EN1740 Computer Aided Visualization and Design

Spring 2012

4/17/2012 – Lecture A

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Last Time:

- Group Project Overview
- Tolerance Analysis
  - CETOL
- Intro to GD&T

Tonight:

- Intro to GD&T
- Motion analysis with Pro/E

Geometric Dimensioning and Tolerancing (GD&T)

Position tolerance requires Datums, Basic Dim’s and Tolerance

Fig. 8-7 & 8-8, B. A. Wilson, GD&T App. And Intr., 2010

Datums establish how to measure the part, ***Basic dimensions*** state theoretical location & ***Position Tolerances*** state allowances

Geometric Dimensioning and Tolerancing (GD&T)

Principal Advantage

• Key advantages of position tolerances:

- *Clarity – Part is located and removes ambiguity*
- *Increase tolerance zone*
- *Bonus tolerances from material modifiers*
- *Go/No-Go Gaging*

Fig. 8-23, B. A. Wilson, GD&T App. And Intr., 2010

Fig. 8-24, B. A. Wilson, GD&T App. And Intr., 2010

Geometric Dimensioning and Tolerancing (GD&T)

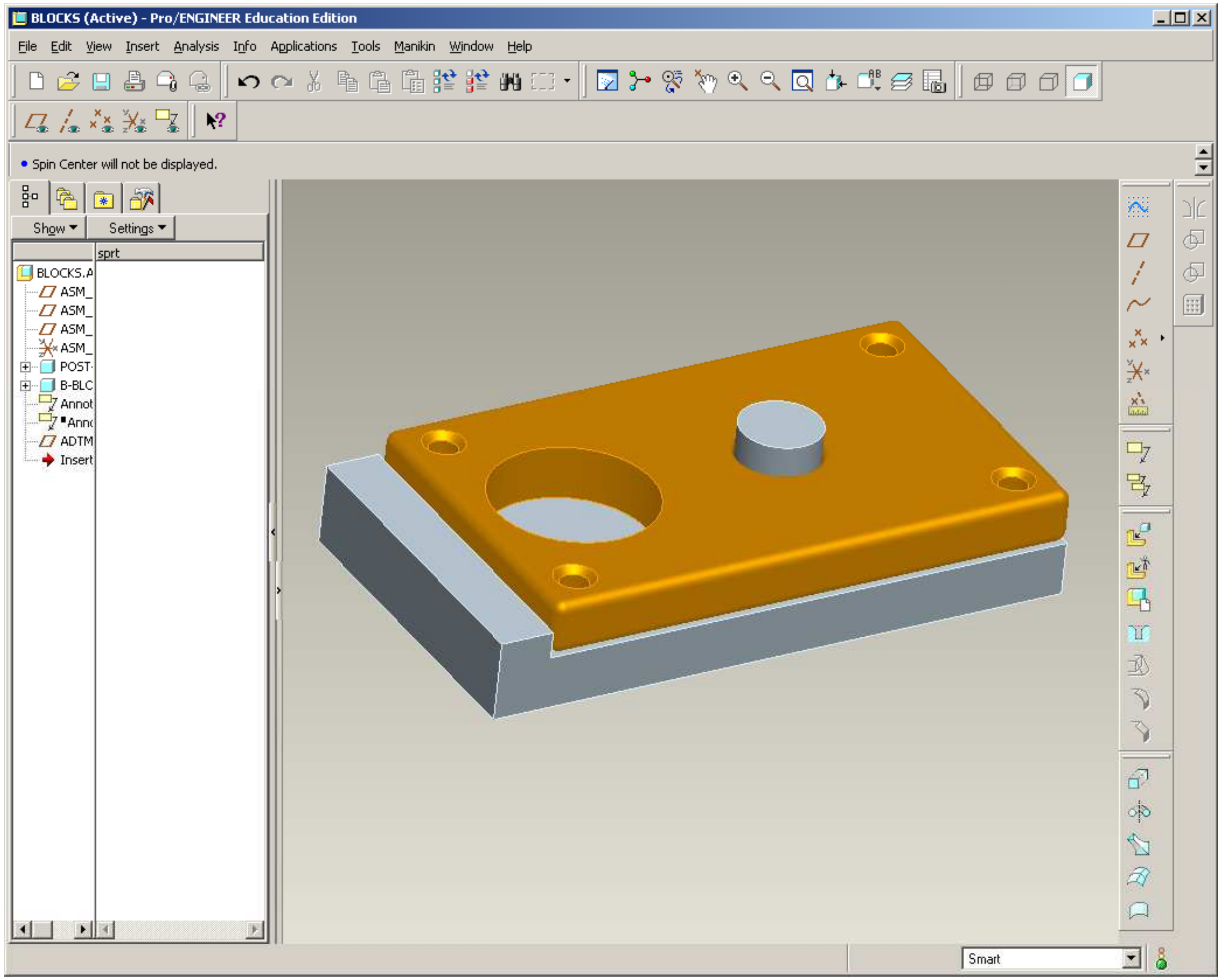
Example

Fig. 8-1, B. A. Wilson, GD&T App. And Intr., 2010

EXERCISE - Design Tolerance Analysis

Tolerance study with GD&T

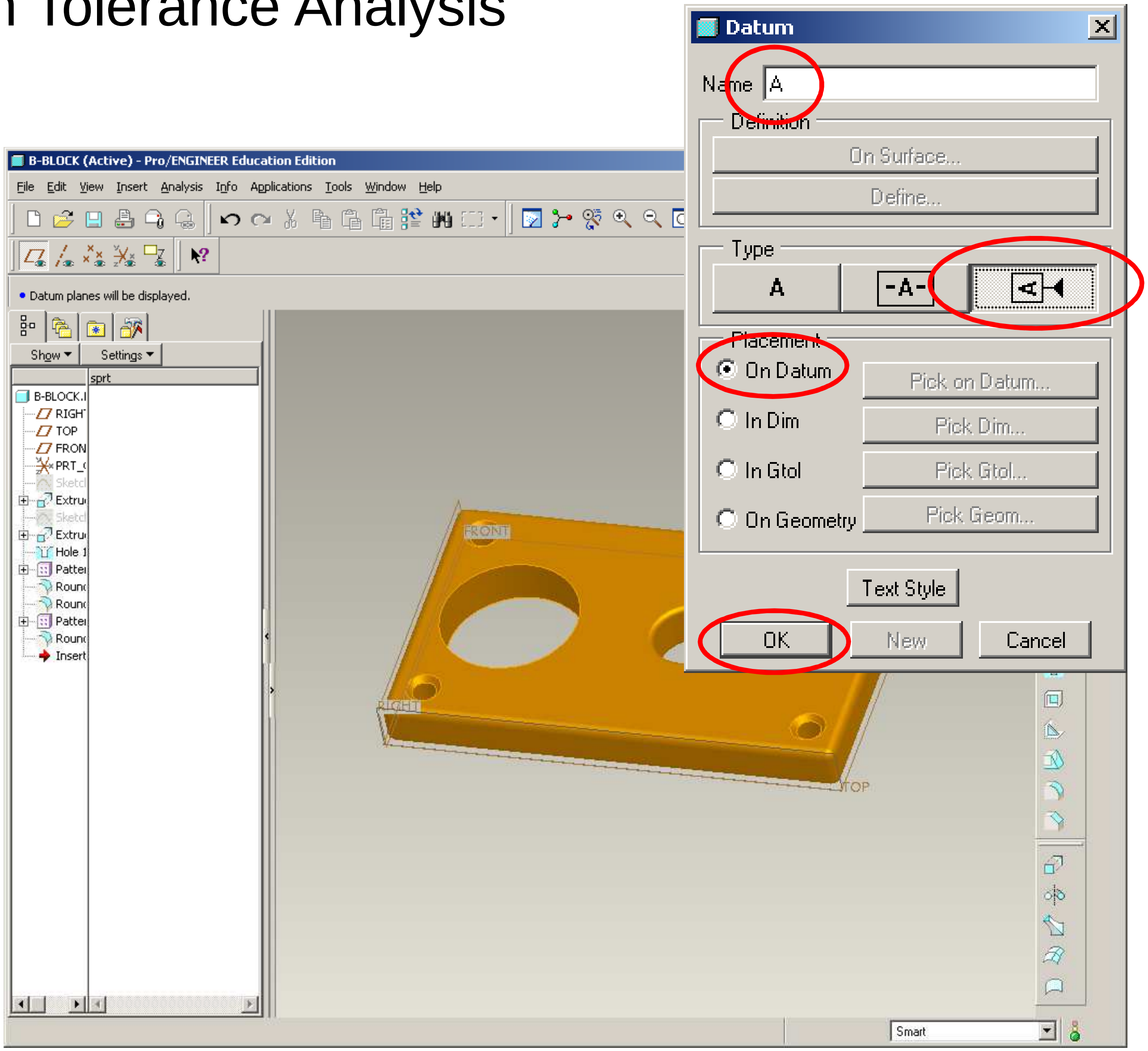
- Get tol_blocks.zip from Supporting Materials page
- Open blocks.asm
- Apply position tol's to hole and pin
- Analyze affect of tolerance on gap between plate and block



EXERCISE - Design Tolerance Analysis

Set Datums

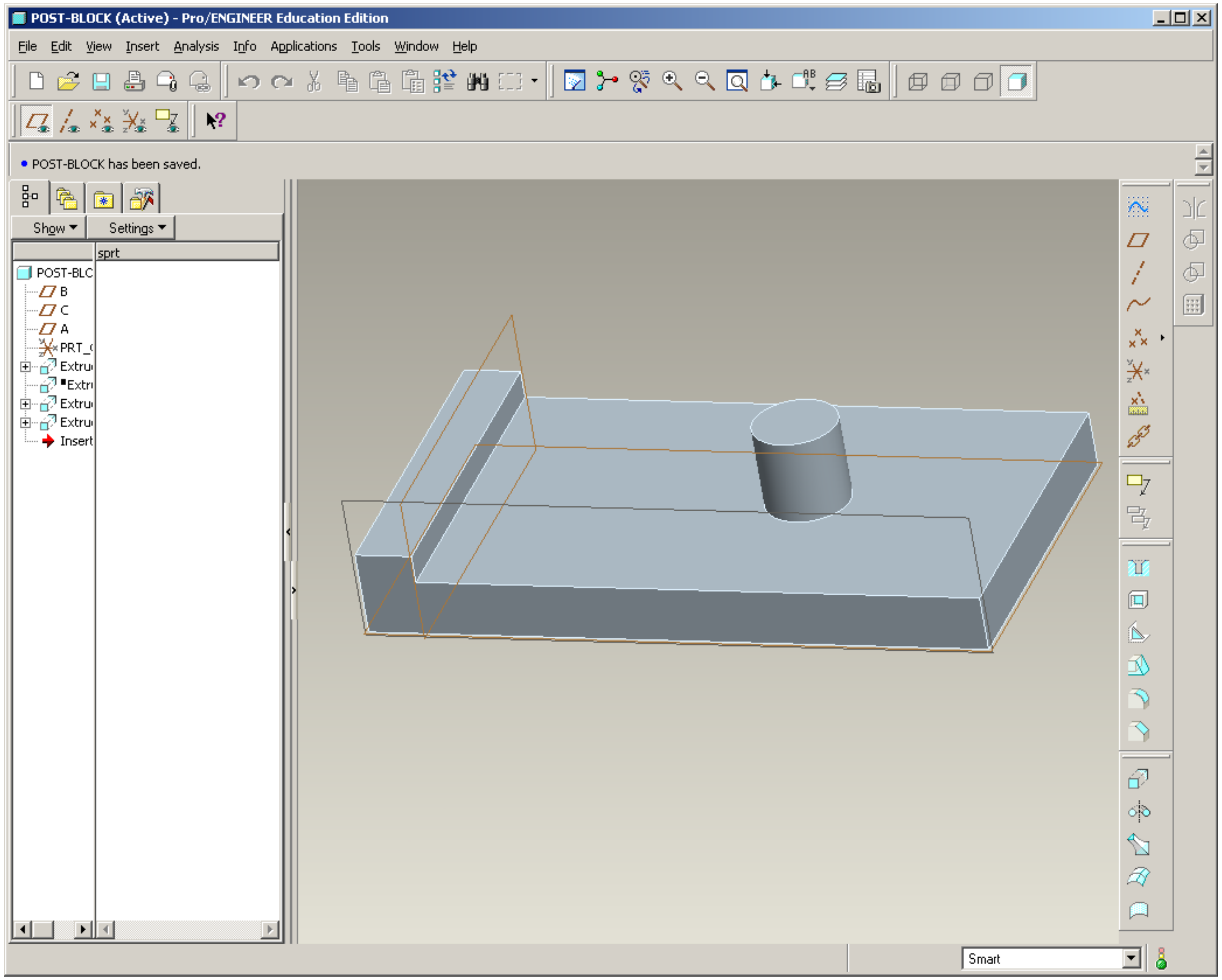
- This will establish the datum feature references
- Set FRONT datum as A (Primary datum)
    - Select FRONT
    - RMB > Properties
    - Change name to A
    - Select last type
    - Placement > On Datum
    - OK
- Repeat setting RIGHT as B and TOP as C



EXERCISE - Design Tolerance Analysis

Set Datums

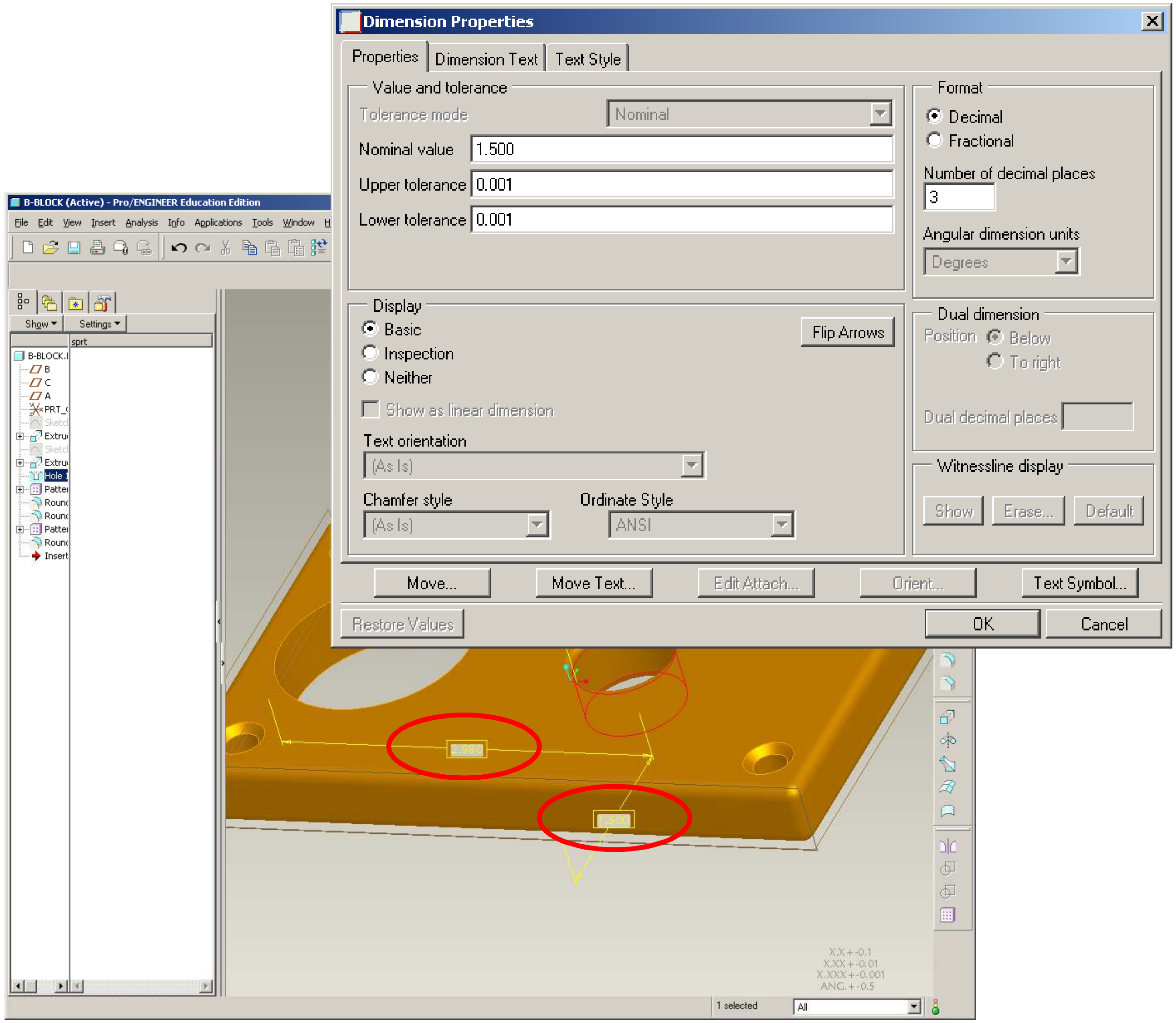
- Repeat for other post-block.prt
    - Set FRONT as A
    - Set RIGHT as B
    - Set TOP as C



EXERCISE - Design Tolerance Analysis

Set Basic Dimensions

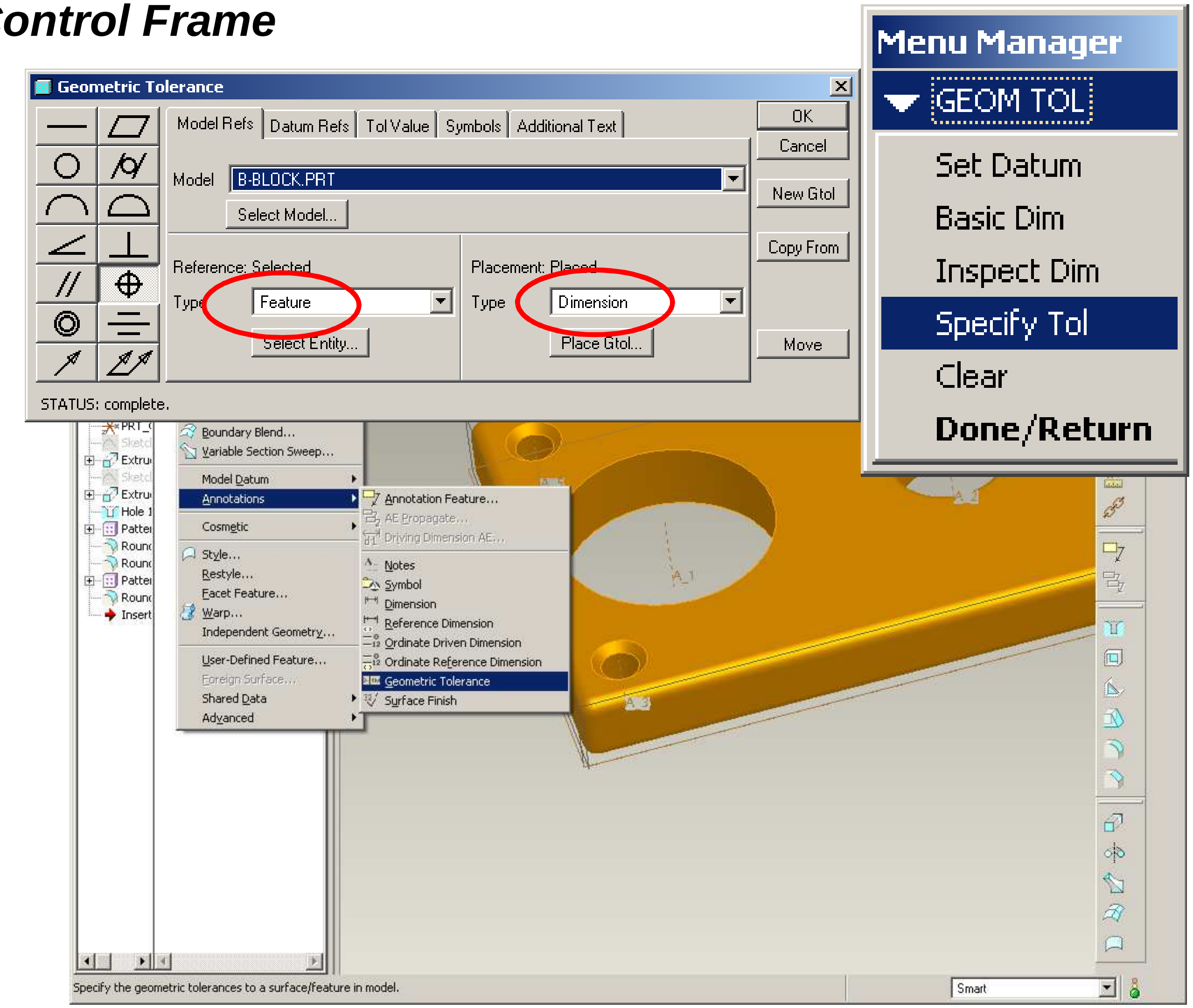
- Set the dimensions that locate the hole as Basic on B-BLOCK.prt
- Repeat for post on POST-BLOCK.prt



EXERCISE - Design Tolerance Analysis

Create GD&T Feature Control Frame

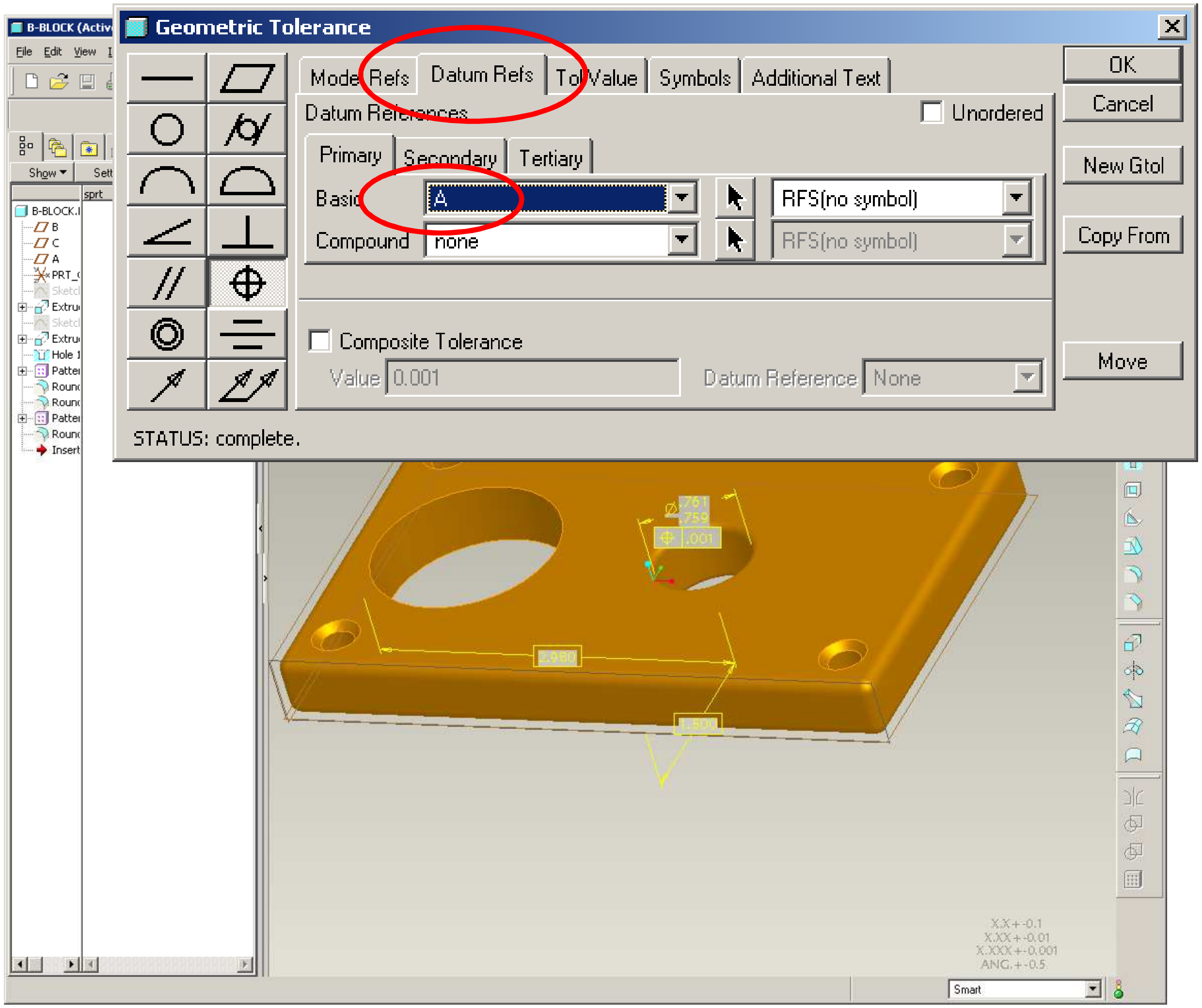
- Create a position tolerance for the hole on B-BLOCK.prt
    - Insert > Annotation > Geometric Tolerance
- Click Specify Tol from Menu Manager
- From Type pick Feature, Select hole
- From Placement pick dimension and select the hole diameter



EXERCISE - Design Tolerance Analysis

Create GD&T Feature Control Frame

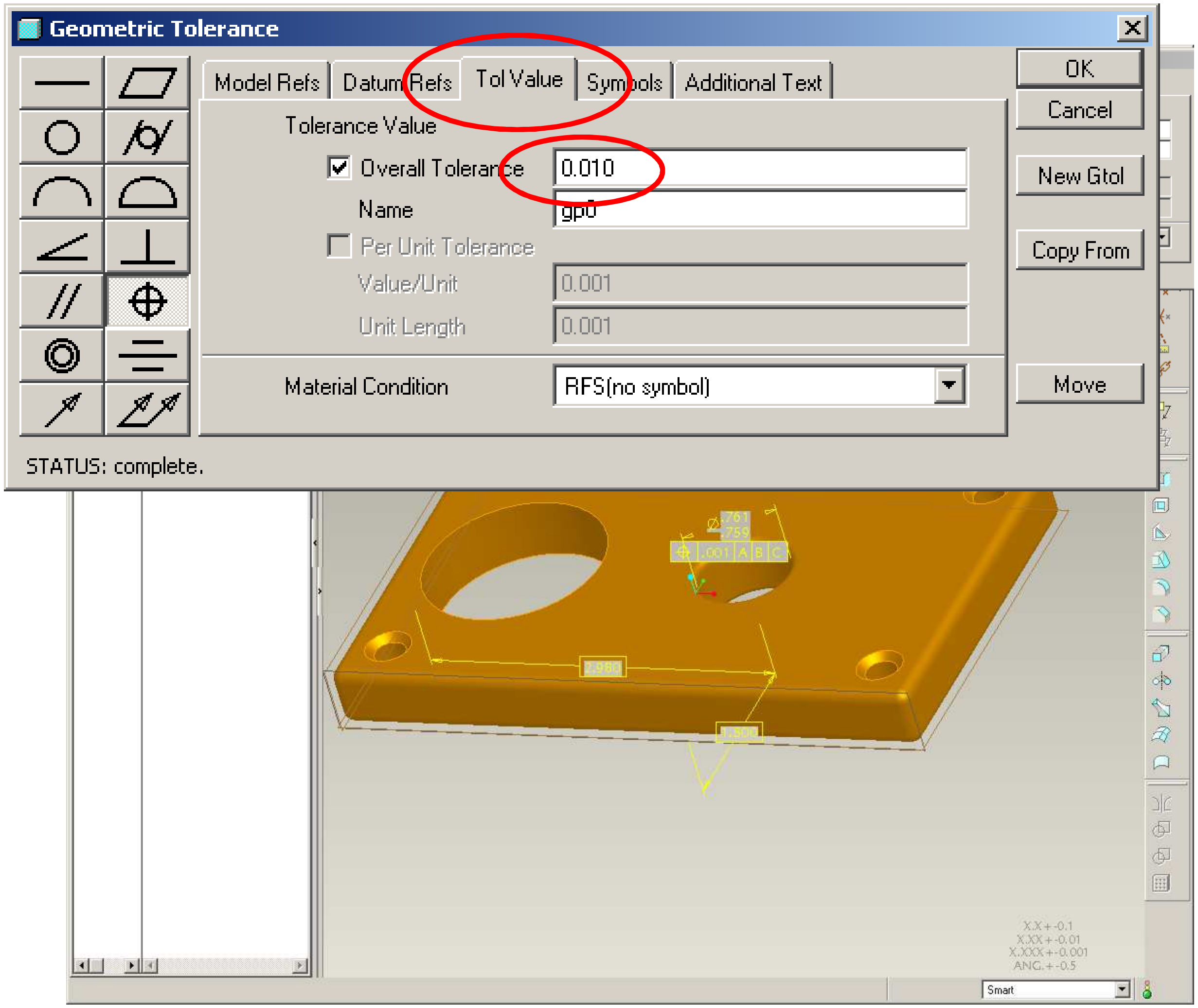
- Set the datum references for the position tolerance
  - A as primary
  - B as secondary
  - C as tertiary



EXERCISE - Design Tolerance Analysis

Create GD&T Feature Control Frame

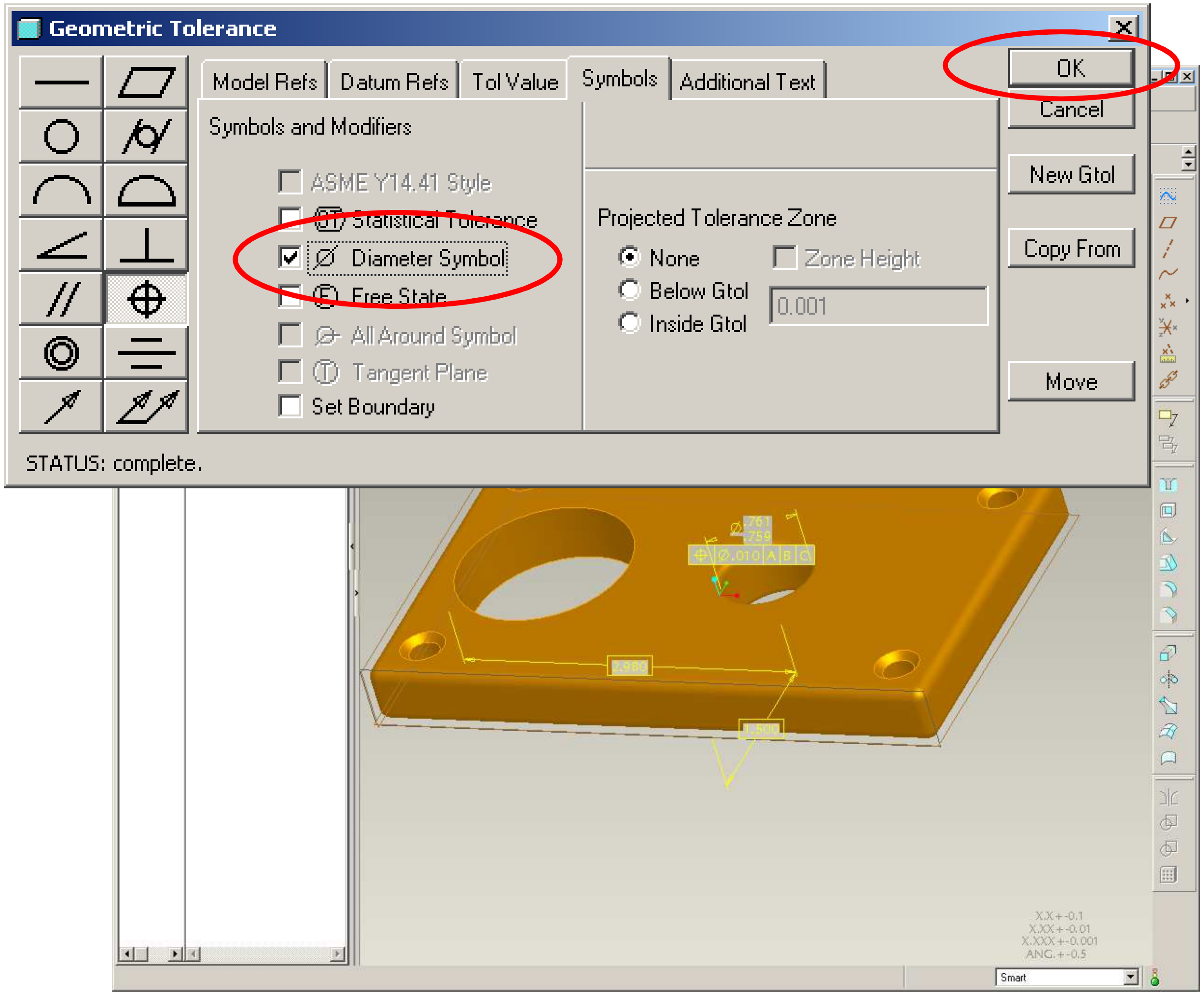
- Set tolerance value to .010



EXERCISE - Design Tolerance Analysis

Create GD&T Feature Control Frame

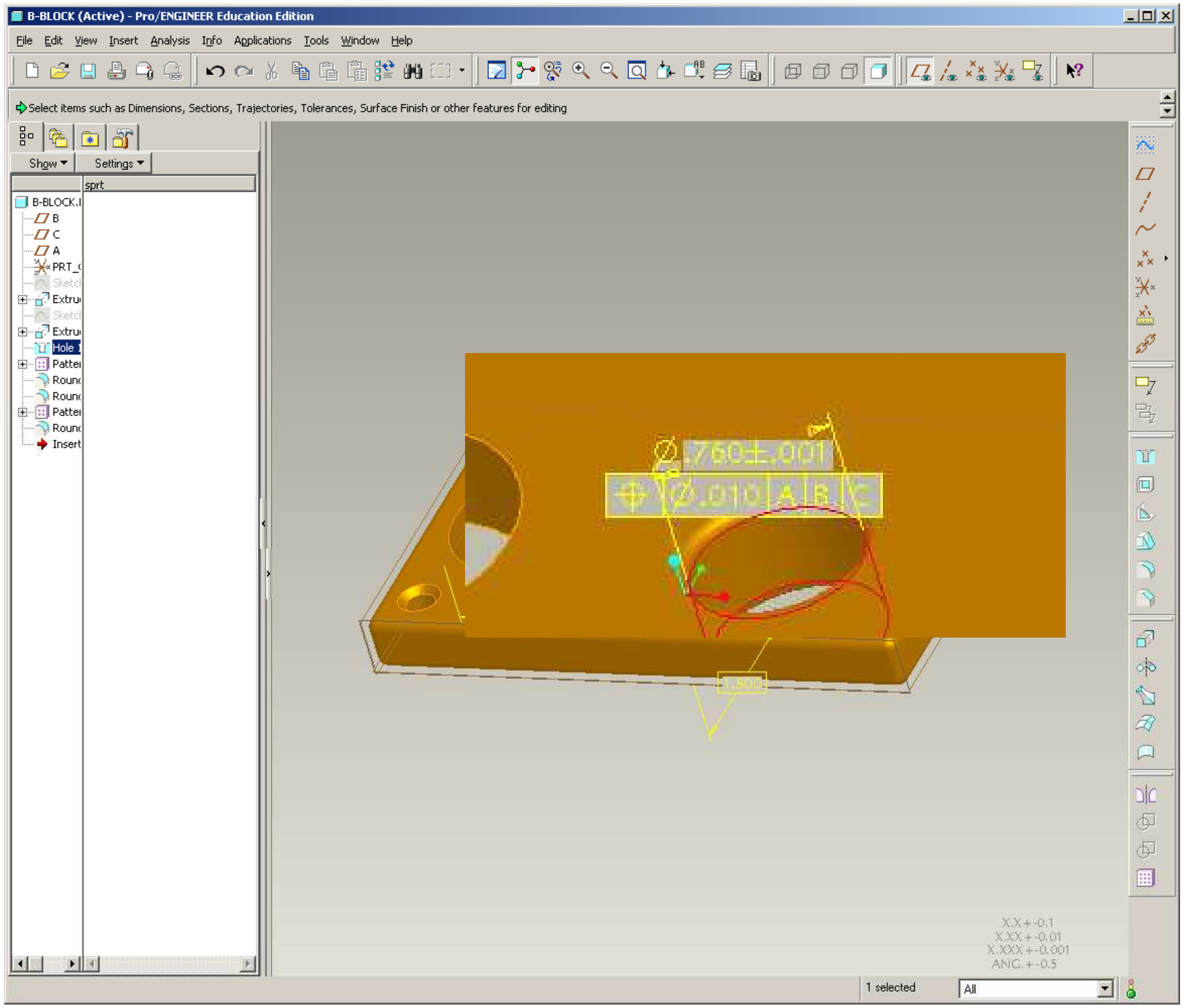
- Turn on the diameter symbol
- Click OK
- Done Return



EXERCISE - Design Tolerance Analysis

Finish Tolerance

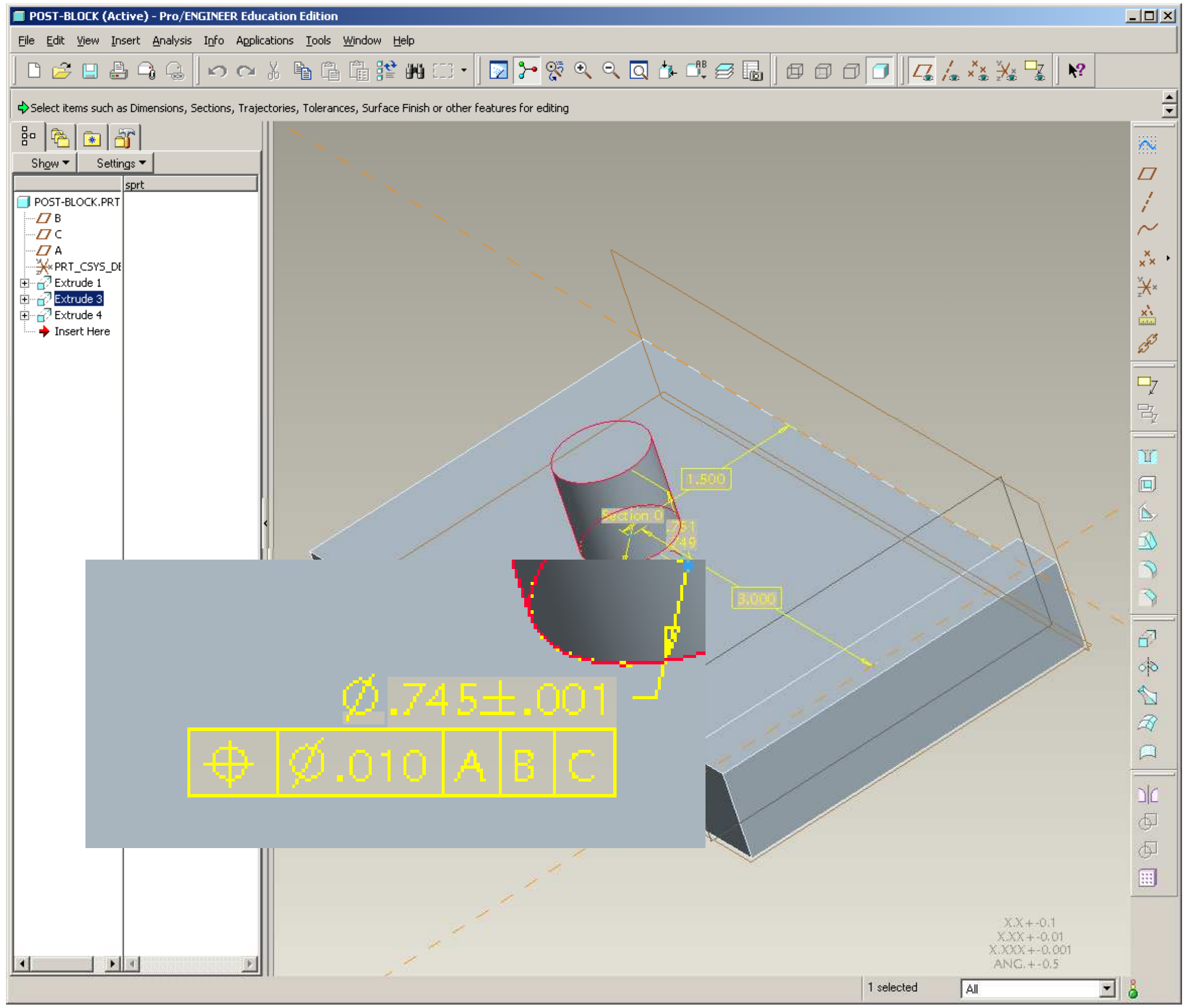
- Change the tolerance type on the dimension to symmetric
- The dimension should appear as shown



EXERCISE - Design Tolerance Analysis

One more time…

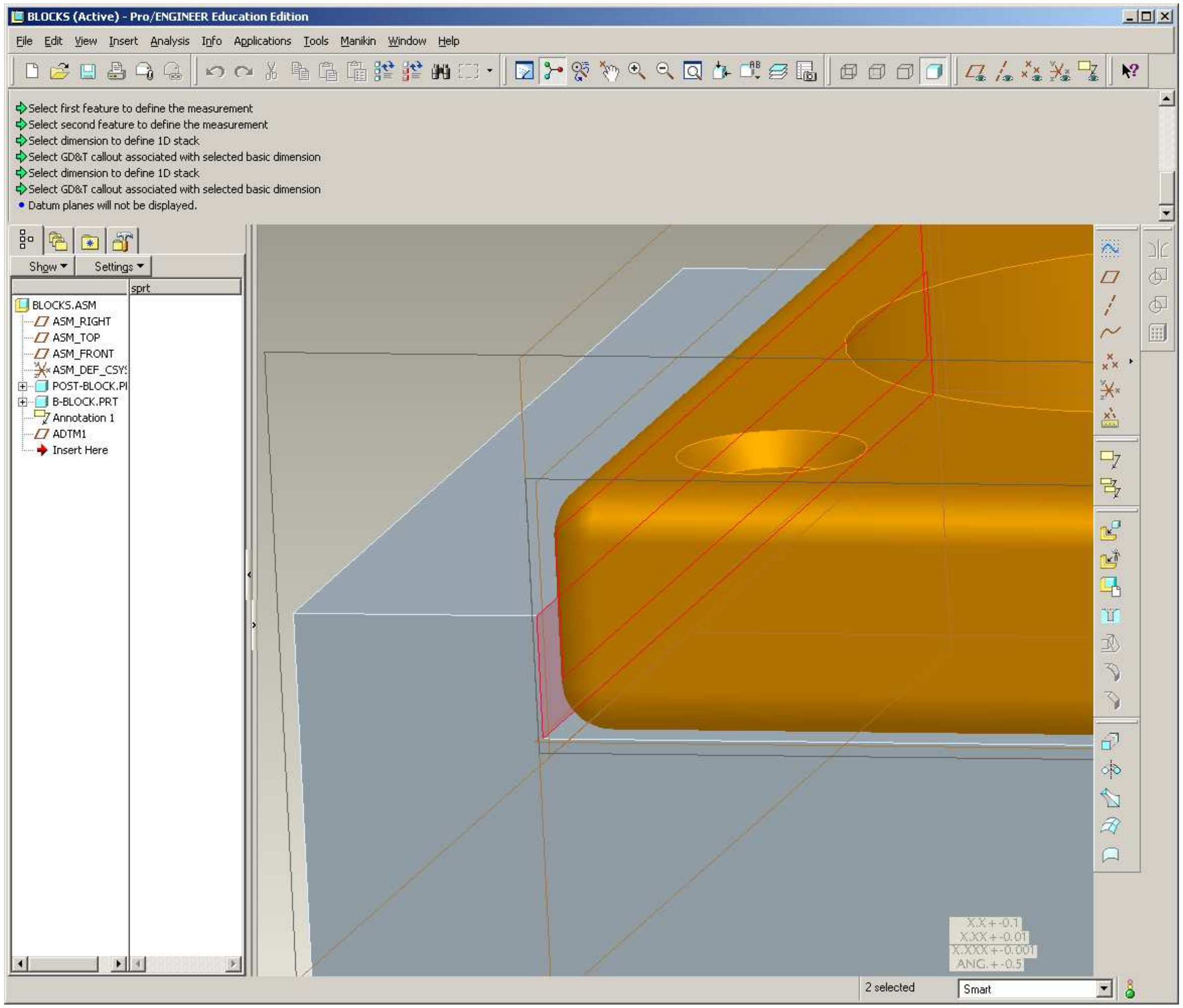
- Repeat the process of setting a position tolerance for the mating feature on post-block.prt



EXERCISE - Design Tolerance Analysis

Analyze gap between edges

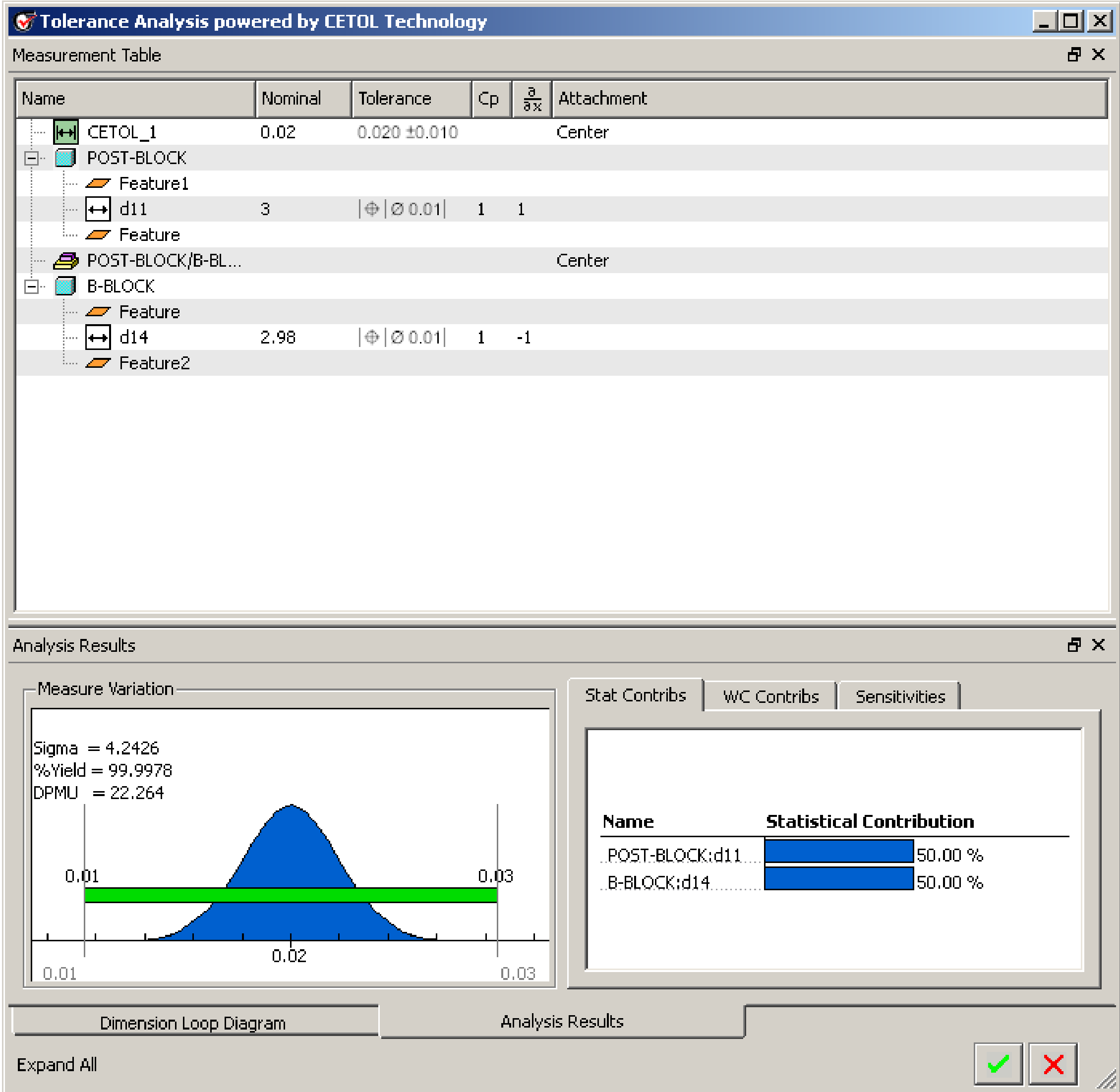
- Start a new CETOL analysis (Analysis > CETOL)
- Select horizontal basic dimension and position tolerance from each component
- MMB when done



EXERCISE - Design Tolerance Analysis

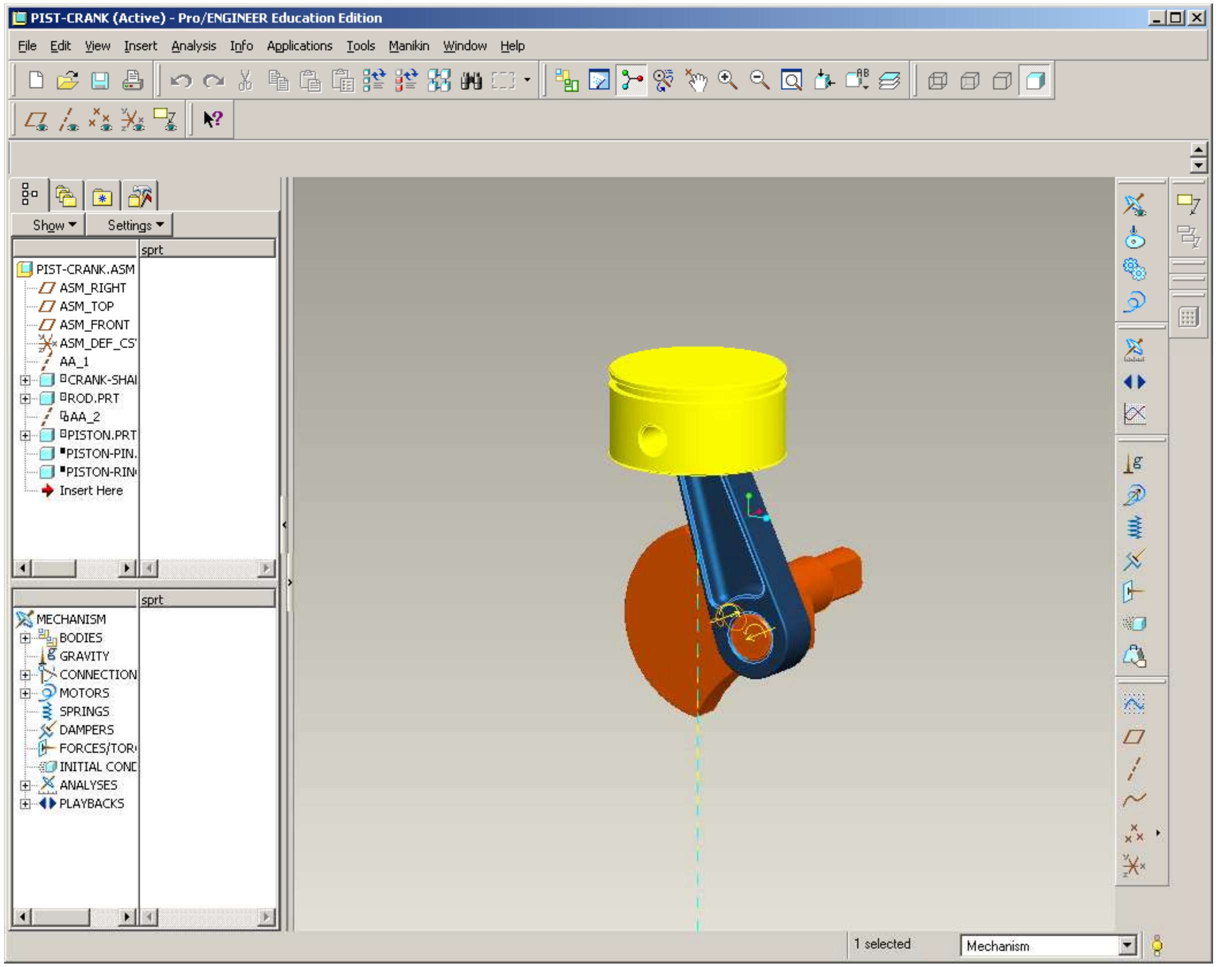
Analyze gap between edges

• Take a look at the results for the default design objective of $\underline{+}$.010



Motion Analysis

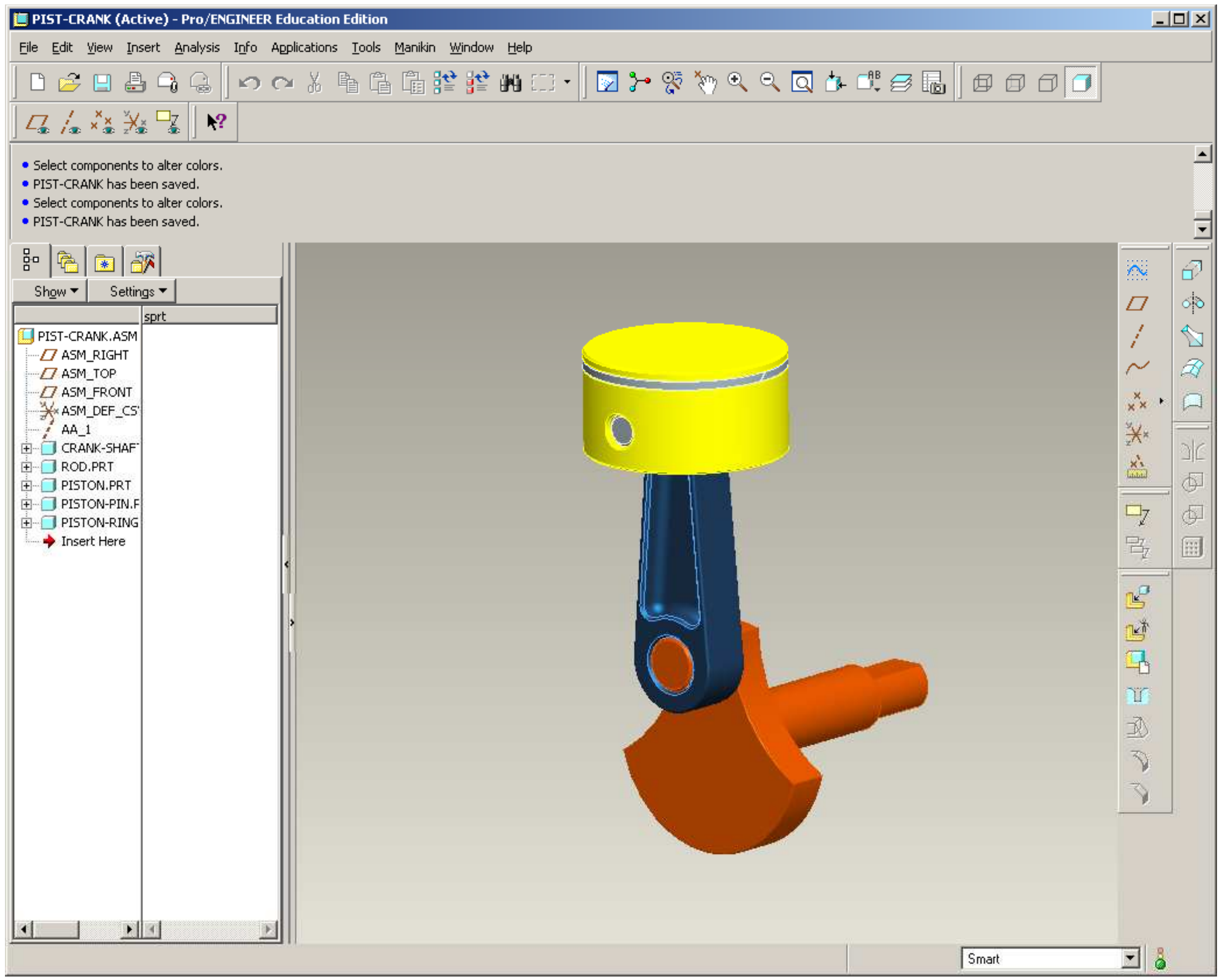
- Using capabilities in Pro/E we can:
  - Visualize mechanism motion
  - Analyze kinematic results
  - Export animation of mechanism



EXERCISE - Motion Analysis

Open the assembly

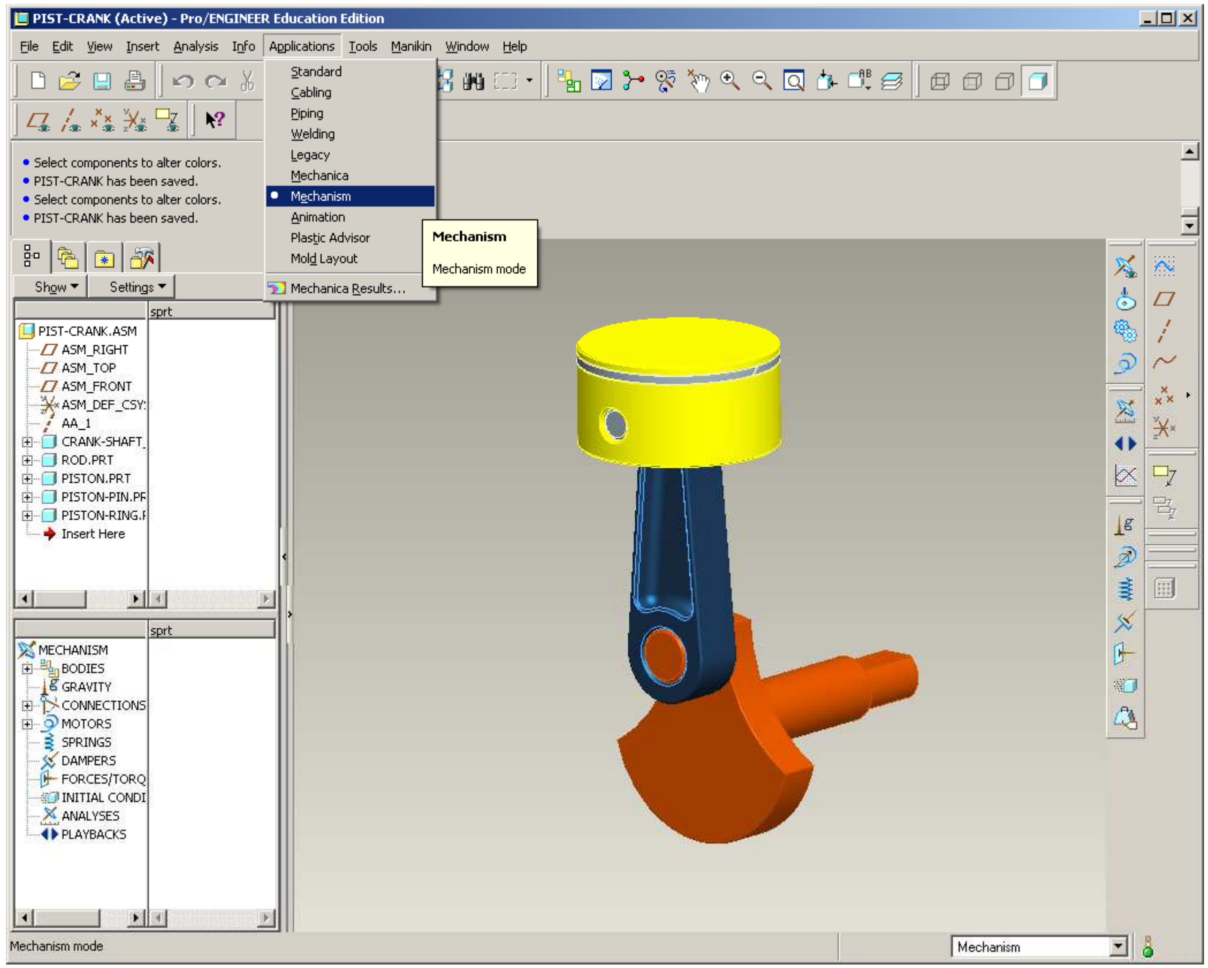
- Download pist-crank.asm from the Supporting Materials page of the web site
- Open the assembly



EXERCISE - Motion Analysis

Switch to the Mechanism Application

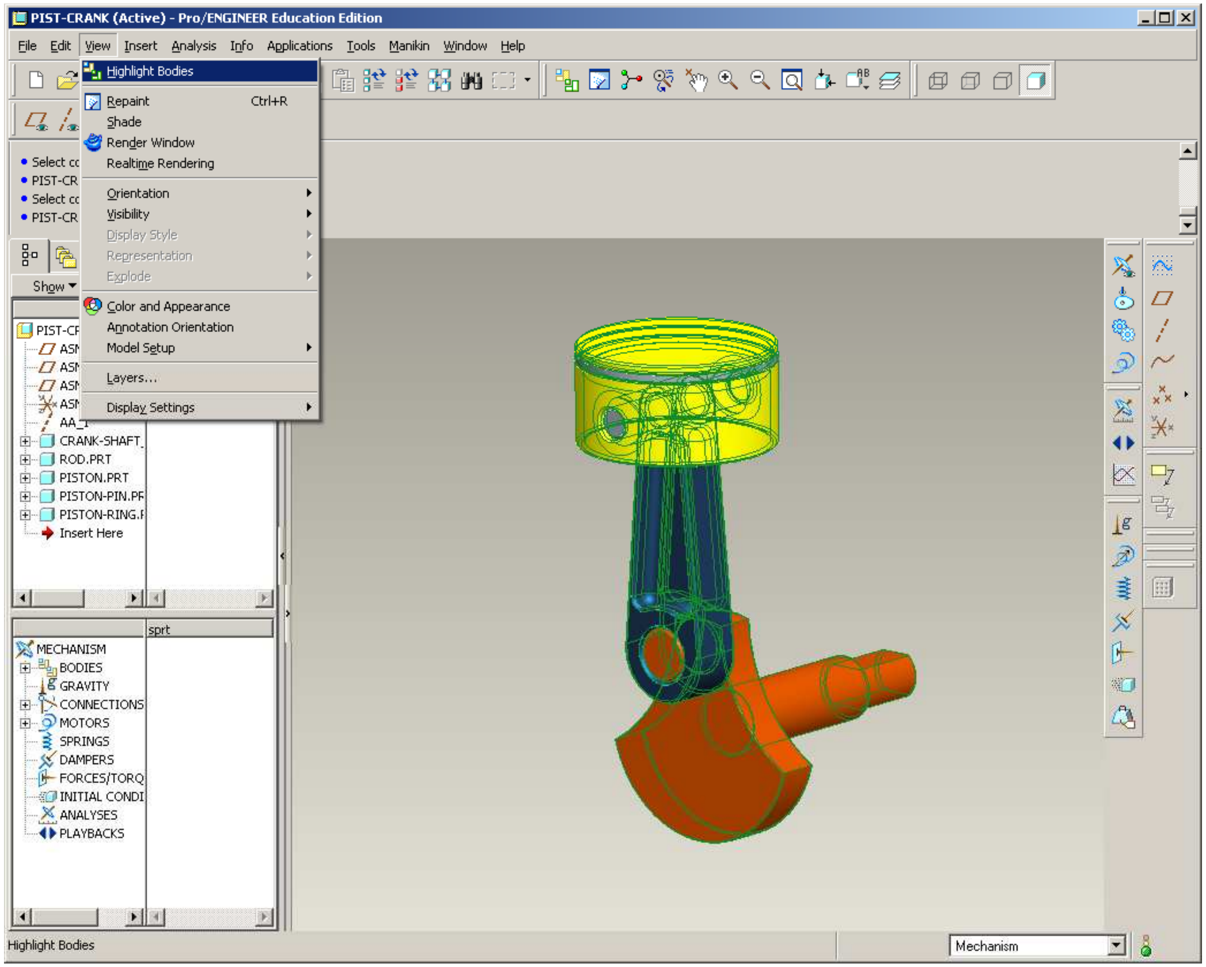
- Applications > Mechanism



EXERCISE - Motion Analysis

Examine current constraints

- View > Highlight Bodies
  - Green highlighting means a body is grounded (has no available DOF's)
  - Other colors are not significant except to differentiate bodies
  - There are a finite number of colors available…may repeat if necessary
- ***Need to "un-ground" the components to allow motion***

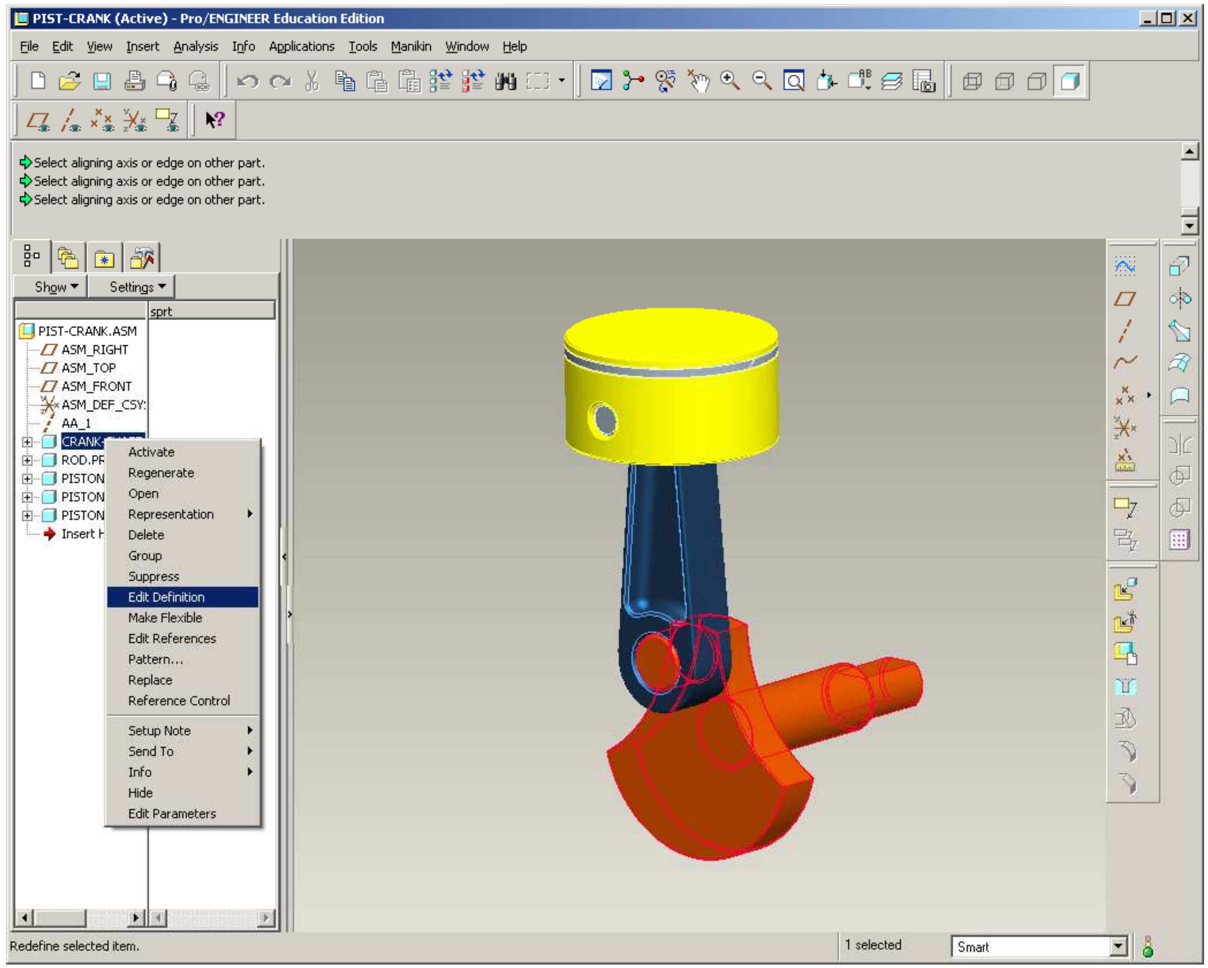


EXERCISE - Motion Analysis

Redefine model constraints

- Switch back to the Standard Application
- We will need to Edit Definition for each component in the assembly
- Start with:

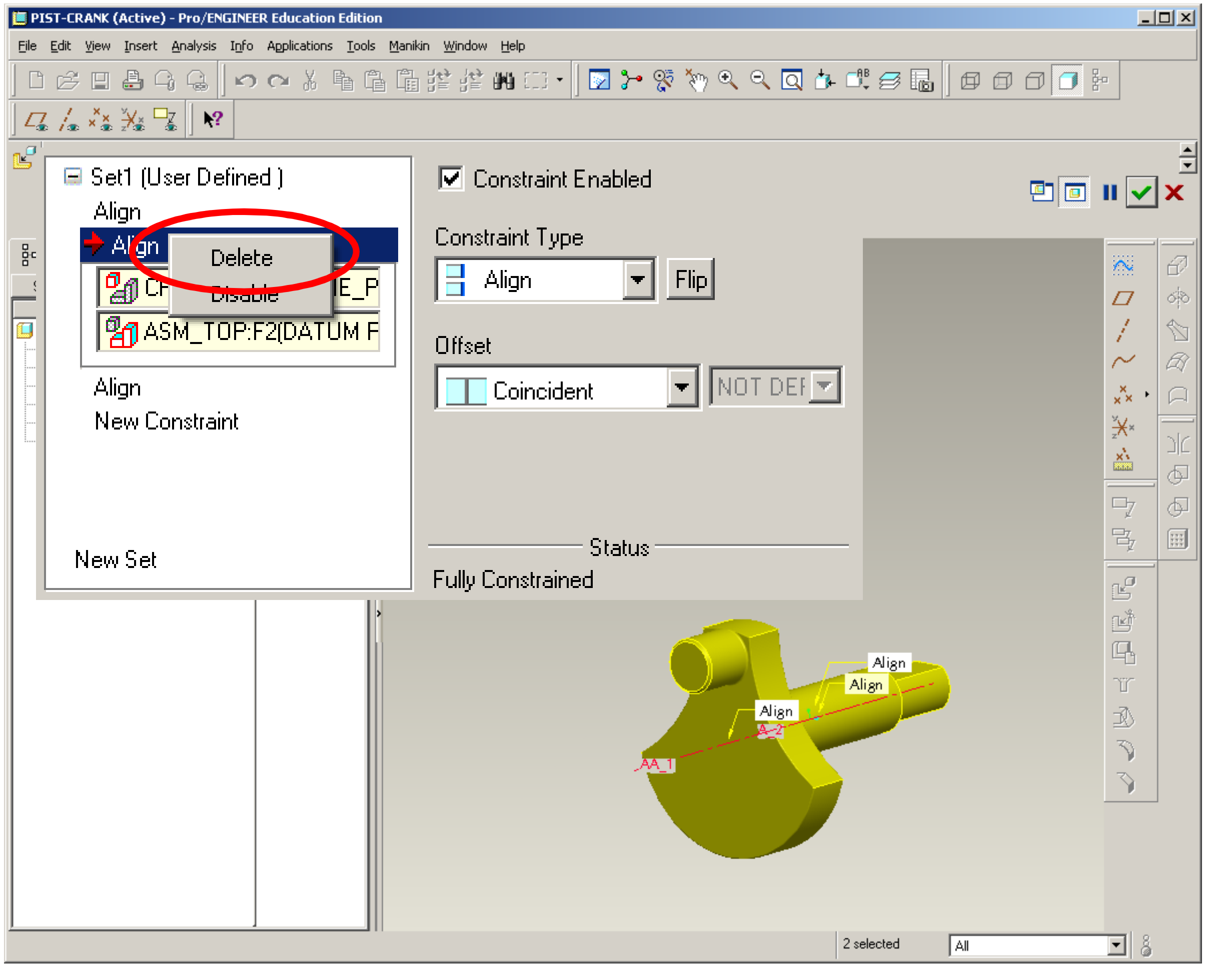
crank-shaft_one_pist.prt



EXERCISE - Motion Analysis

Redefine model constraints

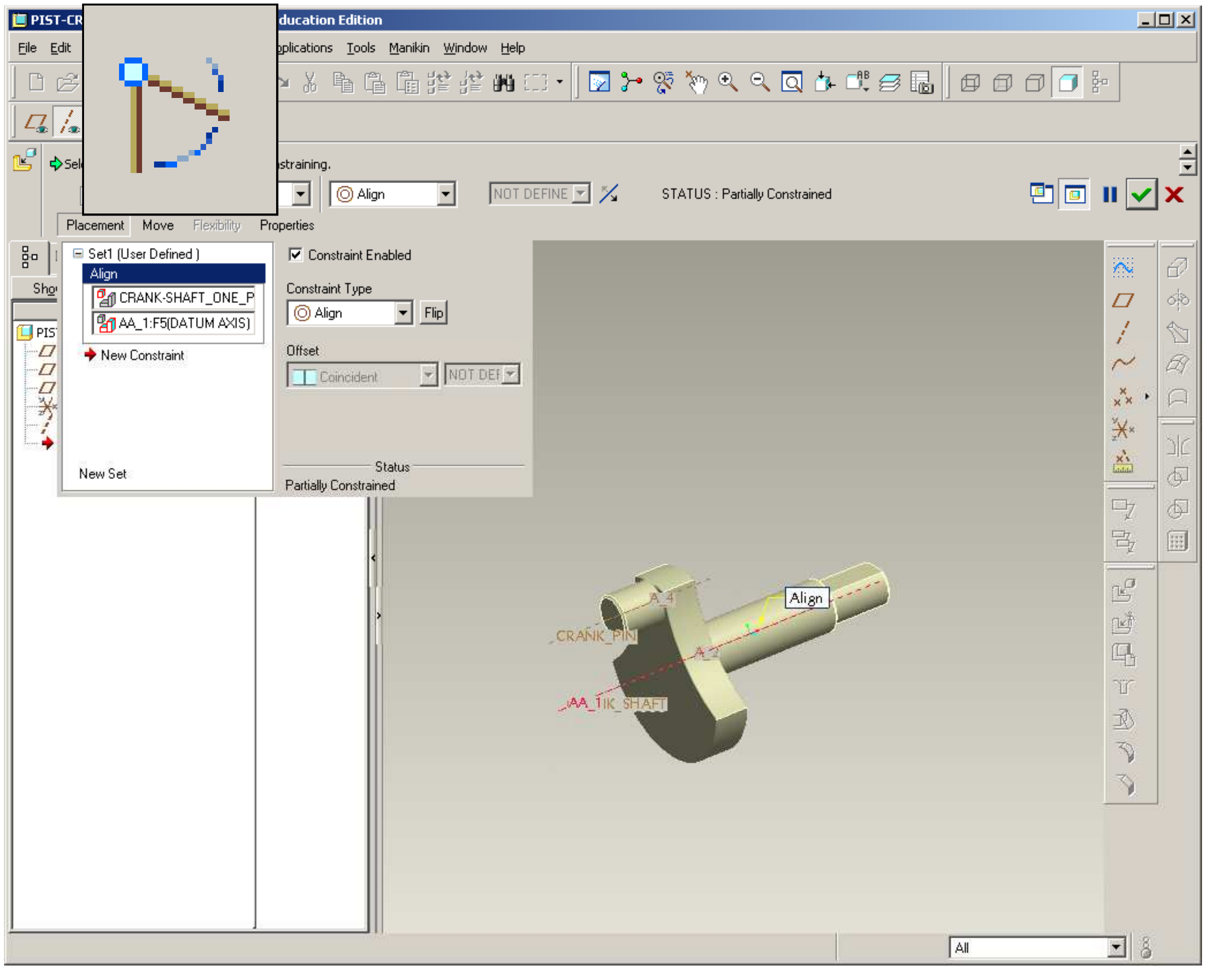
- Examine the constraints currently applied:
    - The first constraint aligns the center axis
    - The next two align planes
- Delete the two planar constraints
    - Select constraint > RMB > Delete



EXERCISE - Motion Analysis

Redefine model constraints

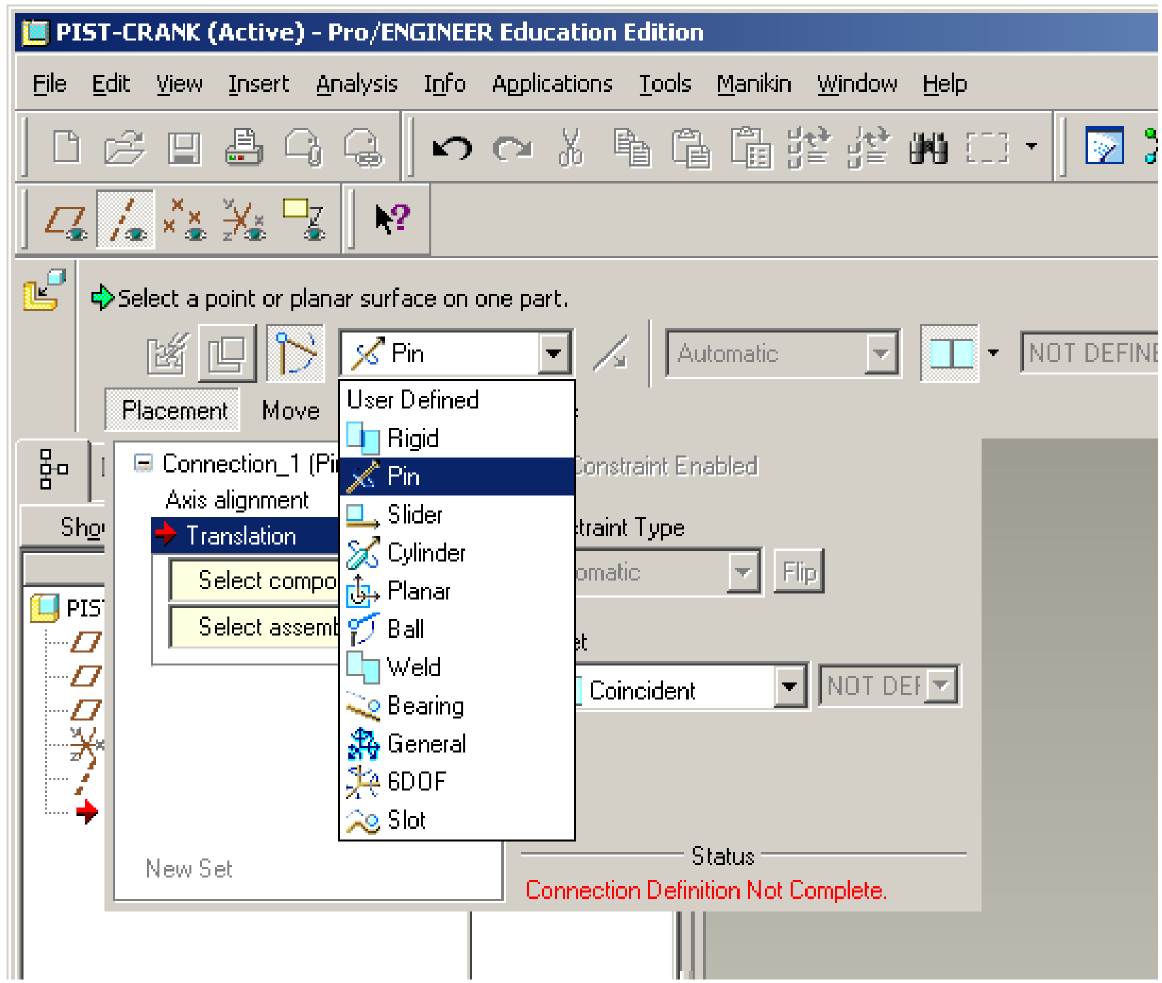
- With just the axis alignment constraint remaining, click the convert icon
    - This icon converts the assembly constraints to mechanism constraints



EXERCISE - Motion Analysis

Redefine model constraints

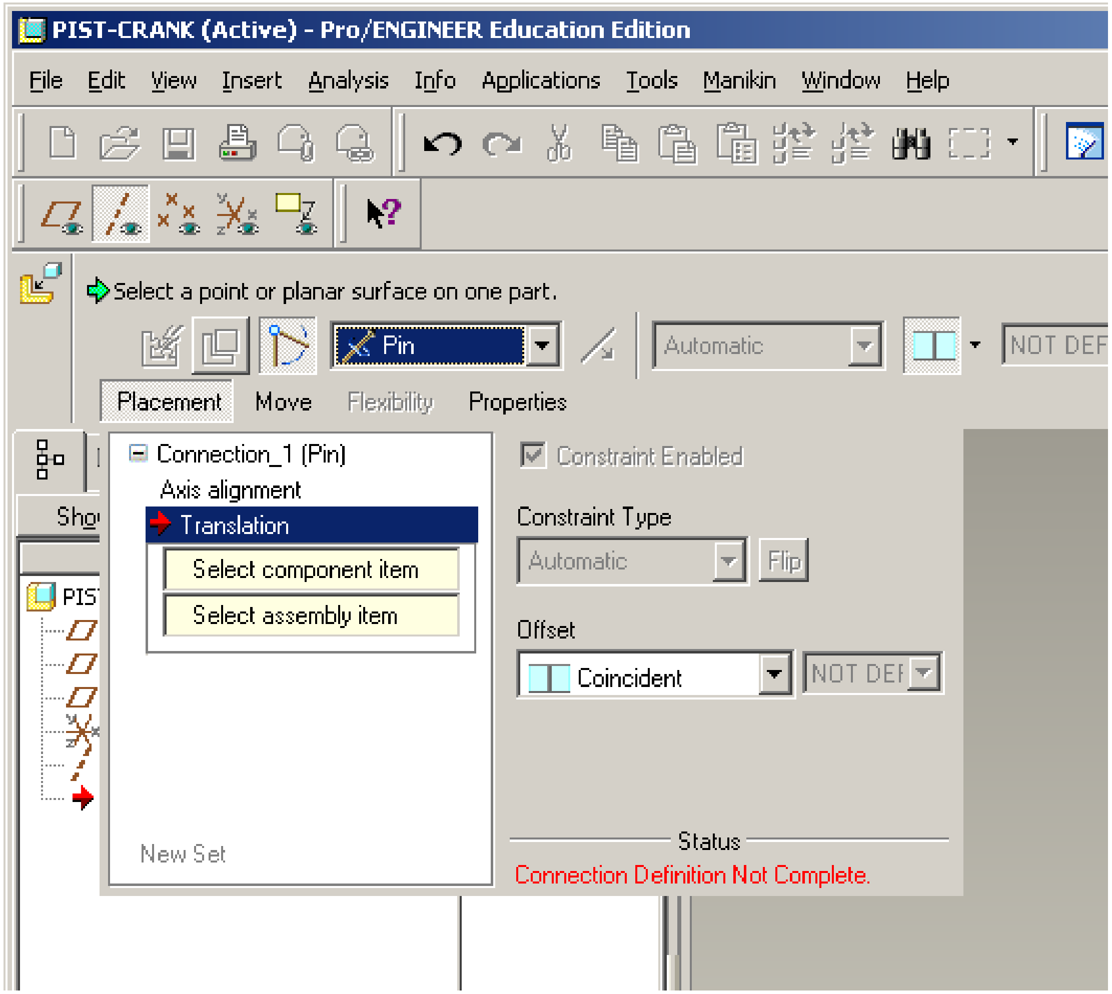
- Drop down the constraint-type menu
- Look at the available types of motion in the list after a co-axial constraint has been established
- Select Pin



EXERCISE - Motion Analysis

Redefine model constraints

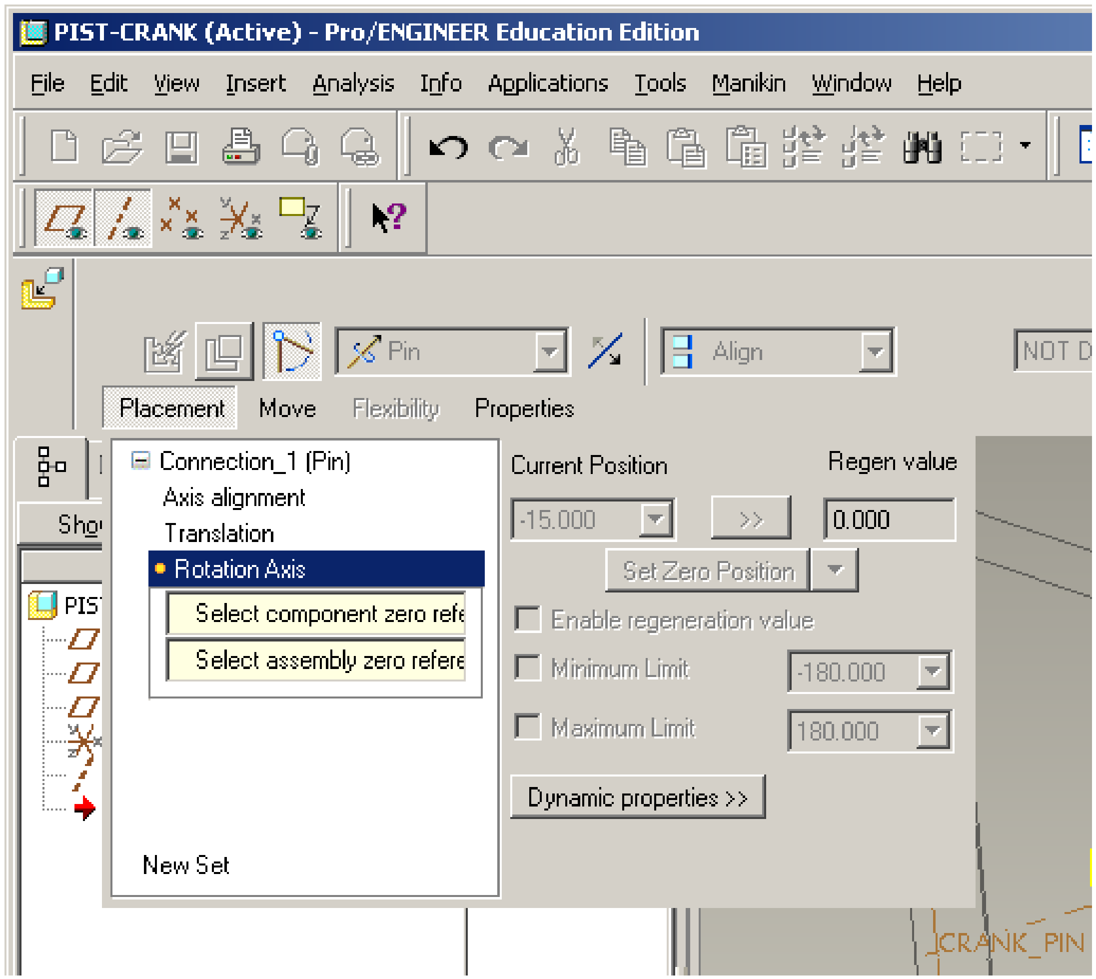
- Return to Placement dialog
- Notice the system is prompting for the next DOF
    - In this case, a Translation constraint
    - Select the RIGHT plane of the crank shaft
    - Select the ASM_RIGHT plane from the assembly



EXERCISE - Motion Analysis

Redefine model constraints

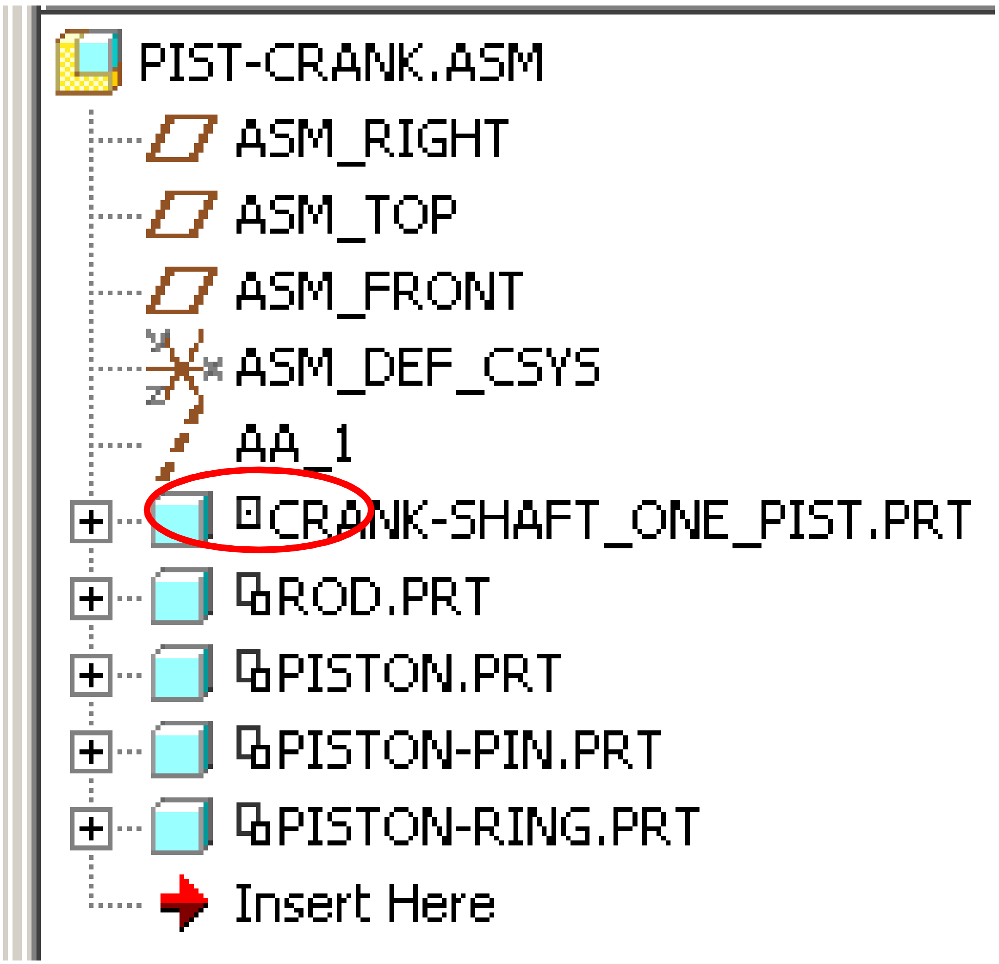
- The system then prompts for the next DOF
    - Connection is labeled Rotation Axis
    - It's actually looking for a reference plane to use as a 0 deg rotation reference
    - Select the TOP plane from the crank shaft
    - Select the ASM_TOP plane from the assembly
- Click Done



EXERCISE - Motion Analysis

Redefine model constraints

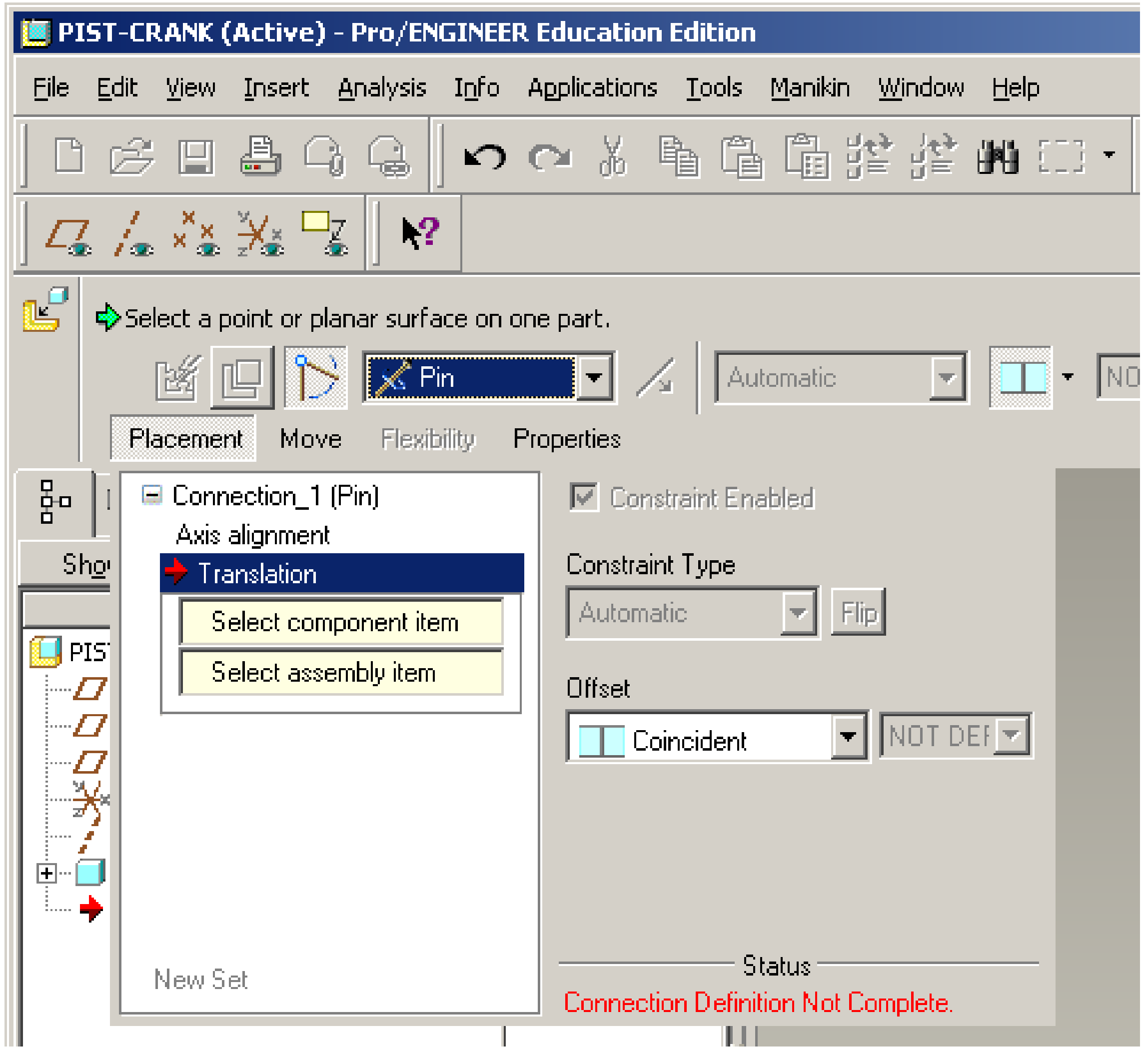
• Notice the Connection Icon next to the part file name in the model tree



EXERCISE - Motion Analysis

Redefine model constraints

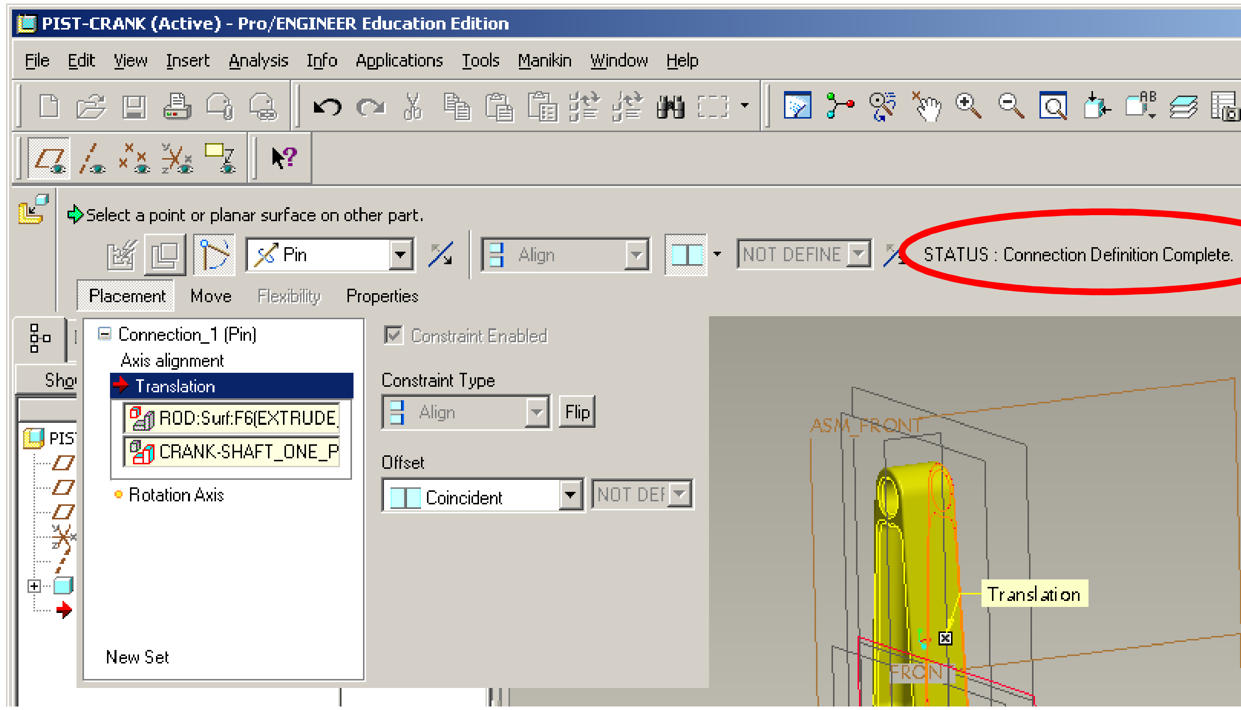
- Now edit the definition of the *rod.prt*
- Delete the two planar constraints
    - Notice this leaves the axis alignment
- Convert the constraint to a Pin type connection



EXERCISE - Motion Analysis

Redefine model constraints

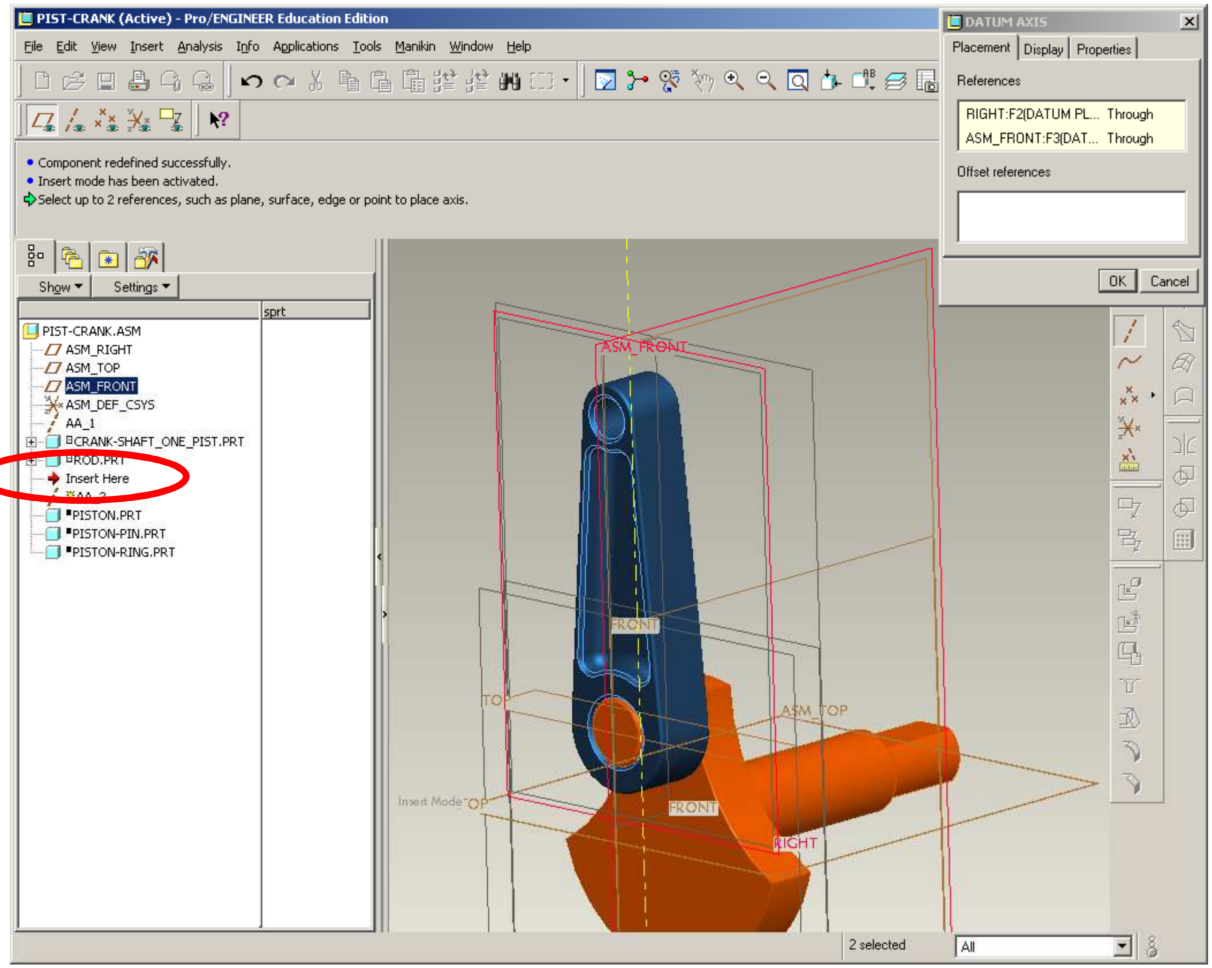
- For the Translation constraint
    - Select the back surface of the rod
    - Select the RIGHT plane of the crank shaft
- Do not specific a Rotation Axis
    - Already done with crank shaft
    - Notice the status of the part is Connection Definition Complete



EXERCISE - Motion Analysis

Redefine model constraints

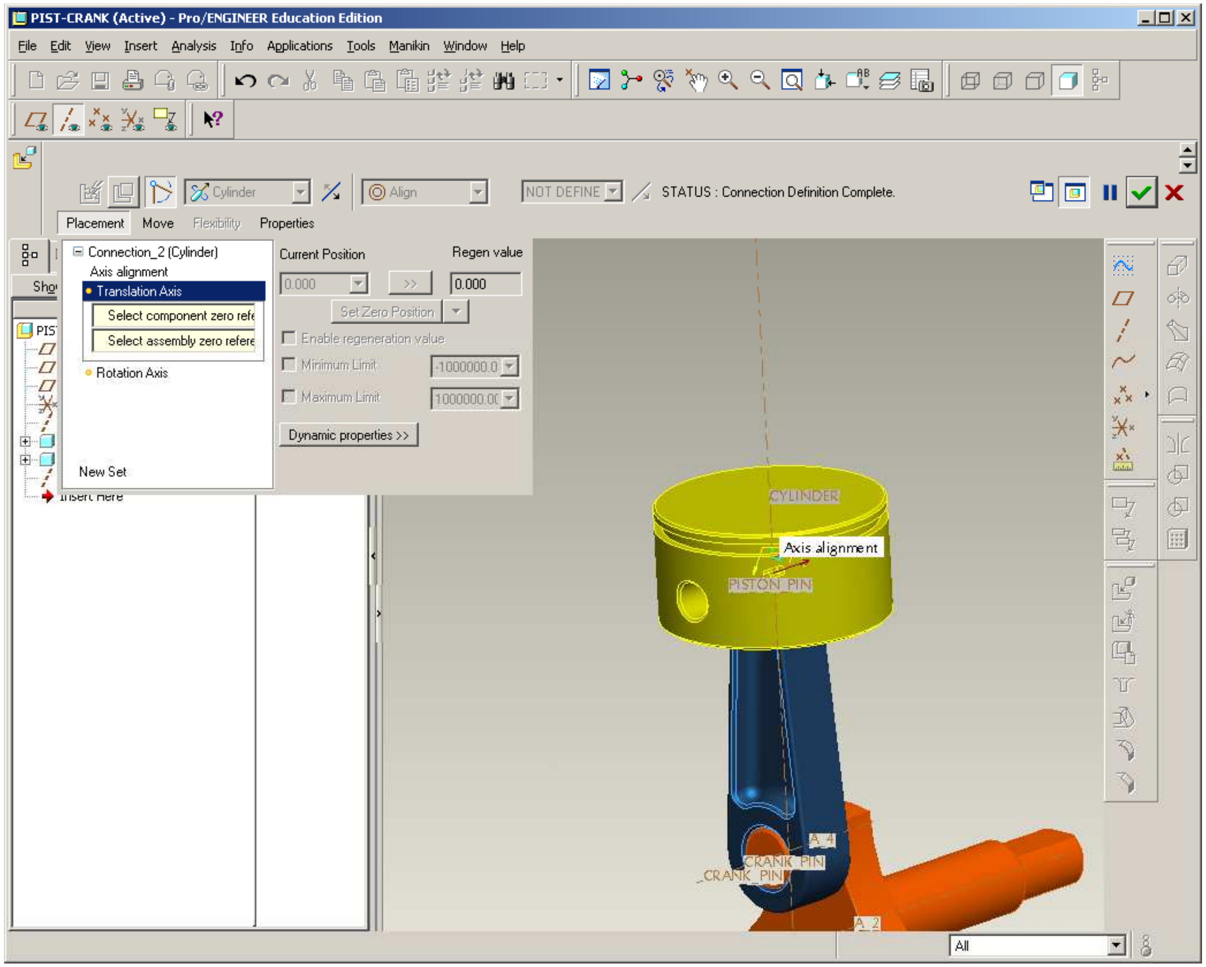
- Before we can redefine the piston constraints we need to add a datum axis
- Drag the Insert Here tab under the rod
- Click the Create Axis icon
- Click the RIGHT plane on the rod
- Holding the Ctrl key, click ASM_FRONT plane
- Click OK



EXERCISE - Motion Analysis

Redefine model constraints

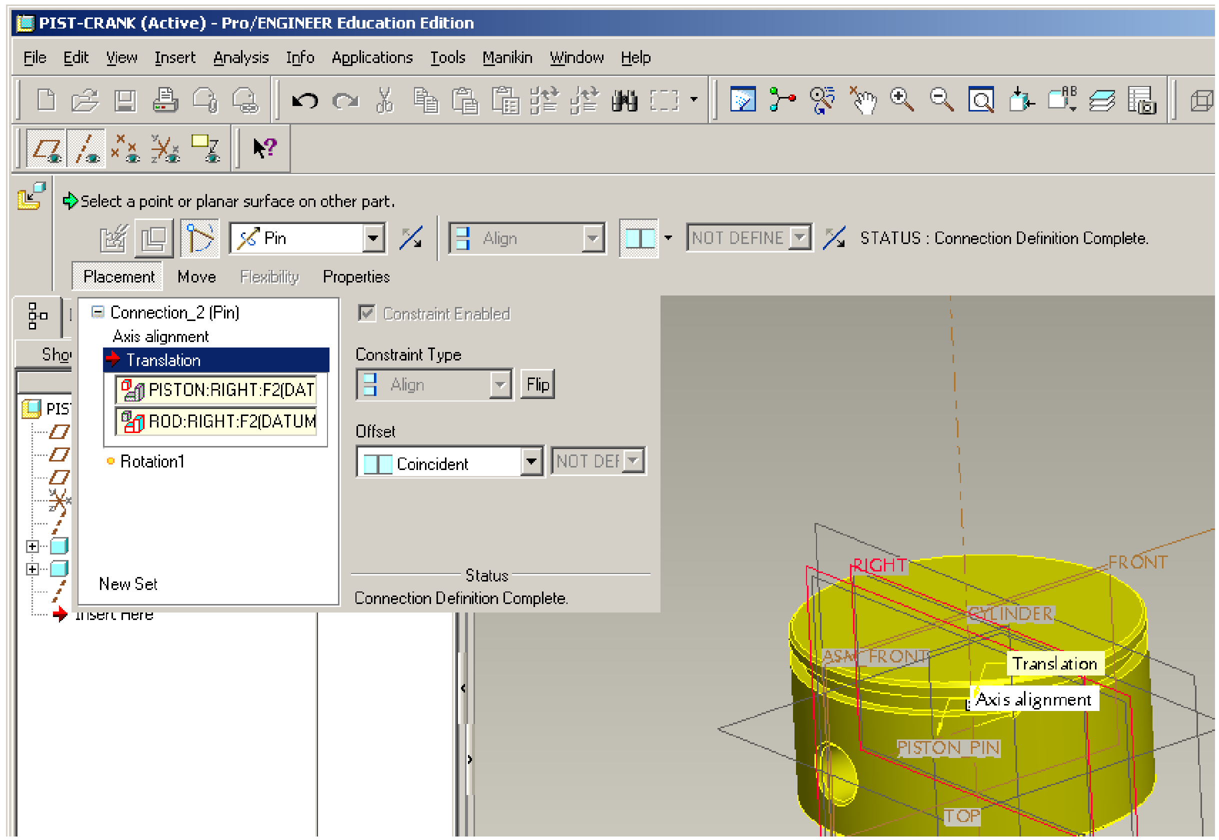
- Resume the rest of the assembly features
    - Drag the Insert Here tag down to the bottom of the tree
- Edit the piston component
    - Remove all constraints but the axis



EXERCISE - Motion Analysis

Redefine model constraints

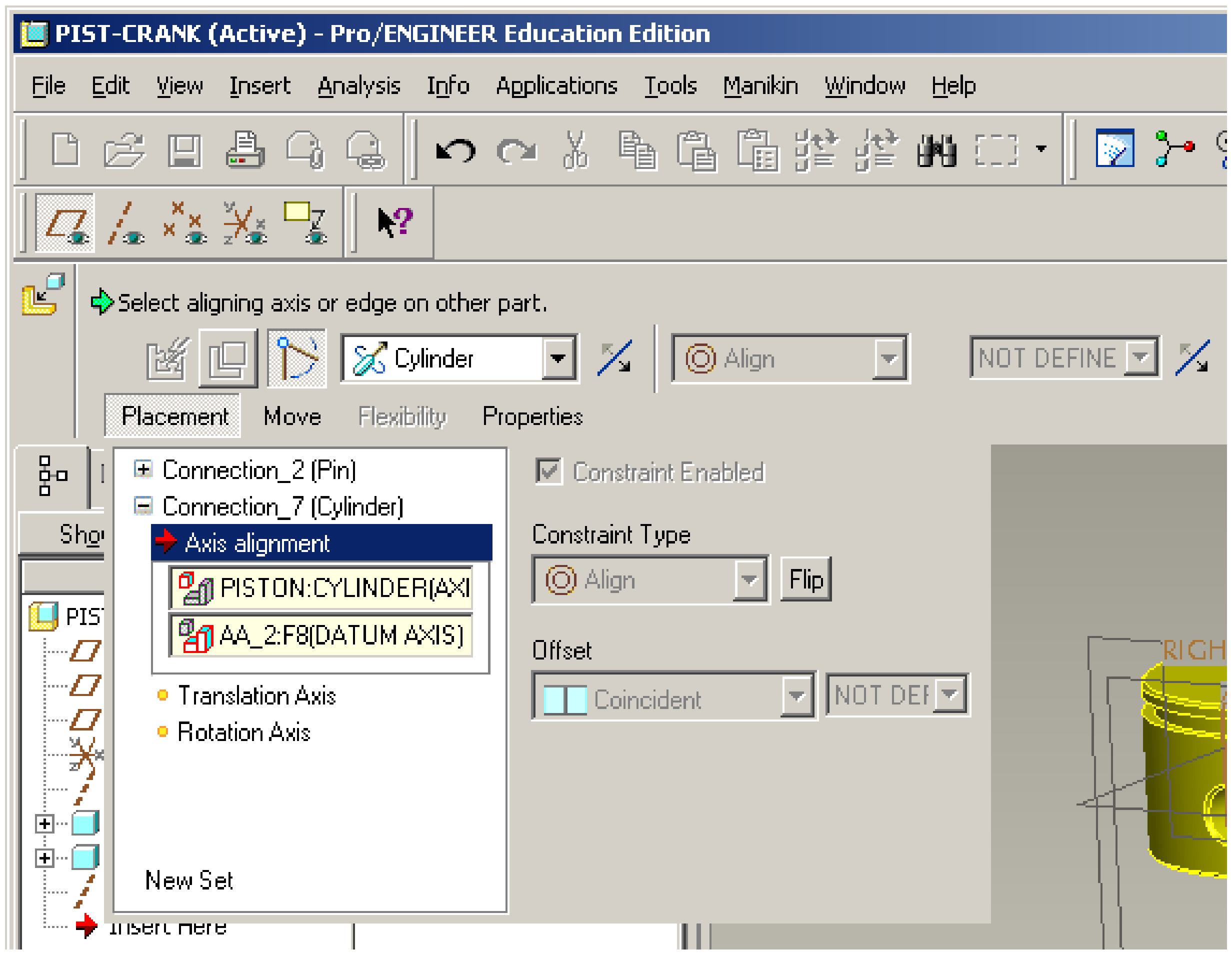
- Convert the original constraint to a Pin connection
    - Edit the Translation constraint
    - Select the RIGHT datum from the piston
    - Select the RIGHT datum from the rod



EXERCISE - Motion Analysis

Redefine model constraints

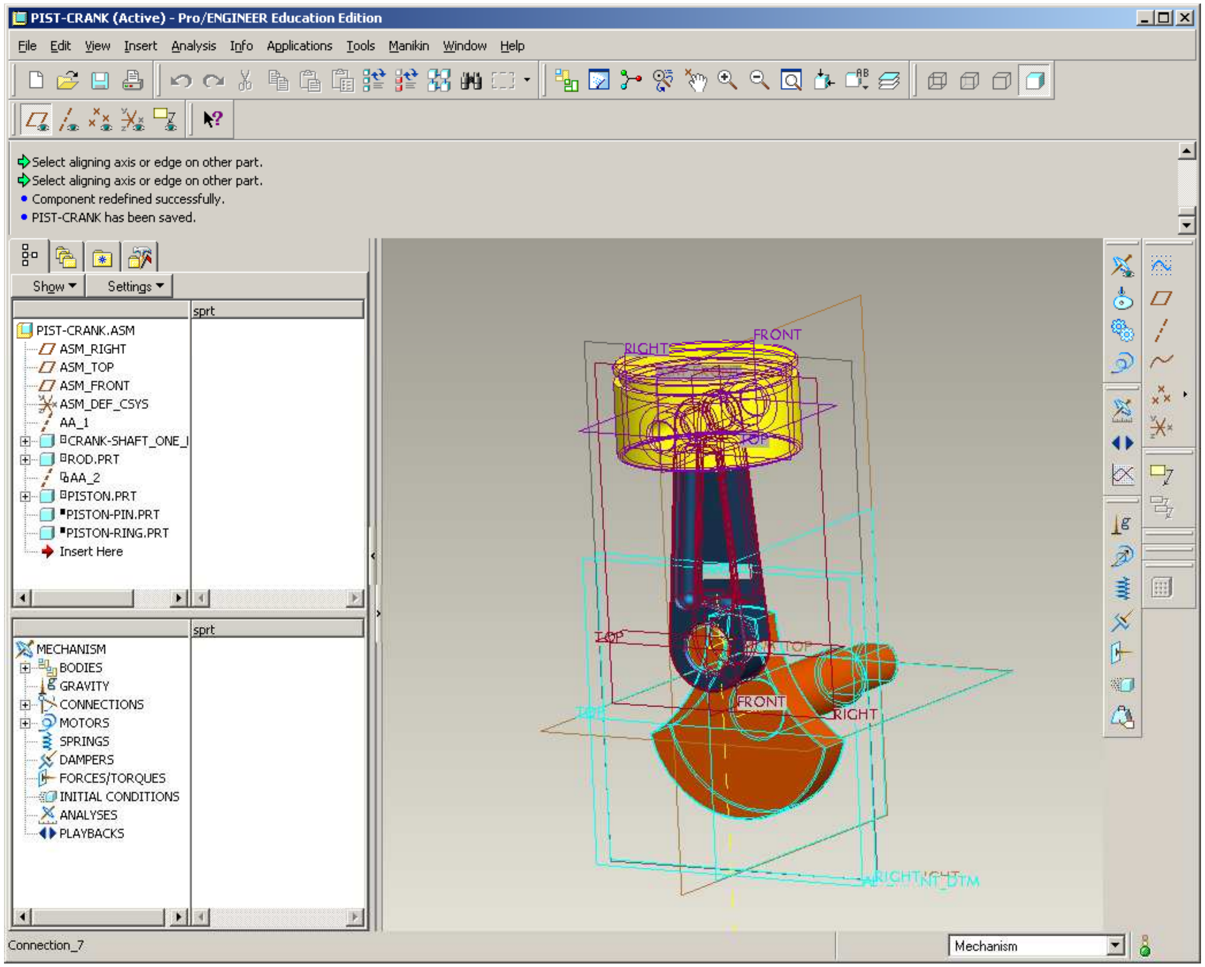
- We need to add an addition connection for the piston
    - Click New Set
    - Change connection type to Cylinder
    - Select the Cylinder axis on the piston
    - Select the datum axis we created earlier in the exercise
- Click Done



EXERCISE - Motion Analysis

Redefine model constraints

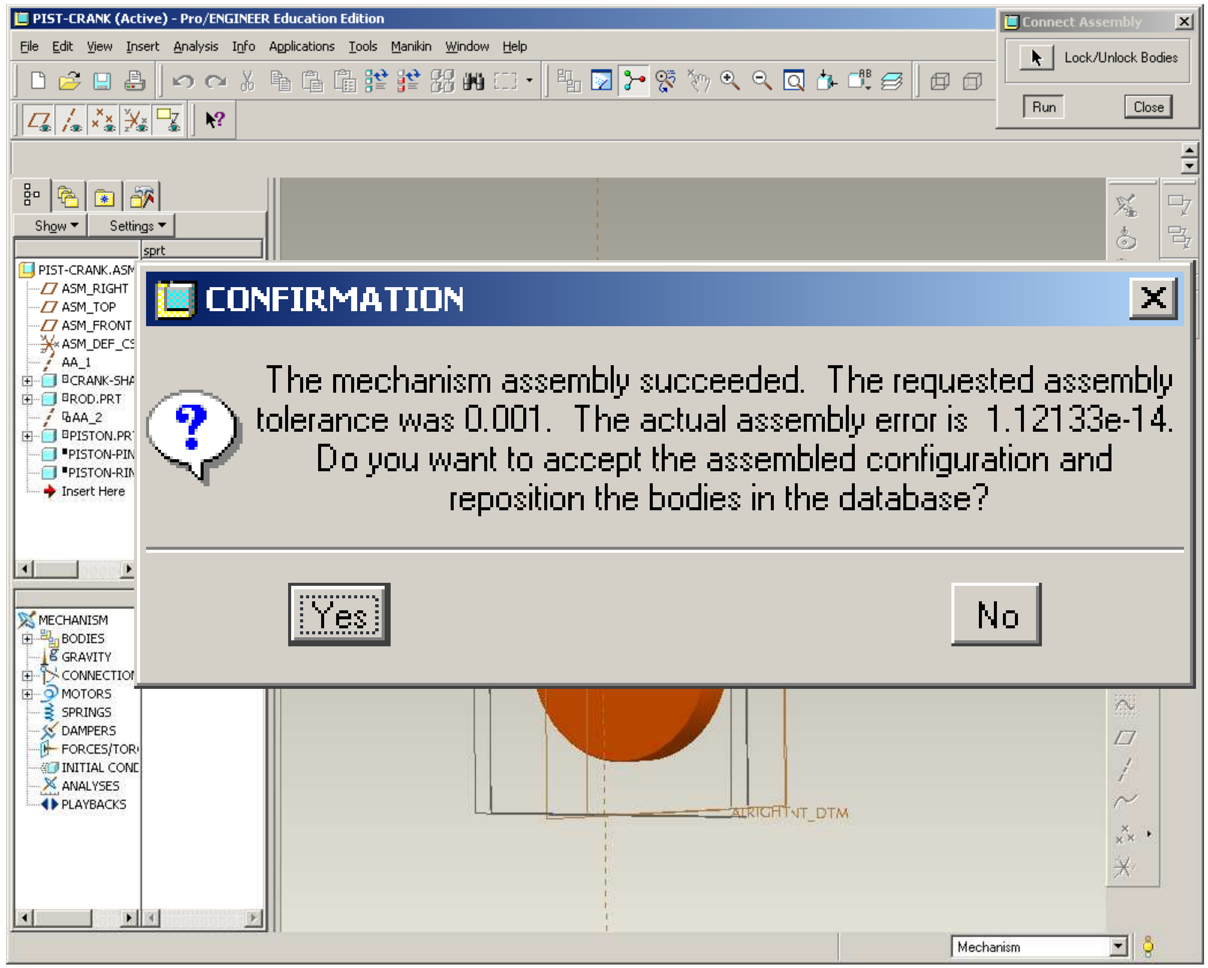
- Suppress the piston-pin and the piston-ring in the model tree
- SAVE
- Switch applications back to Mechanism
- View > Highlight Bodies
- Notice no green left



EXERCISE - Motion Analysis

Run the model

- As another check, run the model
  - Edit > (Re)connect
  - Click Run
- There should be a message saying it was successful
- Click Yes



EXERCISE - Motion Analysis

Drag the mechanism through its motion

- Click Drag
- Click on the end face of the crank shaft
- Rotate the mechanism
- LMB Done.