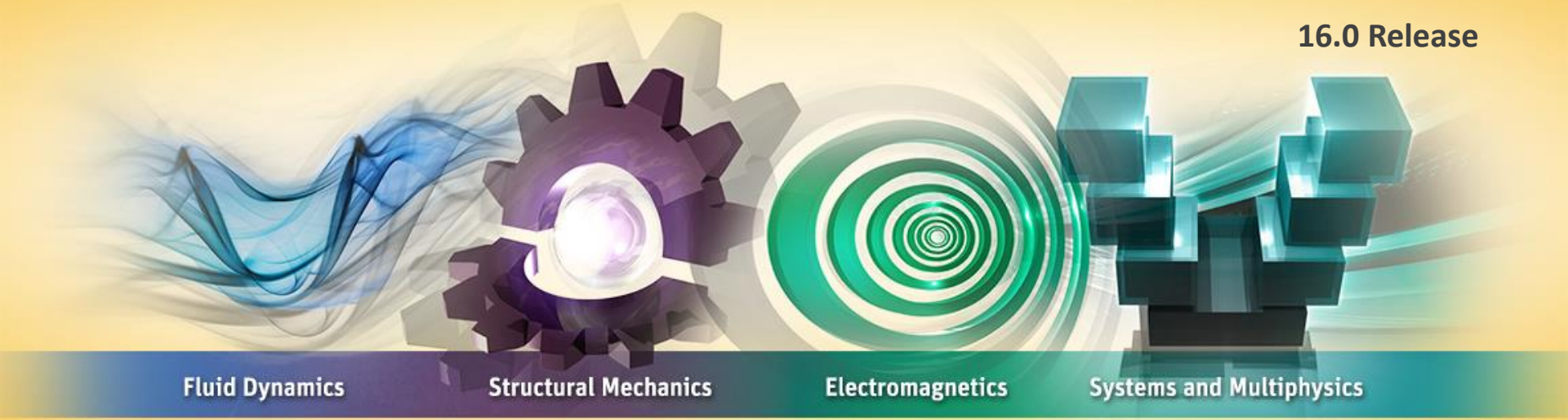
Workshop 5.1
Contact Offset Control

16.0 Release



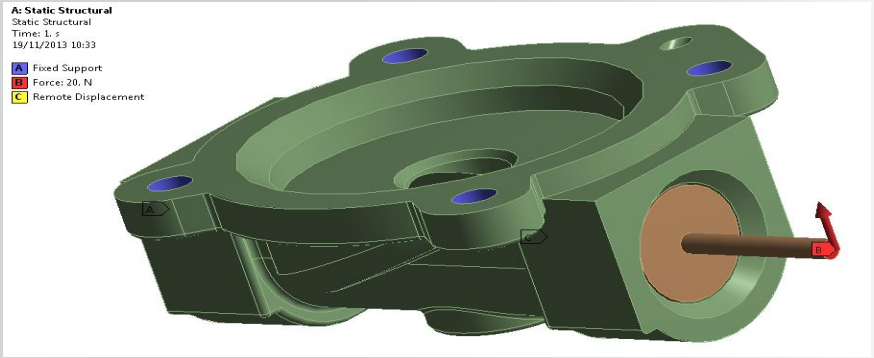
Introduction to ANSYS Mechanical

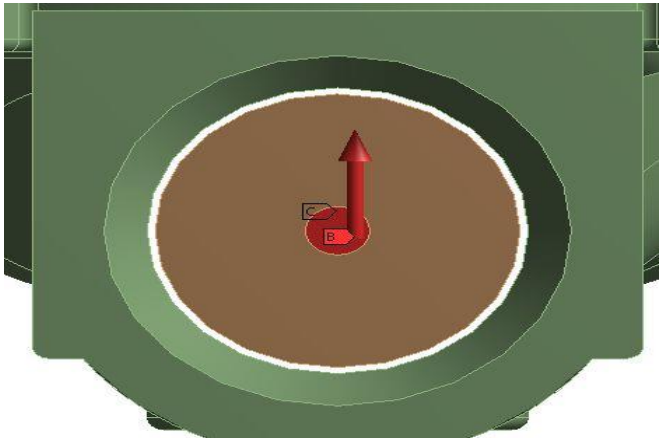
Realize Your Product Promise®

Goals

Problem statement:

- **The model consists of a workbench archive file representing a valve and piston assembly with loads applied (see figure on left).**
- **As the figure on the right shows, a gap exists between the piston and bore (0.39 mm).**
- **Our goal is to:**
  - **Solve the model as is with no interface treatment (results will be non physical).**
  - **Solve the model a second time using an appropriate initial contact offset to close the gap.**

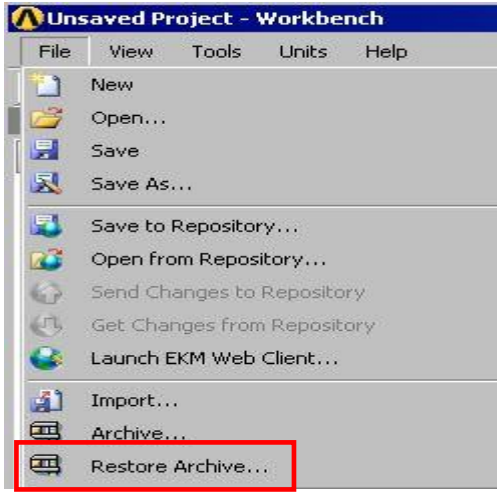


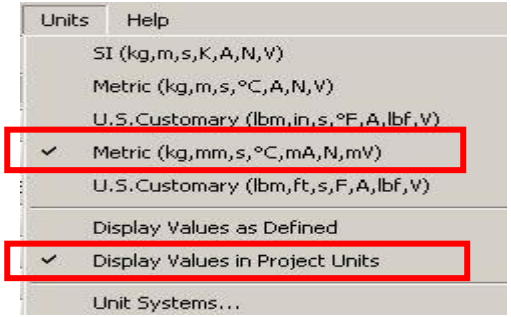


Project Schematic

Begin a new Workbench session and, from the Project page, choose “Restore Archive . . . “ and browse to the file “Contact_Interface.wbpz” and Open (location provided by instructor).

When prompted, “Save” using the default name and the same location.





From the “Units” menu verify:

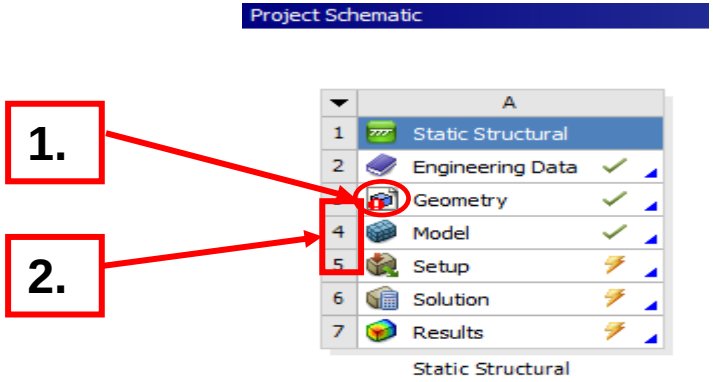
- **Project units are set to “Metric (kg, mm, s, ºC, mA, N, mV).**
- **“Display Values in Project Units” is checked (on).**

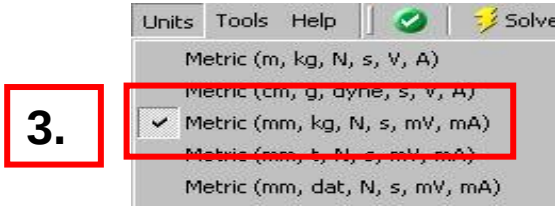
. . . Project Schematic

1. "!" show next to the geometry means that the geometry file is not available and so we can not open it in DesignModeler

2. From the Static Structural system double click (or RMB > Edit) the "Model" cell.

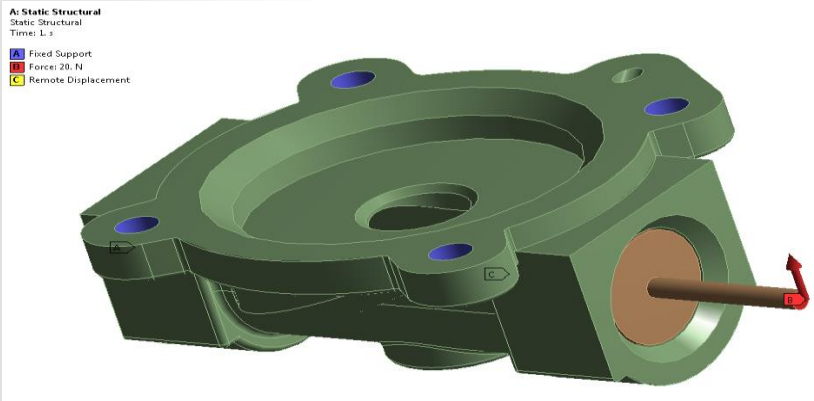
3. When Mechanical opens, verify the units are set to "Metric (mm, kg, s, mV, mA)".





Preprocessing

3. Verify the boundary conditions are set as described here:
   - Force (20N in +Y) applied to the end of the piston shaft.
   - Fixed supports applied to the 4 holes in the valve.
   - Remote displacement applied to the inside face of the piston:
     - X = 0
     - Y = Free
     - Z = 0
     - RotX = 0
     - RotY = 0
     - RotZ = Free



. . . Preprocessing

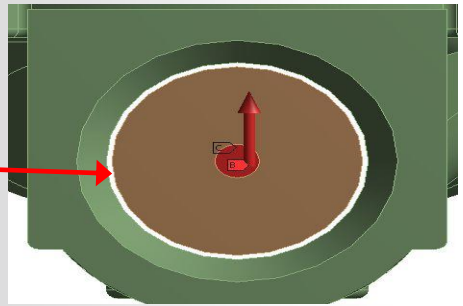
4. Check the current contact settings:
   - Notice the contact type is frictionless and that no offset has been specified in the form of an interface treatment.
   - All other settings are left as default.

Details of "Frictionless - Valve To 1"	
Scope	
Scoping Method	Geometry Selection
Contact	3 Faces
Target	1 Face
Contact Bodies	Valve
Target Bodies	Piston
Definition	
Type	Frictionless
Scope Mode	Automatic
Behavior	Program Controlled
Trim Contact	Program Controlled
Trim Tolerance	0.5 mm
Suppressed	No
Advanced	
Formulation	Program Controlled
Detection Method	Program Controlled
Penetration Tolerance	Program Controlled
Normal Stiffness	Program Controlled
Update Stiffness	Program Controlled
Stabilization Damping Factor	0.
Pinball Region	Program Controlled
Time Step Controls	None
Geometric Modification	
Interface Treatment	Add Offset, No Ramping
Offset	0. mm
Contact Geometry Correction	None

4.

   - Recall that a 0.39 mm gap exists between the piston and valve. With the boundary conditions as set, we should expect the piston to be initially free as the force is applied.

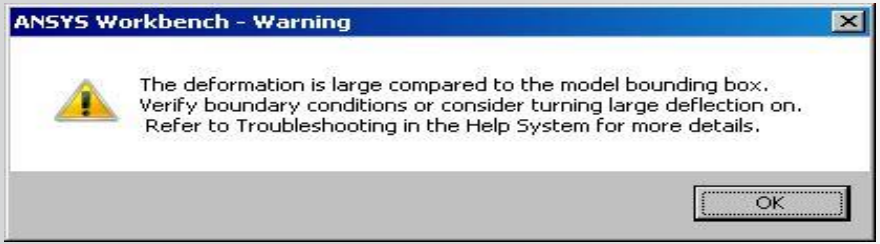
0.39 mm Gap

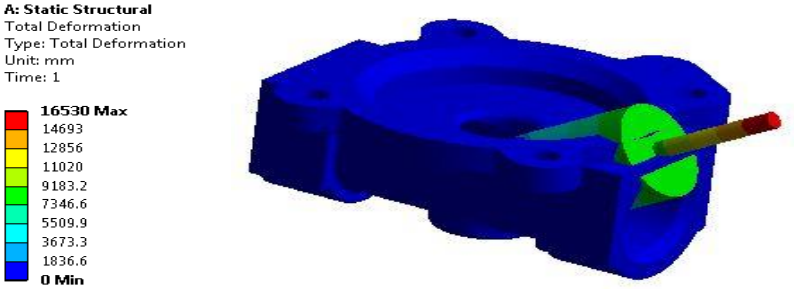


Solution

5. **Solve the model:**

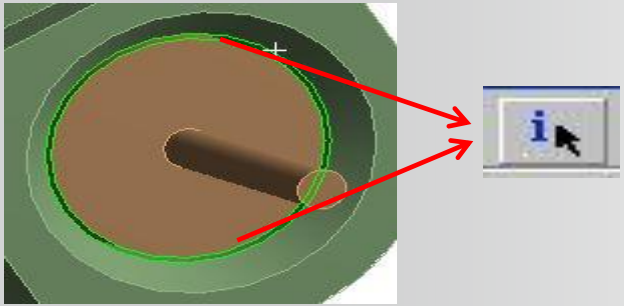
- When the solution completes, go to Solution information in the tree. A message should indicate possible rigid body motion has occurred.
- A quick check of the magnitude of total deformation should confirm the message.
- A magnified deformation shows the 2 parts have separated as expected.





Background

- **Background: how would we find the size of the gap?**
  - **One method is to select the circular lines for the piston and the bore and request the "Selection Information".**



Selection Information

Coordinate System: Global Coordinate System | Show Individual and Summary

Entity	Length (mm)	Centroid X(mm)	Centroid Y(mm)	Centroid Z(mm)	Body	Type	Radius (mm)
2 Edges, Summary	109.26	29.75	-18.097	.2194e-0:			
Edge 1	53.407	29.75	-18.098	.3621e-0:	Piston	Circle	8.5
Edge 2	55.858	29.75	-18.097	.083e-01	Valve	Circle	8.89

  - **From the information panel we can see 8.89 – 8.5 = 0.39 mm gap.**

. . . Background

- **Background: how would we find the size of the gap?**
  - **A second method is to insert the Contact Tool at the Connections branch and "Generate Initial Contact Results".**

  - **The initial information shows a Gap of 0.3851 mm.**

Initial Information

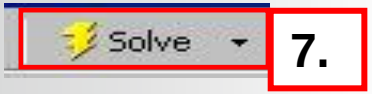
For additional options, please visit the context menu for this table (right mouse button)

Name	Contact Side	Type	Status	Number Contacting	Penetration (mm)	Gap (mm)	G
Frictionless - Valve To 1	Contact	Frictionless	Near Open	0.	0.	0.3851	0
Frictionless - Valve To 1	Target	Frictionless	Inactive	N/A	N/A	N/A	N

Preprocessing

To address the gap in the contact return to the contact details:

6. **In the "Offset" field enter 0.39.**
   - **Verify the Interface Treatment is set to "Add Offset, No Ramping".**
7. **Re-solve the model.**
   - **The model should solve in several iterations.**



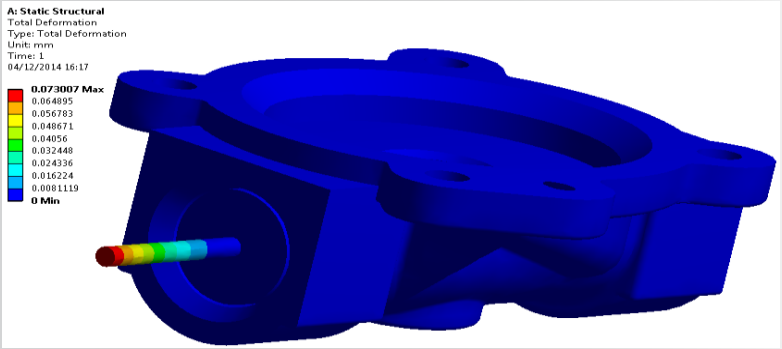
Details of "Frictionless - Valve To Piston"

Scope	
Scoping Method	Geometry Selection
Contact	3 Faces
Target	1 Face
Contact Bodies	Valve
Target Bodies	Piston
Definition	
Type	Frictionless
Scope Mode	Automatic
Behavior	Program Controlled
Trim Contact	Program Controlled
Trim Tolerance	0.5 mm
Suppressed	No
Advanced	
Formulation	Program Controlled
Detection Method	Program Controlled
Penetration Tolerance	Program Controlled
Normal Stiffness	Program Controlled
Update Stiffness	Program Controlled
Stabilization Damping Factor	0.
Pinball Region	Program Controlled
Time Step Controls	None
Geometric Modification	
Interface Treatment	Add Offset, No Ramping
Offset	0.39 mm
Contact Geometry Correction	None
Target Geometry Correction	None

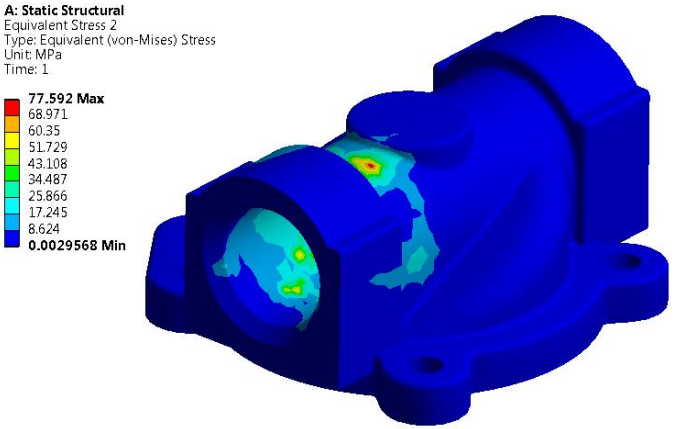
6.

Postprocessing

8. The deformation and stress results now appear to be reasonable.



Total Deformation

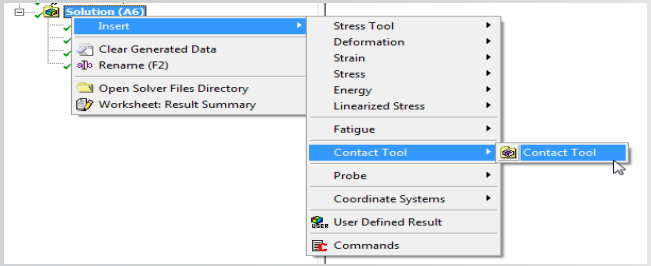


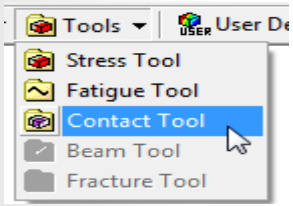
Equivalent Stress on the valve

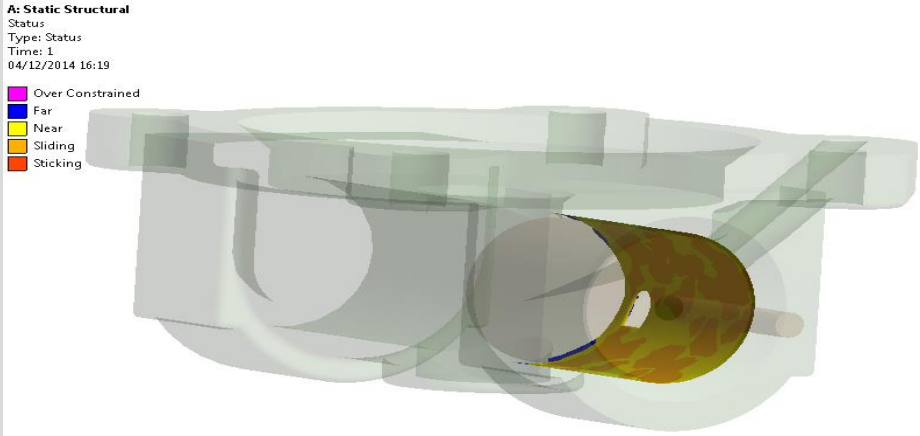
. . . Postprocessing

9. **Insert the Contact Tool into the Solution branch.**

- **Check the Contact Status to verify contact has been maintained.**







Conclusions

Notes:

- **The initial solution verified that rigid body motion was occurring when we tried to apply a force to parts which were separated by an initial gap.**
- **We were able to determine the gap size using 2 different methods in order to determine how to address the contact problem.**
- **With the gap size verified, we input an initial offset at the contact, effectively closing the gap.**

Go Further!

- In the first configuration (Add offset = 0), apply a displacement instead of the force. Why does the calculation not diverge ?
- In the first configuration (Add offset = 0), change the Interface Treatment to “Adjust to Touch”. Is there a difference between this configuration and adding an offset of 0.39mm ?