

Lecture 12

CAD and Parameters

16.0 Release



Fluid Dynamics

Structural Mechanics

Electromagnetics

Systems and Multiphysics

Introduction to ANSYS Mechanical

In this chapter, interoperability with CAD software as well as parameters will be discussed.

- A. CAD Import**
- B. Defining Parameters in Workbench**
- C. Using the Parameter Workspace**
- D. Updating CAD Parameters**
- E. Workshop 12.1 – Parameter Management**

Some CAD functionality are specific to certain CAD software, so these will be designated accordingly.

- Not all CAD software have the same features so there are some differences in CAD-related functionality which is supported in Mechanical.

Numerous *Geometry Interfaces are available for commercial CAD systems:*

- For the latest information on CAD geometry interfaces and supported platforms see the ANSYS Workbench Mechanical documentation.

Geometry Interface licenses can be run in reader mode for all licenses.

Geometry Interfaces can be run in plug-in mode for the CAD software listed under “Associative”.

DesignModeler is the Workbench geometry application and supports all the functions and capabilities listed for commercial CAD systems.

- Note the SpaceClaim Direct modeler also supports these features.

Please note, not all import capabilities described here are available with all CAD systems. Features depend on CAD capabilities and the support provided through the CAD vendor’s API.

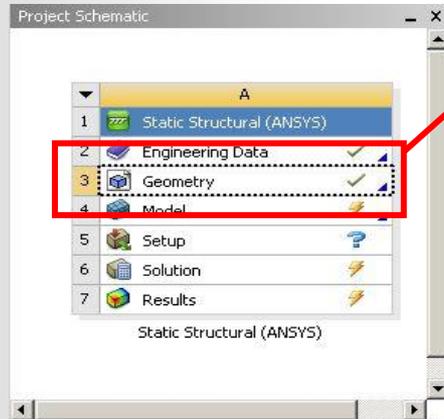
Workbench geometry properties control the import of numerous CAD items in addition to geometry:

- Parameters, Coordinate Systems, Material properties, etc.

To display geometry import properties:

- RMB > Properties, or
- View > Properties.

Geometry Interface	Availability
ACIS (.SAT)	x
AutoCAD	x
Autodesk Inventor	x
Catia V4	x
Catia V5	x
Catia V6	x
Creo Parametric	x
Design Modeler	x
Gambit	x
IGES	x
JT Reader	x
Monte Carlo N-Particle	x
NX	x
Parasolid	x
Solid Edge	x
SolidWorks	x
SpaceClaim	x
STEP	x



	A	B
1	Property	Value
2	General	
3	Component ID	Geometry 3
4	Directory Name	SYS-5
5	Notes	
6	Notes	
7	Used Licenses	
8	Last Update Used Licenses	
9	Geometry Source	
10	Geometry File Name	
11	Basic Geometry Options	
12	Solid Bodies	<input checked="" type="checkbox"/>
13	Surface Bodies	<input checked="" type="checkbox"/>
14	Line Bodies	<input checked="" type="checkbox"/>
15	Parameters	<input checked="" type="checkbox"/>
16	Parameter Key	DS
17	Attributes	<input type="checkbox"/>
18	Named Selections	<input type="checkbox"/>
19	Material Properties	<input type="checkbox"/>
20	Advanced Geometry Options	
21	Analysis Type	3D
22	Use Associativity	<input checked="" type="checkbox"/>
23	Import Coordinate Systems	<input type="checkbox"/>
24	Import Work Points	<input type="checkbox"/>
25	Reader Mode Saves Updated File	<input type="checkbox"/>
26	Import Using Instances	<input checked="" type="checkbox"/>
27	Smart CAD Update	<input type="checkbox"/>
28	Compare Parts On Update	No
29	Enclosure and Symmetry Processing	<input checked="" type="checkbox"/>
30	Decompose Disjoint Geometry	<input checked="" type="checkbox"/>
31	Mixed Import Resolution	None

Import solid, surface, or line bodies:

- Assemblies with mixed solids and surfaces are OK.
- Select desired geometry type to filter import.
- Cannot import a *part* with mixed solids and surfaces.

Use Associativity:

- Allows updating CAD geometry in Mechanical without redefining material properties, loads, supports, etc..

Smart CAD Update:

- only modified components of a CAD assembly are updated.

5	Solid Bodies	<input checked="" type="checkbox"/>
6	Surface Bodies	<input checked="" type="checkbox"/>
7	Line Bodies	<input checked="" type="checkbox"/>

13	Advanced Geometry Options	
14	Analysis Type	3D ▼
15	Use Associativity	<input checked="" type="checkbox"/>

3	Reader Mode Saves Updated File	<input type="checkbox"/>
9	Import Using Instances	<input checked="" type="checkbox"/>
0	Smart CAD Update	<input type="checkbox"/>
1	Enclosure and Symmetry Processing	<input checked="" type="checkbox"/>

Geometry Interface	Surface bodies	Line Bodies	Associativity	Smart CAD Update
ACIS (.SAT)	x	x		
AutoCAD	x	x		
Autodesk Inventor	x	x*	x	x*
Catia V4	x	x		
Catia V5	x	x	x	
Catia V6	x	x		
Creo Parametric	x	x	x	x*
Design Modeler	x	x		
Gambit	x	x		
IGES	x	x		
JT Reader	x	x		
Monte Carlo N-Particle	x			
NX	x	x		
Parasolid	x	x		
Solid Edge	x	x	x	x
SolidWorks	x	x	x	
SpaceClaim	x	x	x	x
STEP	x	x		

* Depends on Reader / Plug-in mode

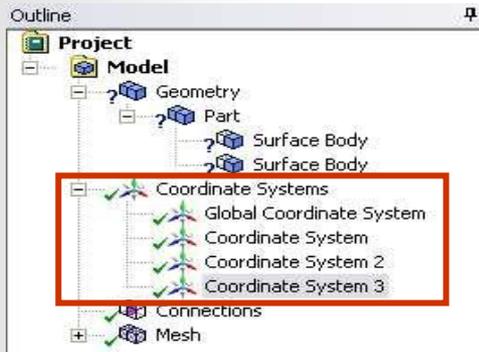
Local Coordinate systems:

- Allows local CS from CAD models to import with geometry.
See current documentation for CAD system support.

13	Advanced Geometry Options	
14	Analysis Type	3D
15	Use Associativity	<input checked="" type="checkbox"/>
16	Import Coordinate Systems	<input type="checkbox"/>

Geometry Interface	Local Coordinate System
ACIS (.SAT)	
AutoCAD	
Autodesk	
Inventor	x *
Catia V4	x
Catia V5	x
Catia V6	
Creo Parametric	x
Design Modeler	x
Gambit	
IGES	
JT Reader	
Monte Carlo N-Particle	
NX	x
Parasolid	
Solid Edge	
SolidWorks	x *
SpaceClaim	x
STEP	

* Depends on Reader / Plug-in mode



Parametric CAD dimensions can be imported into Mechanical.

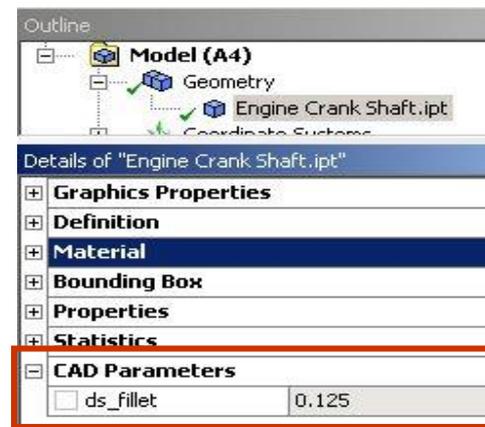
- Check Parameters:
 - The “Parameter Key” provides a filter. When used, only parameters whose names contain the key will be imported (default is “DS”).
 - Note, multiple filters can be used by separating each with “;” (e.g. NS; AB; VR).
 - To import all CAD parameters leave the parameter key field blank.

CAD parameters will appear in the Details view for the part.

Geometry Interface	Parameters Import
ACIS (.SAT)	
AutoCAD	
Autodesk Inventor	x *
Catia V4	
Catia V5	x *
Catia V6	
Creo Parametric	x *
Design Modeler	x
Gambit	
IGES	
JT Reader	
Monte Carlo N-Particle	
NX	x *
Parasolid	
Solid Edge	x
SolidWorks	x *
SpaceClaim	x
STEP	

* Depends on Reader / Plug-in mode

4	Basic Geometry Options	
5	Solid Bodies	<input checked="" type="checkbox"/>
6	Surface Bodies	<input checked="" type="checkbox"/>
7	Line Bodies	<input checked="" type="checkbox"/>
8	Parameters	<input checked="" type="checkbox"/>
9	Parameter Key	DS

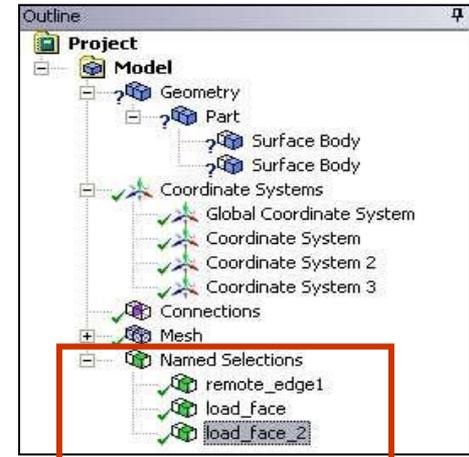


Groups defined in CAD systems can be imported as Named Selections.

Check the “Named Selections” box:

- The Named Selection key provides a filter. When used only groups containing the specified prefix in their name will be imported (default is “NS”).
 - Note, multiple filters can be used by separating each with “;” (e.g. NS; AB; VR).
- To import all groups leave the named selection key field blank.
- Imported Named Selections appear in the tree.

11	Attributes	
12	Named Selections	<input checked="" type="checkbox"/>
13	Named Selection Key	NS



For most CAD systems Workbench offers an alternate way of working with groups of geometry via the Named Selection Manager in the CAD system.

- Access the NS Manager from the ANSYS menu within the CAD system.
- Once opened the NS Manager allows groups to be created independent of the internal CAD groups. Create, Select, Delete, etc. operations



Sample menu from CAD



Geometry Interface	Named Selections
ACIS (.SAT)	x
AutoCAD	x
Autodesk Inventor	x*
Catia V4	x
Catia V5	x
Catia V6	x
Creo Parametric	x
Design Modeler	x
Gambit	
IGES	
JT Reader	x
Monte Carlo N-Particle	
NX	x
Parasolid	x
Solid Edge	x
SolidWorks	x
SpaceClaim	x
STEP	

* Depends on Reader / Plug-in mode

Material Properties assigned in a CAD system can be imported to Workbench (Engineering Data).

Check “Material Properties”:

- Materials imported from CAD will appear in “Engineering Data”
- Material assignments will match the CAD material assignments.

10	Attributes	<input type="checkbox"/>
11	Named Selections	<input type="checkbox"/>
12	Material Properties	<input type="checkbox"/>
13	...	<input type="checkbox"/>

Geometry Interface	Material Properties
ACIS (.SAT)	
AutoCAD	
Autodesk Inventor	x *
Catia V4	
Catia V5	x *
Catia V6	
Creo Parametric	x *
Design Modeler	
Gambit	
IGES	
JT Reader	x
Monte Carlo N-Particle	
NX	x *
Parasolid	
Solid Edge	
SolidWorks	
SpaceClaim	x
STEP	

* Depends on Reader / Plug-in mode

B. Defining Parameters in Workbench

Parameters are defined in Mechanical by toggling the parameter flag on/off.

- Click in the square and a blue “P” will appear.
- Material properties are parameterized in the engineering data application.

Properties of Outline Row 3: Structural Steel					
	A	B	C	D	E
1	Property	Value	Unit		
2	Density	7.85E-09	tonne mm ⁻³	<input type="checkbox"/>	<input type="checkbox"/>
3	Coefficient of Thermal Expansion			<input type="checkbox"/>	<input type="checkbox"/>
6	Isotropic Elasticity			<input type="checkbox"/>	<input type="checkbox"/>
7	Young's Modulus	2E+11	Pa	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
8	Poisson's Ratio	0.3		<input type="checkbox"/>	<input type="checkbox"/>
9	Alternating Stress Mean Stress	Tabular		<input type="checkbox"/>	<input type="checkbox"/>
13	Strain-Life Parameters			<input type="checkbox"/>	<input type="checkbox"/>
21	Tensile Yield Strength	250	MPa	<input type="checkbox"/>	<input type="checkbox"/>
22	Compressive Yield Strength	250	MPa	<input type="checkbox"/>	<input type="checkbox"/>

CAD parameters must be flagged as well to allow access in Workbench (otherwise they are read only).

Example of input parameters

Details of "Pressure"	
Scope	
Scoping Method	Geometry Selection
Geometry	1 Face
Definition	
Define By	Normal To
Type	Pressure
P Magnitude	100. Pa (ramped)
Suppressed	No

Example of output parameters

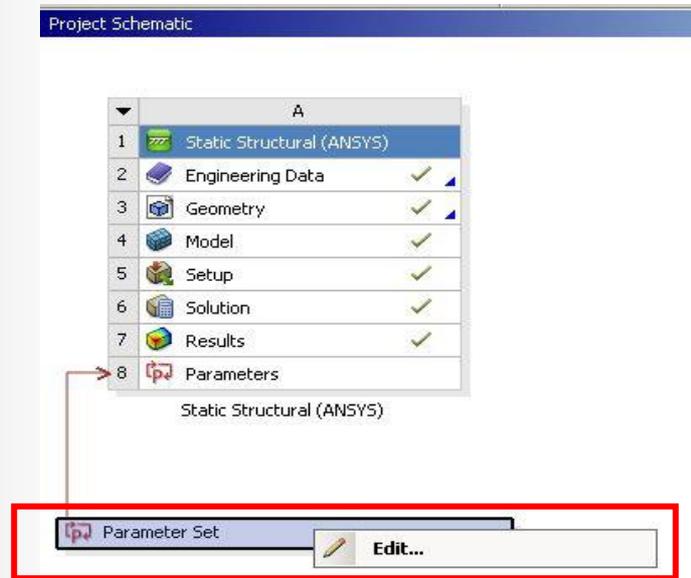
Details of "Equivalent Stress"	
Scope	
Geometry	
Definition	
Type	Equivalent (von-Mises) Stress
Display Time	End Time
Results	
<input type="checkbox"/> Minimum	12.226 Pa
P Maximum	4749.3 Pa
Information	

Properties	
Statistics	
CAD Parameters	
P ds_fillet	0.125

C. Using the Parameter Workspace

Workbench Mechanical uses the Parameter Set workspace to manage parametric data from analysis and geometry sources.

Derived parameters and constants can be created and managed as well.



Double click or “RMB > Edit” the “Parameter Set” to access parameters.

Parameter information is presented in a series of tables:

- **Outline:** lists all input, output or derived parameters.
- **Property:** lists information regarding the parameter highlighted in the outline.

The screenshot displays the ANSYS Parameter Workspace interface. On the left, the 'Outline of All Parameters' window shows a tree view of parameters. On the right, the 'Table of Design Points' window shows a table of parameter configurations. A red box highlights the 'Table of DP' label in the Design Points window. A text box at the bottom right explains the purpose of the Design Points table.

Outline

ID	Parameter Name	Value	Unit
1	Input Parameters		
2	P1	ds_cutout	5
3	P2	Thickness	10
4	New input parameter	New name	New expression
5	Output Parameters		
6	P3	Deformation Probe Maximum X Axis	0.00015174 mm
7	P4	Deformation Probe 2 Maximum X Axis	3.1355E-05 mm
8	P5	Equivalent Stress Maximum	0.95525 MPa
9	P6	Output Parameter	0.00012038 mm
10	New output parameter	New expression	
11	Charts		
12	Parameter Parallel Chart 0		
13	Parameter Parallel Chart 1		

Table of Design Points

Name	P1 - ds_cutout	P2 - Thickness	P3 - Deformation Probe Maximum X Axis	P4 - Deformation Probe 2 Maximum X Axis
1	Current	5	10	mm
2	DP 1	4	8	0.00016891
3	DP 2	2	6	0.00018366
4	DP 3	8	4	

Properties

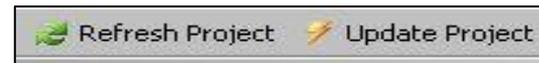
Property	Value
General	
Description	
Error Message	
Expression	5
Usage	Direct Input
Quantity Name	Dimensionless

Table of DP

Table of Design Points: allows multiple parameter configurations to be prepared before solving

To modify a parameter value one can enter a new value in the “Value” field in the Outline window then Update/Refresh the project.

Outline: No data				
	A	B	C	D
1	ID	Parameter Name	Value	Unit
2	[-] Input Parameters			
3	[-] [Static Structural (A1)]			
4	[P] P1	Displacement X Component	2	mm
5	[P] P4	Young's Modulus	45000	MPa
*	[P] New input parameter	New name	New expression	
7	[+] Output Parameters			
8	[-] [Static Structural (A1)]			
9	[P] P2	Total Deformation Maximum	2	mm
10	[P] P3	Equivalent Stress Maximum	0.0013492	MPa
*	[P] New output parameter		New expression	
12	Charts			



Create custom parameters by entering expressions. Expressions can be created using functions or by using already existing parameters.

6	[P] P7	LY_edge	30	
7	[P] P6	LX_edge	30	
8	[P] P10	Depth	35	
9	[P] P8	Area	P6*P7*1[mm^2]	mm^2
10	[P] P9	Pi	acos(-1)	
*	[P] New input parameter	New name	New expression	

Where necessary units can be entered using braces (e.g 1*[mm]).

Use the Table of Design Points to enter multiple values for input parameters. This allows a number of scenarios to be predefined for study.

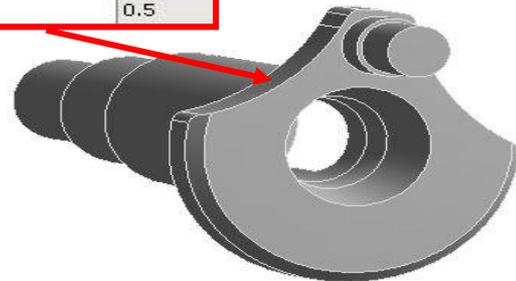
	A	B	C	D	E	F
1	Name	P1 - Displacement X Component	P4 - Young's Modulus	P2 - Total Deformation Maximum	P3 - Equivalent Stress Maximum	<input type="checkbox"/> Exported
2	Units	mm	MPa	mm	MPa	
3	Current	2	45000	⚡ 0	⚡ 0	
4	DP 1	3	36000	⚡ 0	⚡ 0	<input type="checkbox"/>
5	DP 2	4	43000	⚡ 0	⚡ 0	<input type="checkbox"/>
6	DP 3	5	51000	⚡ 0	⚡ 0	<input type="checkbox"/>
*						<input type="checkbox"/>

Once the DP Table is completed choose “Update All Design Points” to automate solving each scenario. By default each scenario overwrites the previous one keeping only the output parameter values. If you wish to retain complete solutions check the “Exported” box next to any or all rows.



Example using design points: A CAD dimension has been promoted to a WB input parameter.

CAD Parameters	
P ds_fillet	0.5

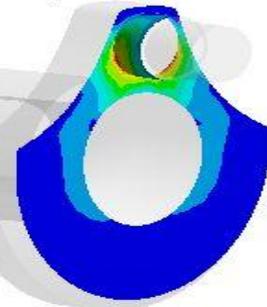
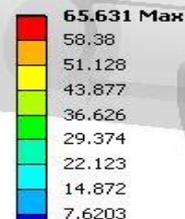


- The stress in a particular region of the model is promoted as an output parameter.
- The mass of the geometry has also been promoted to a parametric output.

Model (A4)	
Geometry	
Details of "Geometry"	
Definition	
Bounding Box	
Properties	
Volume	2382.5 mm ³
P Mass	1.8702e-005 t

Outline	
Solution (A6)	
Solution Information	
Total Deformation	
Equivalent Stress	
Equivalent Stress 2	
Details of "Equivalent Stress 2"	
Scope	
Definition	
Integration Point Results	
Results	
Minimum	0.36898 MPa
P Maximum	65.631 MPa
Information	

A: Static Structural
 Equivalent Stress 2
 Type: Equivalent (von-Mises) Stress
 Unit: MPa
 Time: 1
 11/4/2010 9:16 AM



Example ...

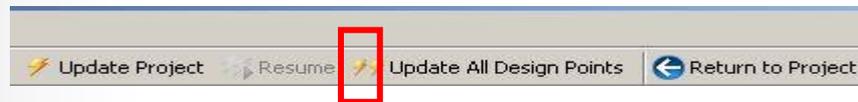
Opening the parameter workspace, the parameters can be seen in the outline.

Outline of All Parameters				
	A	B	C	D
1	ID	Parameter Name	Value	Unit
2	[-] Input Parameters			
3	[-] Static Structural (A1)			
4	P1	ds_fillet	0.5	
*	New input parameter	New name	New expression	
6	[+] Output Parameters			
7	[-] Static Structural (A1)			
8	P3	Equivalent Stress 2 Maximum	65.631	MPa
9	P2	Geometry Mass	1.8702E-05	tonne
*	New output parameter		New expression	

In the table of design points 3 new values are added to the current CAD parameter value.

Table of Design Points				
	A	B	C	D
1	Name	P1 - ds_fillet	P3 - Equivalent Stress 2 Maximum	P2 - Geometry Mass
2			MPa	tonne
3	Current	0.125	0	1.8307E-05
4	DP 1	0.25		
5	DP 2	0.375		
6	DP 3	0.5		
*				

From the top menu “Update All Design Points” is selected.



Example ...

The progress of the updates is reflected in the table.

With updates complete various charts can be created to investigate the data.

	A	B	C	D
1	Name ▾	P1 - ds_fillet 📄	P3 - Equivalent Str... ▾	P2 - Geome... ▾
2			MPa	tonne
3	Current	0.125	67.971	1.8307E-05
4	DP 1	0.25	72.212	1.8439E-05
5	DP 2	0.375	⚡	1.8585E-05
6	DP 3	0.5	⚡	⚡
*				

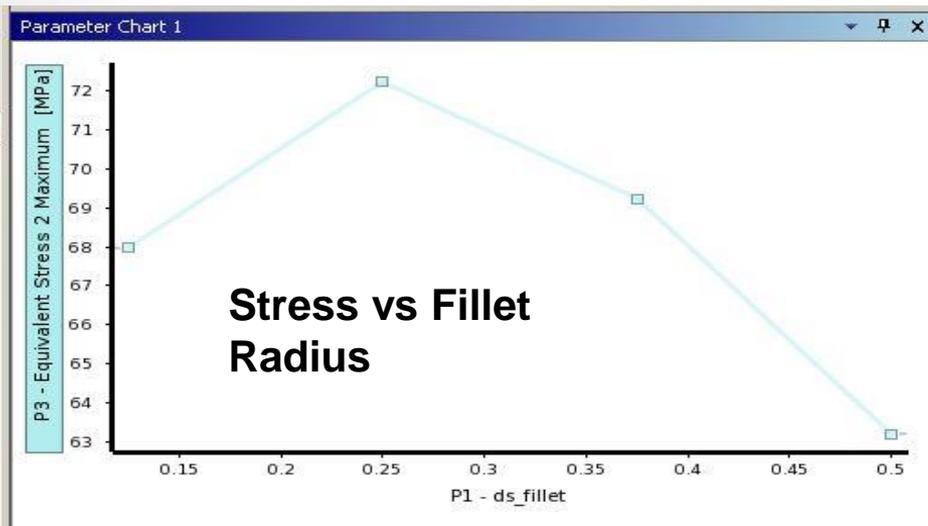
11 Charts

12 Parameter Chart 2

13 Parameter Chart 1

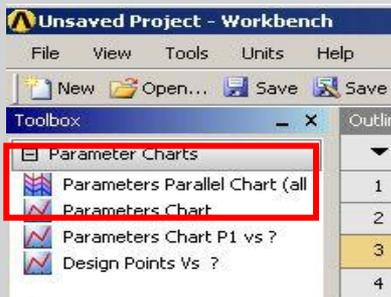
Properties of Outline A13: 1

	A	B
1	Property	Value
2	Parameter Chart: General	
3	Exclude Current Design point	<input type="checkbox"/>
4	X-Axis (Bottom)	P1 - ds_fillet ▾
5	X-Axis (Top)	▾
6	Y-Axis (Left)	P3 - Equivalent Stres... ▾
7	Y-Axis (Right)	▾



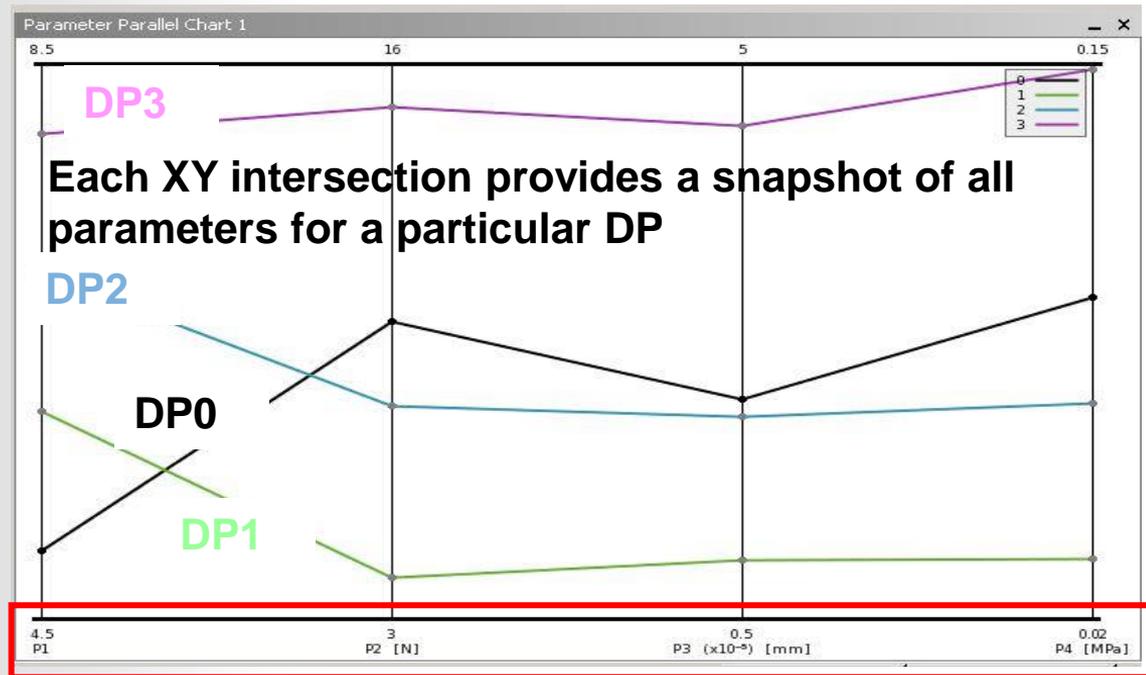
Additional processing in the parameter workspace:

Parameter Parallel Chart shows configuration of all parameters per DP



Horizontal colored lines represent design points.

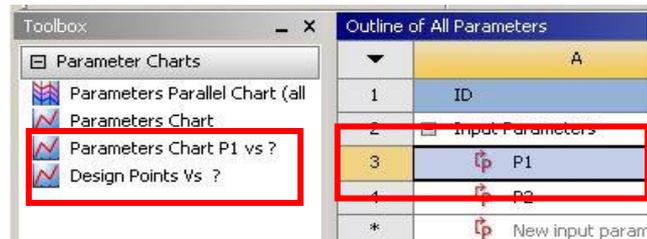
Vertical (Y) lines represent parameters (P1, P2, etc.).



By highlighting parameters, different chart configurations can be selected.

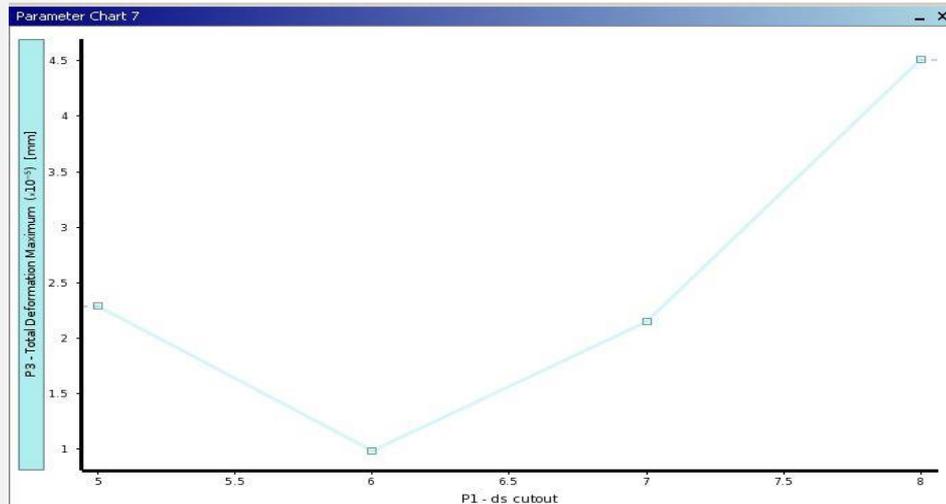
With P1 highlighted notice the chart options are with respect to this parameter.

After selecting (double click) the desired chart to configure the display.



Properties of Outline : A13.7

	A	B
1	Property	Value
2	Parameter Chart: General	
3	Exclude Current Design point	<input type="checkbox"/>
4	X-Axis (Bottom)	P1 - ds_cutout
5	X-Axis (Top)	
6	Y-Axis (Left)	P3 - Total Deformation Maximum
7	Y-Axis (Right)	



As charts are created they are stored in the outline window and can be retrieved by highlighting them.



- Using a RMB in various areas of the chart users can “Edit Properties . . .” to control colors, styles, symbols, interpolation type, etc.
- Legend, line display, background, etc..

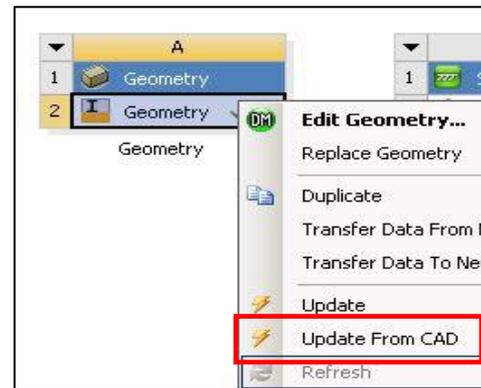
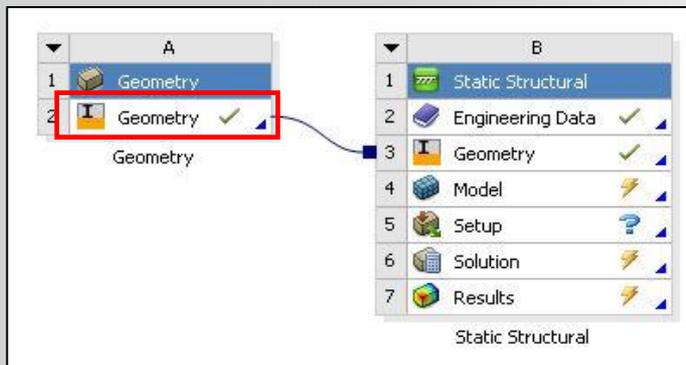


Properties of Chart : P1 - ds_fillet vs P2 - Geometry Mass

	A	B
1	Property	Value
2	Variable	
3	Label	P1 - ds_fillet vs P2 - Geometry Mass
4	Is Included in Legend	<input checked="" type="checkbox"/>
5	Display As	Line
6	Style	
7	Smoothed Edges	<input checked="" type="checkbox"/>
8	Line Style	Solid
9	Symbol Style	Rectangle
10	Fill Style	None
11	Line Width	3
12	Symbol Size	7
13	Line Colors	
14	Fill Colors	
15	Symbol Outline Colors	
16	Number of Color Bands	0
17	Show Linear Interpolation of Lines	<input checked="" type="checkbox"/>

Update From CAD (Project Schematic):

- After modifying the geometry in the CAD system, RMB the “Geometry” cell and “Update From CAD”. This will update the Mechanical geometry to match the CAD system.

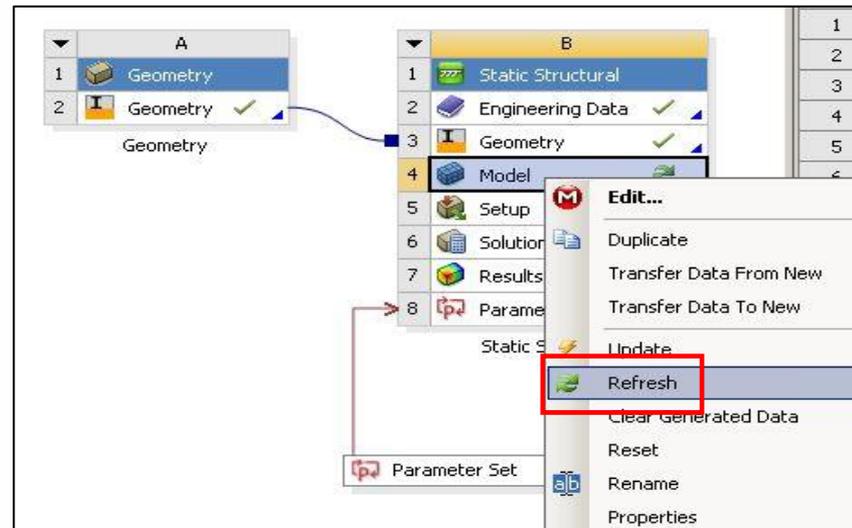


- Update from Workbench:

- Make sure CAD parameter is promoted in Mechanical.
- Modify parameter value in WB Parameter Set.
 - Refresh: causes CAD and Mechanical *geometry* to match new parameter values.
 - Update: causes CAD and Mechanical geometry to update and remesh.



Outline: No data			
	A	B	C
1	ID	Parameter Name	Value
2	Input Parameters		
3	Static Structural (B1)		
4	P1	D5_Overall	10.25
*	New input parameter	New name	New expression
6	Output Parameters		



E. Workshop 12.1

- Workshop 12.1 – Parameter Management
- Goal:

Use the Workbench Parameter Workspace to setup multiple scenarios to explore structural responses in the bracket shown. Material thickness will be varied in the gusset with the bracket thickness held constant then the process will be reversed.

