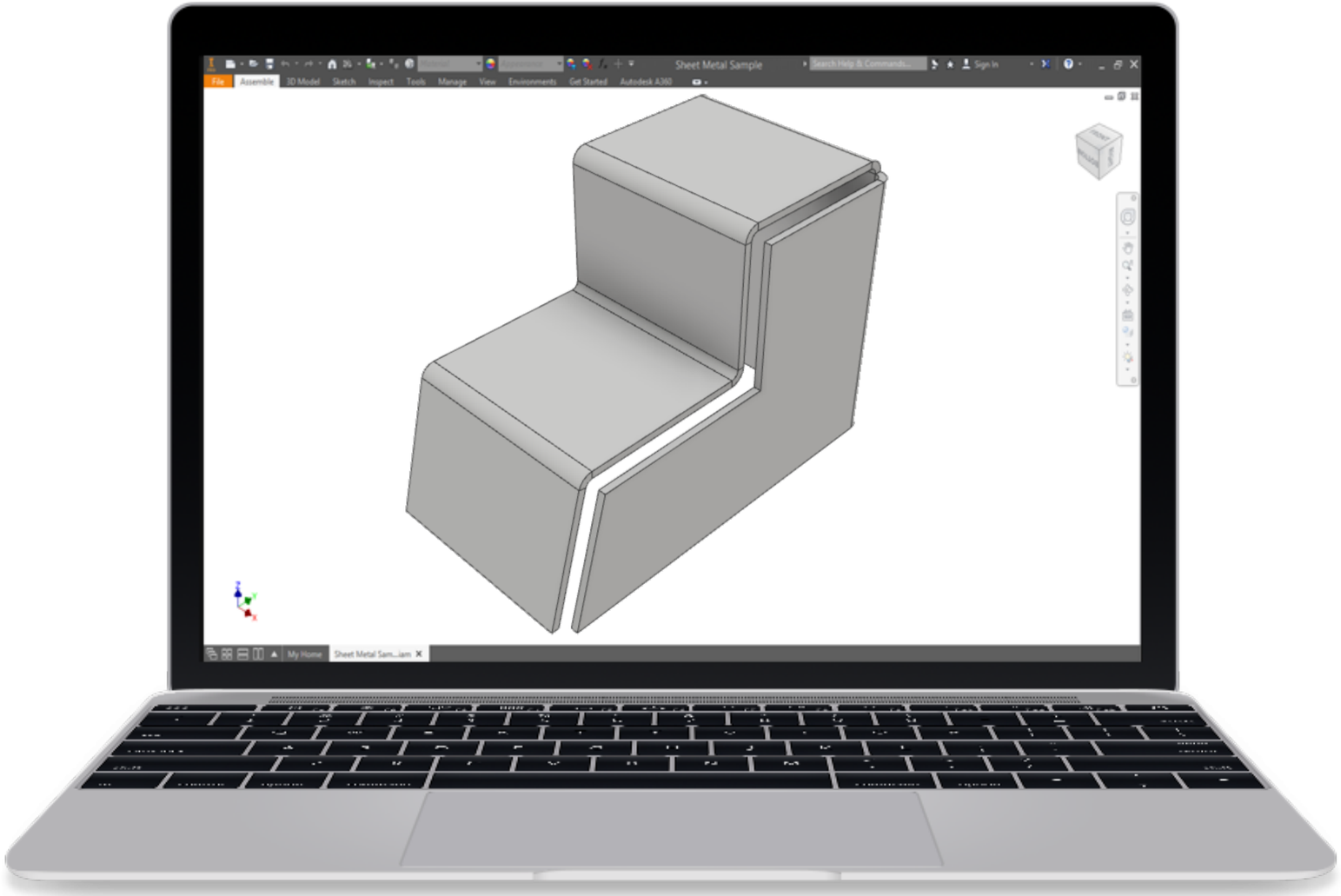




Select a base face

Select a base face to get the Thickness value

Demo Time


Sheet Metal Sample
File
Assemble
3D Model
Sketch
Inspect
Tools
Manage
View
Environments
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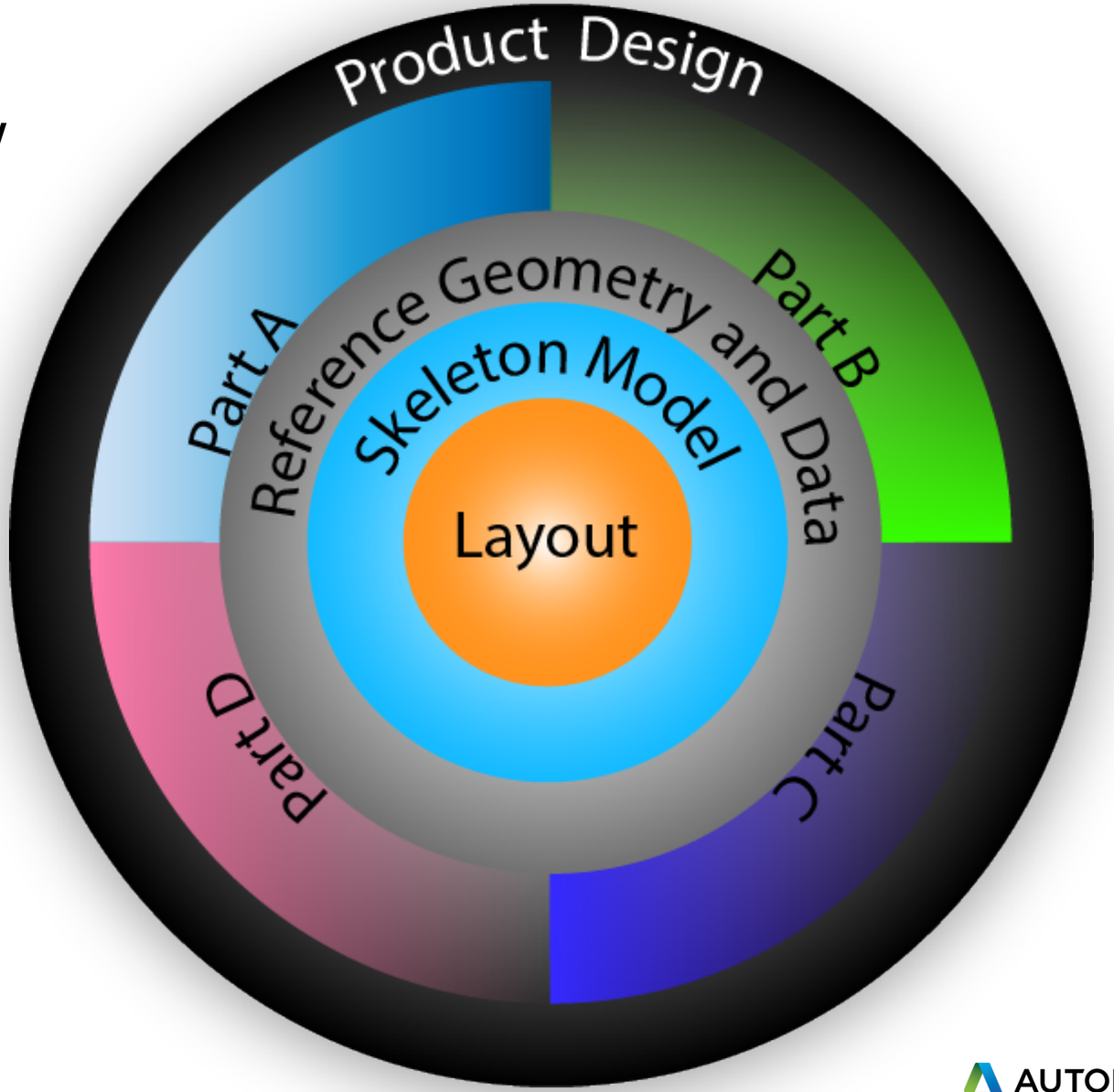
Top-Down Design with Inventor Sheet Metal

Top-Down Design Characteristics

In contextual Design
Supportive for Collaboration
High efficiency on Design Changes
Quick response on Cost control

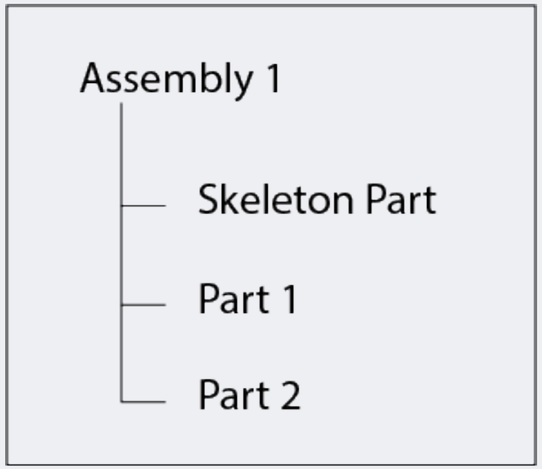
Approaches to Make Top-Down Design

- New Parts within Assembly
- Derive Skeleton Model
- Sheet Metal Multiple Body

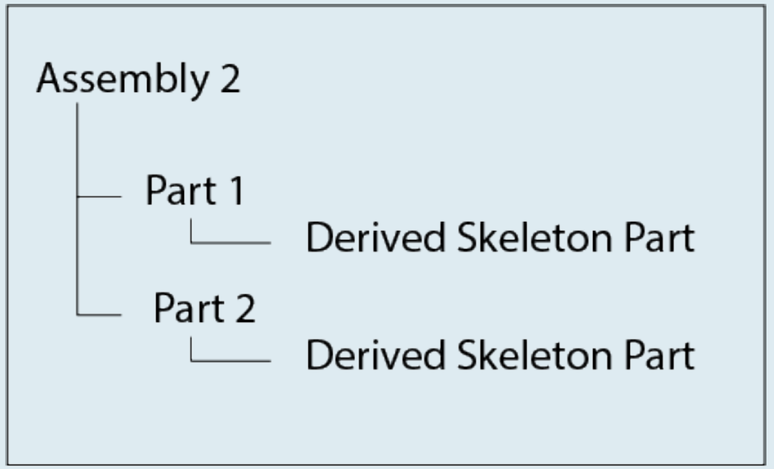


File Structure for Different Approaches

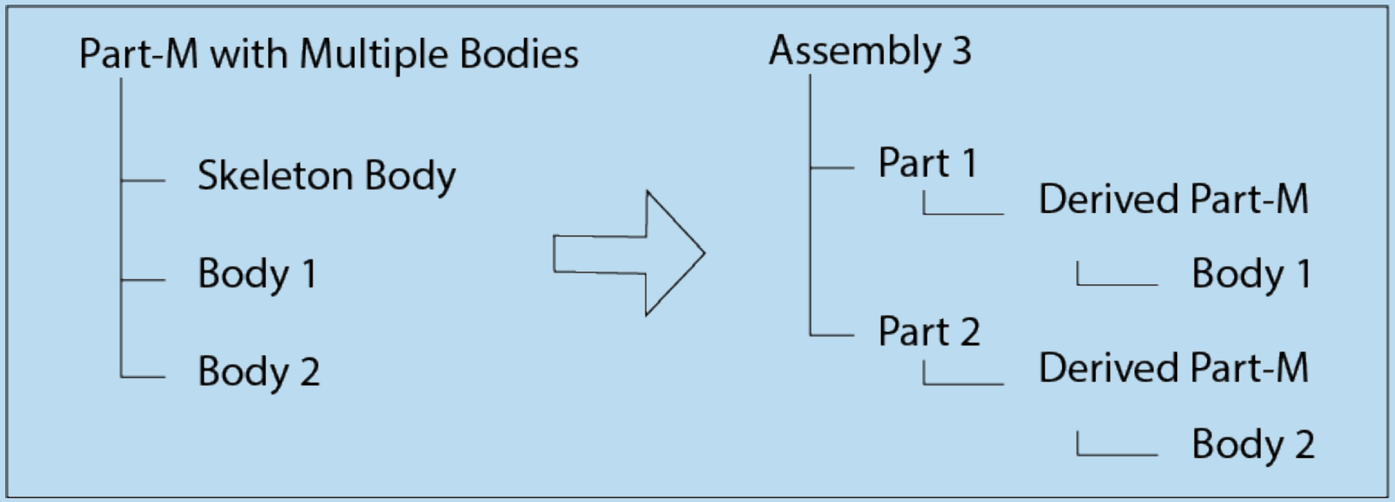
New Parts within Assembly



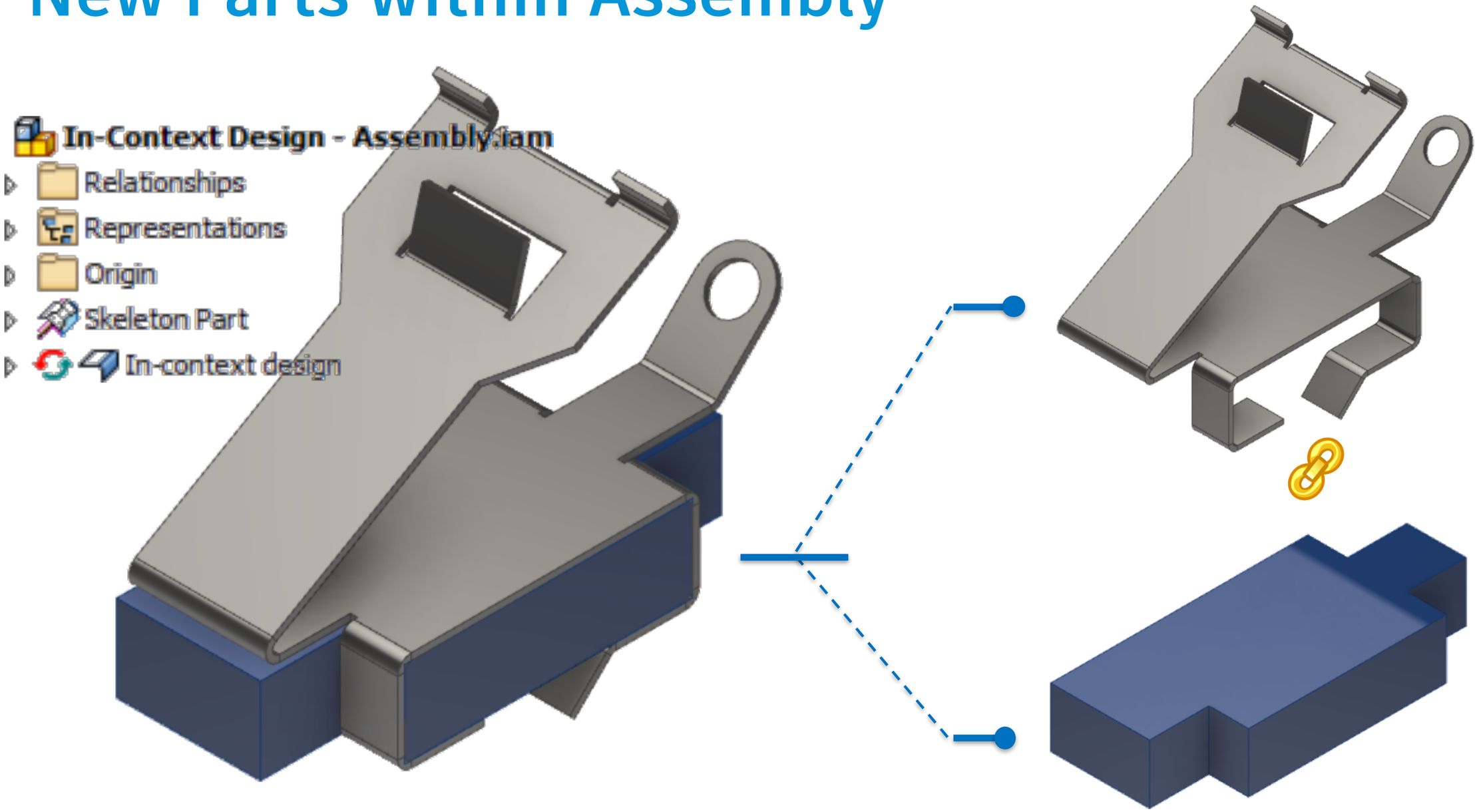
Derive Skeleton Model



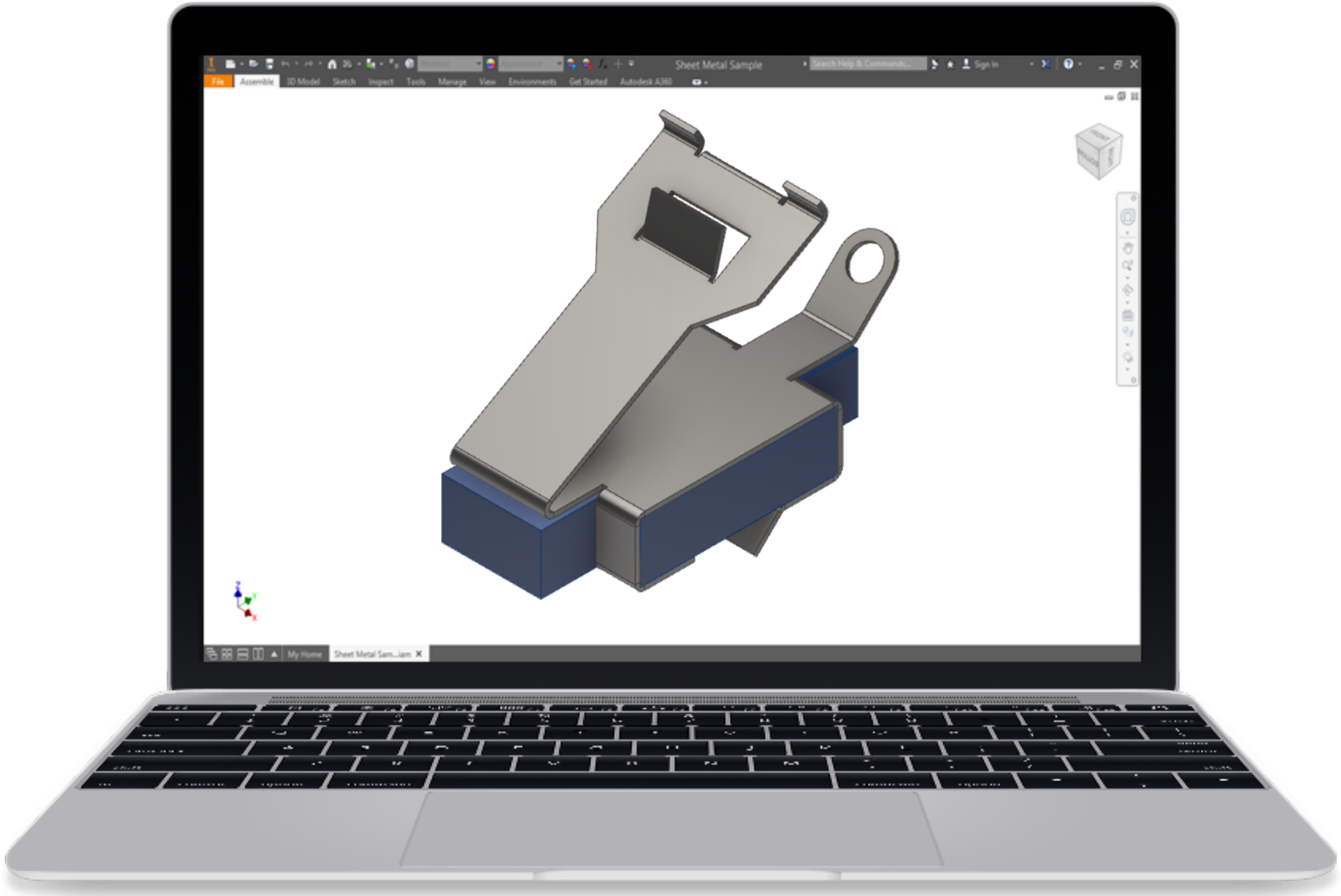
Sheet Metal Multiple Body



New Parts within Assembly



Demo Time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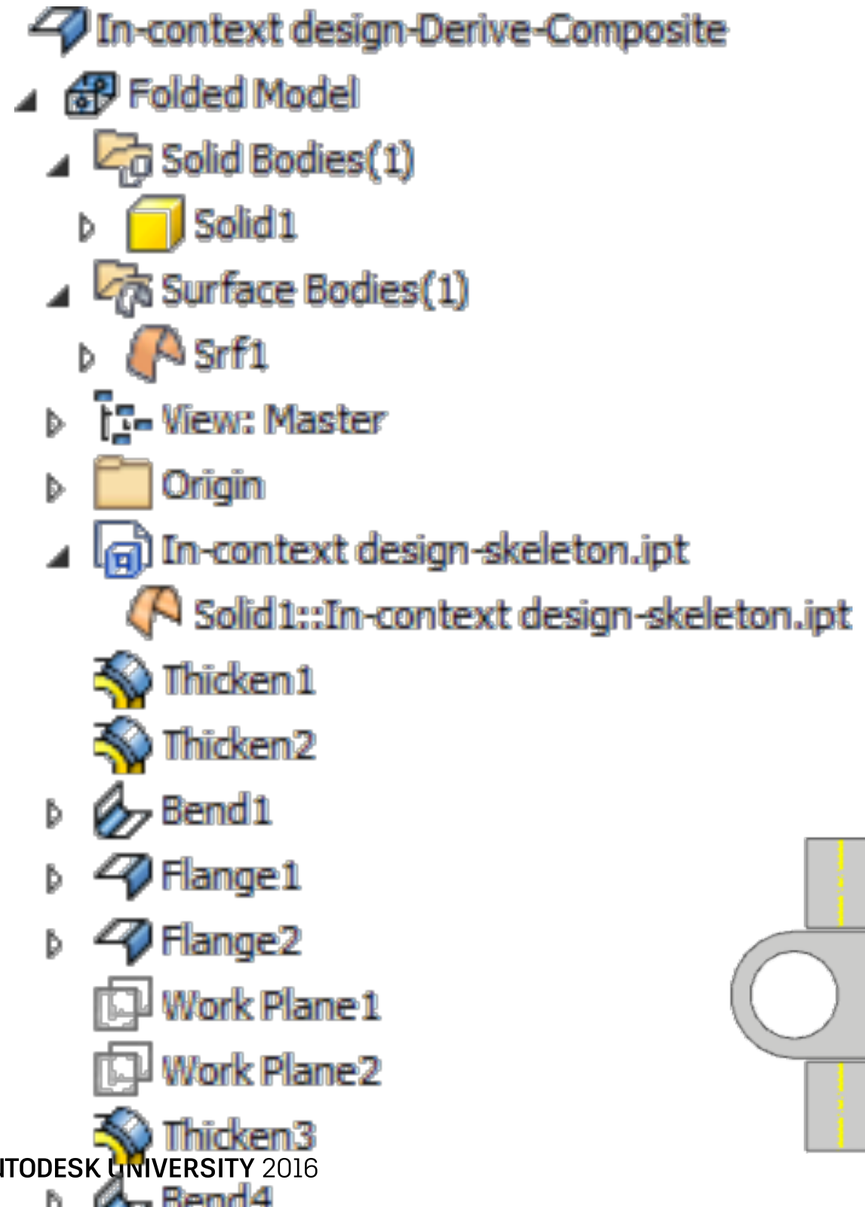
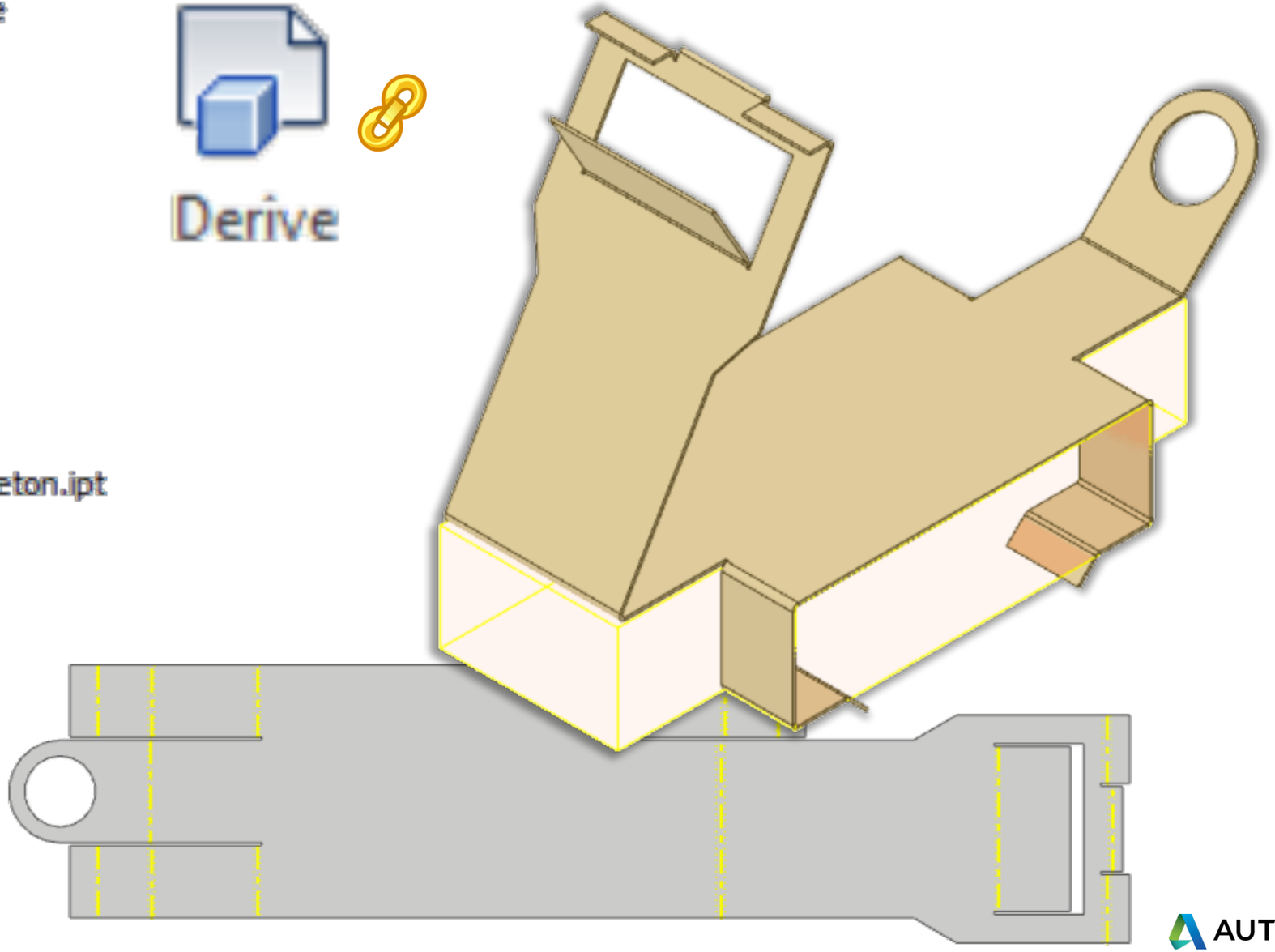
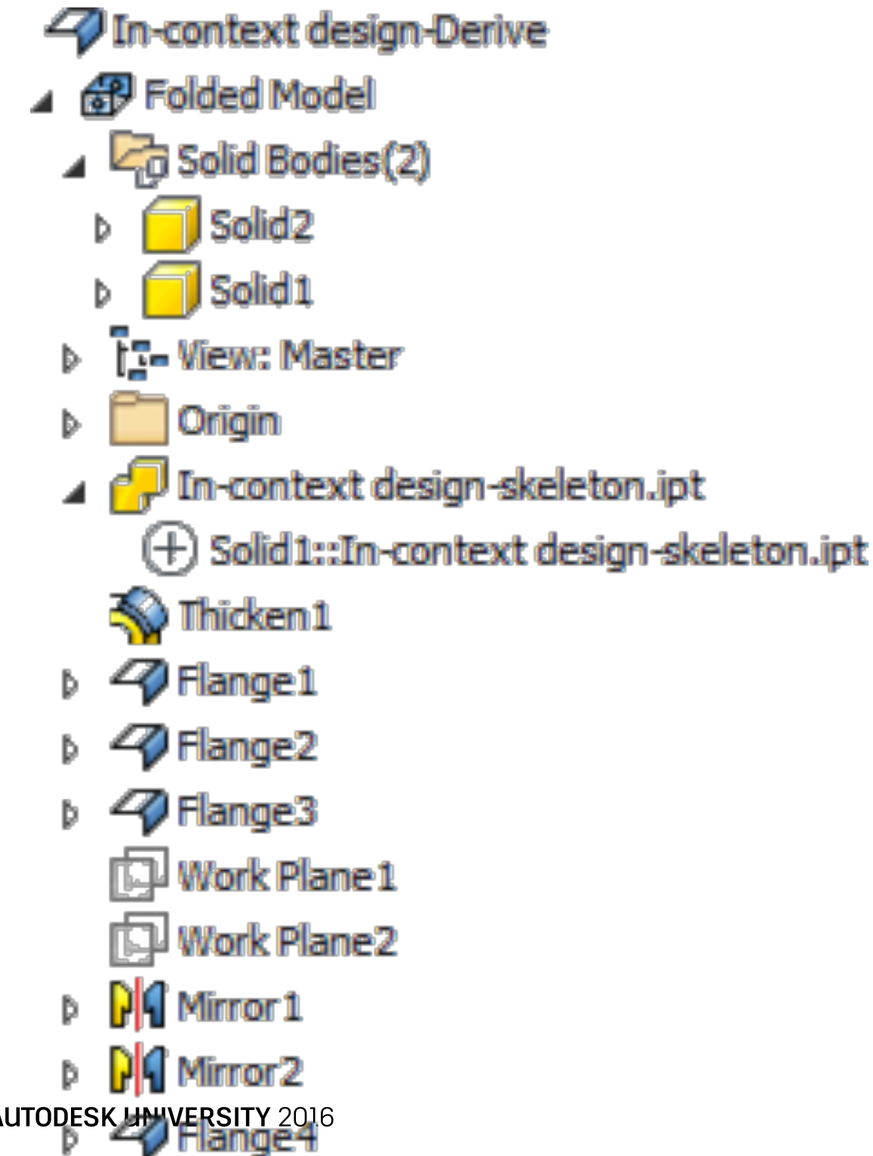
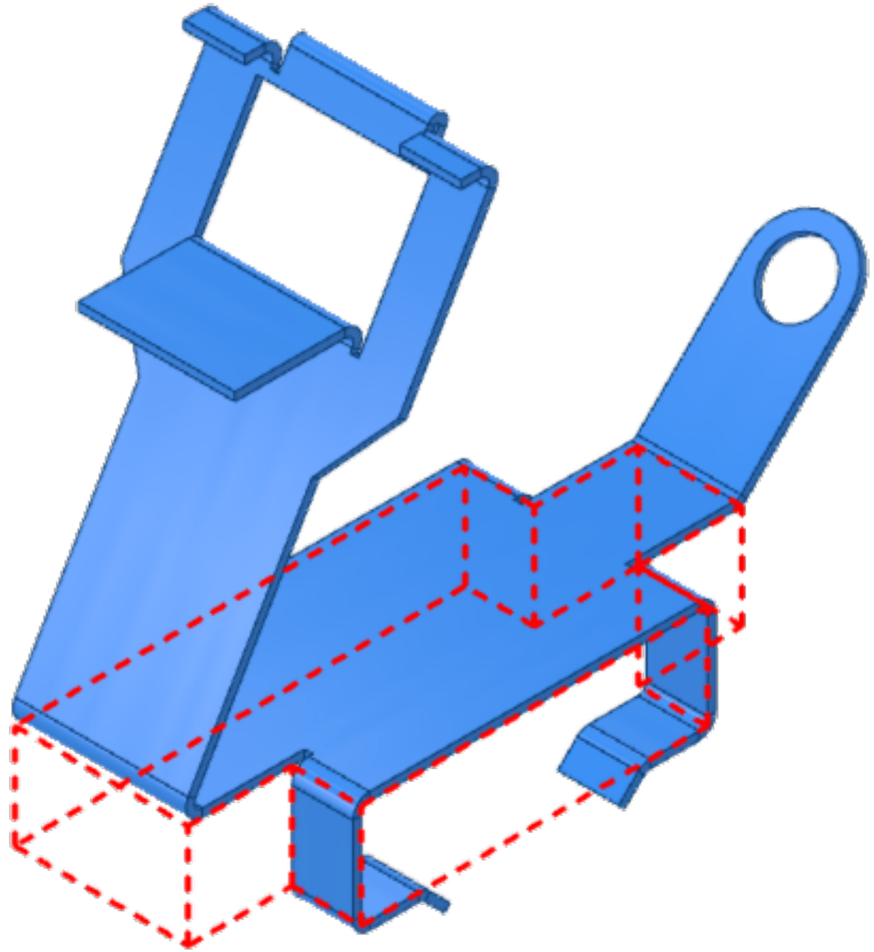
Derive Skeleton Model as Surface



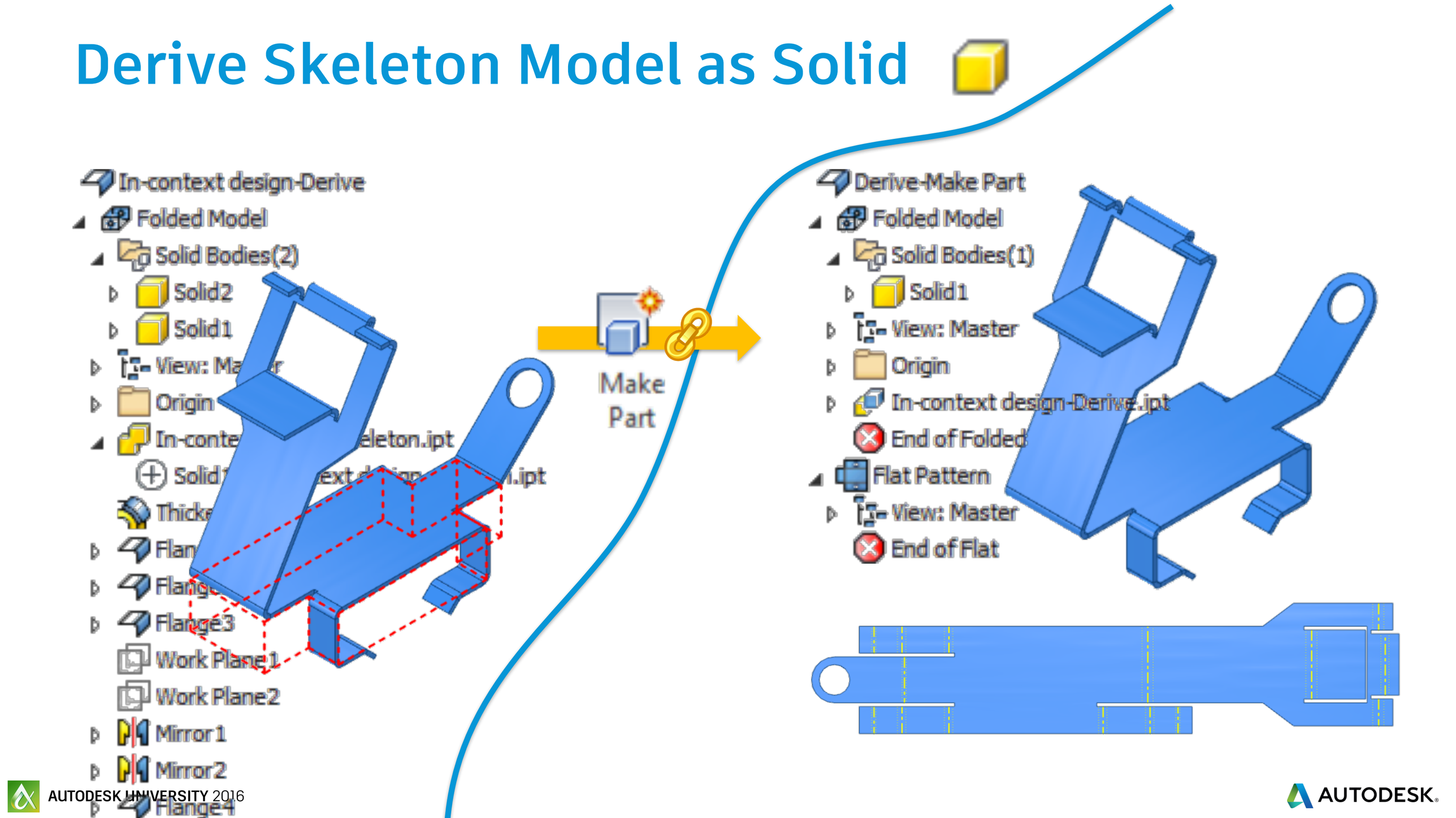


Derive Skeleton Model as Solid

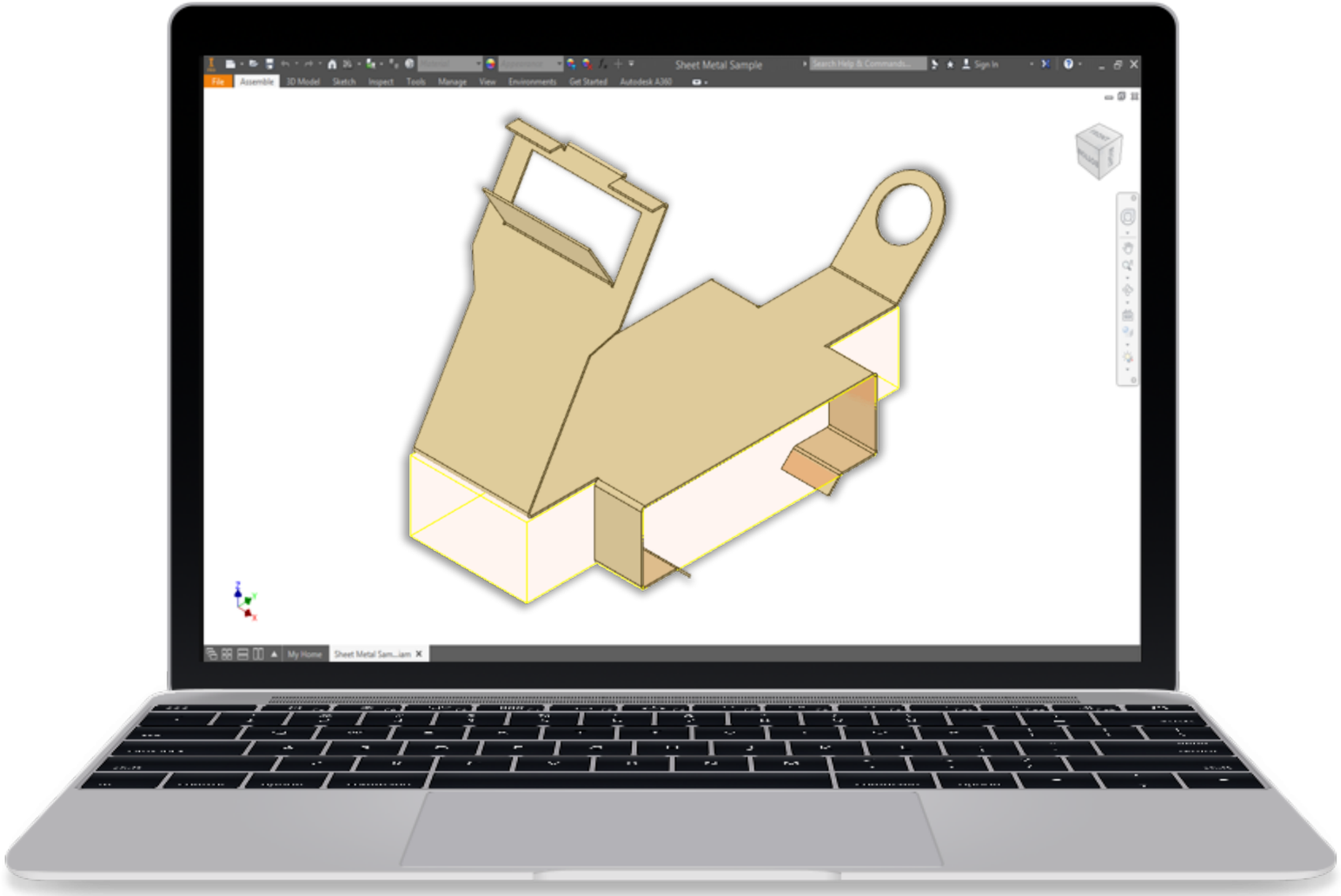




Derive Skeleton Model as Solid



Demo Time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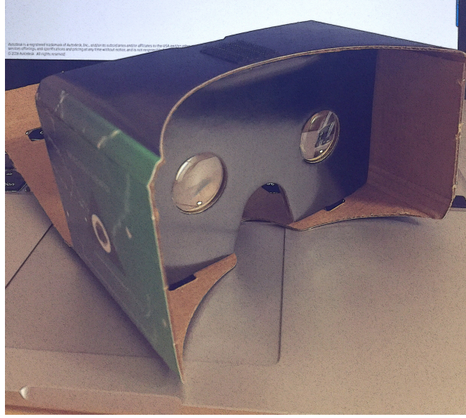
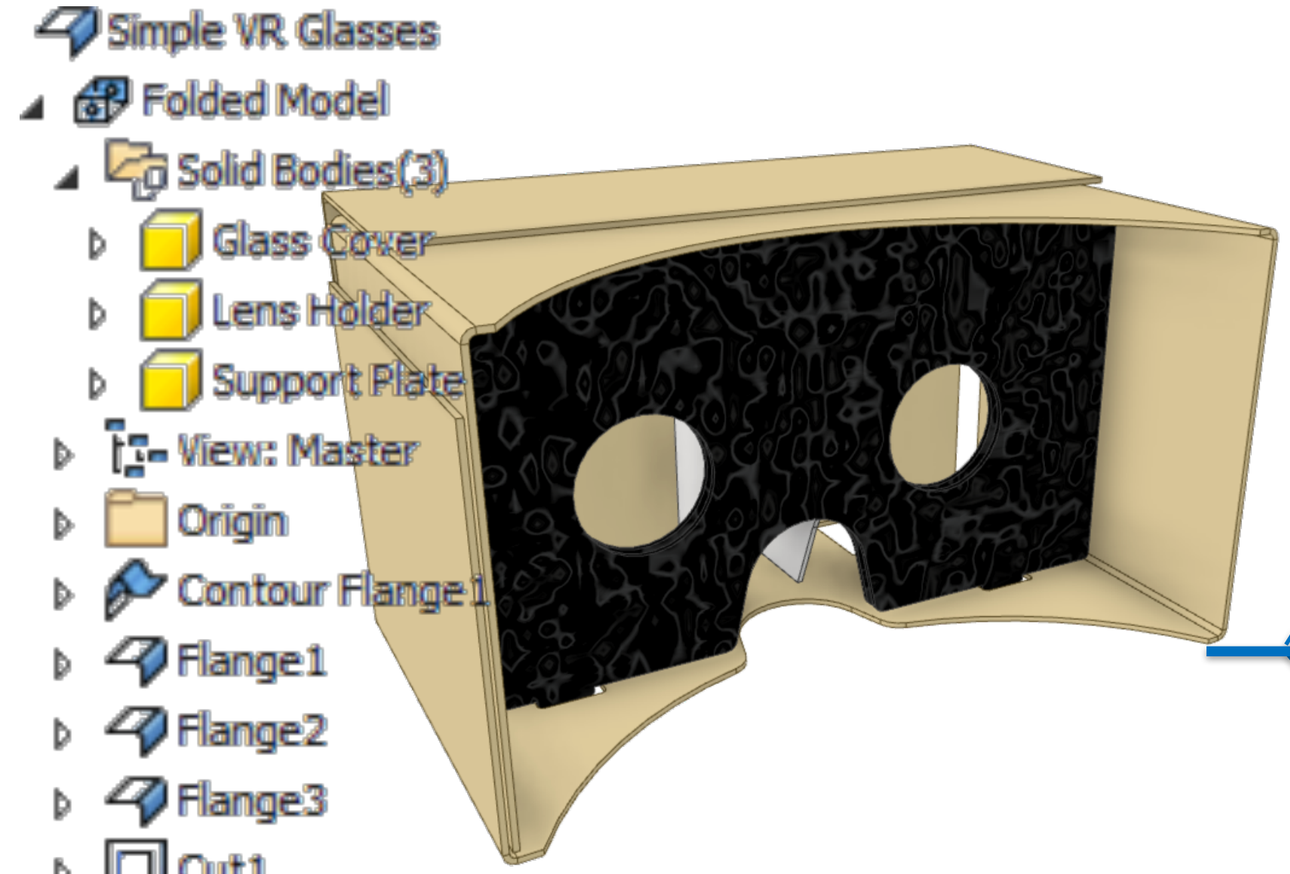
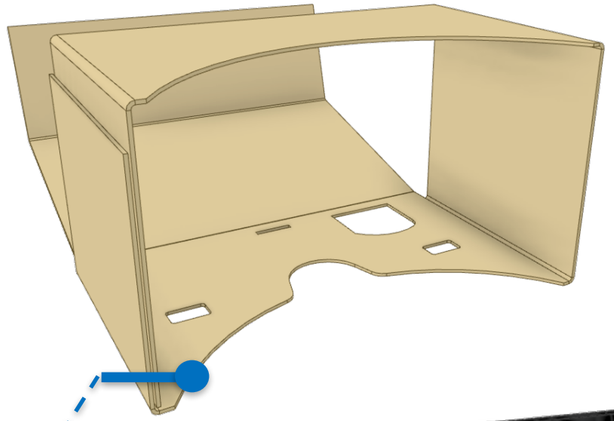
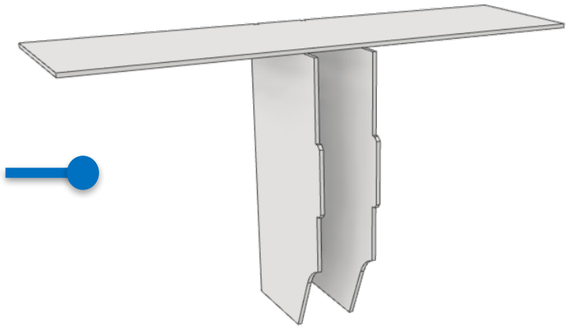
Sheet Metal Multiple Body

From Scratch









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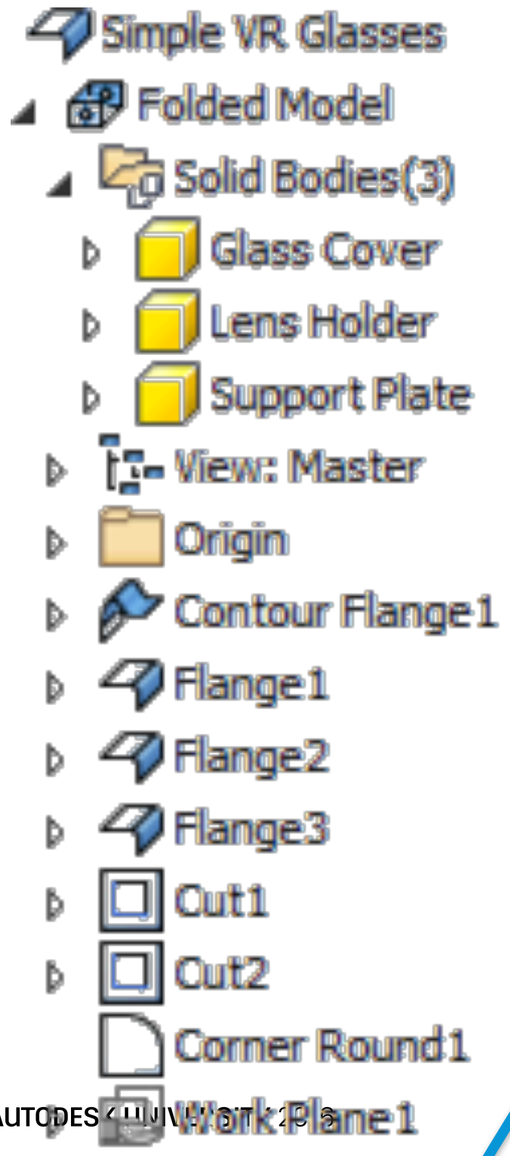
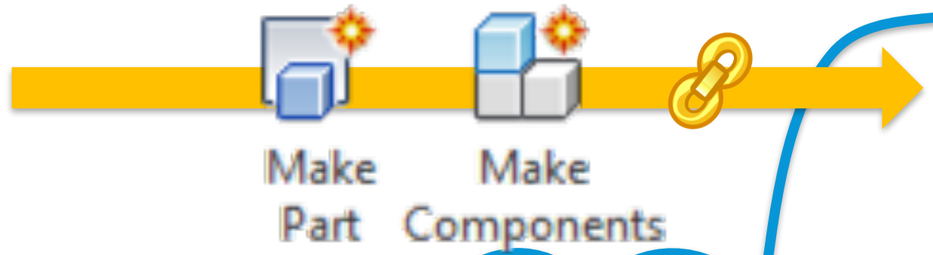
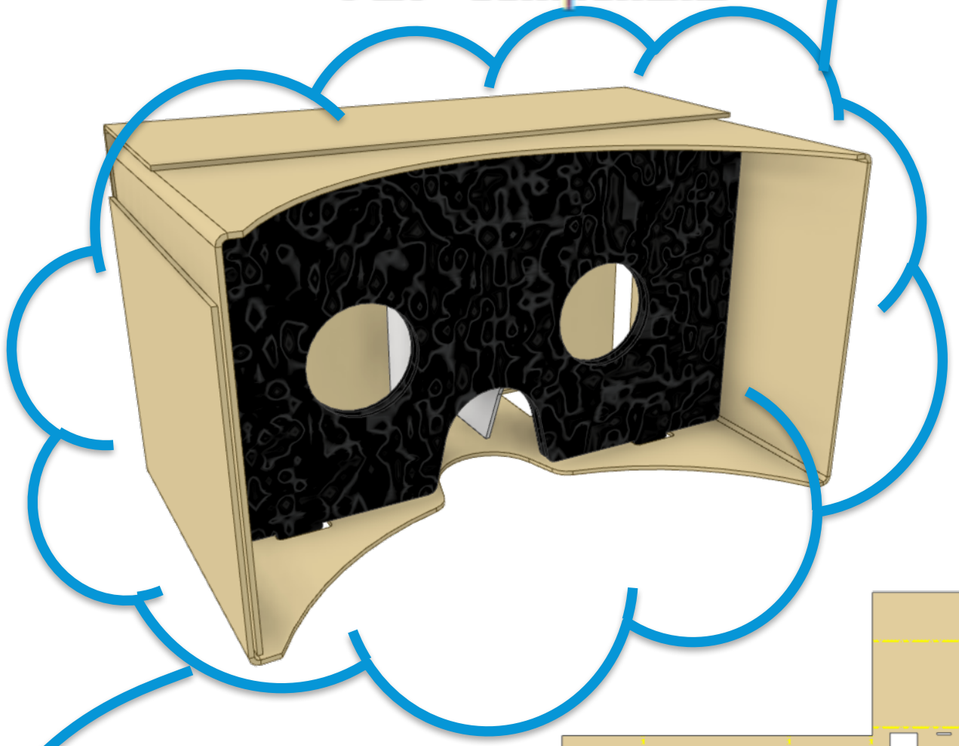
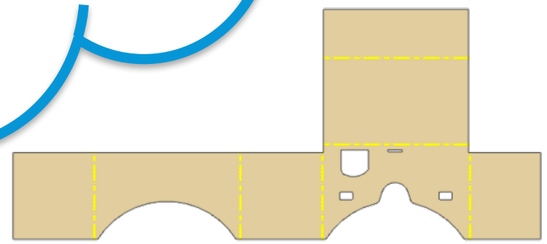
Sheet Metal Multiple Body

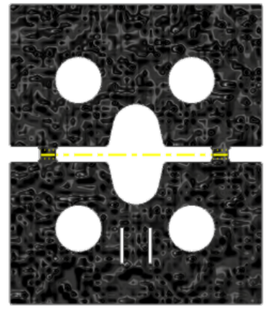
From Scratch

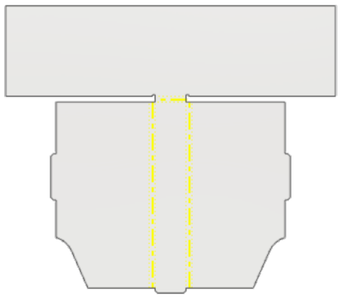




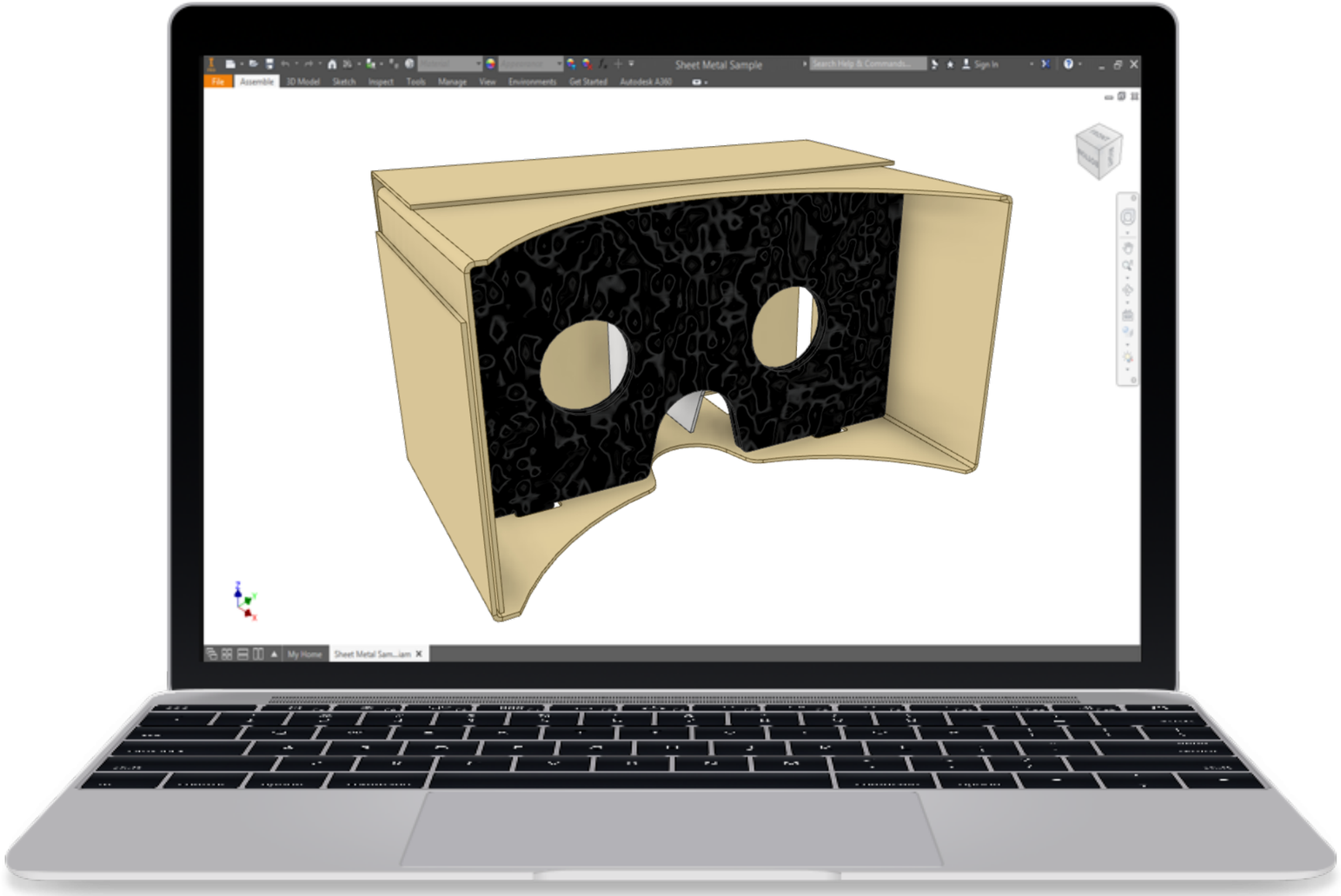








Demo Time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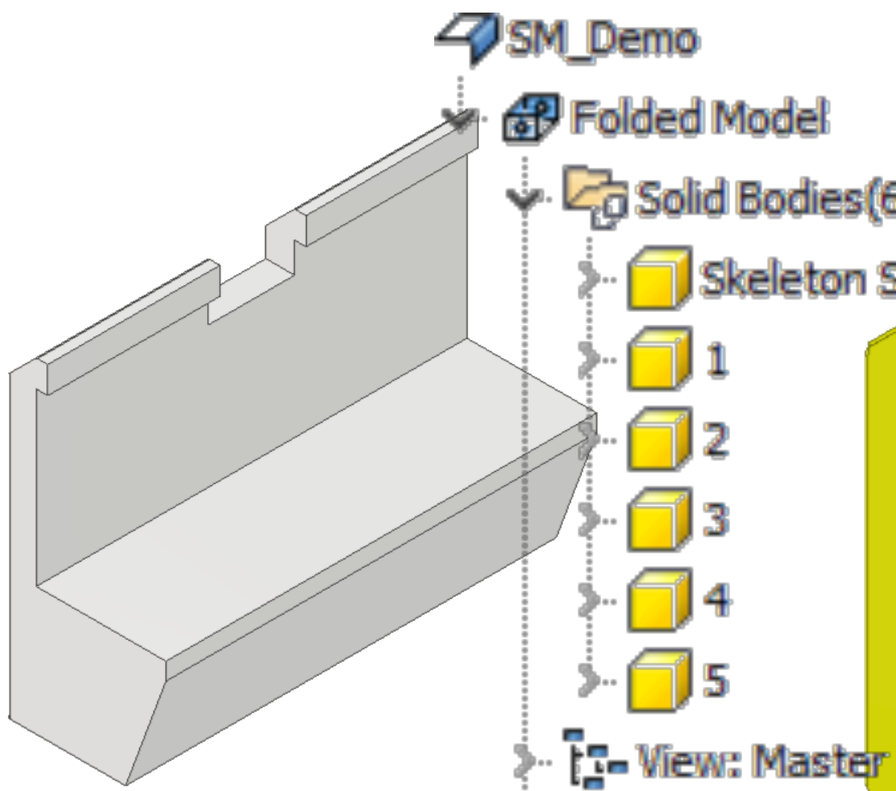
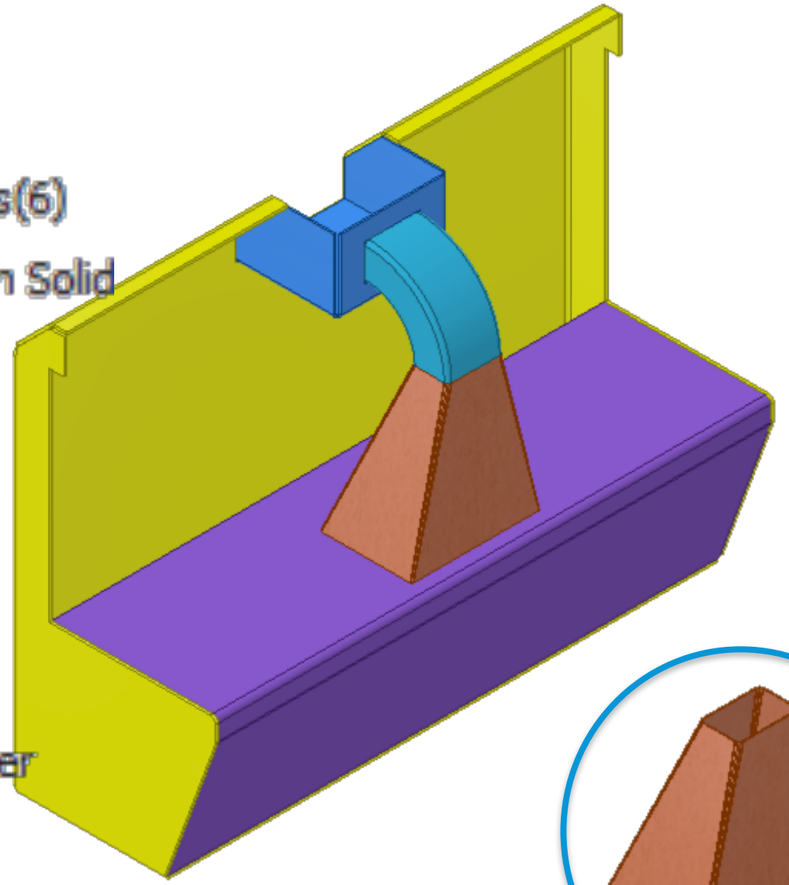
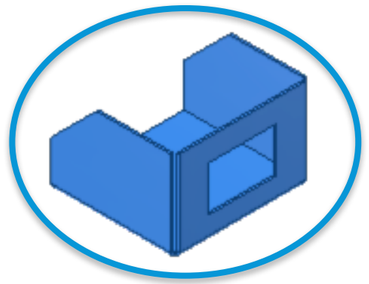
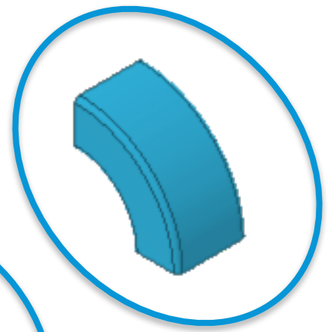
Sheet Metal Multiple Body

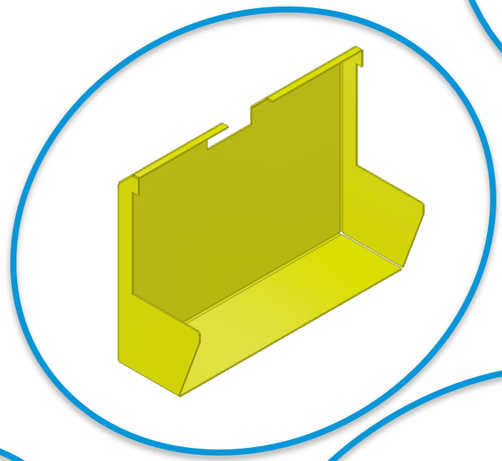
From Skeleton

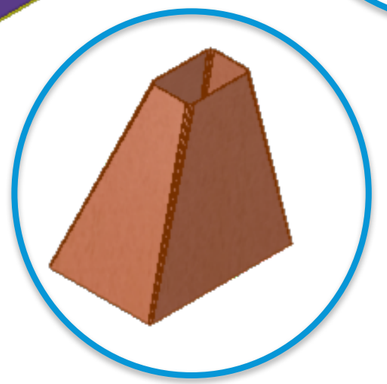


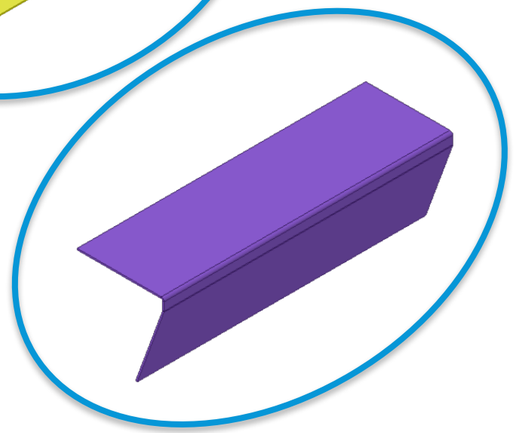






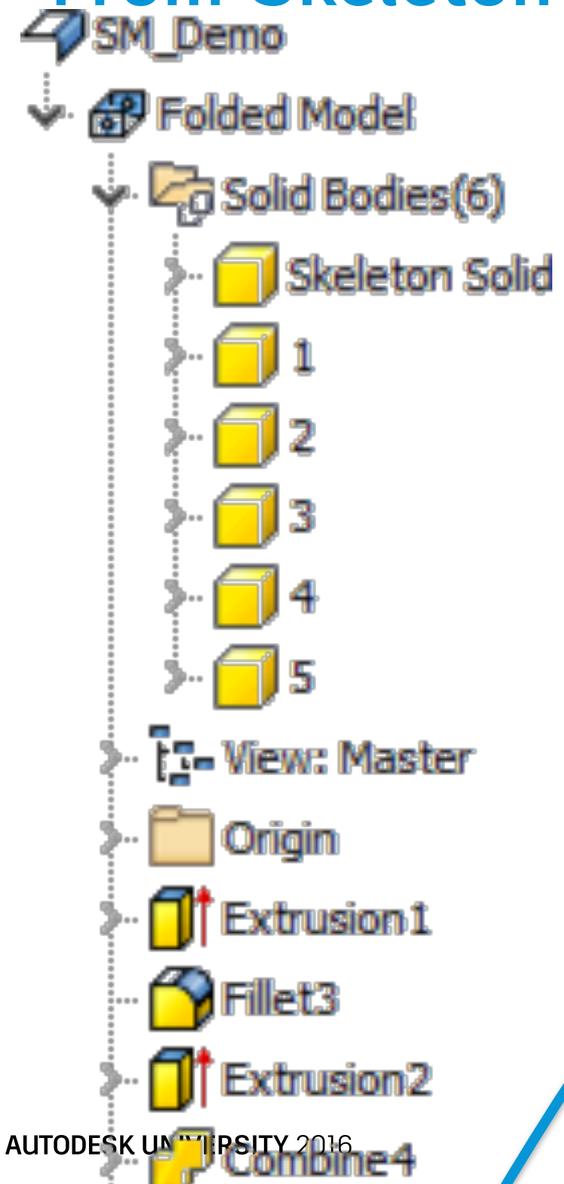


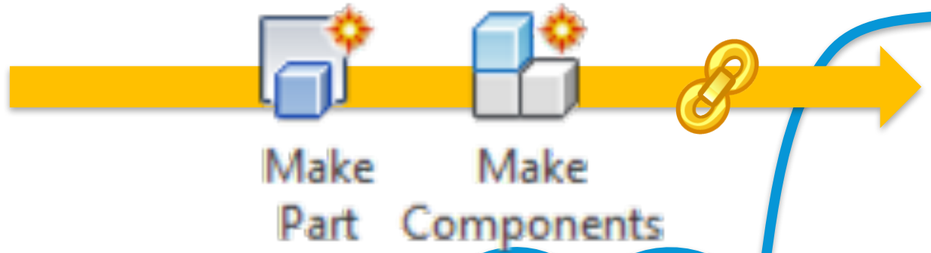


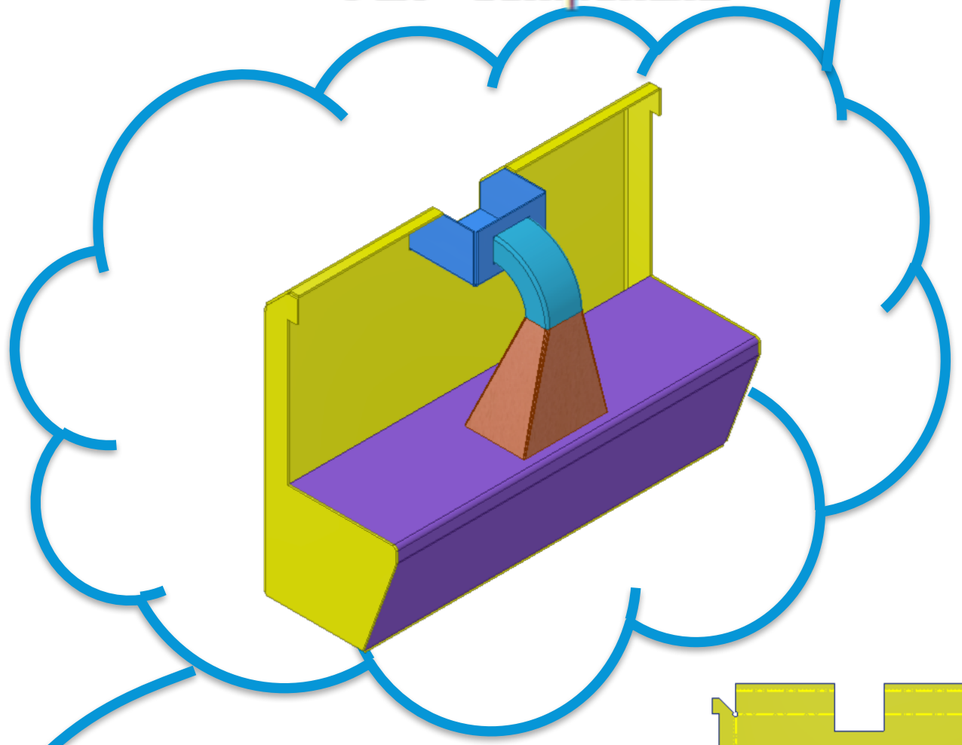


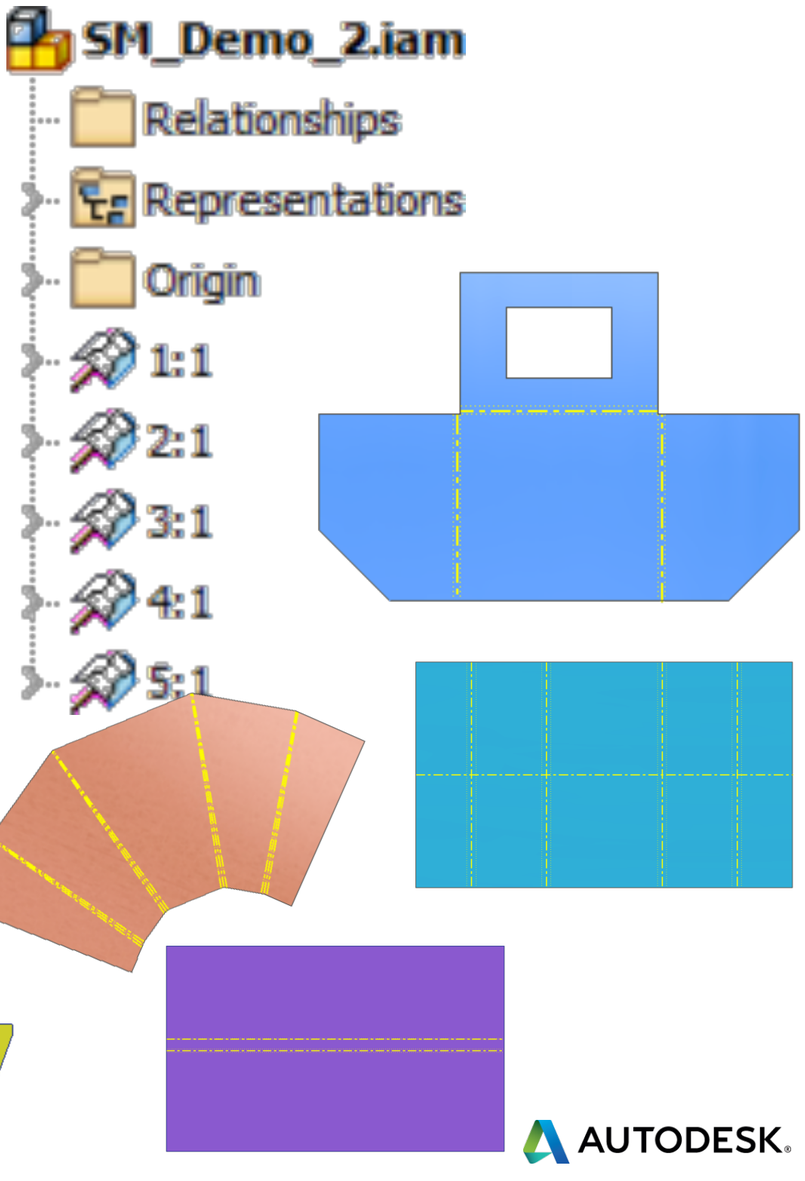
Sheet Metal Multiple Body

From Skeleton

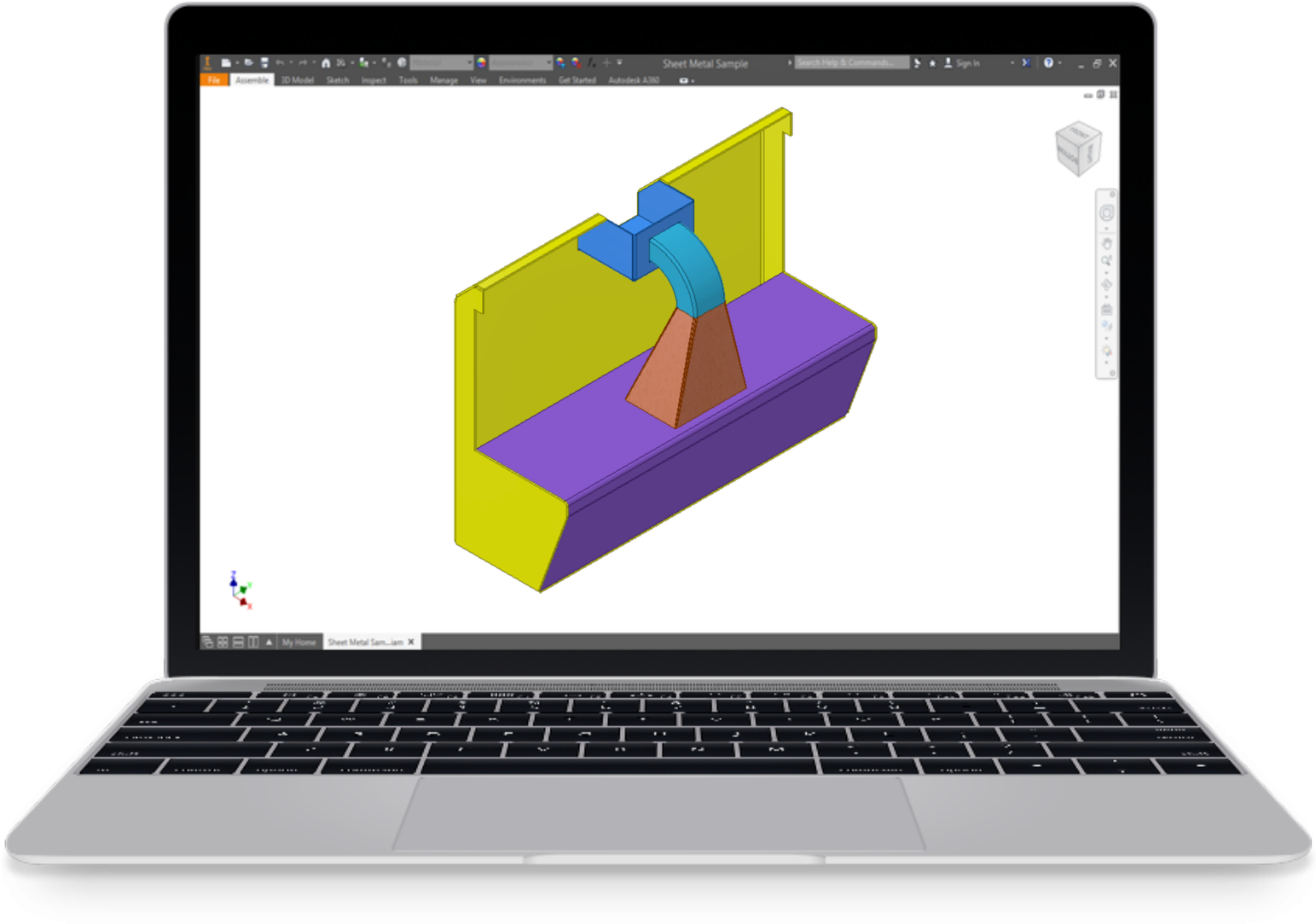








Demo Time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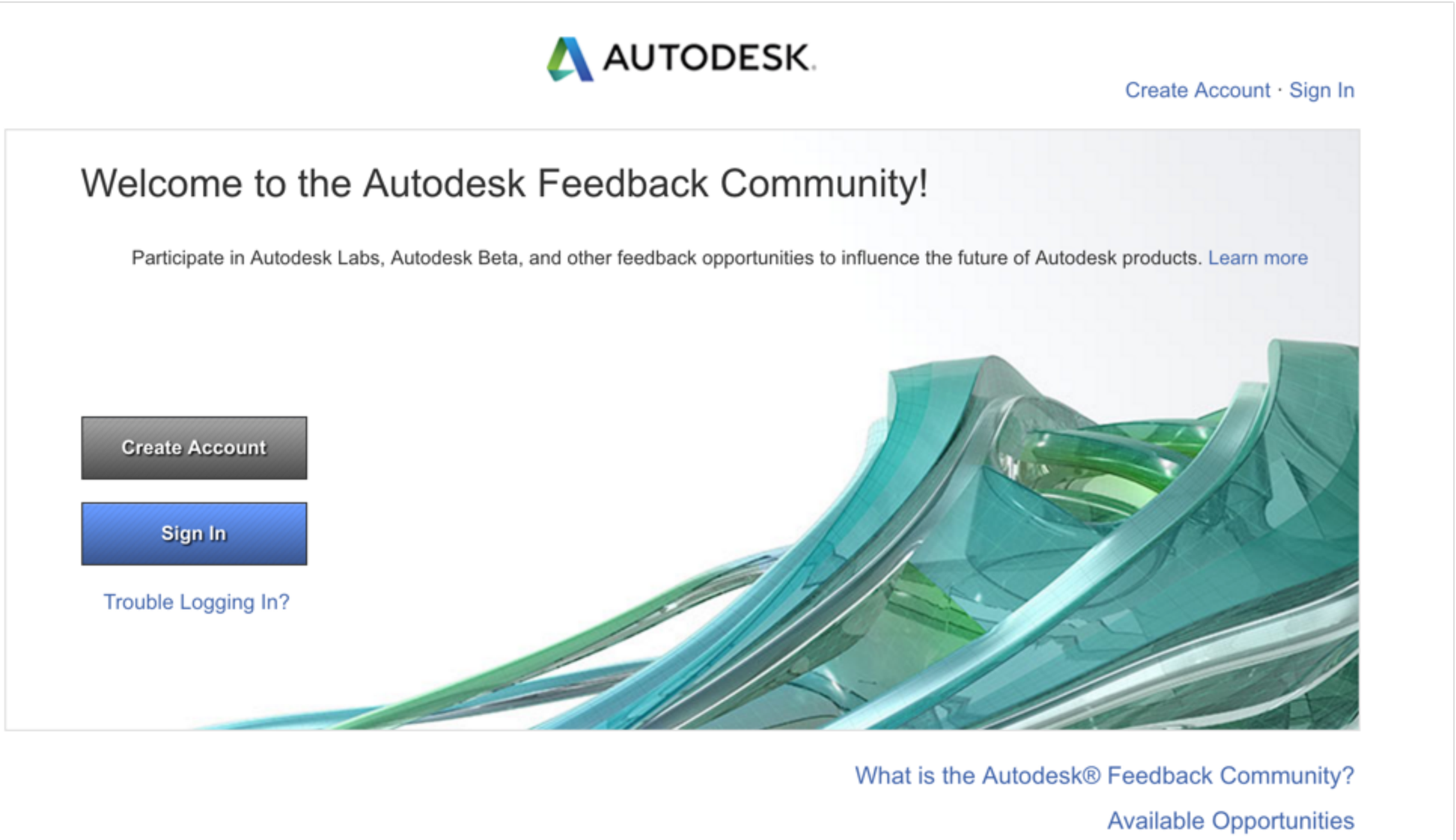
Join Beta Forum to involve in Future



Review objectives

At the end of this class, you will be able to:

Set up and Manage Inventor Sheet Metal Styles/Rules

Make Sheet Metal Features

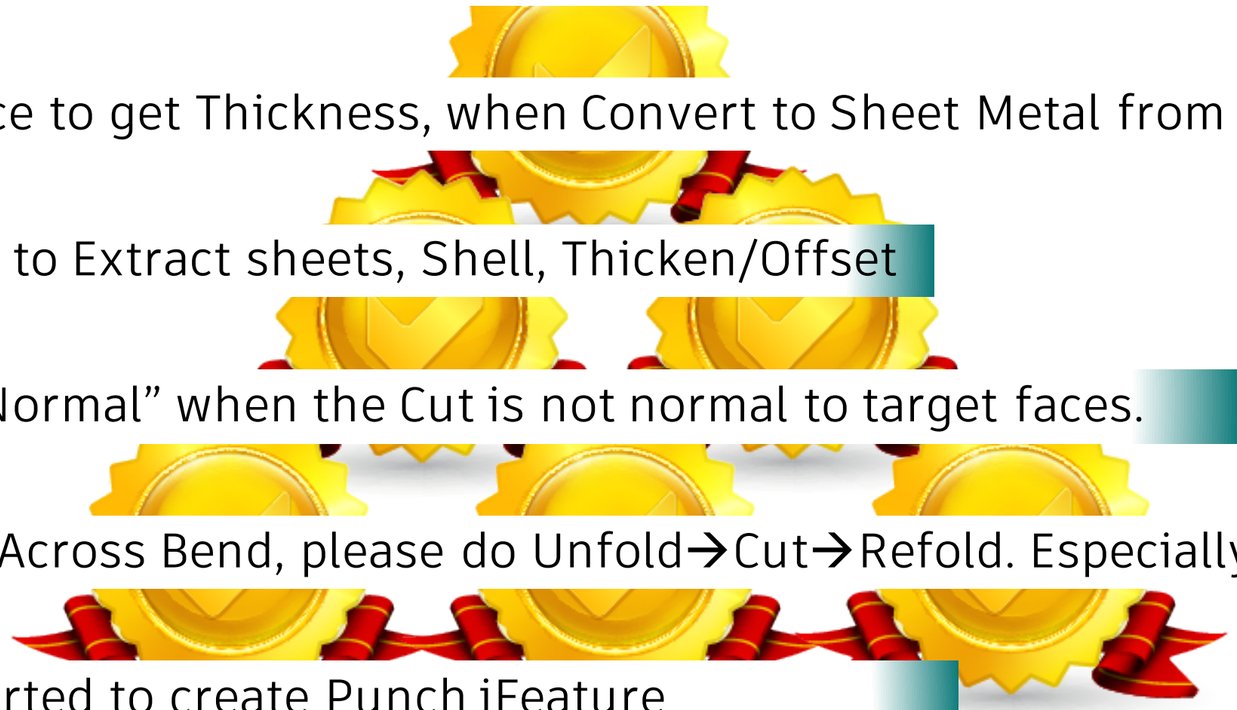
Make Top-down Design with Inventor Sheet Metal

Get Tips to ease your work

Know where to find us

Tips Collection

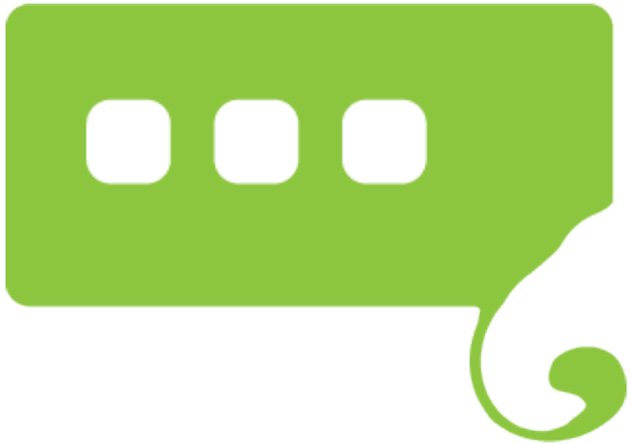
- Make a Rip before Flat Pattern for Lofted Flange
- To make a Flange always parallel with an adjacent angled face, please link the angle parameter.
- Pick a base face to get Thickness, when Convert to Sheet Metal from Standard Part.
- Common tools to Extract sheets, Shell, Thicken/Offset
- Check on “Cut Normal” when the Cut is not normal to target faces.
- To achieve Cut Across Bend, please do Unfold→Cut→Refold. Especially when there is no planar face.
- Features supported to create Punch iFeature
  | Cut | Extrude | Revolve | Sweep | Fillet |
- Turn on “Defer Update” when the Sheet Metal part becomes complex.




Q&A

Where to find us?

For questions or comments

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