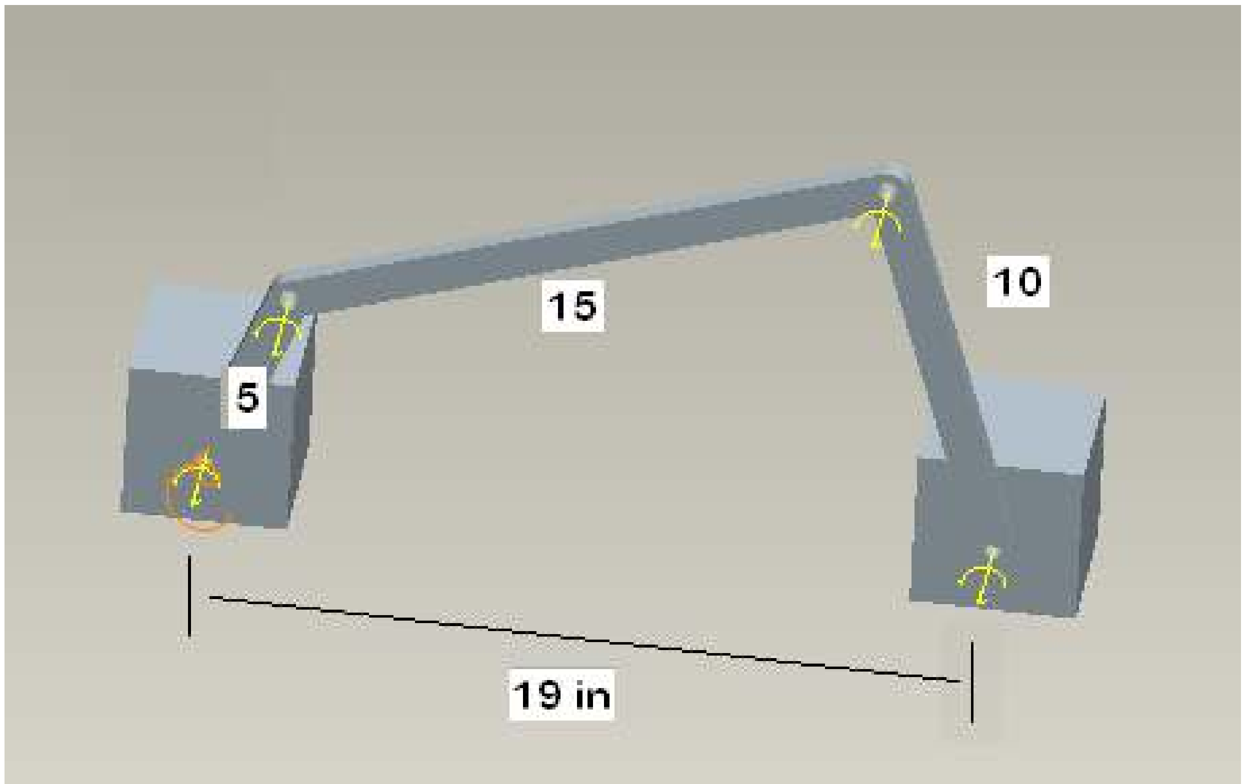
Mechanism Analysis in Pro/E

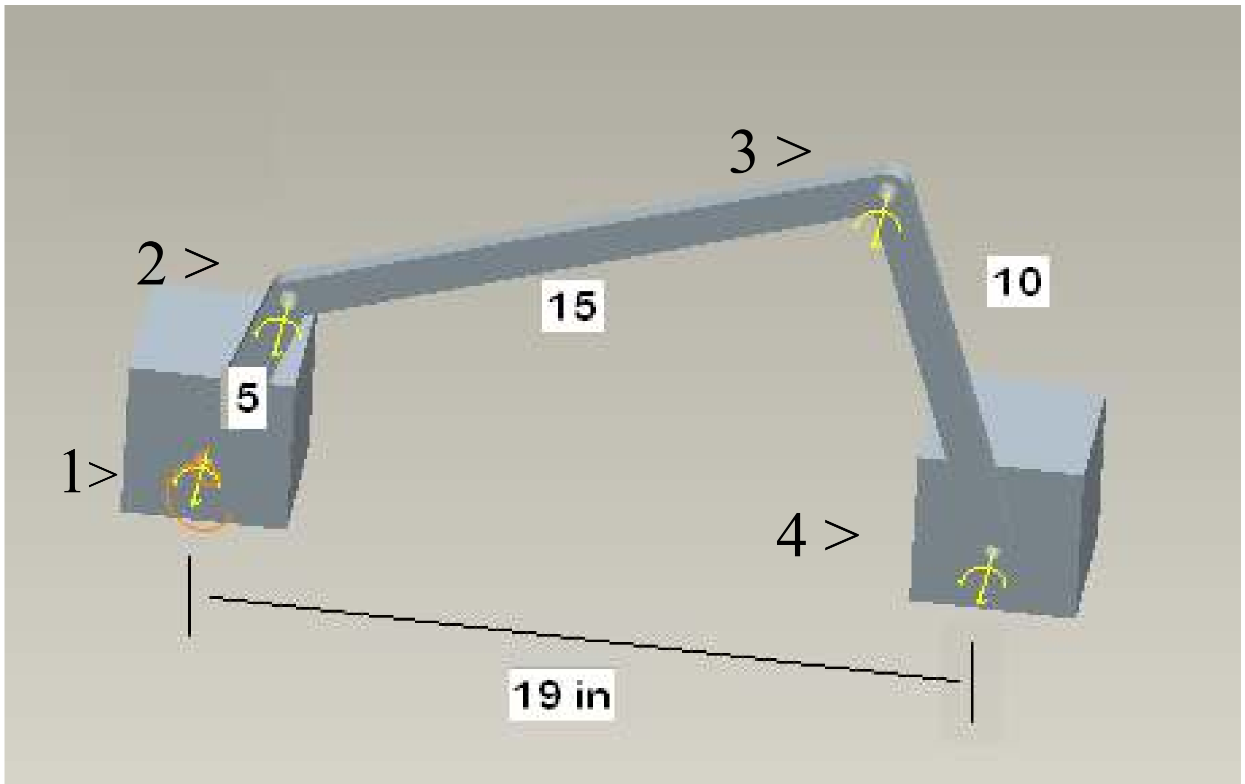


MAE 4344
Mechanical & Aerospace Engineering
University of Texas at Arlington
Mukund Narasimhan & Kent L Lawrence

Link Specs

- Each link is 0.5 inch thick and 1.0 inch wide.
- The pin holes are 0.5 inch in diameter, and link lengths are between pin hole centers.
- The material for each is steel.

Joint definitions

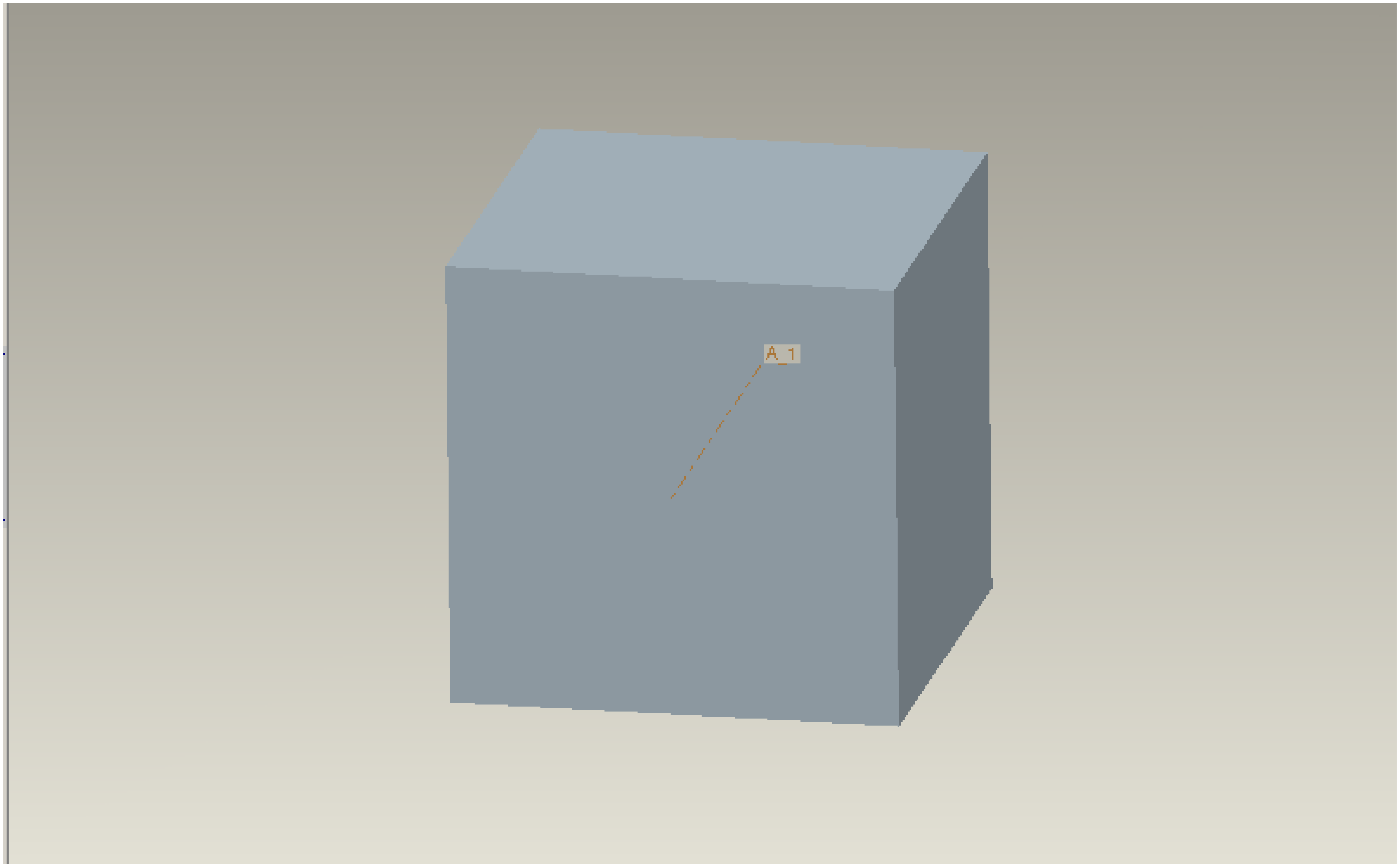


Motion

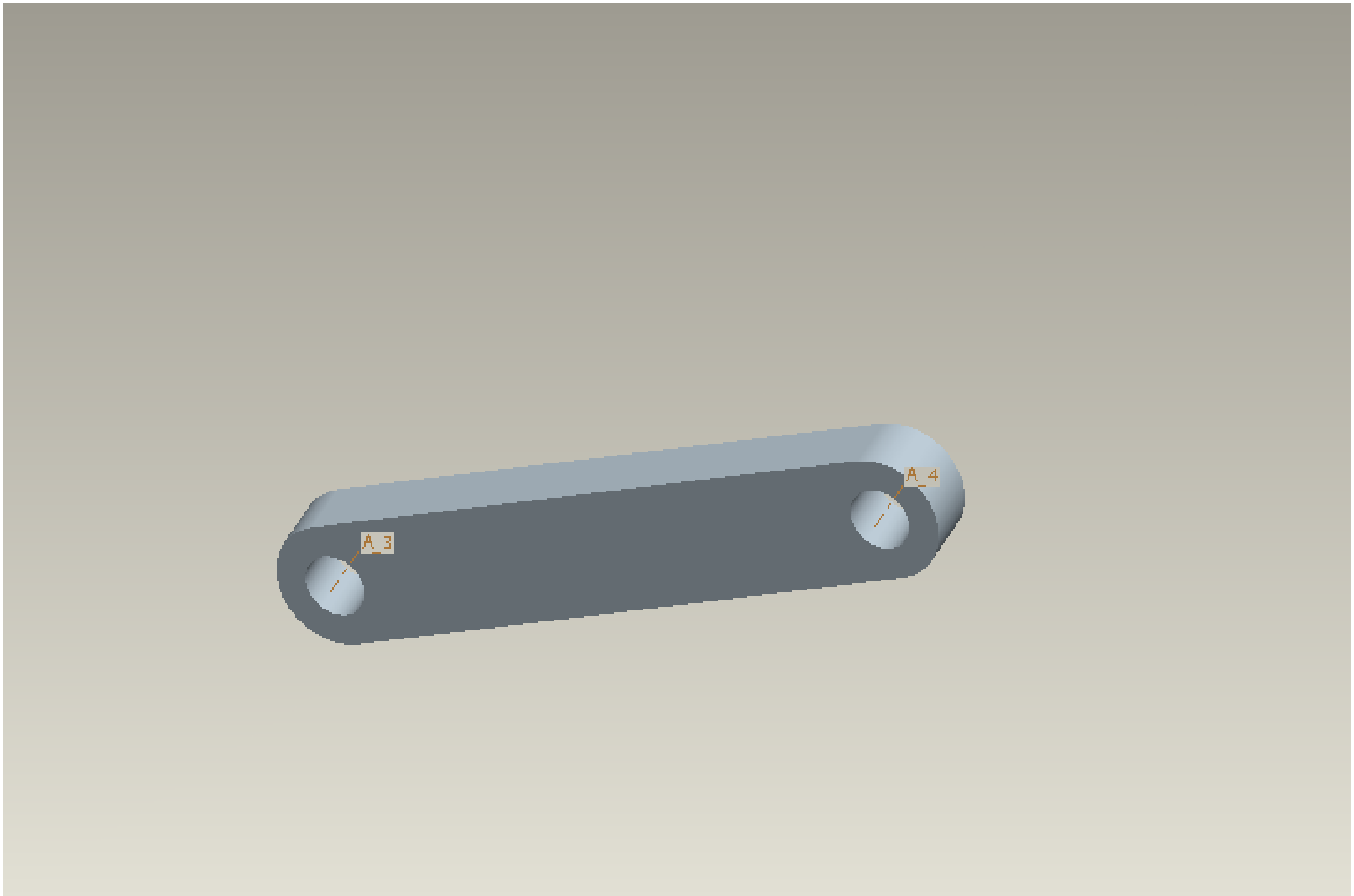
- The 5 inch input link rotates at a constant angular speed of 1800 rpm = 10,800 deg/sec in a CCW sense.

- Find the connection forces at each joint for one revolution of the mechanism.

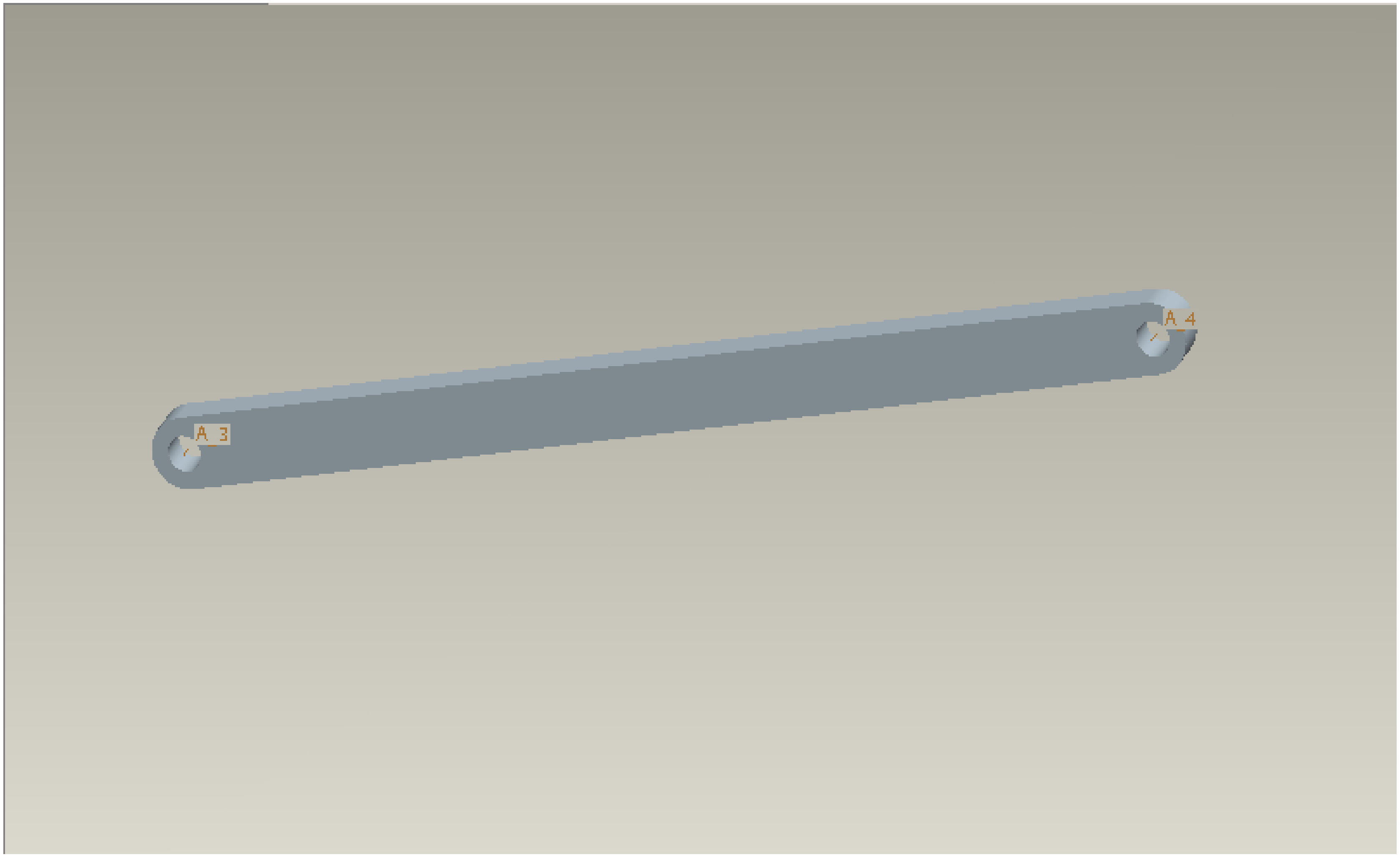
GROUND BLOCK



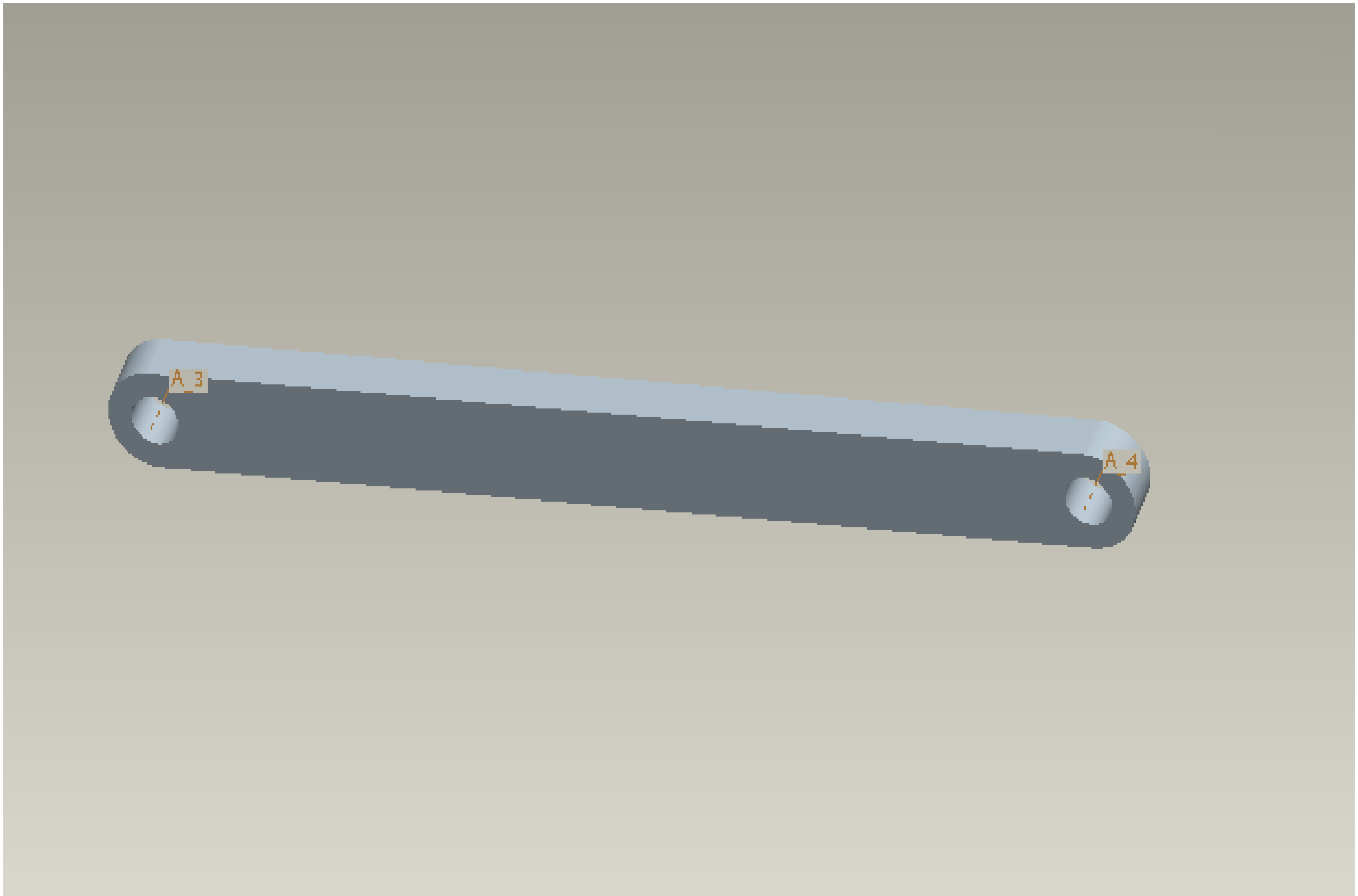
Change units from Inch Lbm Sec to Inch Lbf Sec for ALL parts.



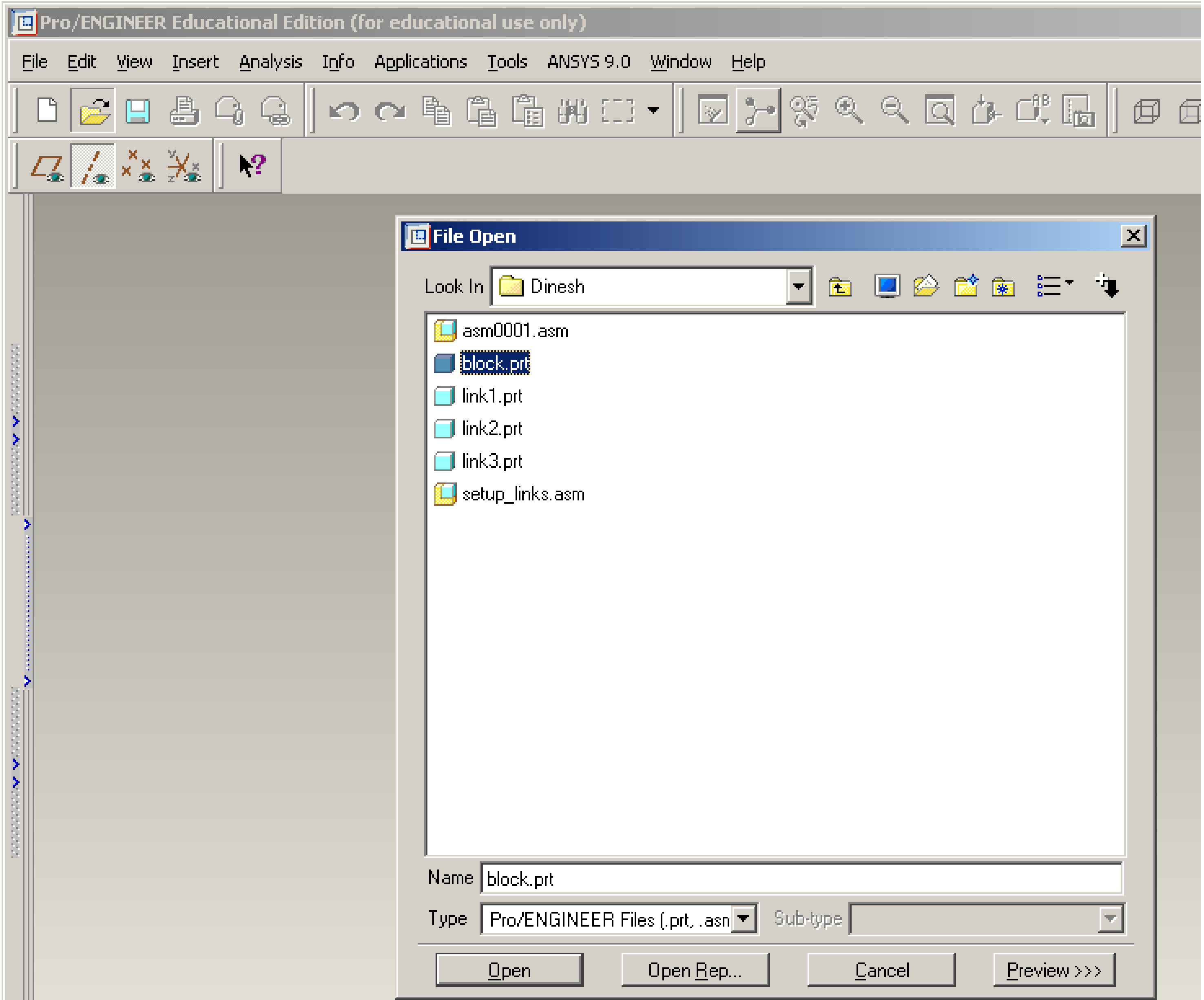
LINK 1



LINK 2

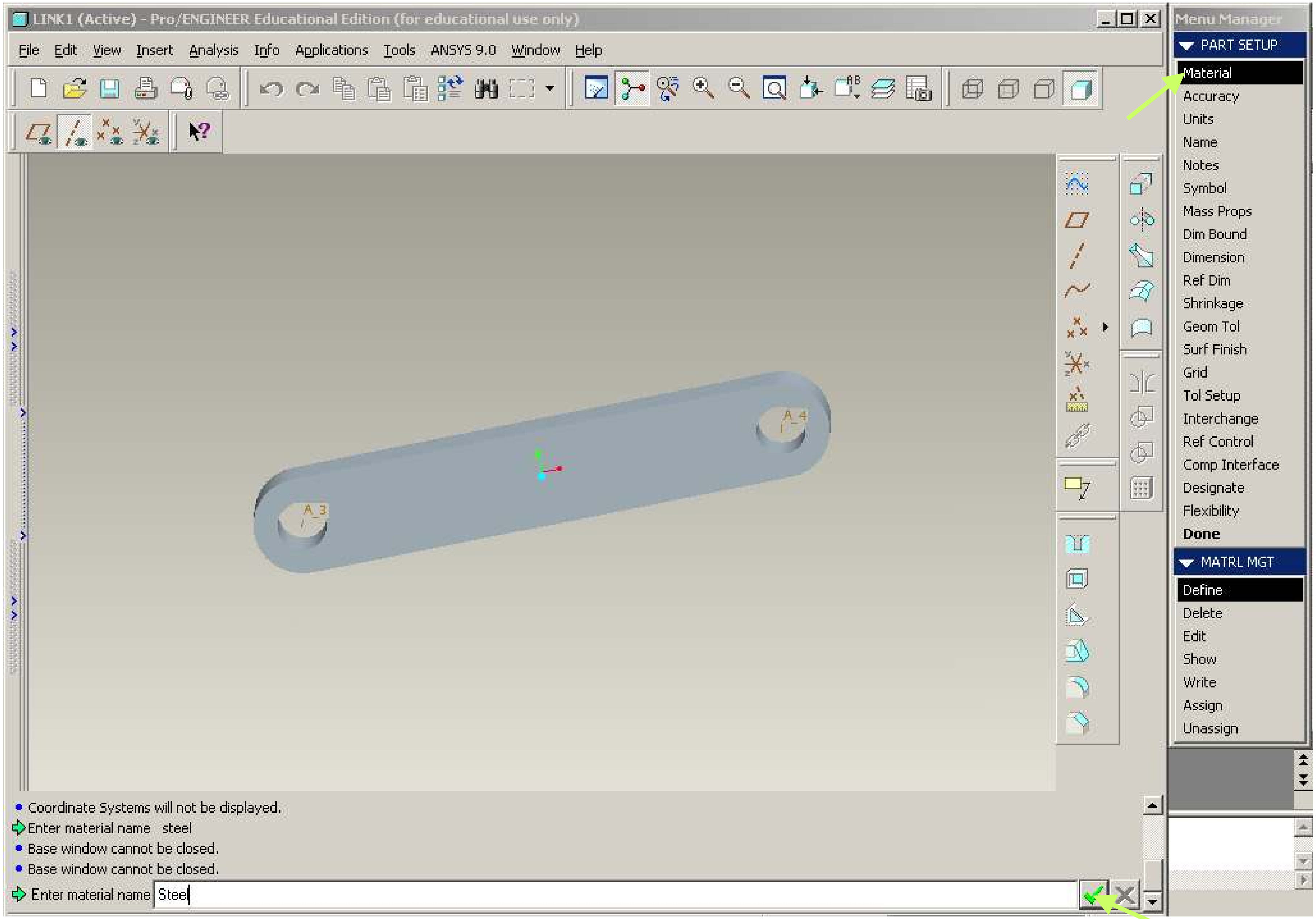


LINK 3

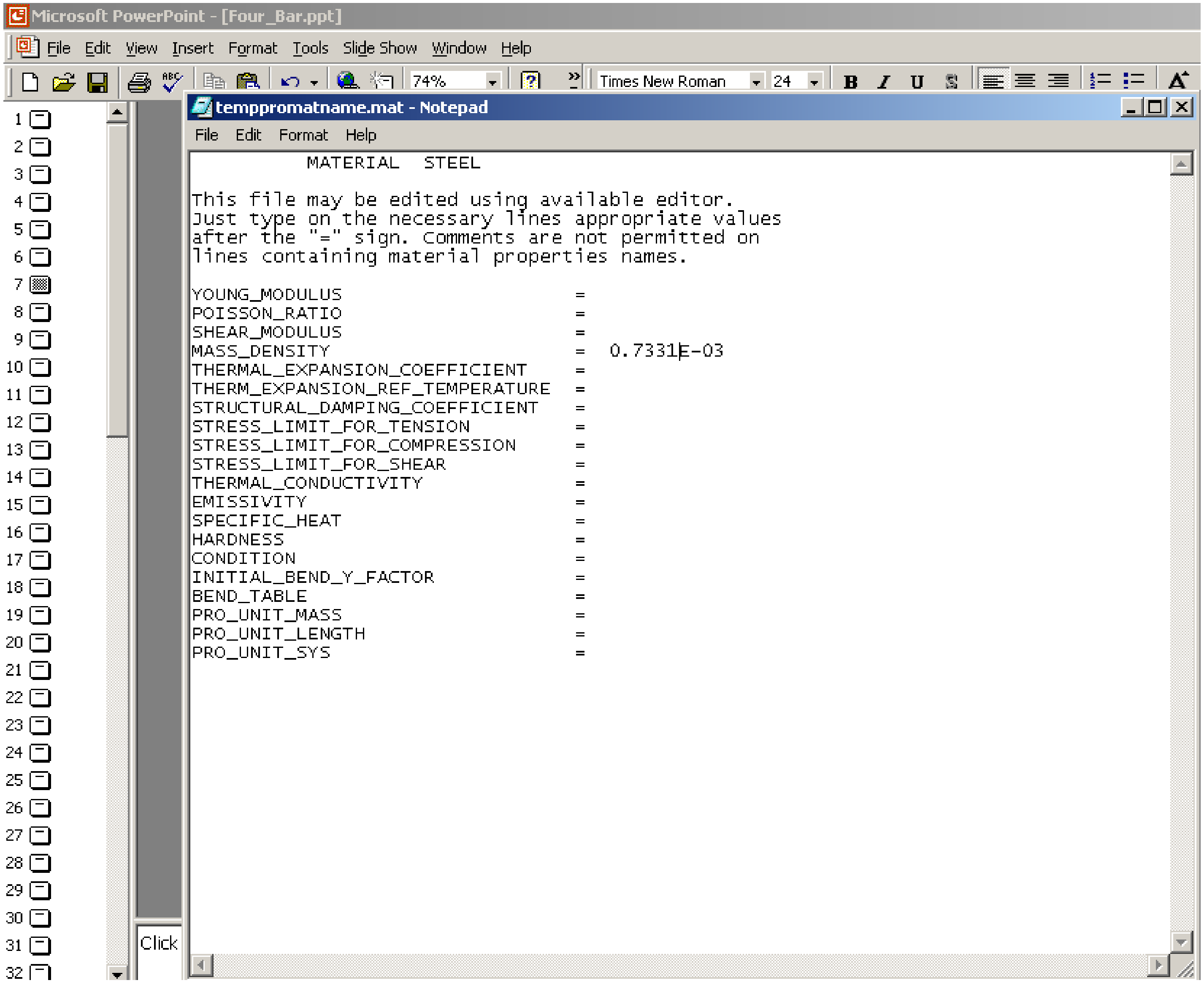


Define Materials
for all Parts >>

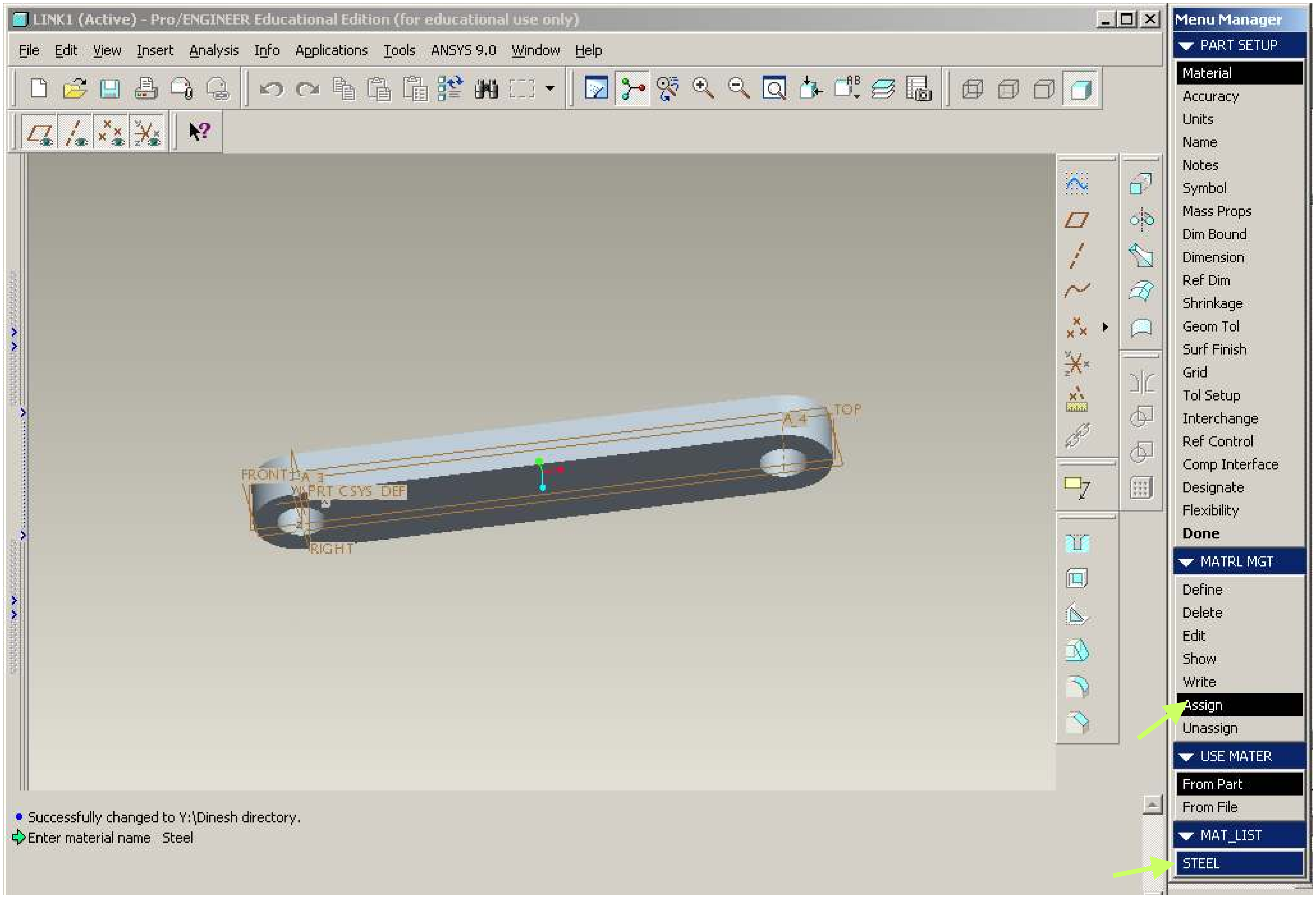
File > Open > Select **link1.prt**



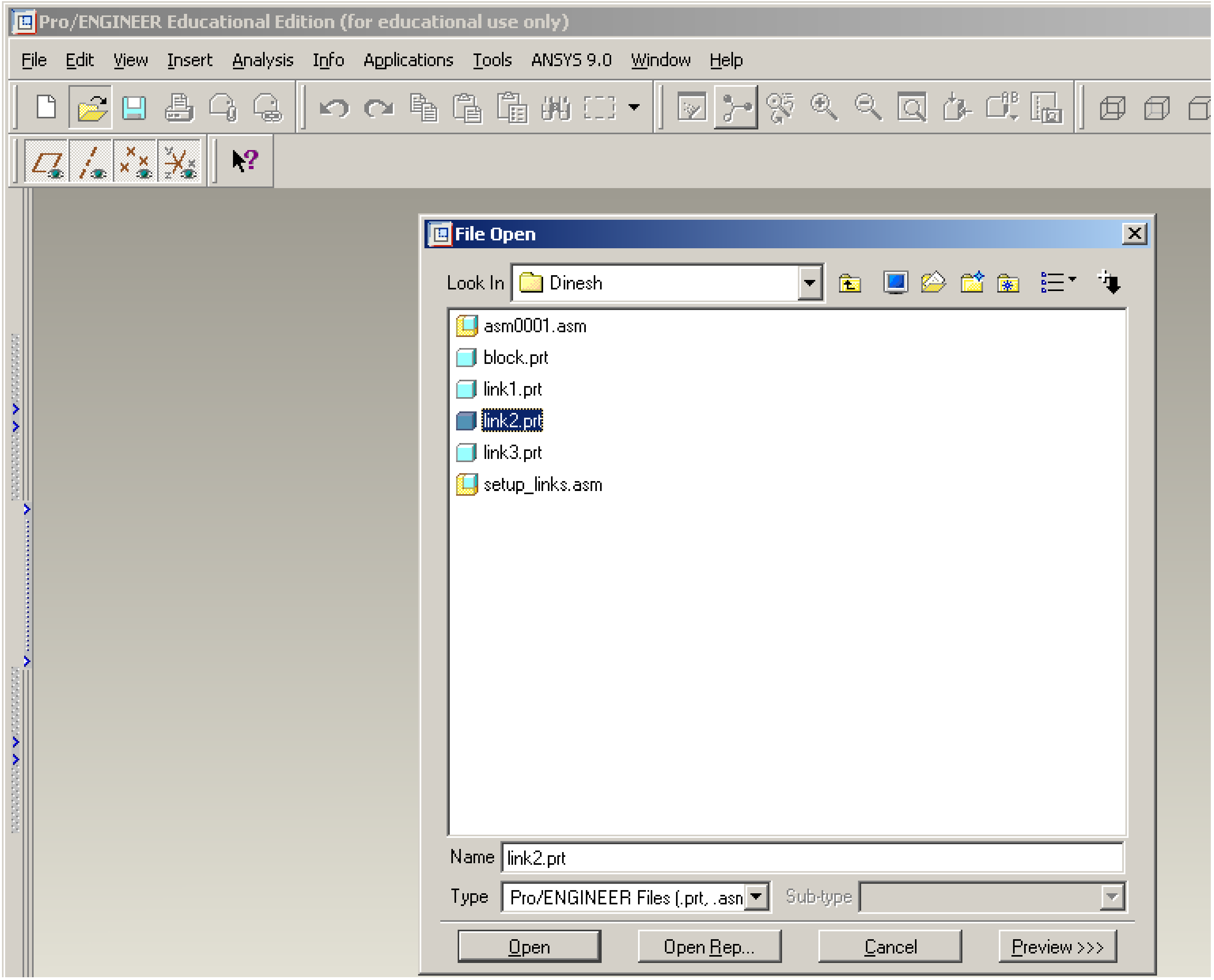
Edit > Setup > Material > Define > (Enter material name) Steel > Accept



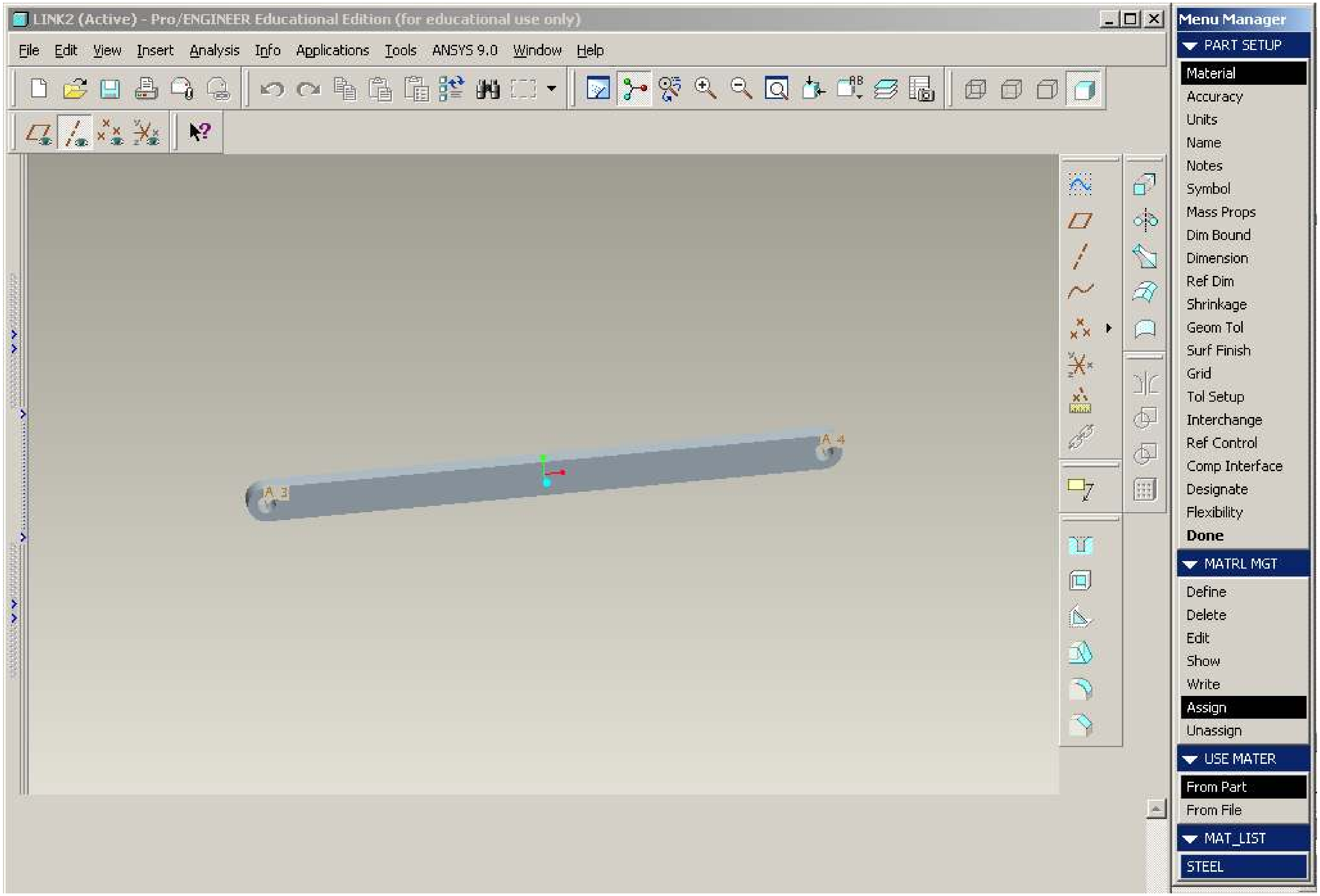
A notepad opens up > Enter MASS_DENSITY = 0.7331E-03 > File > Save as > Steel.mat > Exit (First toggle on 'all files' not 'TXT'.)



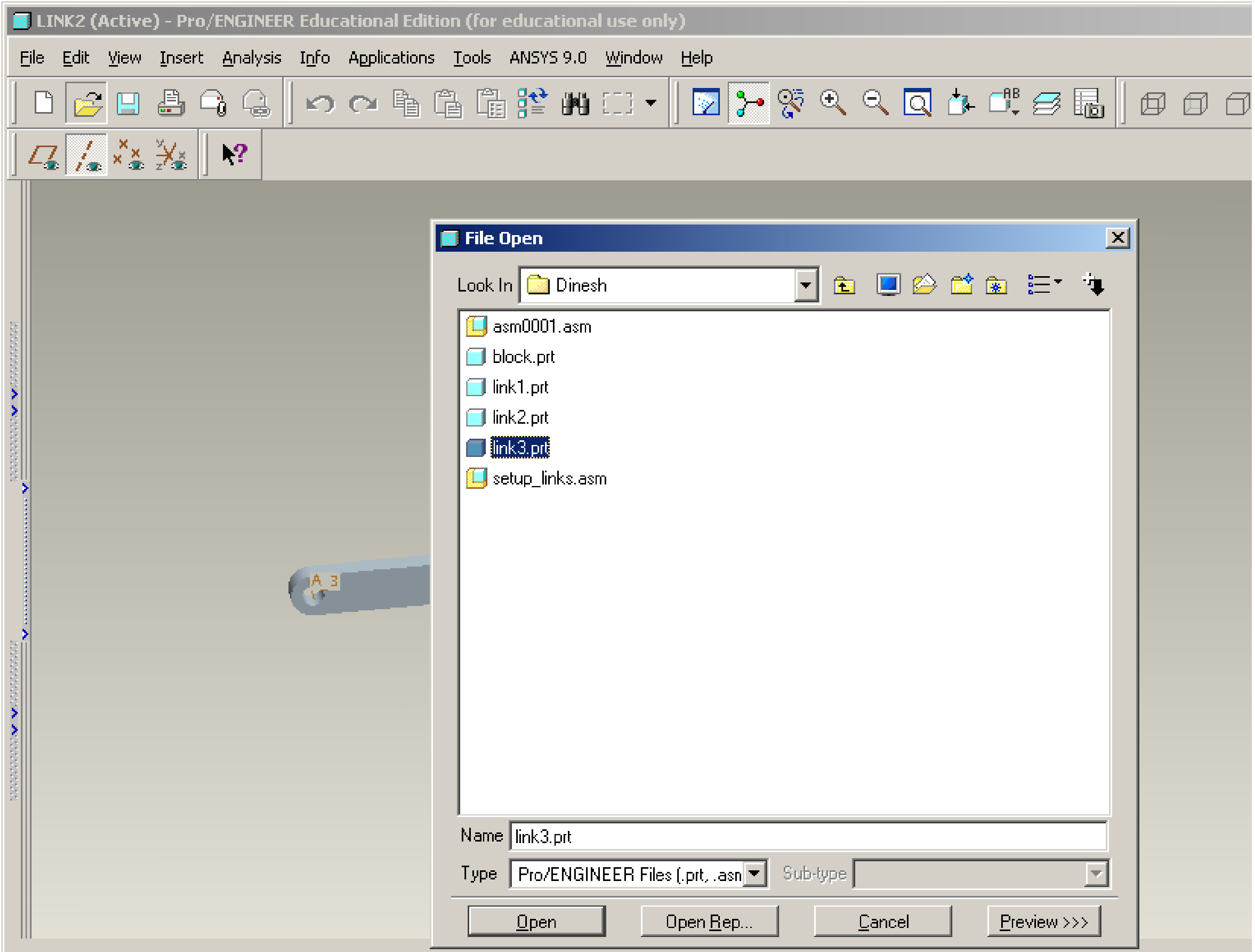
Assign > From Part > STEEL > Accept > Done



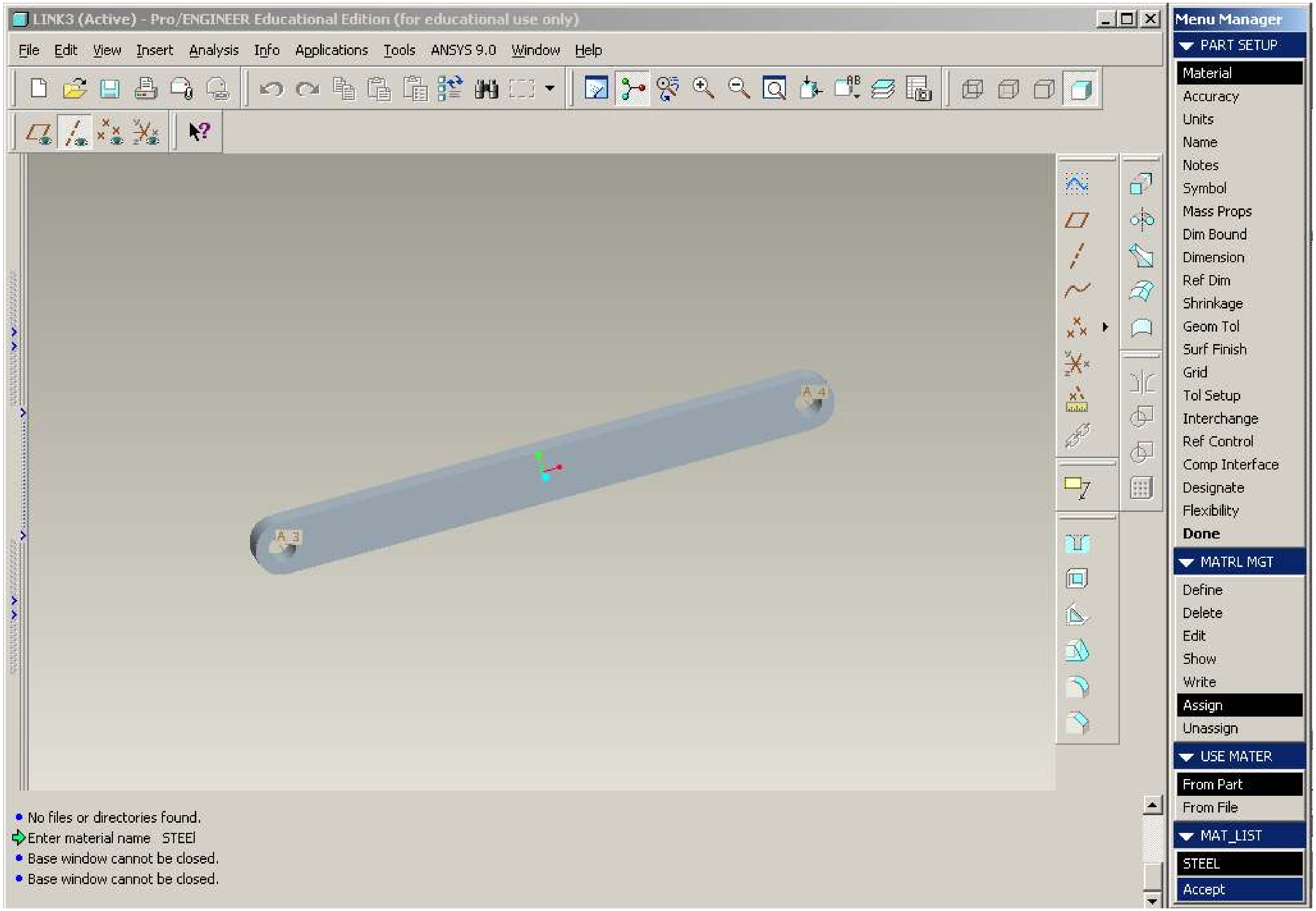
File > Open > Select **link2.prt**



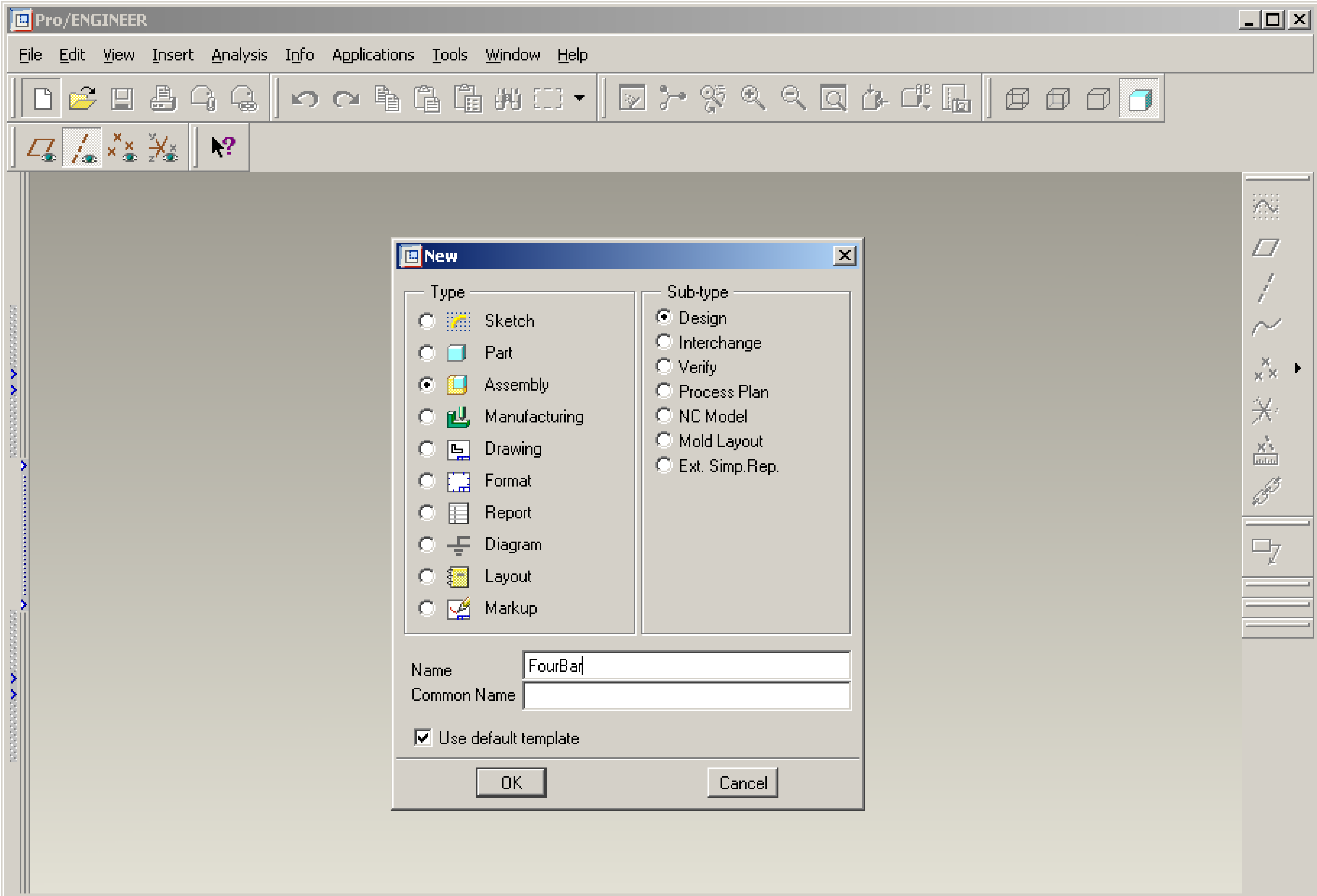
Edit > Setup > Material > Assign > From Part > STEEL > Done



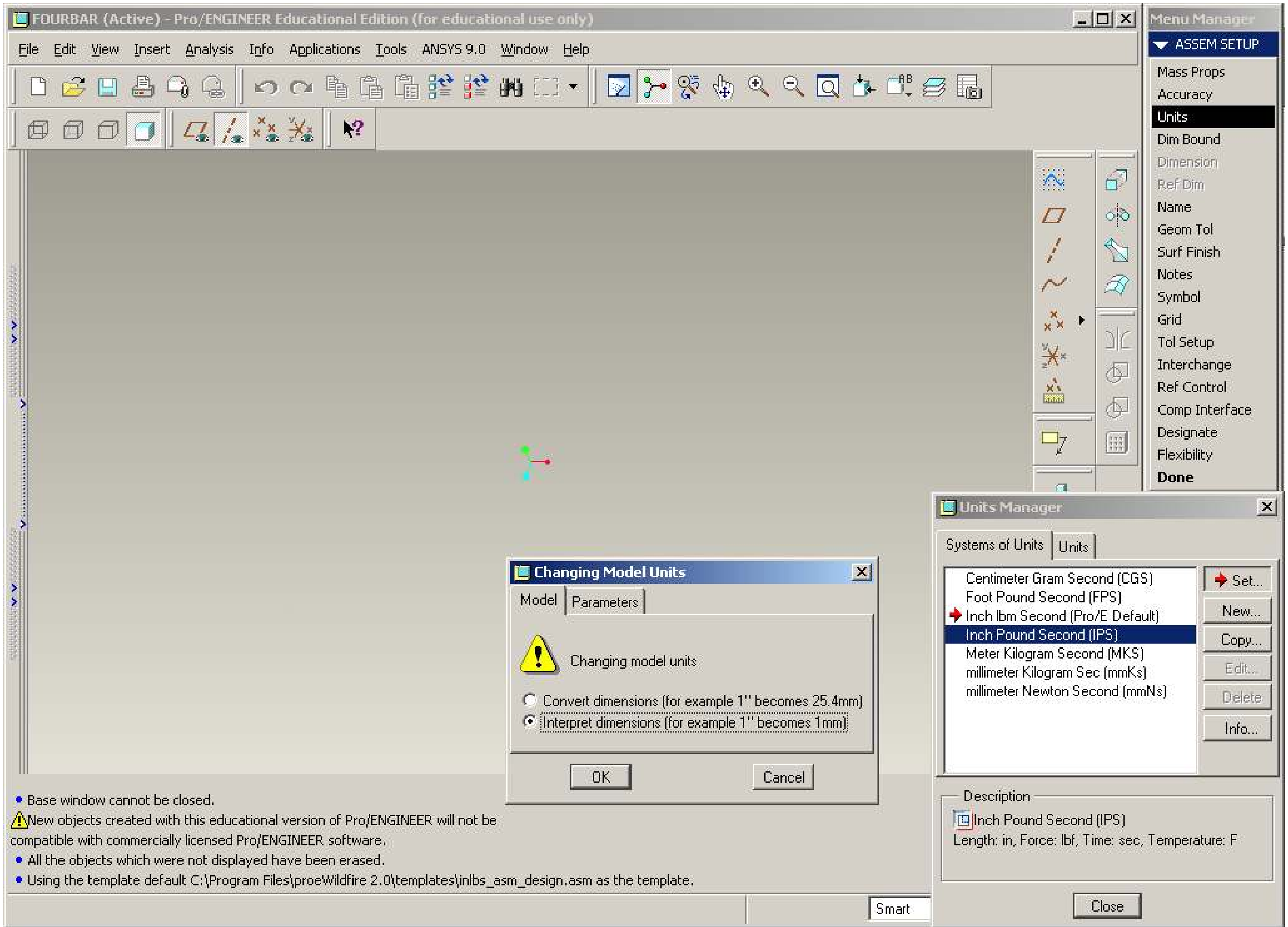
File > Open > Select **link3.prt**



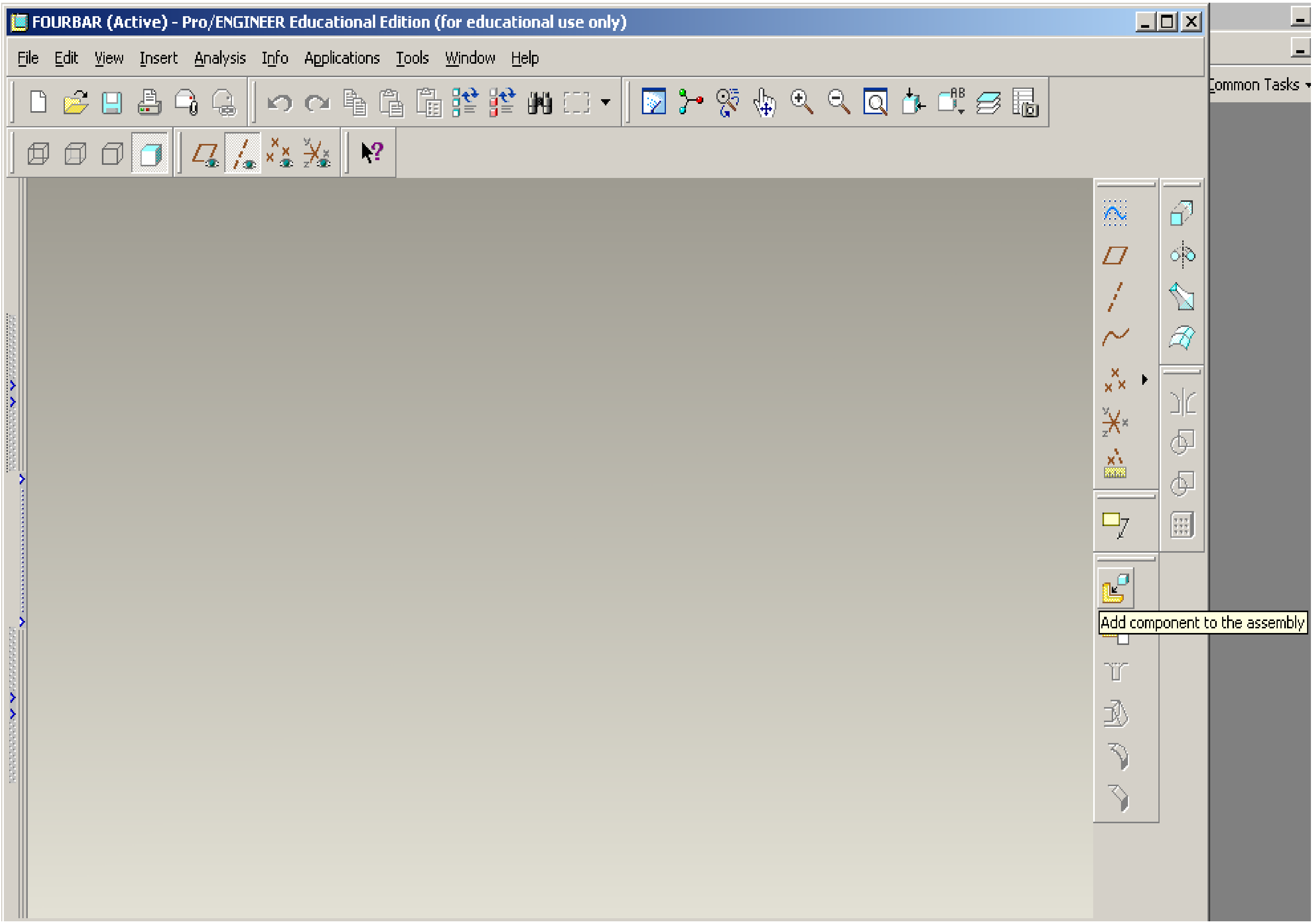
Edit > Setup > Material > Assign > From Part > STEEL > Done



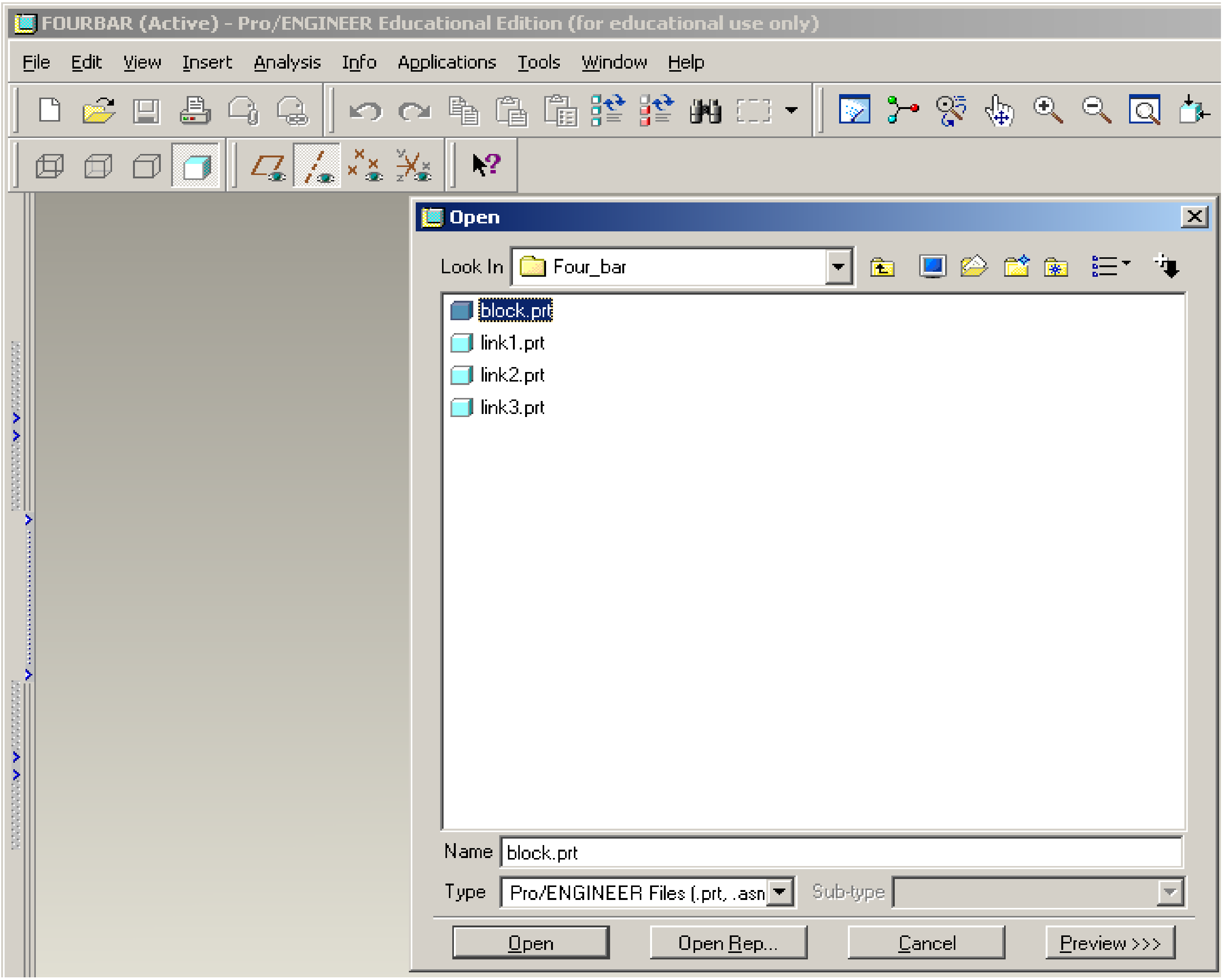
FILE > NEW > ASSEMBLY > NAME FourBar > OK



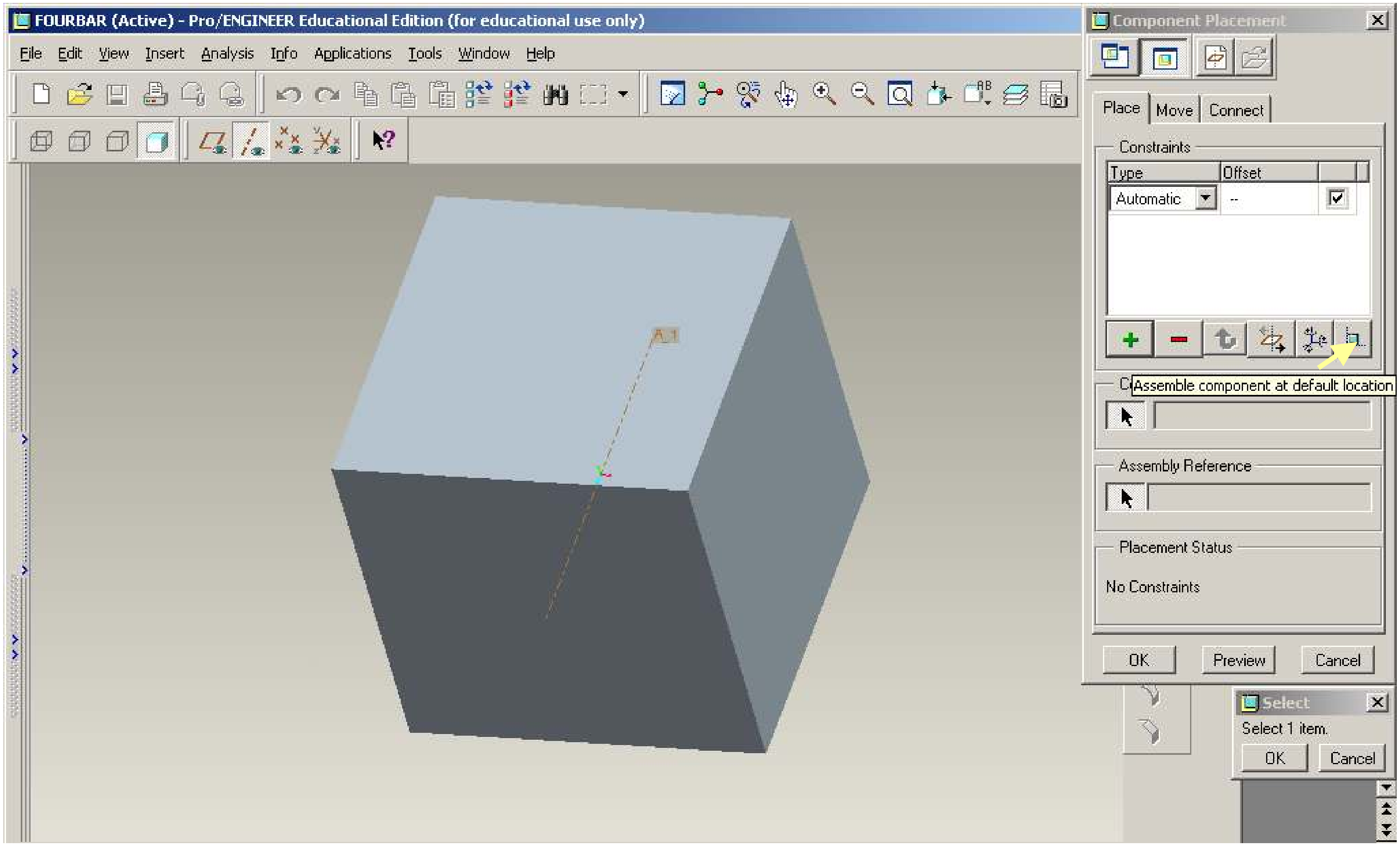
SET UNITS FOR ASSEMBLY Edit > Setup > Units > Select Inch Pound Second > Set > Select the 1st option > Ok > Close > Done



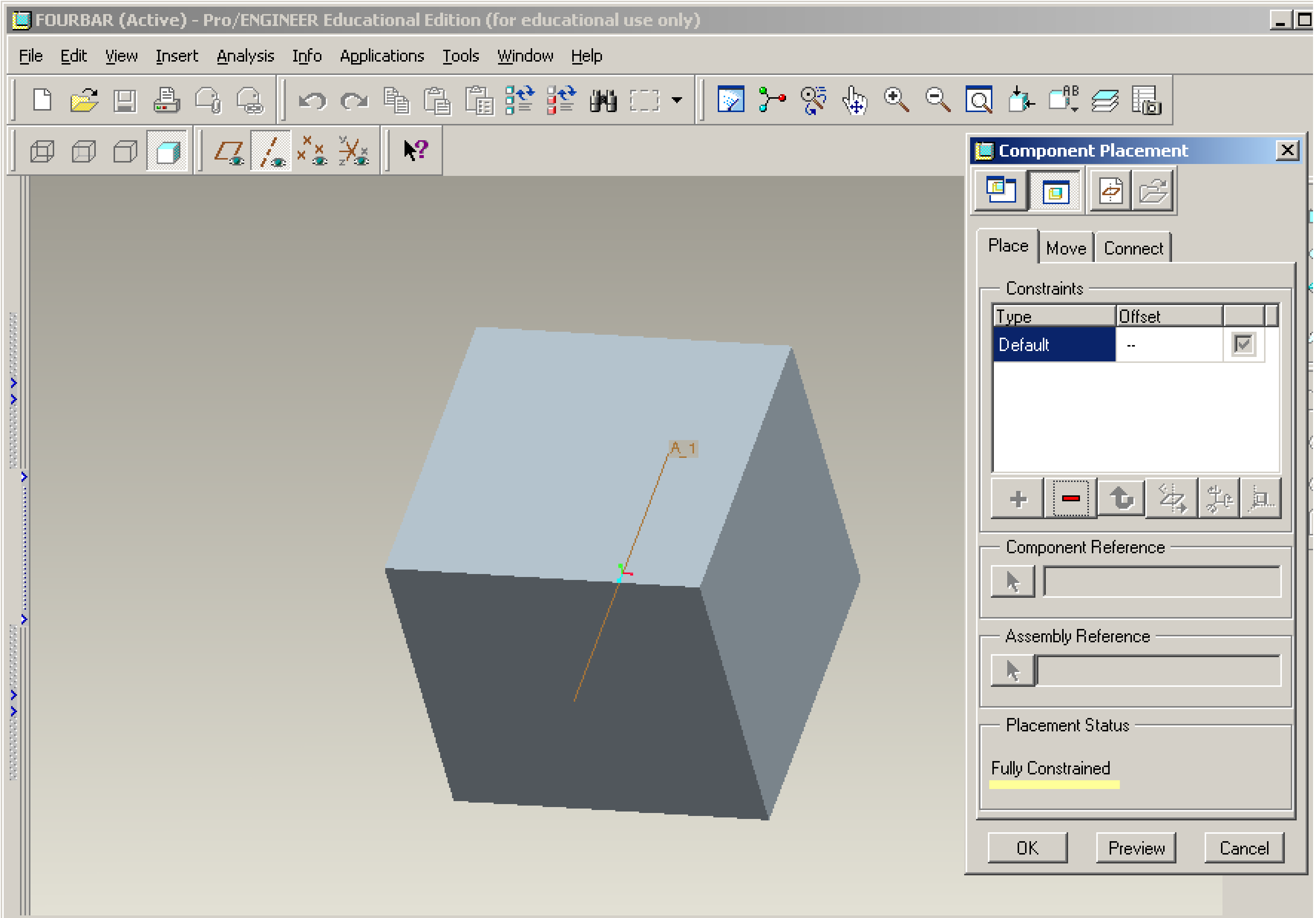
Click on “Add Component to the assembly” icon



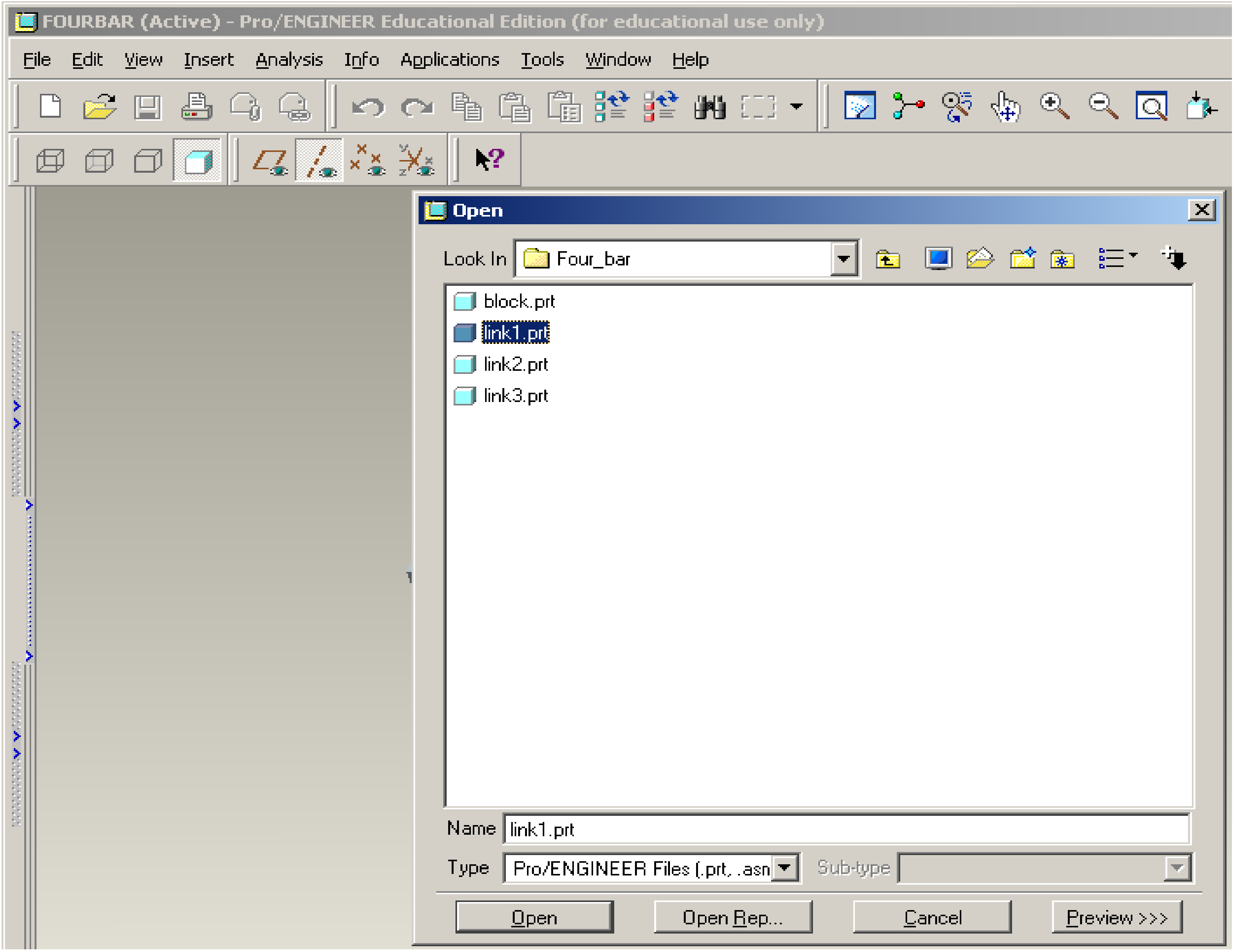
Select block1.prt > Open



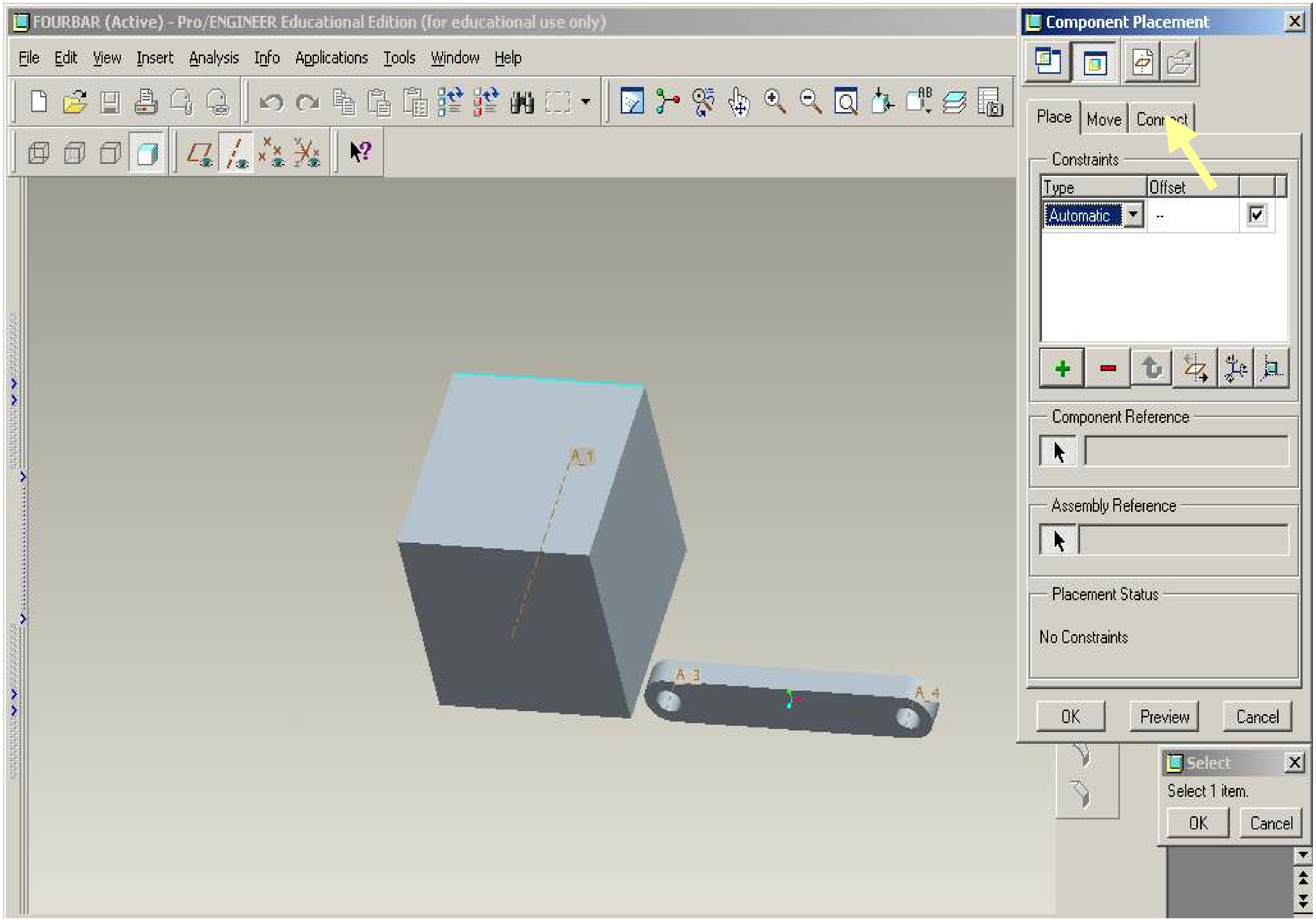
Click on the icon " Assemble Component at default location"


FOURBAR (Active) - Pro/ENGINEER Educational Edition (for educational use only)
File Edit View Insert Analysis Info Applications Tools Window Help
A_1
Component Placement
Place Move Connect
Constraints
Type Offset
Default --
Component Reference
Assembly Reference
Placement Status
Fully Constrained
OK Preview Cancel

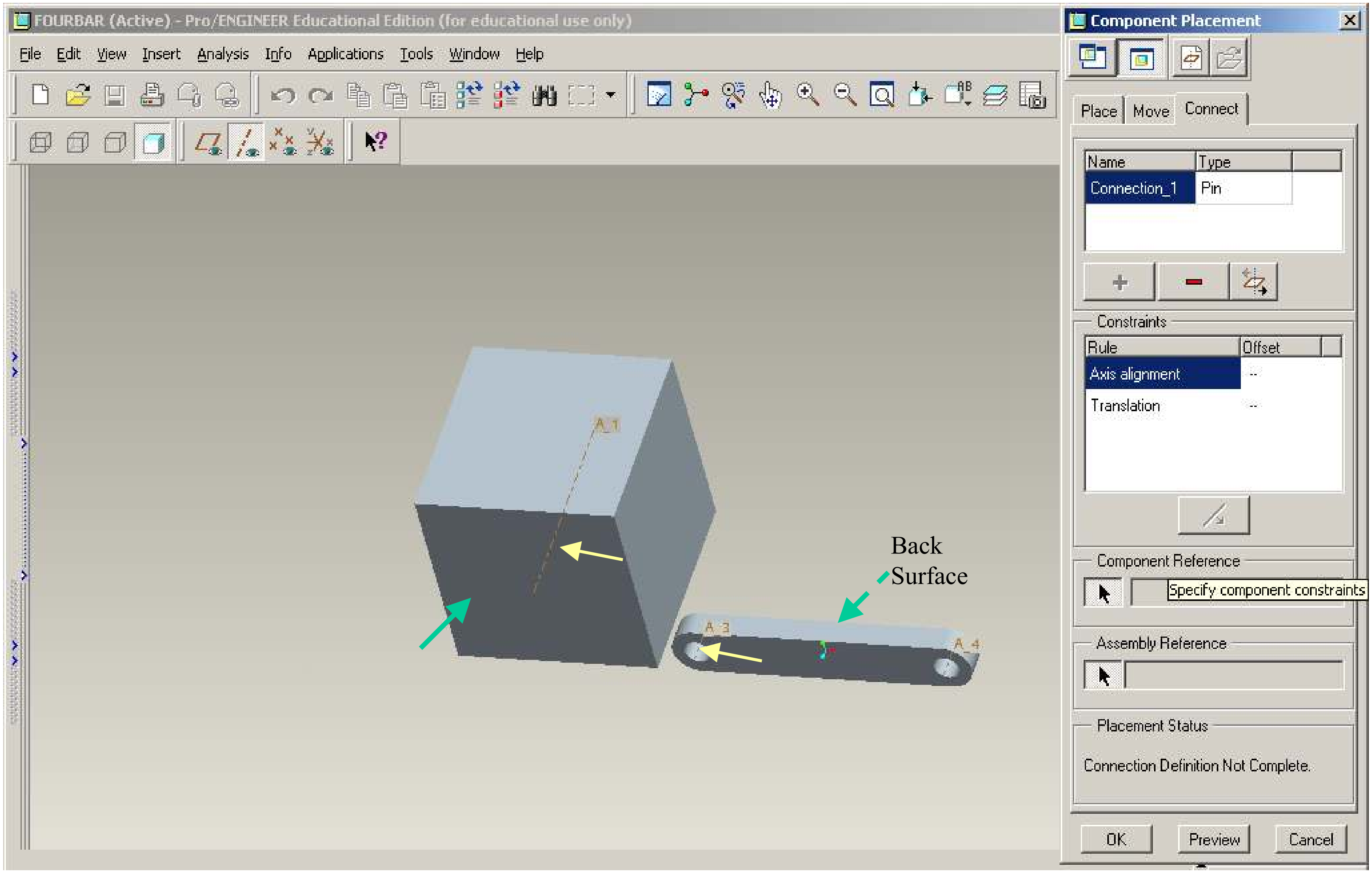
Click on Ok



Click on “Add Component to the assembly” > link1.prt > Open

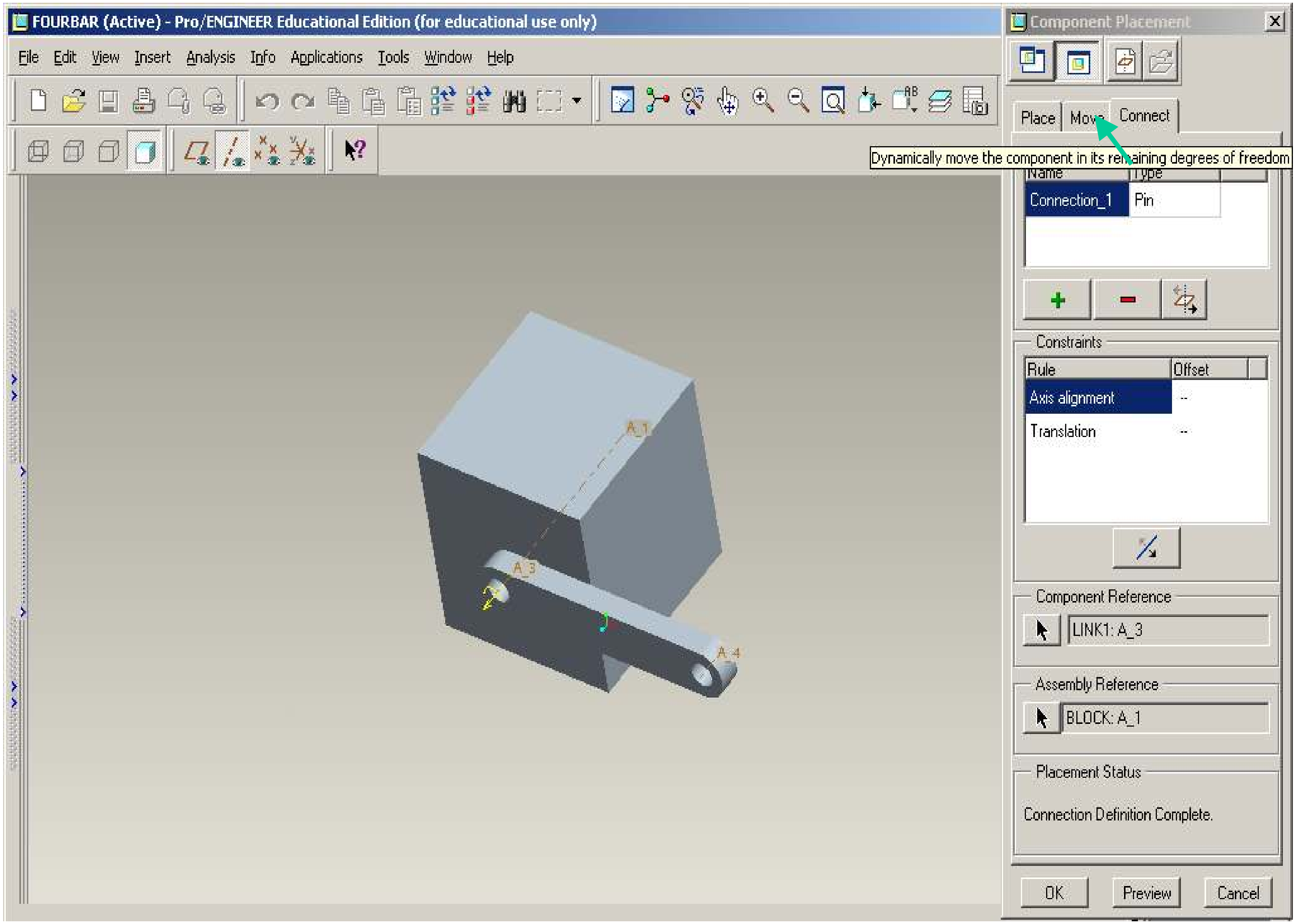


Click on CONNECT Tab at top-right

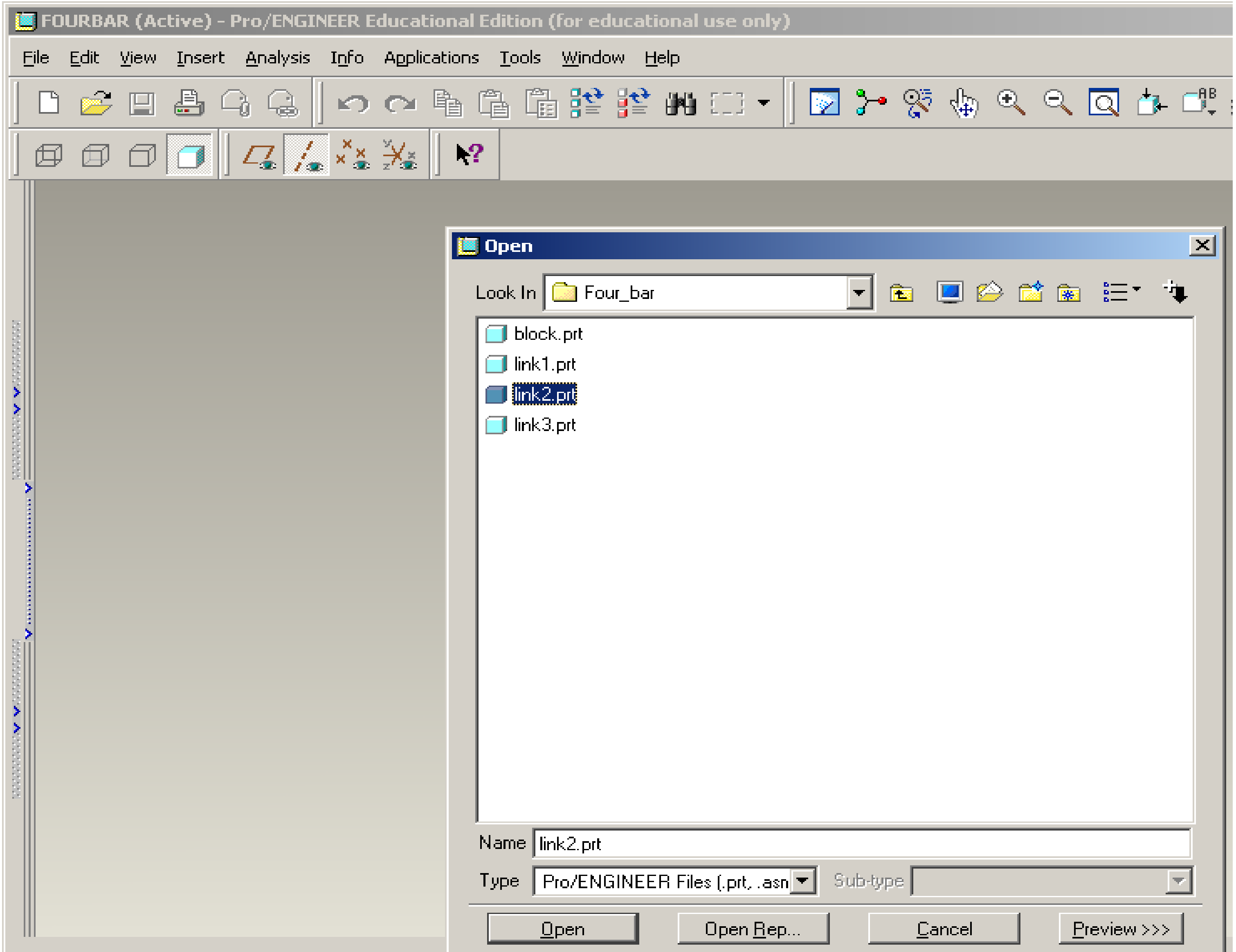


Keep the default “Pin” joint > Axis Alignment > Select A1 and A3 axes (Yellow Arrows)

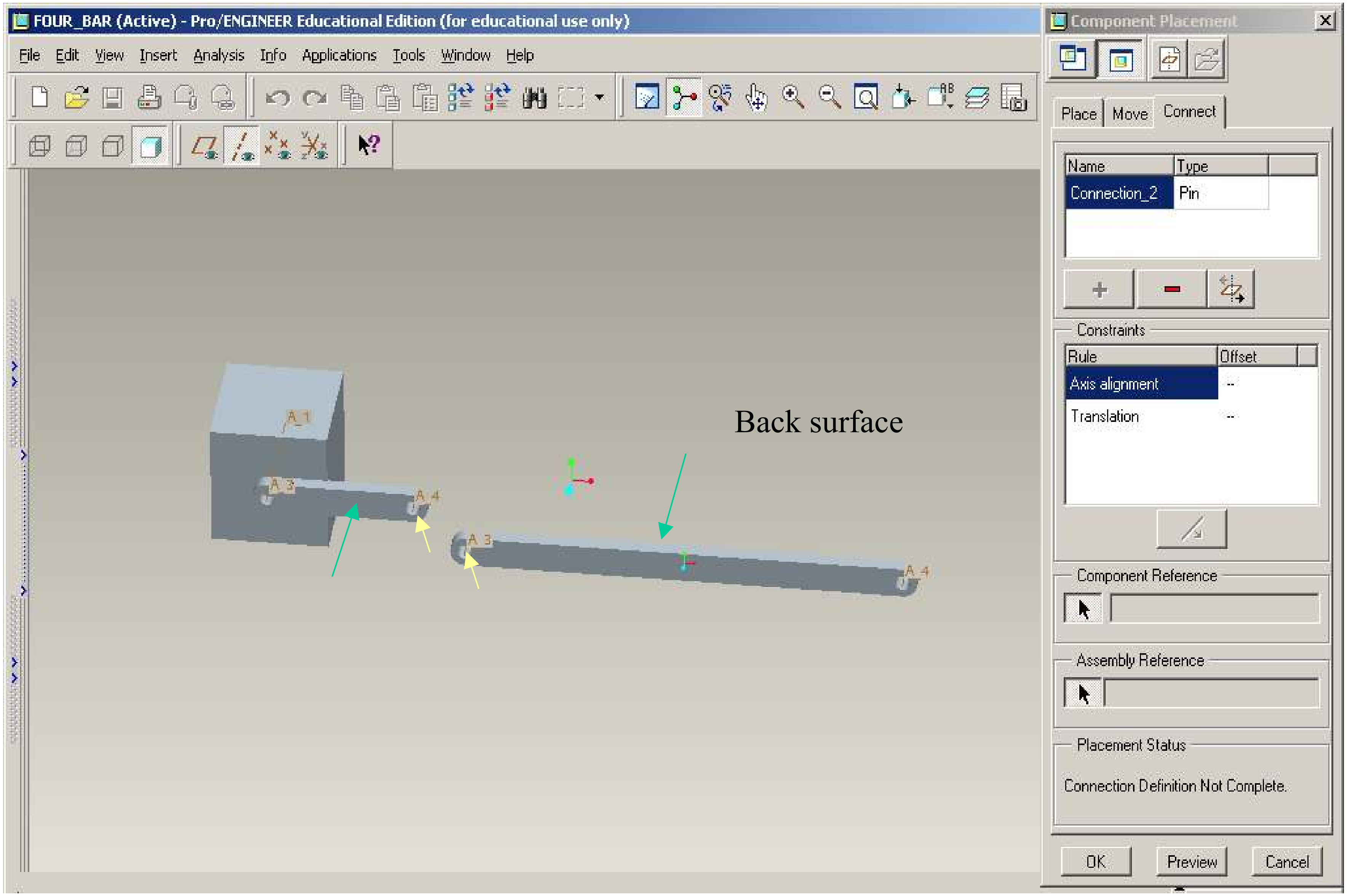
Translation > Select the surfaces as shown (Green Arrows)



Click on Move Tab and rotate the link to required position

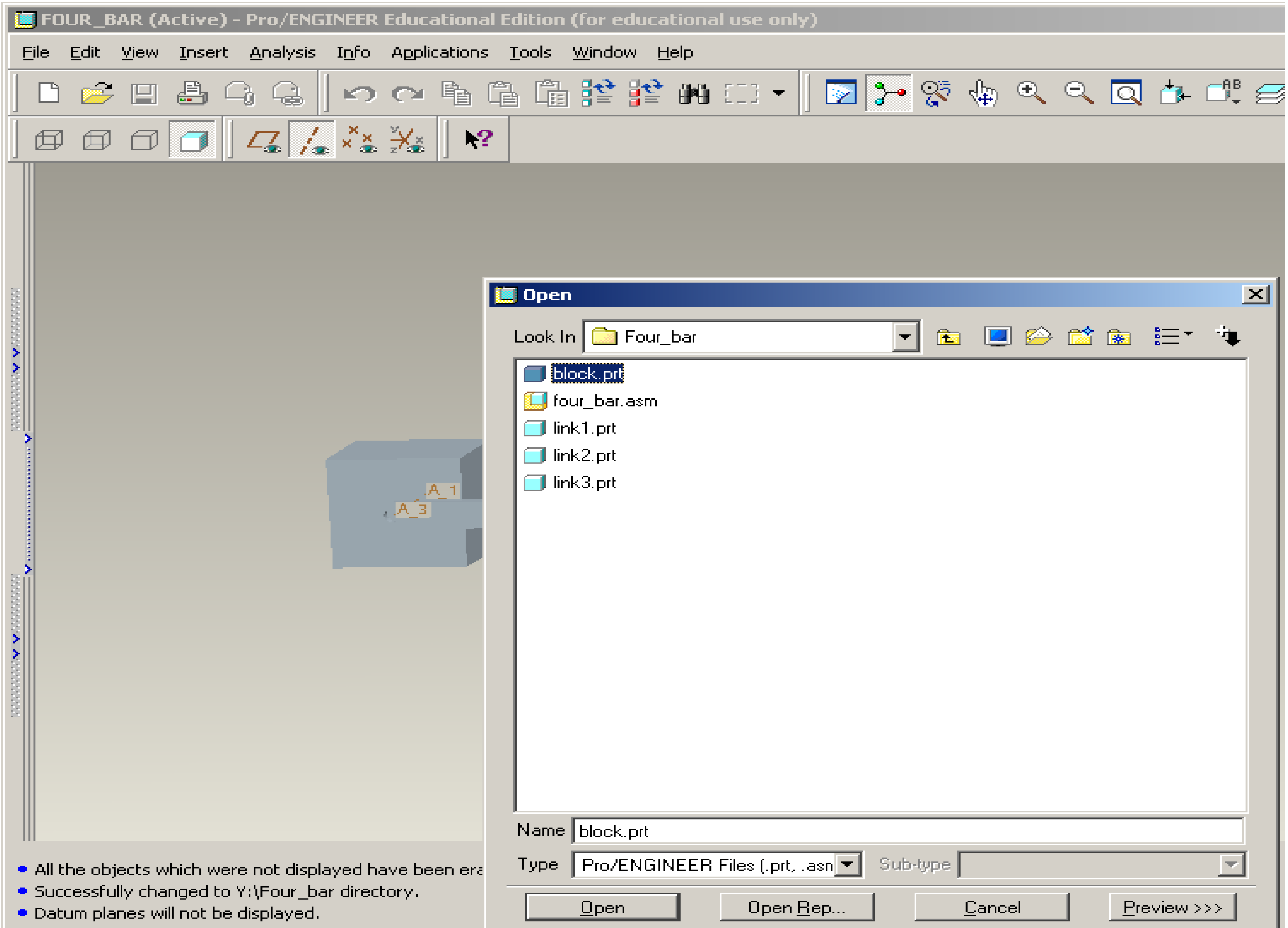


Click on “Add Component to the assembly” > link2.prt > Open



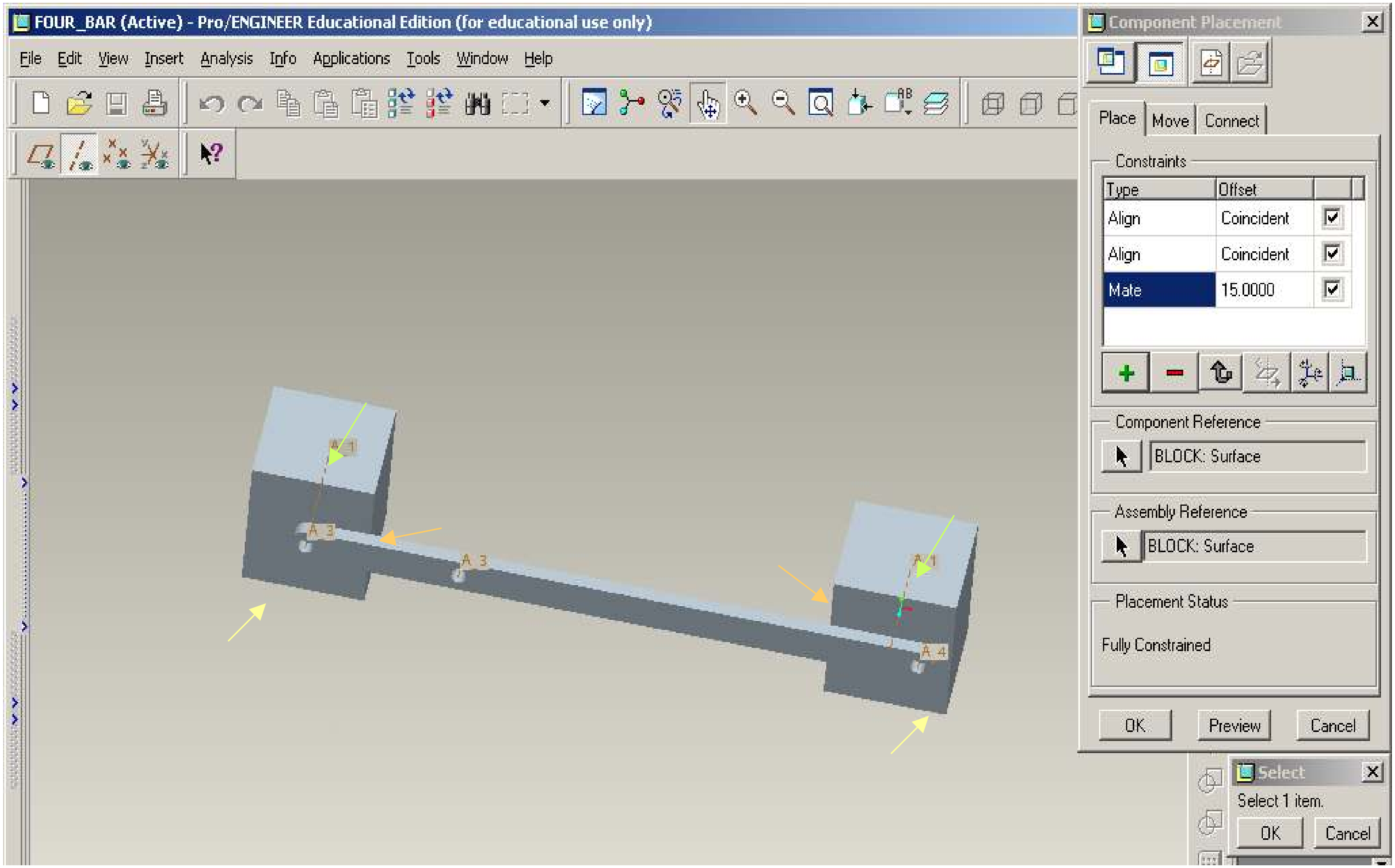
Keep the default "Pin" joint > Axis Alignment > Select A4 and A3 axes (Yellow Arrows)

Translation > Select the surfaces as shown (Green Arrows)



Insert Base Block Again

Select block1.prt > Open

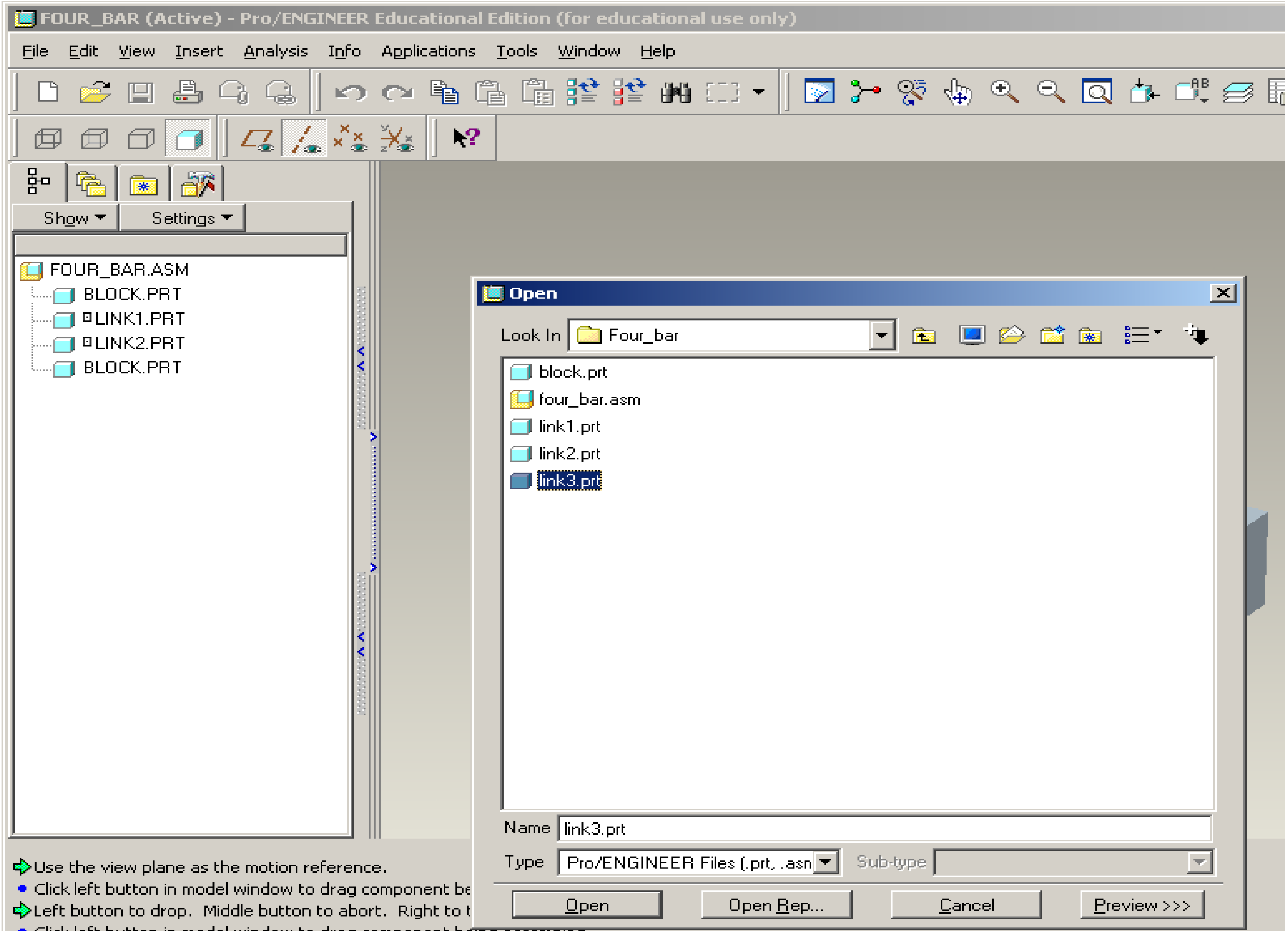


Place (not Connect)

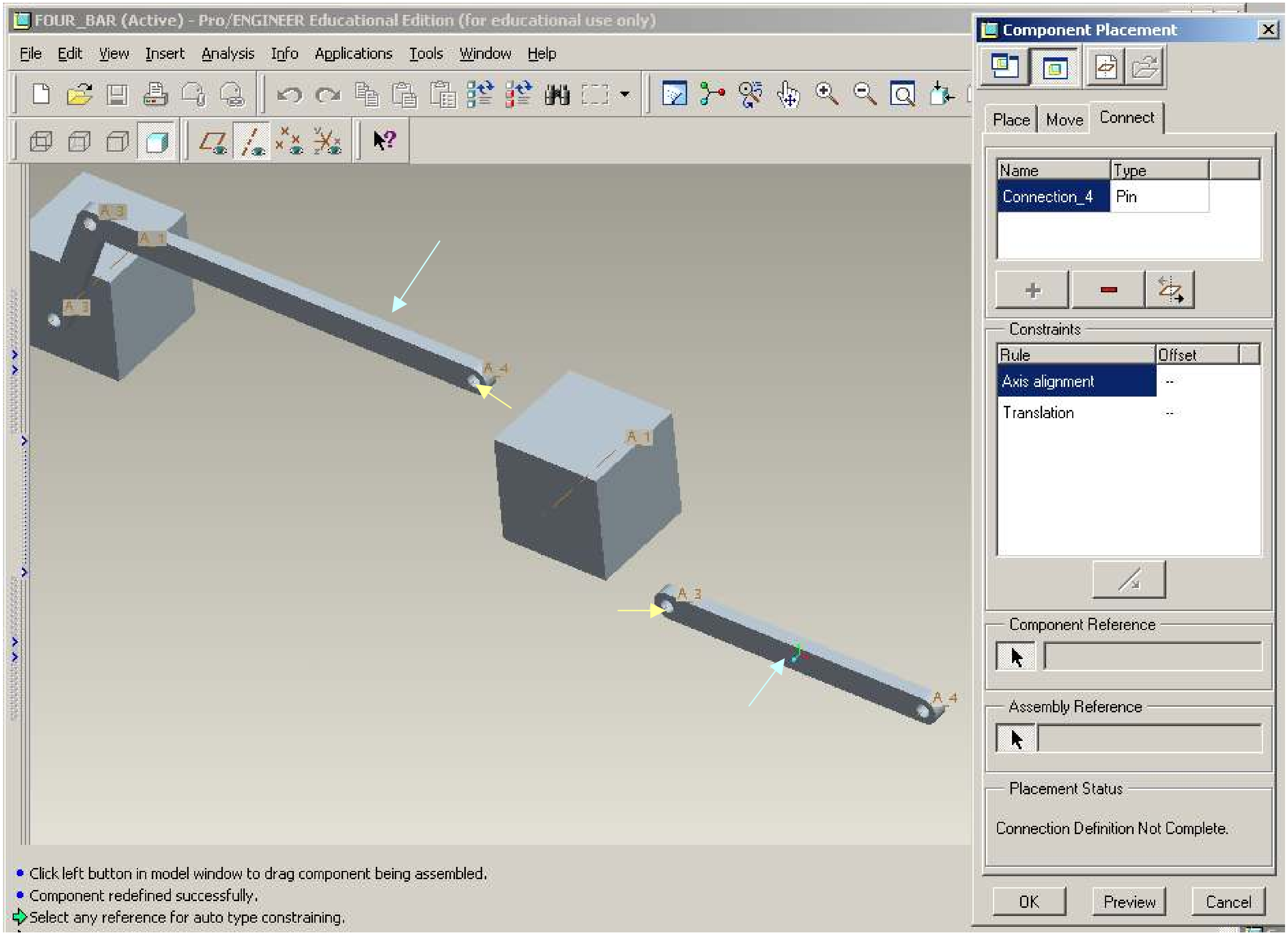
First Align Constraint – surfaces indicated by yellow arrows

Second Align Constraint – surfaces indicated by green arrows

Third Mate Constraint – surfaces indicated by orange arrows

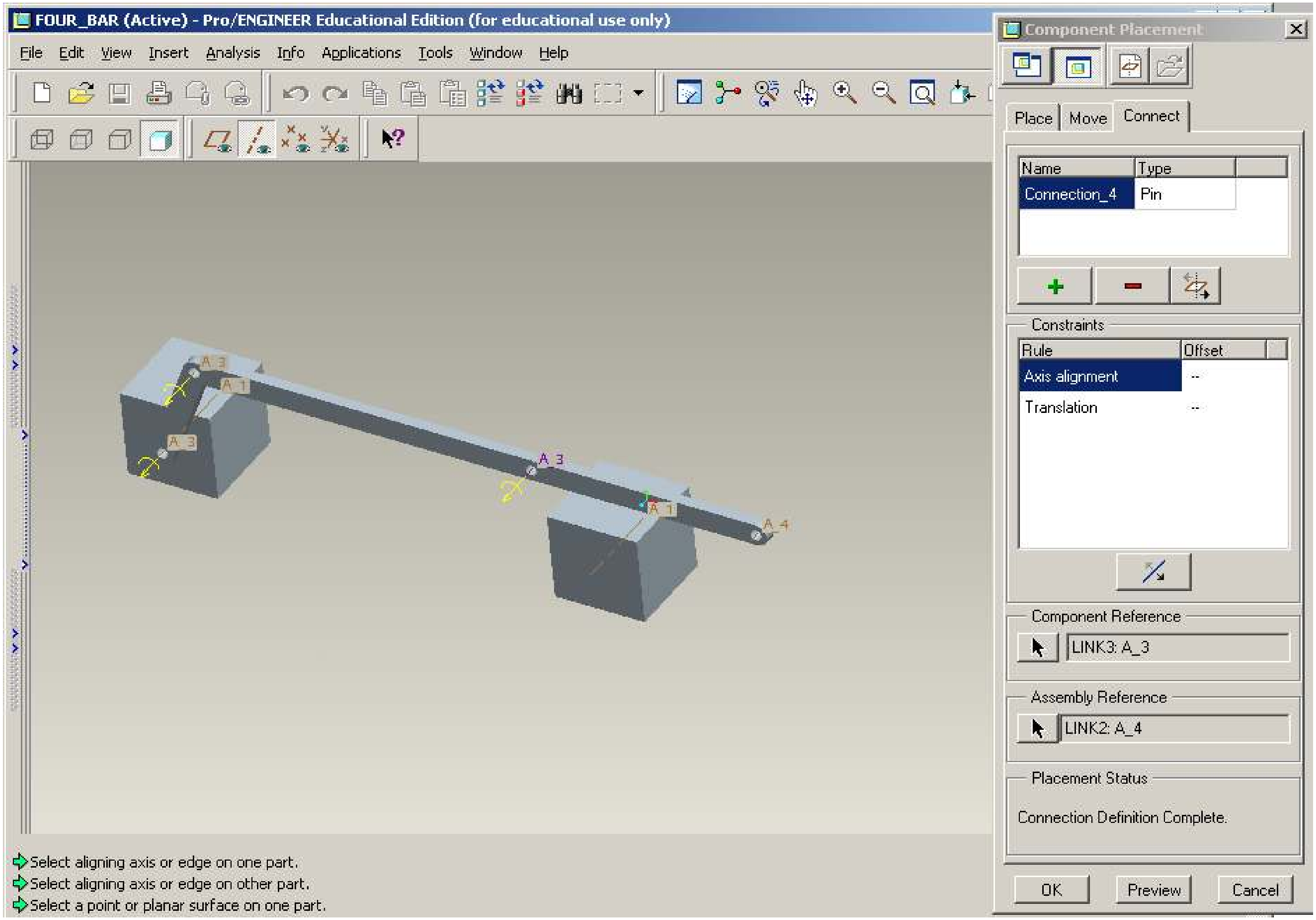


Select link3.prt > Open

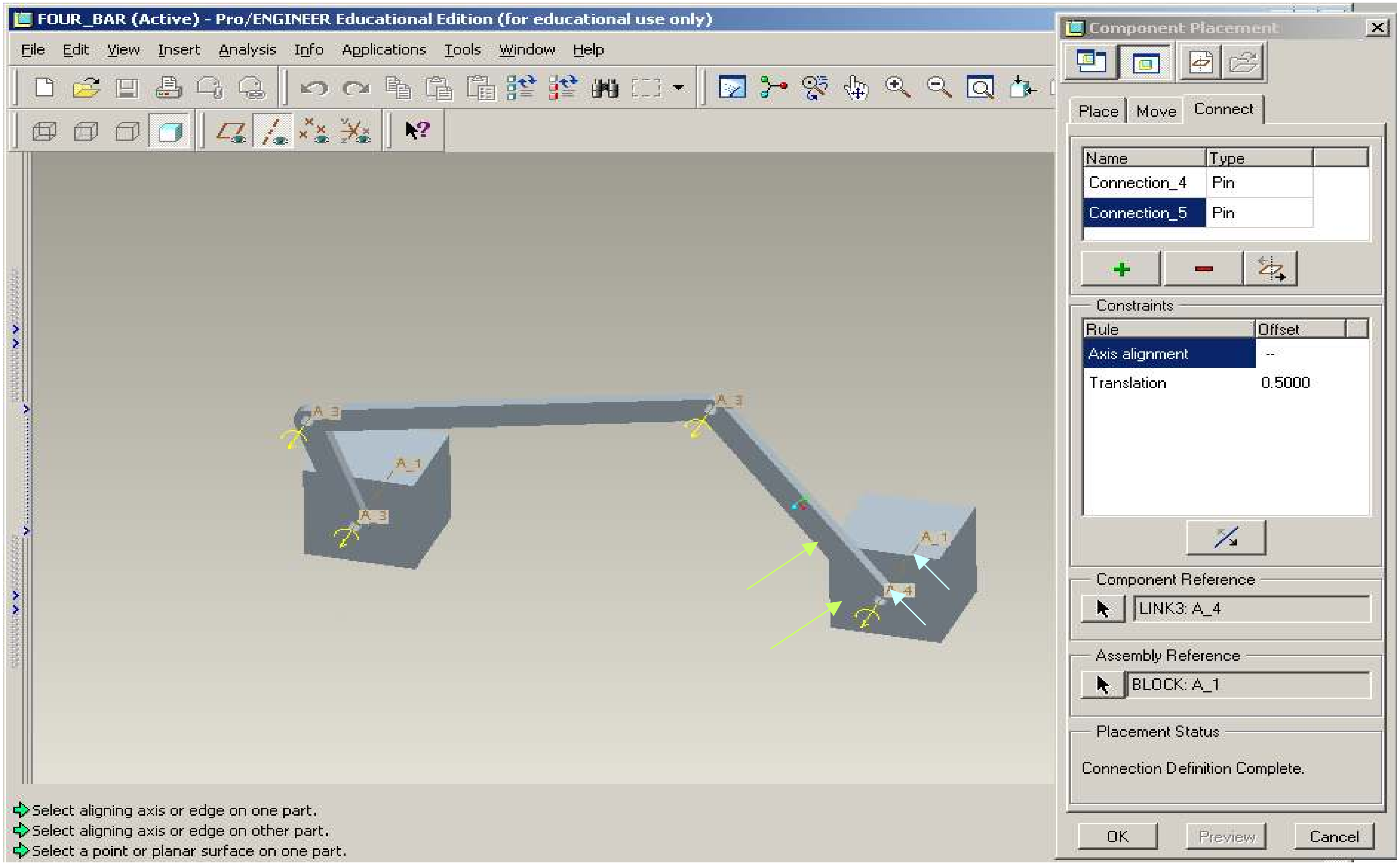


Keep the default "Pin" joint > Axis Alignment > Select A4 and A3 axes (Yellow Arrows)

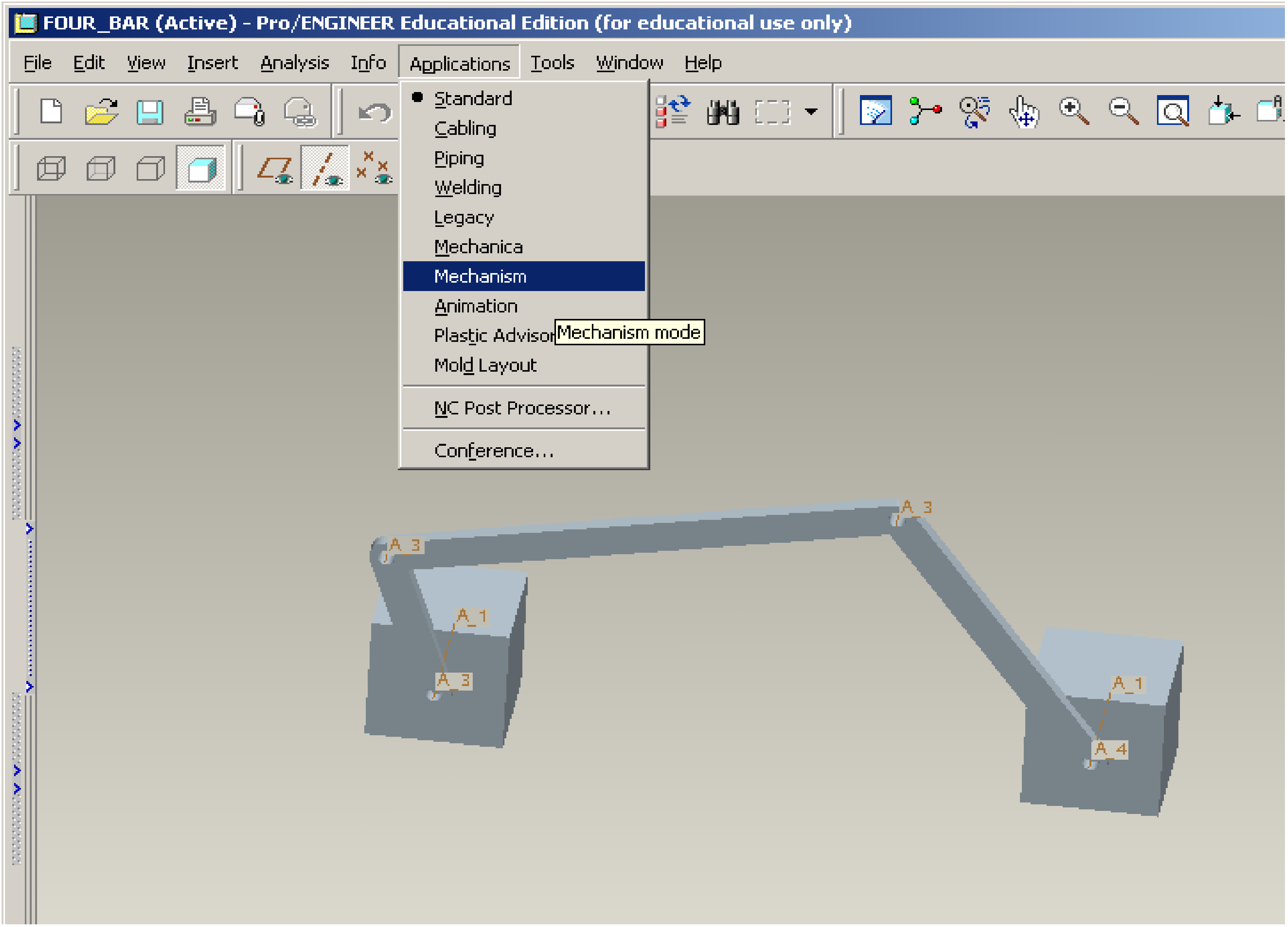
Translation > Select the surfaces as shown (blue Arrows)



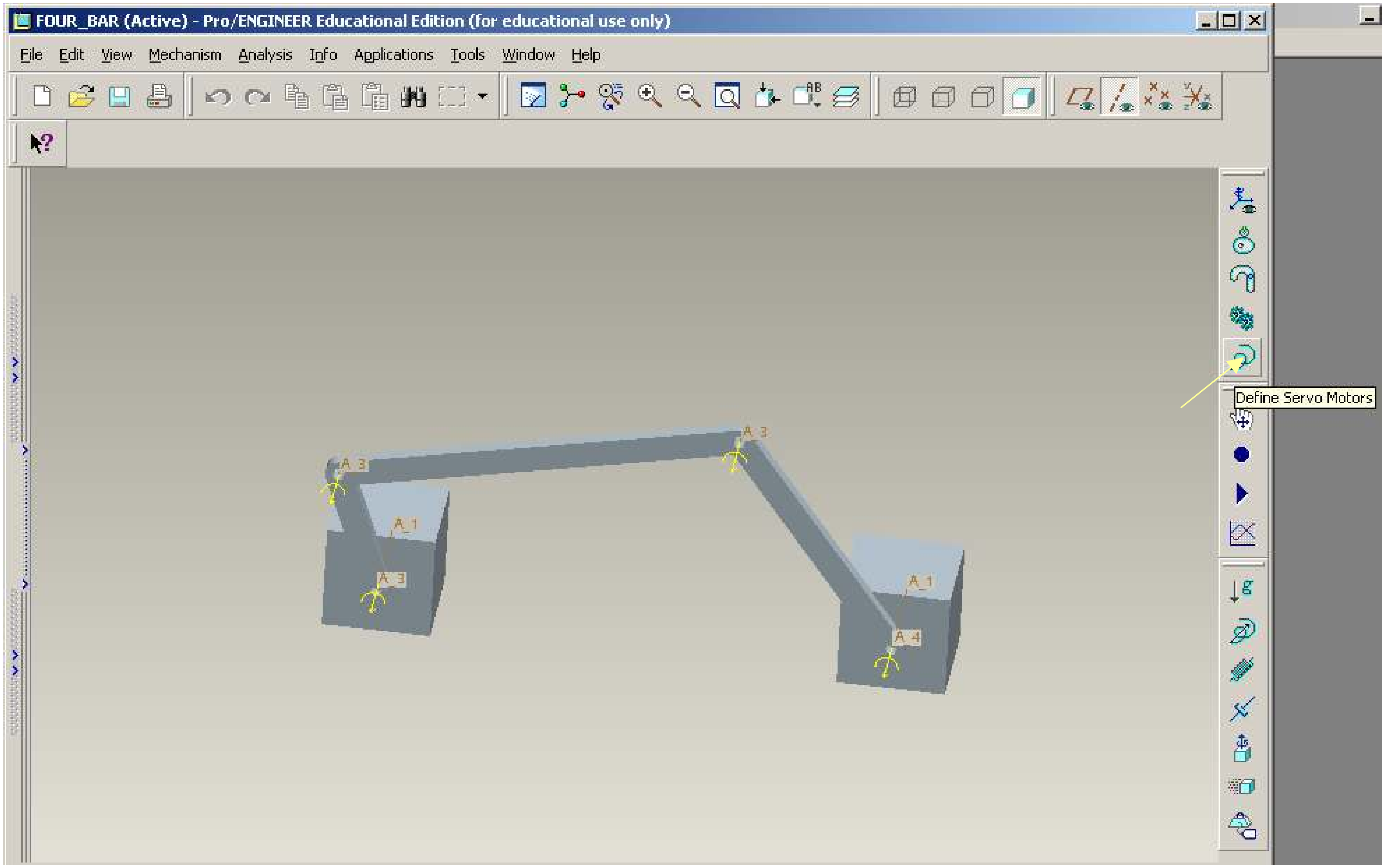
Click on ok. Add one more Connection > Pin joint



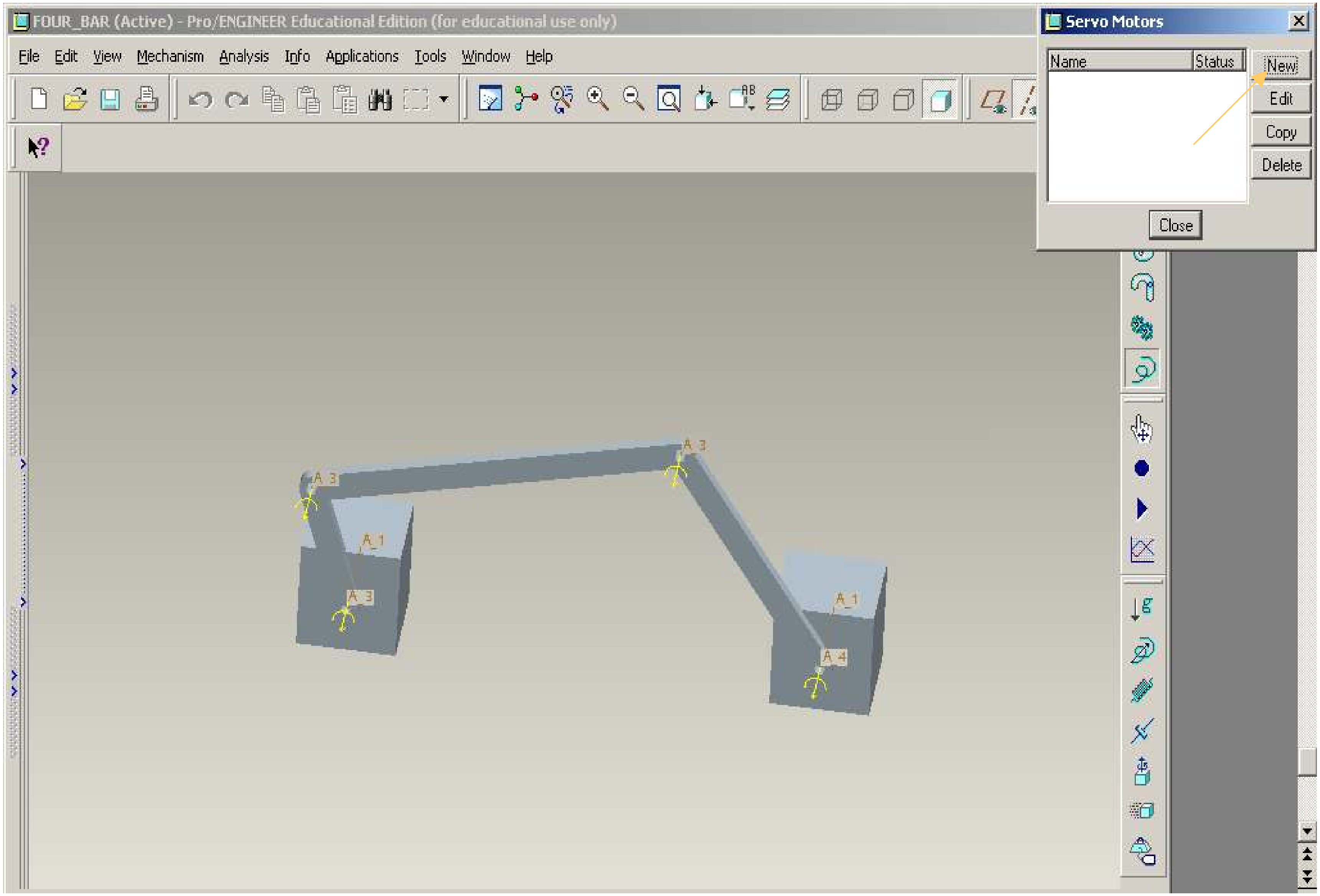
Align the A4 with A1 and for Translation – Select the surfaces as indicated by green arrows.



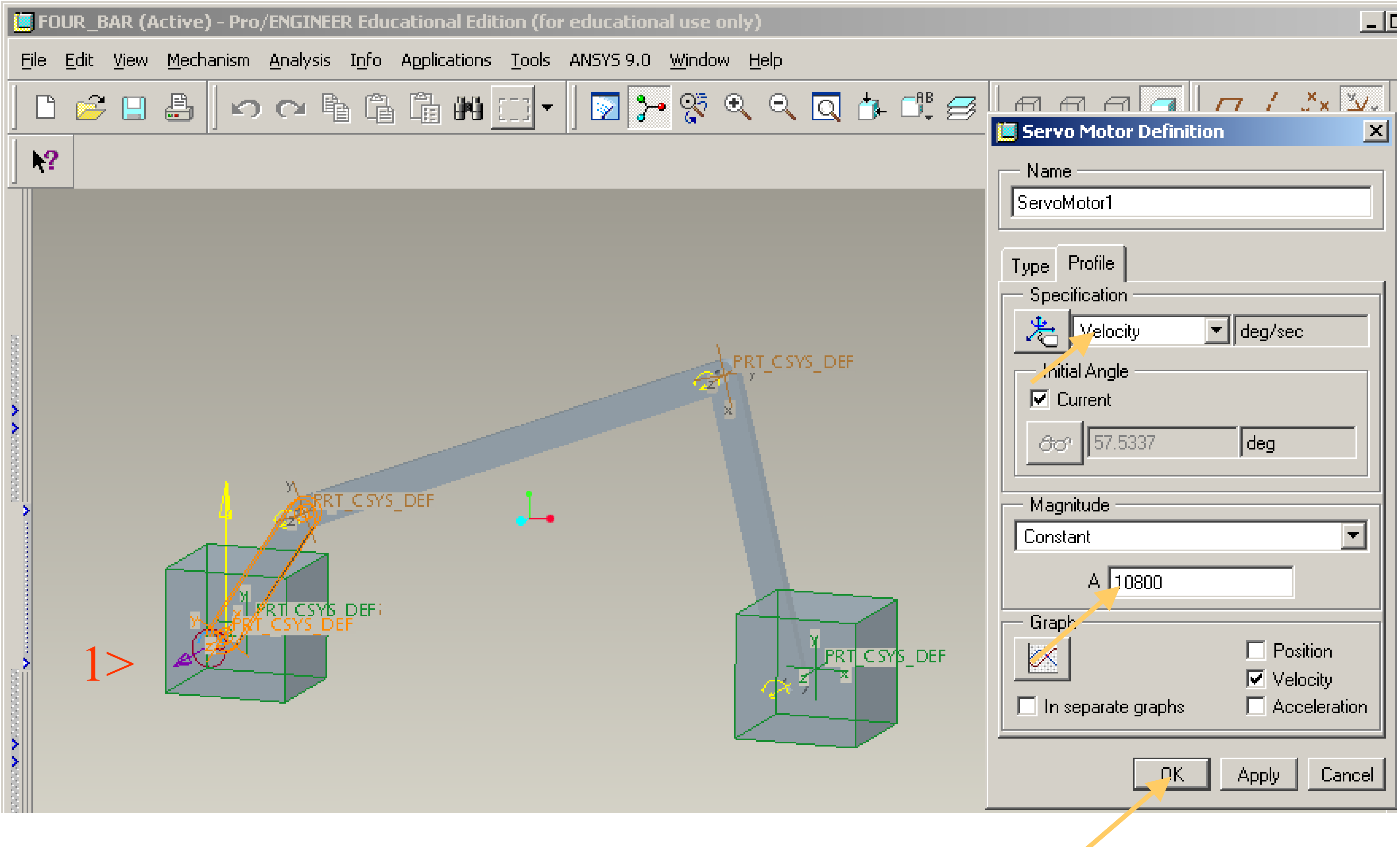
Mechanism Mode – Select Mechanism option from the menu bar.



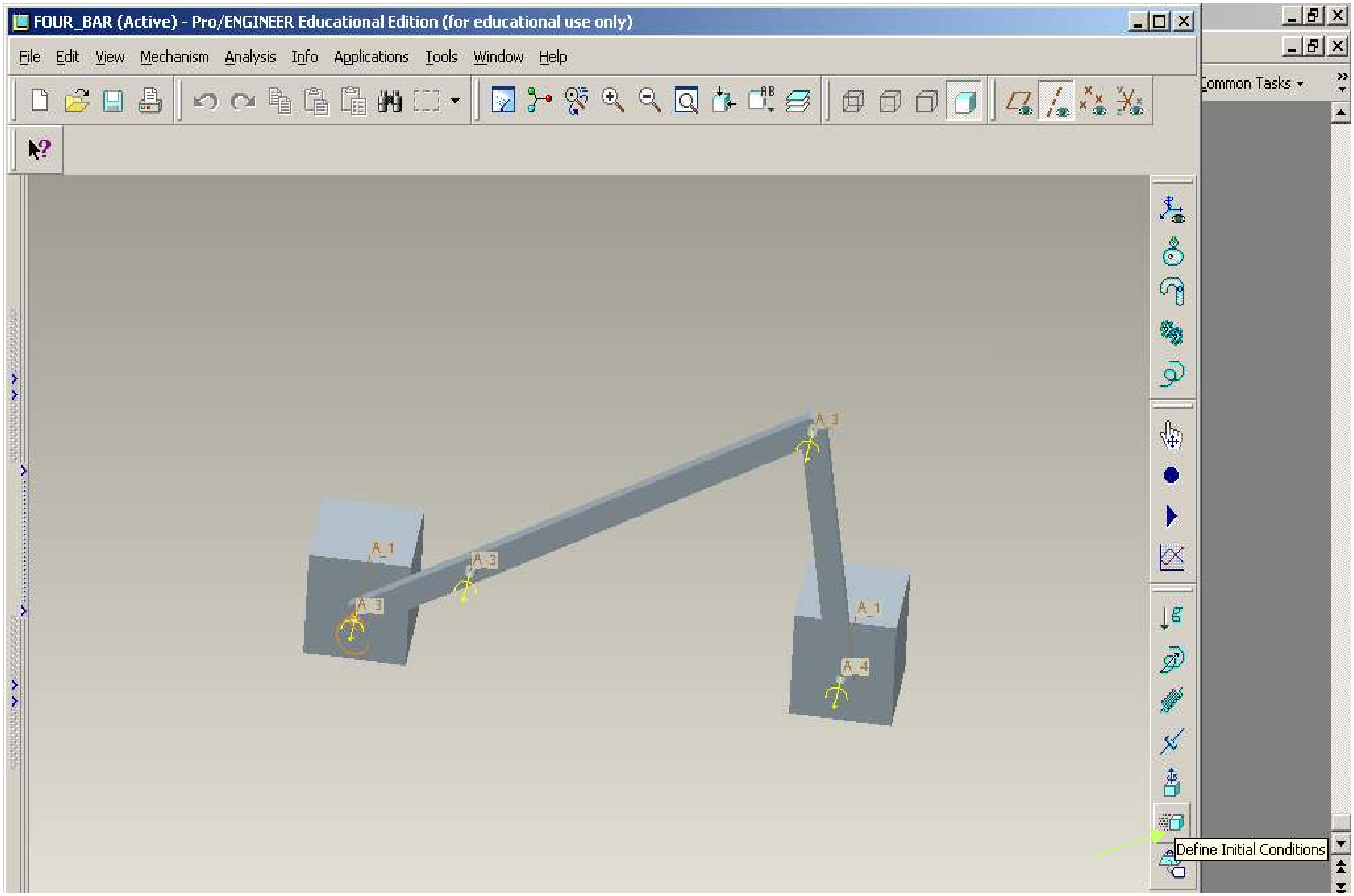
To define the driver, select the Define Servo Motors icon.



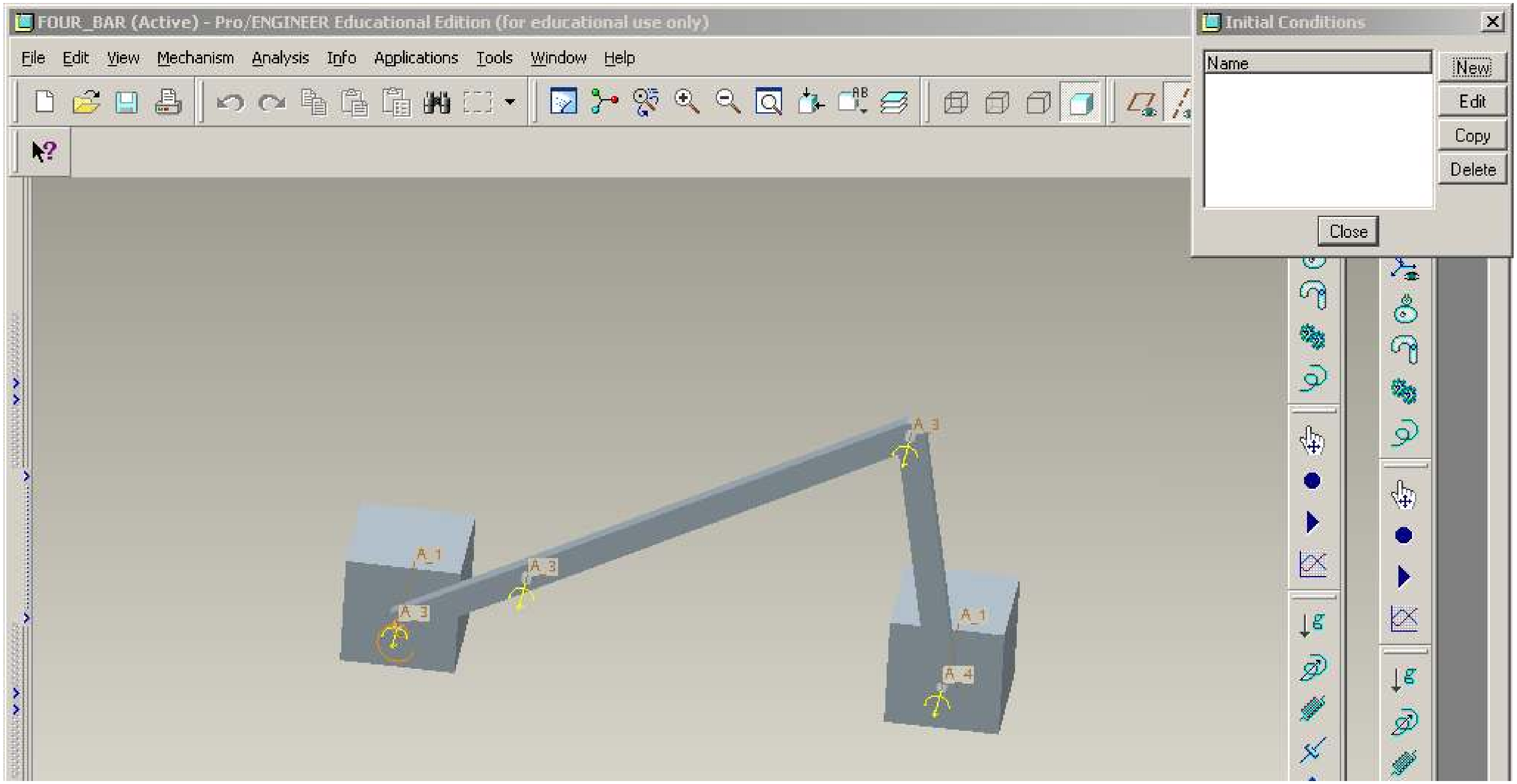
Click on New button to define the parameters of the servo motor.



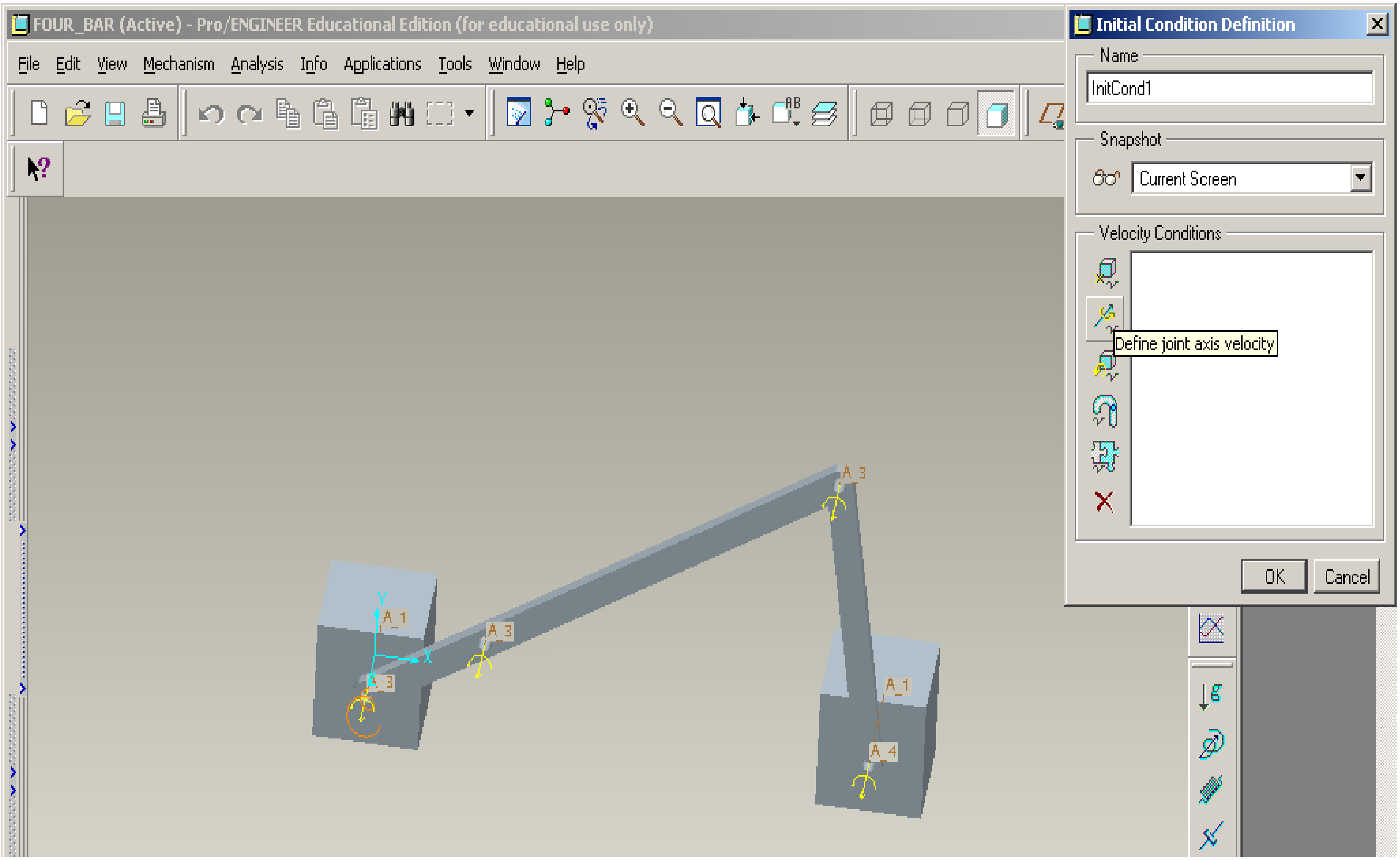
Select the JOINT 1 axis indicated by orange colored arrow to be the servo motor axis. > Enter 10800 > OK > Close



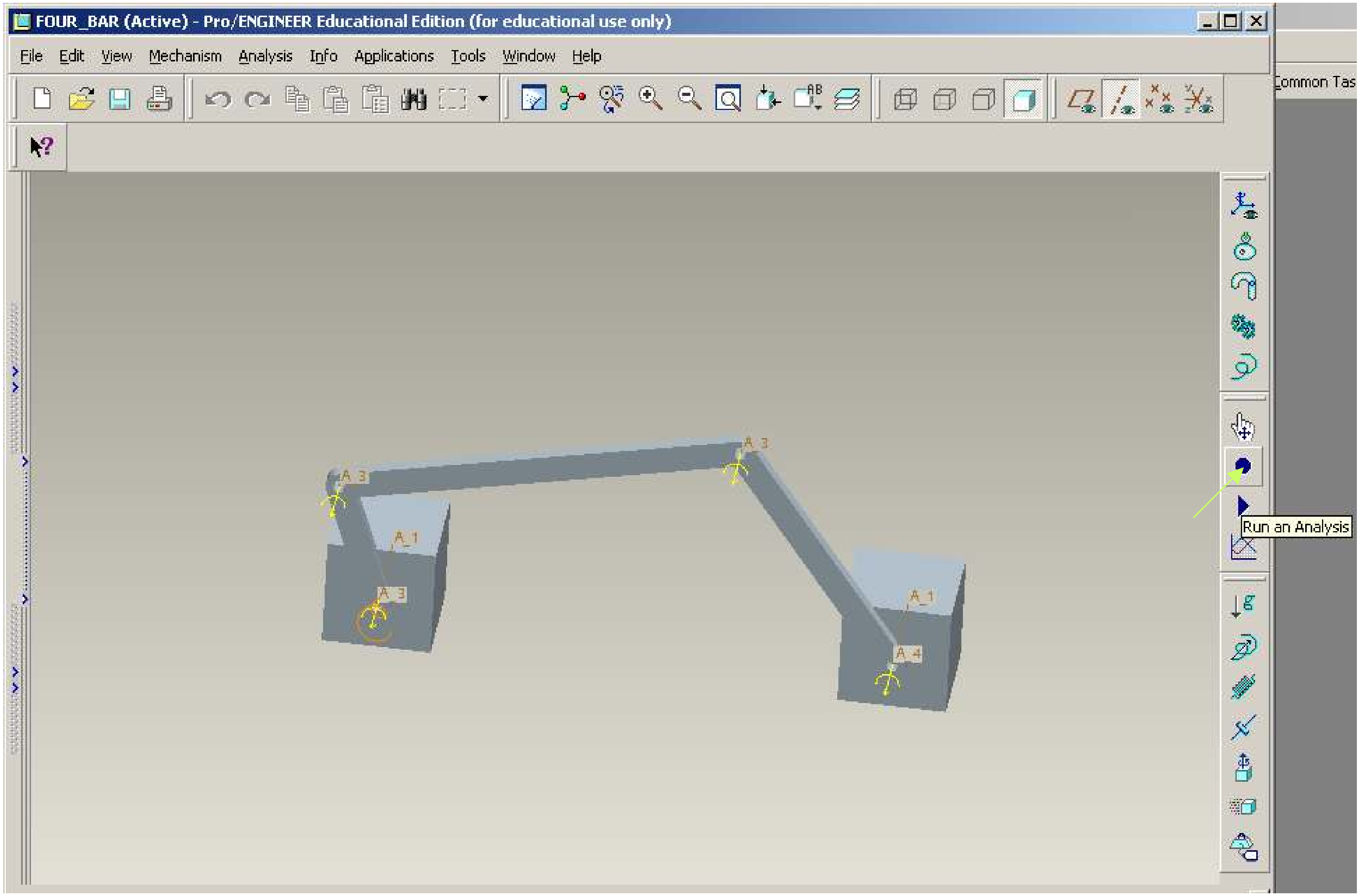
Click on Define Initial Conditions to set the initial parameters.



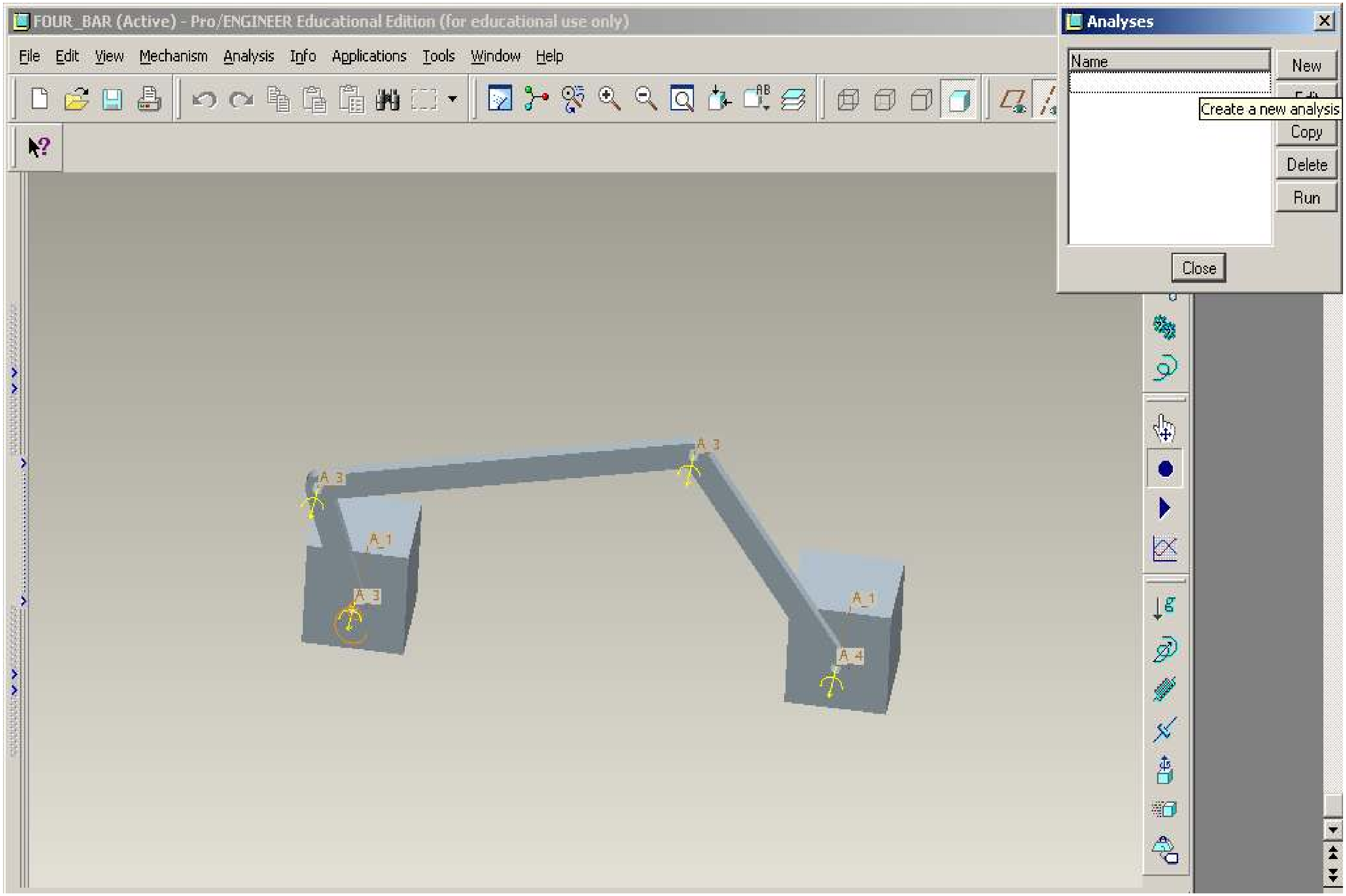
Select New to define new conditions.



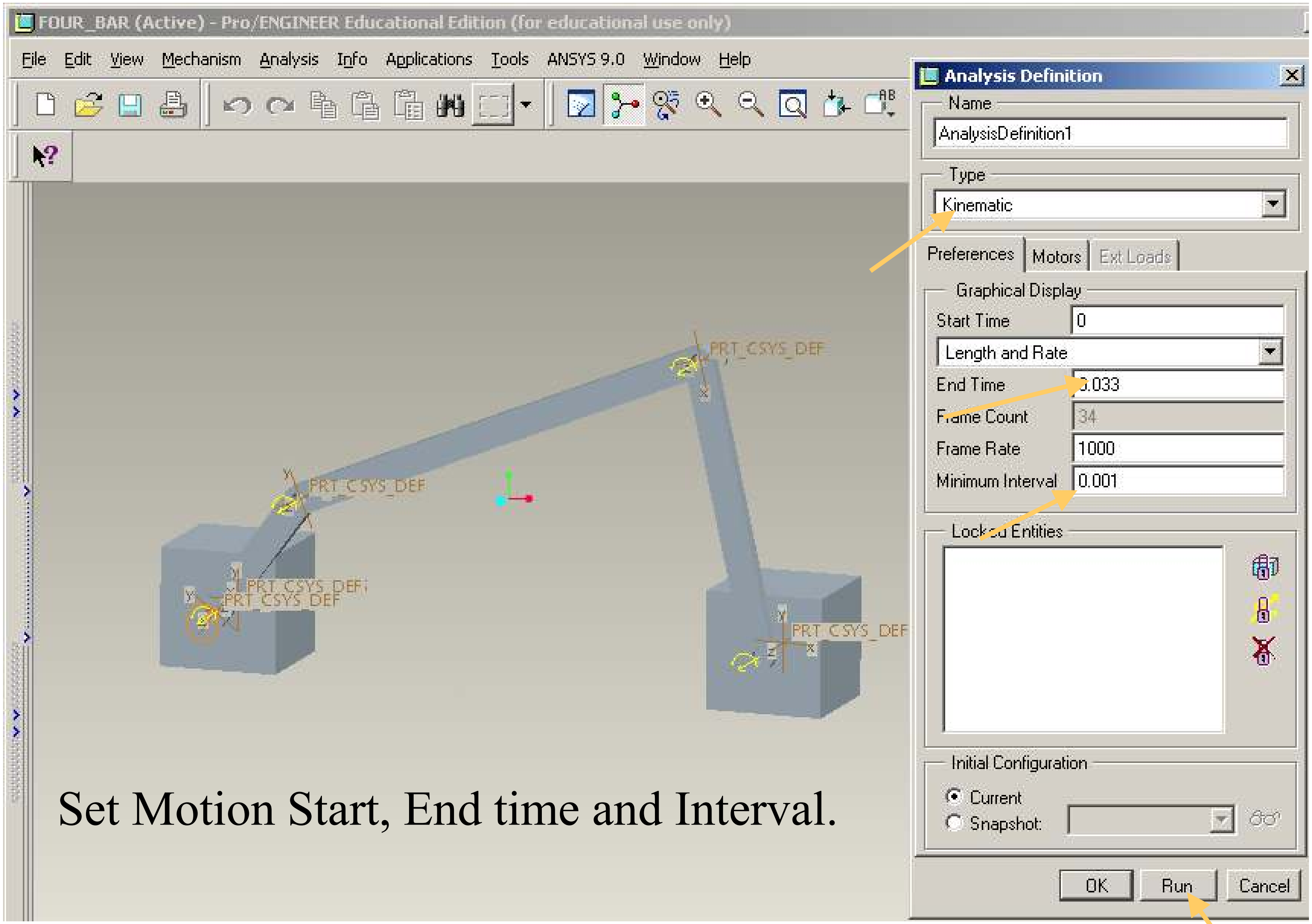
Define any initial desired parameters.



Click on Run Analysis icon as indicated



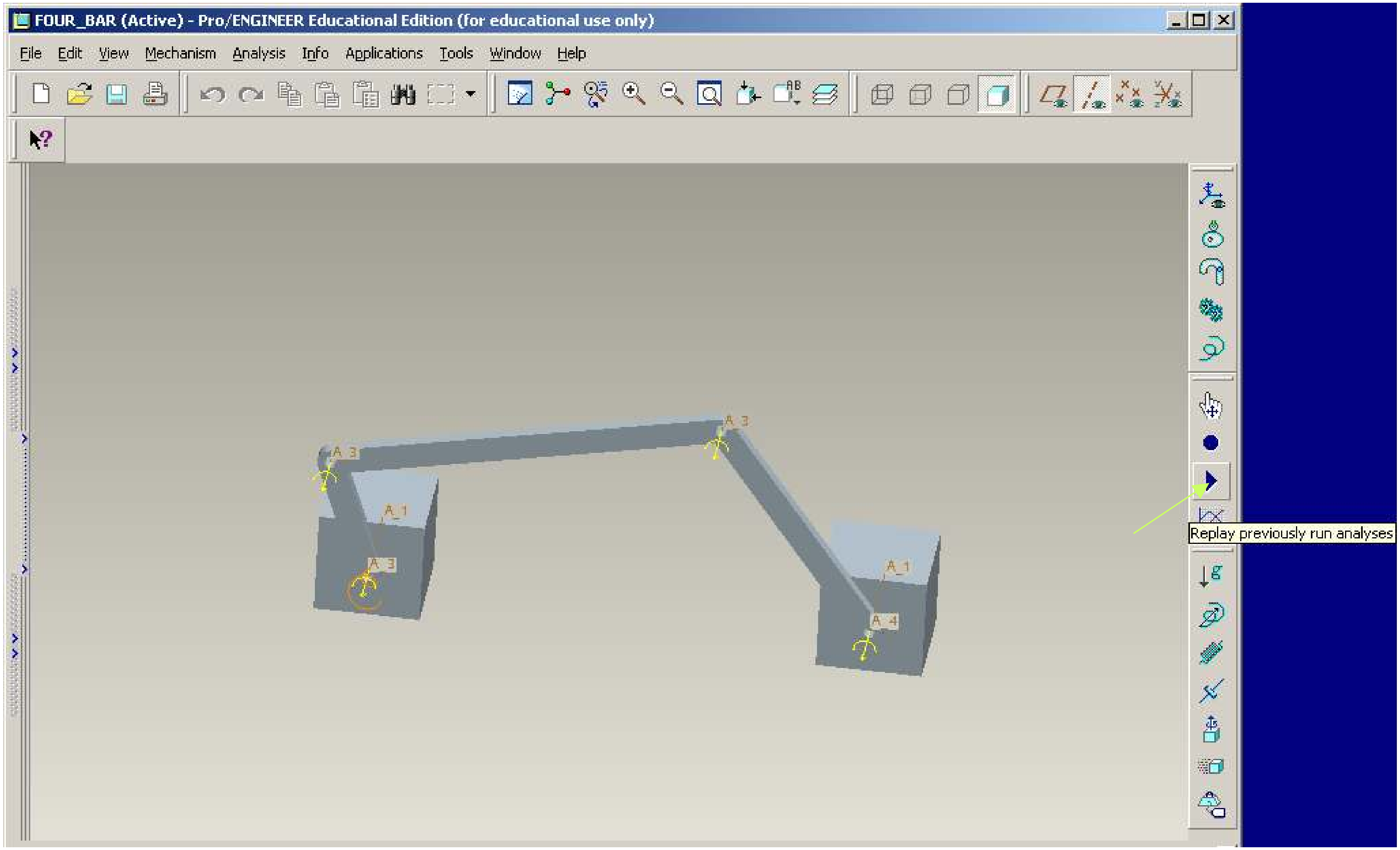
1. Do KINEMATIC Analysis First Click on New.



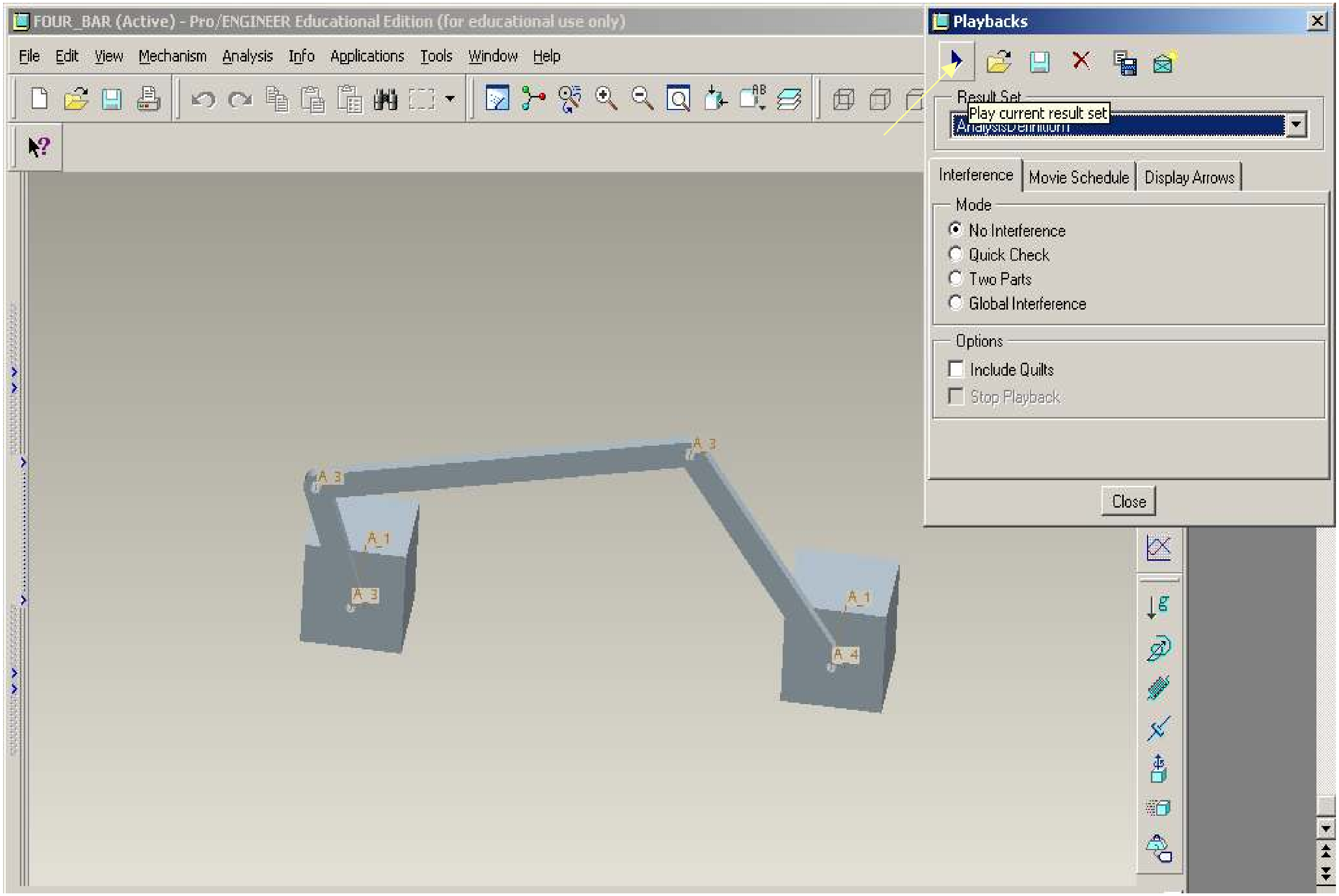
Set Motion Start, End time and Interval.

Click on Run to compute the results > OK > Close

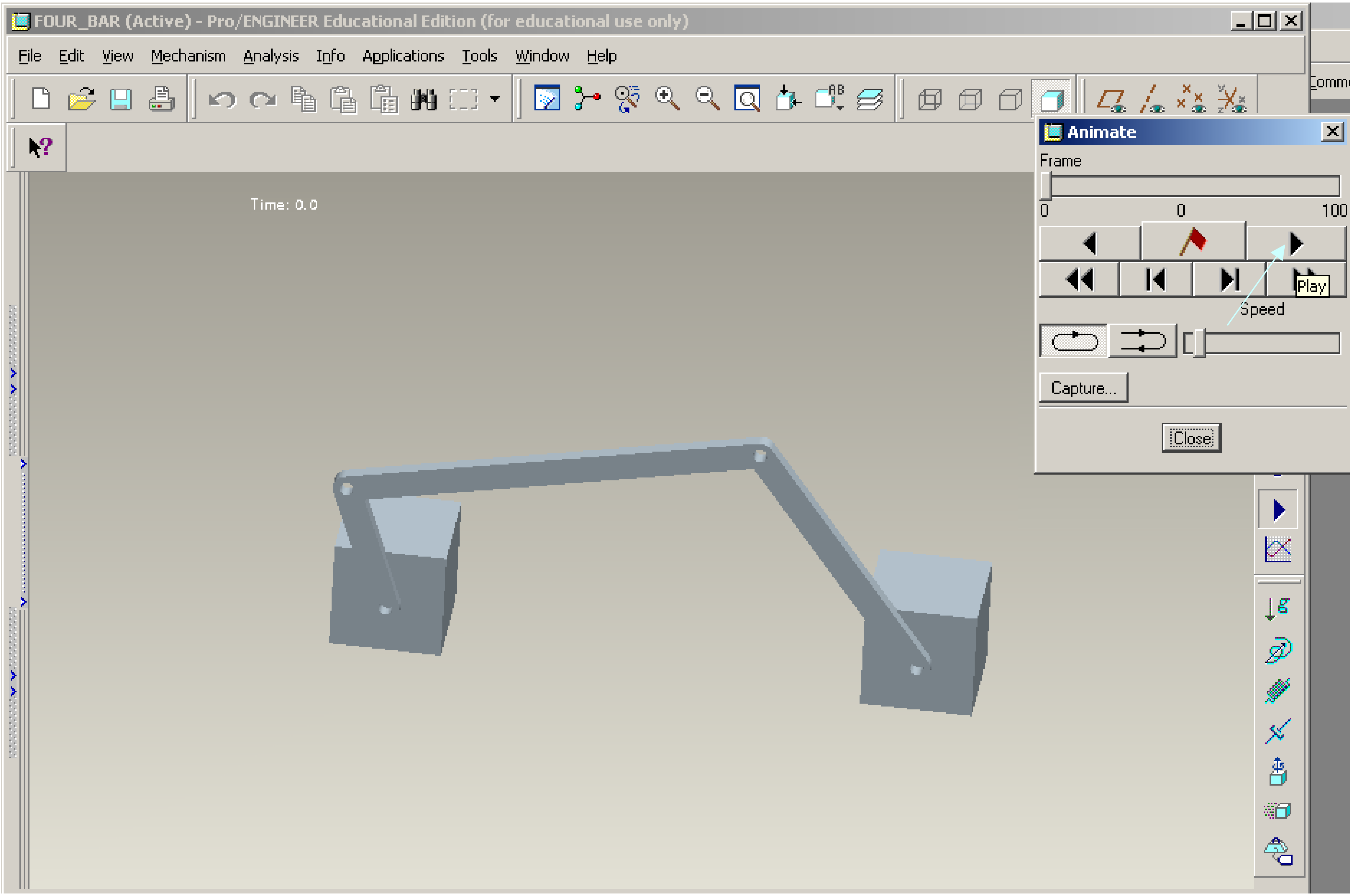
Note that the initial configuration is the current position.



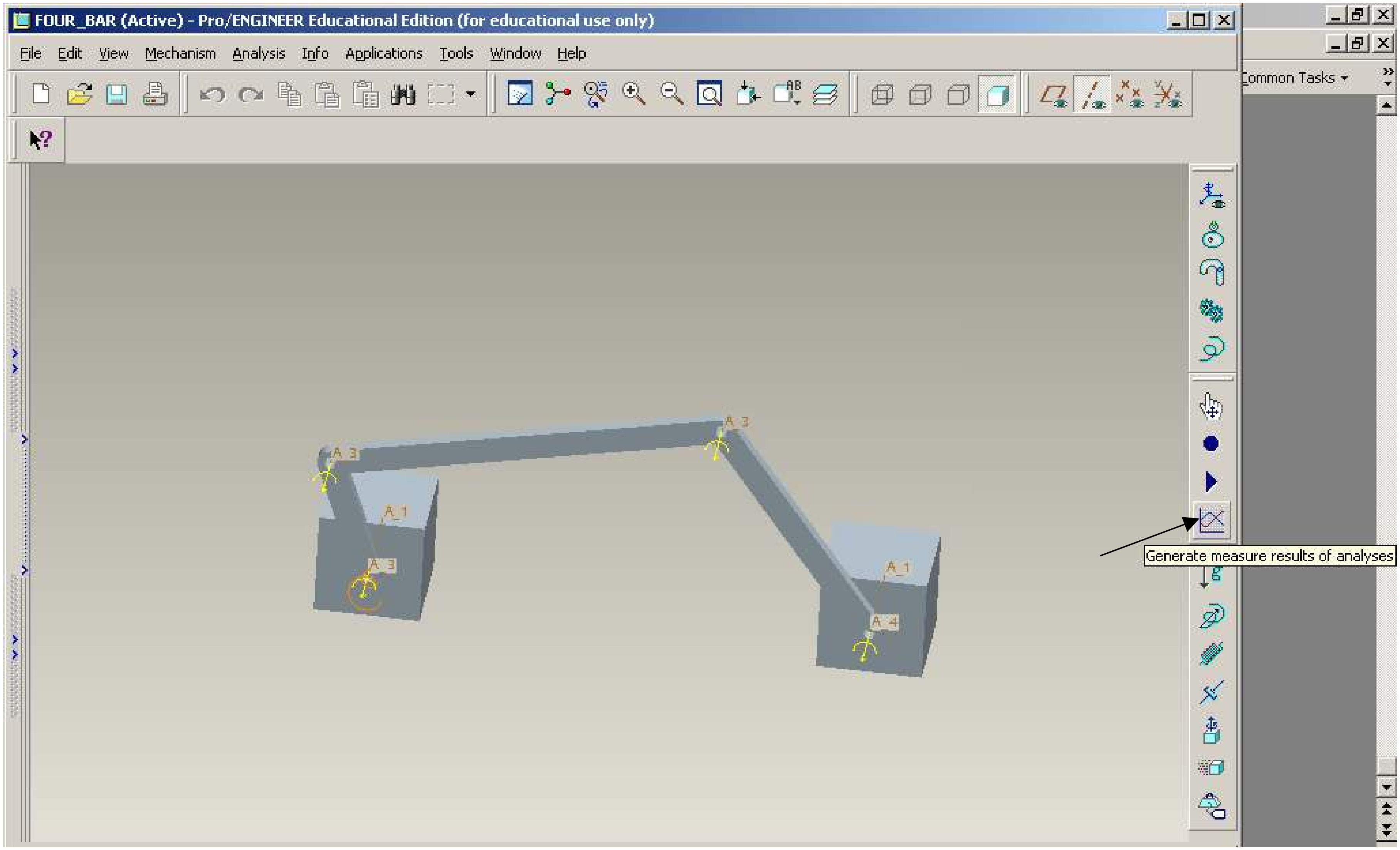
Select Replay previously run analyses to display the motion.



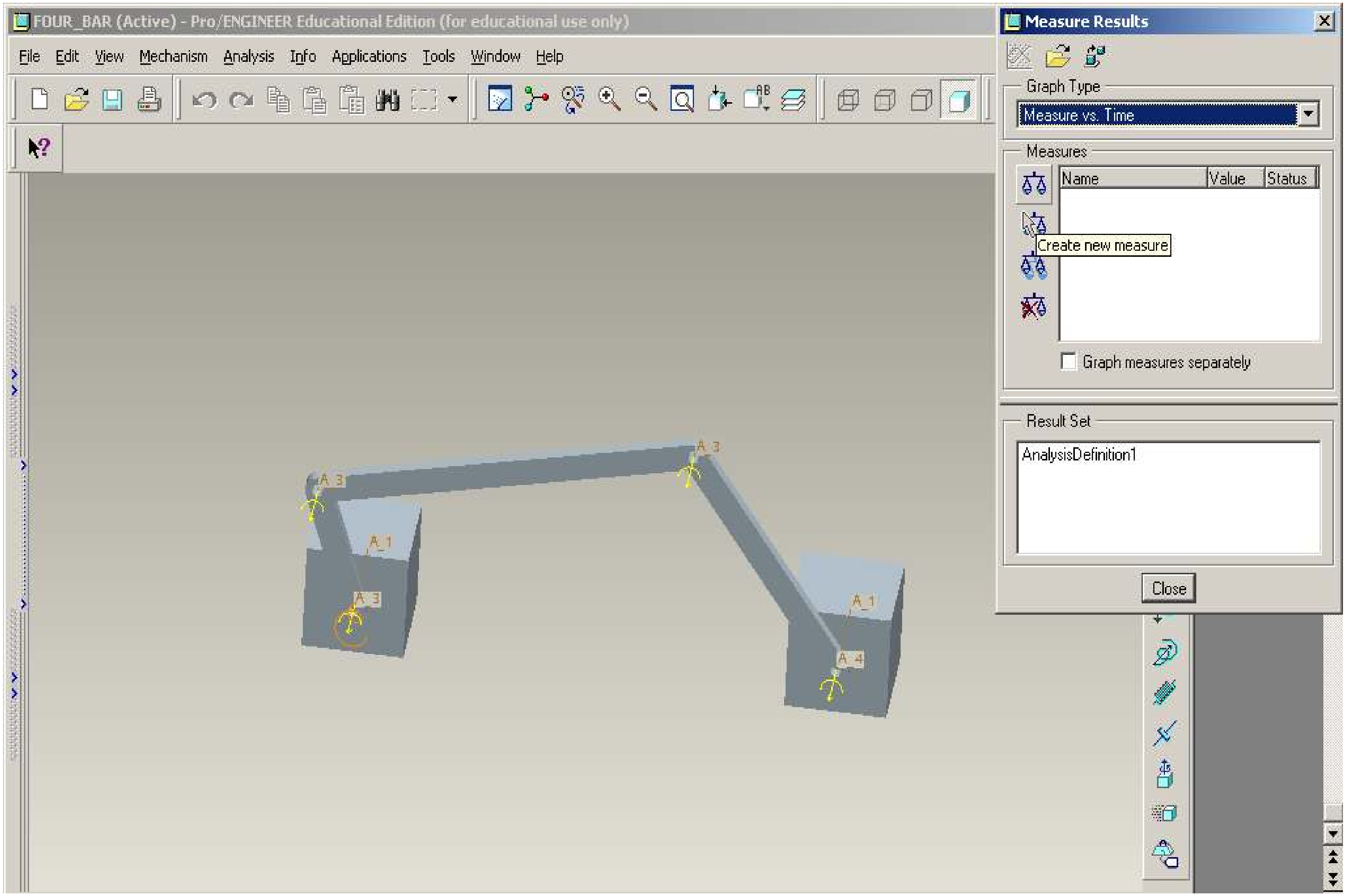
Click on Play current result set to run the analysis.



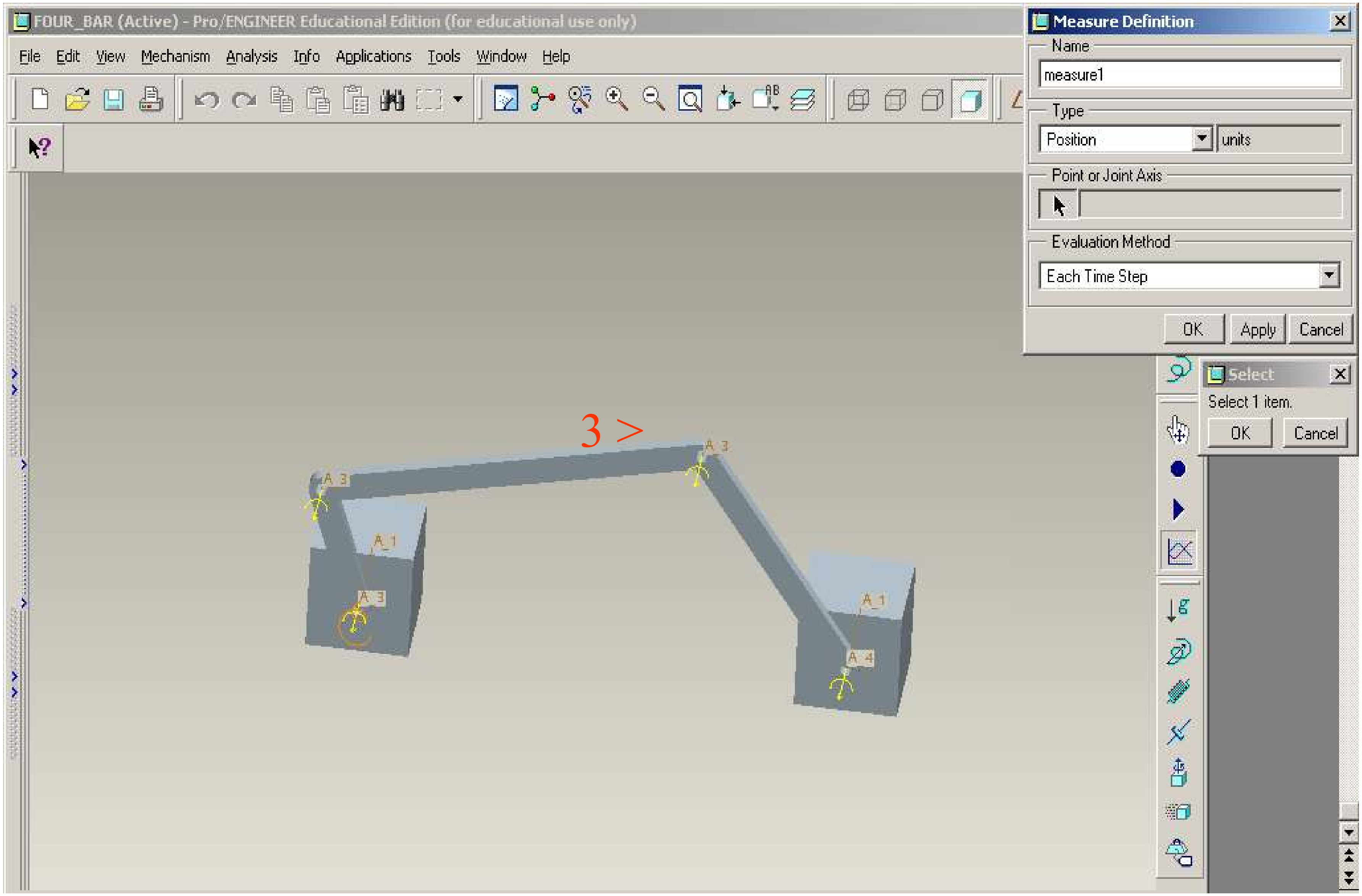
Click the play option to play the animation.



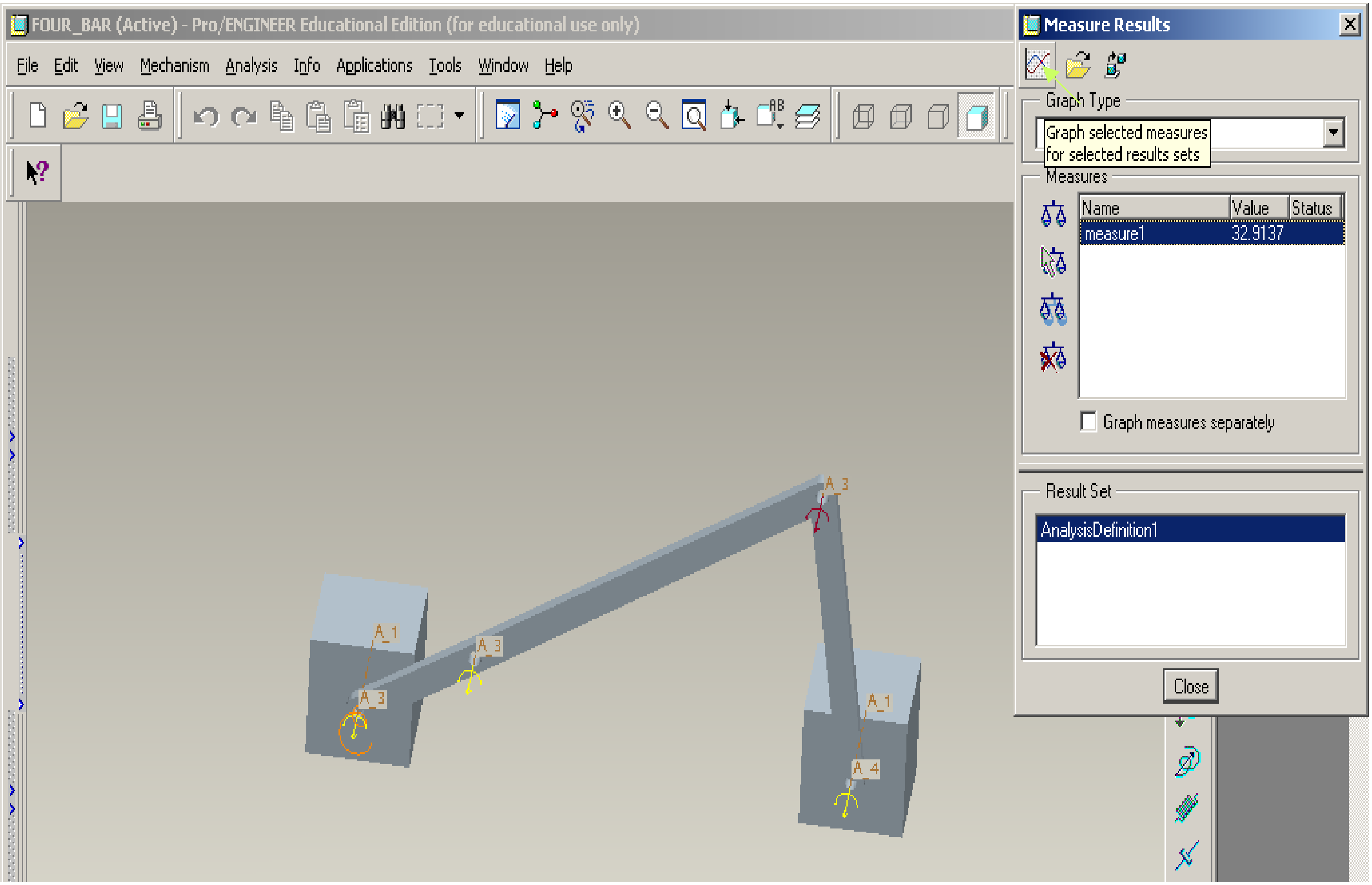
Click on the graph icon to generate the graphs.



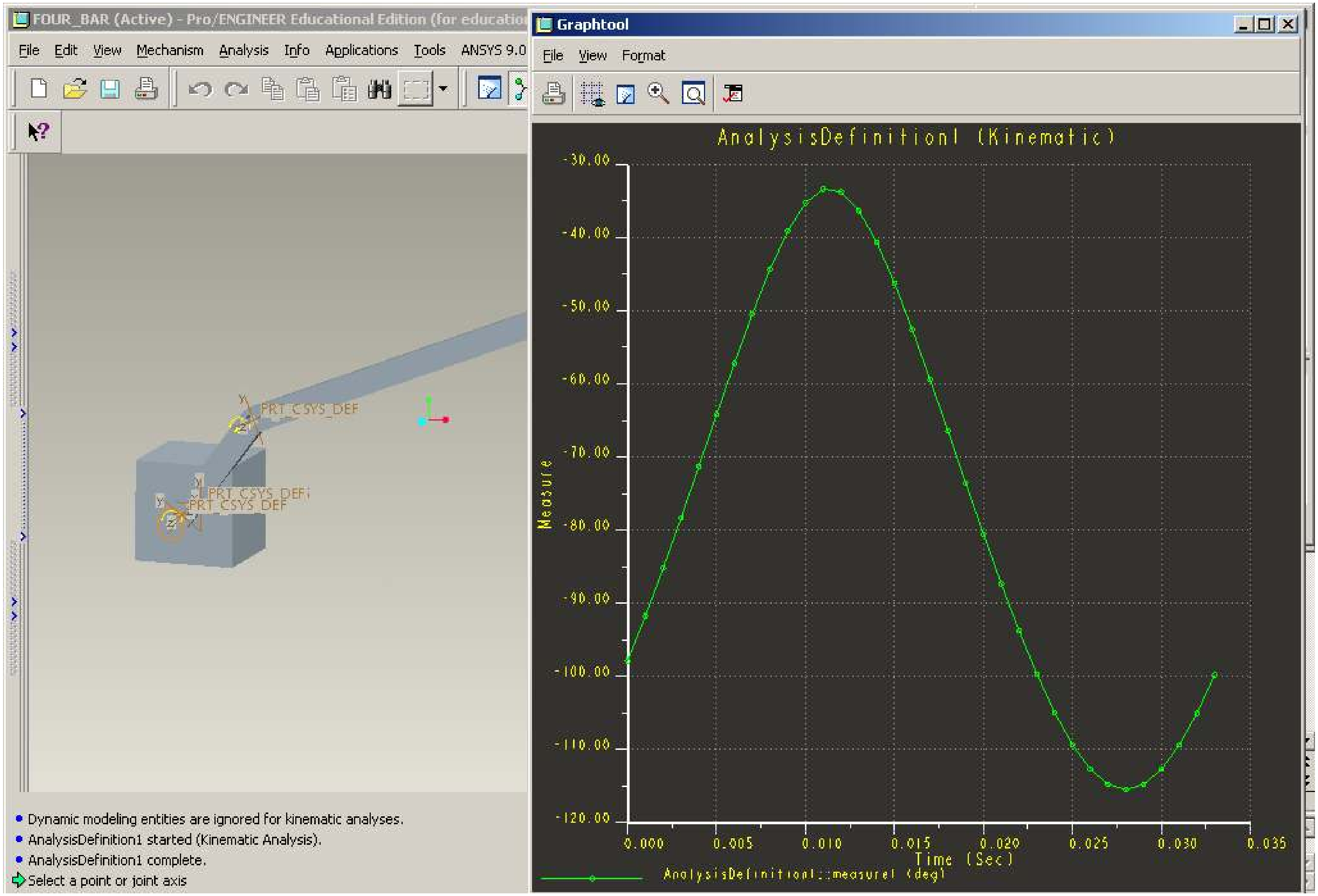
Click on create new measure.



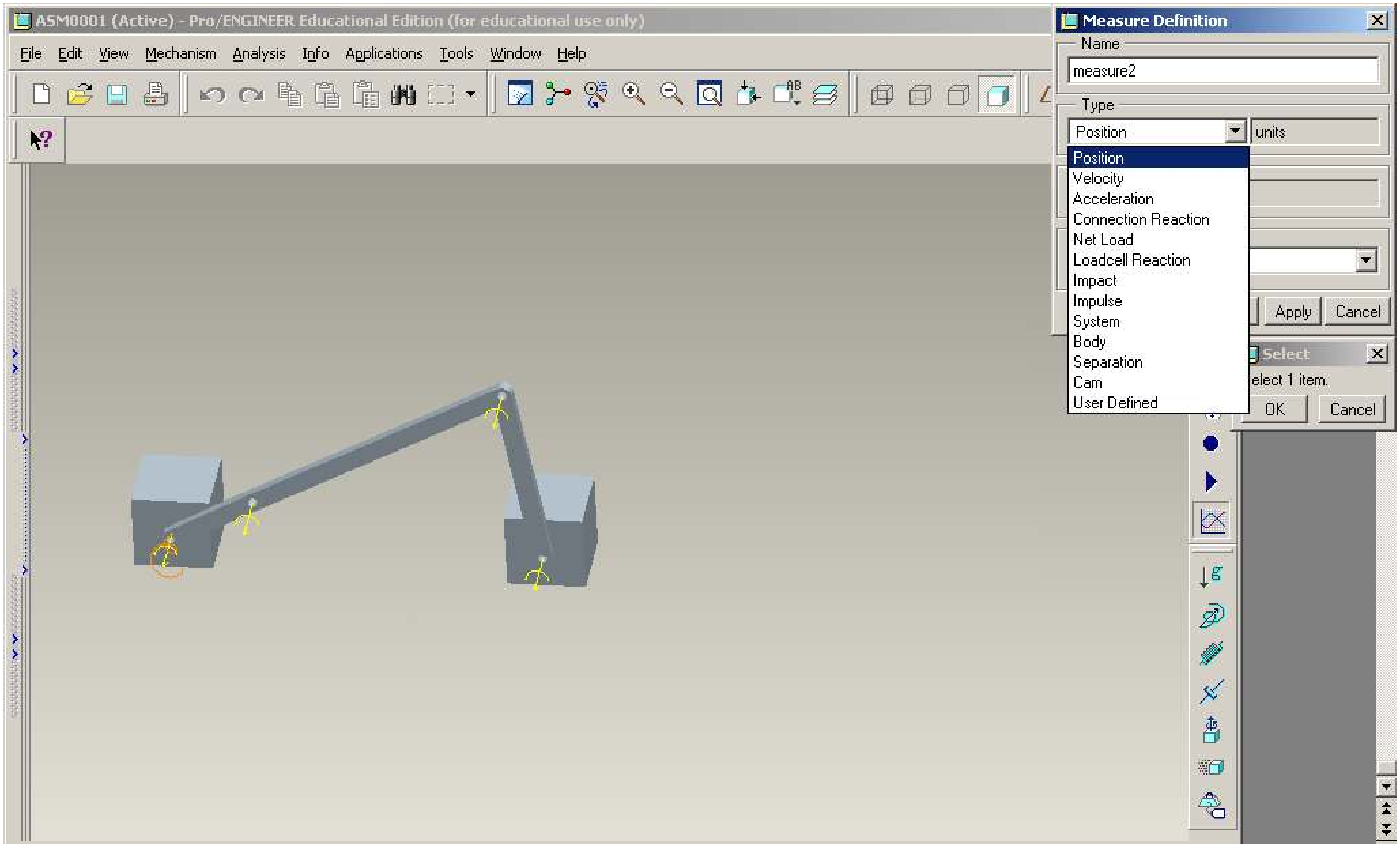
Use default name measure1. Select Type of parameter > Position > select the JOINT 3 axis > OK.



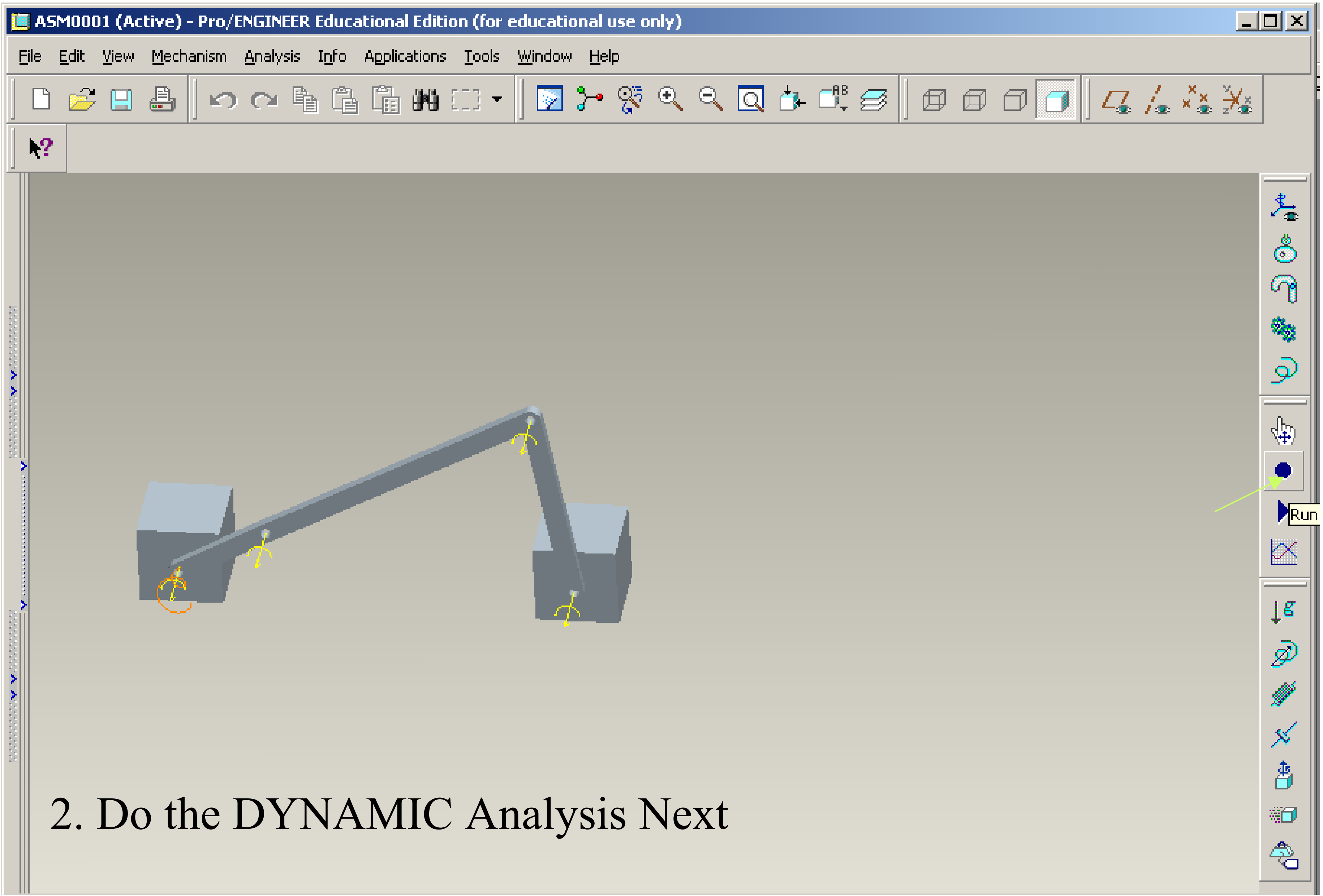
Select the Graph icon at the Top.



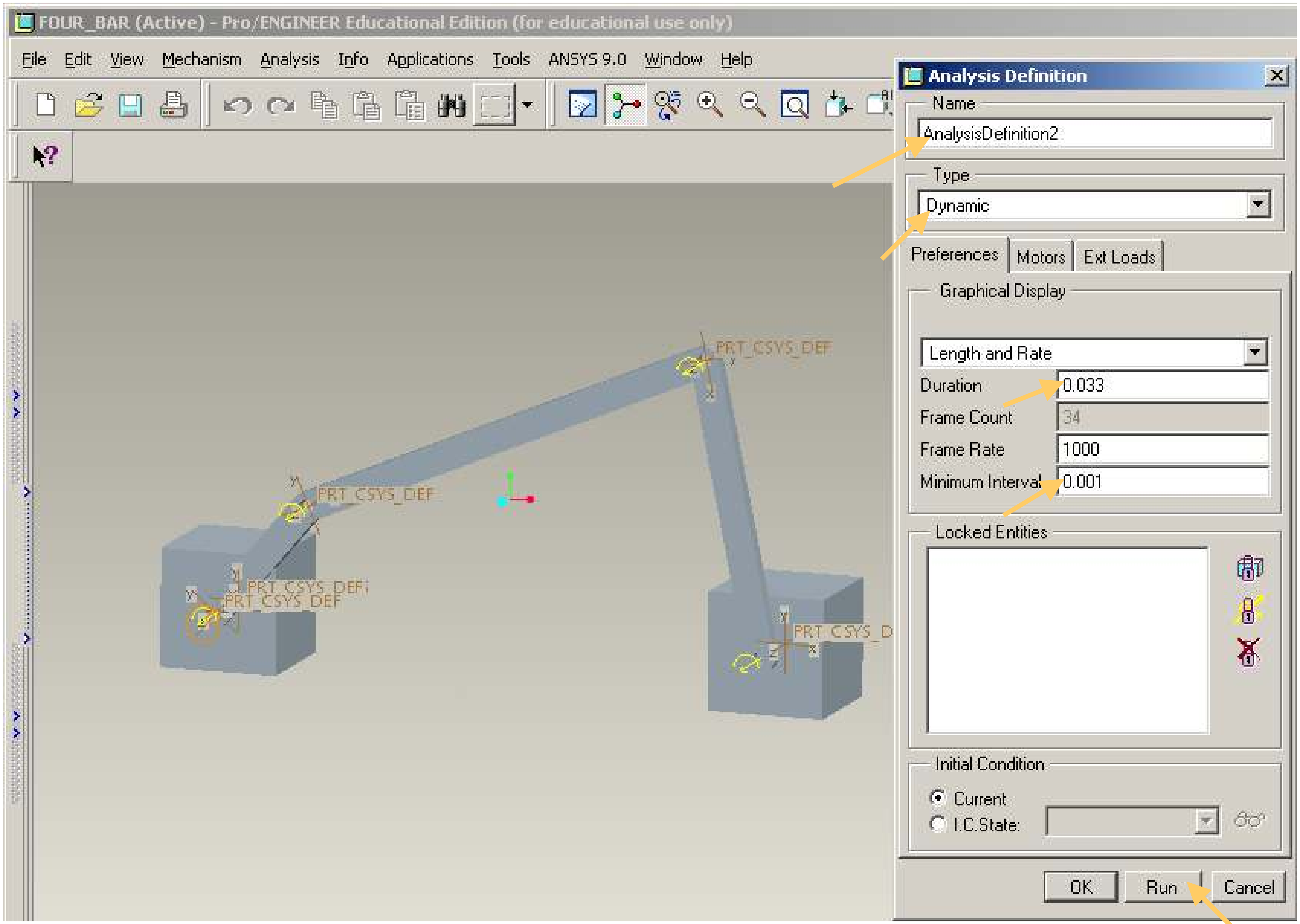
This gives the position/displacement of joint shown in red.



Graphs can be obtained for various options shown.

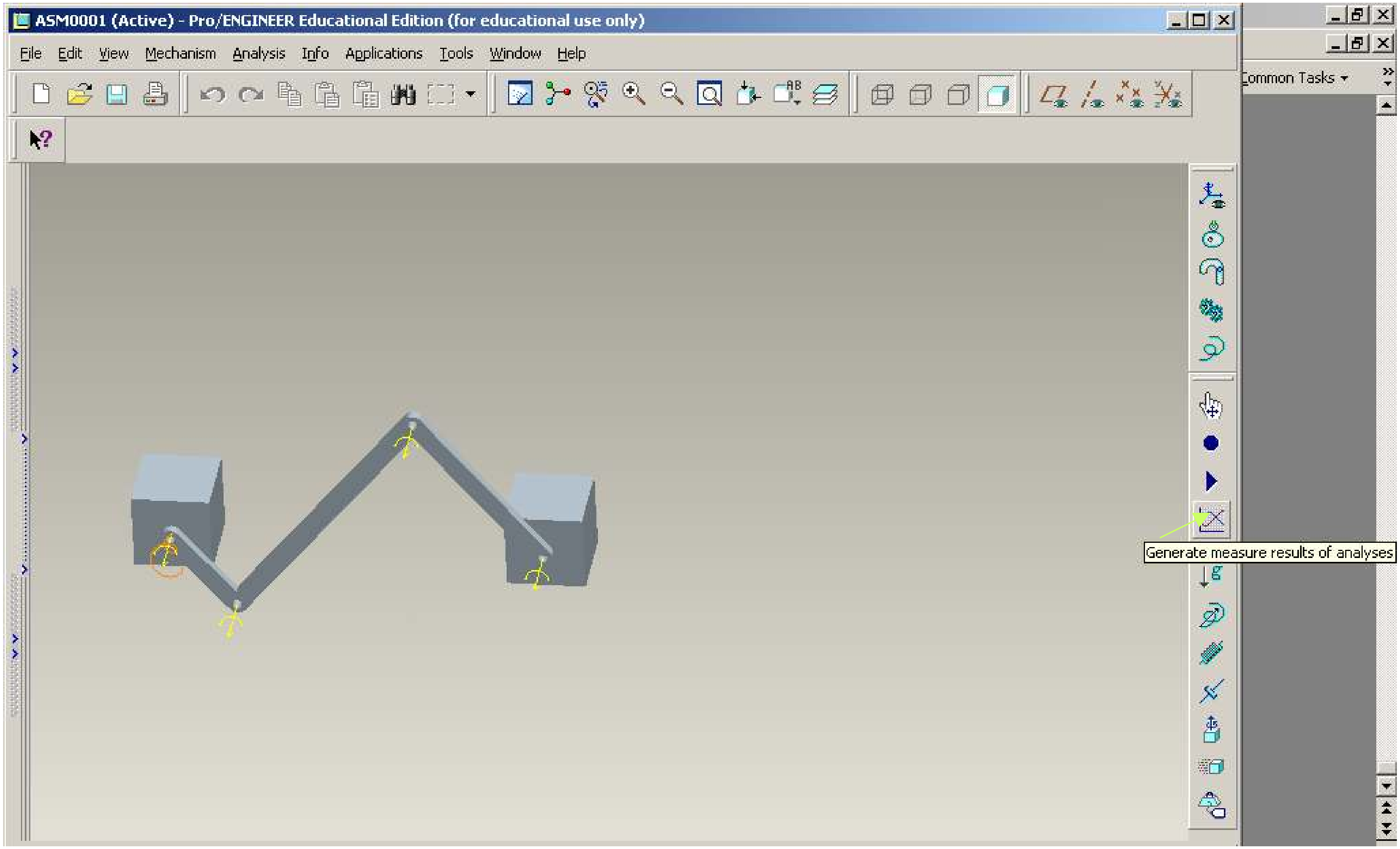


Click on the icon shown to generate dynamic analysis of this Mechanism

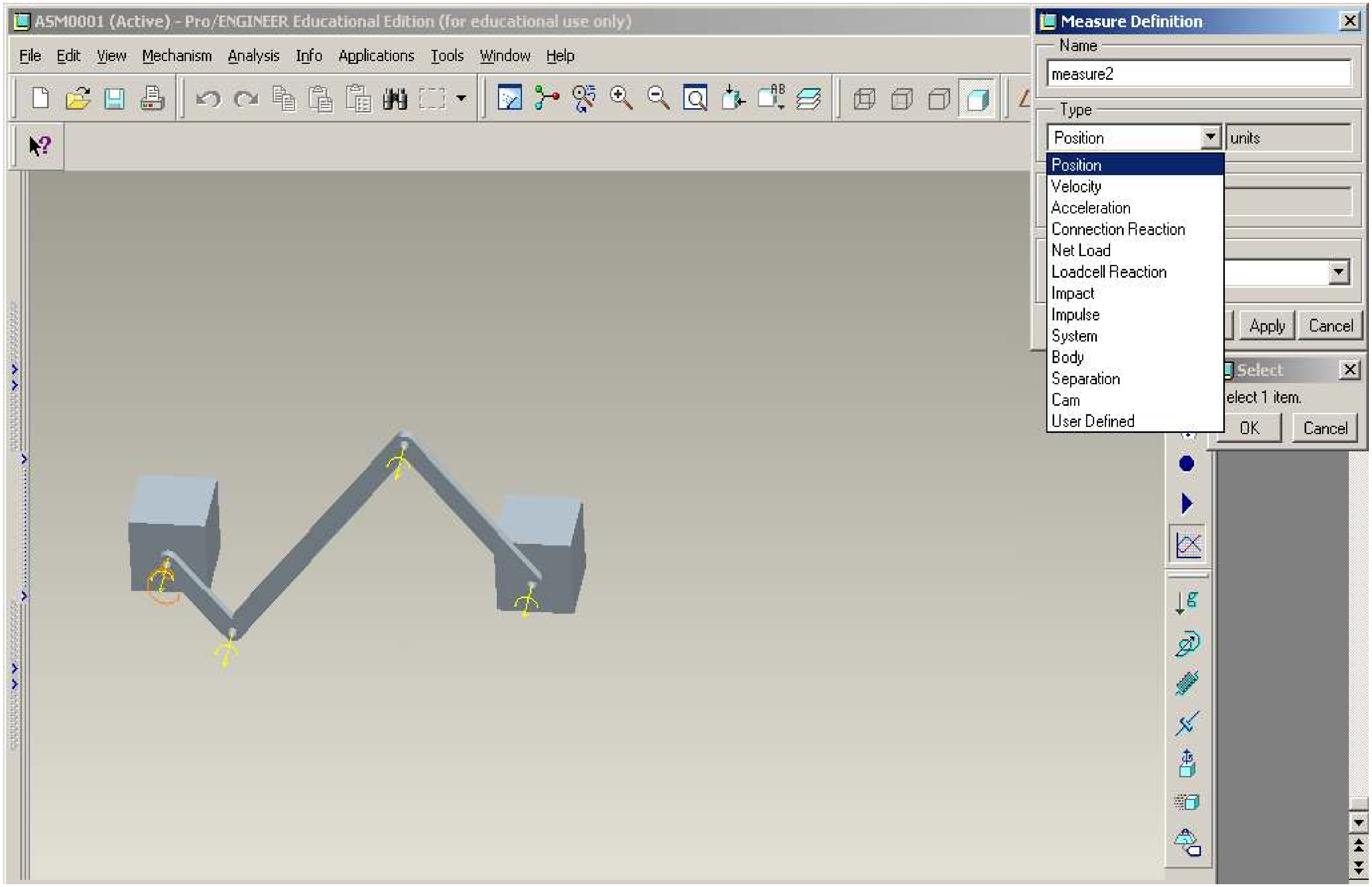


Click on Analysis Icon > New > Select Type Dynamic > Run > OK > Close

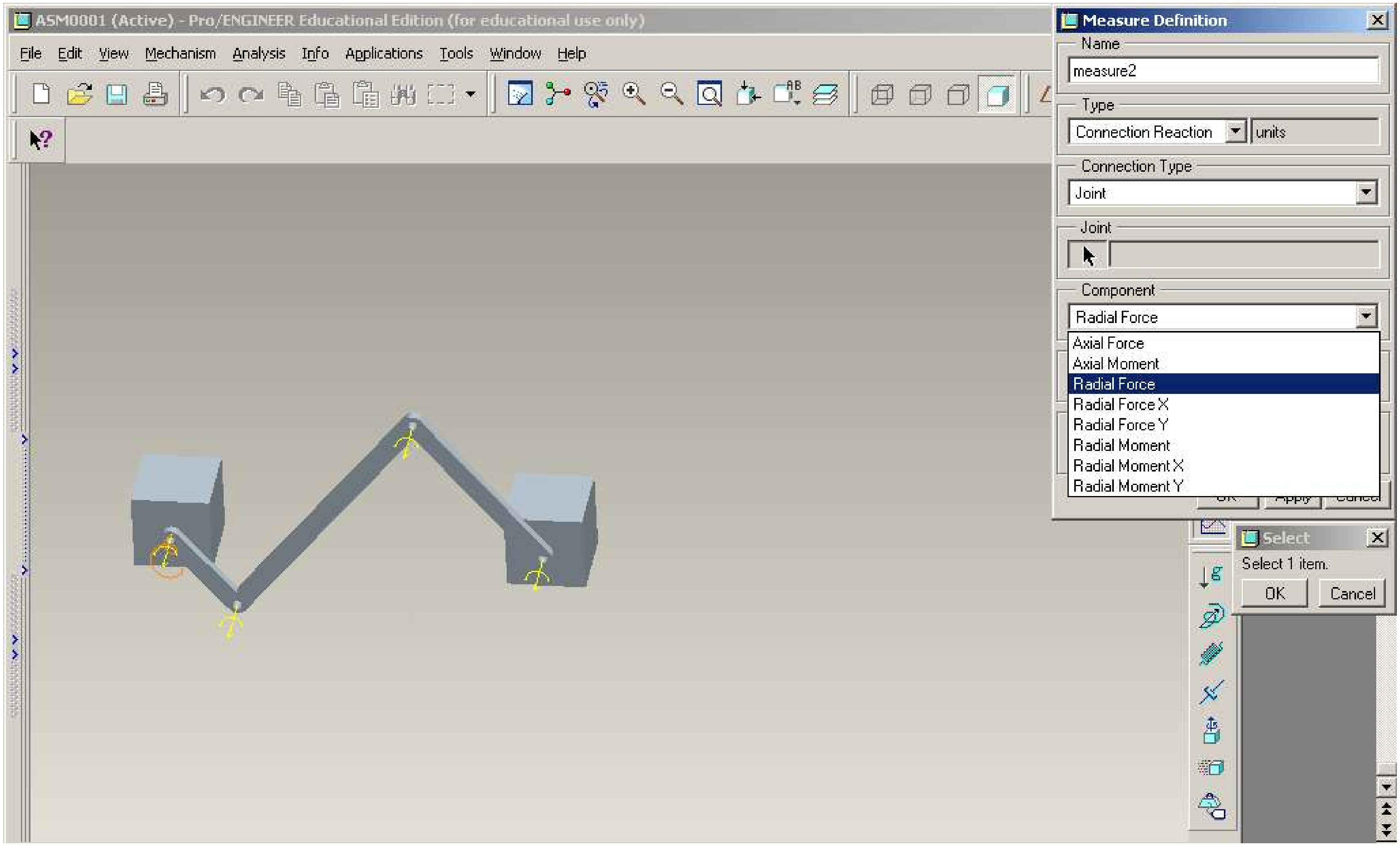
Note that the initial condition is the current state.



Select Generate Measure Results of Analyses to obtain the value of forces on the selected joints.

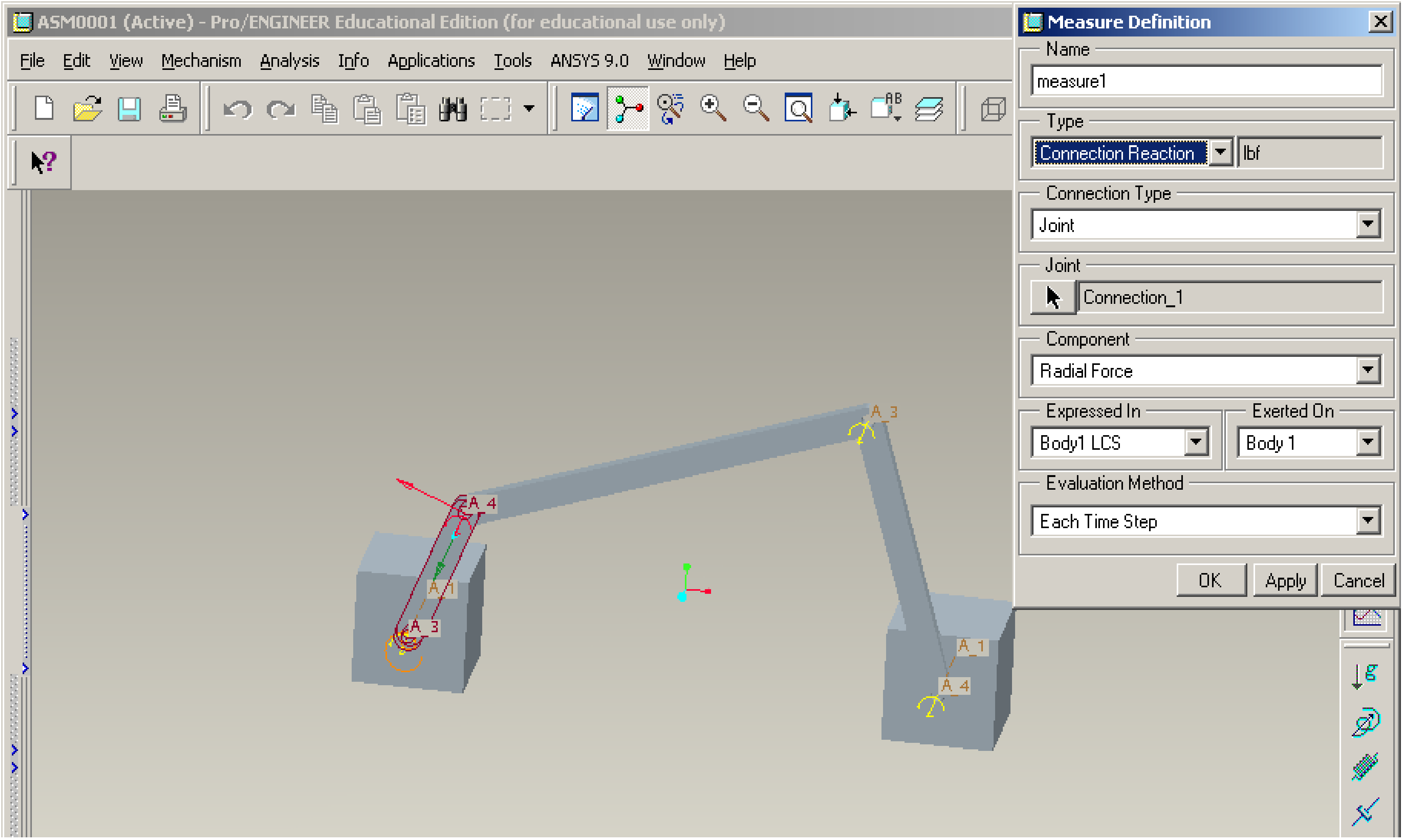


Select Connection Reactions to obtain Reactions at the joints.

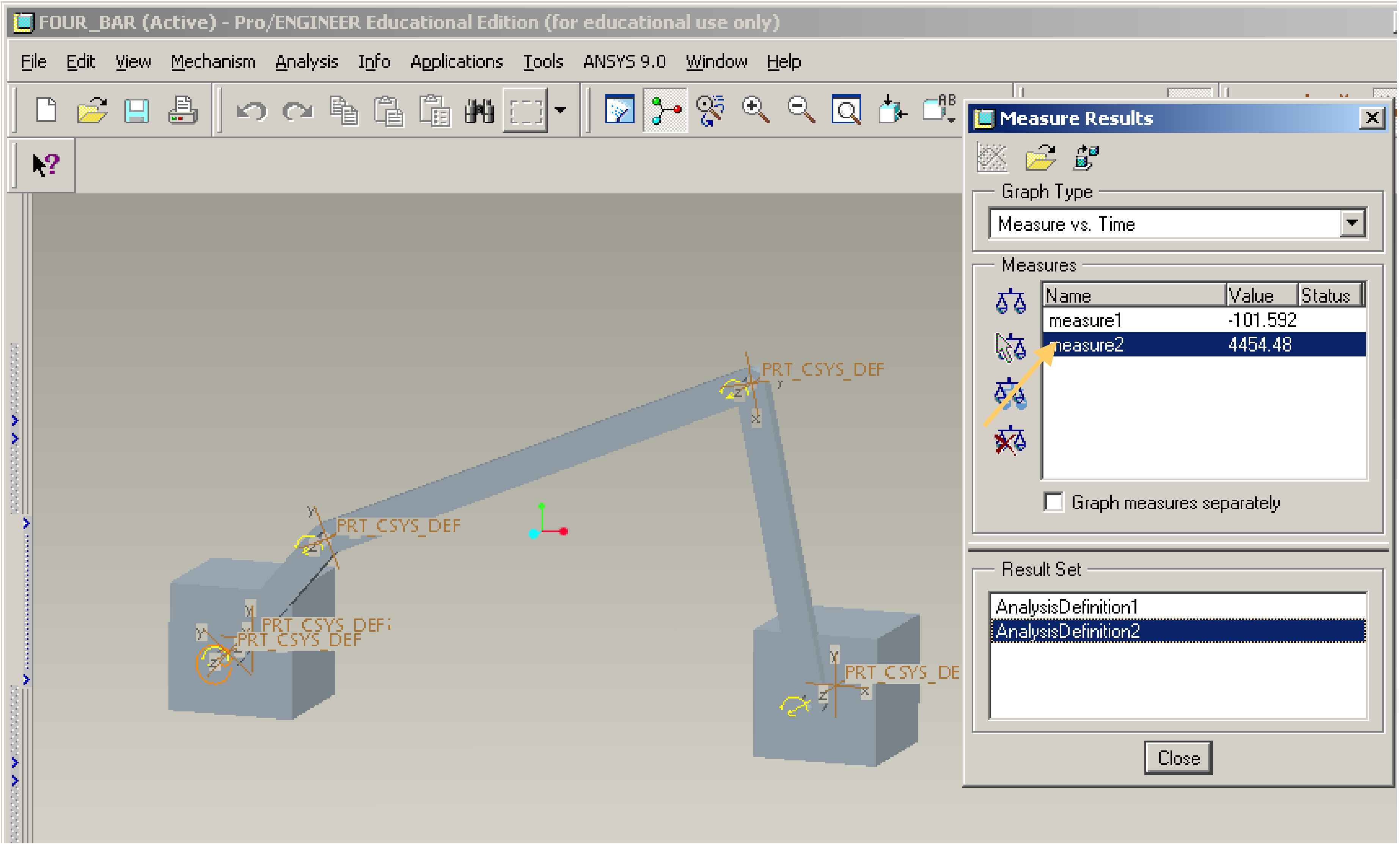


Select the joint and the measure to be plotted onto the Graph.

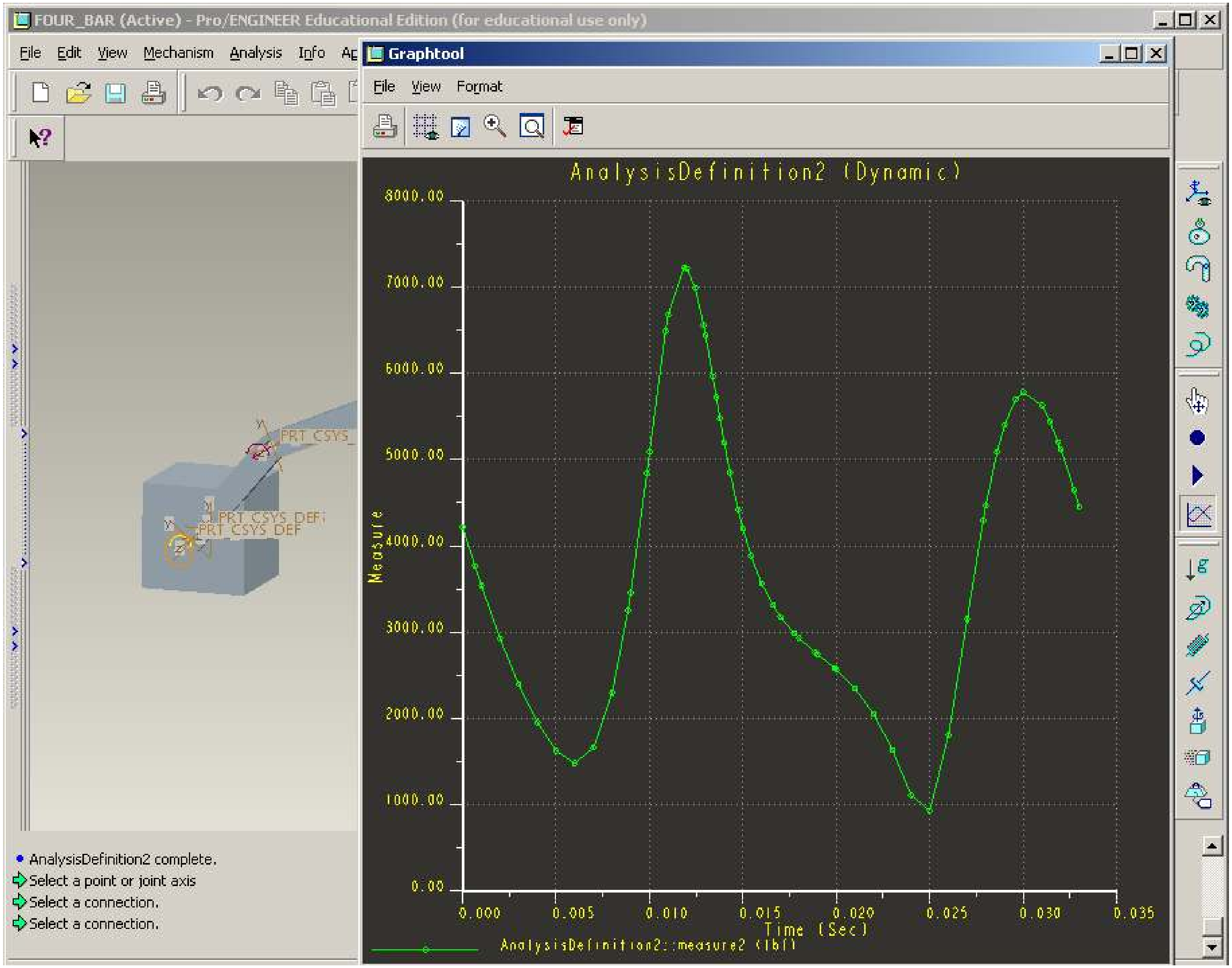
In this case the Radial Forces are computed for all the Joints.



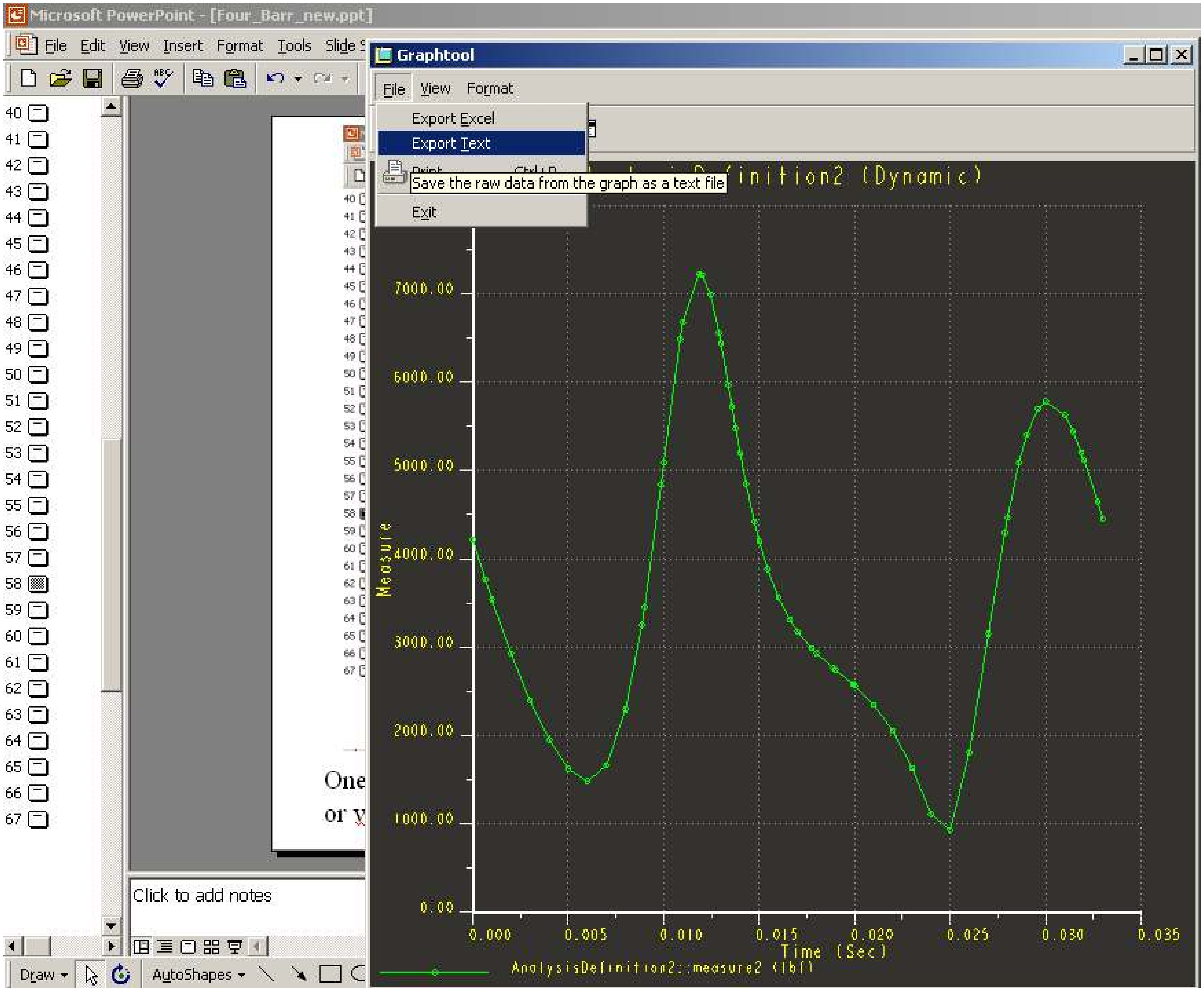
Now the JOINT 2 is selected and component to be plotted – Radial Force > OK.



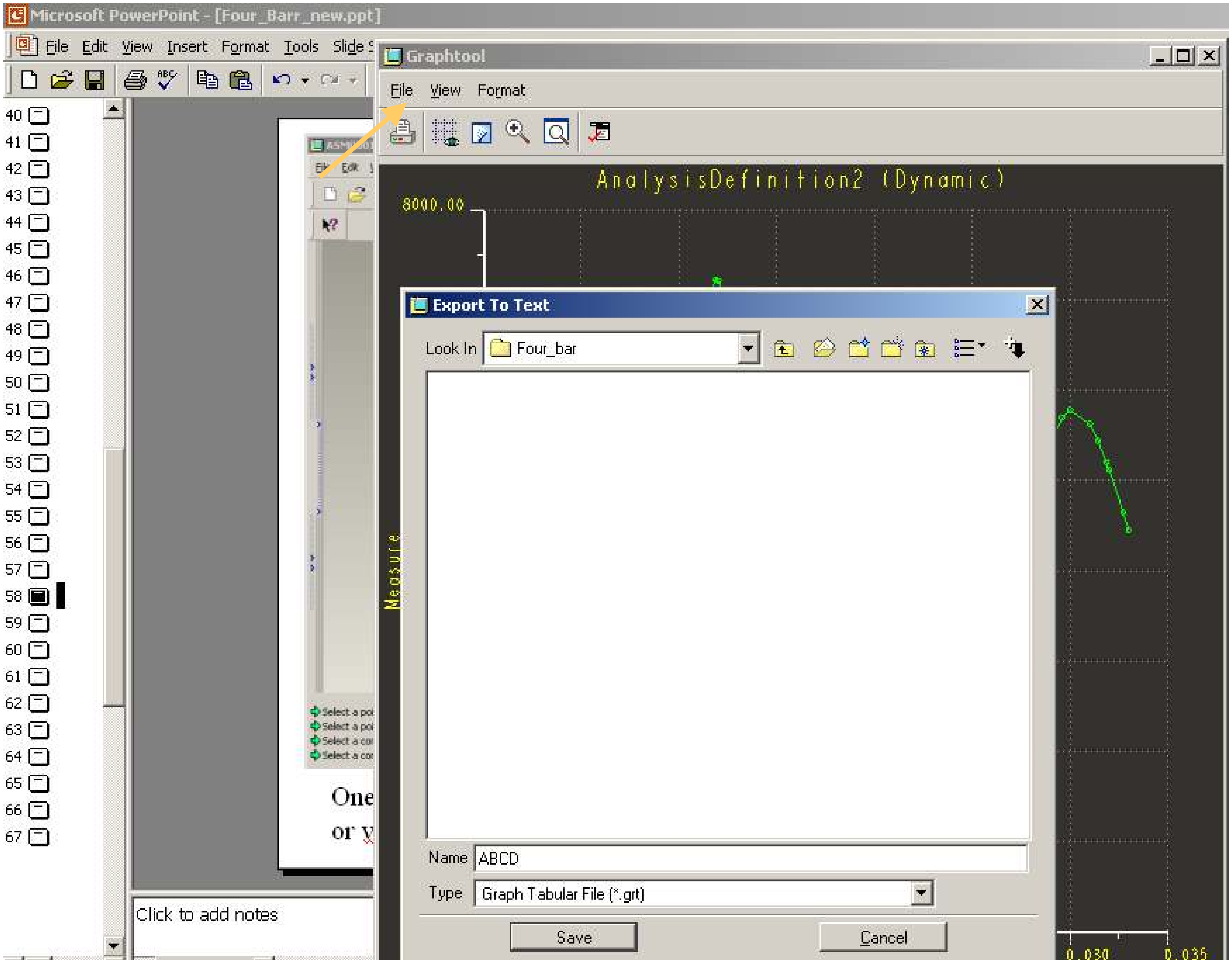
Select measure2 and Analysis Definition2 > Click on the Graph icon at the top left.



The Graph shows the Connection Reactions at JOINT 2.



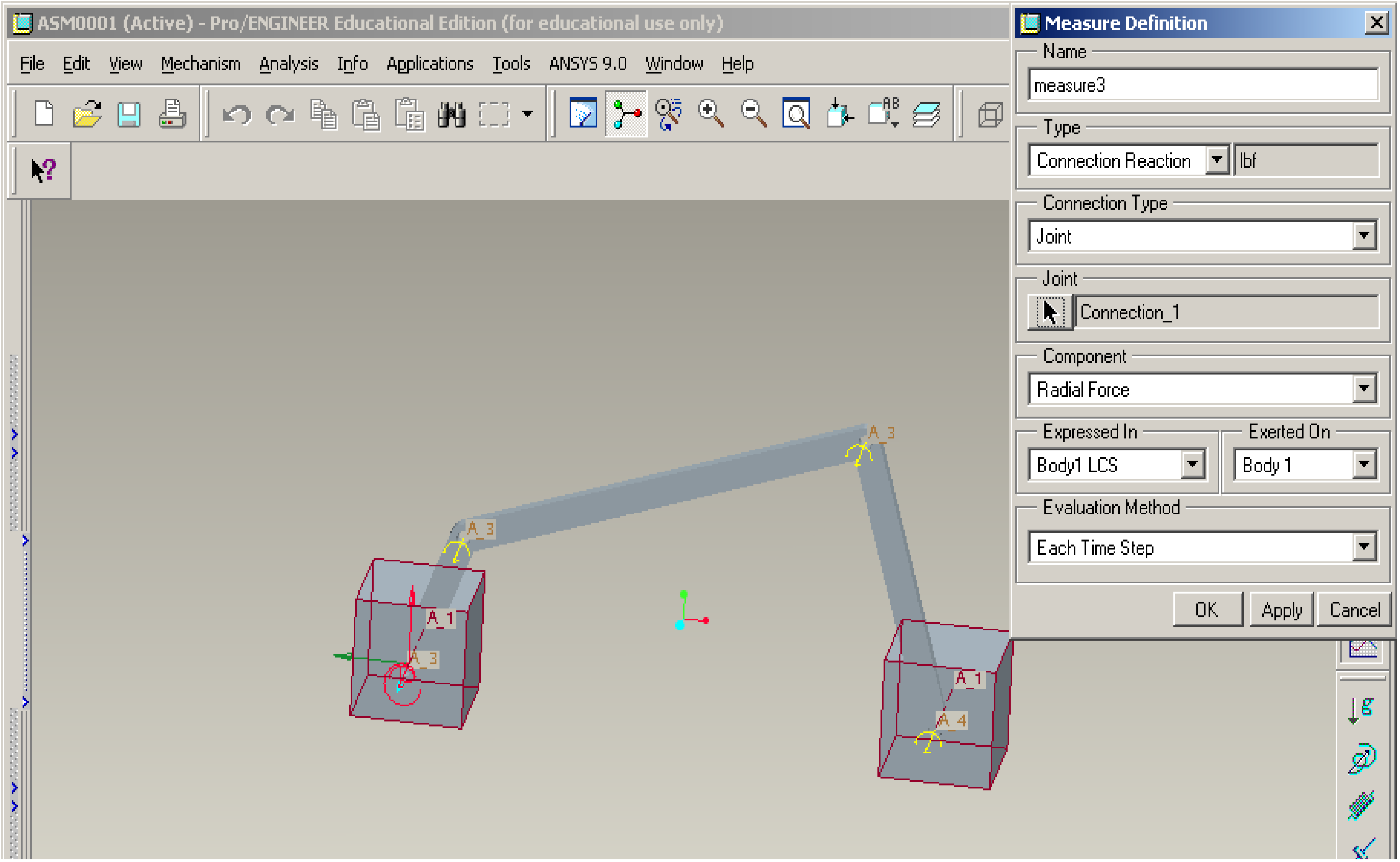
File > Export Text



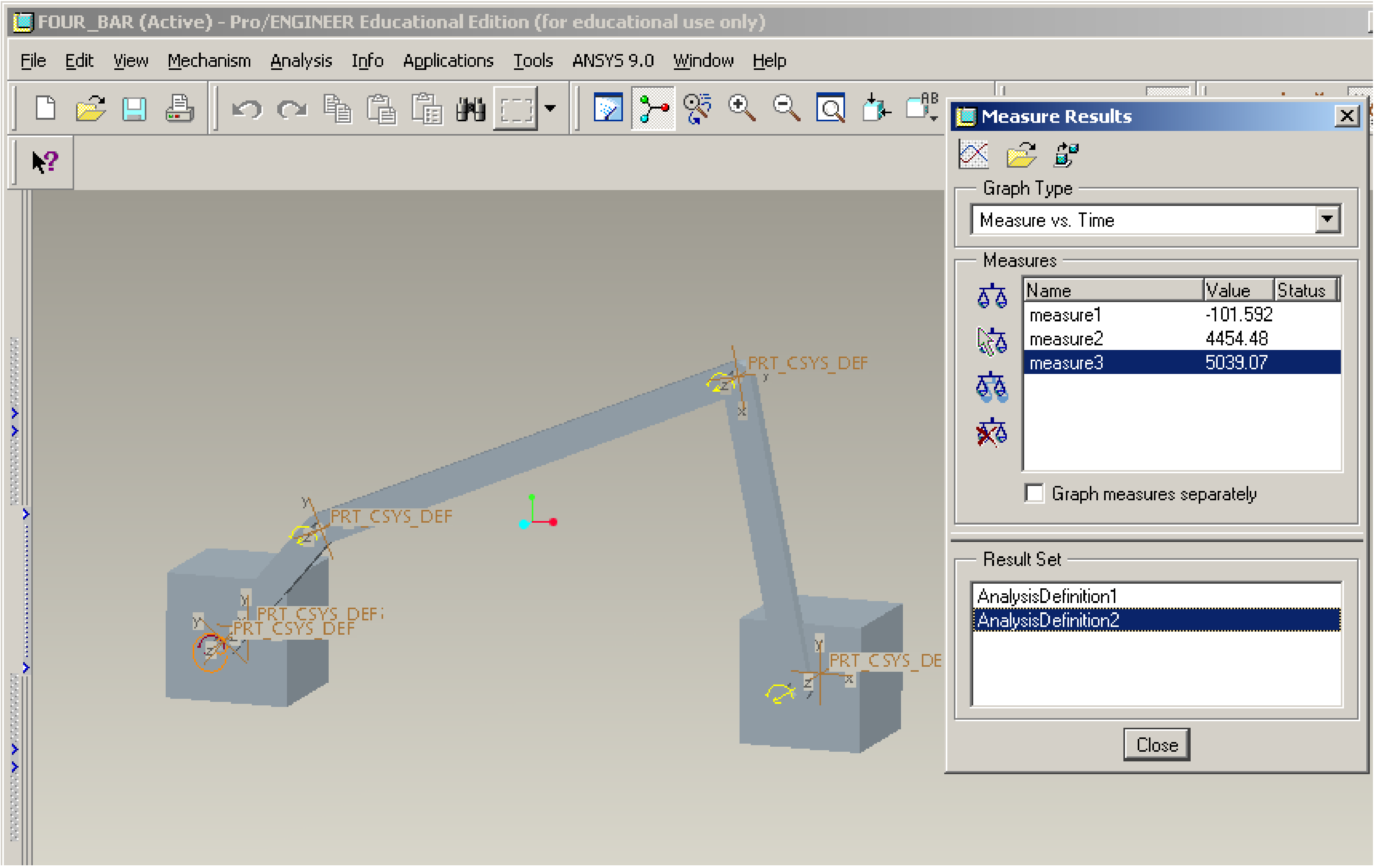
One can also write the results into Text file. Later this can be opened in notepad or wordpad.

Slides 65 through 73 do the same for JOINTS 1, 3, & 4.

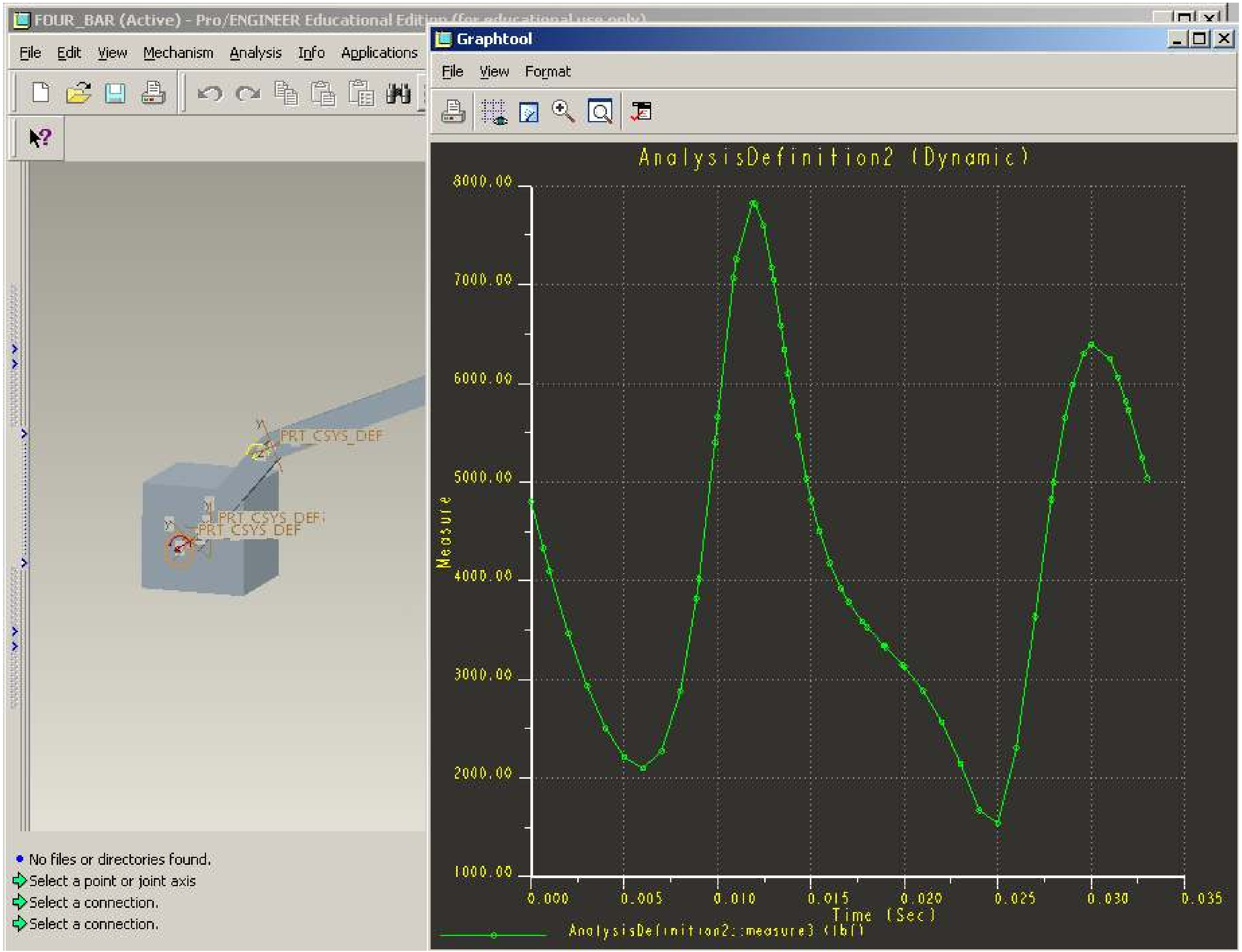
Skip ahead to Slide 74



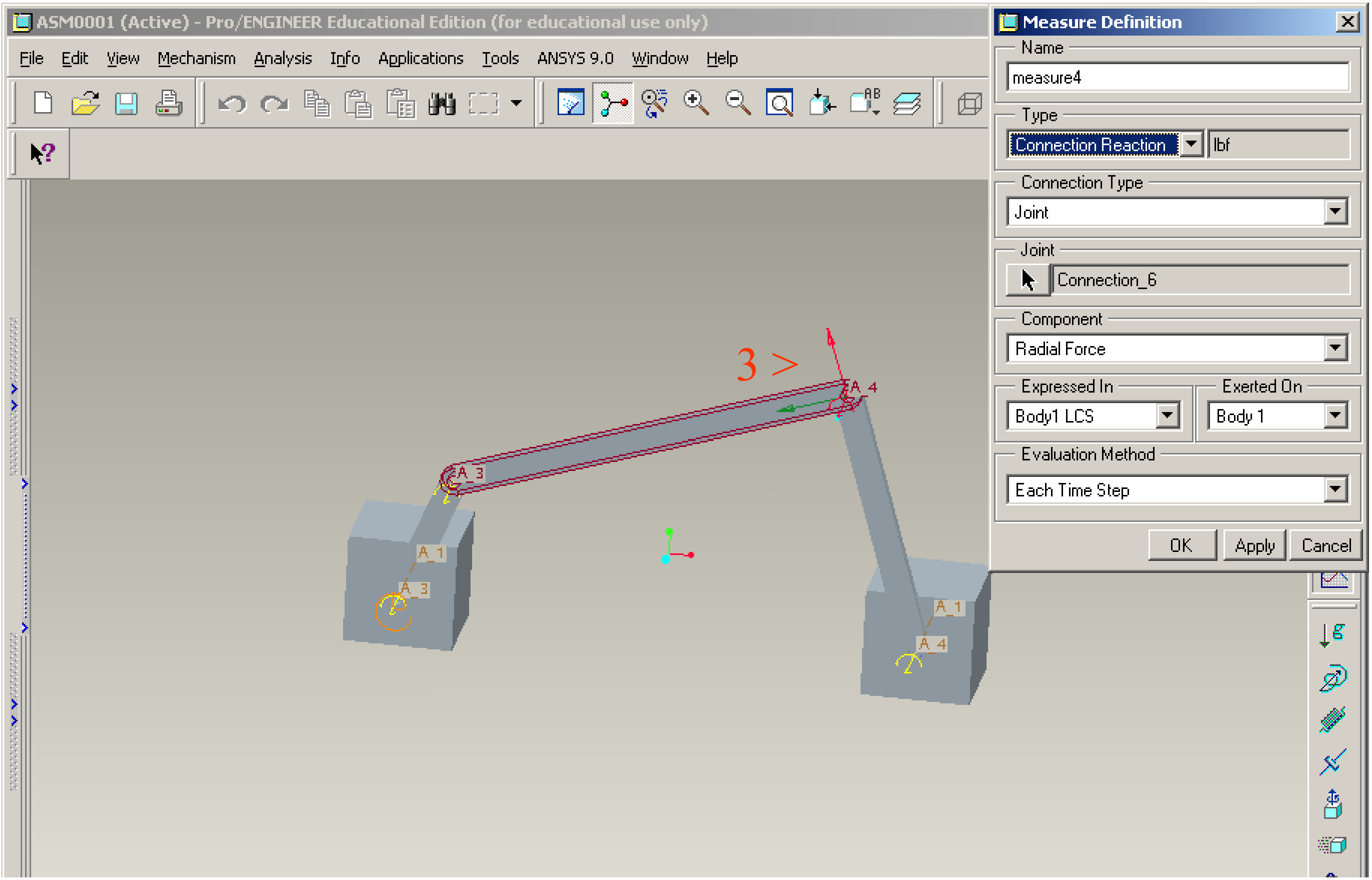
Select JOINT 1 > component to be plotted – Radial Force > OK



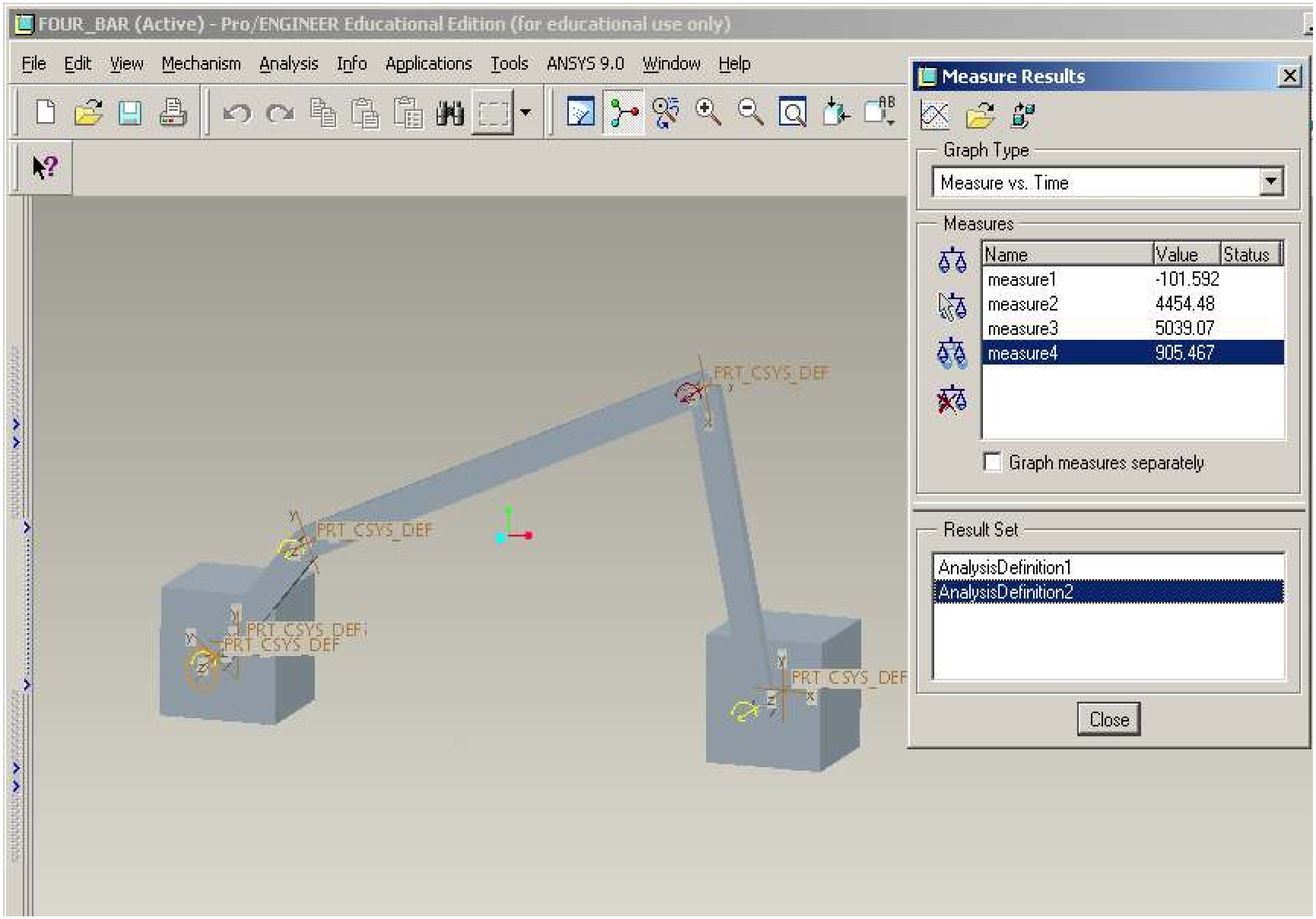
Select measure3 and Analysis Definition2 > Click on the Graph icon at the top left



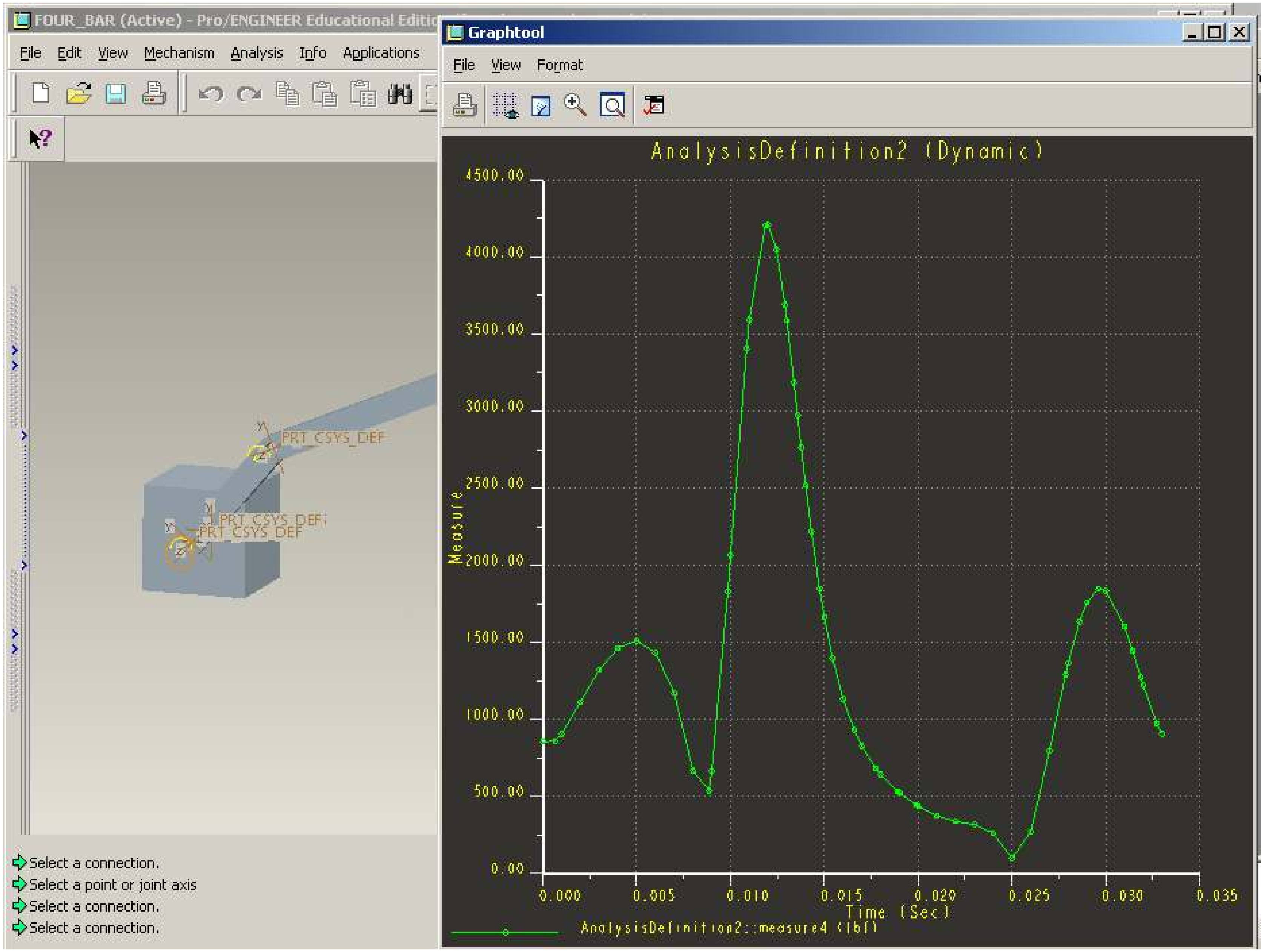
The Graph shows the Connection Reactions at JOINT 1.



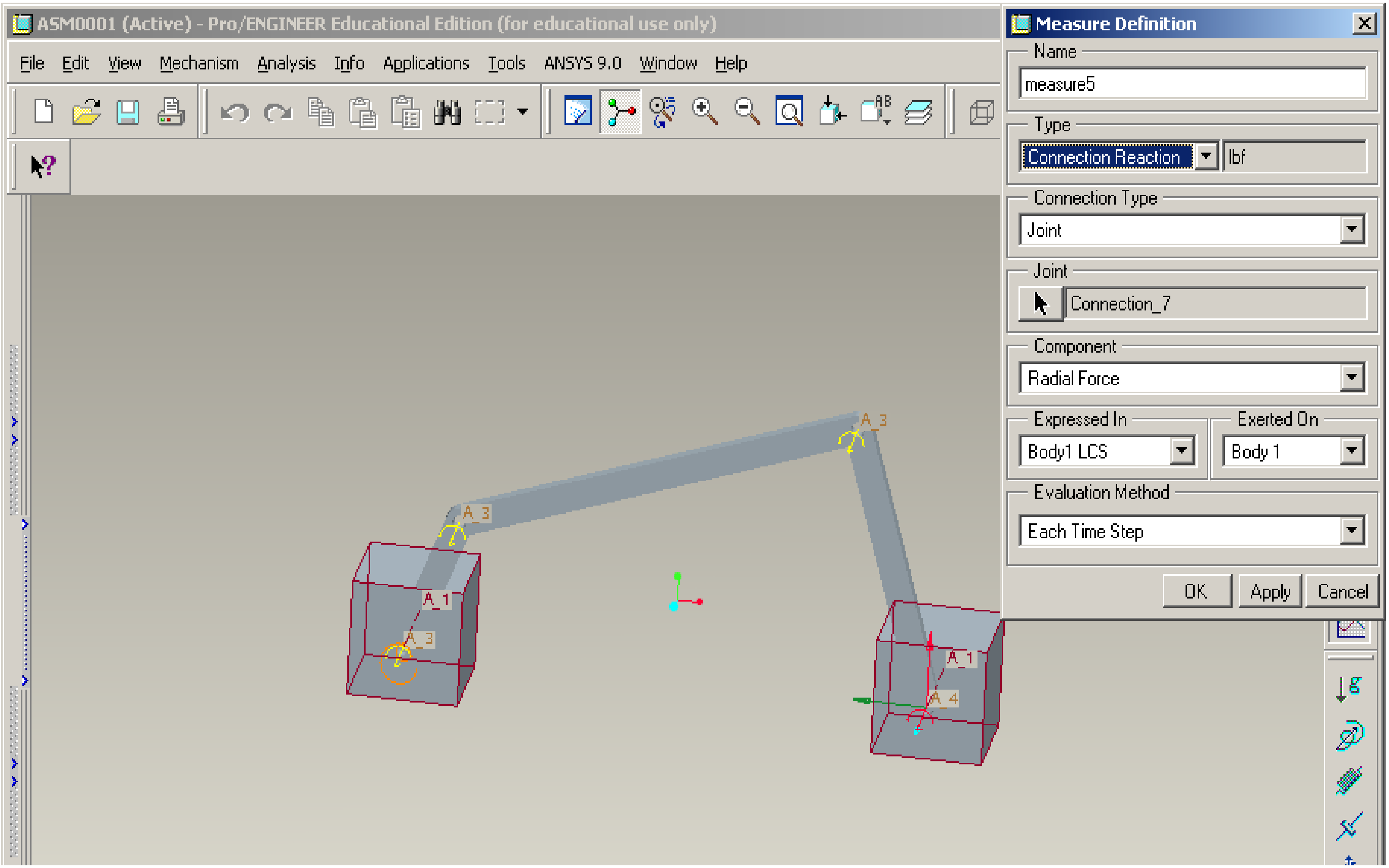
Select JOINT 3 > component to be plotted – Radial Force > OK



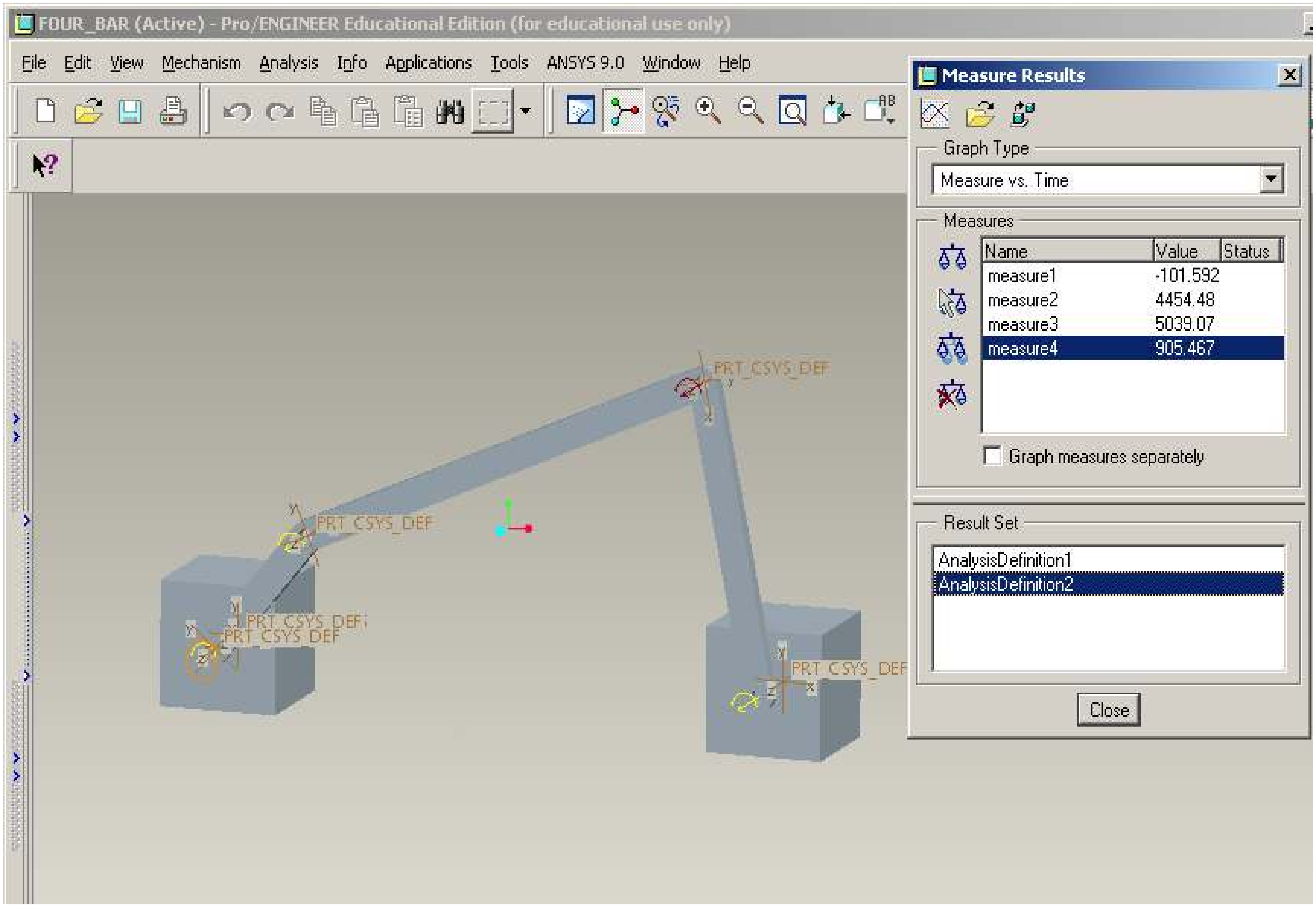
Select measure4 and Analysis Definition2 > Click on the Graph icon at the top left



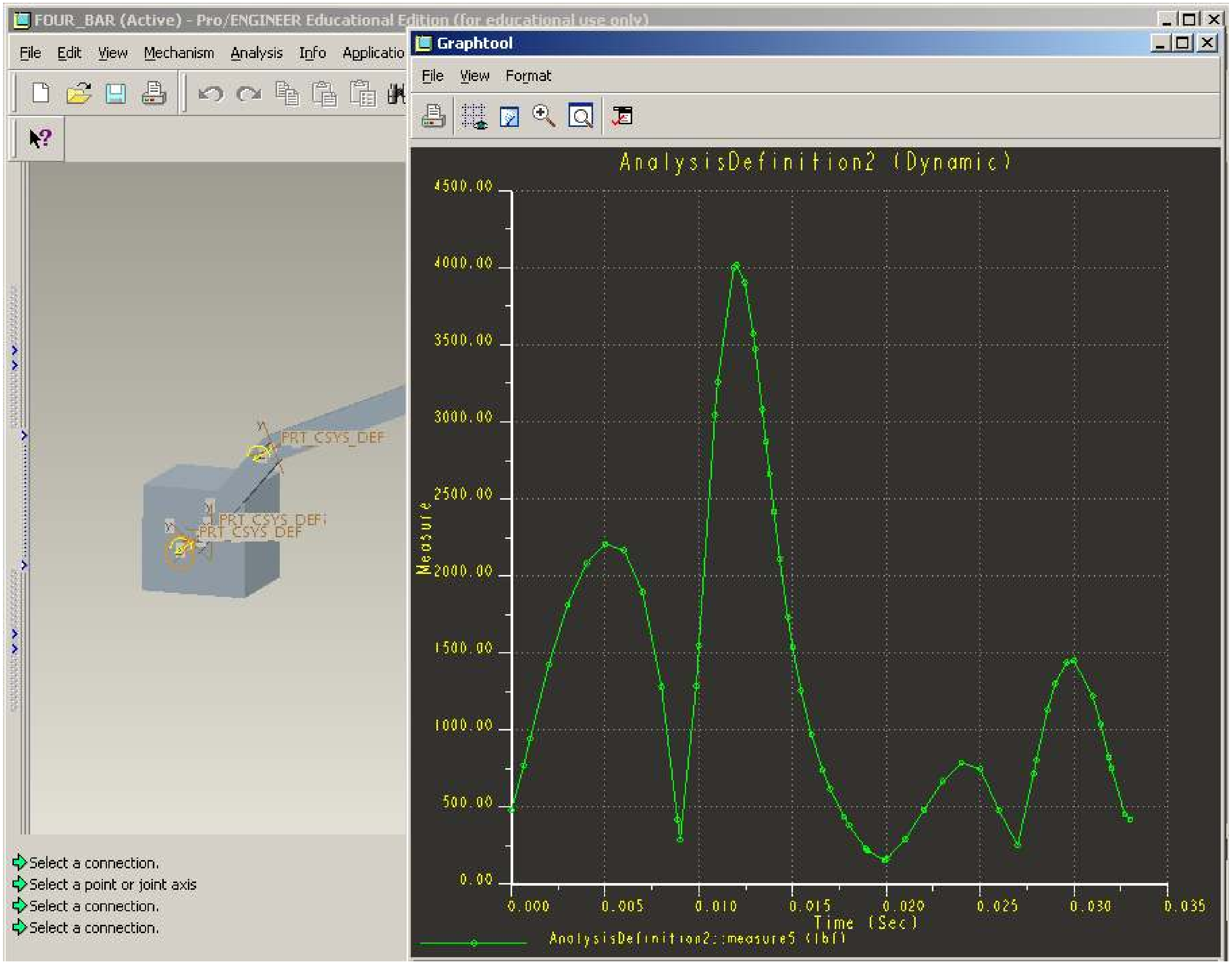
The Graph shows the Connection Reactions at JOINT 3.



Select Fourth Joint > component to be plotted – Radial Force > Ok

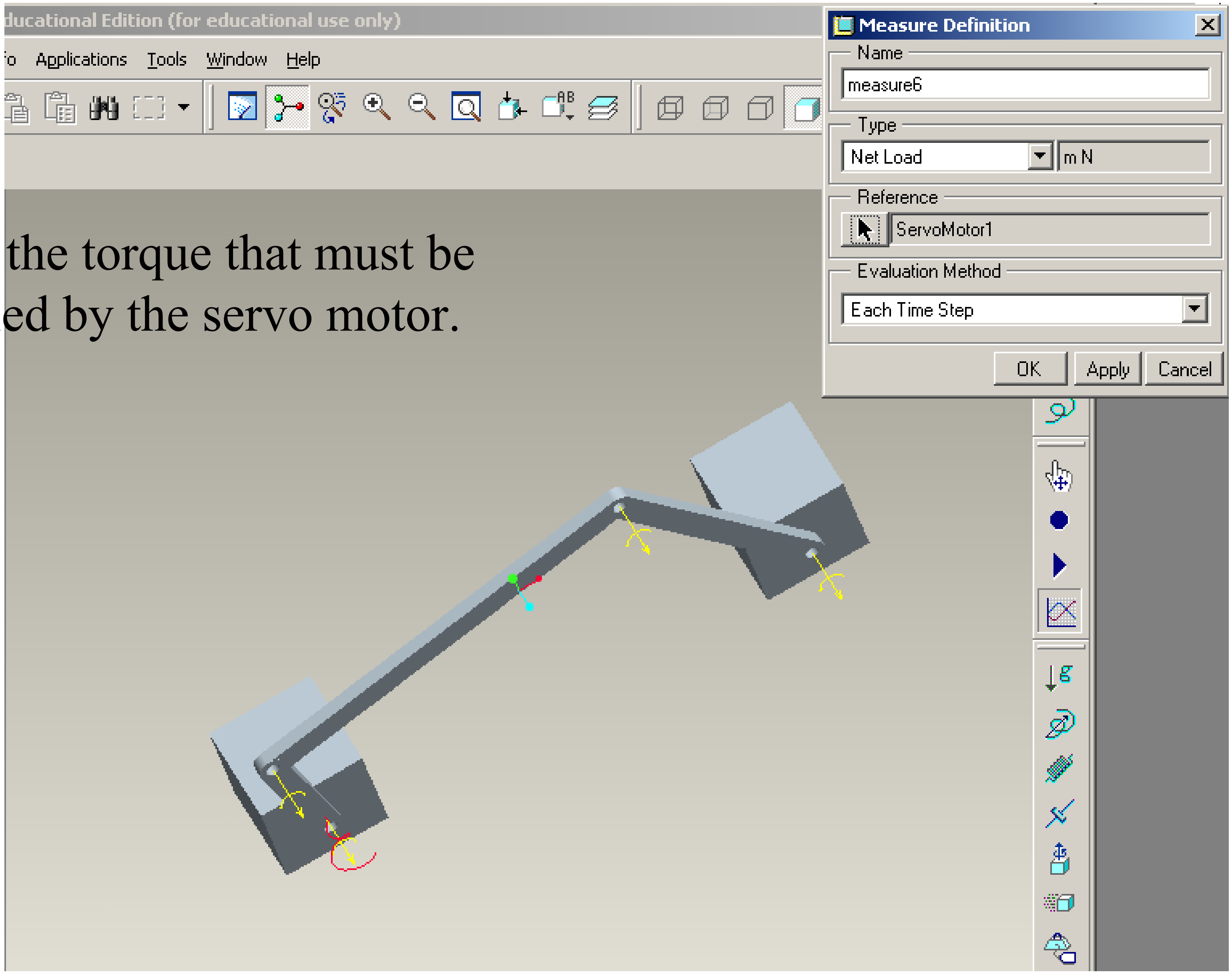


Select measure5 and Analysis Definition2 > Click on the Graph icon at the top left



The Graph shows the Connection Reactions at JOINT 4.

Find the torque that must be applied by the servo motor.



Create new measure > Net load > (pick the servo motor)

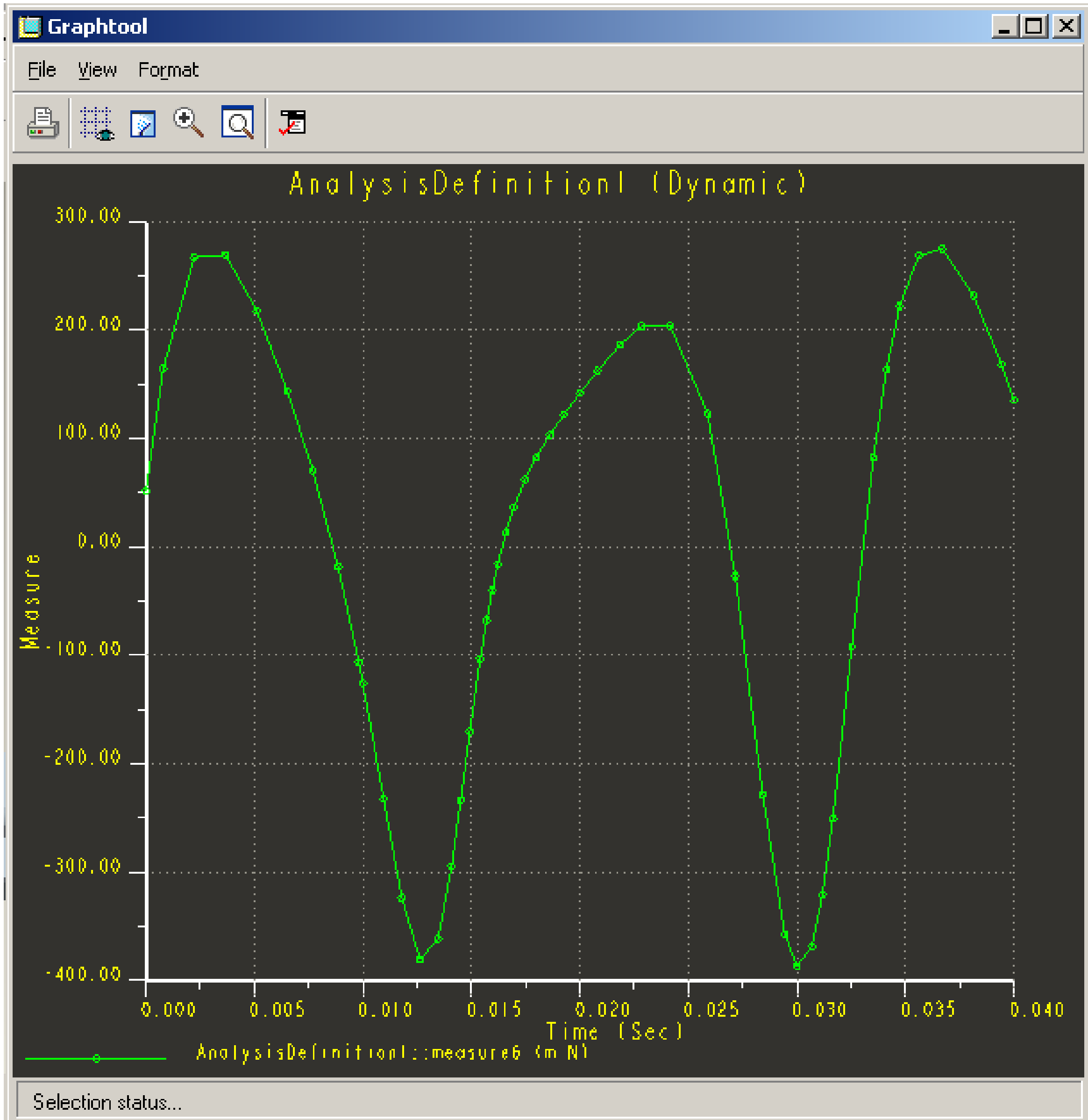
Information note:

To verify this analysis with an existing SI analysis everything was switched to SI for the Torque calculation.

Note on previous slide that the measure units are m-N as are the torque results on the next slide.

To verify these results, either convert your lbf-in torque to N-m for comparison or convert units during the analysis as we did.

Servomotor Torque in m-N



Fin