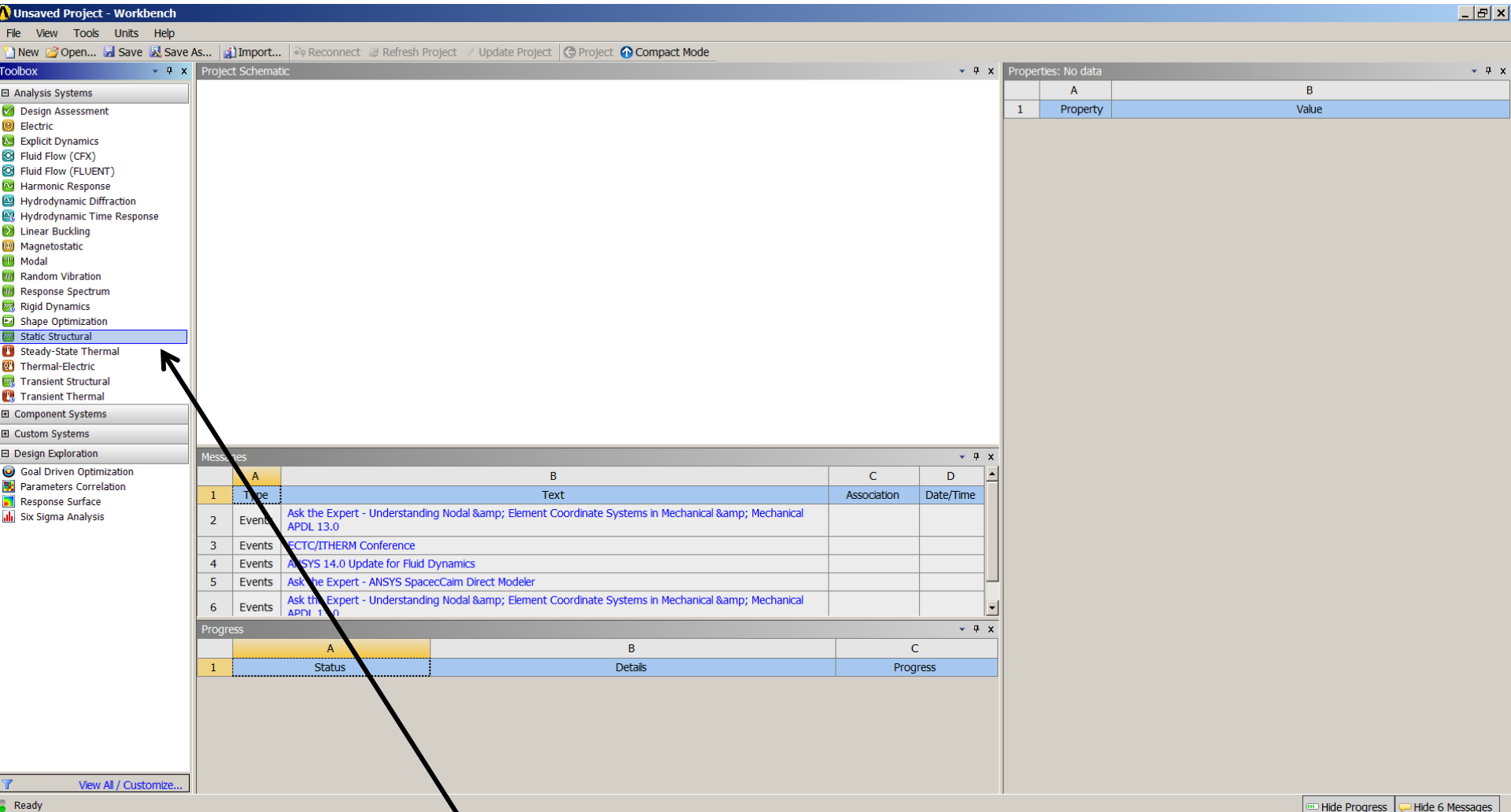


Optimization of a beam
Workbench 14.0

Aalborg Universitet esbjerg
Søren Heide Lambertsen



Click on Static structural

Unsaved Project - Workbench

File View Tools Units Help

New Open... Save Save As... Import... Reconnect Refresh Project Update Project Project Compact Mode

Toolbox

- Analysis Systems
 - Design Assessment
 - Electric
 - Explicit Dynamics
 - Fluid Flow (CFX)
 - Fluid Flow (FLUENT)
 - Harmonic Response
 - Hydrodynamic Diffraction
 - Hydrodynamic Time Response
 - Linear Buckling
 - Magnetostatic
 - Modal
 - Random Vibration
 - Response Spectrum
 - Rigid Dynamics
 - Shape Optimization
 - Static Structural
 - Steady-State Thermal
 - Thermal-Electric
 - Transient Structural
 - Transient Thermal
- Component Systems
- Custom Systems
- Design Exploration
 - Goal Driven Optimization
 - Parameters Correlation
 - Response Surface
 - Six Sigma Analysis

Project Schematic

- A
 - 1 Static Structural
 - 2 Engineering Data
 - 3 Geometry
 - 4 Model
 - 5 Setup
 - 6 Solution
 - 7 Results

Static Structural

Properties of Schematic A3: Geometry

	A	B
1	Property	Value
2	General	
3	Component ID	Geometry
4	Directory Name	SYS
5	Geometry Source	
6	Geometry File Name	
7	Basic Geometry Options	
8	Solid Bodies	<input checked="" type="checkbox"/>
9	Surface Bodies	<input checked="" type="checkbox"/>
10	Line Bodies	<input type="checkbox"/>
11	Parameters	<input checked="" type="checkbox"/>
12	Parameter Key	DS
13	Attributes	<input type="checkbox"/>
14	Named Selections	<input type="checkbox"/>
15	Material Properties	<input type="checkbox"/>
16	Advanced Geometry Options	
17	Analysis Type	3D
18	Use Associativity	<input checked="" type="checkbox"/>
19	Import Coordinate Systems	<input type="checkbox"/>
20	Import Work Points	<input type="checkbox"/>
21	Reader Mode Saves Updated File	<input type="checkbox"/>
22	Import Using Instances	<input checked="" type="checkbox"/>
23	Smart CAD Update	<input type="checkbox"/>
24	Enclosure and Symmetry Processing	<input checked="" type="checkbox"/>
25	Mixed Import Resolution	None

Messages

	A	B	C	D
1	Type	Text	Association	Date/Time
2	Events	Ask the Expert - Understanding Nodal & Element Coordinate Systems in Mechanical & Mechanical APDL 13.0		
3	Events	ECTC/ITHERM Conference		
4	Events	ANSYS 14.0 Update for Fluid Dynamics		
5	Events	Ask the Expert - ANSYS SpaceClaim Direct Modeler		
6	Events	Ask the Expert - Understanding Nodal & Element Coordinate Systems in Mechanical & Mechanical APDL 13.0		

Progress

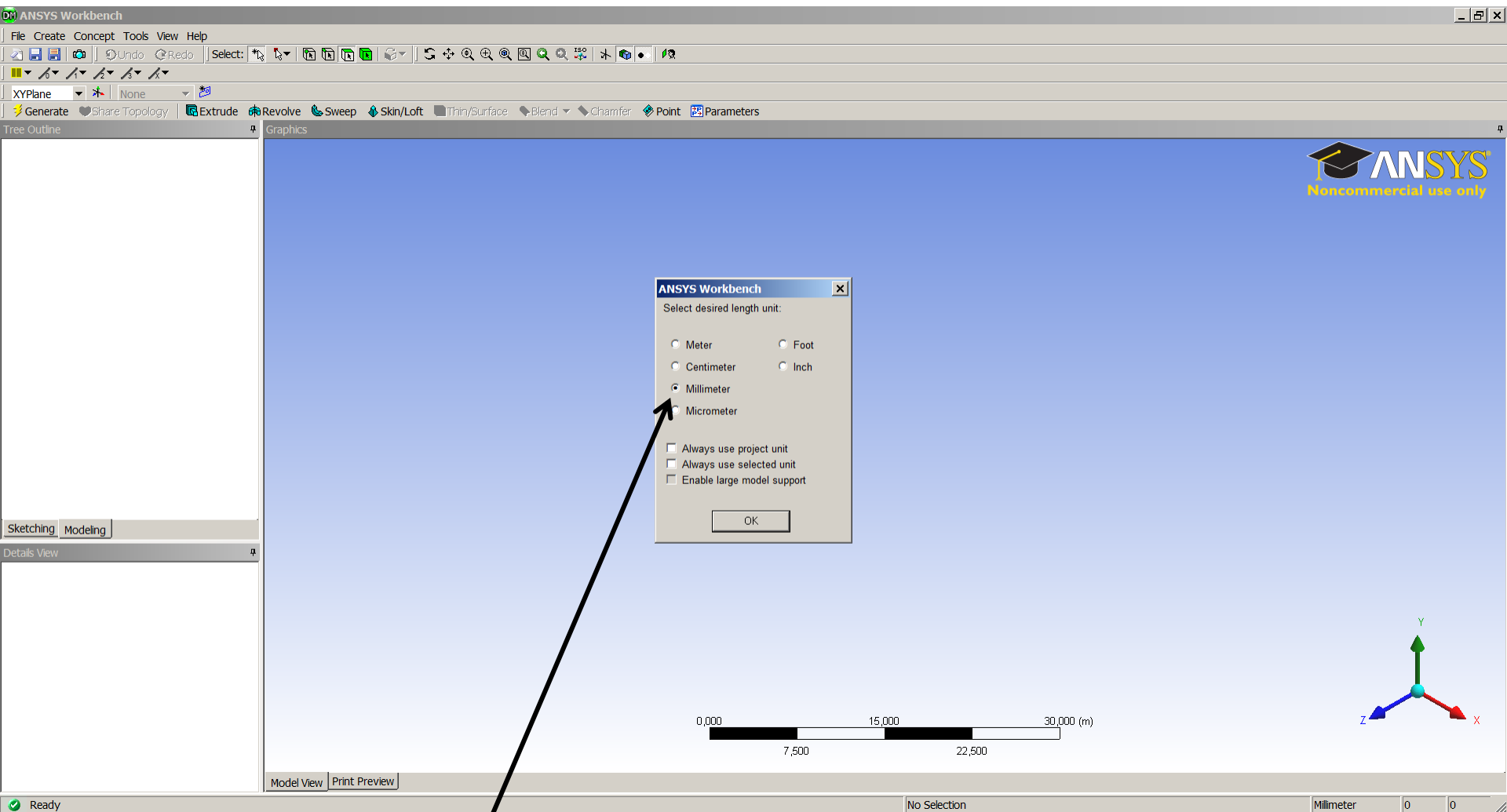
	A	B	C
1	Status	Details	Progress

View All / Customize...

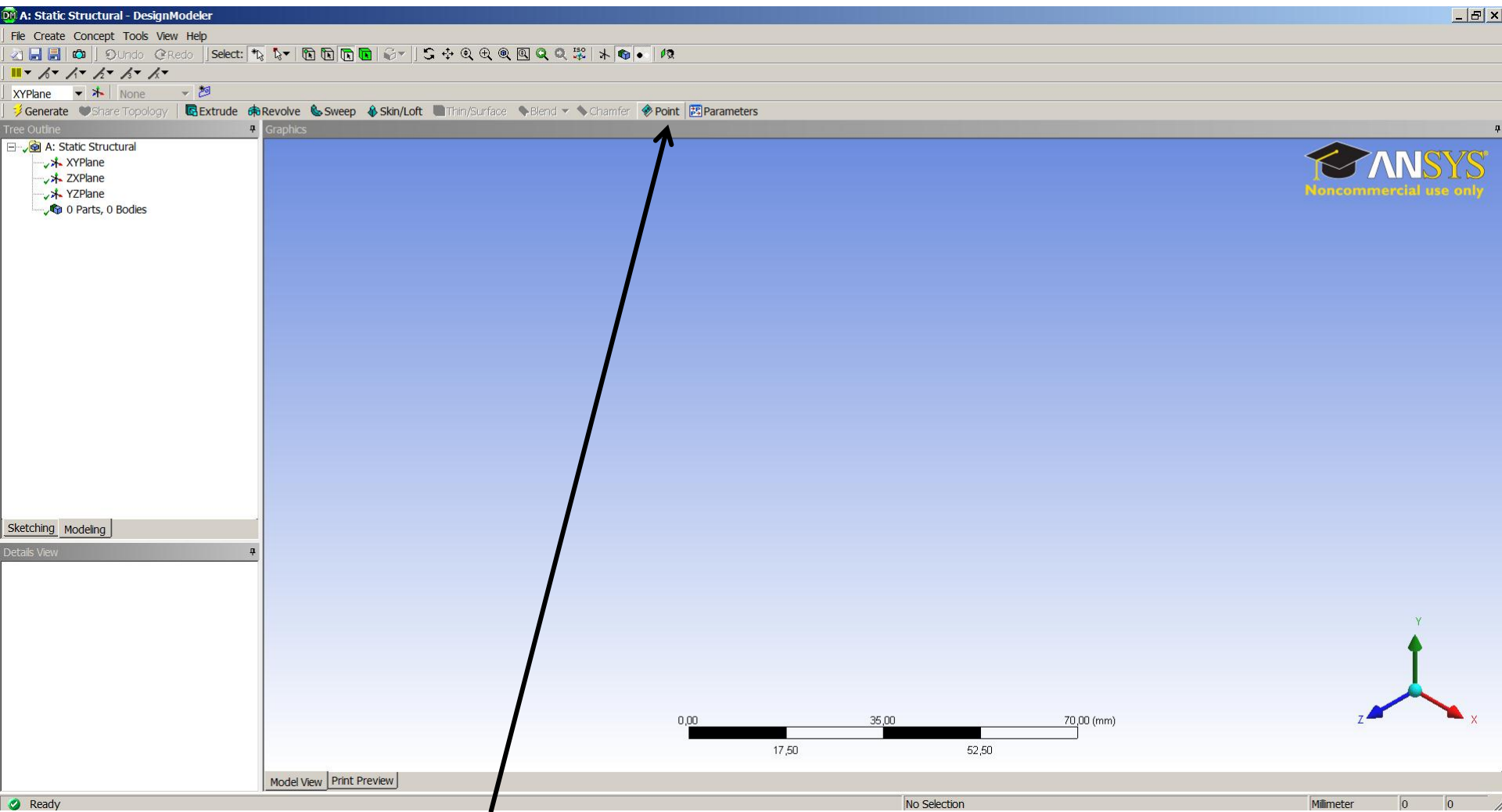
Double-click component to edit.

Hide Progress Hide 6 Messages

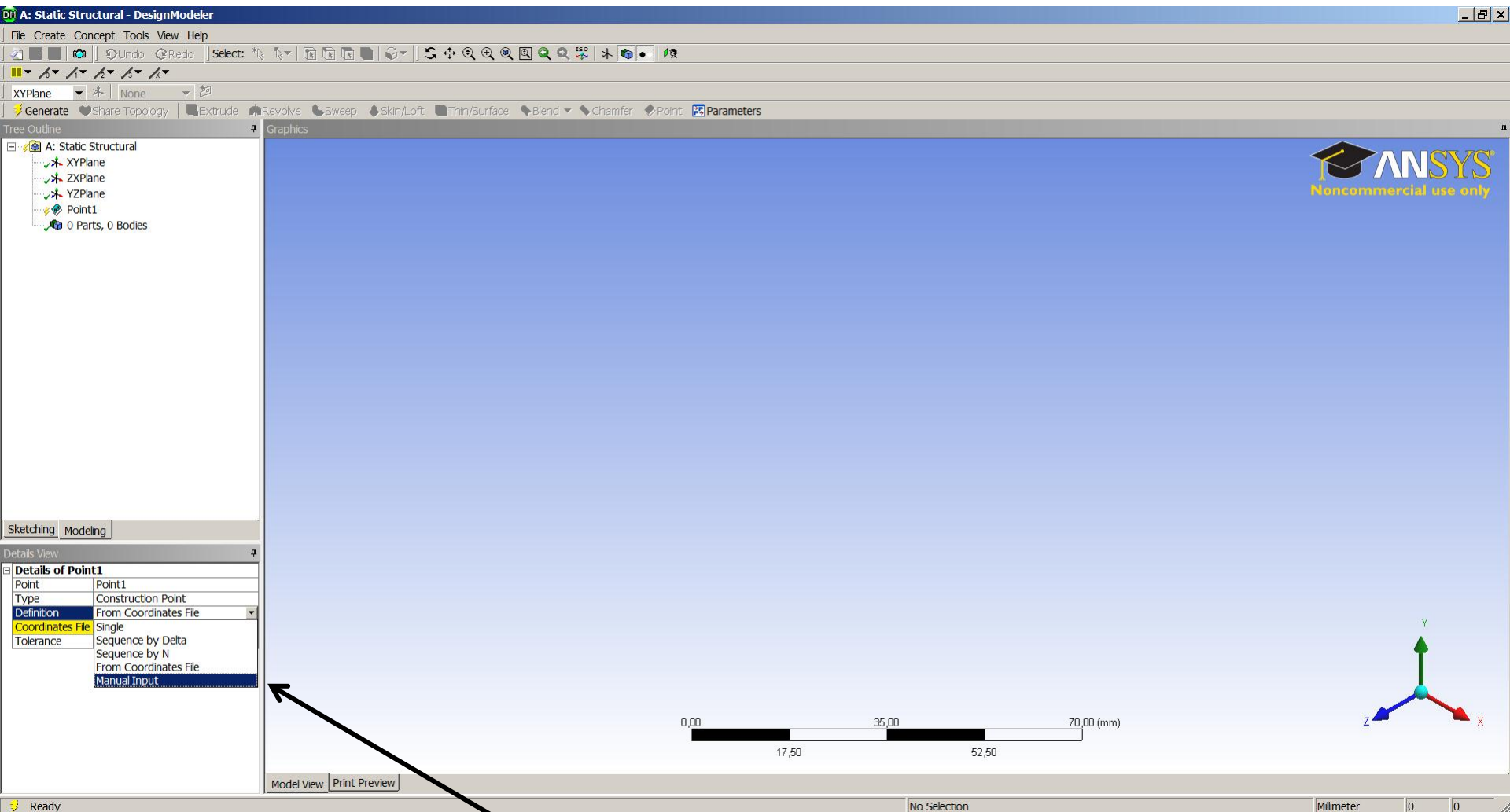
Click on Geometry



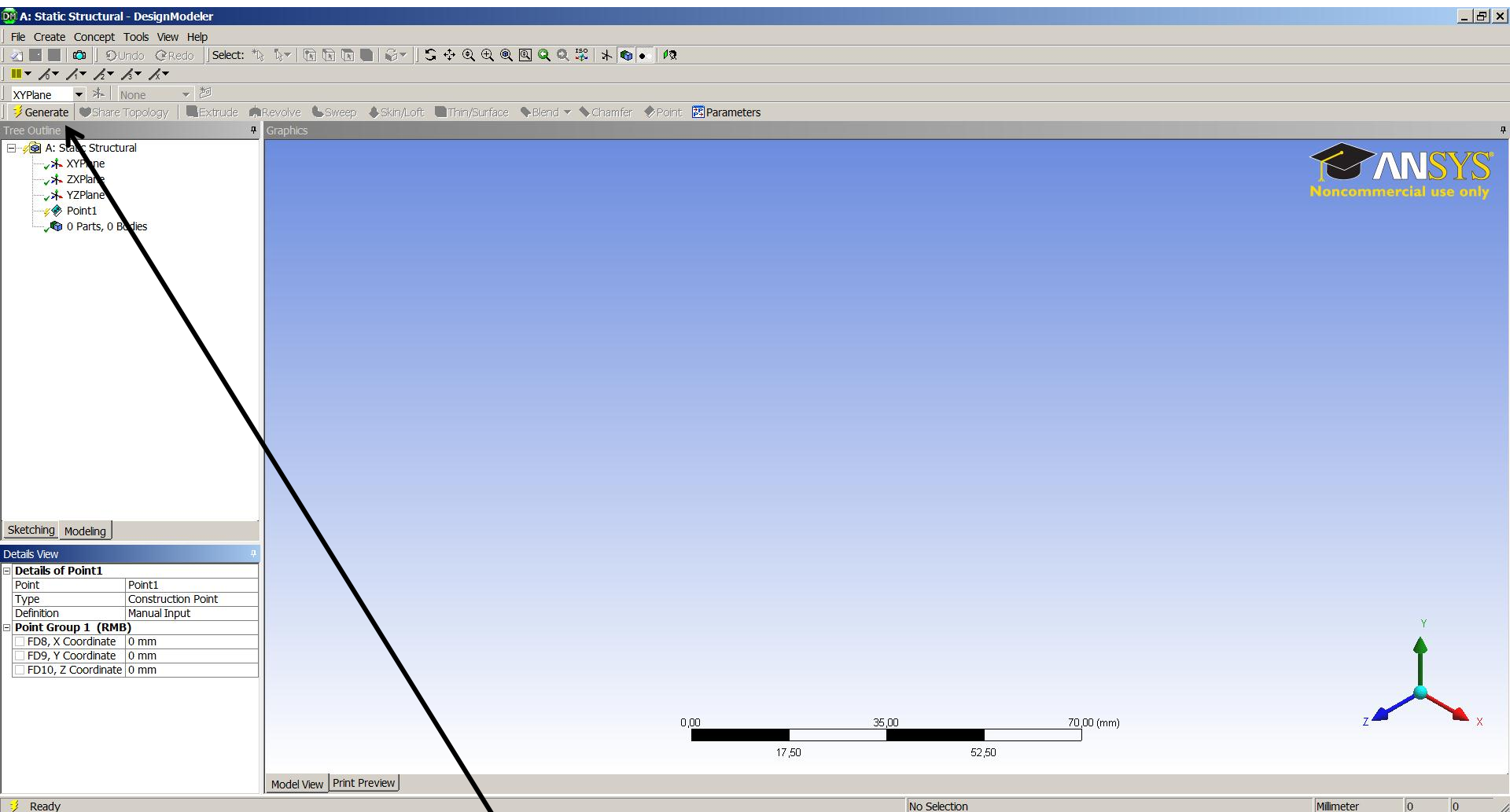
Chose Millimeter and click OK



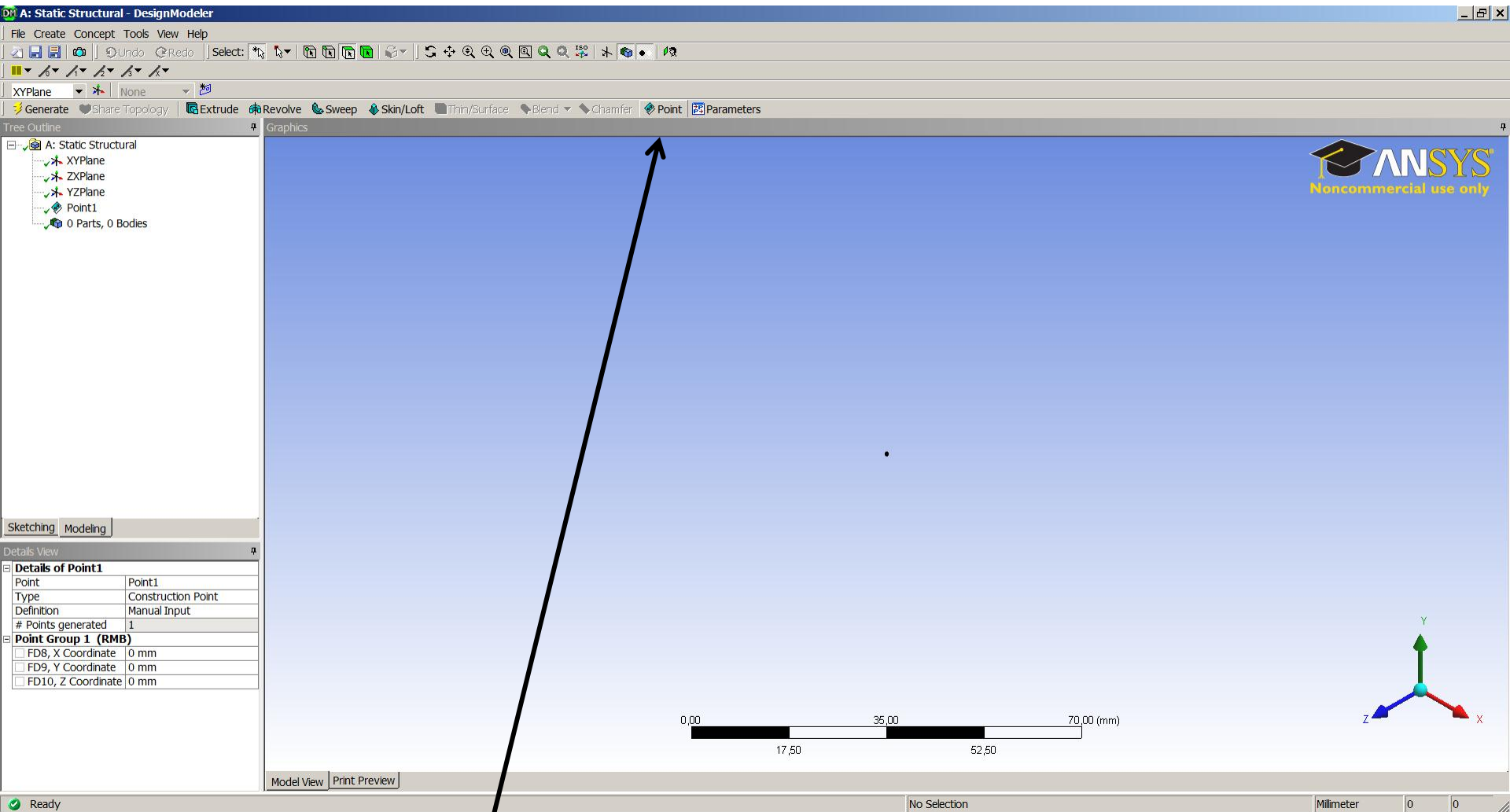
Click on Point



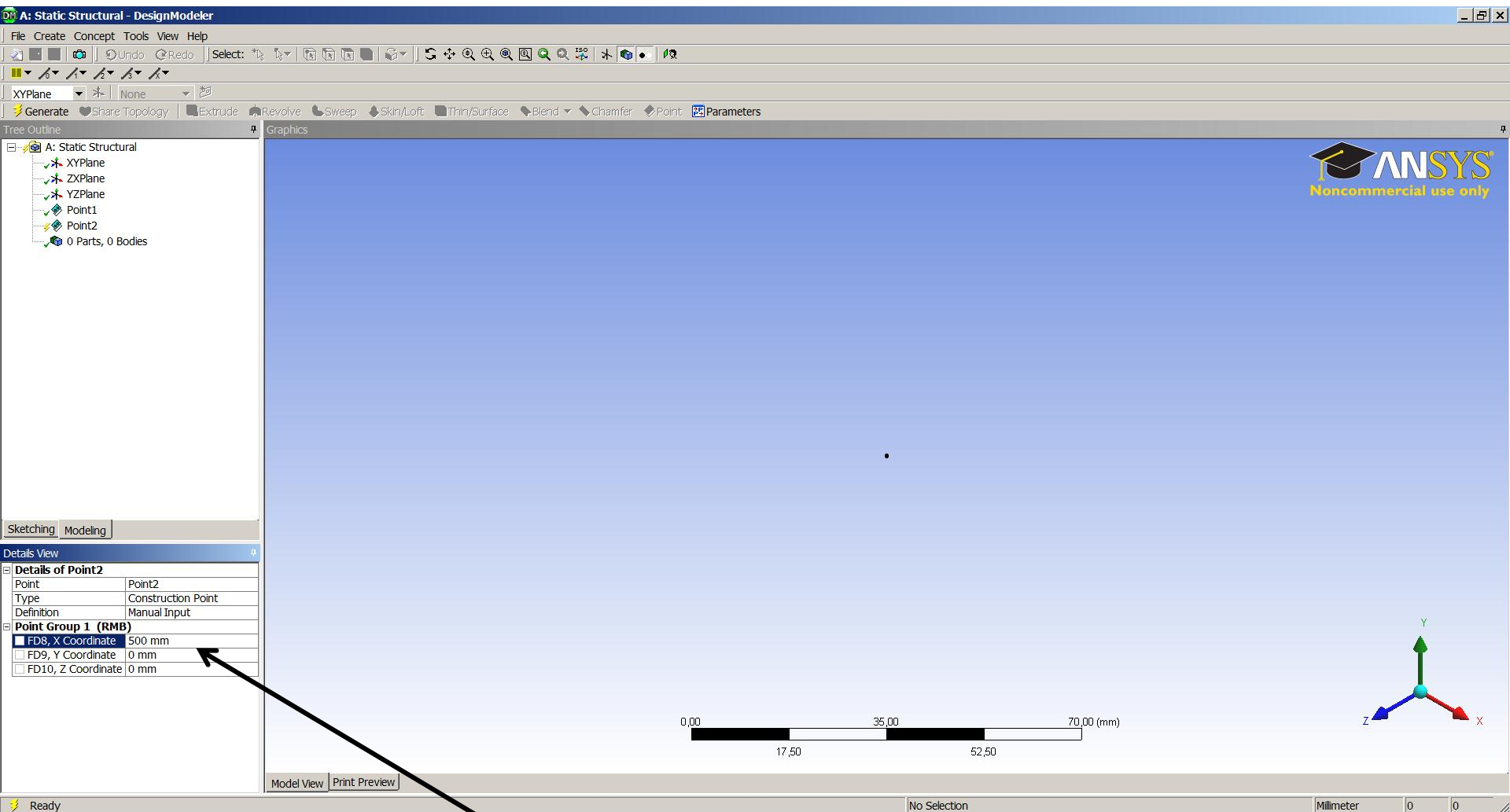
Select Manual input



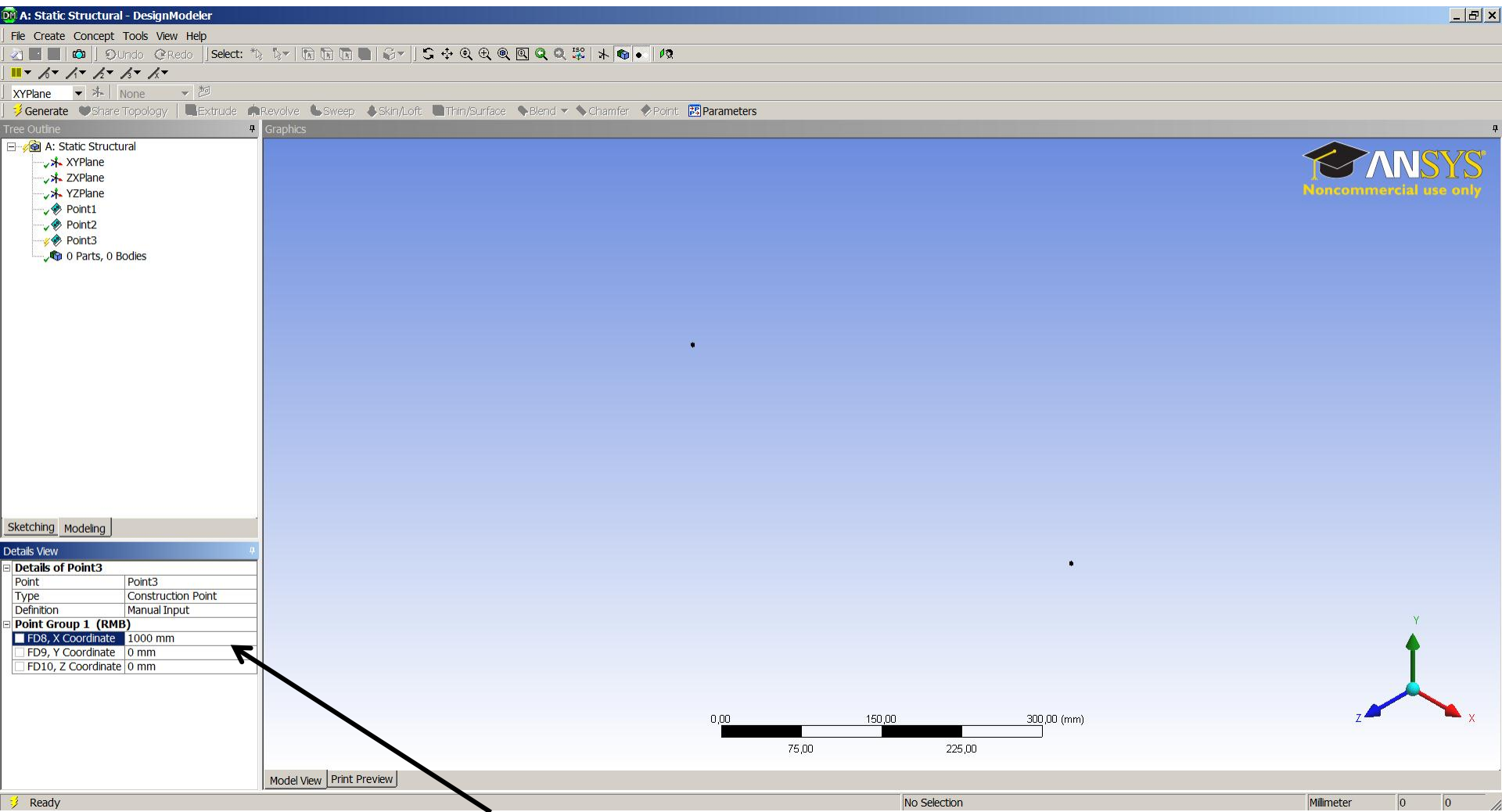
Click generate



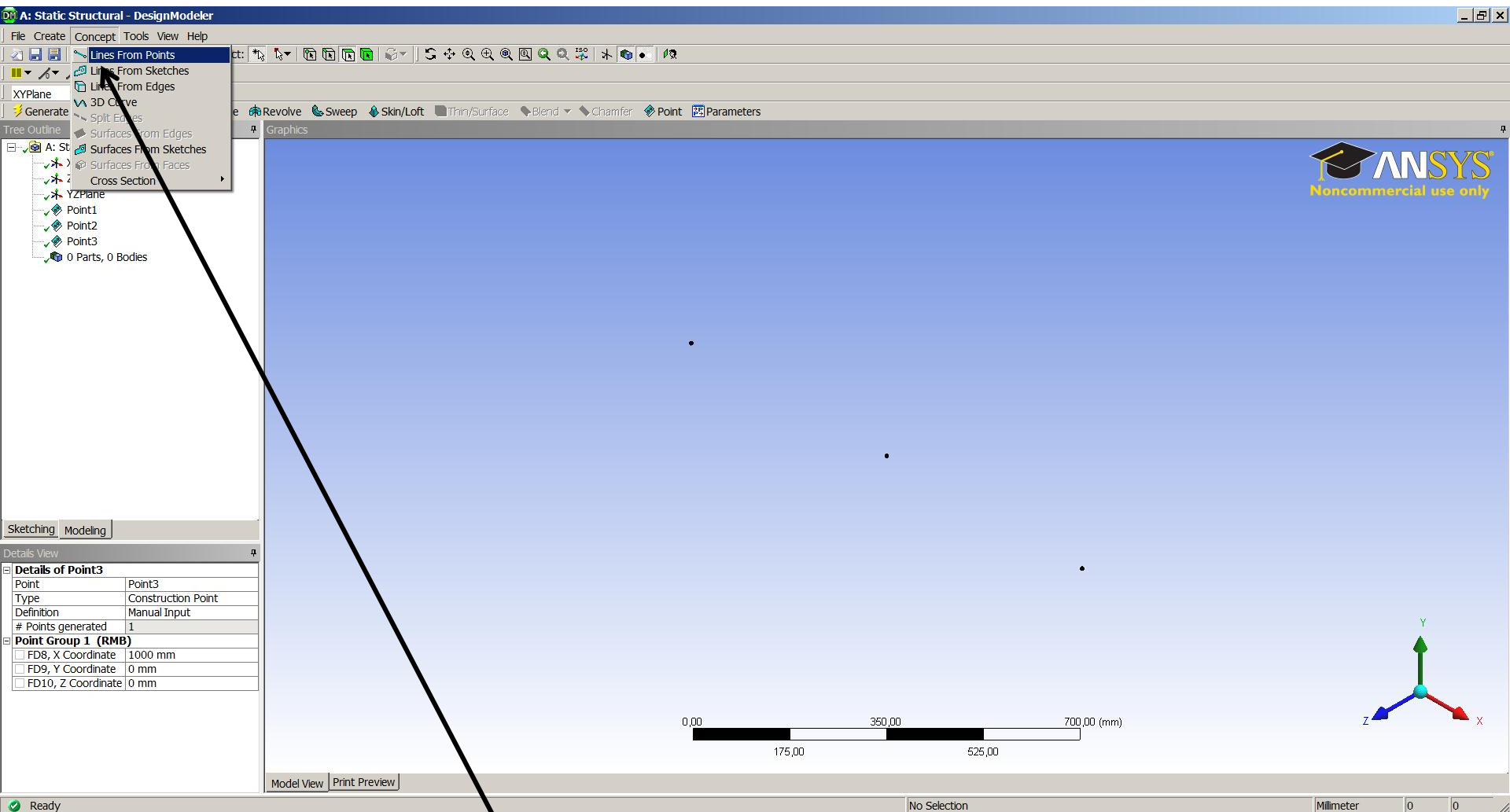
Insert a new Point 1



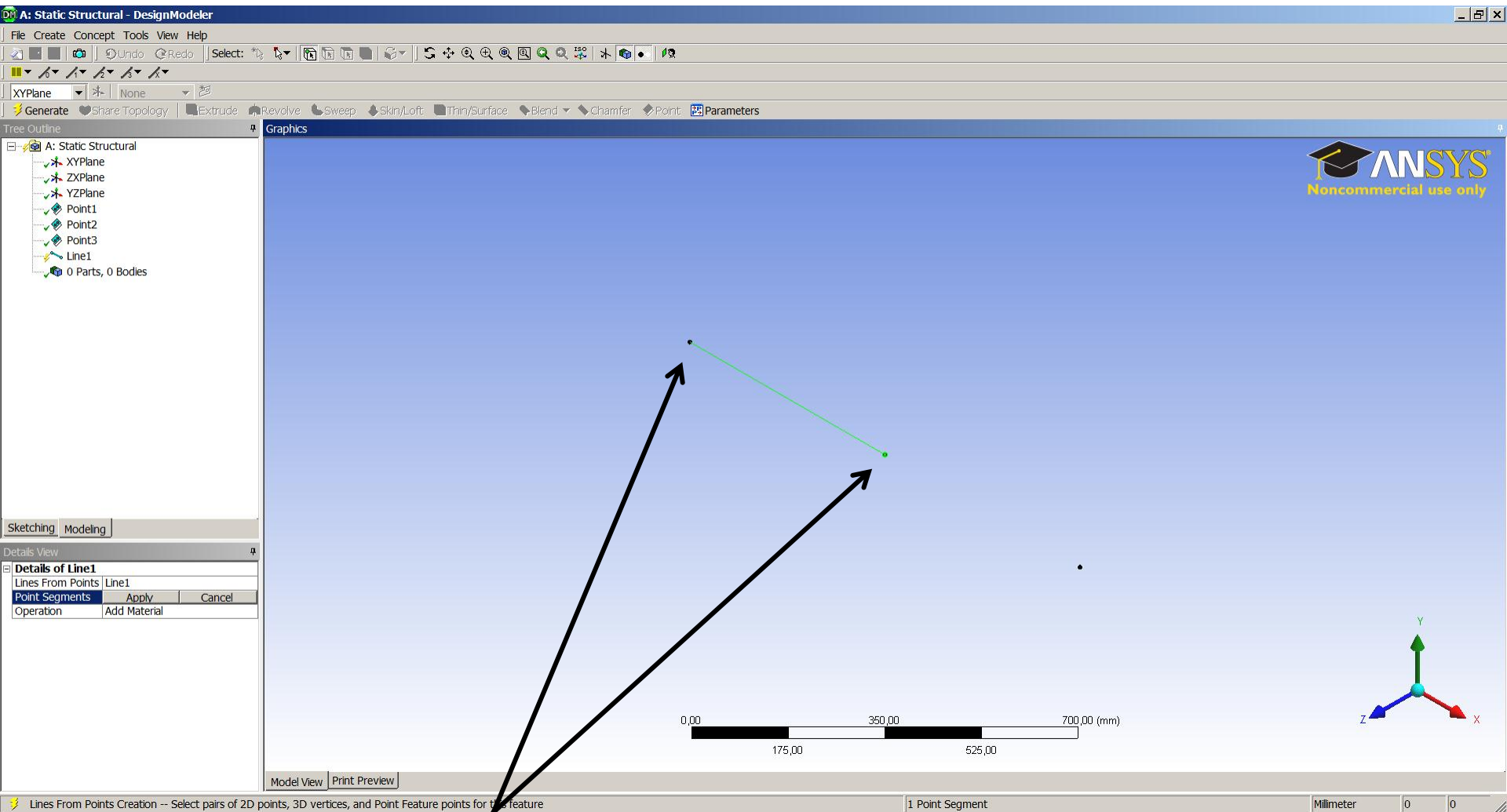
Then insert the point 2 at x=500mm



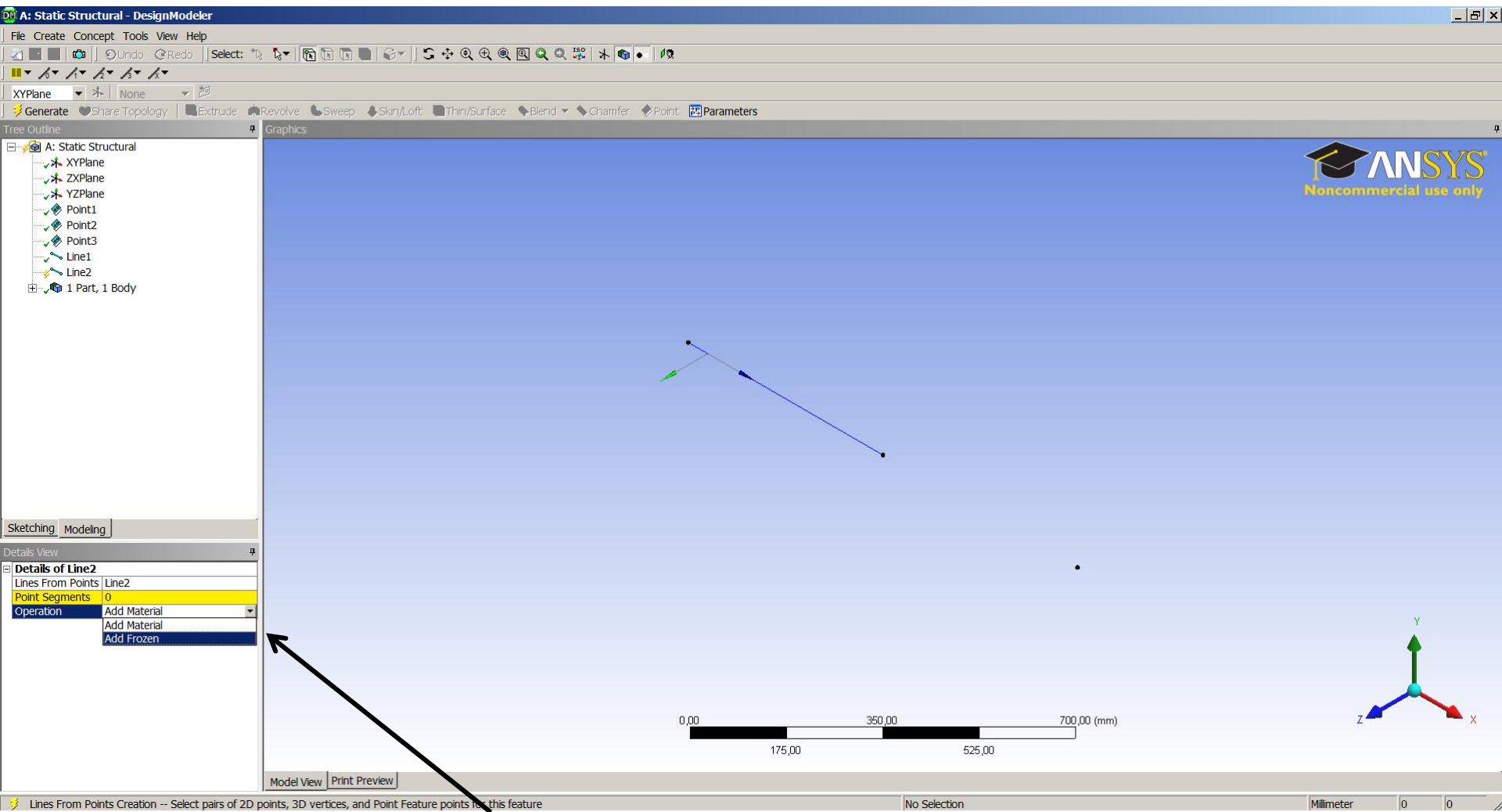
Insert a point again and set x=1000



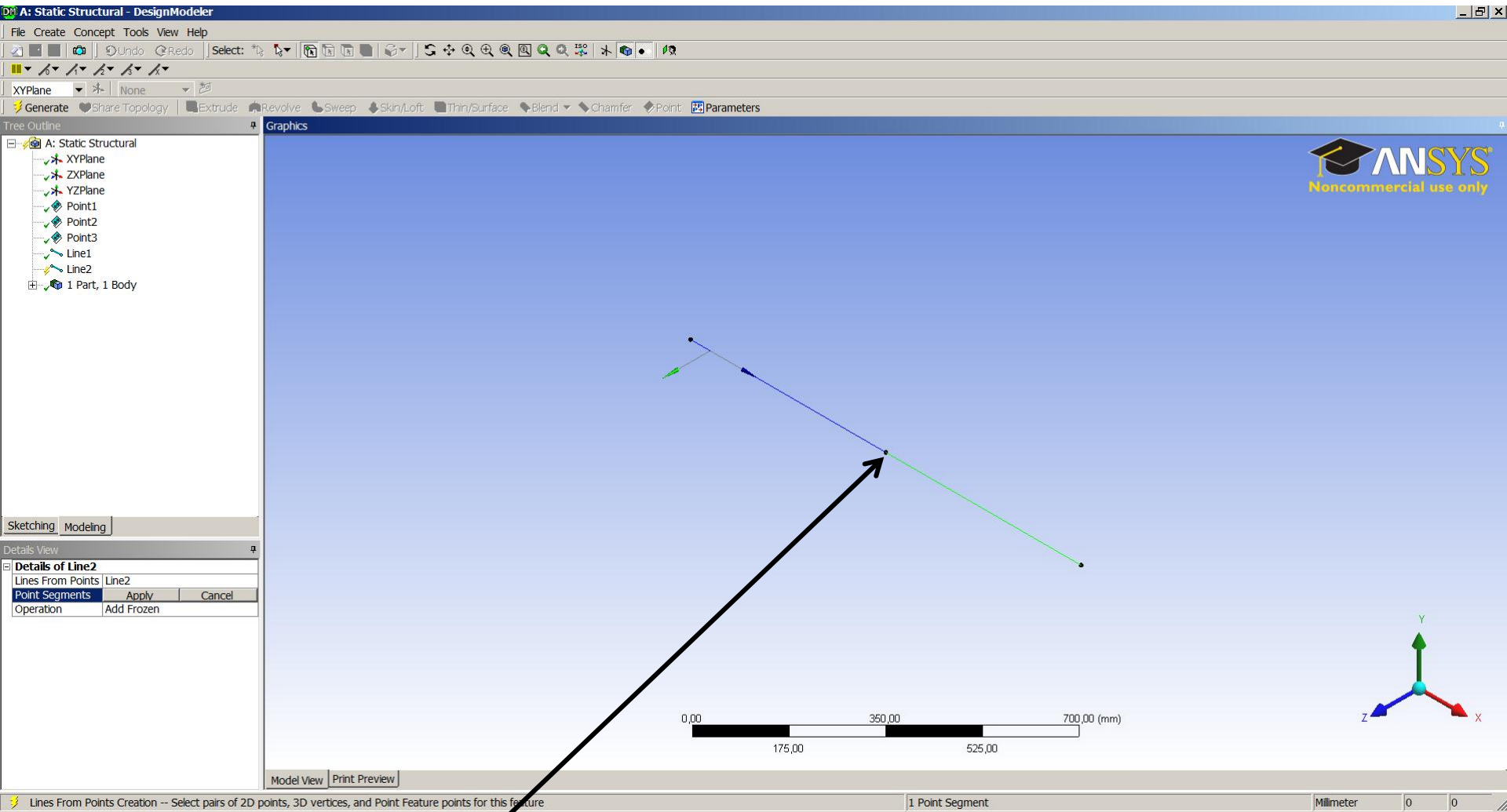
Then select lines from points



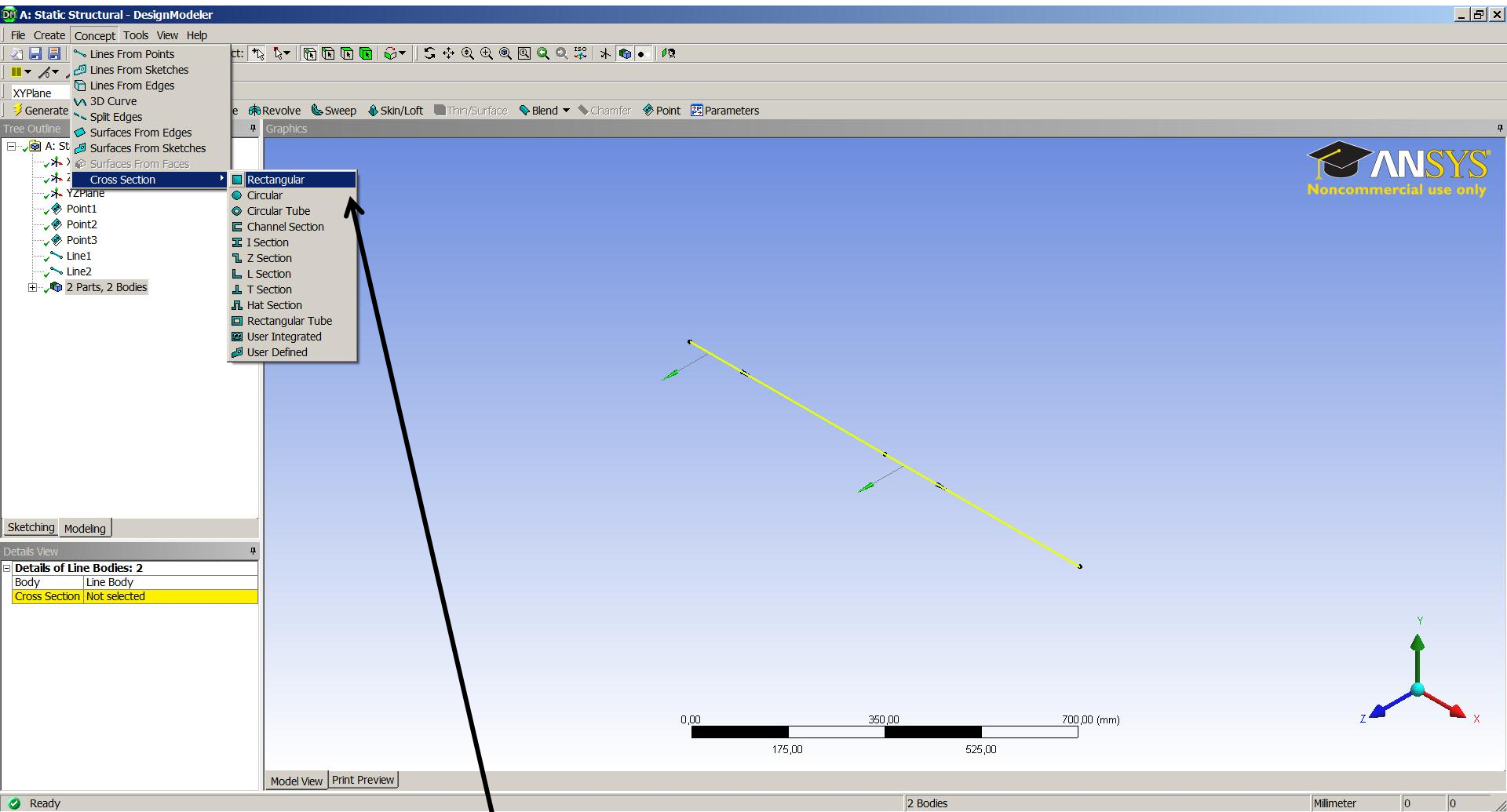
Select point 1 and hold the ctrl bottom down and select point 2 and click generate.



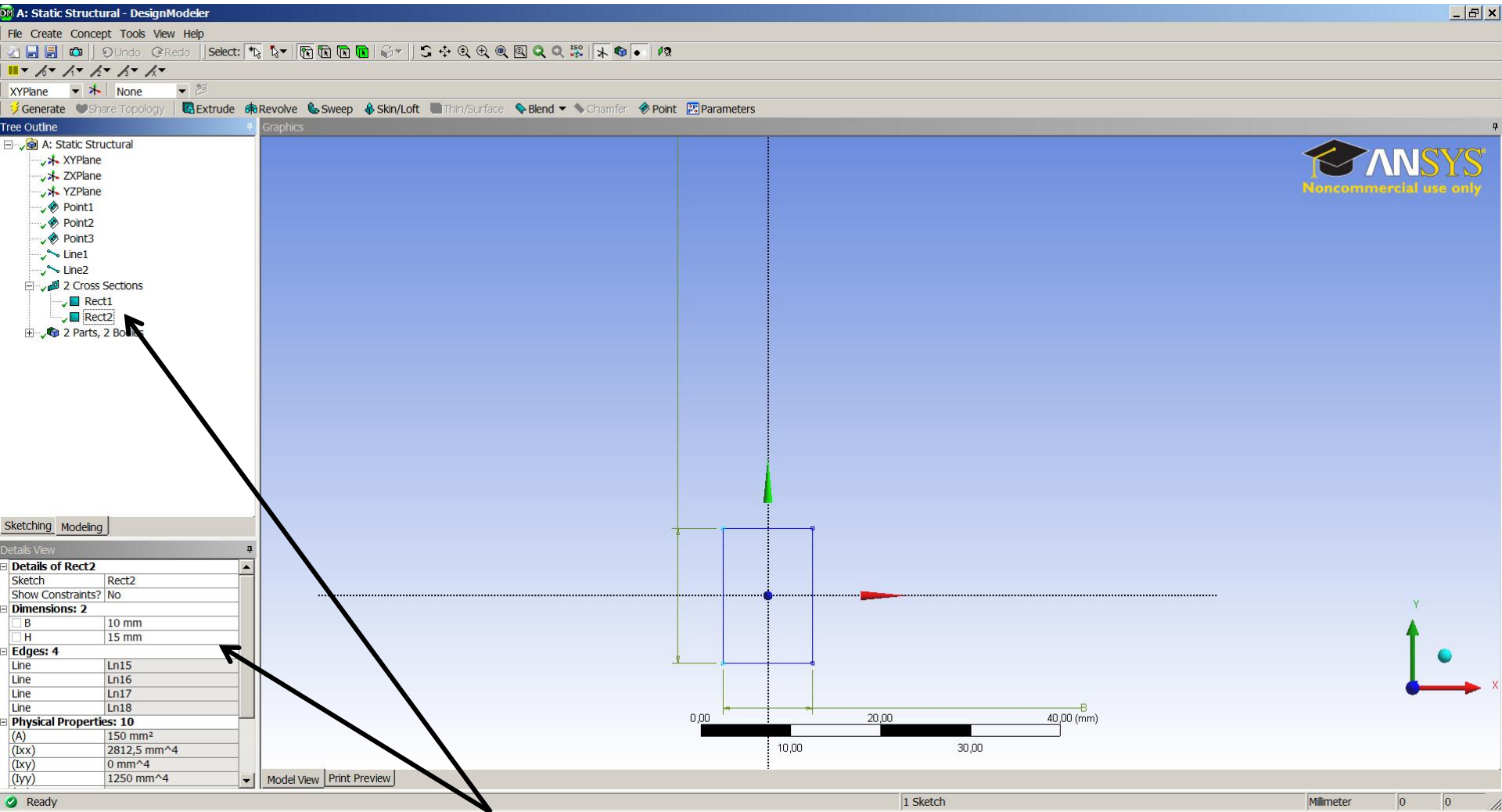
Insert a new line and select Add frozen.



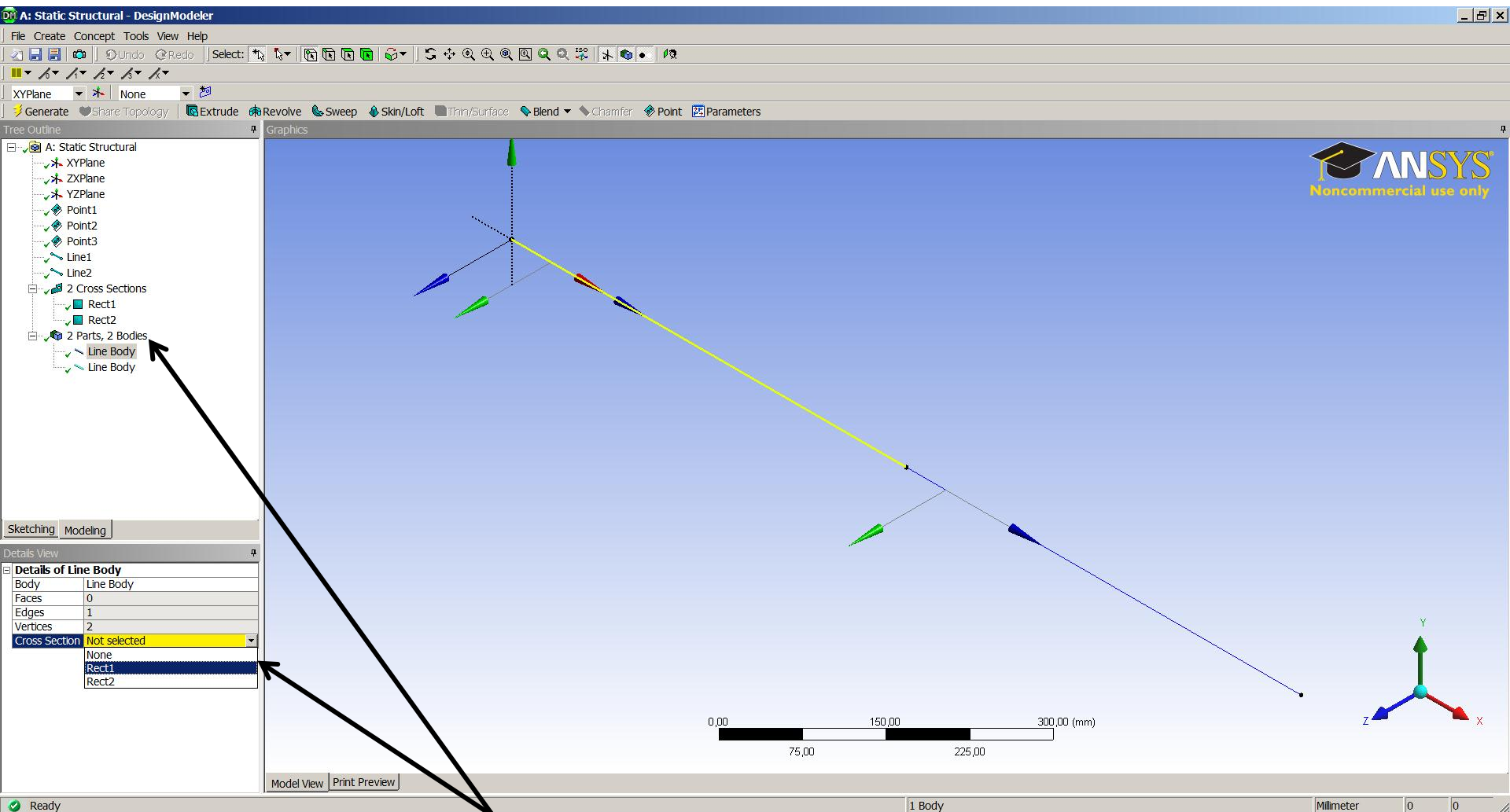
Make a line between point 2 and point 3



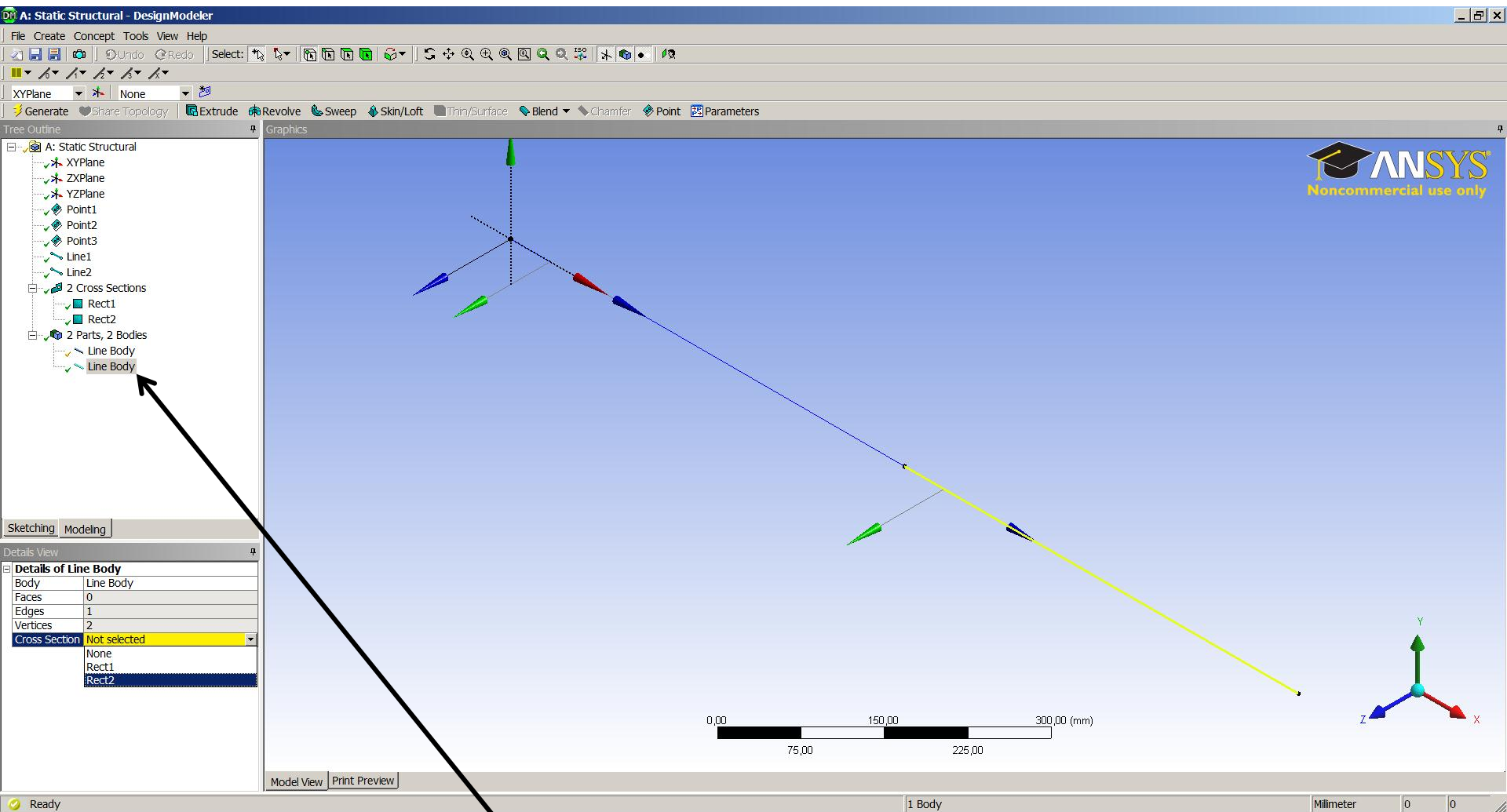
Select a Cross section. In this example the Rectangular is used.



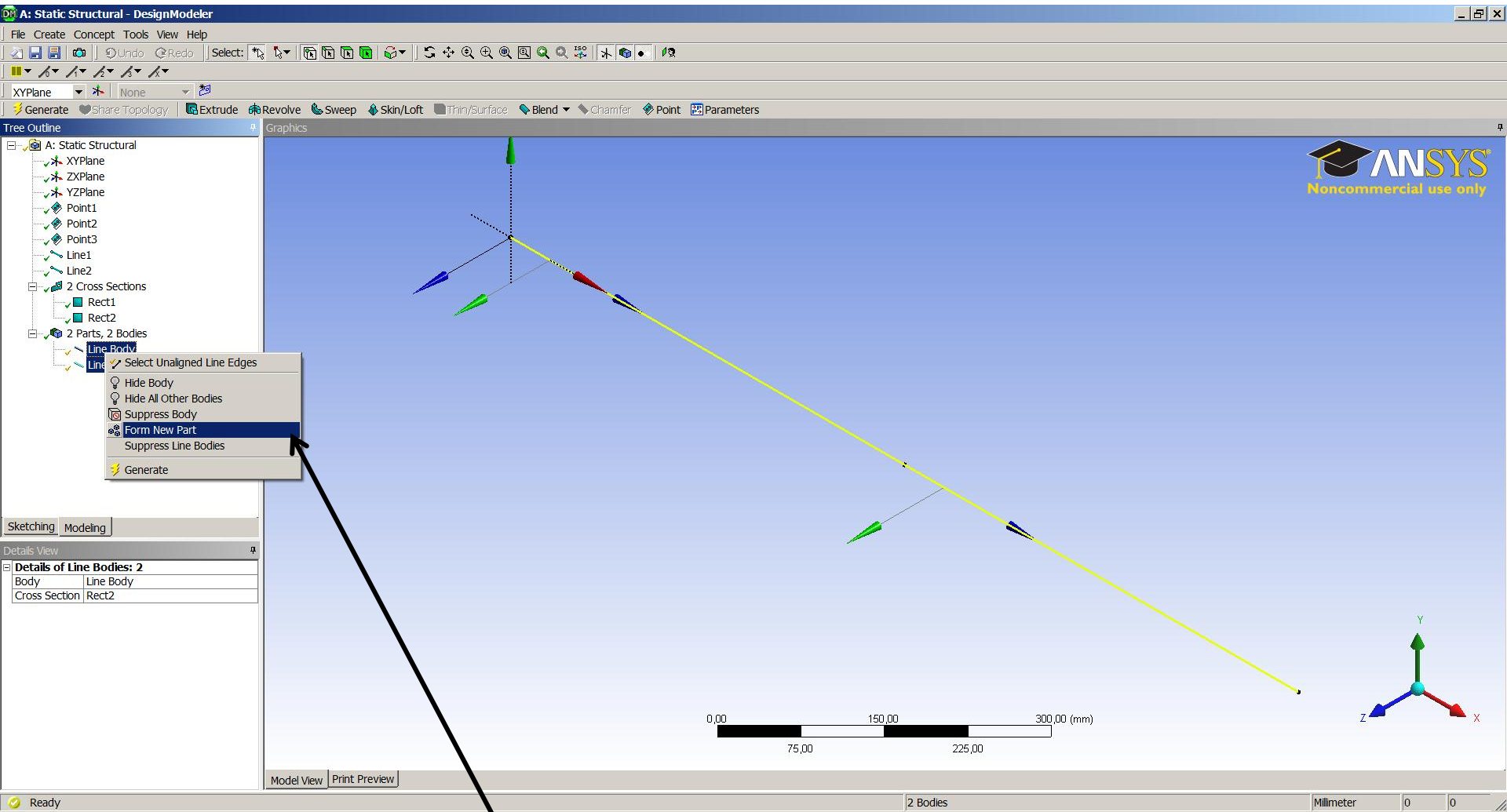
Insert a cross section again and set H=15mm.



Select line 1 and add Rect1 cross section



Add cross section Rect2 to the line 2.



Select the two bodies and right click on the mouse and select From New Part. Close the window

Unsaved Project - Workbench

File View Tools Units Help

New Open... Save Save As... Import... Reconnect Refresh Project Update Project Project Compact Mode

Toolbox

- Analysis Systems
 - Design Assessment
 - Electric
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 - Transient Thermal
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- Custom Systems
- Design Exploration
 - Goal Driven Optimization
 - Parameters Correlation
 - Response Surface
 - Six Sigma Analysis

Project Schematic

A

- Static Structural
- Engineering Data
- Geometry
- Model
- Setup
- Solution
- Results

Static Structural

Properties of Schematic A4: Model

	A	B
1	Property	Value
2	General	
3	Component ID	Model
4	Directory Name	SYS
5	System Information	
6	Physics	Structural
7	Analysis	Static Structural
8	Solver	Mechanical APDL

Messages

	A	B	C	D
1	Type	Text	Association	Date/Time
2	Events	Ask the Expert - Understanding Nodal & Element Coordinate Systems in Mechanical & Mechanical APDL 13.0		
3	Events	ECTC/ITHERM Conference		
4	Events	ANSYS 14.0 Update for Fluid Dynamics		
5	Events	Ask the Expert - ANSYS SpaceClaim Direct Modeler		
6	Events	Ask the Expert - Understanding Nodal & Element Coordinate Systems in Mechanical & Mechanical APDL 13.0		

Progress

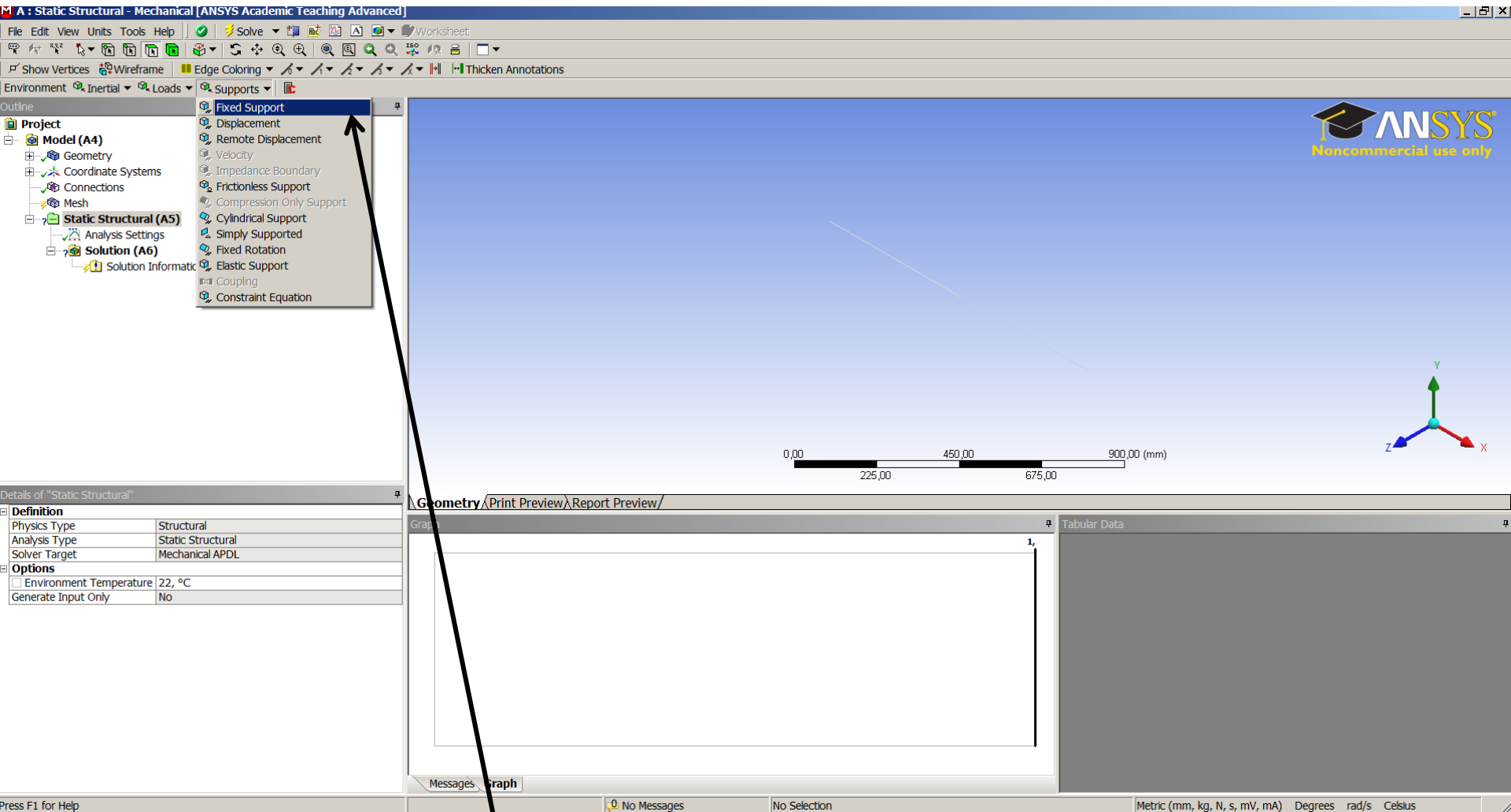
	A	B	C
1	Status	Details	Progress

View All / Customize...

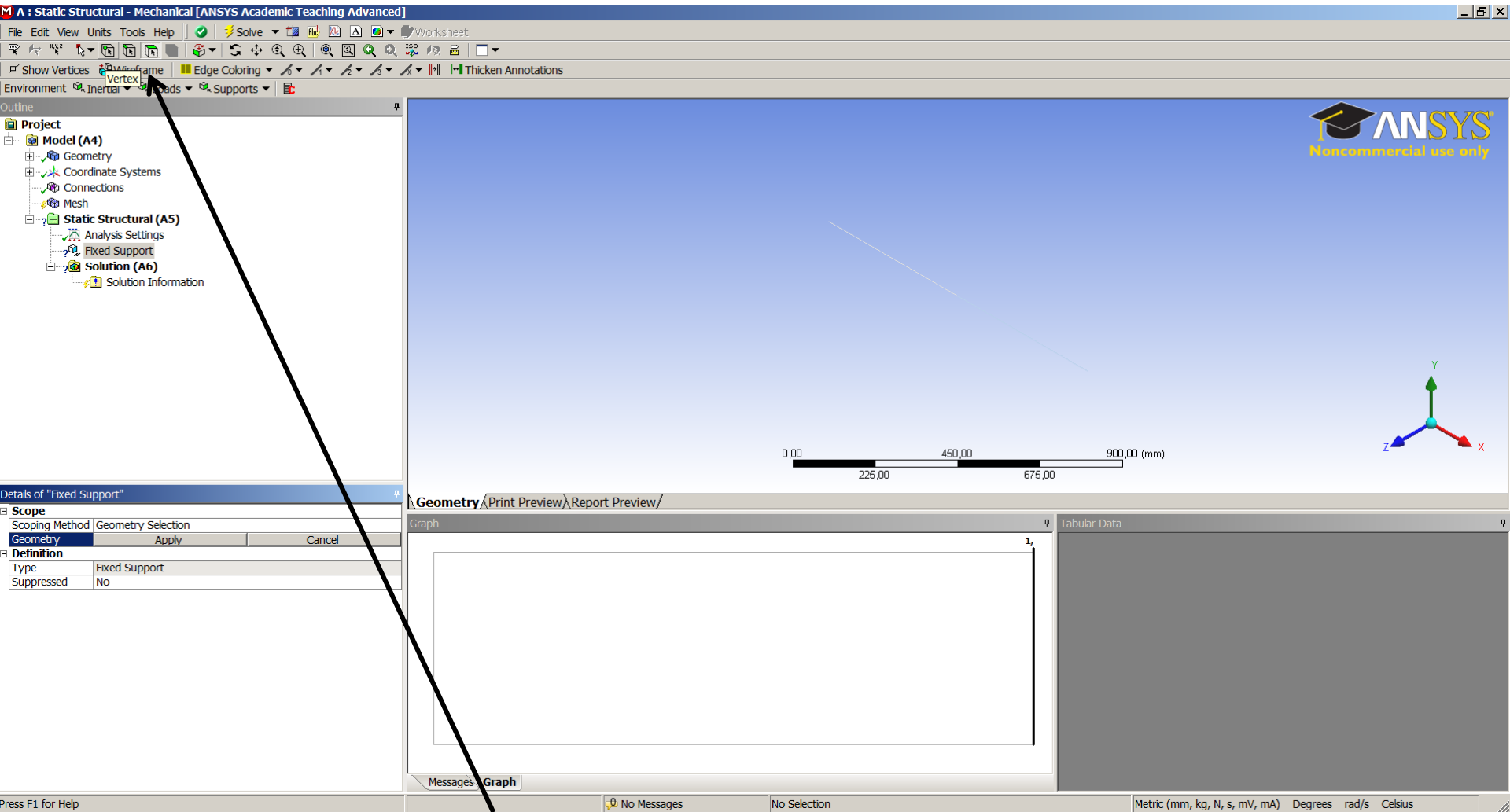
Right-click to update component.

Hide Progress Hide 6 Messages

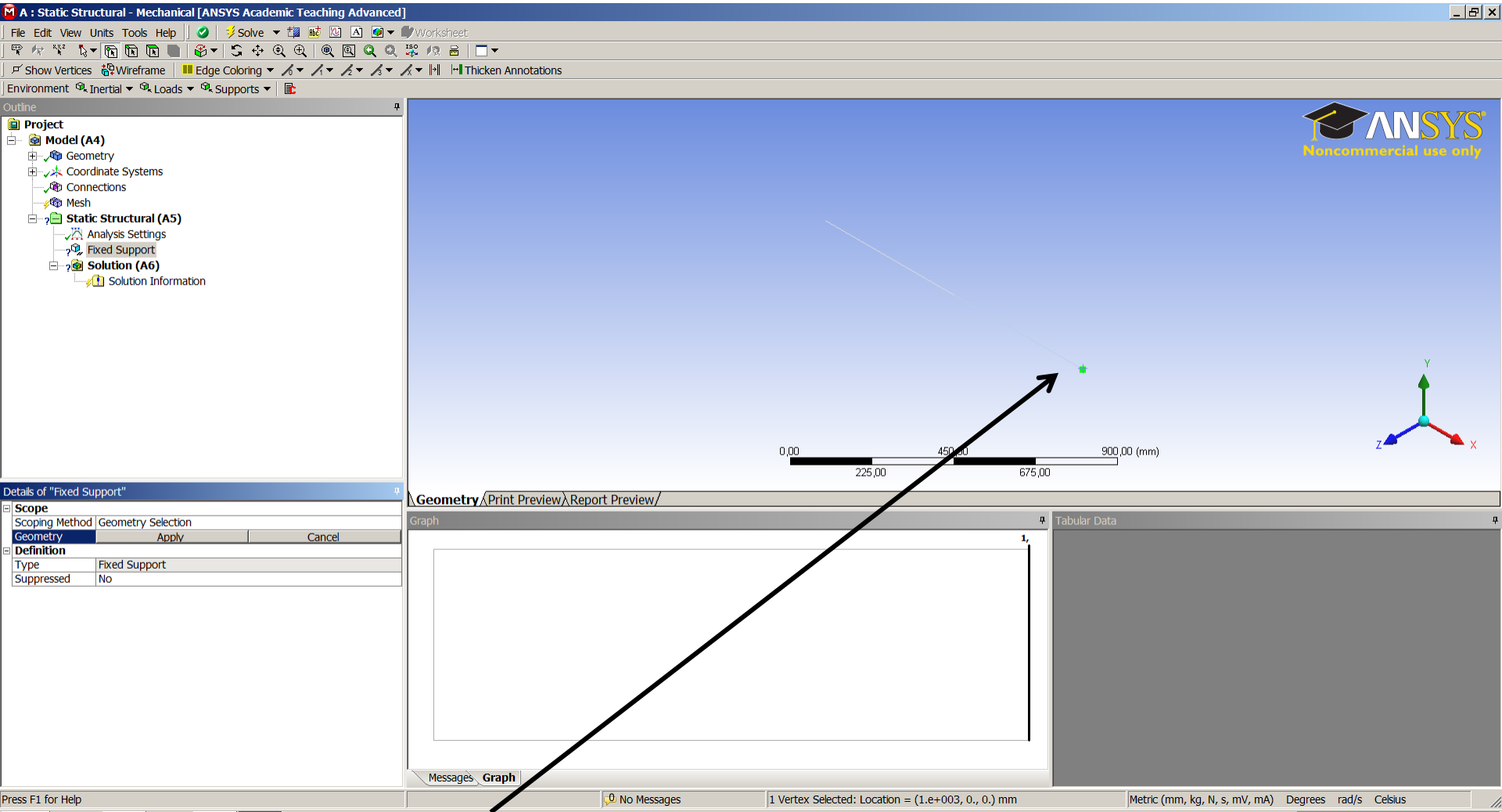
Click on Model



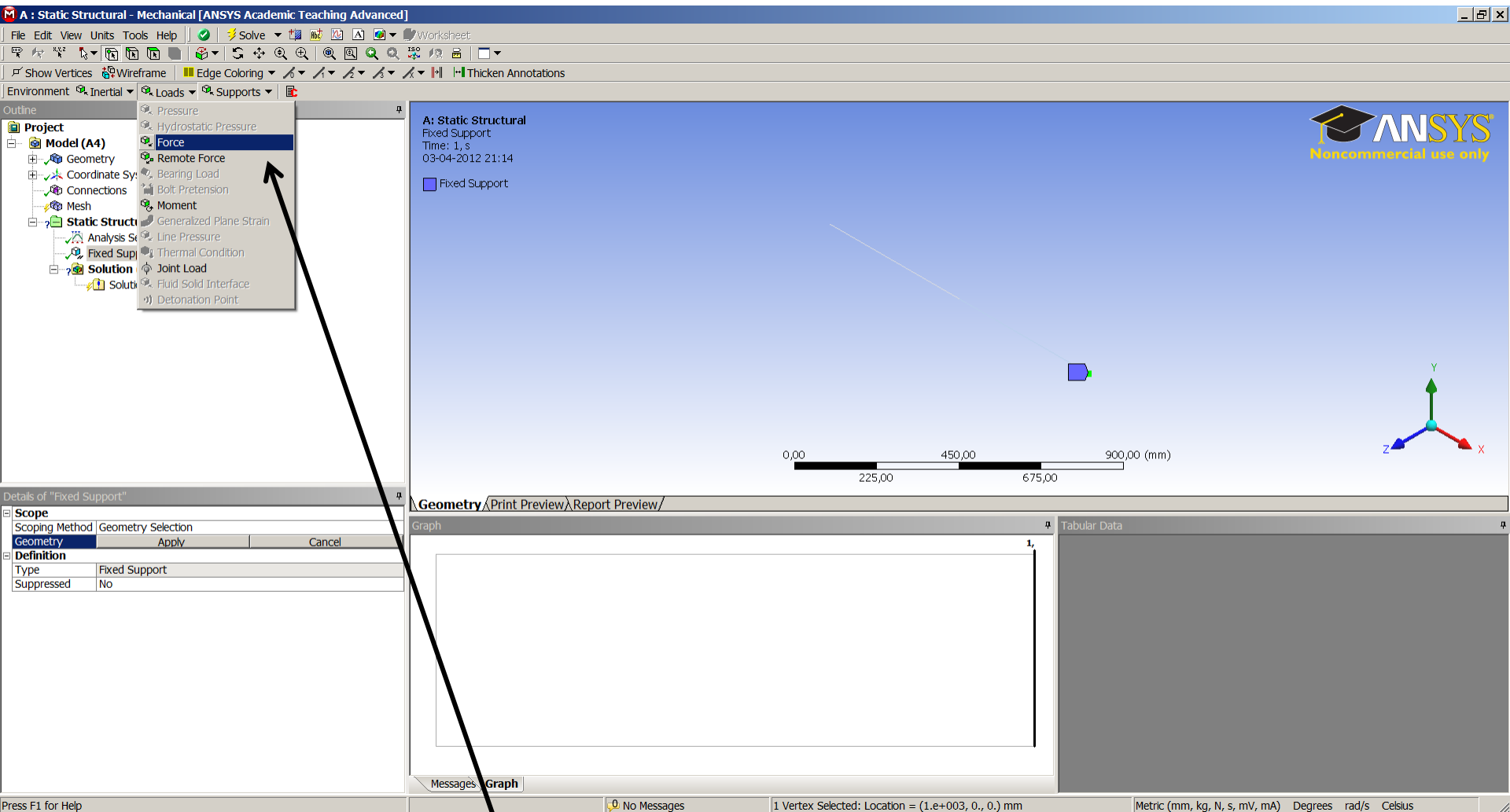
Insert a Fixed Support



Click on Vertex



Select point 3 and click on apply



Insert a Force

A : Static Structural - Mechanical [ANSYS Academic Teaching Advanced]

File Edit View Units Tools Help | Solve | Worksheet

Show Vertices Wireframe Edge Coloring | Thicken Annotations

Environment Inertial Loads Supports

Outline

- Project
 - Model (A4)
 - Geometry
 - Coordinate Systems
 - Connections
 - Mesh
 - Static Structural (A5)
 - Analysis Settings
 - Fixed Support
 - Force
 - Solution (A6)
 - Solution Information

A: Static Structural
 Force
 Time: 1, s
 03-04-2012 21:15

Force: 0, N
 Components: 0,, 0,, 0, N

0,00 225,00 450,00 675,00 900,00 (mm)

Y
 X
 Z

Details of "Force"

Scope

Scoping Method	Geometry Selection
Geometry	1 Vertex

Definition

Type	Force
Define By	Vector
Magnitude	Components
Direction	Vector
Suppressed	No

Geometry | Print Preview | Report Preview

Graph

Tabular Data

Steps	Time [s]	Force [N]
1	0,	0,
2	1,	0,
*		

Message Graph | No Messages | No Selection | Metric (mm, kg, N, s, mV, mA) Degrees rad/s Celsius

Select Components

A: Static Structural - Mechanical [ANSYS Academic Teaching Advanced]

File Edit View Units Tools Help Solve Worksheet

Show Vertices Wireframe Edge Coloring Thicken Annotations

Environment Inertial Loads Supports

Outline

- Project
 - Model (A4)
 - Geometry
 - Coordinate Systems
 - Connections
 - Mesh
 - Static Structural (A5)
 - Analysis Settings
 - Fixed Support
 - Force
 - Solution (A6)
 - Solution Information

A: Static Structural
Force
Time: 1, s
03-04-2012 21:15

Force: 10, N
Components: 0,, 10,, 0, N

0,00 225,00 450,00 675,00 900,00 (mm)

Y
X
Z

Details of "Force"

Scope

Scoping Method	Geometry Selection
Geometry	1 Vertex

Definition

Type	Force
Define By	Components
Coordinate System	Global Coordinate System
<input type="checkbox"/> X Component	0, N (ramped)
<input checked="" type="checkbox"/> Y Component	10, N (ramped)
<input type="checkbox"/> Z Component	0, N (ramped)
Suppressed	No

Geometry Print Preview Report Preview

Graph

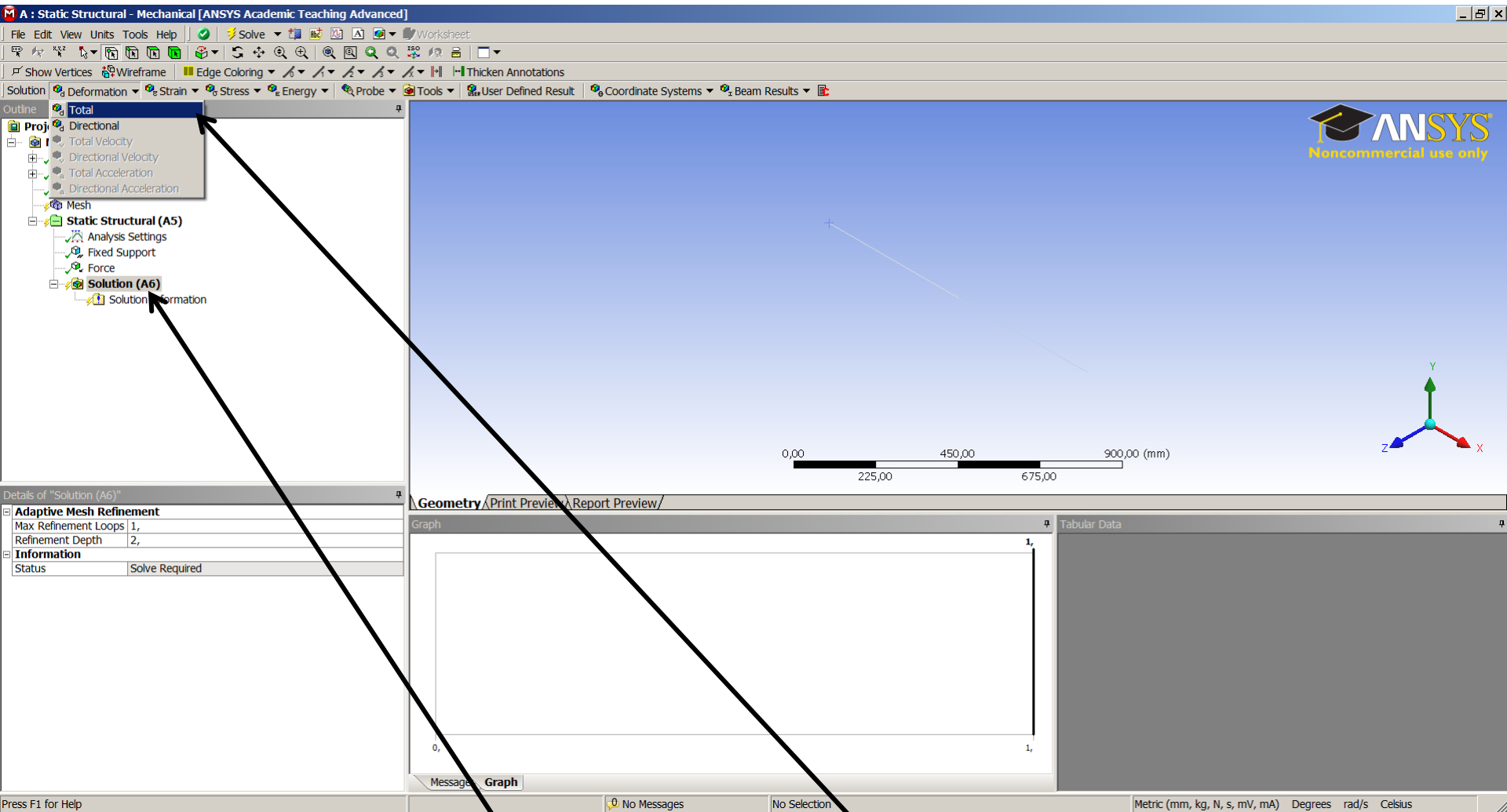
Tabular Data

Steps	Time [s]	X [N]	Y [N]	Z [N]
1	0,	0,	0,	0,
2	1,	0,	10,	0,
*				

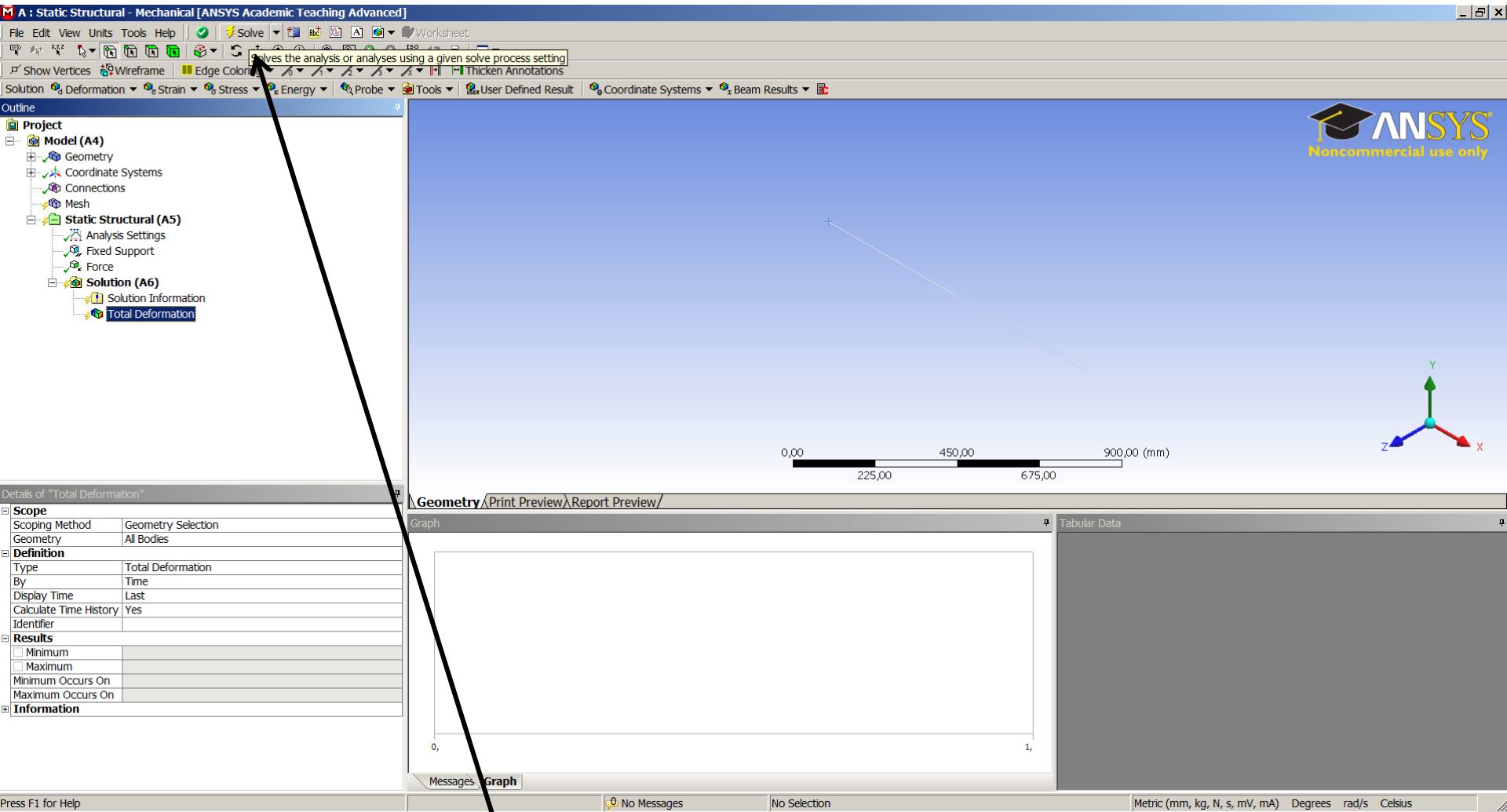
Press F1 for Help

No Messages No Selection Metric (mm, kg, N, s, mV, mA) Degrees rad/s Celsius

Click on point 1 and apply then set the Y component to 10 N



Click on Solution and insert Total deformation



Click on Solve

A : Static Structural - Mechanical [ANSYS Academic Teaching Advanced]

File Edit View Units Tools Help | Solve | Worksheet

Show Vertices Wireframe Edge Coloring | Thicken Annotations

Result 3,5 (Auto Scale) | Probe

Outline

- Project
 - Model (A4)
 - Geometry
 - Coordinate Systems
 - Connections
 - Mesh
 - Static Structural (A5)
 - Analysis Settings
 - Fixed Support
 - Force
 - Solution (A6)
 - Solution Information
 - Total Deformation

A: Static Structural
 Total Deformation
 Type: Total Deformation
 Unit: mm
 Time: 1
 03-04-2012 21:16

14,168 Max
 12,594
 11,02
 9,4453
 7,8711
 6,2969
 4,7227
 3,1484
 1,5742
 0 Min

0,00 225,00 450,00 675,00 900,00 (mm)

Geometry | Print Preview | Report Preview

Graph | Tabular Data

Animation | 10 Frames | 2 Sec (Auto)

Messages | Graph

No Messages | No Selection | Metric (mm, kg, N, s, mV, mA) | Degrees | rad/s | Celsius

Solution is done

M : Static Structural - Mechanical [ANSYS Academic Teaching Advanced]

File Edit View Units Tools Help | Solve | Worksheet

Show Vertices Wireframe Edge Coloring | Thicken Annotations

Result 3,5 (Auto Scale) | Probe

Outline

- Project
 - Model (A4)
 - Geometry
 - Coordinate Systems
 - Connections
 - Mesh
 - Static Structural (A5)
 - Analysis Settings
 - Fixed Support
 - Force
 - Solution (A6)
 - Solution Information
 - Total Deformation

A: Static Structural
 Total Deformation
 Type: Total Deformation
 Unit: mm
 Time: 1
 03-04-2012 21:16

14,168 Max
 12,594
 11,02
 9,4453
 7,8711
 6,2969
 4,7227
 3,1484
 1,5742
 0 Min

0,00 225,00 450,00 675,00 900,00 (mm)

Y
 X
 Z

Details of "Total Deformation"

Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Total Deformation
By	Time
Display Time	Last
Calculate Time History	Yes
Identifier	
Results	
<input type="checkbox"/> Minimum	0, mm
<input checked="" type="checkbox"/> Maximum	14,168 mm
Minimum Occurs On	Line Body
Maximum Occurs On	Line Body
Information	

Geometry | Print Preview | Report Preview

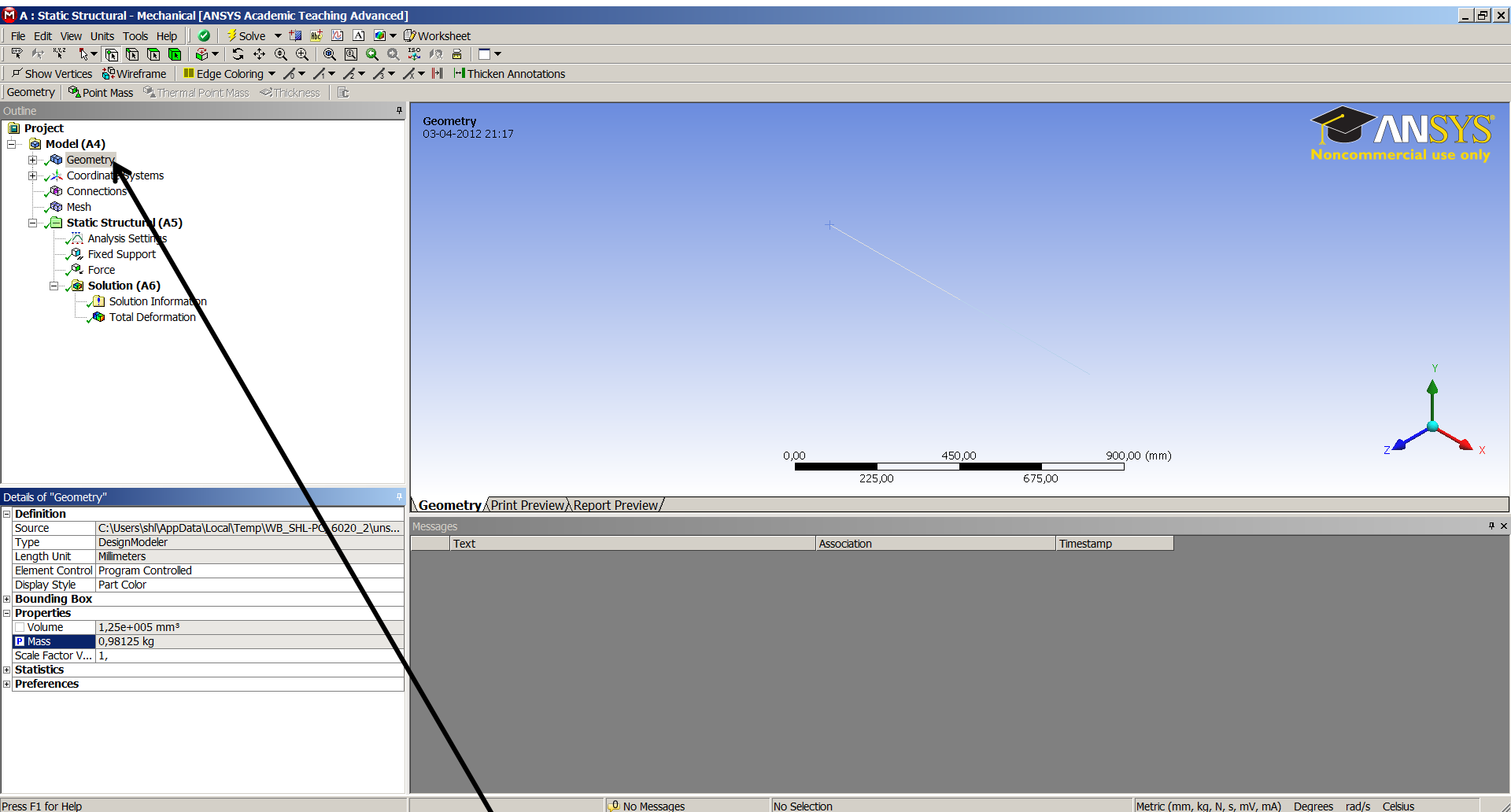
Graph

Animation | 10 Frames | 2 Sec (Auto)

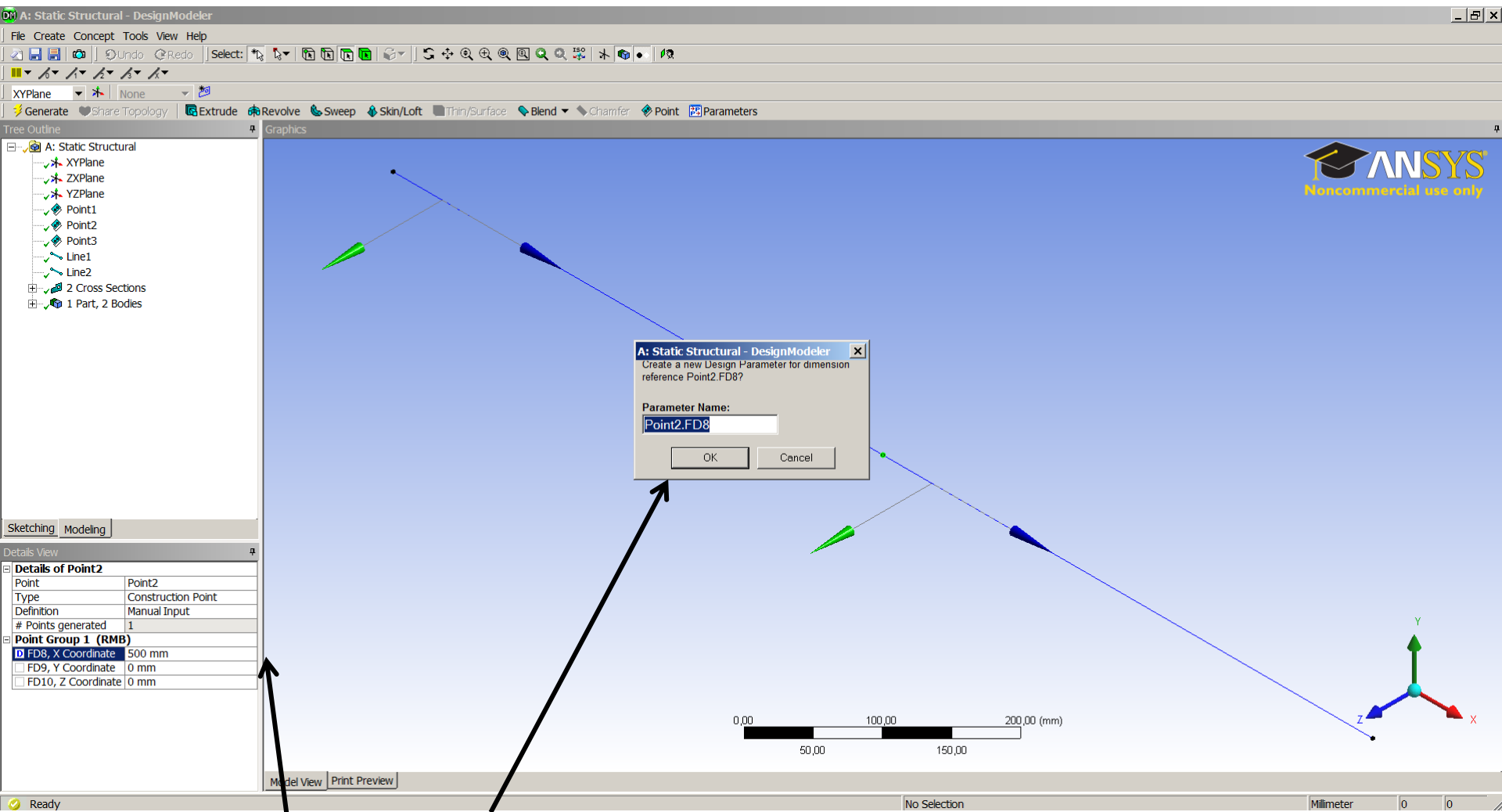
Messages | Graph

No Messages | No Selection | Metric (mm, kg, N, s, mV, mA) | Degrees | rad/s | Celsius

Click on the box beside Maximum when it is selected a P sign will show up



Click in Geometry and click on the box beside Mass.
Close the window and start design modeler



Click on the box for the x coordinate for point 2. Click OK and close the window

Unsaved Project - Workbench

File View Tools Units Help

New Open... Save Save As... Import... Reconnect Refresh Project Update Project Update All Design Points Project Compact Mode

Toolbox

- Analysis Systems
 - Design Assessment
 - Electric
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 - Fluid Flow (CFX)
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 - Transient Thermal
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- Custom Systems
- Design Exploration
 - Goal Driven Optimization
 - Parameters Correlation
 - Response Surface
 - Six Sigma Analysis

Project Schematic

A

- 1 Static Structural
- 2 Engineering Data ✓
- 3 Geometry ✓
- 4 Model ✓
- 5 Setup ✓
- 6 Solution ✓
- 7 Results ✓
- 8 Parameters

Static Structural

Parameter Set

Properties of Schematic: Parameter Set

	A	B
1	Property	Value
2	Design Point Update Process	
3	Update Option	Run in Foreground
4	Design Point Update Order	Update from Current

Messages

	A	B	C	D
1	Type	Text	Association	Date/Time
2	Events	Ask the Expert - Understanding Nodal & Element Coordinate Systems in Mechanical & Mechanical APDL 13.0		
3	Events	ECTC/ITHERM Conference		
4	Events	ANSYS 14.0 Update for Fluid Dynamics		
5	Events	Ask the Expert - ANSYS SpaceClaim Direct Modeler		
6	Events	Ask the Expert - Understanding Nodal & Element Coordinate Systems in Mechanical & Mechanical APDL 13.0		

Progress

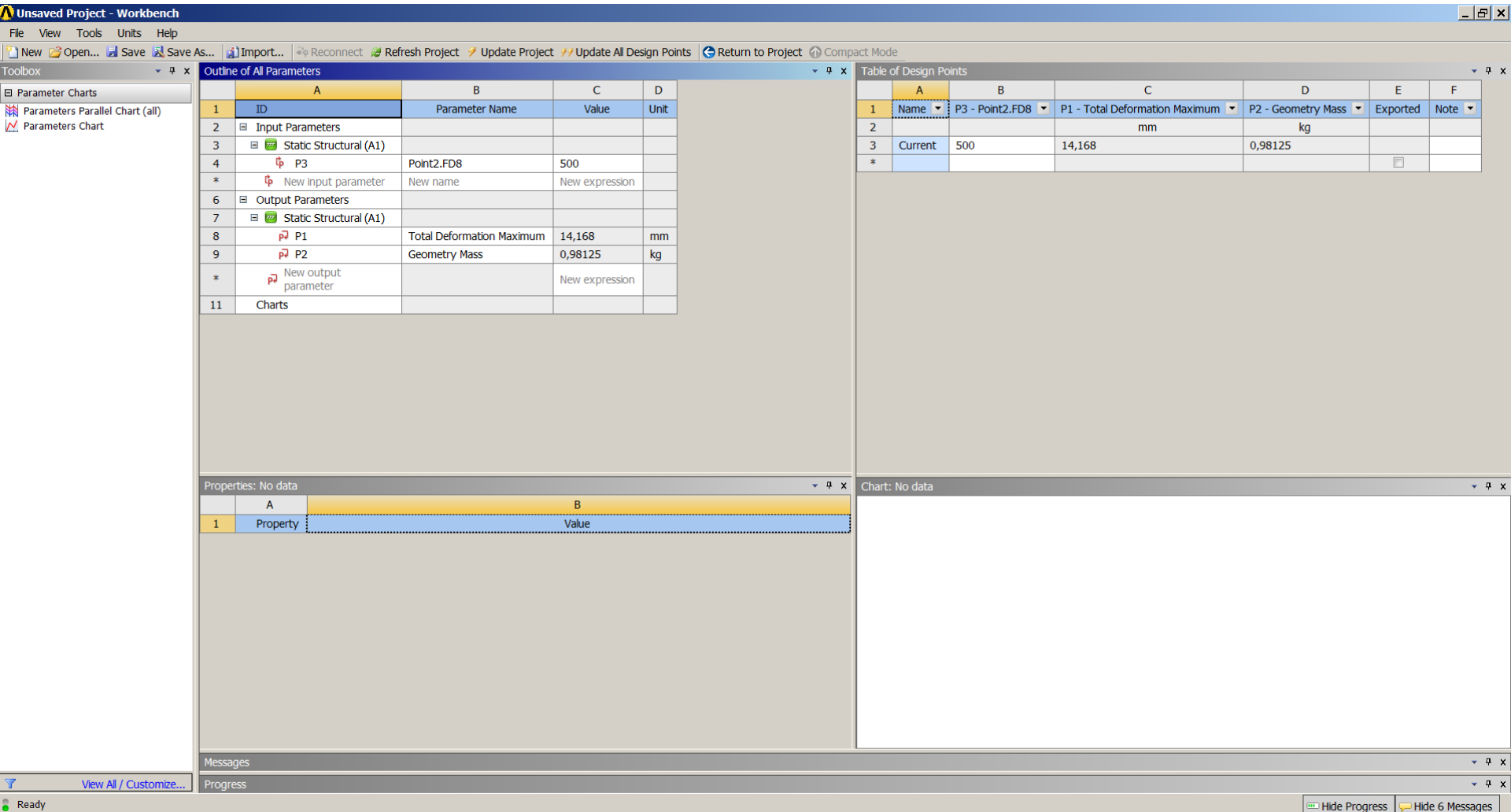
	A	B	C
1	Status	Details	Progress

View All / Customize...

Double-click to view and edit all project parameters.

Hide Progress Hide 6 Messages

Click on Parameter set



A new window is showing with the parameter then close the window

- Analysis Systems
 - Design Assessment
 - Electric
 - Explicit Dynamics
 - Fluid Flow (CFX)
 - Fluid Flow (FLUENT)
 - Harmonic Response
 - Hydrodynamic Diffraction
 - Hydrodynamic Time Response
 - Linear Buckling
 - Magnetostatic
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 - Static Structural
 - Steady-State Thermal
 - Thermal-Electric
 - Transient Structural
 - Transient Thermal
- Component Systems
- Custom Systems
- Design Exploration
 - Goal Driven Optimization**
 - Parameters Correlation
 - Response Surface
 - Six Sigma Analysis



	A	B
1	Property	Value
2	General	
3	Description	
4	Error Message	
5	Expression	500
6	Expression Type	Constant
7	Usage	Input
8	Quantity Name	Dimensionless
9	Design Point Update Process	
10	Update Option	Run in Foreground
11	Design Point Update Order	Update from Current

	A	B	C	D
1	Type	Text	Association	Date/Time
2	Events	Ask the Expert - Understanding Nodal & Element Coordinate Systems in Mechanical & Mechanical APDL 13.0		
3	Events	ECTC/ITHERM Conference		
4	Events	ANSYS 14.0 Update for Fluid Dynamics		
5	Events	Ask the Expert - ANSYS SpaceClaim Direct Modeler		
6	Events	Ask the Expert - Understanding Nodal & Element Coordinate Systems in Mechanical & Mechanical APDL 13.0		

	A	B	C
1	Status	Details	Progress

Click on Goal Driven optimization

Unsaved Project - Workbench

File View Tools Units Help

New Open... Save Save As... Import... Preview Design of Experiments Update Design of Experiments Reconnect Refresh Project Update Project Update All Design Points Project Compact Mode

Toolbox

- Analysis Systems
 - Design Assessment
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 - Fluid Flow (FLUENT)
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 - Hydrodynamic Time Response
 - Linear Buckling
 - Magnetostatic
 - Modal
 - Random Vibration
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 - Rigid Dynamics
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 - Thermal-Electric
 - Transient Structural
 - Transient Thermal
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- Custom Systems
- Design Exploration
 - Goal Driven Optimization
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 - Six Sigma Analysis

Project Schematic

3 Geometry ✓
4 Model ✓
5 Setup ✓
6 Solution ✓
7 Results ✓
8 Parameters ✓

Static Structural

Parameter Set

B

- Goal Driven Optimization
- Design of Experiments
- Response Surface
- Optimization

Goal Driven Optimization

Messages

1	A	B	C	D
Type	Text		Association	Date/Time
2	Events	Ask the Expert - Understanding Nodal & Element Coordinate Systems in Mechanical & Mechanical APDL 13.0		
3	Events	ECTC/ITHERM Conference		
4	Events	ANSYS 14.0 Update for Fluid Dynamics		
5	Events	Ask the Expert - ANSYS SpaceClaim Direct Modeler		
6	Events	Ask the Expert - Understanding Nodal & Element Coordinate Systems in Mechanical & Mechanical APDL 13.0		

Progress

1	A	B	C
Status	Details		Progress

Properties of Schematic B2: Design of Experiments

	A	B
1	Property	Value
2	General	
3	Component ID	Design of Experiment
4	Directory Name	GDO
5	Design Points	
6	Preserve Design Points After DX Run	<input type="checkbox"/>
7	Design of Experiments	
8	Design of Experiments Type	Central Composite Design
9	Design Type	Auto Defined

View All / Customize...

Double-click component to edit.

Hide Progress Hide 6 Messages

Click on Design of experiments

Unsaved Project - Workbench

File View Tools Units Help

New Open... Save Save As... Import... Preview Design of Experiments Update Design of Experiments Reconnect Refresh Project Update Project Update All Design Points Return to Project Compact Mode

Toolbox

Charts

- Parameters Parallel
- Design Point vs Parameter

	A	B	C
1		Enabled	Quick Help
2	Design of Experiments		
3	Input Parameters		
4	Static Structural (A1)		
5	P3 - Point2.FD8	<input checked="" type="checkbox"/>	
6	Output Parameters		
7	Static Structural (A1)		
8	P1 - Total Deformation Maximum		
9	P2 - Geometry Mass		
10	Charts		

	A	B	C	D
1	Name	P3 - Point2.FD8	P1 - Total Deformation Maximum (mm)	P2 - Geometry Mass (kg)

Properties of Outline A5: P3

	A	B
1	Property	Value
2	General	
3	Units	
4	Type	Design Variable
5	Classification	Continuous
6	Values	
7	Lower Bound	450
8	Upper Bound	550
9	Initial Value	500

Chart: No data

Ready

View All / Customize... Hide Progress Hide 6 Messages

In the new window you can see the input parameter value. Click on Update Design of Experiments

Unsaved Project - Workbench

File View Tools Units Help

New Open... Save Save As... Import... Preview Design of Experiments Update Design of Experiments Reconnect Refresh Project Update Project Update All Design Points Return to Project Compact Mode

Toolbox

- Charts
- Parameters Parallel
- Design Point vs Parameter

Outline of Schematic B2: Design of Experiments

	A	B
1		Enabled
2	Design of Experiments	
3	Input Parameters	
4	Static Structural (A1)	
5	P3 - Point2.FD8	<input checked="" type="checkbox"/>
6	Output Parameters	
7	Static Structural (A1)	
8	P1 - Total Deformation Maximum	
9	P2 - Geometry Mass	
10	Charts	
11	Parameters Parallel	
12	Design Points vs Parameter	

Table of Schematic B2: Design of Experiments

	A	B	C	D
1	Name	P3 - Point2.FD8	P1 - Total Deformation Maximum (mm)	P2 - Geometry Mass (kg)
2	1	500	14,168	0,98125
3	2	450	13,942	1,0009
4	3	550	14,444	0,96163
5	4	475	14,049	0,99106
6		525	14,299	0,97144

Properties of Outline A5: P3

	A	B
1	Property	Value
2	General	
3	Units	
4	Type	Design Variable
5	Classification	Continuous
6	Values	
7	Lower Bound	450
8	Upper Bound	550
9	Initial Value	500

Messages

Progress

View All / Customize...

Now different value of deformation and mass calculated on the base of upper and lower bound of Point 2 is showing.