EXERCISE BOOK

Student Notes:

# Cross-Brand Training

Exercises

# DMU Kinematics Simulator

**Version 5 Release 21**
**January 2012**

**EDU_CRB_EN_KIN_FX_V5R21**

Student Notes:

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Student Notes:

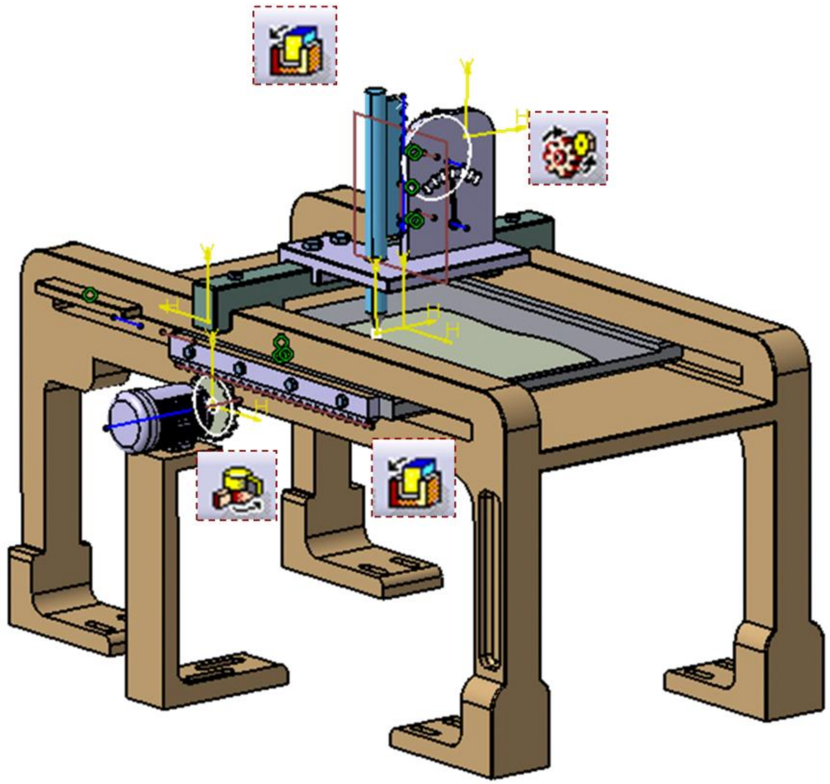
# Creating Joints

## Recap Exercise

30 min

In this step you will :

- Create joints for the Surface Analyzer mechanism.
- Fix a part for the mechanism.

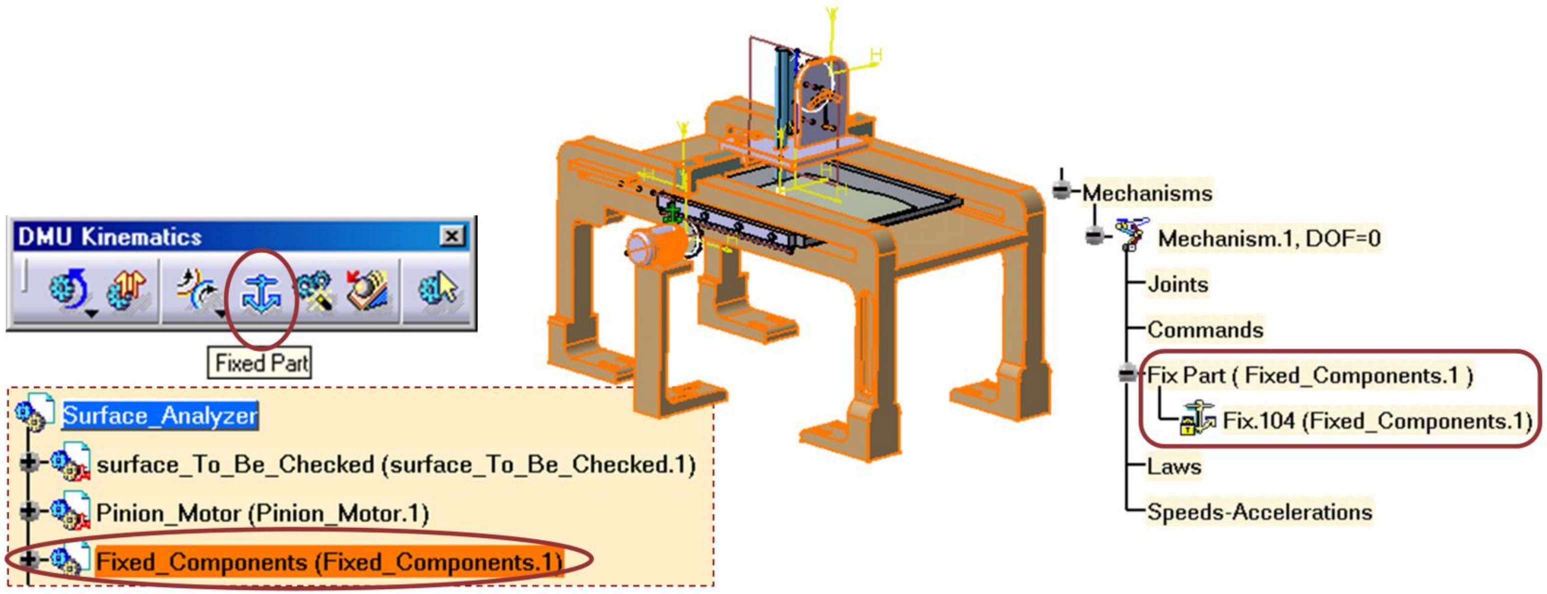


Student Notes:

# Do It Yourself (1/11)

Data Used: Surface_Analyzer_Joints_Start.CATProduct

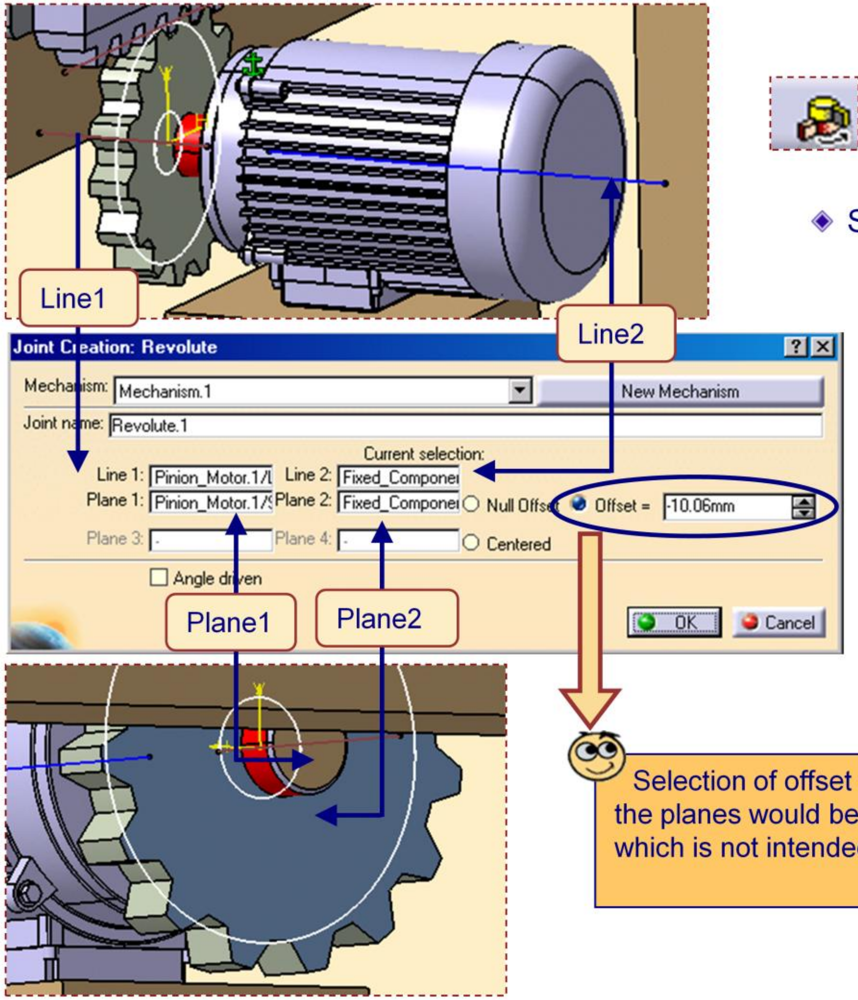
- Create a new mechanism by selecting 'New Mechanism' from menu 'Insert > New Mechanism' and fix a component for the mechanism as shown.



Student Notes:

# Do It Yourself (2/11)

- Create a 'Revolute' joint between MOTOR.1 and Pinion_Motor.1



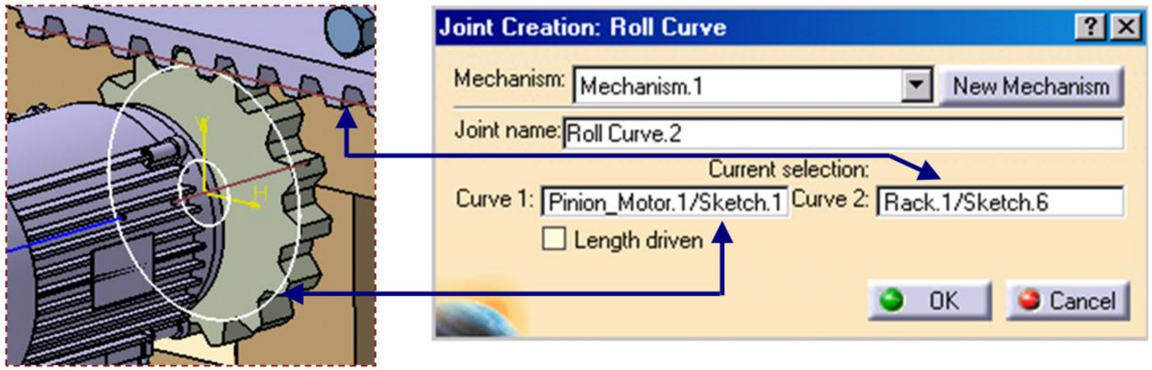

- Select the inputs for the joint as shown.

Selection of offset option is mandatory otherwise the planes would become coincident to each other which is not intended in this case.

Student Notes:

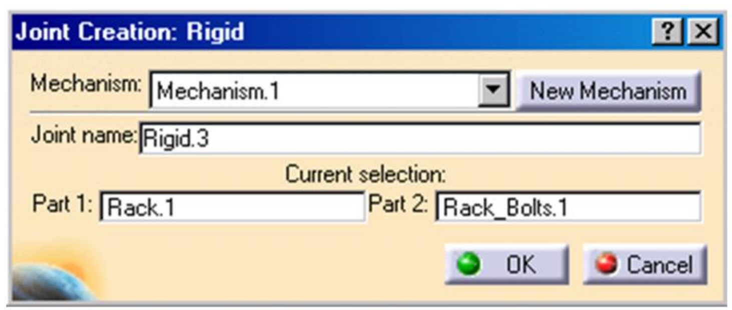
# Do It Yourself (3/11)

- Create a ‘Roll Curve Joint’ between ‘Pinion_Motor.1’ and ‘Rack.1’ as shown below.


- Create a ‘Rigid’ joint between ‘Rack.1’ and ‘Rack_Bolts.1’.

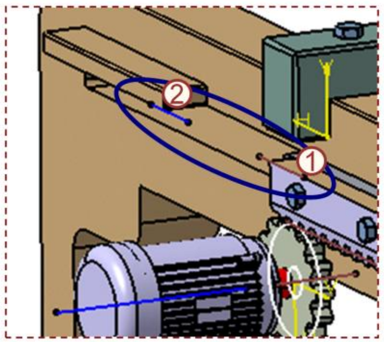


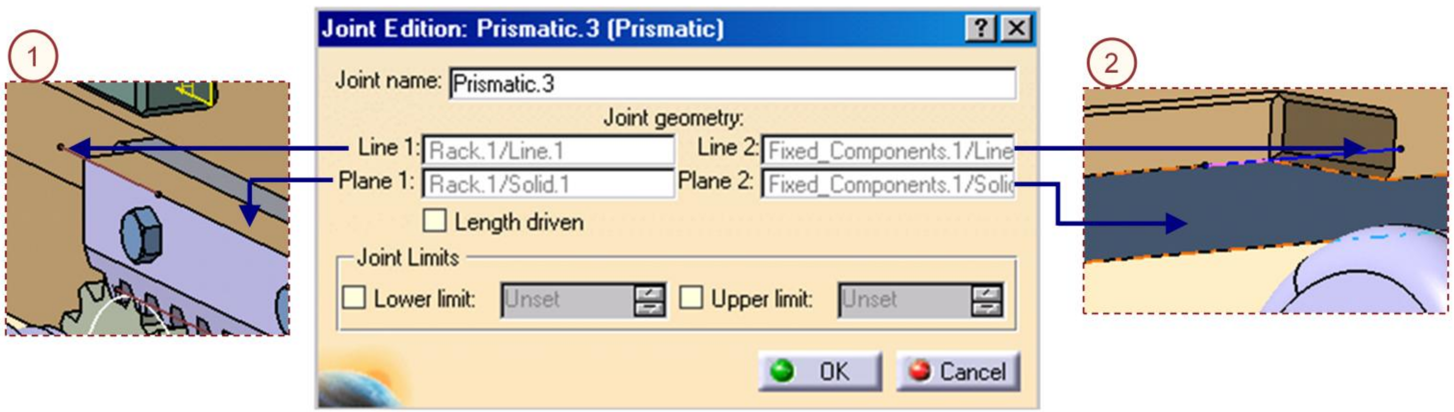


Student Notes:

# Do It Yourself (4/11)

- Create a ‘Prismatic Joint’ between the ‘Rack.1’ and ‘STRUCTURE.1’ as shown.



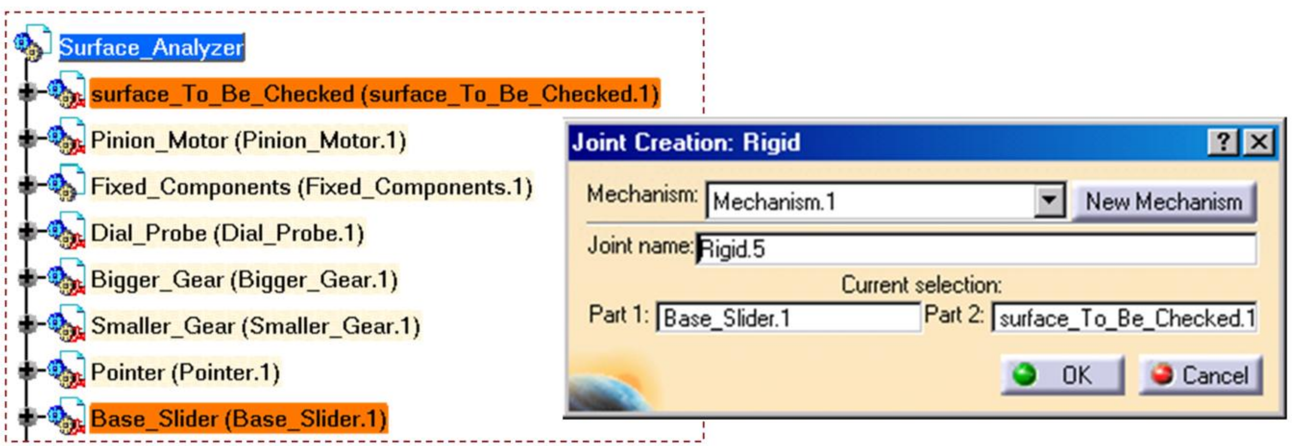
Student Notes:

# Do It Yourself (5/11)

- Create a 'Rigid' joint between 'Rack.1' and 'Base_Slider.1'



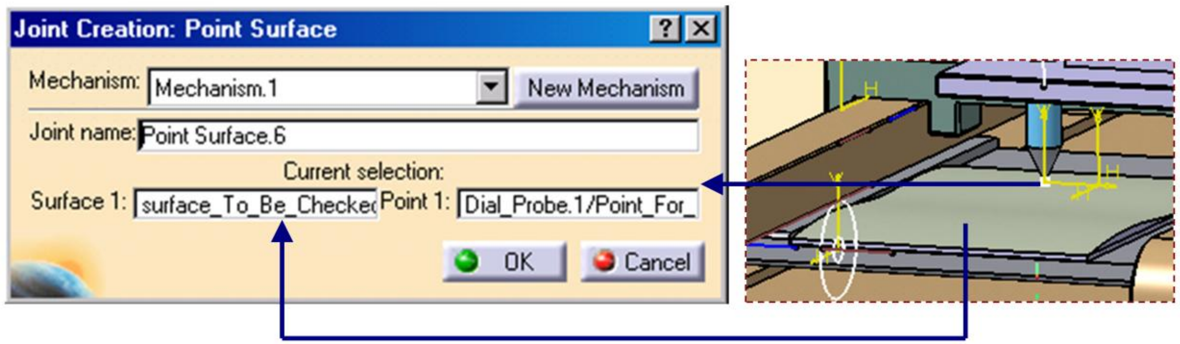

- Similarly create a 'Rigid' joint between 'Base_Slider.1' and 'surface_To_Be_Checked.1'.

Student Notes:

# Do It Yourself (6/11)

- Create a 'Point Surface Joint' between 'surface_To_Be_Checked.1' and 'Dial_Probe.1' as shown.

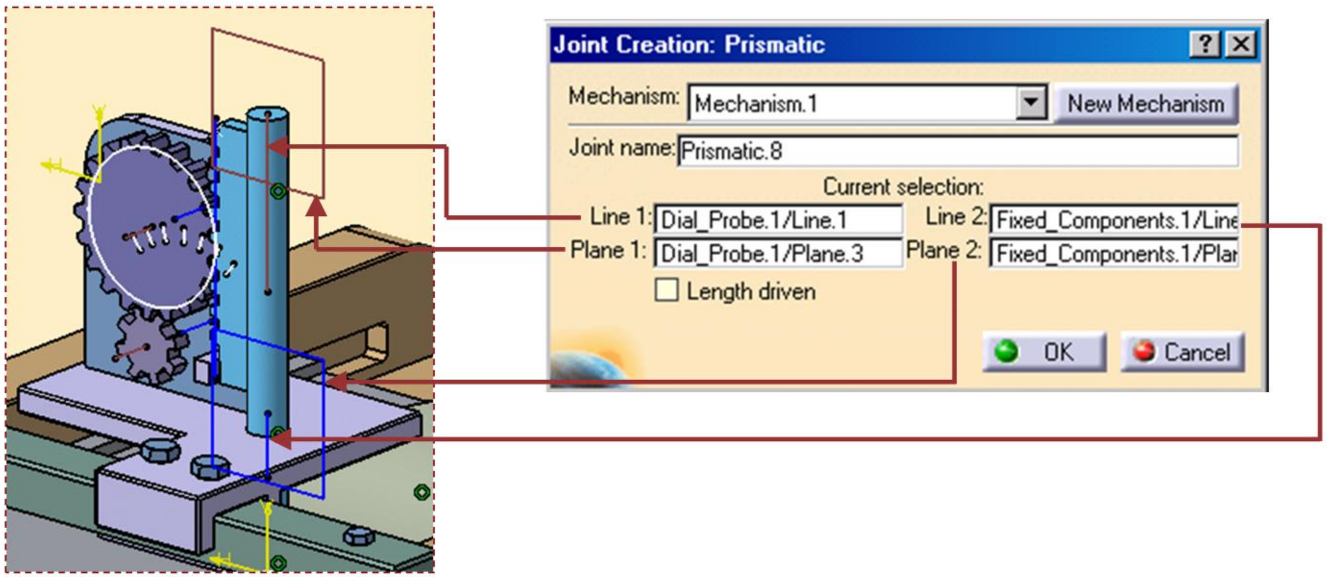




To be able to create a 'Point Surface' joint, the point should be coincident to the surface. You can create a coincident constraint between the point and the surface using the assembly design coincident constraint tool.

Student Notes:

# Do It Yourself (7/11)

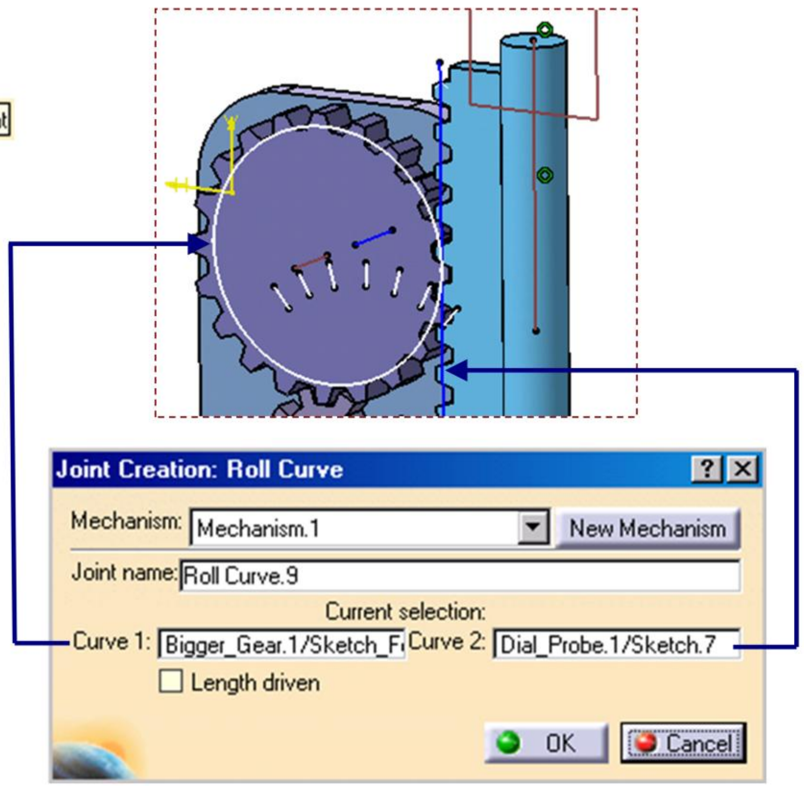
- Create a Prismatic Joint between 'Dial_Body.1' and 'Dial_Probe.1'. Select the inputs as shown.



Student Notes:

# Do It Yourself (8/11)

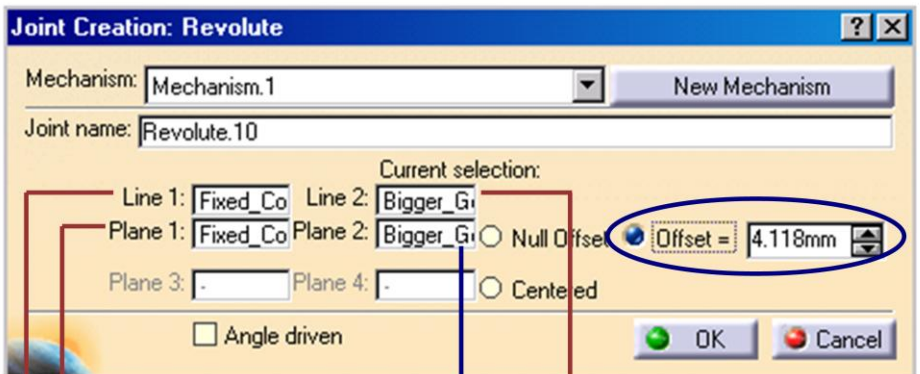
- Create a ‘Roll Curve Joint’ between the ‘Dial_Probe.1’ and ‘Bigger_Gear.1’. Select the curves for the joint as shown.

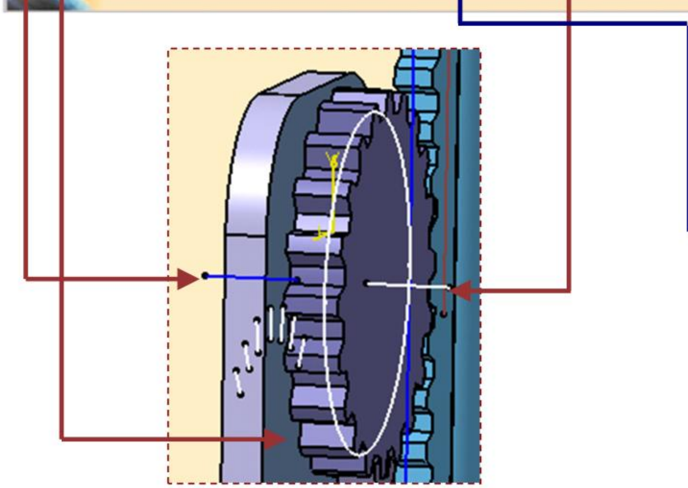
Student Notes:

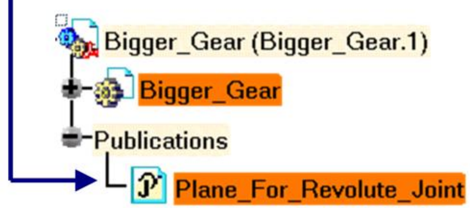
# Do It Yourself (9/11)

- Create two 'Revolute Joints' as shown.
  - Create a 'Revolute Joint' between 'Bigger_Gear.1' and 'Dial_Body.1' as shown.




Make sure that you use the offset option.



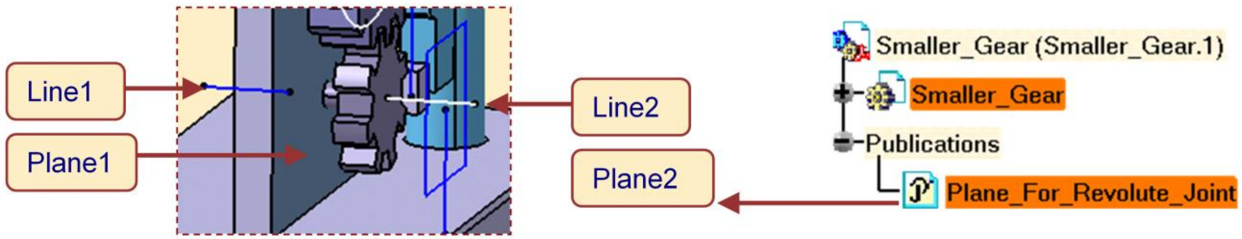



For Plane 2, you can select the published element already created for you.

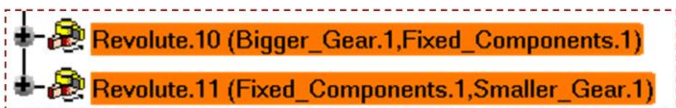
Student Notes:

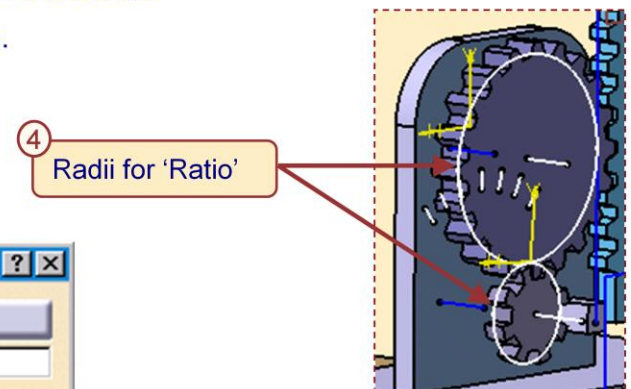
# Do It Yourself (10/11)

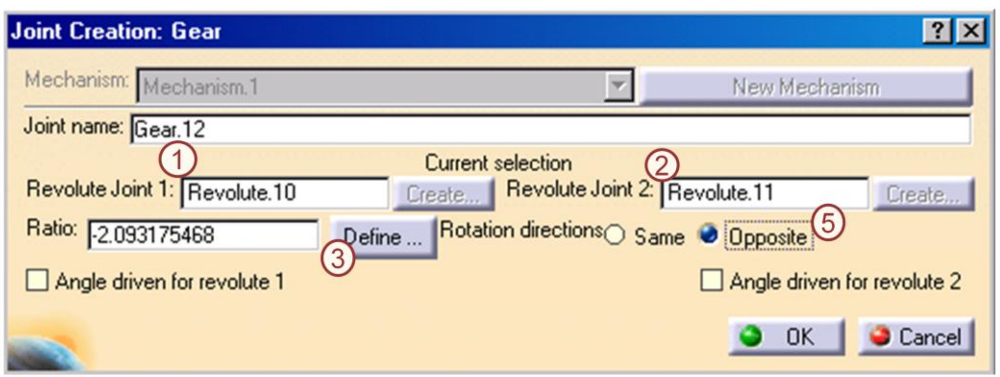
- Similarly create a ‘Revolute Joint’ between the ‘Smaller_Gear.1’ and ‘Dial_Body.1’ with inputs as shown. Make sure that you use the ‘Offset’ option.




- Create a ‘Gear Joint’ from the two ‘Revolute Joints’ that you have created.
  - To define the ‘Ratio’, select the radii of the gears as shown.

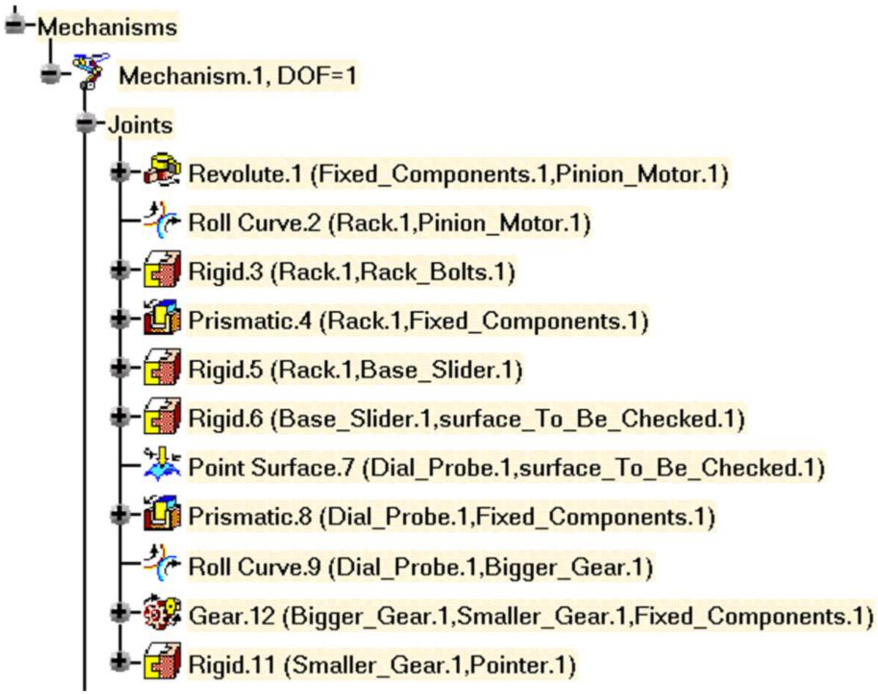



# Do It Yourself (11/11)

- Create a ‘Rigid Joint’ between the ‘Smaller_Gear.1’ and ‘Pointer.1’






Student Notes:

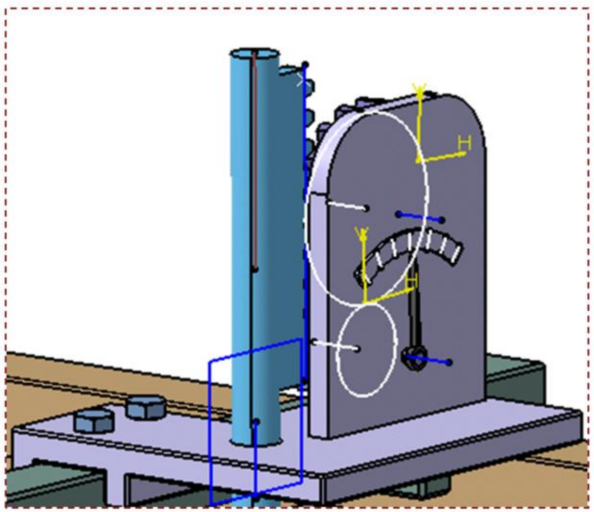
# Simulation

## Recap Exercise

15 min

In this step you will :

- Define the driving command for the mechanism.
- Define a law for the mechanism.
- Simulate the mechanism.



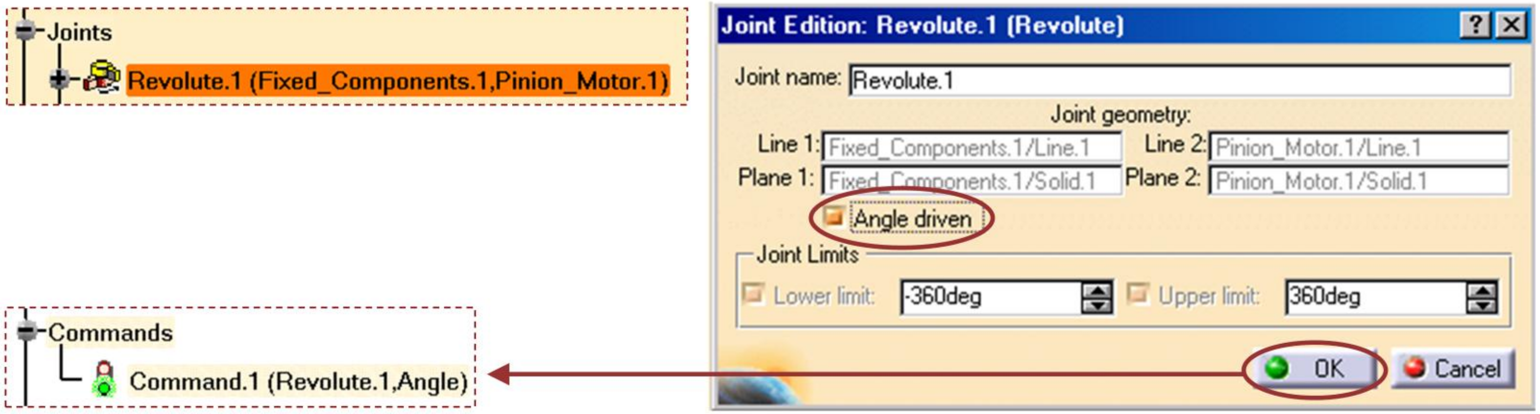
Student Notes:

Student Notes:

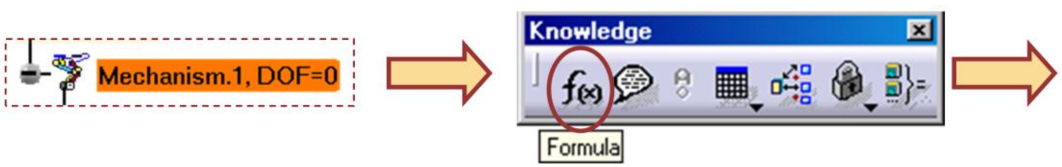
# Do It Yourself (1/3)

Data Used: Surface_Analyzer_Simulation_Start.CATProduct

- Define the driving joint of the mechanism and specify the driving command.




- Assign a value of 10s to the time parameter of the mechanism.

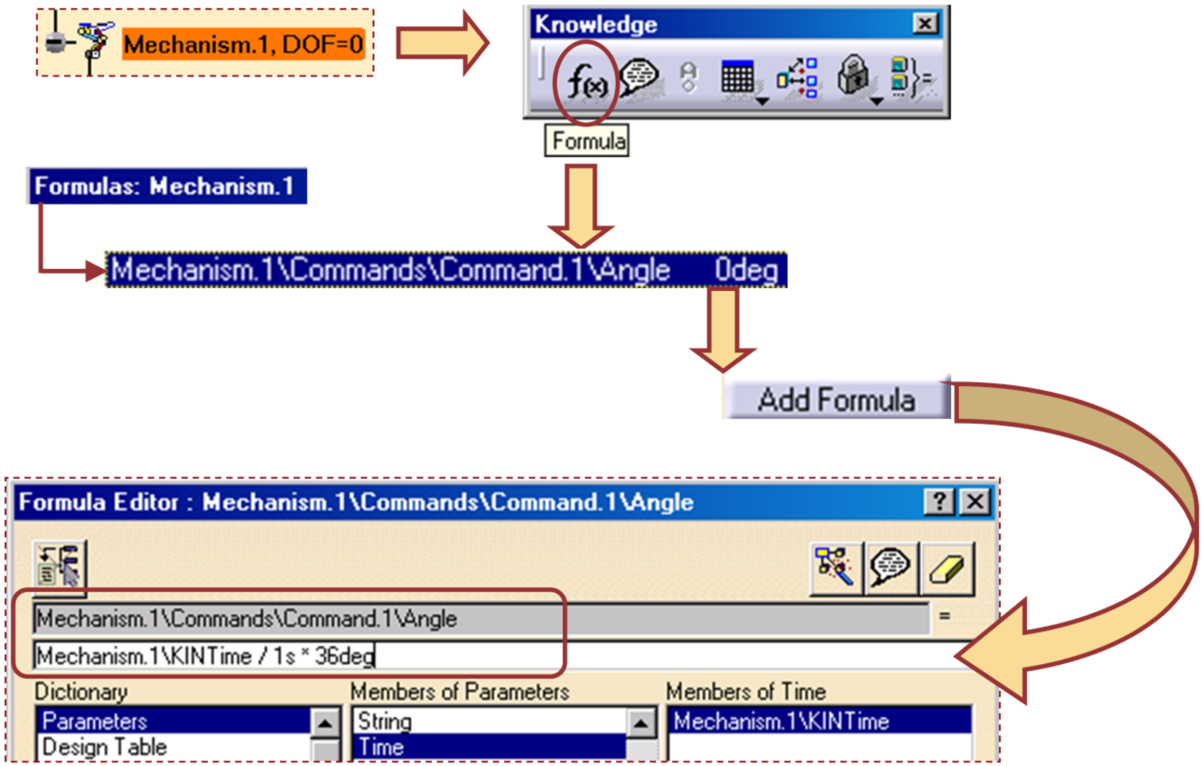



Mechanism.1\KINTime = 10s

Student Notes:

# Do It Yourself (2/3)

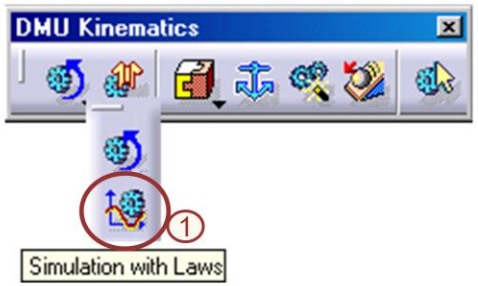
- Create a relation between the Kinematic time and the driving command of the mechanism.

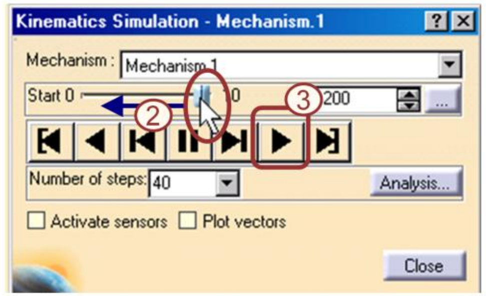


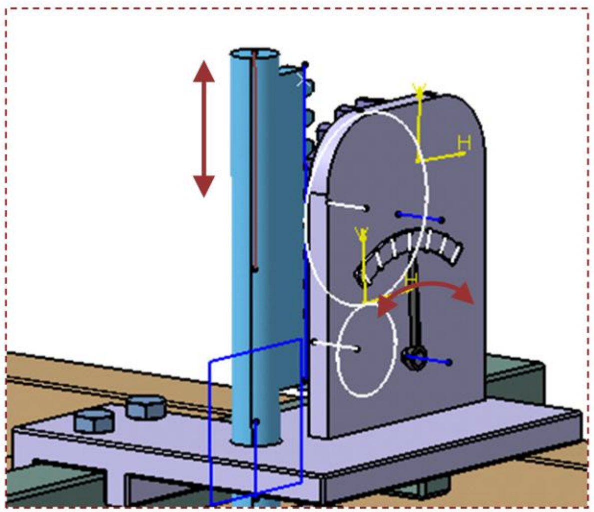
Student Notes:

# Do It Yourself (3/3)

- Simulate the mechanism using the 'Simulation with Laws' tool.



- Watch the motion of probe and the pointer.

Student Notes:

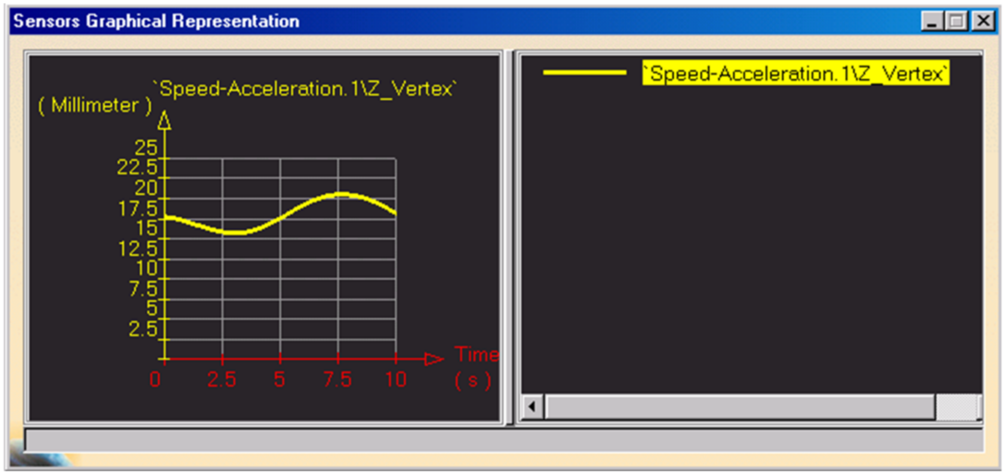
# Analysis

## Recap Exercise

15 min

In this step you will :

- Create a 'Speed and Acceleration' for a point in the mechanism.
- Measure vertical displacement of a point in the mechanism.
- Plot graphs for the displacement of the point.

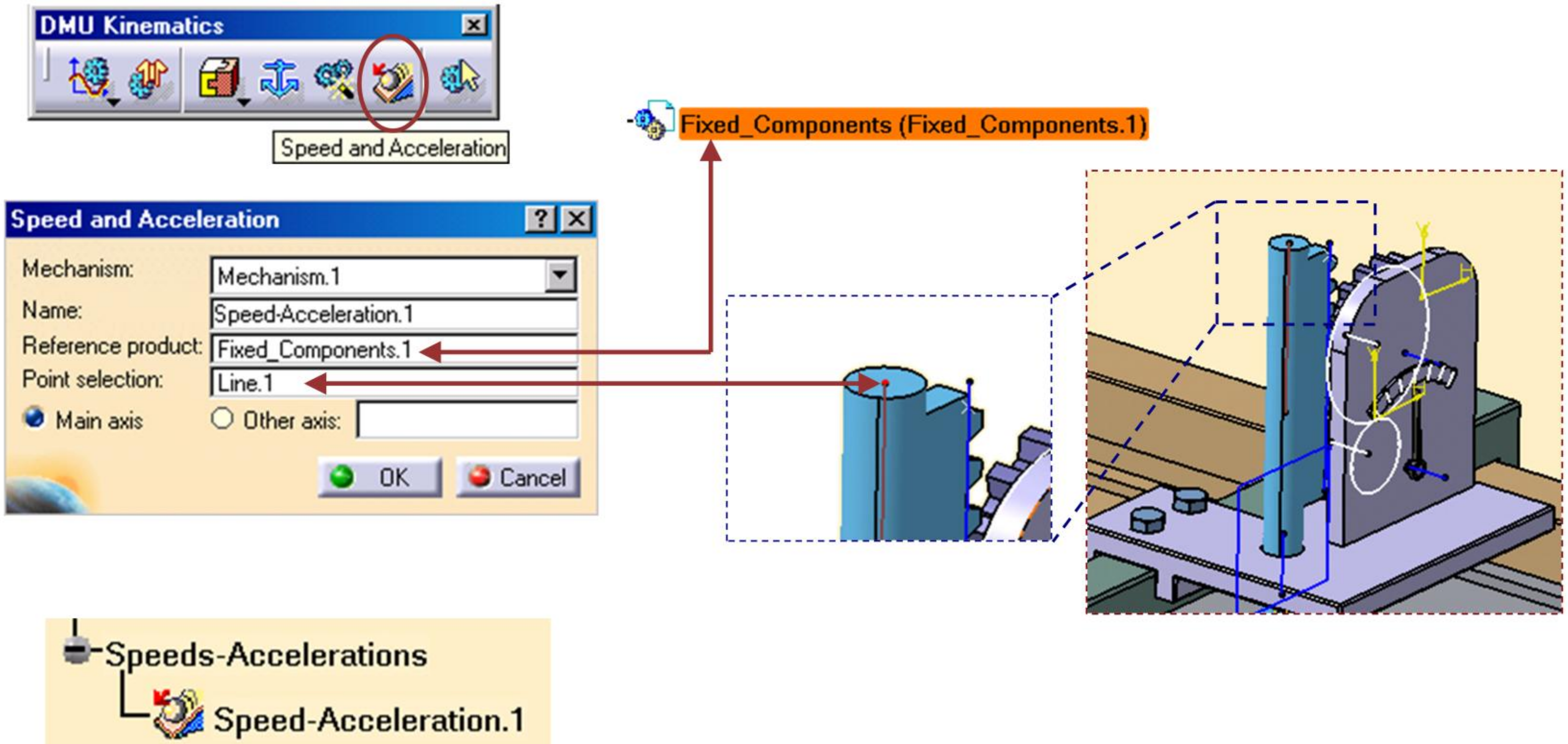


Student Notes:

# Do It Yourself (1/3)

Data Used: Surface_Analyzer_Analysis_Start.CATProduct

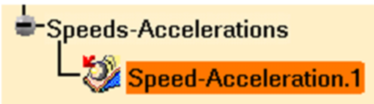
- Create a 'Speed and Acceleration' report for a point on the 'Dial Probe' as shown.



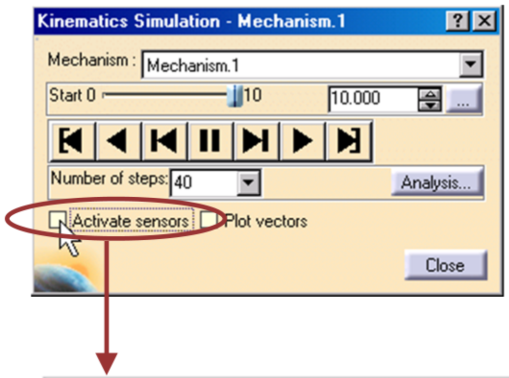
Student Notes:

# Do It Yourself (2/3)

- Activate the vertical displacement sensor and simulate the mechanism.

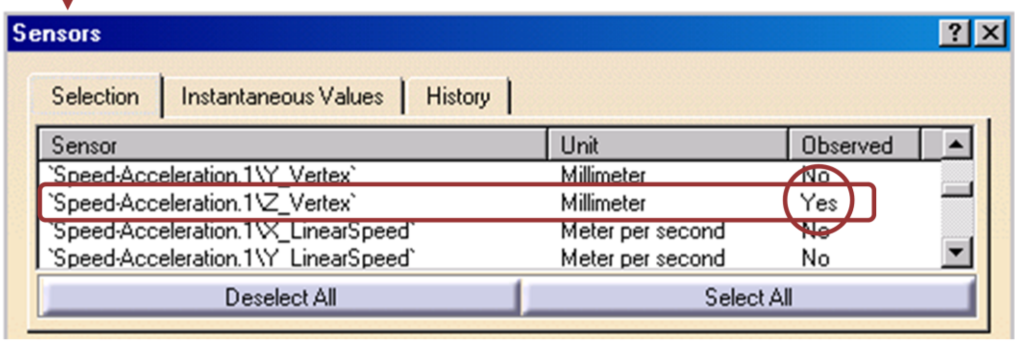



◆ Double click on 'Speed-Acceleration' in the specification tree.




◆ Select the 'Activate Sensors' option

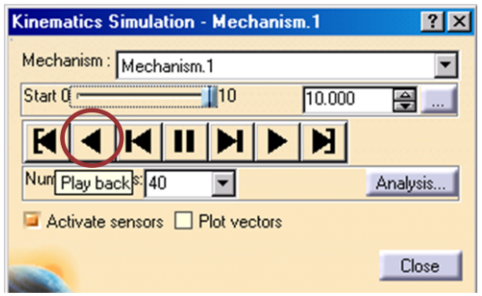
◆ In the 'Sensors' dialog box, click on 'Speed-Acceleration.1\Z_Vertex' to activate it for observation as shown below.



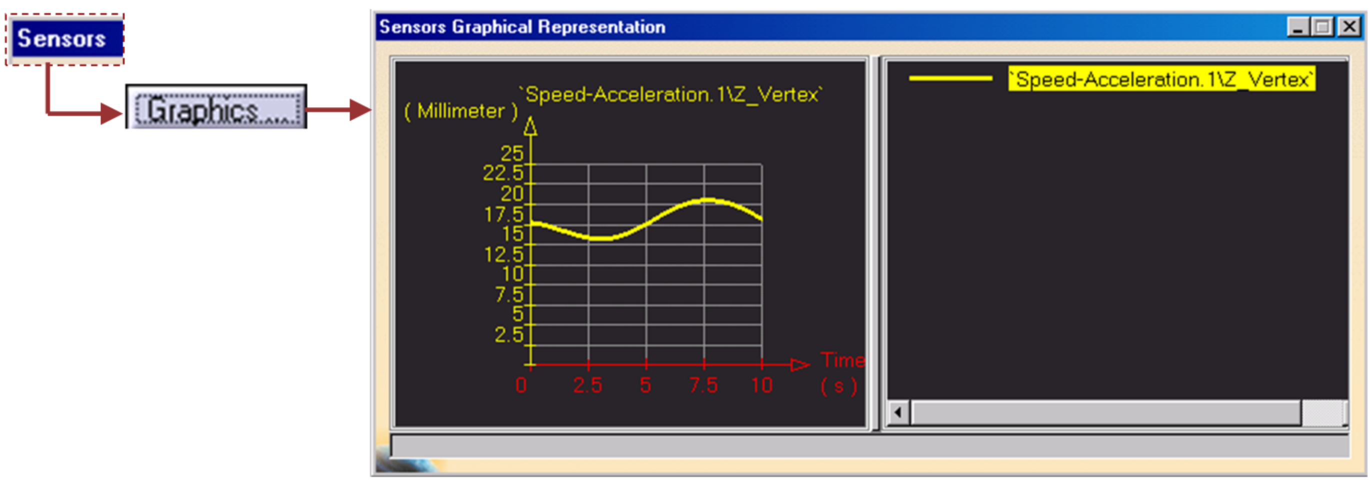
Student Notes:

# Do It Yourself (3/3)

- Keeping the 'Sensors' dialog box open, click the 'Play Back' button and play the simulation.




- Click the 'Graphics' button of the 'Sensors' dialog box to display the graphical output of the vertical displacement of the selected point against time.



Student Notes:

# Elliptical Trainer - Master Exercise

*Now you will practice the concepts learnt throughout the course.*

- **Master Exercise Presentation**
- **Master Exercise Step 1: Animating the concept sketch**
- **Master Exercise Step 2: Defining the Kinematics**
- **Master Exercise Step 3: Performing Clash Analysis**
- **Master Exercise Step 4: Swept Volume and Distance Analysis**
- **Master Exercise Step 5: Generating Trace**
- **Master Exercise Step 6: Speed and Acceleration Analysis**

Student Notes:

# Elliptical Trainer

*Master Exercise Presentation*


In this exercise you will design the mechanism from an assembly and analyze it.

To do so, you will have to :

- Define the Kinematics of the assembly
- Simulate the mechanism
- Perform Clash and Distance analysis on the mechanism
- Perform Speed and Acceleration analysis

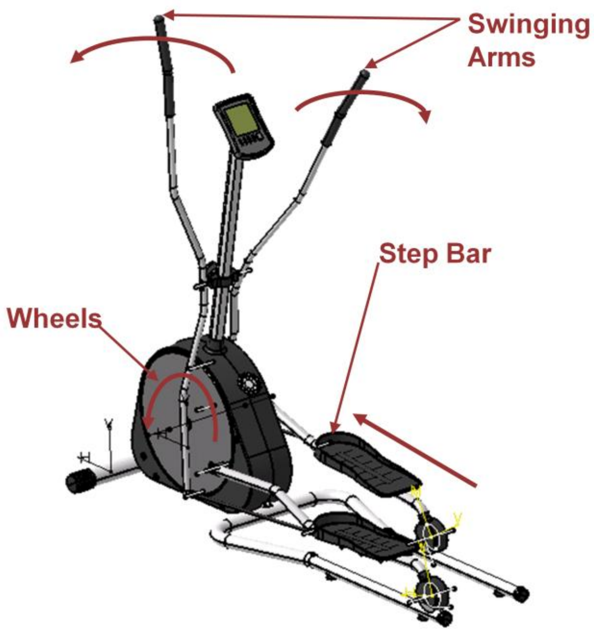
Student Notes:

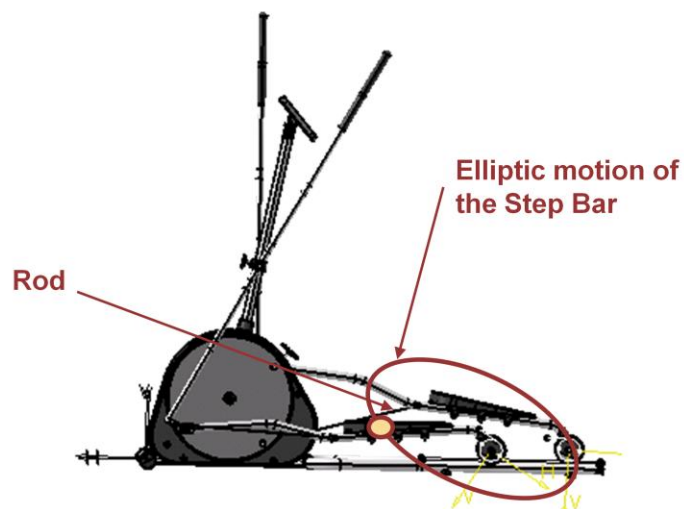
## Design Intent – Elliptical Trainer

**The Elliptical trainer Assembly consists primarily of the Swinging Arms, Step Bar and Rod. All these components are connected to the Wheels and supported by the Chassis**

**The intension here is to form a mechanism such that the rotation of wheels causes:**

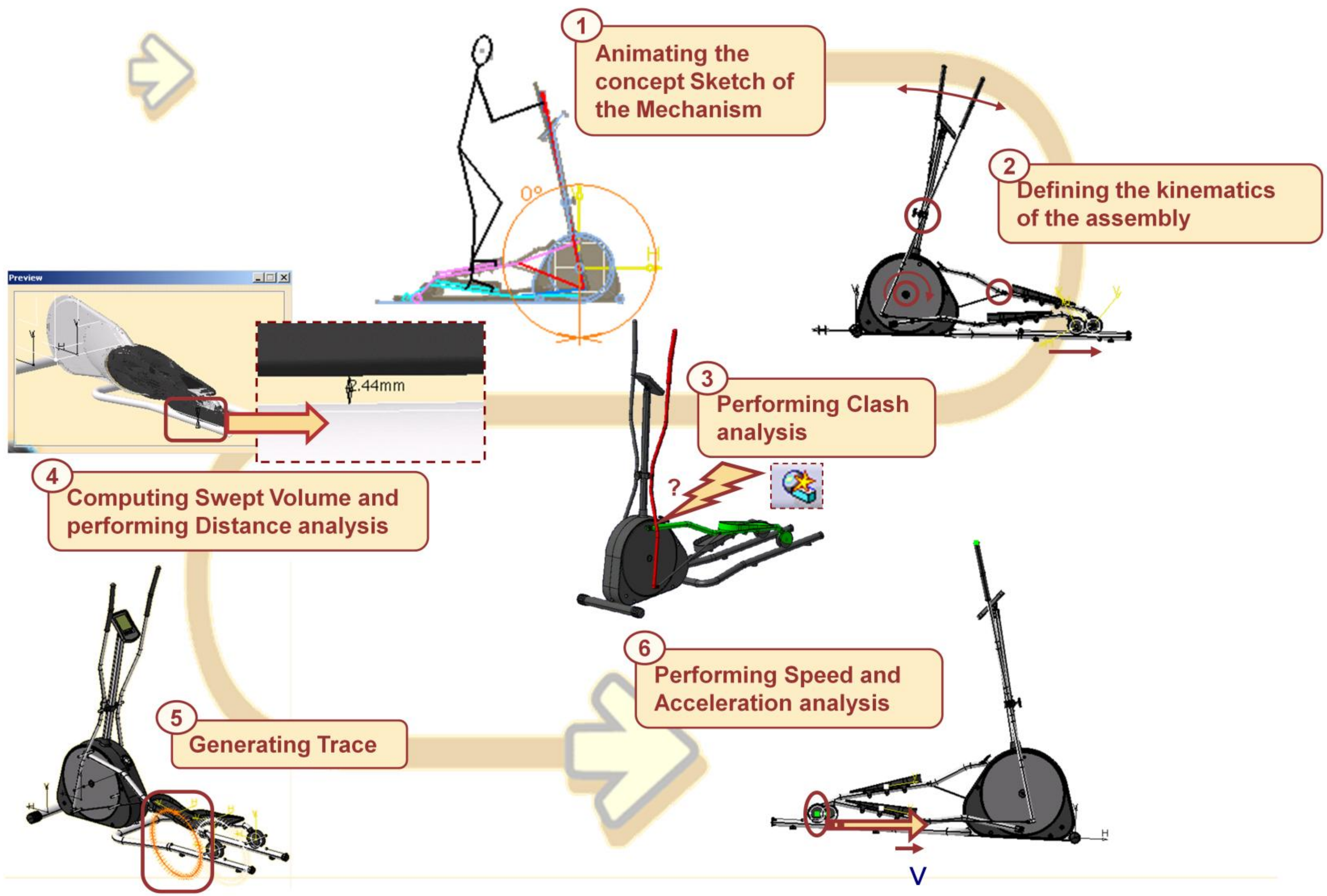
- **The Arms to swivel and**
- **The Step Bar to have an elliptical motion as shown in the figure**



Student Notes:

# Elliptical Trainer Mechanism - Design Process

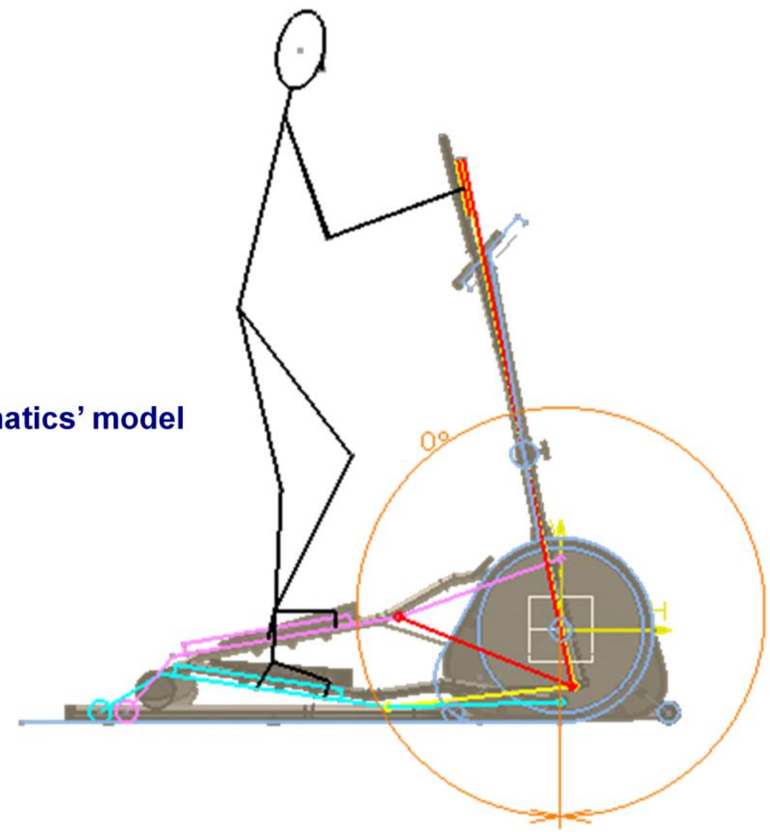


Student Notes:

# Elliptical Trainer

## Step 1 – Animating the concept sketch of the mechanism

10 min



**In this step you will :**

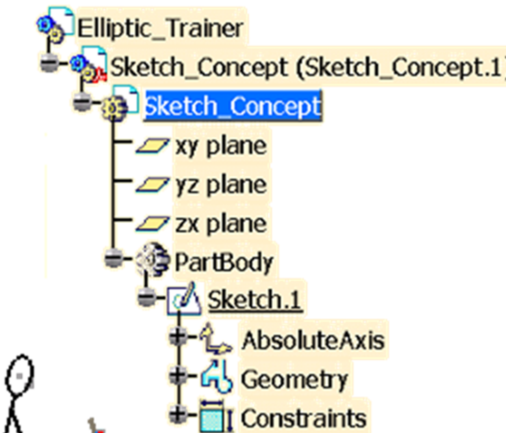
- **Open the Elliptic_Trainer assembly**
- **Activate a 'Sketch'**
- **Animate the 'Sketch' to understand the Kinematics' model**

Student Notes:

# Do It Yourself (1/2)

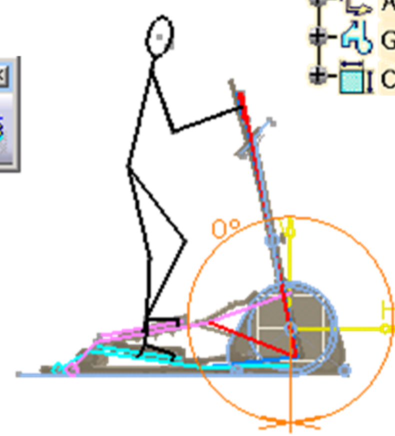
**CATIA Data Used: KIN_Elliptic_Trainer.CATProduct**

- **Open the Elliptic_Trainer assembly and animate the sketch.1 of Sketch_Concept part to understand the kinematics of the Elliptic Trainer.**
  - **Open the CATProduct.**
  - **Hide the 'SportsMan' component.**
  - **Activate 'Sketch_Concept' part and activate the sketch.1.**




  - **If required, activate the 'Dimensional Constraints' tool to make the sketch constraints visible.**
  - **If required, deactivate the 'Diagnostics' tool to visualize the colors of the sketch.**

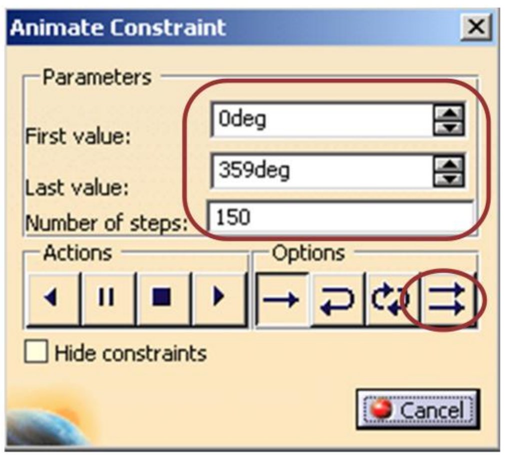




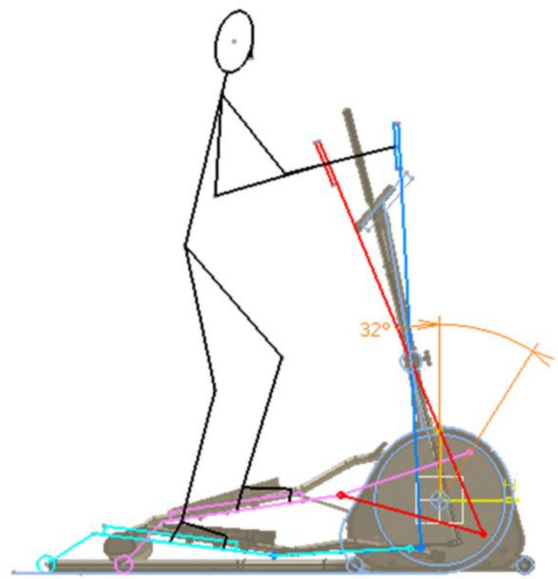
Student Notes:

# Do It Yourself (2/2)

- Animate the Angle.108 constraint with the following parameters and notice the animation of the sketch.






- Hide the Sketch after completing the animation.

Student Notes:

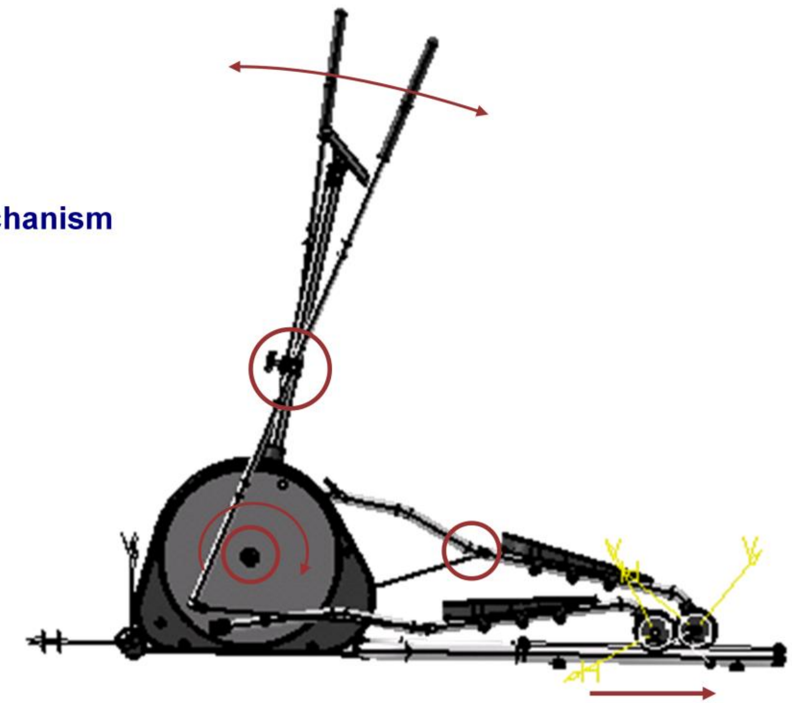
# Elliptical Trainer

## *Step 2 - Defining the Kinematics of the assembly*

*30 min*

**In this step you will :**

- **Define the Joints for the mechanism**
- **Define the driving command for the mechanism**
- **Define the Law for the mechanism**
- **Simulate the mechanism**

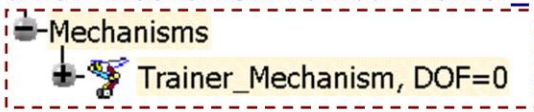


Student Notes:

# Do It Yourself (1/13)

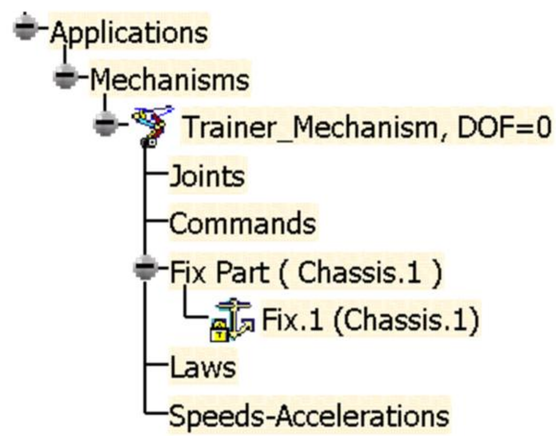
CATIA Data Used: KIN_Elliptic_Trainer_Step2.CATProduct

- Define the Joints for the Mechanism
  - Create a new mechanism named 'Trainer_Mechanism'





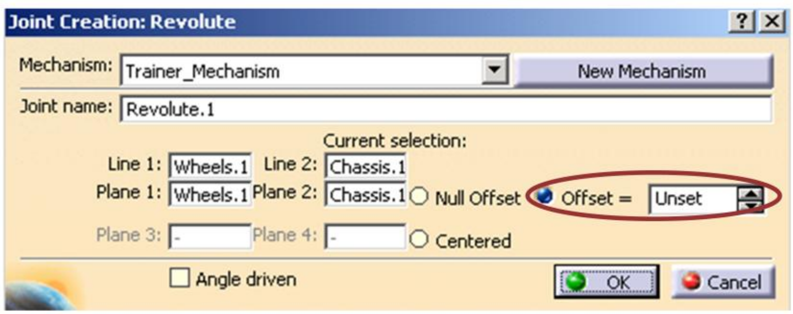
  - Define a 'Fix' part for the mechanism.
    - Using the 'Fixed Part' tool, fix the 'Chassis.1' component.

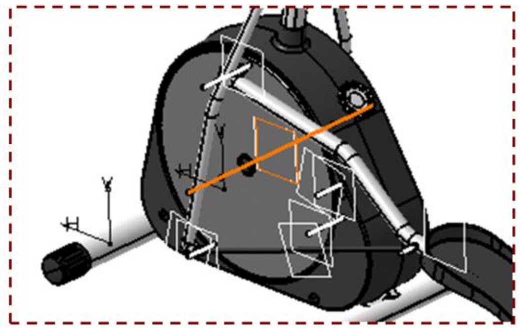



Student Notes:

# Do It Yourself (2/13)

- ◆ **Define a 'Revolute Joint' between Wheels and Chassis**
  - **For the inputs of the joint, select the following published geometries from appropriate components.**
  - **Select the 'Offset' option.**



**Wheels – Chassis**

| | | | |
|---|---|---|---|
| | Wheels (Wheels.1) | | Chassis (Chassis.1) |
| **Line 1:** | Wheels_Chassis_Axis | **Line 2:** | Chassis_Wheels_Axis |
| **Plane 1:** | Wheels_Chassis_Plane | **Plane 2:** | Chassis_Wheels_Plane |

*Student Notes:*

# Do It Yourself (3/13)

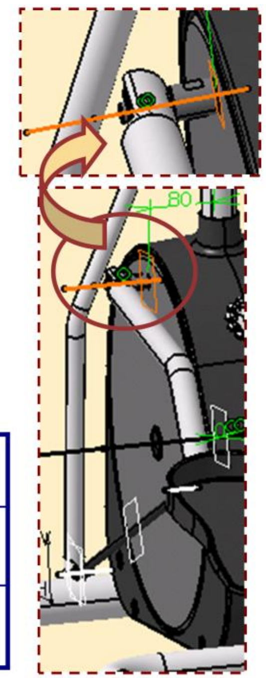
- **Define ‘Revolute’ joints between Wheels and StepBar ( Left and Right )**
  - **For the inputs of the joints, select the following published geometries from appropriate components.**
  - **Select the ‘Offset’ option and keep the default offset value in the ‘Joint Creation’ panel.**

## Wheels – StepBar – Left

| | | | |
|---|---|---|---|
| | Wheels (Wheels.1) | | Step_Bar_Left (Step_Bar_Left.1) |
| **Line 1:** | Wheels_StepBar_Axis_Left | **Line 2:** | StepBar_Wheels_Axis_Left |
| **Plane 1:** | Wheels_StepBar_Plane_Left | **Plane 2:** | StepBar_Wheels_Plane_Left |

## Wheels – StepBar – Right

| | | | |
|---|---|---|---|
| | Wheels (Wheels.1) | | Step_Bar_Right (Step_Bar_Right.1) |
| **Line 1:** | Wheels_StepBar_Axis_Right | **Line 2:** | StepBar_Wheels_Axis_Right |
| **Plane 1:** | Wheels_StepBar_Plane_Right | **Plane 2:** | StepBar_Wheels_Plane_Right |



Student Notes:

# Do It Yourself (4/13)

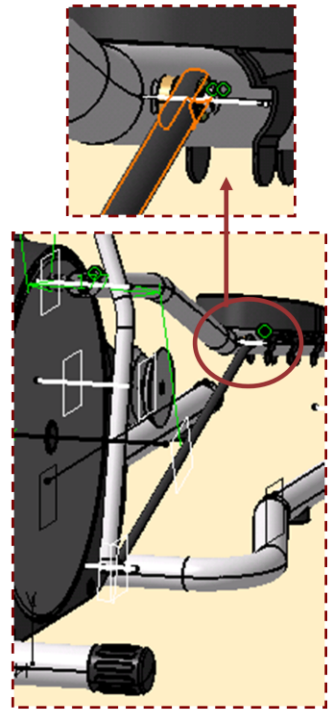
- **Define 'Revolute' joints between Rod and StepBar ( Left and Right )**
  - **For the inputs of the joints, select the following published geometries from appropriate components.**
  - **Select the 'Offset' option and keep the default offset value in the 'Joint Creation' panel.**

**Rod_Left – Step_Bar_Left**

| | | | |
|---|---|---|---|
| | rod (rod_Left.1) | | Step_Bar_Left (Step_Bar_Left.1) |
| Line 1: | Rod_StepBar_Axis | Line 2: | StepBar_Rod_Axis_Left |
| Plane 1: | Rod_StepBar_Plane | Plane 2: | StepBar_Rod_Plane_Left |

**Rod_Right – Step_Bar_Right**

| | | | |
|---|---|---|---|
| | rod (rod_Right.1) | | Step_Bar_Right (Step_Bar_Right.1) |
| Line 1: | Rod_StepBar_Axis | Line 2: | StepBar_Rod_Axis_Right |
| Plane 1: | Rod_StepBar_Plane | Plane 2: | StepBar_Rod_Plane_Right |



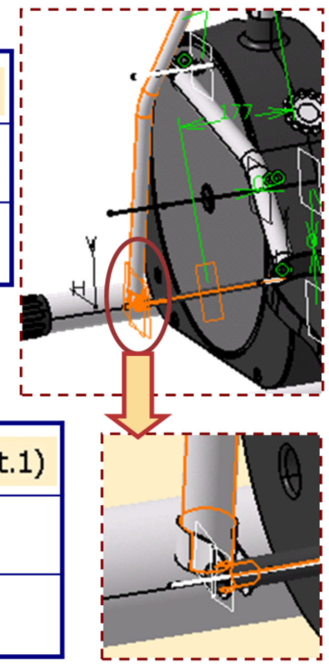
Student Notes:

# Do It Yourself (5/13)

- Define 'Revolute' joints between Rod and SwingArm ( Left and Right )
  - For the inputs of the joints, select the following published geometries from appropriate components.
  - Select the 'Offset' option and keep the default offset value in the 'Joint Creation' panel.

### Rod – SwingArm – Left

| | | | |
|---|---|---|---|
| | rod (rod_Left.1) | | Swing_Arm_Left (Swing_Arm_Left.1) |
| Line 1: | Rod_SwingArm_Axis | Line 2: | SwingArm_Rod_Axis_Left |
| Plane 1: | Rod_SwingArm_Plane | Plane 2: | SwingArm_Rod_Plane_Left |



### Rod – SwingArm – Right

| | | | |
|---|---|---|---|
| | rod (rod_Right.1) | | Swing_Arm_Right (Swing_Arm_Right.1) |
| Line 1: | Rod_SwingArm_Axis | Line 2: | SwingArm_Rod_Axis_Right |
| Plane 1: | Rod_SwingArm_Plane | Plane 2: | SwingArm_Rod_Plane_Right |

Student Notes:

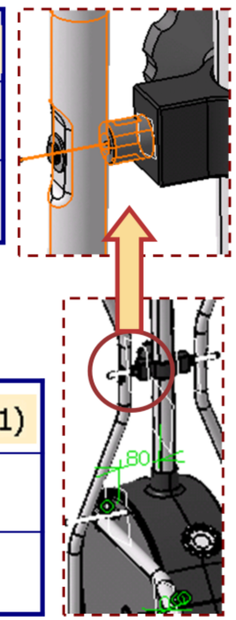
# Do It Yourself (6/13)

◈ **Define 'Revolute' joints between Chassis and SwingArm ( Left and Right )**

- **For the inputs of the joints, select the following published geometries from appropriate components.**
- **Select the 'Offset' option and keep the default offset value in the 'Joint Creation' panel.**

## Chassis – SwingArm – Left

| | Chassis (Chassis.1) | | Swing_Arm_Left (Swing_Arm_Left.1) |
|---|---|---|---|
| Line 1: | Chassis_SwingArm_Axis_Left | Line 2: | SwingArm_Chassis_Axis_Left |
| Plane 1: | Chassis_SwingArm_Plane_Left | Plane 2: | SwingArm_Chassis_Plane_Left |



## Chassis – SwingArm – Right

| | Chassis (Chassis.1) | | Swing_Arm_Right (Swing_Arm_Right.1) |
|---|---|---|---|
| Line 1: | Chassis_SwingArm_Axis_Right | Line 2: | SwingArm_Chassis_Axis_Right |
| Plane 1: | Chassis_SwingArm_Plane_Right | Plane 2: | SwingArm_Chassis_Plane_Right |

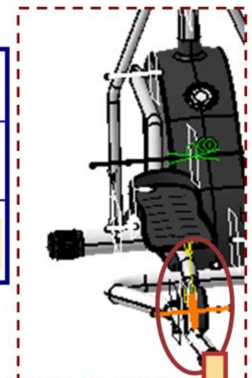
Student Notes:

# Do It Yourself (7/13)

- **Define 'Revolute' joints between Rolling_Wheel and StepBar ( Left and Right )**
  - **For the inputs of the joints, select the following published geometries from appropriate components.**
  - **Select the 'Offset' option and keep the default offset value in the 'Joint Creation' panel.**

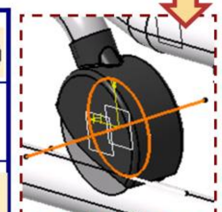
**RollingWheel – StepBar – Left**

| | Rolling_Wheel (Rolling_Wheel_Left) | | Step_Bar_Left (Step_Bar_Left.1) |
|---|---|---|---|
| Line 1: | RollingWheel_StepBar_Axis | Line 2: | StepBar_RollingWheel_Axis_Left |
| Plane 1: | RollingWheel_StepBar_Plane | Plane 2: | StepBar_RollingWheel_Plane_Left |



**RollingWheel – StepBar – Right**

| | Rolling_Wheel (Rolling_Wheel_Right) | | Step_Bar_Right (Step_Bar_Right.1) |
|---|---|---|---|
| Line 1: | RollingWheel_StepBar_Axis | Line 2: | StepBar_RollingWheel_Axis_Right |
| Plane 1: | RollingWheel_StepBar_Plane | Plane 2: | StepBar_RollingWheel_Plane_Right |

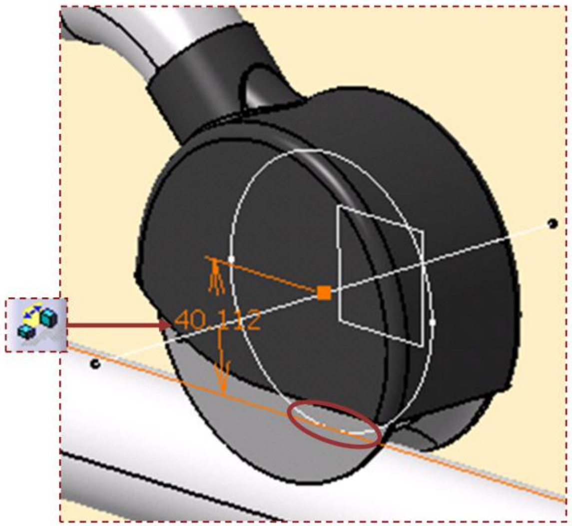


Student Notes:

# Do It Yourself (8/13)

- Define a 'Roll-Curve' joint between the Rolling_Wheel and Chassis ( Left and Right )

The Roll Curve Joint requires the geometry elements to be tangent to each other. So it may be sometimes required to position the elements before creating the joints.



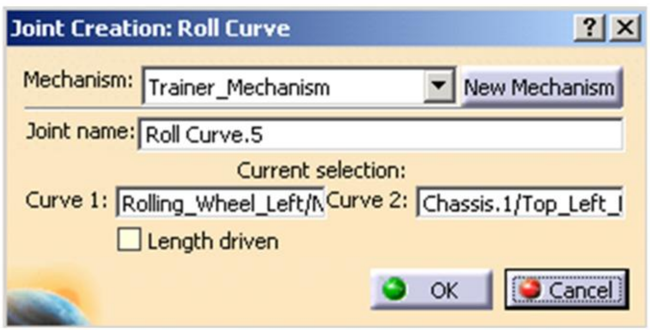

In this case, to make the geometries exactly tangent, you can create an 'Assembly Offset' constraint with the value as shown above. Later you can delete this constraint.

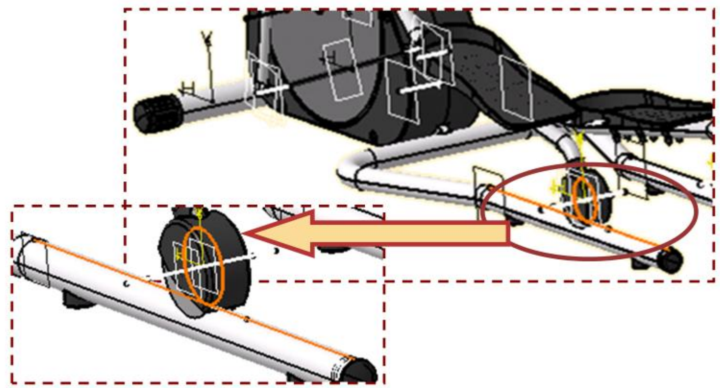
EXERCISE BOOK

Student Notes:

# Do It Yourself (9/13)

- **For the inputs of the joint, select the following published geometries from appropriate components.**



### RollingWheel – Chassis – Left

| | | | |
|---|---|---|---|
| | Rolling_Wheel (Rolling_Wheel_Left) | | Chassis (Chassis.1) |
| Curve 1: | RollingWheel_Chassis_Circle | Curve 2: | Chassis_RollingWheel_Line_Left |

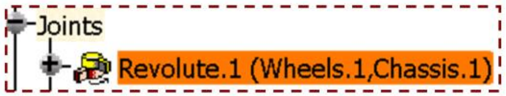
### RollingWheel – Chassis – Right

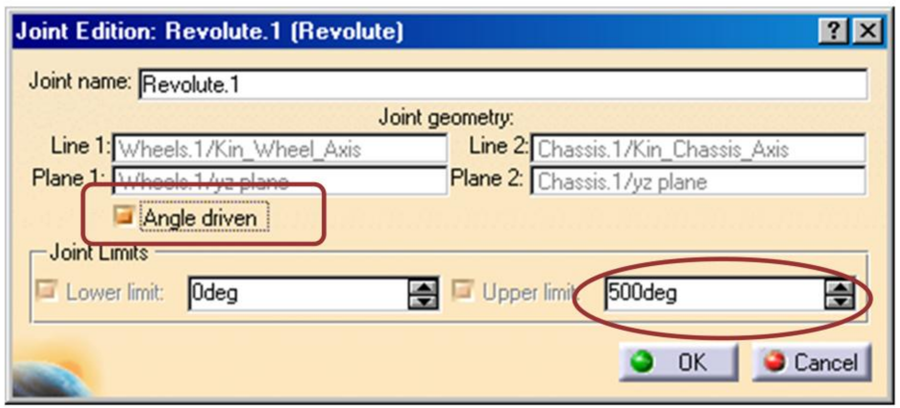
| | | | |
|---|---|---|---|
| | Rolling_Wheel (Rolling_Wheel_Right) | | Chassis (Chassis.1) |
| Curve 1: | RollingWheel_Chassis_Circle | Curve 2: | Chassis_RollingWheel_Line_Right |

Student Notes:

# Do It Yourself (10/13)

- Define the driving command for the mechanism.
  - Make the Revolute.1 joint (between Wheels and Chassis), 'Angle Driven'.



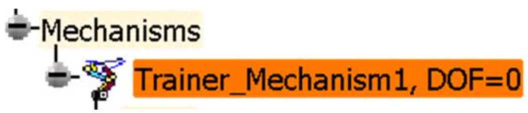




  - Specify the 'Joint Limits' as shown in the above 'Joint Edition' panel.

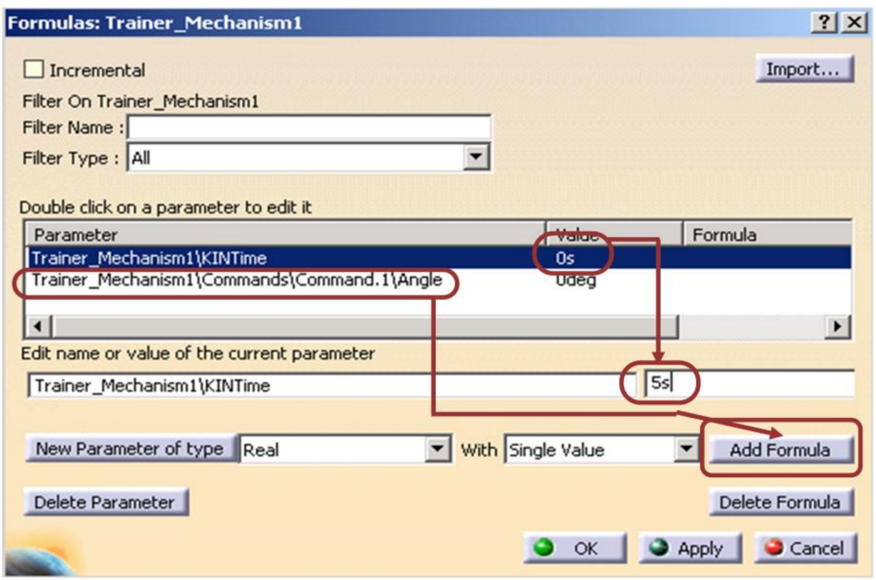
Student Notes:

# Do It Yourself (11/13)

- Define the Law for the mechanism
  - Specify the value of the Kinematics time 'KINTime' for the mechanism as 5 seconds and specify a relation of this 'KINTime' with the driving command of the mechanism.
    - Select the mechanism in the specification tree and click on the 'Formula' tool.







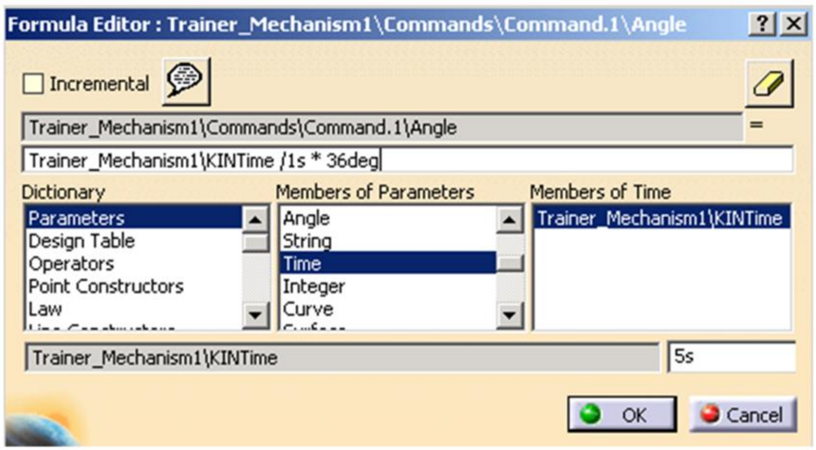

- In 'Formulas' panel, specify the 'KINTime' as 5 seconds.
- Select the 'Angle' parameter and click on the 'Add Formula' button to open the 'Formula Editor'.

Student Notes:

# Do It Yourself (12/13)

- In the 'Formula Editor' panel, specify the following relation between the 'Driving parameter' and the 'Kinematics' time.

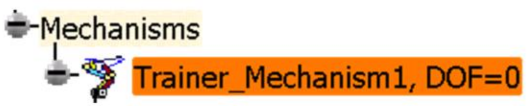
Trainer_Mechanism1\Commands\Command.1\Angle = Trainer_Mechanism1\KINTime /1s * 36deg

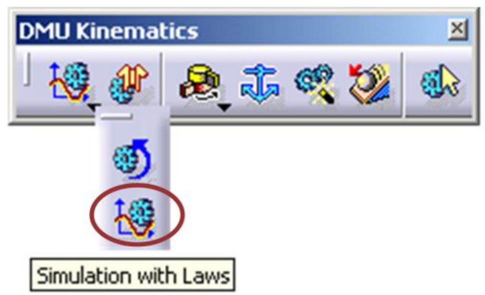


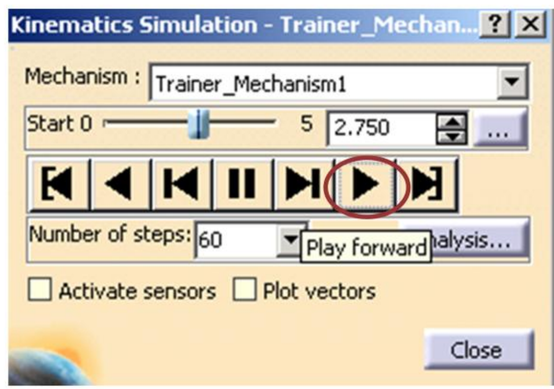
Student Notes:

# Do It Yourself (13/13)

- **Simulate the mechanism with laws.**
  - **Select the mechanism in the specification tree and use the ‘Simulation with Laws’ tool to simulate it**



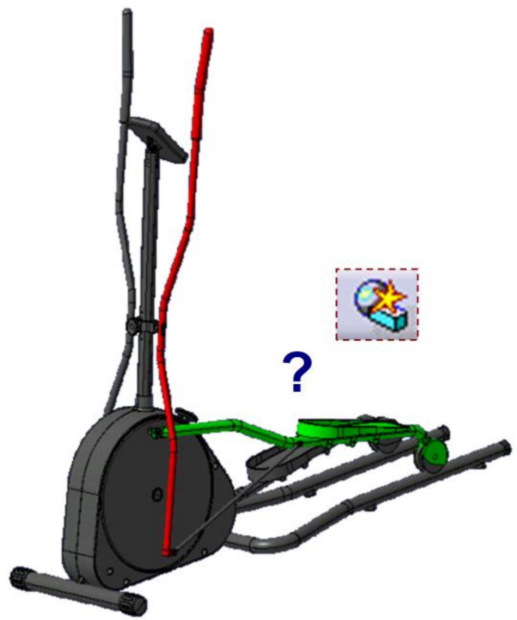



Student Notes:

# Elliptical Trainer

## Step 3 – Performing Clash Analysis

20 min




**In this step you will :**

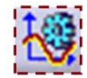
- **Perform a Clash Analysis between two components during simulation.**

Student Notes:

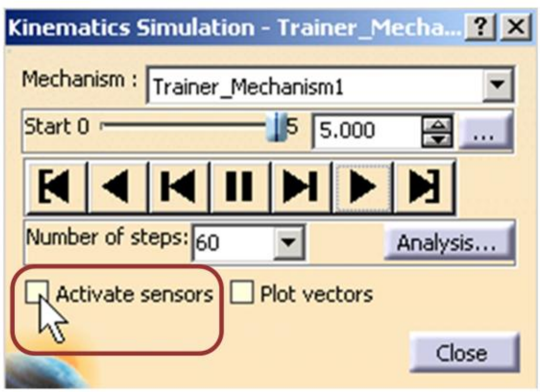
# Do It Yourself (1/3)

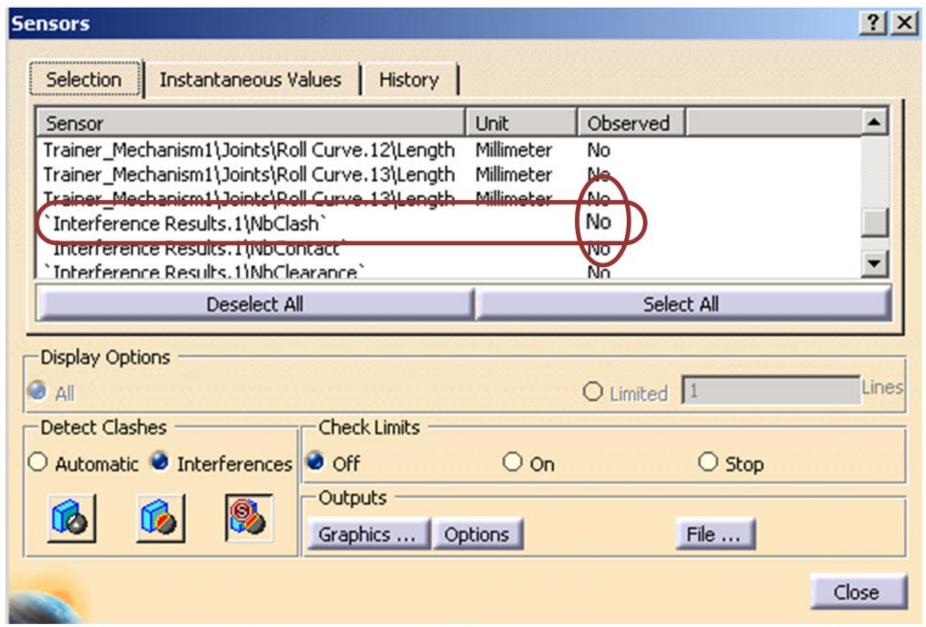
**CATIA Data Used: KIN_Elliptic_Trainer_Step3.CATProduct**

- **Perform clash analysis between the Step_Bar_Left and Rod_Left**
  - **For the 'Kinematics Simulation', activate the sensors and switch on the clash detection sensor.**
    - **Click on the 'Simulation with Laws' tool.**



    - **In the 'Kinematics Simulation' panel, check the 'Activate sensors' option.**
    - **In the 'Sensors' panel, click on the 'Interference Results.1\NBClash' to switch on the clash detection.**

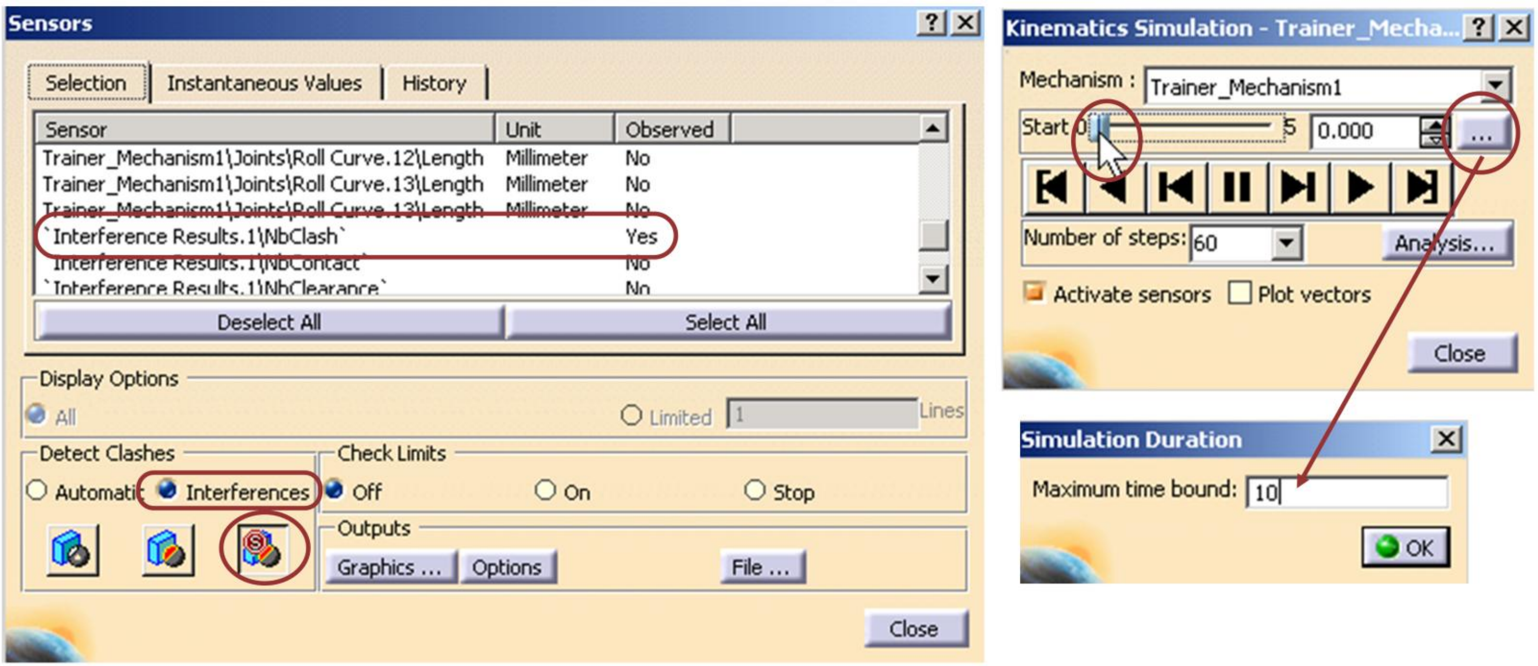


Student Notes:

# Do It Yourself (2/3)

- **In the 'Sensors' panel, select the other options as specified below and play the simulation.**
  - **In the 'Detect Clashes' box, select 'Interferences' and 'Stop' button.**
  - **Keeping the 'Sensors' panel on, go to the 'Kinematics Simulation' panel.**
  - **Drag the slider to the beginning, change the 'Maximum time bound' to 10 seconds and play the simulation.**



# Do It Yourself (3/3)

- **Note the simulation and verify that there is no clash between the components**

**If there is no clash, the simulation will continue till the end without stopping.**

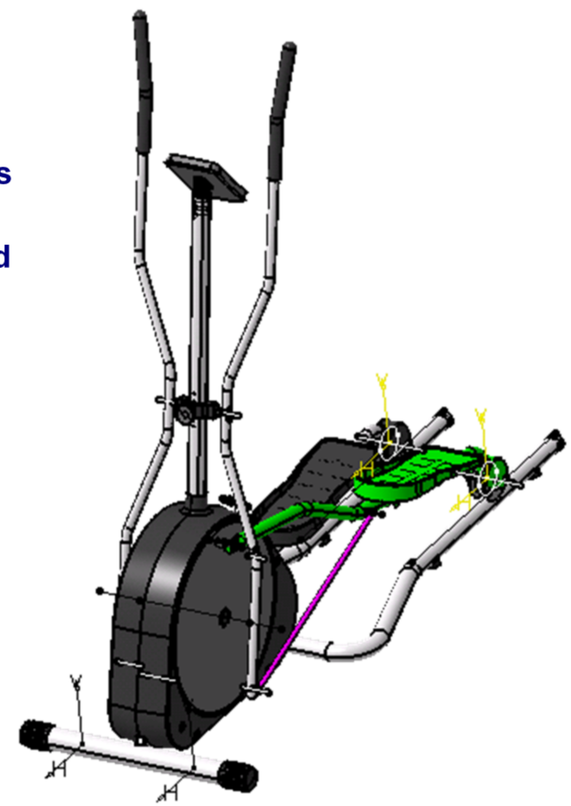
***Student Notes:***

Student Notes:

# Elliptical Trainer

## *Step 4 – Computing Swept Volume and performing Distance Analysis*

*25 min*



**In this step you will :**

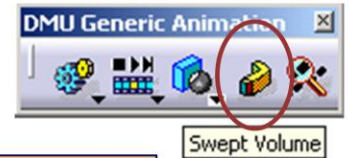
- **Compute and save the swept volume for some components of the mechanism.**
- **Perform a distance analysis between the swept volume and the fixed component in the mechanism.**

Student Notes:

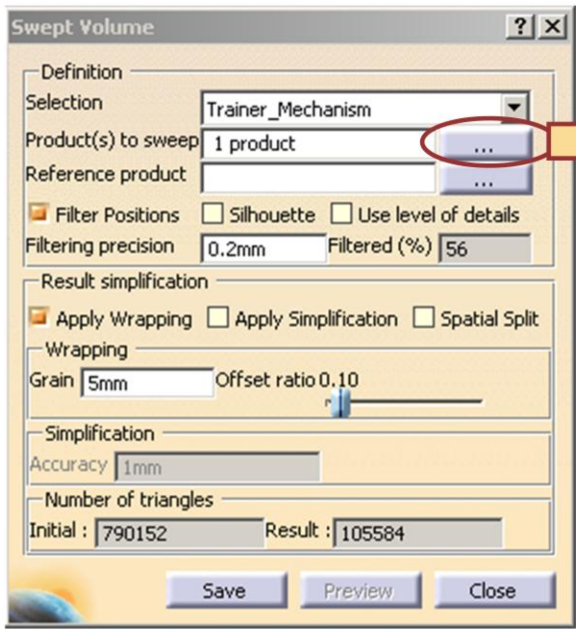
# Do It Yourself (1/5)

**CATIA Data Used: KIN_Elliptic_Trainer_Step4.CATProduct**

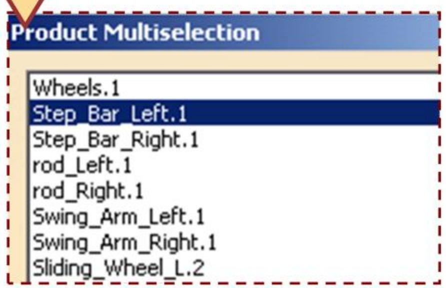
- **Generate the swept volume for 'Step_Bar_Left' and 'Rod_Left.1' and save the swept volumes as a CGR files.**
  - **Generate the swept volume for 'Step_Bar_Left'.**
    - **Click the 'Swept Volume' tool and in the panel, click the button near 'Products to sweep'.**

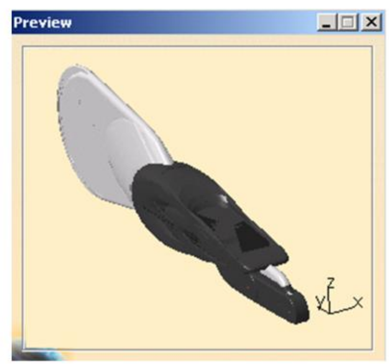



**You need to have 'Digital Mockup Optimizer' license to complete this task.**




- **In the 'Product Multiselection' panel select only 'Step_Bar_Left.1' and click 'Preview' button to view the result of the swept volume.**



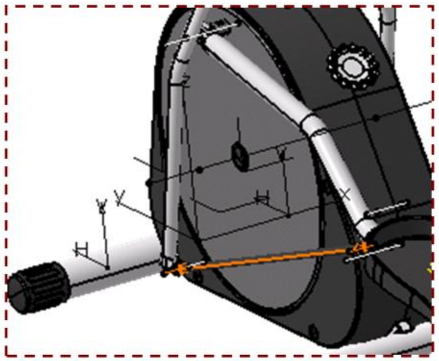



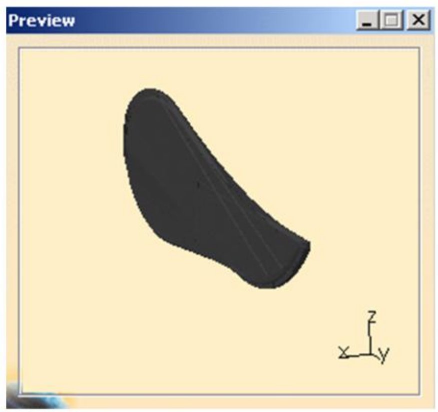

- **Click on 'Save' button and save the swept volume as a CGR file.**

**Student Notes:**

# Do It Yourself (2/5)

- **In the similar way, generate and save the swept volume for 'Rod_Left.1' component.**



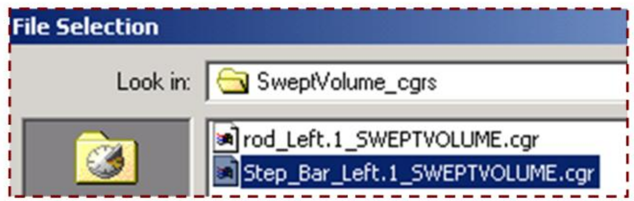



Student Notes:

# Do It Yourself (3/5)

- **Insert the recently saved CGR files in the 'Elliptic Trainer' assembly and perform a distance and band analysis between:**
  - **Swept volume of 'Step_Bar' and Swept Volume and Chassis.**
  - **Swept volume of 'Rod_Left.1' and Chassis.**
- **Insert the CGR files in 'Elliptic_Trainer.CATProduct' using the usual 'Insert Existing Component' command.**

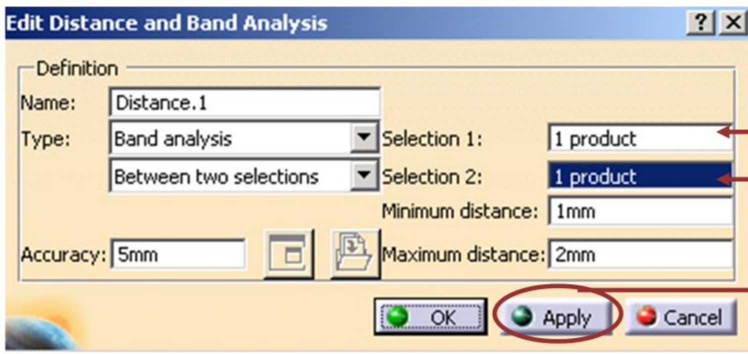




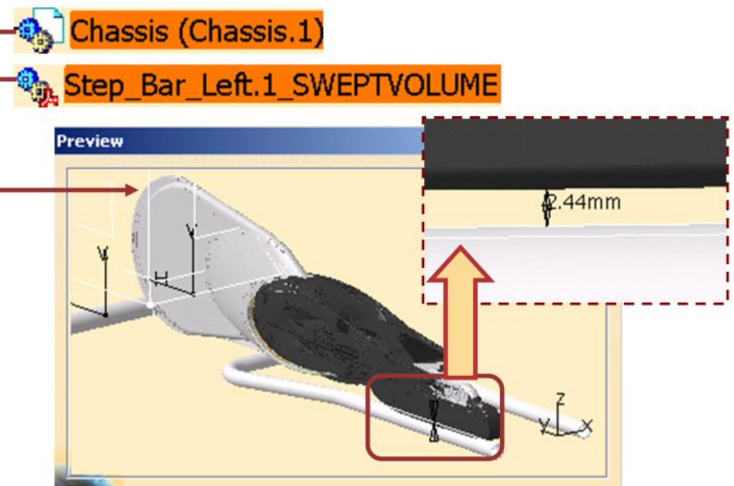

<u>*Student Notes:*</u>

# Do It Yourself (4/5)

- **Perform a band analysis between Swept volume of 'Step_Bar' and Chassis**
  - **Use the following parameters for band analysis and click the 'Apply' button to preview the result of the analysis.**




**You need to have 'Space Analysis' license to complete this task.**



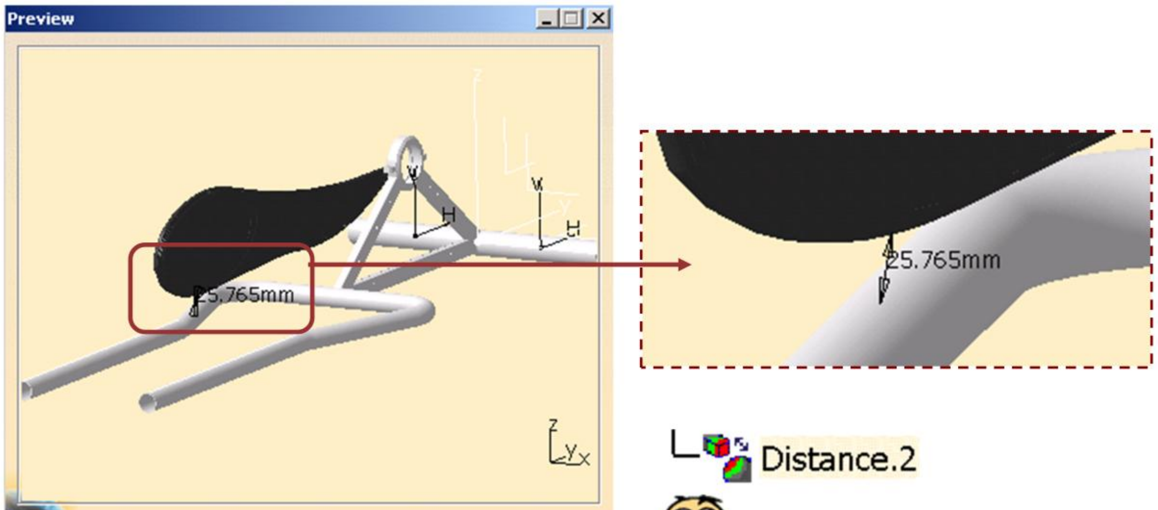

  - **You can zoom in the preview window to note the minimum distance.**
  - **Click OK to save this analysis' result.**


**The analysis values are representative and not necessarily the exact values that will be seen by the user.**

Student Notes:

# Do It Yourself (5/5)

- **In the similar way, perform a band analysis between 'Rod_Left.1' - Swept Volume and Chassis.**




**The analysis values are representative and not necessarily the exact values that will be seen by the user.**

Student Notes:

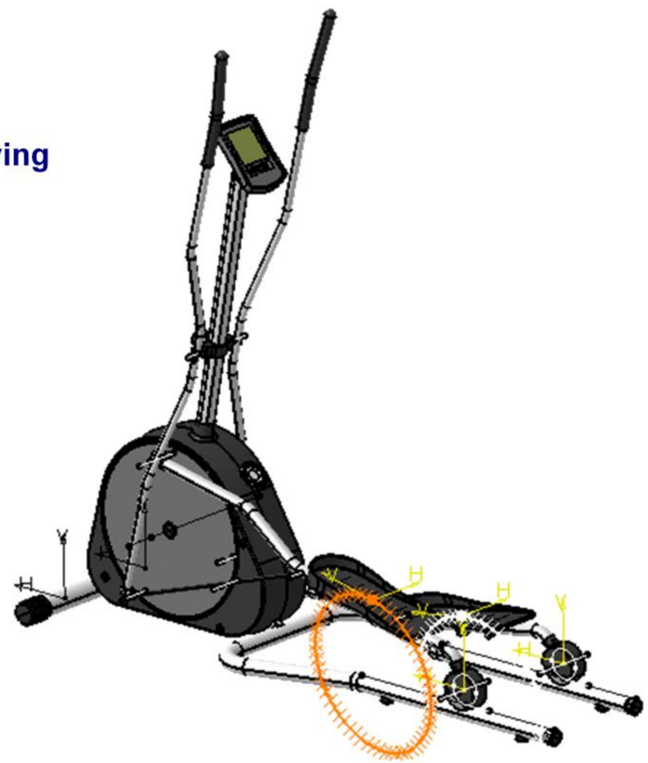
# Elliptical Trainer

## Step 5 – Generating Trace

15 min

In this step you will :

- Generate the trace curve from a point in one of the moving components in the mechanism.
- Copy and paste the trace curve into the corresponding component in the assembly.



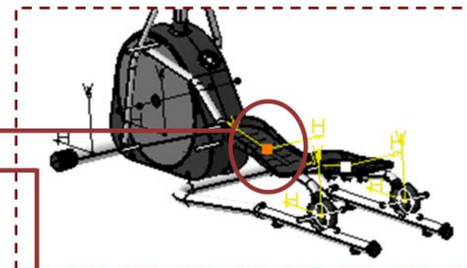
Student Notes:

# Do It Yourself

**CATIA Data Used: KIN_Elliptic_Trainer_Step5.CATProduct**

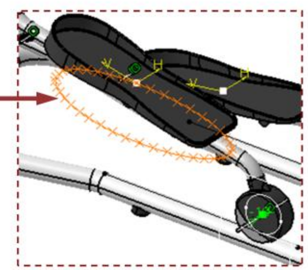
- **Use the 'Trace' tool and generate a trace of the point in the 'Pad' part (footrest), of the 'Step_Bar_Left.1' component as shown in the picture.**
  - **Insert a new part in the root assembly and name it as 'Trace_Part'.**
  - **Select the following inputs for the 'Trace' command as shown in the picture.**






**Newly created part**

  - **Click OK to generate the new trace in the new 'Trace_Part'**

**The trace shows the locus of points along which the foot would move during the operation of the Trainer.**

**Student Notes:**

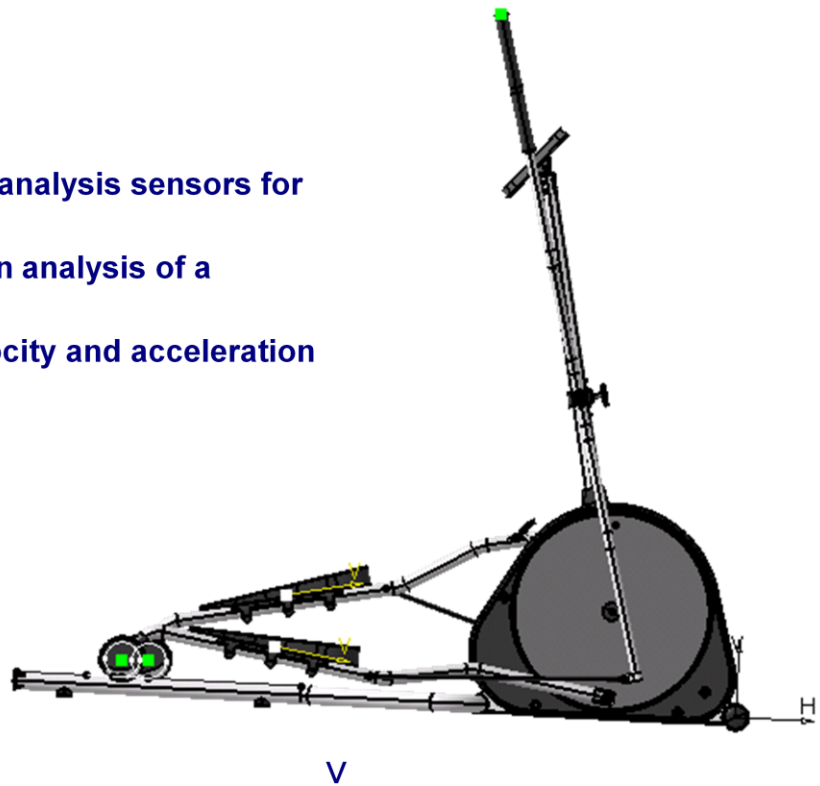
# Elliptical Trainer

## *Step 6 – Performing Speed and Acceleration Analysis*

*20 min*

**In this step you will :**

- **Define a speed and acceleration analysis sensors for the simulation.**
- **Perform a speed and acceleration analysis of a component of the mechanism.**
- **View the graphical output of velocity and acceleration with respect to time.**

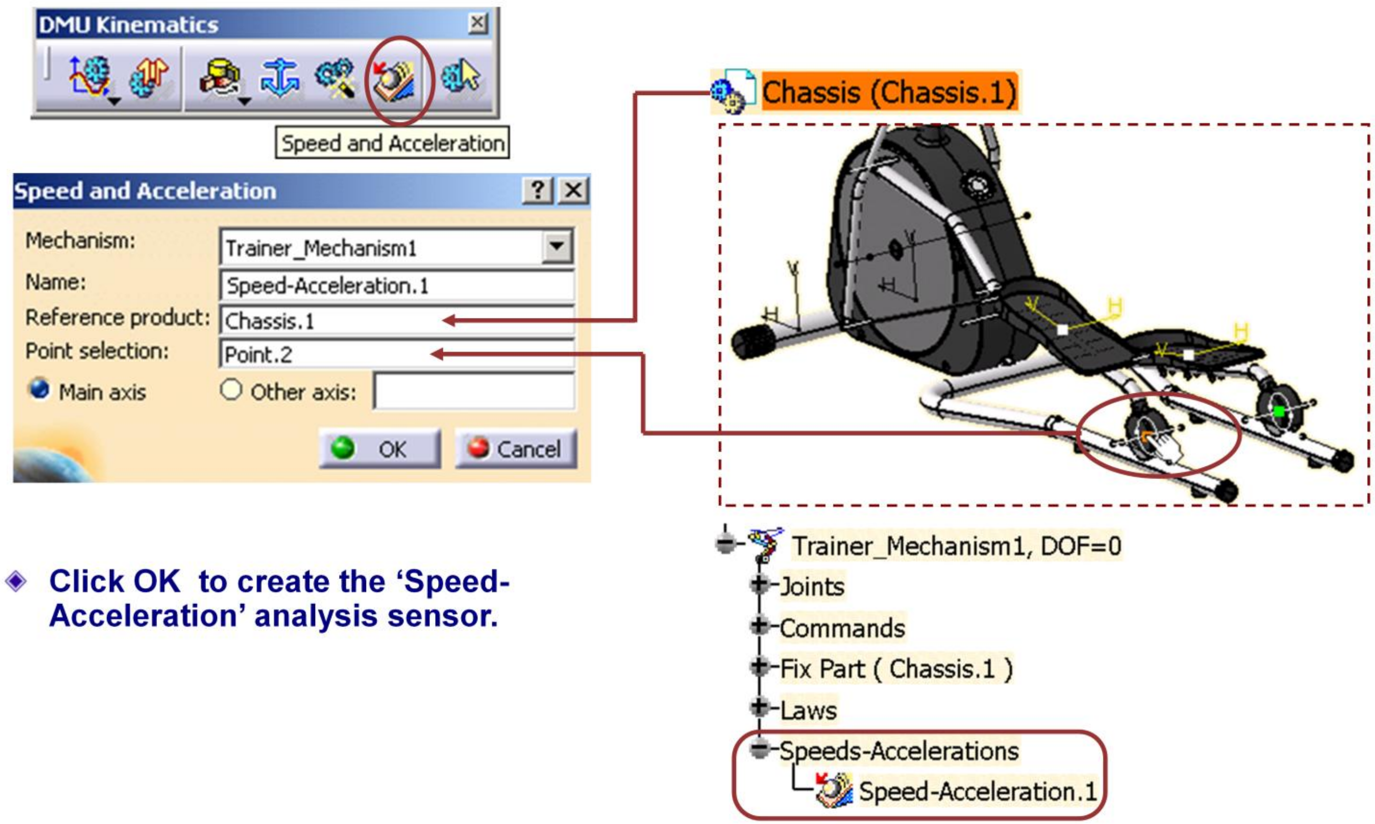


Student Notes:

# Do It Yourself (1/4)

CATIA Data Used: KIN_Elliptic_Trainer_Step6.CATProduct

- Define a speed and acceleration analysis sensor for a point on the 'Rolling Wheel' axis
  - Select the following inputs for defining the 'Speed and Acceleration' sensor.

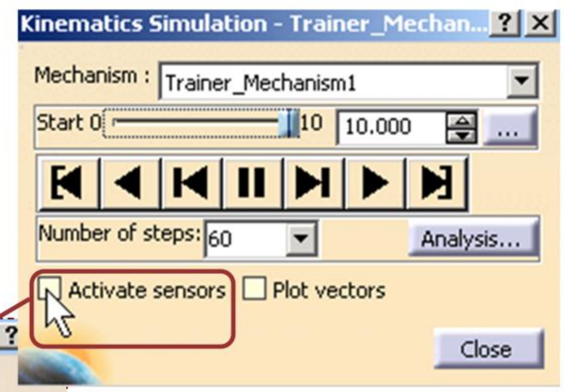



  - Click OK to create the 'Speed-Acceleration' analysis sensor.

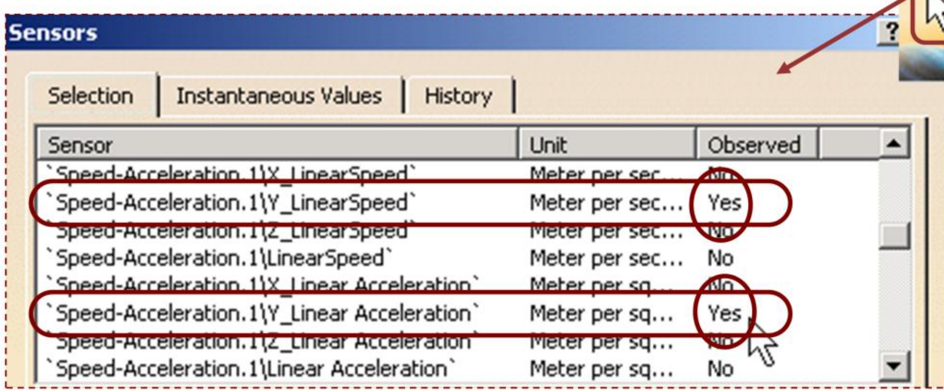
# Do It Yourself (2/4)

- **Perform the speed and acceleration analysis by activating the sensor during the simulation of mechanism.**
  - **Double click on the mechanism to open the simulation panel**


  - **In the simulation panel, check the 'Activate Sensors' option to open the 'Sensors' panel.**




  - **In the 'Sensors' panel, activate the sensors as shown in the picture.**

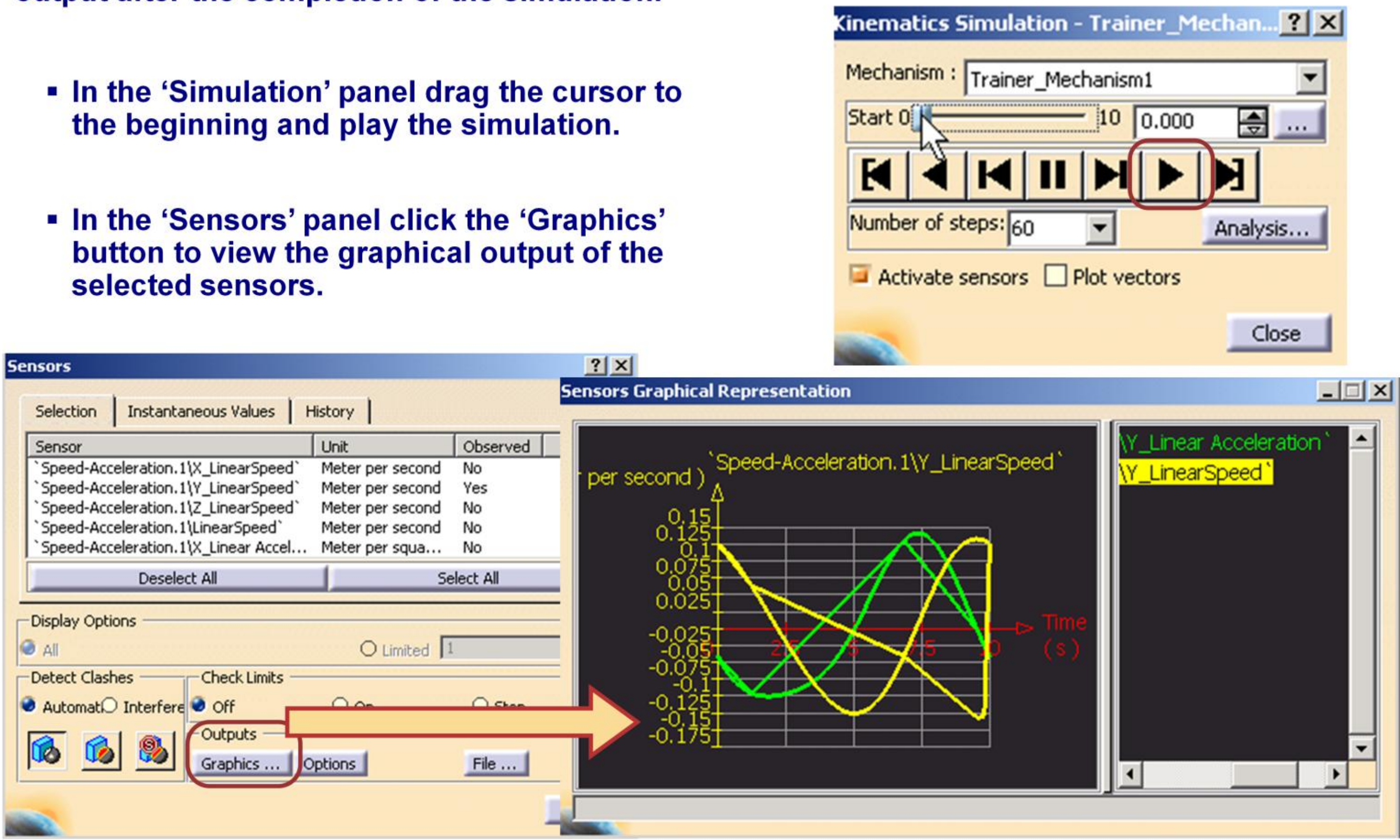



*Student Notes:*

Student Notes:

# Do It Yourself (3/4)

- **Keeping the 'Sensors' panel open, play the simulation and view the graphics output after the completion of the simulation.**
  - **In the 'Simulation' panel drag the cursor to the beginning and play the simulation.**
  - **In the 'Sensors' panel click the 'Graphics' button to view the graphical output of the selected sensors.**



Student Notes:

# Do It Yourself (4/4)

- From the Graphics output, find out the the maximum speed reached during the simulation and also find out the time at which this maximum speed is reached.