RobotStudio Courseware 5.60

Learning the Basics

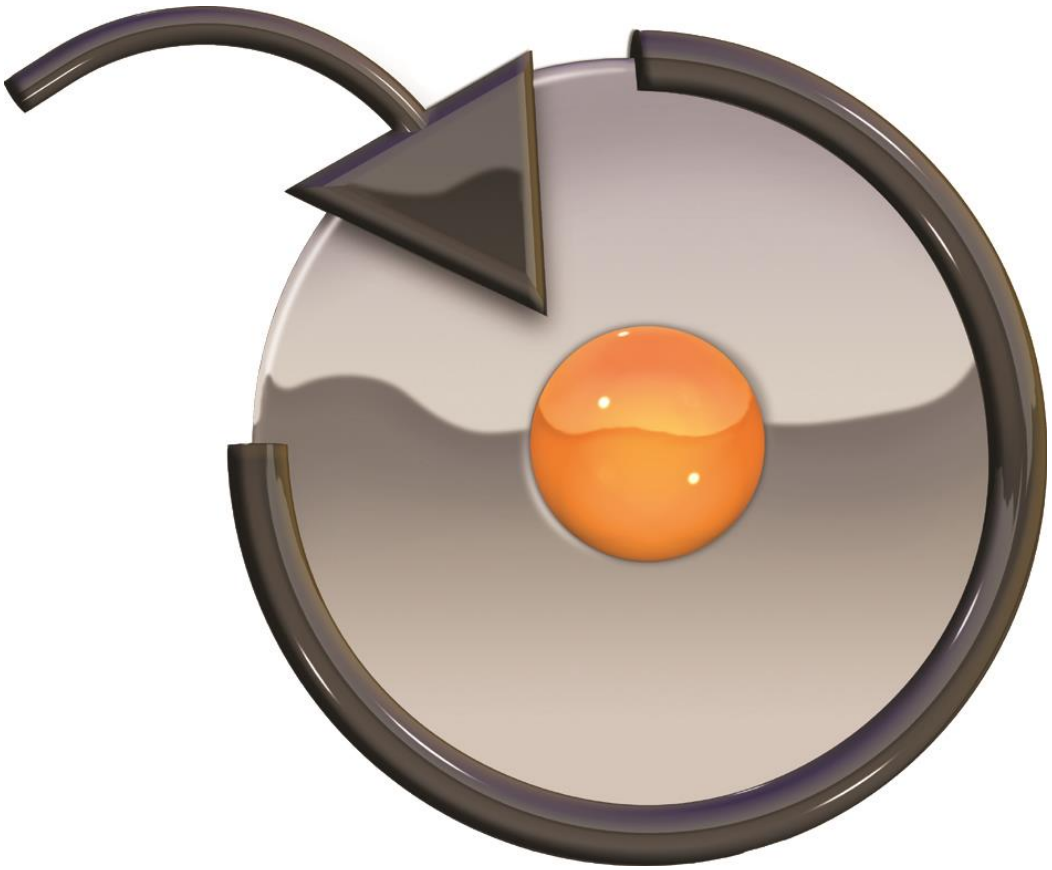


ABB AB
Robotics Products
SE-721 68 Västerås
Sweden

2014-04-08 ABB

1. Courseware

1.1. Courseware files

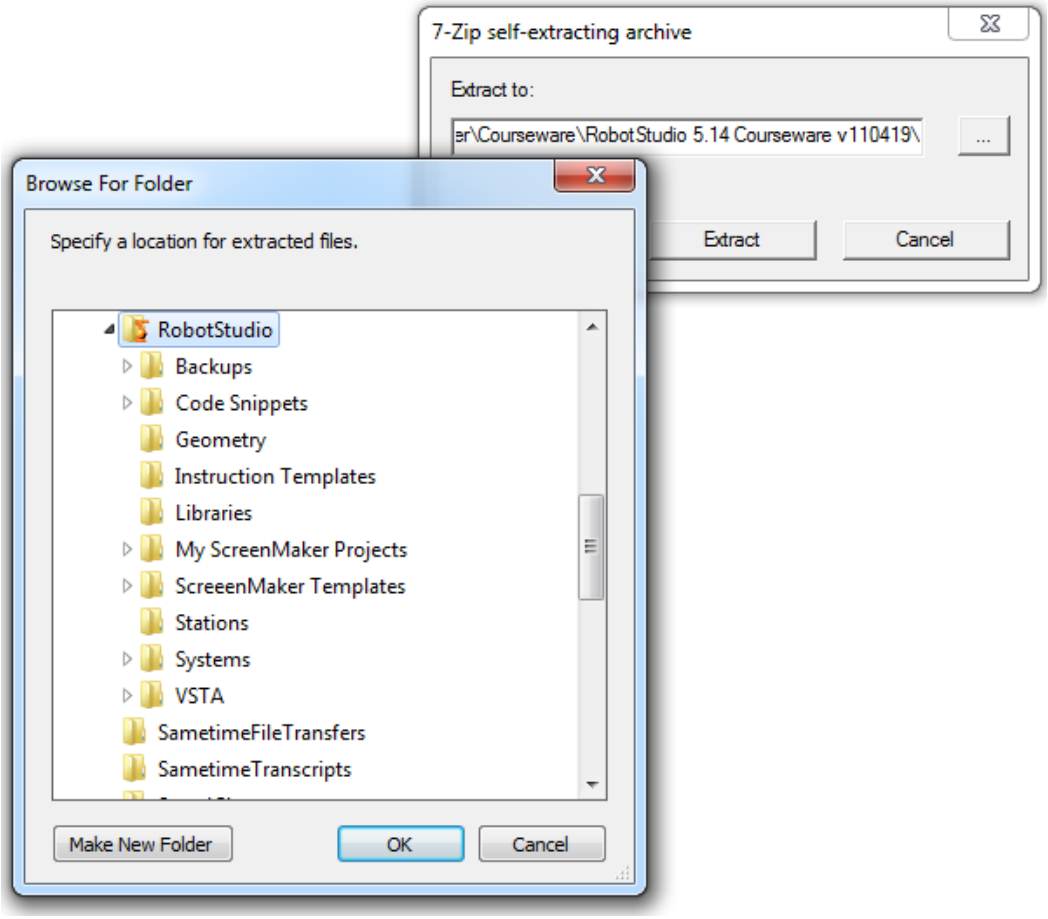
Overview

In this exercise we will unpack the courseware files and set the default RobotStudio folder.

Extracting the Courseware folder

Along with the RobotStudio Courseware you have received a *RobotStudio Courseware.exe* file.

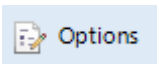
1. Double click the *RobotStudio Courseware.exe* file.
2. In the **Zip Self-Extractor** dialog, browse to where you have your **My Documents** folder and select the **RobotStudio** folder.



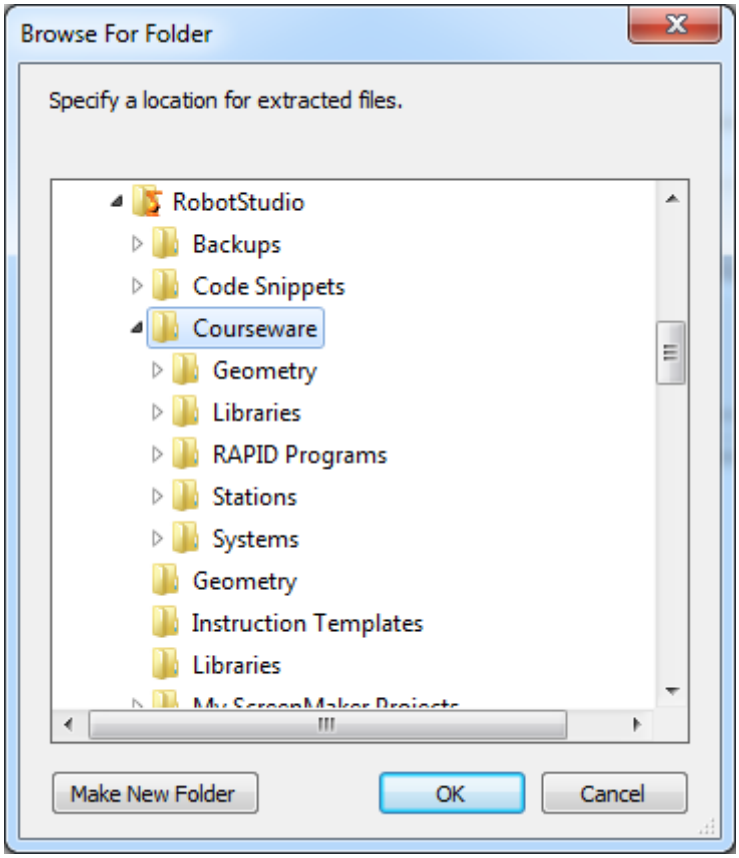
3. Click the **Unzip/Extract** button.

Setting the RobotStudio User Project Folder

4. On the **File** tab click **Options**.

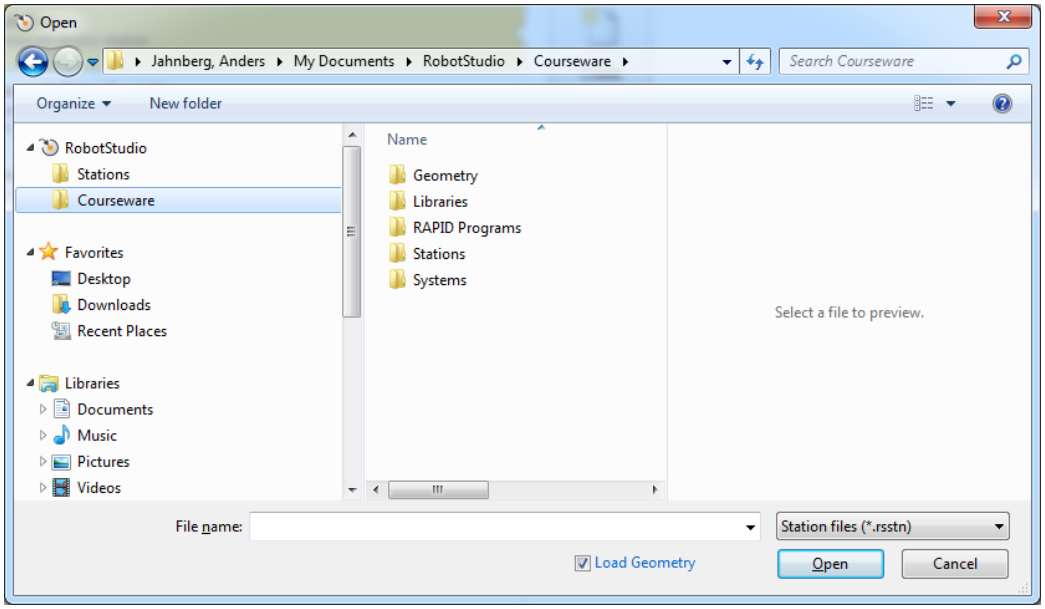


5. In the **Options** dialog select **Files & Folders**.
6. In the **User Project Folder** click the browse […] button.
7. Browse to the *Courseware* folder that you just extracted and click the **OK** button.



8. Click **OK**.

By setting the User Project Folder you have now created a shortcut that will appear in all open, import load and save dialogs. For example:



Here we can see the Courseware button in the Open dialog

Challenge

If you have an internet connection you can visit the RobotStudio community. Go to http://www.abb.com/roboticssoftware .

2. Learning the basics

2.1. RobotStudio Overview

2.1.1. Exploring RobotStudio

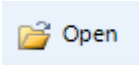
Overview

Before starting with the actual exercises, we will take a quick look at RobotStudio and commonly used functions.

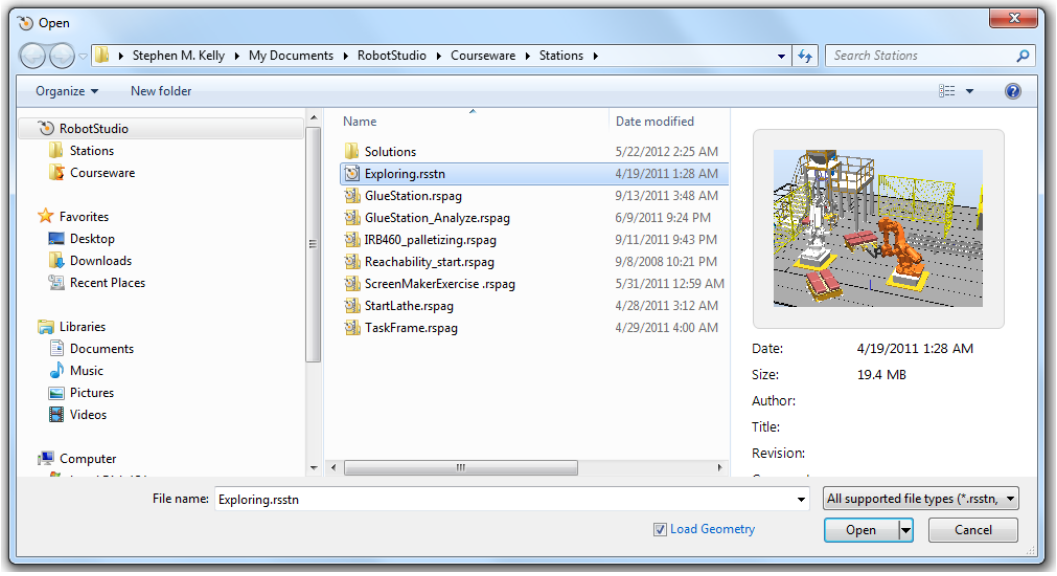
To open a demo station

Now we will open a demo station to play with. Do not save any changes to the station during this exercise.

1. On the **Start** menu select
   All Programs > *ABB Industrial IT* > *Robotics IT* > *RobotStudio 5.60* > *RobotStudio*
   to start RobotStudio.
2. In the **File** tab, click Open.

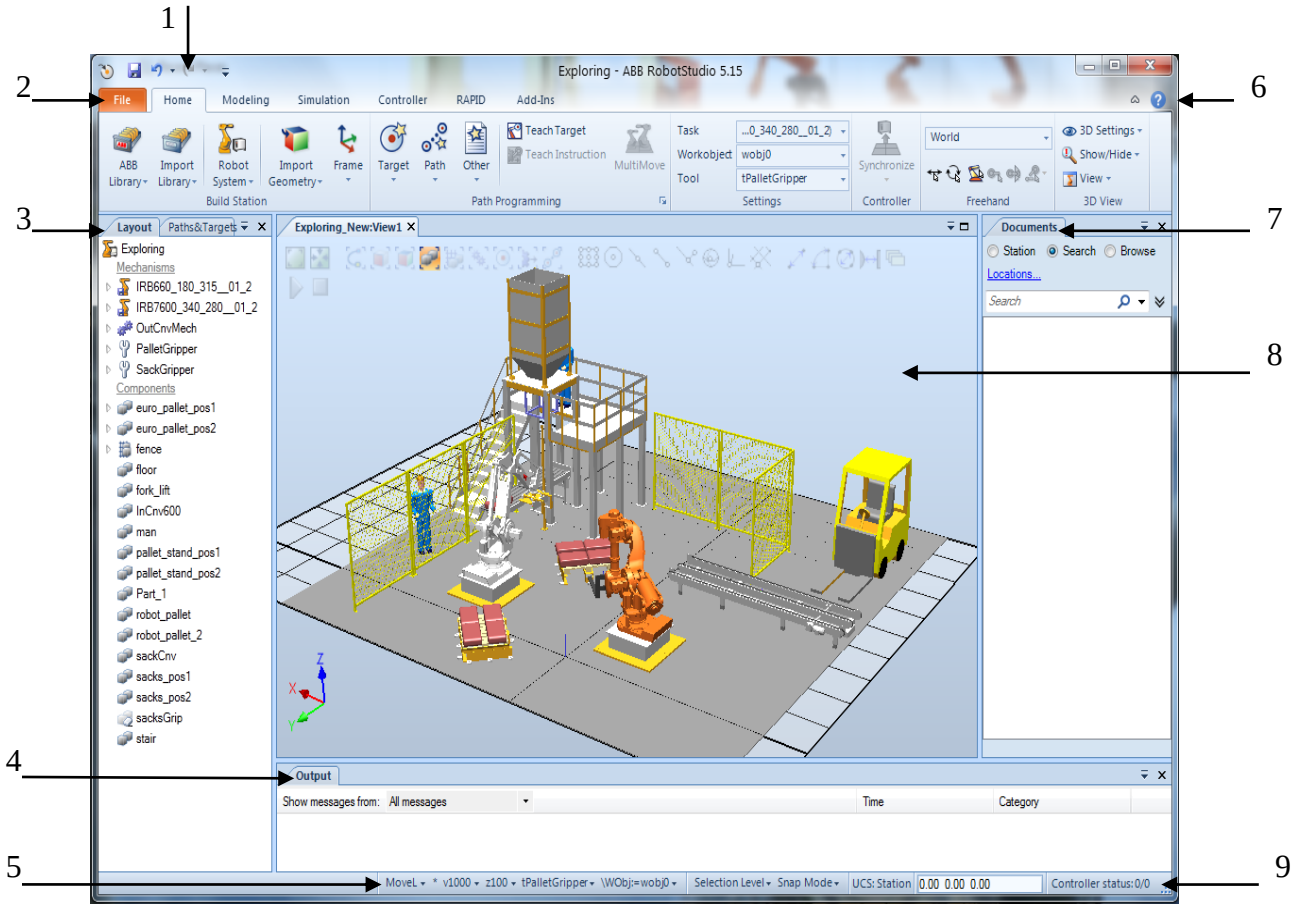
   

3. Browse to the folder *\Courseware\Stations* and open the station *Exploring*.



The main parts of RobotStudio window

The picture on the next page shows the main parts of RobotStudio:



1	**Quick Access** Toolbar For quick access to commonly used commands and settings. To add an item to the toolbar, right click the item and select **Add to quick access toolbar** or click the arrow next to the toolbar and select **Customize Commands**.	
2	Tabs The tabs contain collections of commands and setting items for different aims according to the following table:	
	File	Opening, saving stations and options etc.
	Home	Building up stations, creating systems, creating paths with graphical programming.
	Modeling	Creating and grouping components, creating solids, curves and surfaces, measurements and CAD operations. This is also from where you create **Smart Components** and use the **Mechanism Modeler**.
	Simulation	Setting up, configuring, controlling, monitoring and recording simulations.
	Controller	For working with system parameters and configuration and setting up relationships to transfer programs, data etc. between controllers. (VC (Virtual Controller) or live controllers)

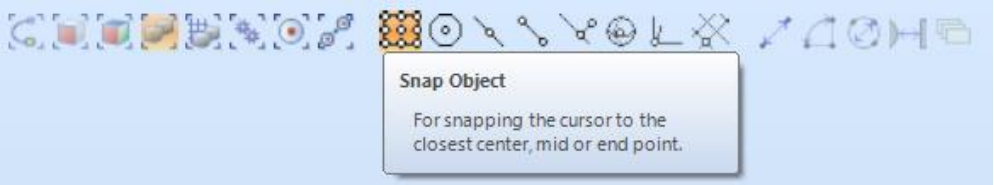
	Rapid	Editor for writing new and/or debugging existing Rapid programs.
	Add-Ins	PowerPacs and Add-Ins.
	Modify	This is a contextual tab, which is only visible when an object is selected. It list specific commands for that object type.
3	**Layout** and **Paths&Targets** browser The **Layout** browser displays the physical items of the station, such as robots and tools. When working with the objects, you either select them here or in the Graphics window. The **Paths&Targets** browser displays programming data such as controllers, tool data, work objects and targets.	
4	**Output** window and **Simulation Watch** The **Output** window displays messages from RobotStudio and the Virtual Controller. Some messages are active: by clicking on them you get more information. In **Simulation Watch** you will be able to monitor values of dynamic properties and IO signals in Smart Components. **Note**: Depending on main tab, different windows will show.	
5	**Active Toolbar** Shows active templates and parameters such as speed data and zone data. These are the default settings that will be used when creating **Move** instructions.	
6	**RobotStudio Help** menu Here you will find help on **RobotStudio**, **Rapid**, **API** etc.	
7	**Documents Manager** Allows you to easily search and browse for files to load into the station. It is also possible to add references to files and folders or embed files into the station.	
8	**Graphics window** The Graphics window displays the objects in the station. Here you select objects and parts of objects when building and programming stations. Icons for **selection levels** and **snap modes** can be found at the top of the Graphics window. Using correct selection level and snap mode settings is important for successful work in the Graphics window.	
9	**Controller status bar** A green light indicates that the controller is in **AUTO** mode, yellow that it is **MANUAL** mode, and red that it is not started.	

To explore selection levels and snap modes

1. In the Graphics window click the **Part Selection** icon.

The name of an icon appears as a ToolTip when holding the cursor over the icon.

2. In the Graphics window click the **Snap Object** icon.



This is a multi-snap mode, snapping to the closest center, edge or corner.

3. In the Graphics window click the fork lift. The entire fork lift is now highlighted red. You can also see the pick point as a white star that has snapped to the closest center/edge/corner.
4. On the **Home** tab, in the **Freehand** group click the **Move** button. A cross with arrows in the X, Y and Z directions now appear on the truck. Drag the arrows to move the object.

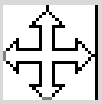
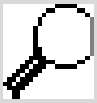
5. On the **Home** tab, in the **Freehand** group click the **Jog Joint** button and then select any joint on one of the robots. By pressing the left mouse button on one of the joints in the Graphics window you are able to jog it in any direction.

6. Continue exploring the selection levels and snap modes by snapping to corners, edges and center points of parts, tools, entities and surfaces etc.
7. Close the station without saving when you are done.

2.1.2. Navigating the Graphics window using the mouse

Navigating the Graphics window using the mouse

The table below shows how to navigate the Graphics window using the mouse:

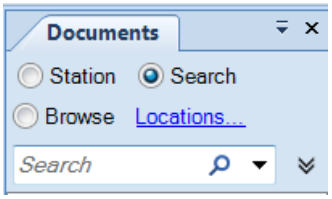
To	Use the keyboard / mouse combination	Description
Select Items 		Just click the item to select. To select multiple items, press the SHIFT key while clicking the new items.
Rotate the station 	**CTRL + SHIFT +** 	Press CTRL + SHIFT + the left mouse button while dragging the mouse to rotate the station. With a 3-button mouse you can use the left and middle buttons, instead of the keyboard combination.
Pan the station 	**CTRL +** 	Press CTRL + the left mouse button while dragging the mouse to pan the station.
Zoom the station 	**CTRL +** 	Press CTRL + the right mouse button while dragging the mouse to the left to zoom out. Dragging to the right zooms in. With a 3-button mouse you can also use the middle button, instead of the keyboard combination.
Zoom using window 	**SHIFT +** 	Press SHIFT + the right mouse button while dragging the mouse across the area to zoom into.
Select using window 	**SHIFT +** 	Press SHIFT + the left mouse button while dragging the mouse across the area to select all items that match the current selection level.

2.1.3. Managing document folders

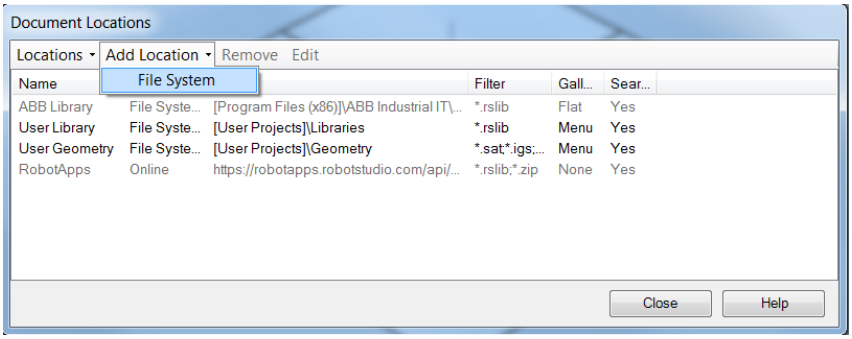
Create a gallery for frequently used documents

It is possible for the users to create a document gallery in order to easily access their frequently used documents. The galleries can be created using the **Documents** window, and are also placed in **Import Library** or **Import Geometry** menus in the **Home** tab.

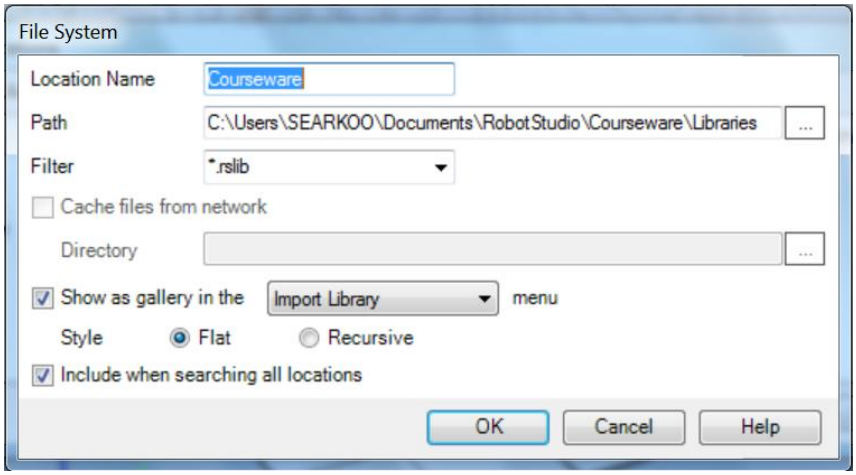
1. On the Documents window, press on **Locations** in order to add and locate your galleries.



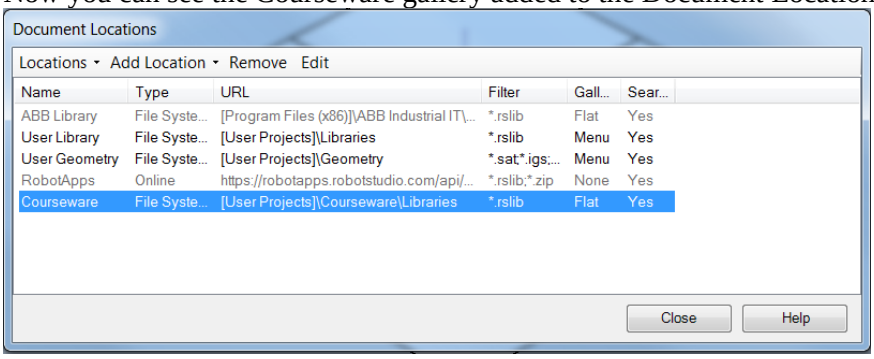
2. When the **Document Locations** dialogue box appears, click on **Add Location > File System**, as depicted in the picture below. By doing so, the **File System** dialogue box will pop up.



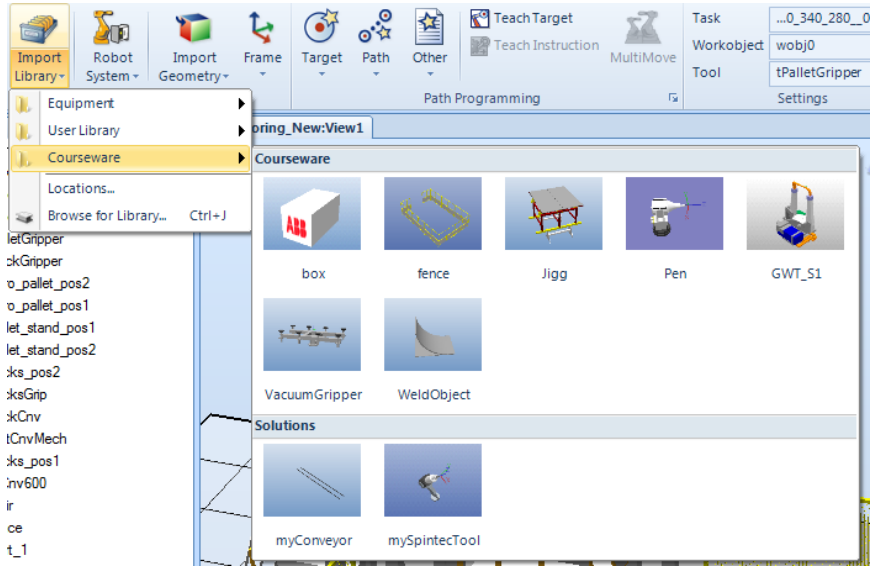
3. Now we want to create a gallery for the library objects located in the courseware folder. On the **File System** dialogue box, name the new location as Courseware. Then set the path to the Library folder located in the Courseware folder, and select *.rslib as a Filter from the dropdown menu. Set up the rest of parameters as shown in the following picture and press OK.



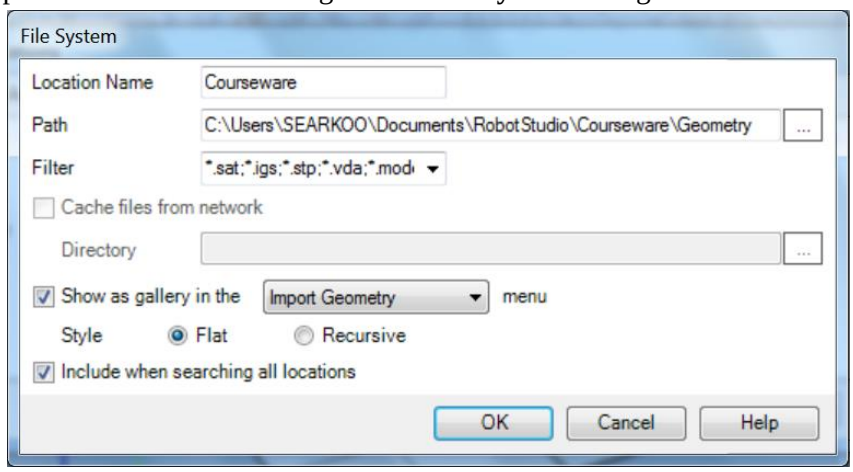
4. Now you can see the Courseware gallery added to the Document Locations list.



5. Press **OK** in order to complete the task and add the gallery to the Import Library menu. The result will be the same as the below picture.



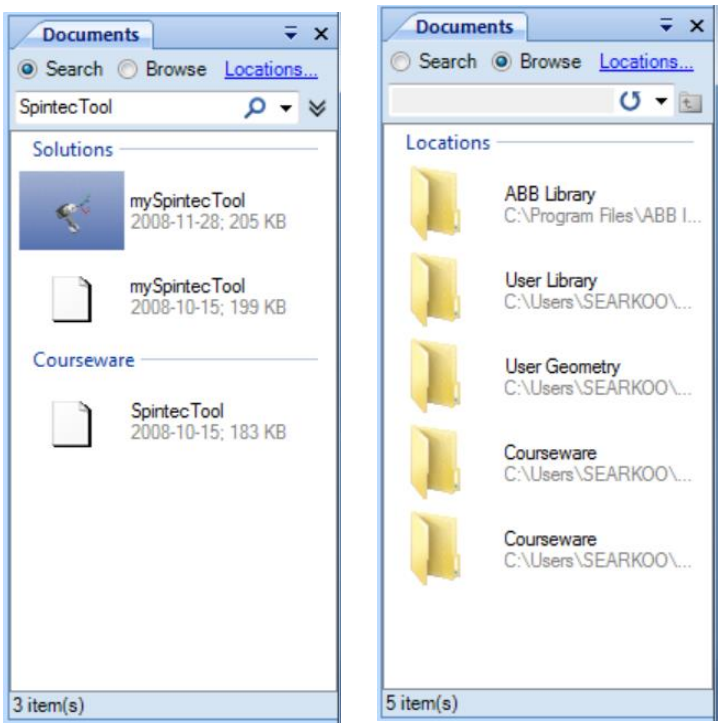
You can now create a gallery for **Import Geometries** following the above instruction. See the picture below for the settings in the **File System** dialogue box.



Searching a specific documents

Using the **Search** function in **Documents** window, you can search for a document by its name. The result will appear on the Documents window. Then you can double-click on the found item(s) in order to import it to the station. You can also use the **Browse** function in

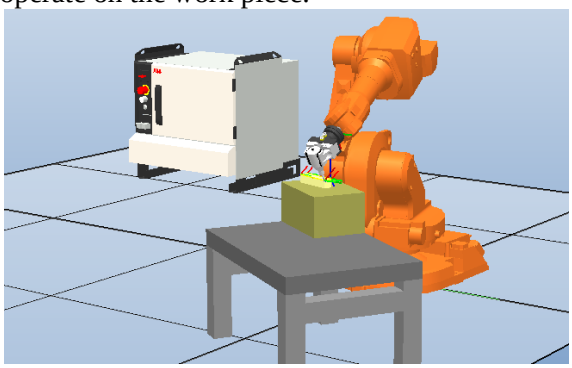
order to browse to all available locations created in **Document Locations**. These functions provide an easy, quick access to your documents.



2.2. Creating a basic station

Goal of the chapter

In these exercises we will learn how to build a basic station containing a robot, a tool, a fixture and a work piece as shown in the picture. Later in the course we will program the robot to operate on the work piece.



2.2.1. Creating a new station

Overview

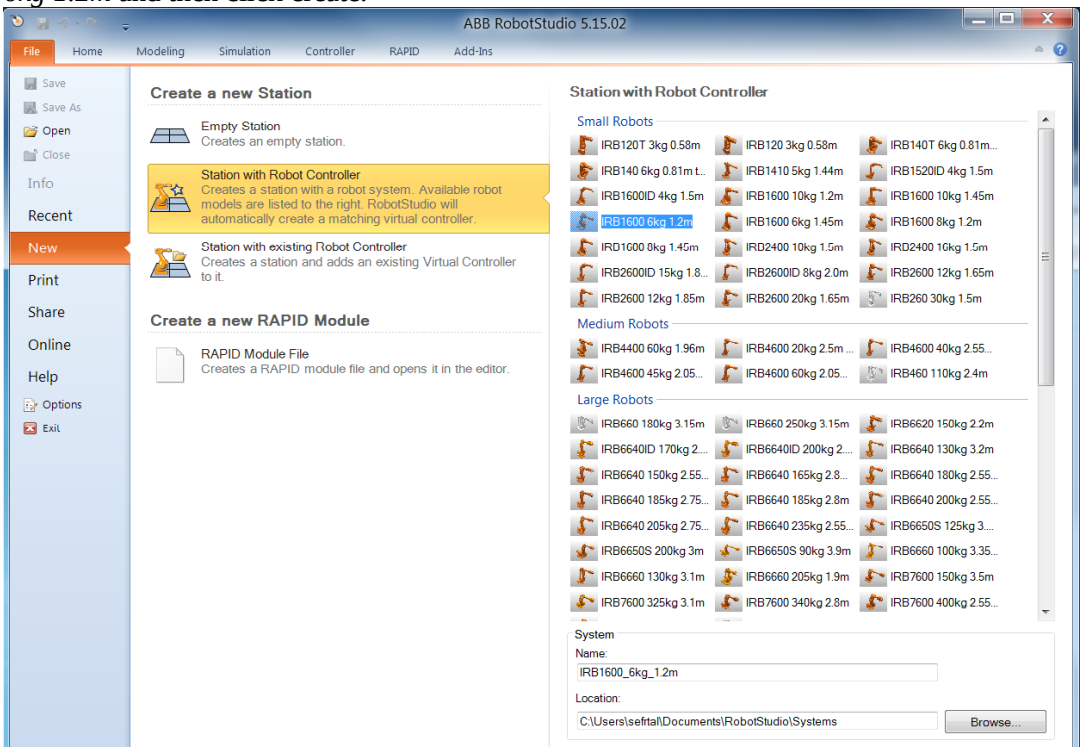
A new station can be created in three ways:

- With no system - starting from scratch with an empty station and then add a new or existing system to it.
- With a template system - this is the simplest way to create a new station with a robot and a link to a rudimentary system template.
- With an existing system - this creates a new station containing one or more robots in accordance with an existing, built system.

In this exercise we will use the second alternative.

Creating the new station

1. In the **File** tab, click **New** and then select a new **Station with Robot Controller.**
2. By default, **template systems** are listed in the right pane of the window. Select *IRB1600 6kg 1.2m* and then click create.



3. In the **File** tab select **Save As**.
4. Browse to the folder *\Courseware\Stations* and save the station as *MyStation_1*.

Learn more

Click the **Help** button  in the top right corner of RobotStudio.

See the help section	for information about
Workflow for building a new station	Creating stations and systems.

2.2.2. Adding a tool

Overview

We will now import and attach a tool to the robot. This is done in two steps: first we import the tool to the station and then we attach it to the robot.

The tool that we will import is a library component, which means that it is a RobotStudio object that has been saved as a separate file. The library import creates a link from the station to the library file on the hard drive. Therefore, several stations can share the same library component.

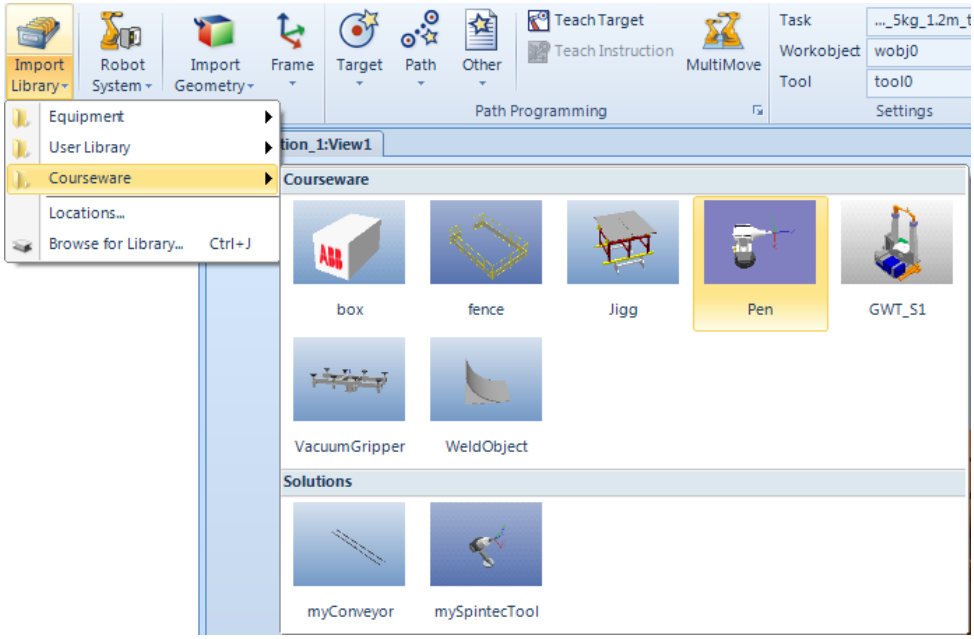
On the Home tab you can find the Import library button, it has two sections:

1. The upper button opens up a dialog where you can browse for libraries.

2. The lower part that opens up default RobotStudio libraries and personal galleries.


Importing the tool

1. Open the station from the last exercise (*Mystation_1*), unless it is already open.
2. In the **Home** tab click the **Import Library** button. Since you have already created the Courseware gallery to this menu, you can now easily select the needed library component from this gallery. Click the Courseware gallery and select *Pen.*

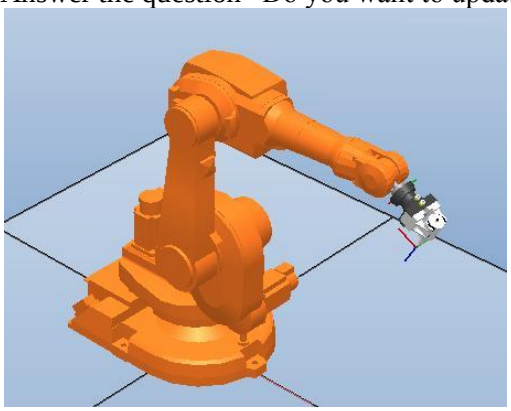


The tool will be imported to the station and placed at the origin of the world coordinate system, thus hidden inside the robot. However, in the Layout browser you can see that the tool has been imported.

Attaching the tool

1. Inside the **Layout** browser, drag the tool *Pen* and drop it on the robot *IRB1600*.

2. Answer the question “Do you want to update the position of Pen” with **Yes**.



The tool is moved to the wrist of the robot.

3. **Save** the station as *MyStation_2*.

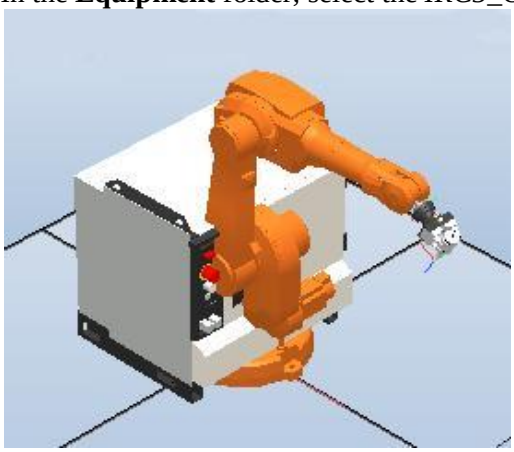
2.2.3. Importing the controller cabinet

Overview

We will now import a model of the controller cabinets to the station. The controller model is for visual representation only, the Virtual Controller runs regardless if there is a cabinet or not.

Importing the controller cabinet

1. Open the station from the last exercise (*Mystation_2*), unless it is already open.
2. On the **Home** tab click the **Import Library** button (lower section).
3. In the **Equipment** folder, select the *IRC5_Control-Module* library.



The cabinet will be imported to the station and placed at the origin of the world coordinate system.

4. Save the station as *MyStation_3*.

2.2.4. Moving the controller cabinet

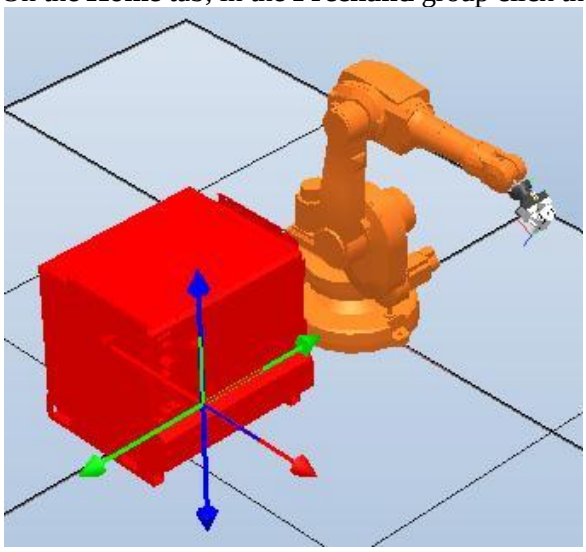
Overview

We will now move the controller to a more suitable position in the station. If not the exact position is important, **Freehand** move is an easy way to modify the position of objects.

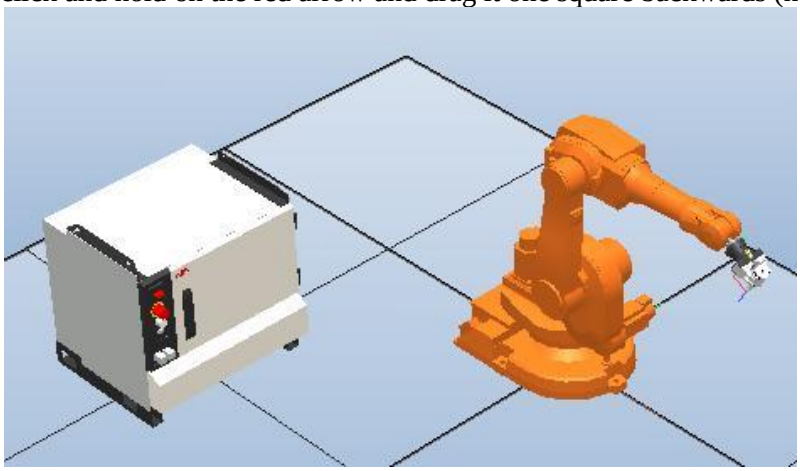
RobotStudio has several functions for moving objects, each suitable for different situations. In this exercise the exact position is not important as long as it is placed out of reach from the robot so we will use the **Freehand** move.

Moving the controller cabinet part

1. Open the station from the last exercise (*Mystation_3*), unless it is already open.
2. In the **Layout** browser select *IRC5_Control-Module* or use selection level **Part** to make the selection directly in the graphics window.
3. On the **Home** tab, in the **Freehand** group click the **Move**  button.



4. Click and hold on the green arrow in the Freehand move cross, then drag the controller one floor square (about 1 meter) to the right of the robot (negative Y direction). Then click and hold on the red arrow and drag it one square backwards (negative X direction).



5. Save the station as *MyStation_4*.

2.2.5. Importing CAD files

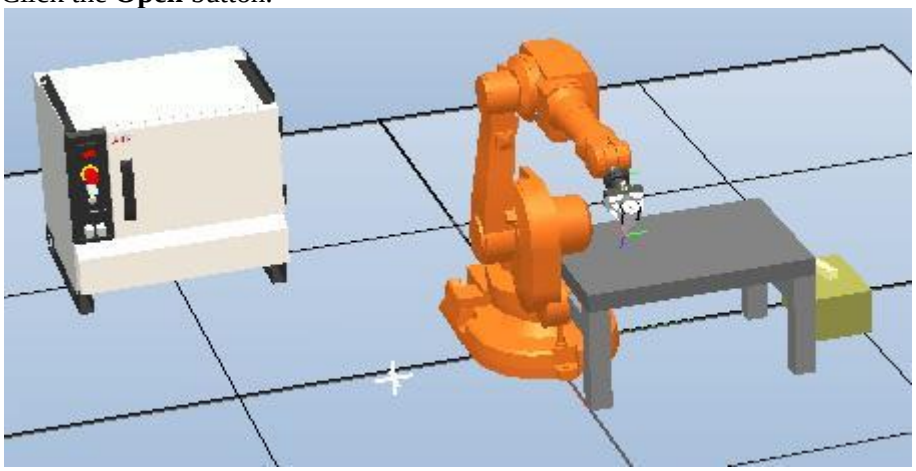
Overview

You add work pieces and custom equipment, like fixtures or conveyors, by importing the CAD models of the objects. In this exercise we will import a table and box.

Importing the CAD files

1. Open the station from the last exercise (*Mystation_4*), unless it is already open.
2. On the **Home** tab click **Import Geometry**.
3. In the **Open** dialog browse to *\Courseware\Geometry* then hold down the [CTRL] key and select the objects *Box.sat* and *Table.sat*.

4. Click the **Open** button.



5. Save the station as *MyStation_5*.

Learn more

Click the **Help** button in the top right corner of RobotStudio.

See the help section	for information about
Libraries, geometries and CAD files	Supported CAD formats and import options
Troubleshooting and optimizing geometries	How to solve geometry problems like slow updates and invisible parts.

Challenge

The detail level of a model can be changed to increase the performance for large models. Open the **Options** dialog and go to **Graphics**>**Performance**.

To increase performance for large models, set the detail level to **Coarse**. This only affects the visual representation of the object, not the accuracy when generating curves and targets.

To improve visual display and make it easier to select points in objects with many details, set the detail level to **Fine**.

When you are finished, change back to the default value, **Automatic**. RobotStudio will then determine which level to use based on the zoom factor in the station. This increases the file size of the station.

2.2.6. Positioning the table

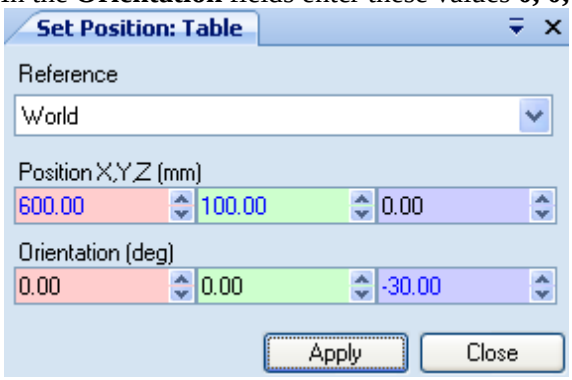
Overview

The table will be moved 600 mm from the **Base Frame** of the robot in X direction, 100 mm in Y direction, and finally with a -30º rotation around Z. We will use the **Set Position** command for this movement.

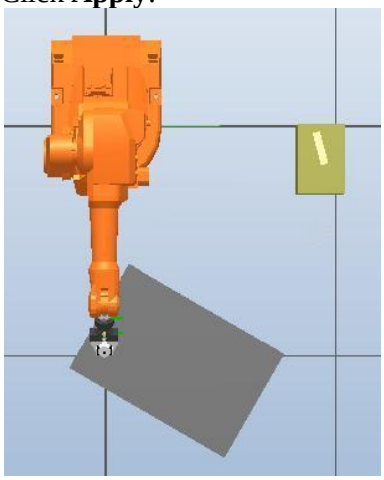
Positioning the table

1. Open the station from the last exercise (*Mystation_5*), unless it is already open.
2. In the **Layout** browser right click the *Table* and select **Set Position**.

3. In the **Set position** dialog, in the **Reference** list select the **World** coordinate system.
4. In the **Position** fields enter these values **600, 100, 0**.
5. In the **Orientation** fields enter these values **0, 0, –30**.



6. Click **Apply**.



7. Save the station as *MyStation_6*.

2.2.7. Placing the box

Overview

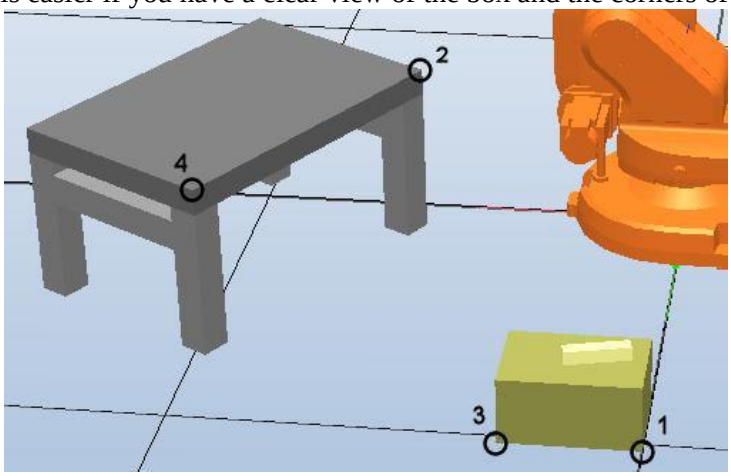
We will now place the box at one of the corners of the table. For placing an object relative another without knowing the exact coordinates, the **Place** commands are well suited. Now we will use the **Place by two points** command since we need to both move the box and change its orientation around one axis.

TIP!
When selecting a corner of an object, make sure to click inside the surface of the object, this to make sure the pick point will snap correctly.

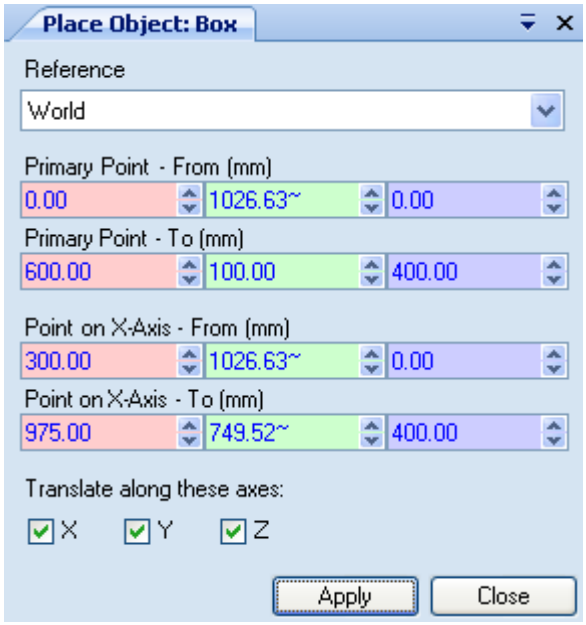
Placing the box on the table

1. Open the station from the last exercise (*Mystation_6*), unless it is already open.
2. In the Graphics window select the **Part Select** level and the **Snap End** mode.

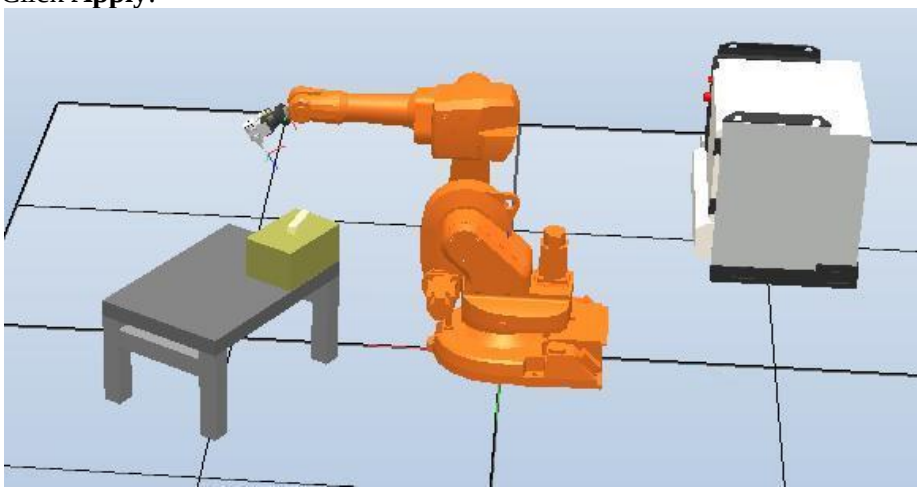
3. Rotate and zoom the station so you get a view similar to the one in the picture below. It is easier if you have a clear view of the box and the corners of the table.



4. In the **Layout** browser right click the *box* part, point to **Place** select **Two Points**.
5. When the text insertion point is positioned in any of the **Primary point - From** boxes, click the corner of the box marked with **1** in the picture.
6. When the text insertion point is positioned in any of the **Primary point - To** boxes, click the corner of the table marked with **2**.
7. When the text insertion point is positioned in any of the **Point on X-Axis -From** boxes, click the corner of the box marked with **3**.
8. When the text insertion point is positioned in any of the **Point on X-Axis -To** boxes, click the corner of the table marked with **4**.



9. Click **Apply**.



The primary point on the box is now moved to the primary point on the table and the points on the X-Axis set the orientation of the box.

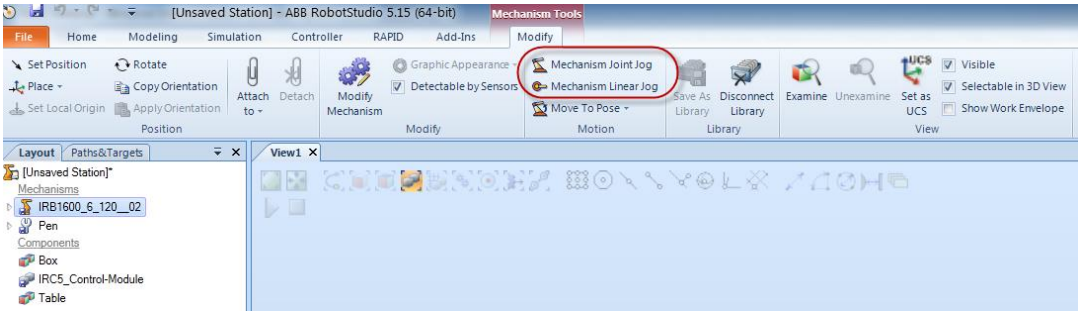
10. Save the station as *Mystation_7*.

2.3. Programming the basic station

2.3.1. Jogging the robot

Overview

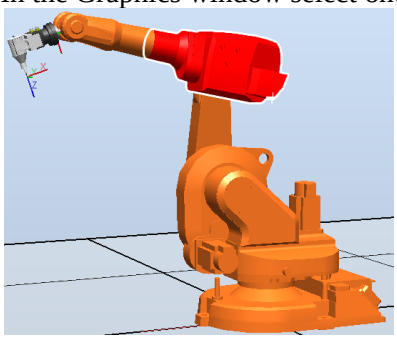
Before programming the station, we will practice jogging the robot. Jogging the robot can be done in several ways but here will use the freehand functionality. Note that both **Mechanism Joint Jog** and **Mechanism Linear Jog** are available also from the **Modify** tab which is enabled when the robot is selected in the Layout browser.



Jogging the robot joint by joint

1. Open the station from the last exercise (*Mystation_7*), unless it is already open.
2. On the **Home** tab, in the **Freehand** group click **Jog Joint**.

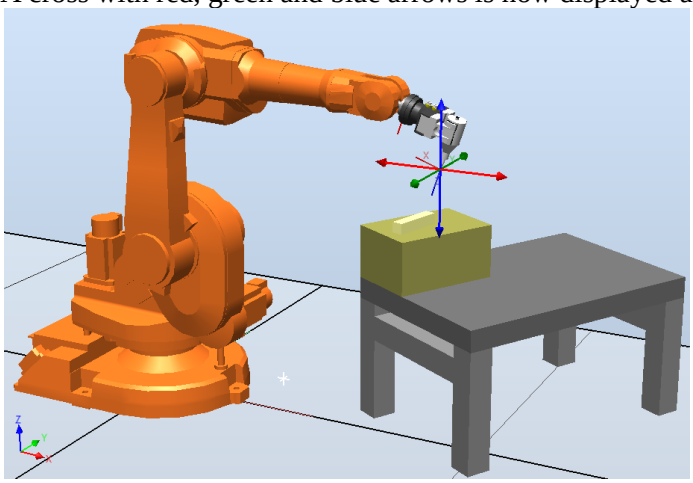
3. In the Graphics window select one of the joints and move it by dragging the mouse.



Jogging the robot linearly

1. On the **Home** tab, in the **Freehand** group click **Jog Linear**.

2. In the Graphics window select the robot by clicking on it.
   A cross with red, green and blue arrows is now displayed at the Tool Center Point (TCP).



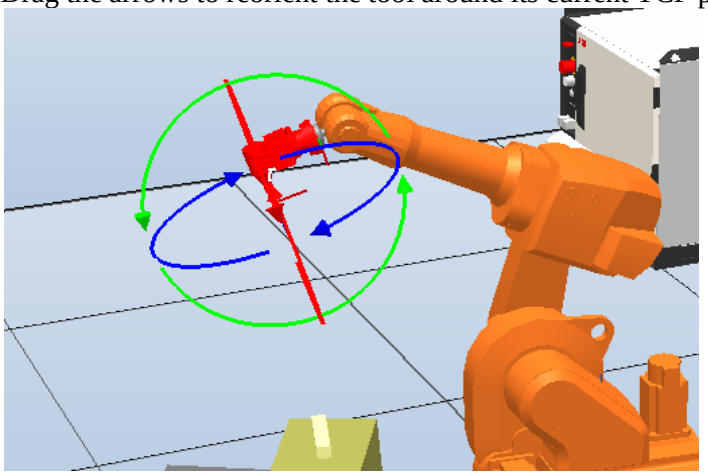
3. Click and drag the arrows to jog the robot. Use the red arrow for X direction, green for Y and blue for Z.

Reorienting the tool of the robot

1. On the **Home** tab, in the dropdown list of the **Freehand** group select **Active Tool**.
2. Click the button for **Jog Reorient**.

3. In the Graphics window select any part of the robot.
   Circular arrows are now displayed around the TCP.

4. Drag the arrows to reorient the tool around its current TCP position.



Jumping back to the neutral position

After finishing the jogging practice, jump back to the original neutral position.

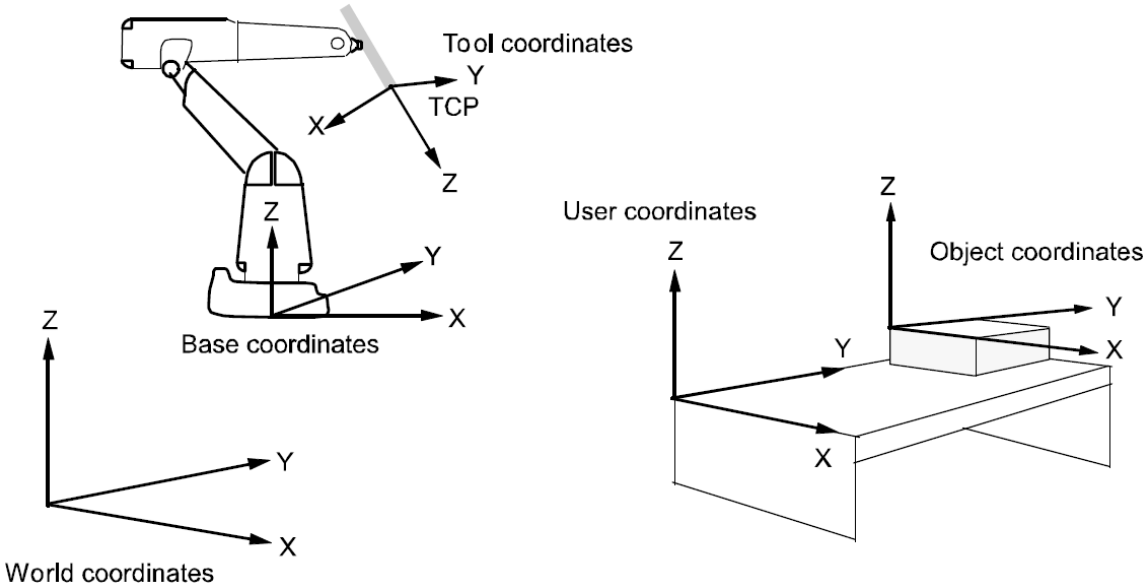
1. In the **Layout** browser, open the context menu by right clicking the robot and then select **Jump Home**.

2.3.2. Creating a Workobject

Overview

The first thing we will do when programming the station is to create a workobject coordinate system. Workobjects are special coordinate systems in which the programmed positions are stored. Correctly used, workobjects facilitate calibration and modifications of the cell layout: if repositioning the work piece or the robot itself, you just reposition the workobject correspondingly, and the program is up-to-date again.

Programming a robot without having specific workobjects is possible, but not recommended. A default workobject, *Wobj0*, which always is fixed at the origin of the controller's world coordinate system, will be used in that case.



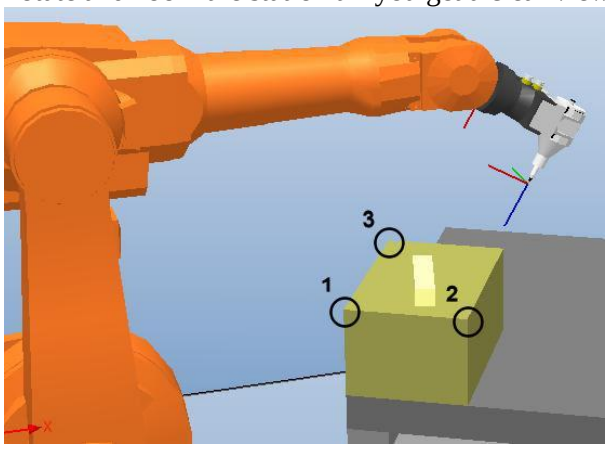
A workobject consist of two frames. The **User Frame** (User coordinate system) is referenced from the **World Coordinate System** and the **Object Frame** (Object coordinate system) is

referenced from the **User Frame**. See picture above where the position of two different parts located in the same fixture are described.

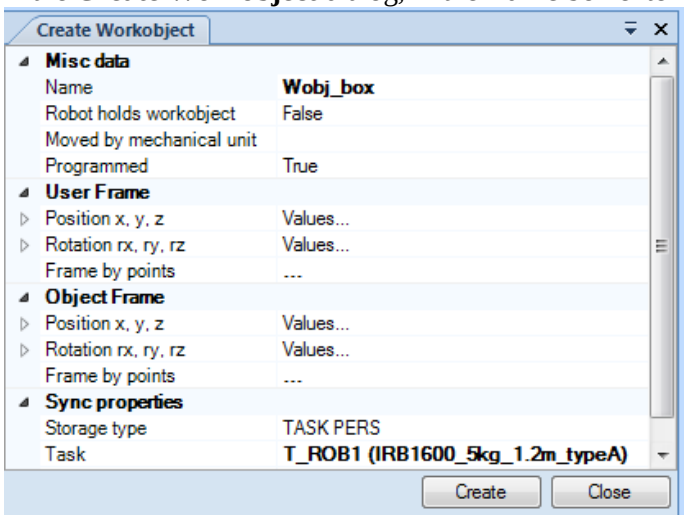
Creating the workobject

1. Open the station from the last exercise (*Mystation_7*), unless it is already open.
2. In the Graphics window select the **Part Select** selection level and the **Snap Object** snap mode.

3. Rotate and zoom the station till you get a clear view of the top of the box.

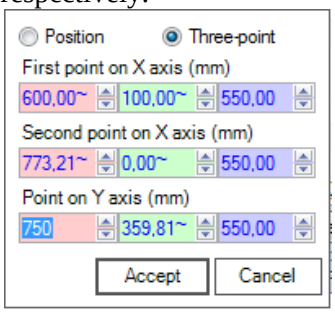


4. On the **Home** tab click on **Other** and select **Create Workobject** from the drop-down menu.
5. In the **Create Workobject** dialog, in the **Name** box enter *Wobj_Box*.

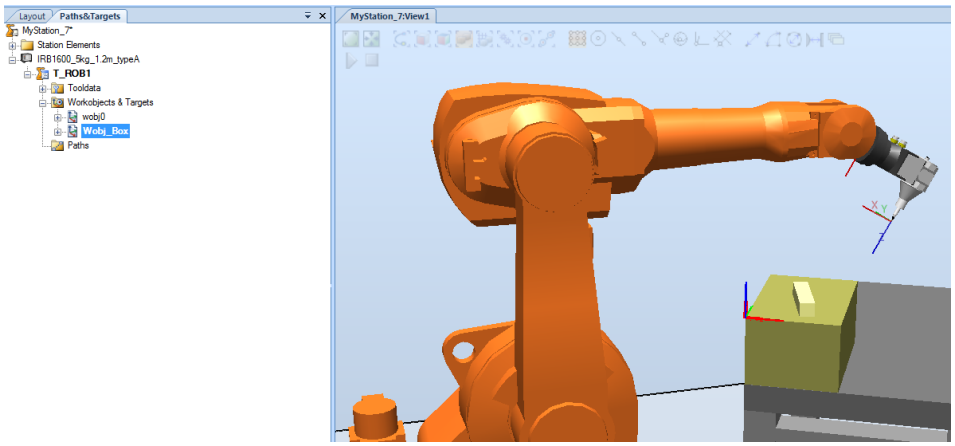


6. In the **User Frame** group click the **Frame by points** box and then click the drop-down arrow.
7. In the **Frame by points** dialog select **Three-point** as method for defining the frame.
8. Set the insertion point in one of the **First point on X axis** boxes and then click the corner of the box marked as **1** in the picture above.
   The coordinates of the selected point are now inserted in the boxes and the insertion point moved to the **Second point on X** axis boxes.

9. Continue clicking in corners **2** and **3** in **Second point on X axis** and **Point on Y axis**, respectively.



10. Click **Accept**.
    The Create frame by points dialog will close.
11. In the Create Workobject dialog click **Create**.
    A workobject, displayed as a coordinate system, is now created on the box. You can also see the workobject in the **Paths&Targets** browser.



12. Save the station as *MyStation_8*.

Learn more

Click the **Help** button in the top right corner of RobotStudio.

See the help section	for information about
About coordinate systems	Workobjects and other coordinate systems useful when programming a robot.

2.3.3. Programming motion

Overview

Paths are RobotStudio elements that contain the instructions for the robot. The order in which the instructions are stored in the path is the order in which they will be executed.

We will create a path where the robot moves along the sides of the small box on top of the big one. This is done by 'graphical programming', i.e. by clicking in the graphics.

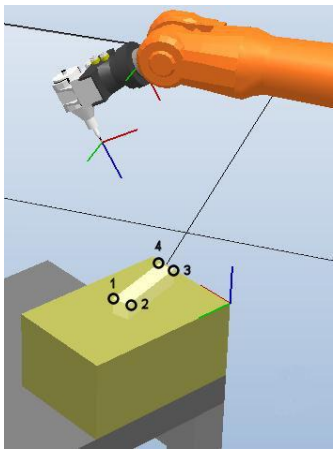
To get a working robot path, we need to go through a couple of different steps. First we will use the corner points of our graphical part to create targets. After this we will adjust the

orientation of the targets. Finally we will add these targets to a path and set appropriate axes configurations for each instruction.

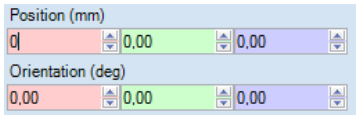
Creating the targets

1. Open the station from the last exercise (*Mystation_8*), unless it is already open.
2. In the Graphics window select **Part Selection** level and **Snap End**.

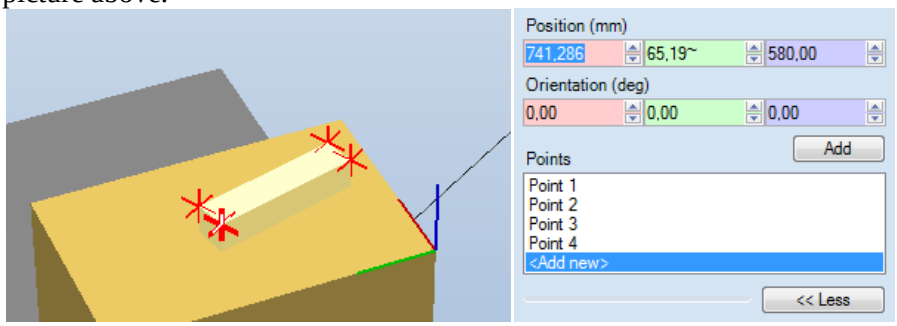
3. Zoom and rotate the station so that you get a clear view of the tool and the small box.



4. On the **Home** tab click the **Target** drop-down and select **Create Target**.
5. In the **Create Target** dialog, make sure the pointer is set to the first Position box.



6. In the Graphics windows click the corners on the top surface in the same order as in the picture above.



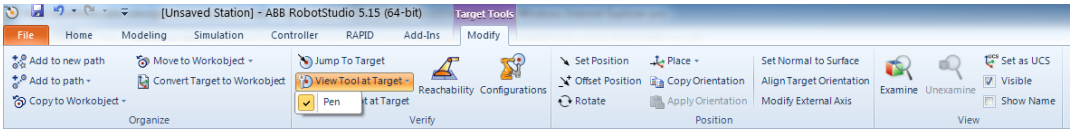
The red stars show positions where targets will be created.

7. In the **Create Target** dialog click the **Create** button.
   Now 4 targets are created with default orientation (0,0,0).

Adjusting the target orientation

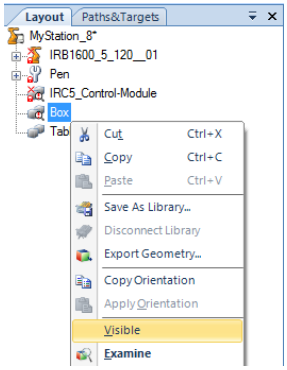
To get a good view on the current orientation of the targets we will use the function **View Tool at Target** which will give us a preview on how the tool will be oriented around the targets.

1. In the **Paths&Targets** browser select the first target (Target_10) and click the **Modify** tab.
2. In the **View Tool at target** drop-down, select **Pen**.



As the orientation of our targets are zero and our TCP has Z pointing out from the tool, the preview of the tool will be hidden in the box. To be able to see this preview we need to make the box invisible

3. In Layout browser un-check **Visible** in the context menu of the box.

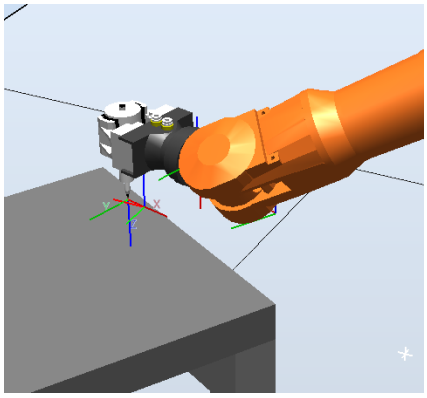


Next step is to set a suitable configuration on the first target and then re-use this orientation for the rest of our targets. If the exact orientation is known, it is easiest to manually type these values into the **Set Position** dialog. In this case when we have no exact values we will manually adjust the orientation of the first target.

4. In the Freehand group select reference Local in drop-down list. Then select Target_10 in **Paths&Targets** browser and then enable the **Rotate** button.

As a help to see if a target is reachable we will now enable the function **View Robot at Target**.

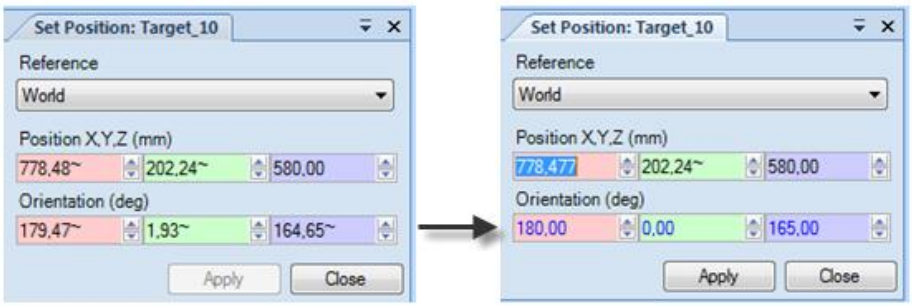
5. In the context menu of Target_10, select **View Robot at Target**. Now the robot will jump to the target as soon as it is possible to reach.
6. Rotate the target approximately +180 degrees around the Y axis by click&drag on the green arrow.
7. Rotate the target approximately +15 degrees around the Z axis by click&drag on the blue arrow.



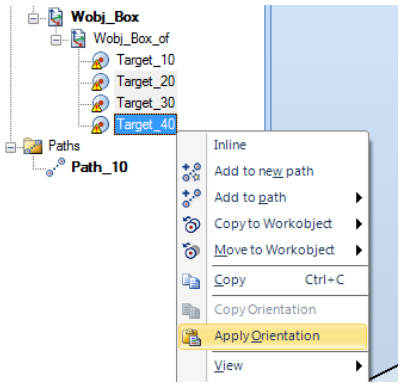
Tip!
If you press the [**f**]-key while rotating, the rotation will execute in smaller steps.

8. In the context menu of Target_10, click **Modify Target>Set Position**.

9. Select **World** as reference and make the final adjustments to round off the angles as in pictures below. Press **Apply**.



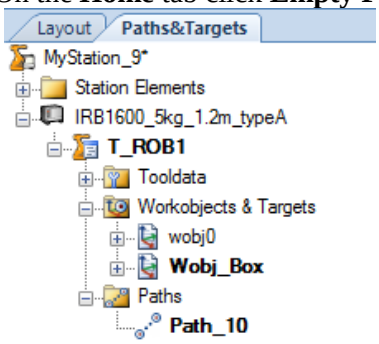
10. In the context menu of Target_10, select **Copy Orientation**.
11. Multi-select the three remaining targets and click **Apply Orientation** from the context menu. Now all targets will have the same orientation.



12. Make the box visible again by checking **Visible** from the context menu.
13. Step through the targets and make sure they are all possible to reach. As **View Robot at Target** is activated the robot will automatically jump to the targets if possible.
14. Disable **View Tool at Target**, **View Robot at Target.**
15. Save the station as *MyStation_9*.

Adding the targets to a path

1. Open the station from the last exercise (*Mystation_9*), unless it is already open.
2. On the **Home** tab click **Empty Path** from the **Path** drop-down menu.

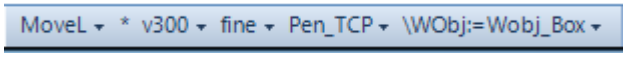


An empty path, Path_10, is now created and displayed in the Paths&Targets browser.

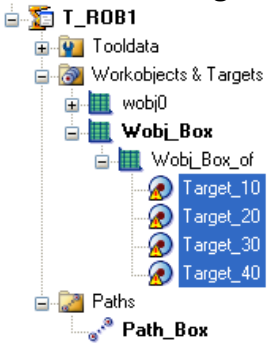
3. Right click the path, select **Rename** and change the name to *Path_Box.*

On the **Status Bar** down at the bottom of the interface you can see the active instruction template. These are the default settings that will be used when creating the Move instructions.

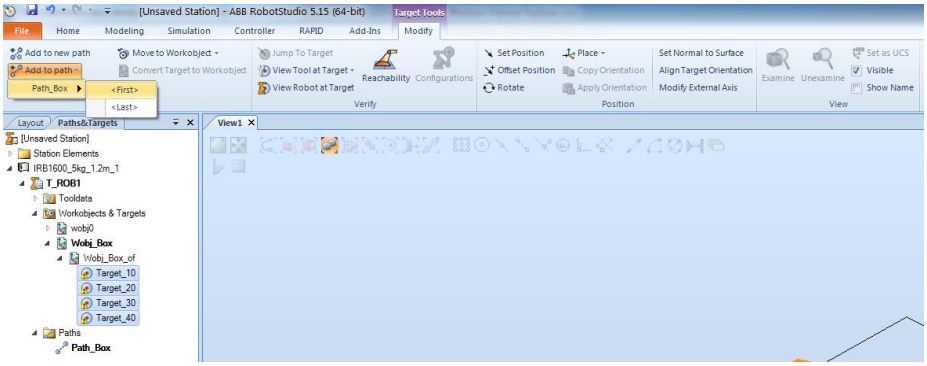
4. Change the parameters according to the picture below.



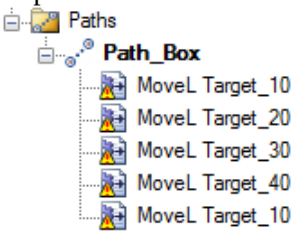
5. In the **Paths&Targets** browser multi-select the four targets.



6. On the **Modify** tab click the **Add to Path** button and select **Path_Box** and **First**.

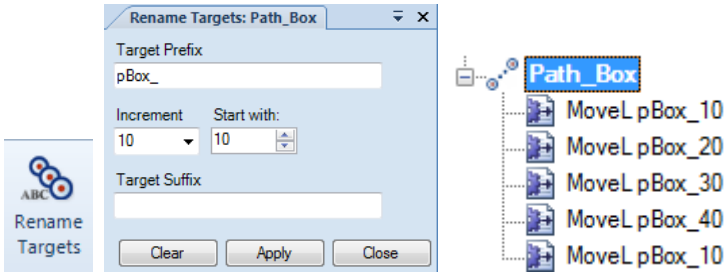


7. In the **Paths&Targets** browser select *Target_10*.
8. On the **Modify** tab click the **Add to Path** button and select **Path_Box** and **Last**. Now the loop is closed.



Tip!
You can also use drag&drop to create the instructions.

9. Select the path, and in the **Modify** tab select **Rename Targets**. Write *pBox_* as target prefix and press **Apply**. This function also available from the context menu of the path.



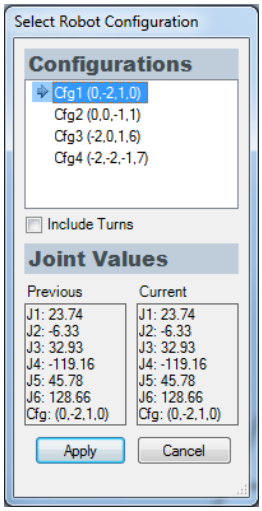
10. Save the station as *MyStation_10*.

Setting axes configuration

Before we can setup and run a simulation we need to define what axes configurations the robot should have for each target. This can be done manually by stepping through each instruction and clicking **Configurations** from the context menu. In this way you will get a list of all available configurations. In cases where we have many instructions a more efficient way is to use **Auto Configuration**. In this way we will only set the start configuration and then RobotStudio will calculate the configuration for the rest of the instructions in order to get as smooth movements of the robot axes as possible.

1. Open the station from the last exercise (*Mystation_10*), unless it is already open.
2. Select **Path_Box** and click Auto Configuration from the **Modify** tab.

3. Select the first configuration in the list and press **Apply**. The robot will now run through all instructions and get valid configurations on all remaining.



4. Save the station as *MyStation_11*.

Tip!
Auto Configuration is also available from the path context menu.

Learn more

Click the **Help** button in the top right corner of RobotStudio.

See the help section	for information about
About targets and paths	Targets, paths and move instructions.
Robot axis configurations	Axes configurations

2.3.4. Running the Simulation

Overview

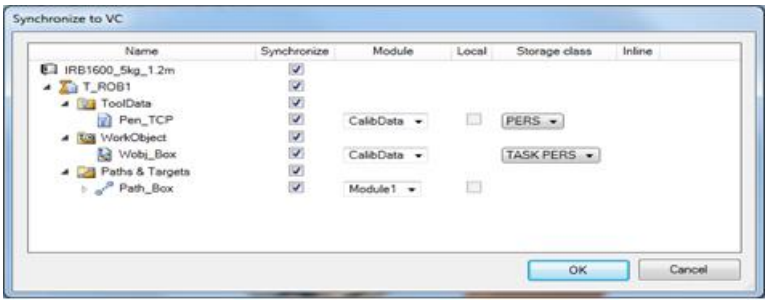
Now we have completed all steps required to proceed creating a RAPID program. The strength with the virtual controller is that we use the same software as the real robot controller. This means that we are able to run a simulation where we get very close to the

same behavior as on a real robot controller. The robot program will be stored on the system running on the virtual controller, just as the program for a real robot is stored on its system.

Synchronize to the Virtual Controller

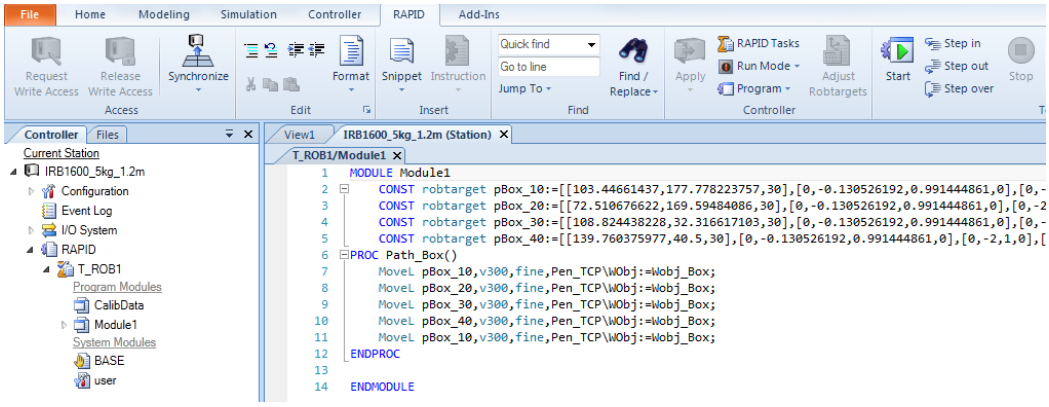
1. Open the station from the last exercise (*Mystation_11*), unless it is already open.
2. On the **Home** tab, click the **Synchronize** button.

3. In the **Synchronize to VC** dialog make sure all data are selected and then click **OK**.



All program data is now transferred from the RobotStudio station to the virtual controller.

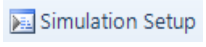
4. To get a view of the result, expand the tree structure in the Rapid tab, and double click **Module1** as shown below.



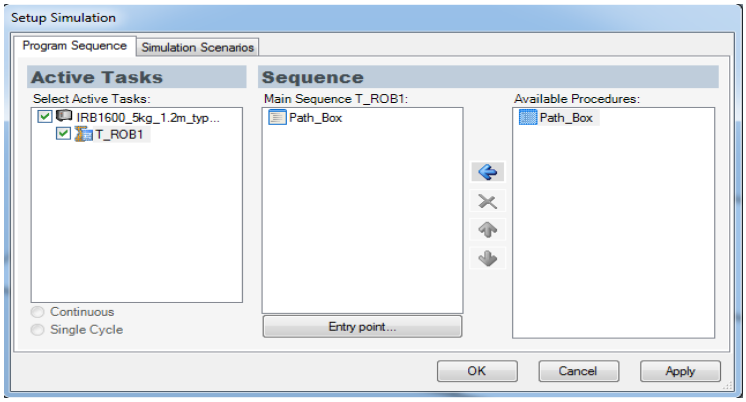
Setup the Simulation

To be able to start a simulation we need to define where the robot should start the execution. This can be done by adding a main sequence directly in the Rapid Editor or we can use the Simulation Setup dialog where we get this done automatically.

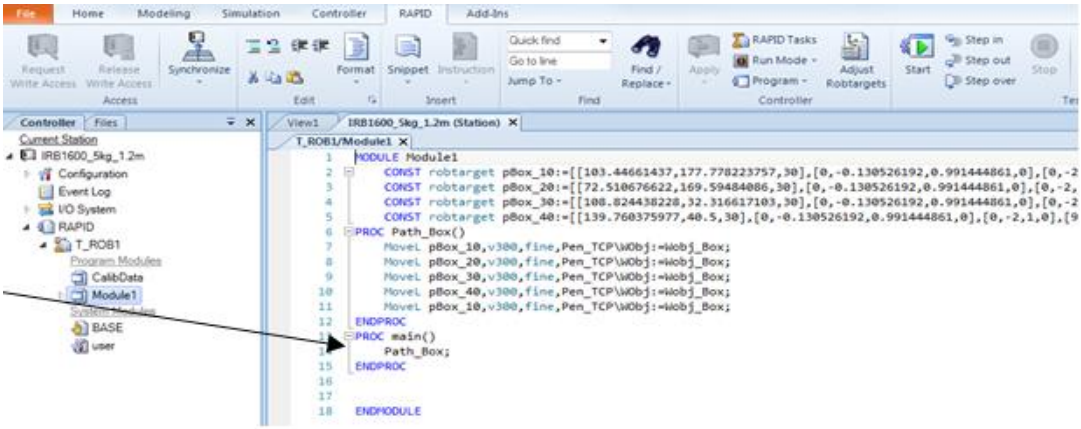
1. On the **Simulation** tab click the **Simulation Setup** button.



2. Select *Path_Box* and click the arrow pointing to the left in order to add it to main procedure.



3. Click the **OK** button.
4. Now go back to the Rapid editor to see the resulting main sequence.



5. In the Simulation tab click the **Play** button. The robot will now execute the RAPID program.

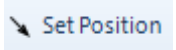
2.3.5. Adding a start and home position

Overview

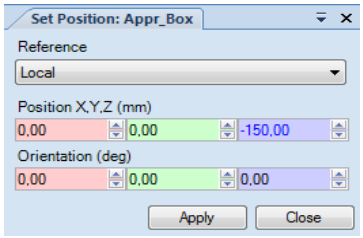
To be sure that the robot can execute this linear path we will add a new target which we will use as an approach/depart target. As the path, so far, only consists of linear instructions problems will appear in situations where the actual position of the robot makes a linear movement to the first instruction impossible.

Adding an approach/depart target

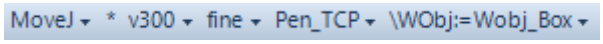
1. In the **Paths&Targets** browser select copy from the **pBox_10** context menu. Then click Paste from the **Wobj_Box** context menu.
2. Rename the target to **Appr_Box**.
3. Select **Appr_Box** and click **Set Position** from the **Modify** tab.



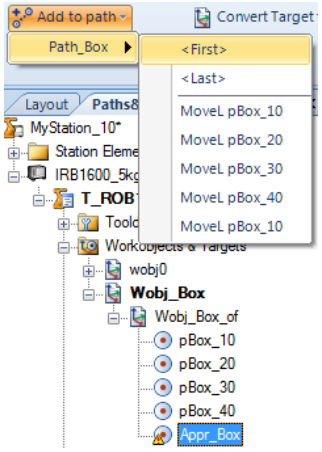
4. Set the reference to **Local** and move the target -150mm in the Z direction. Press **Apply**.



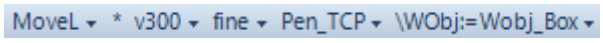
5. In the toolbar for active templates, change to **MoveJ** and set the parameters as below.



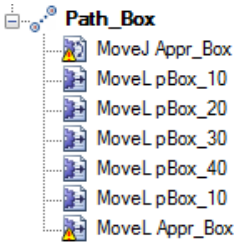
6. Select the target **Appr_Box** and then add it to the top of the path.



7. Change back to **MoveL** as active template.



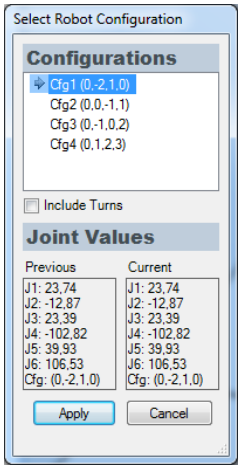
8. Repeat step 6 but now add the instruction last in the path.



Note that the yellow triangle warning appears on the new instructions. This is because no axes configuration is set yet.

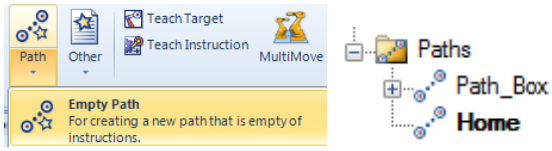
9. Select **Path_Box** and click **Auto Configuration** from the **Modify** tab.

10. Select the first configuration in the list and click **Apply**. The selected configuration will now be set to the first target and calculated for the others.

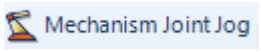


Now we will also add a Home position that we will place in a separate path.

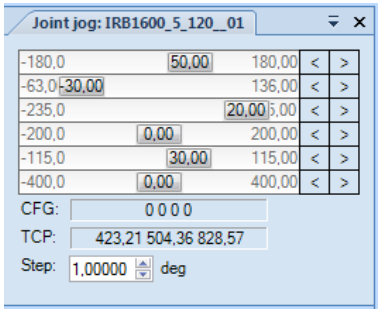
11. From **Home** tab, create a new empty path and rename it to **Home**.



12. In **Home** tab, select **Jump Home** from the context menu of the robot. The robot will now reset the axes to default values.
13. From the **Modify** tab, select **Mechanism Joint Jog.**



14. Jog the robot according to the screenshot below.

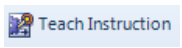


Tip!

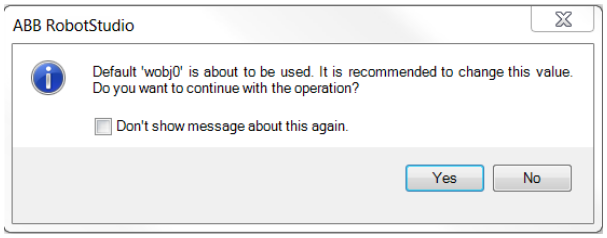
Click the separate boxes for each axis and press space on your keyboard. Now you will be able to write exact values.

15. Change active work object to **wobj0** from the **Settings** group in **Home** tab.
16. In the toolbar for active templates, change to **MoveJ** and set the parameters as below.

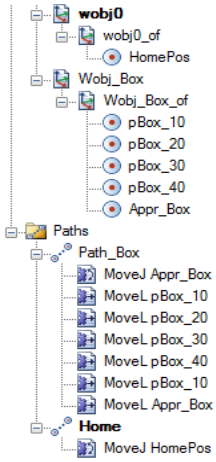
17. In **Path Programming group** of **Home** tab, click **Teach Instruction.**



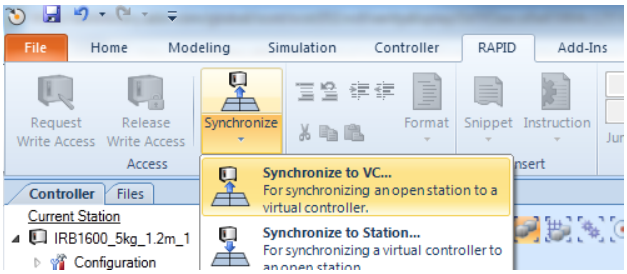
A new target will now be created in **wobj0** and a **MoveJ** instruction will be added to the new Path. Press yes on the message that follows.



18. Rename the new target to **HomePos**.



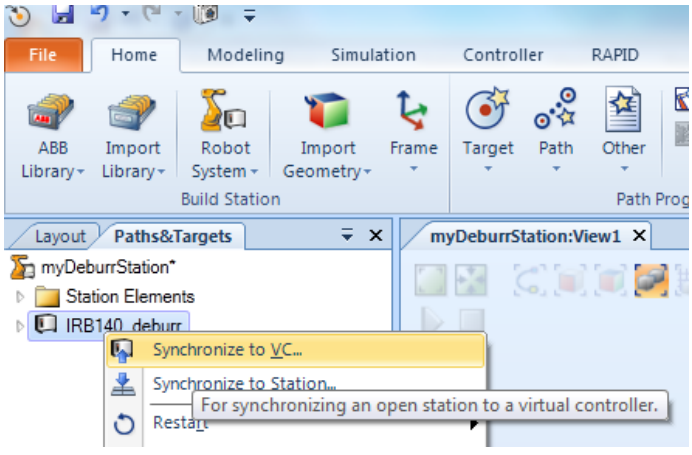
19. To transfer the new instructions to the virtual controller, click **Synchronize to VC** from the **RAPID** tab.



20. Make sure everything is selected and then click **OK**.
21. Save the station as *MyStation_12*.

Tip!

Note that synchronization can be done in several ways. The **Synchronize** button appears in both the **Home** and **Rapid** tabs. Alternatively right clicking on either the system or a particular path in the **Paths&Targets Browser** on the **Home** gives you this same option.



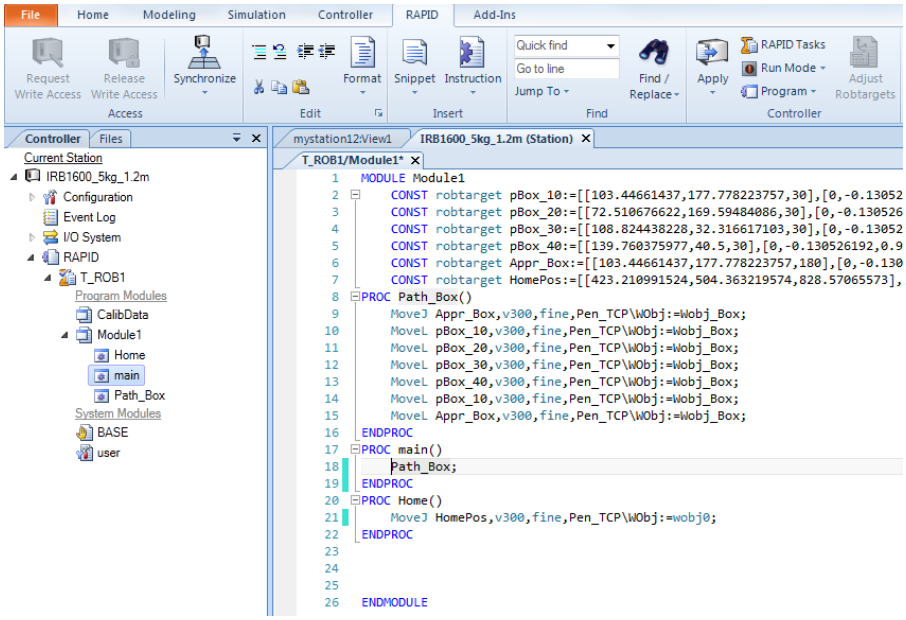
2.3.6. Using the Rapid Editor for basic adjustments

Overview

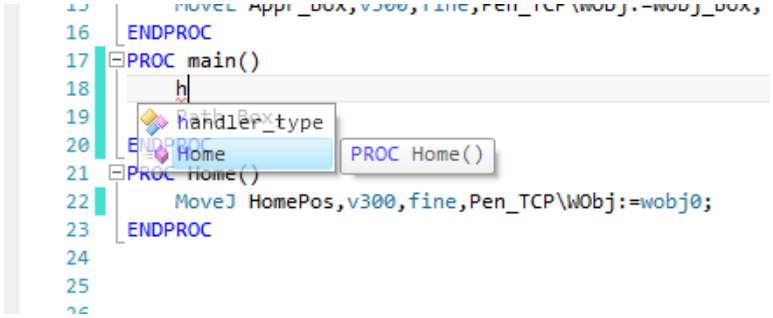
In this section we will look into how to use the Rapid Editor for basic adjustments of our program. We will also step through each instruction one by one. Later in the course we will learn how to use the more advanced features for debugging and editing.

Rapid Editor

1. Open the station from the last exercise (*Mystation_12*), unless it is already open.
2. In the **Rapid** tab, expand the tree structure and double click **Module1** as shown below.



3. Click in the main procedure and add a call to the **Home**.

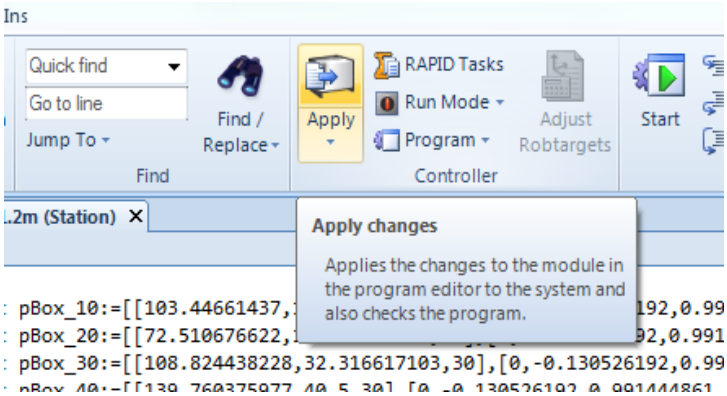


Note the IntelliSense as you start to type. The return key will add the highlighted instruction/procedure.

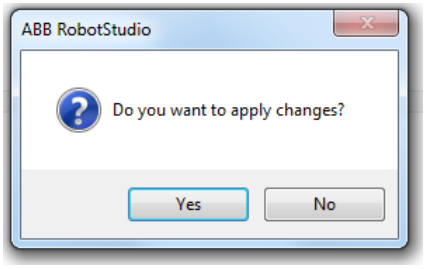
4. Change the speed to **v1000** in the **HomePos** instruction.

```
MoveJ HomePos,v1000,fine,Pen_TCP\WObj:=wobj0;
```

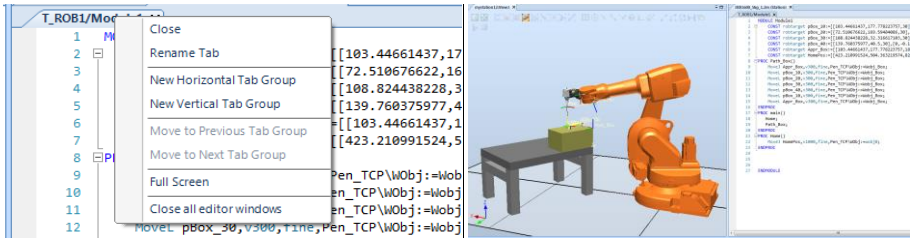
5. Click **Apply** changes.



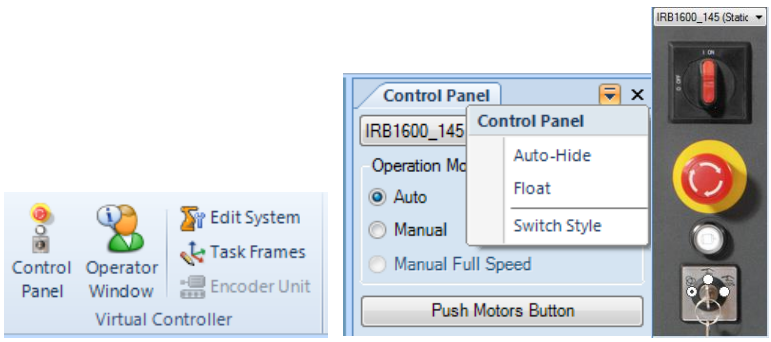
6. Confirm the change by clicking **YES**.



7. To be able to see both our graphical view and the program, click **New Vertical Tab Group** by right clicking the editor tab.

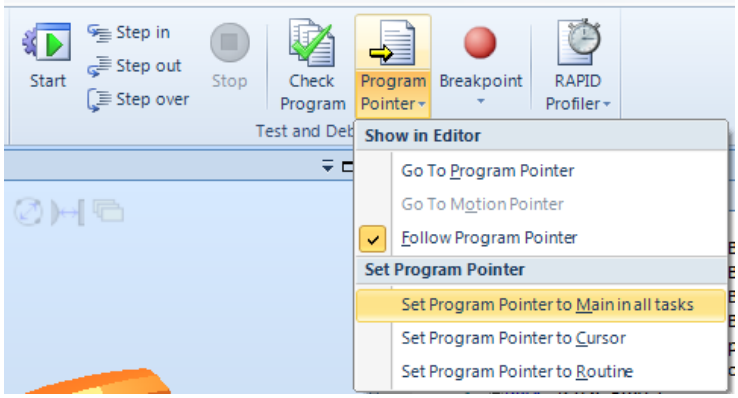


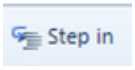
8. In the Virtual Controller group of the **Controller** tab, open **the Control Panel** and change to **AUTO** mode and push the **Motors Button**.



Tip!
Click the button up in the right corner to switch style of the **Control Panel**.

9. Back in the **Rapid** tab Set the program pointer to the **main** routine

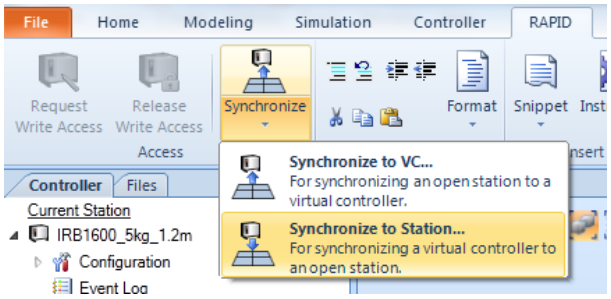


10. Use the Step in (**F11**) function 

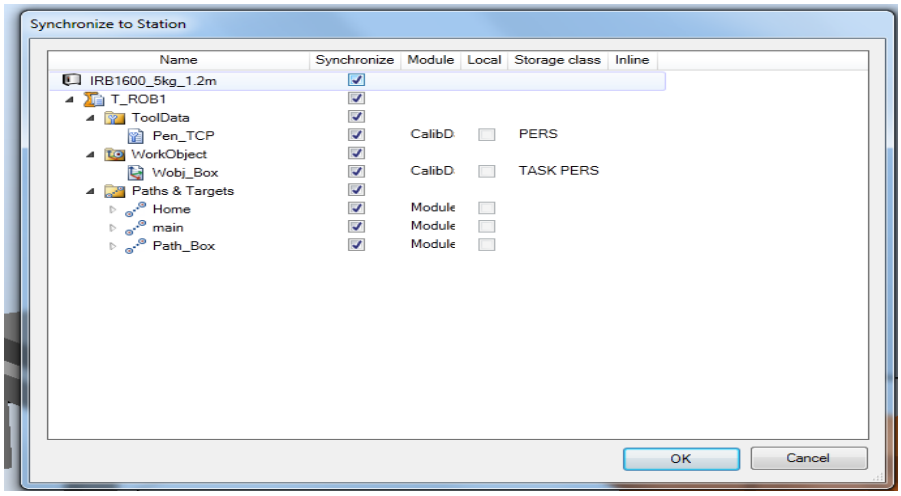
to step through the program.

    As we now have done changes to the program directly in the virtual controller, we need to synchronize the changes back to the station.

11. While still in the **Rapid** tab, click the lower half of the **Synchronize** button to reveal the **Synchronize to Station** feature. Synchronize to the station.

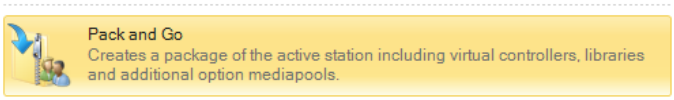


12. In the dialog, check the top node so that everything get selected and press **OK**.



13. In **Simulation** tab, click the **Play** button. Note that the robot now first go to the Home position we added to the main procedure from the **Rapid Editor**.

14. Save the station as *MyStation_13*
15. Save the station as a **Pack&Go** from the **Share** section of the **File** tab. A **Pack&Go** file will include all data required to restore the station and system so this is the recommended way of saving a project when finished or when moving to another PC.



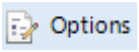
2.3.7. Simulation settings

Overview

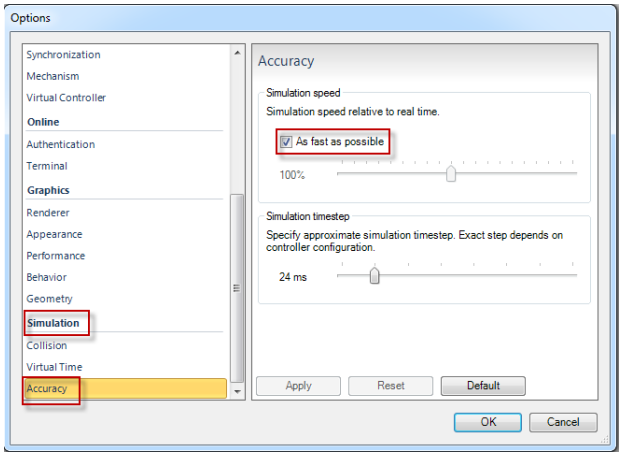
In this section we will look into the RobotStudio options for simulation settings. The Simulation speed setting allow you to set the simulations speed relative the real time. This can be useful when having longer simulations where you want to save time running through the simulations.

RobotStudio Options

1. Open the station from the last exercise (*Mystation_13*), unless it is already open.
2. From the **File** tab, click **Options.**

3. Go to the Simulation section and click **Accuracy** and check **As fast as possible.** Then click **OK**.

4. Press **Play** from the **Simulation** tab to run the simulation again. Now note that it will run through the simulation in a much shorter time but the resulting process time will be the same.
5. Go back to **Options** and uncheck **As fast as possible** again.

Learn more

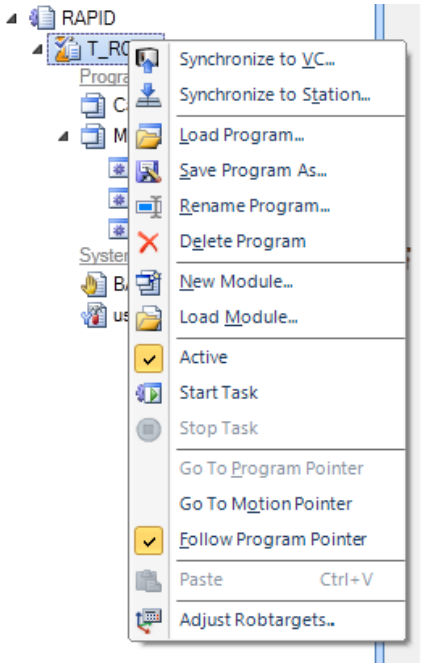
Click the **Help** button  in the top right corner of RobotStudio.

See the help section	for information about
Options	RobotStudio Options

2.3.8. Saving the robot program

Saving the robot program

1. In the **Rapid** browser, select **Save program As** from T_ROB1 context menu.



2. In the folder *\Courseware\RAPID Programs* save the program as *BoxProgram_1*.

Summary

Now we have created a robot program that can be loaded to a real robot. The saved modules can be viewed or edited using the Rapid editor or any text editor.

Basically, our program exists in three independent versions now:

- In RobotStudio, where the positions and motion properties are saved in the path.
- In the virtual controller, where it is stored in the controller's program memory just as on a real controller.
- As files on the hard drive, which we saved from the virtual controller through RobotStudio.

2.4. Local Origin

Overview

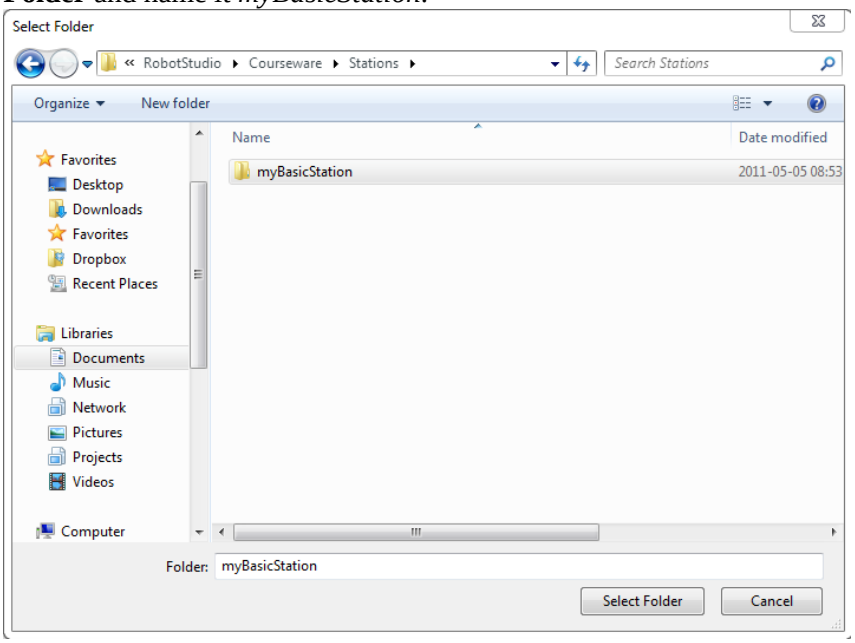
In the next three exercises we will work with the same station but with another tool and work piece loaded. The tool will be created from a CAD file using the tool wizard. We will also work with a new work piece which will require some changes to the station, concerning frames. We will start with looking into **Local origin**.

Each CAD file has its own local coordinate system called **Local origin**. In this exercise we will explain why this coordinate system has big impact on many operations in Robot Studio. We will import a CAD file for a tool that was saved in a way that we need to modify its coordinate system to be able to use it in our simulations.

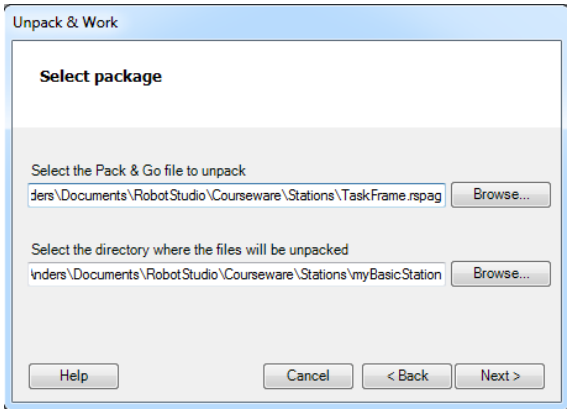
Tool wizard

1. From the **Share** section in the **File** tab select **Unpack & Work** and unpack the file **TaskFrame.rspag** from *Courseware\Stations.*
2. In the **Select the directory where the files will be unpacked** field click the **Browse** button.

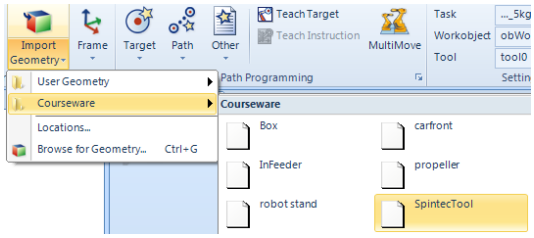
3. In the dialog browse to *\MyDocuments\RobotStudio\Courseware\Stations* click **New Folder** and name it *myBasicStation*.



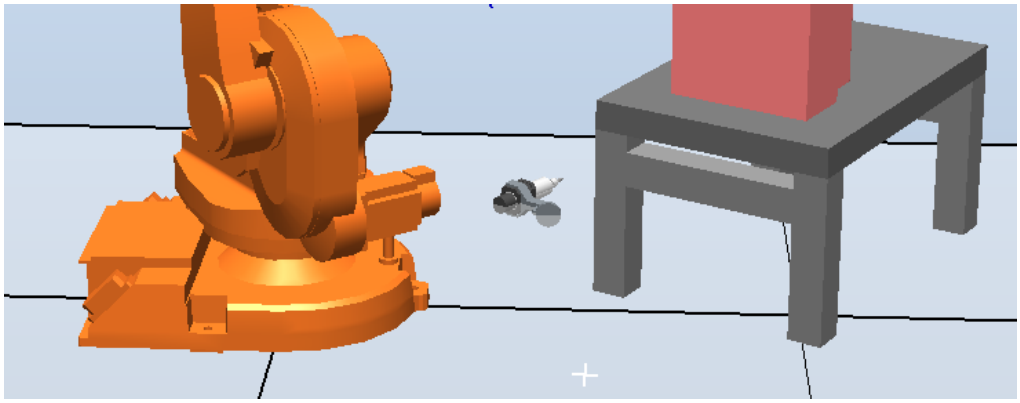
4. Click the **Select Folder** button.



5. Click the **Next** button.
6. Check the controller system dialog and click the **Next** button.
7. Click the **Finish** button.
8. When finished, click the **Close** button.
9. Import the geometry *SpintecTool.sat* from the Courseware folder.



A geometry representing the tool is now imported to the station and placed with its local origin in the zero point of the world coordinate system. As the local origin on this specific part is not placed in the attach point of the tool you will see the offset between the coordinate system and actual CAD part.



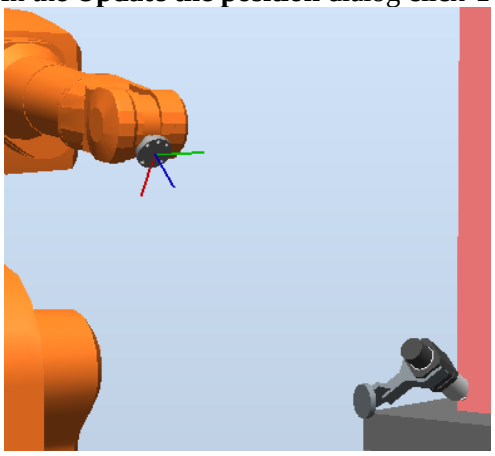
Attach to Robot

To show why this can be a problem we will attach the tool geometry to the robot.

1. In the **Layout** browser right click the *SpintecTool* and on the context menu point to **Attach to** and select the robot.

   Tip!
   Drag&drop is often easier when using the **Attach** command.

2. In the **Update the position** dialog click **Yes**.

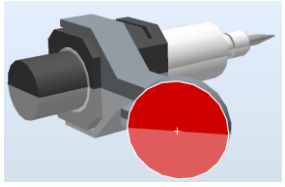


   Due to the definition of the local coordinate system of the part, you get an offset of the tool. This is what we now have to fix.

3. In the context menu of the *SpintecTool*, select **Detach**.

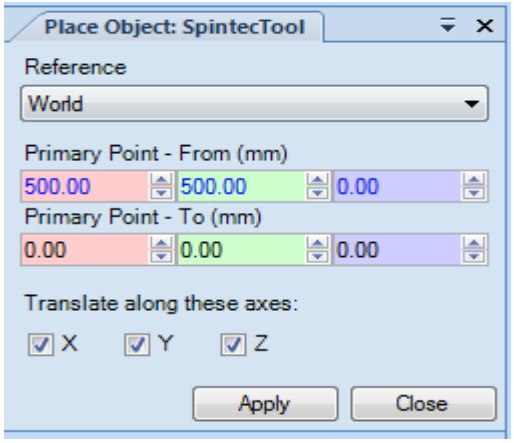
Setting the Local Origin

1. Make the robot invisible by un-checking **Visible** from the context menu.
2. In graphics, zoom so you get a good view of the tool.



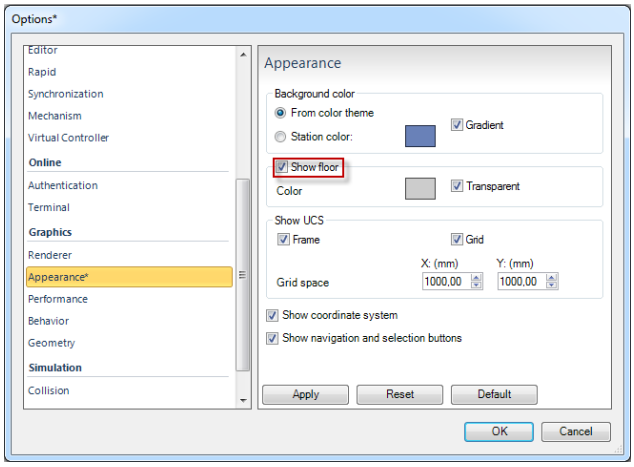
3. Select Selection level **Surface** and Snap mode **Center**.

4. In the **Layout** browser right click the *SpintecTool* and select **Place.** In this case we will place the object by one point.
5. Make sure the pointer is in one of the Position boxes and then click the surface as in picture above.

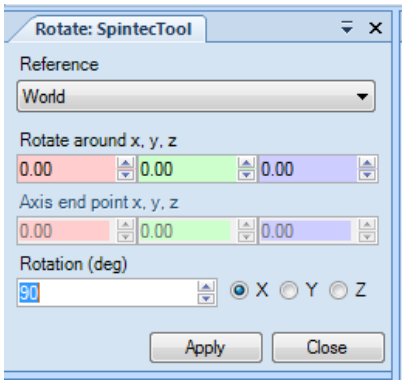


Tip!

To avoid clicking on the floor, go into RS Options and make the floor invisible.



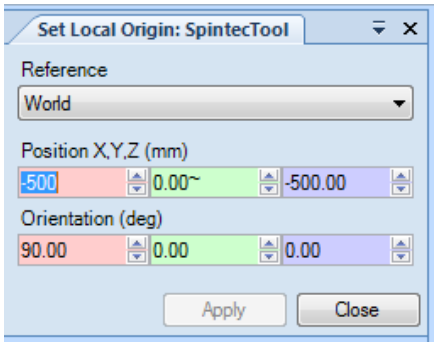
6. Click **Apply**. This will move the *SpintecTool* to RobotStudio world zero.
7. In the **Layout** browser right click the *SpintecTool* and select **Rotate.** In this case we will rotate the object about the world coordinate system by 90 degrees. Click **Apply**.



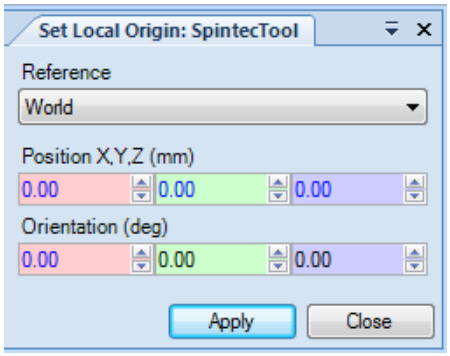
At this point if we were to attach the tool to the robot it would still not go to the correct position as the attachment point reference is still the local coordinate system of the part.

In the next steps we will adjust the local coordinate system to match the position of the model.

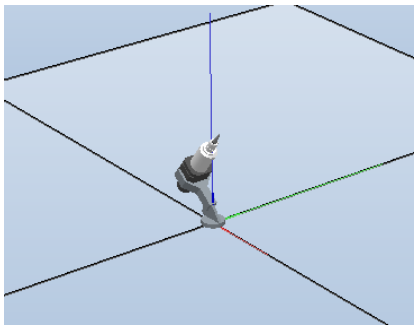
8. In the **Layout** browser right click the *SpintecTool* and select **Set Local Origin.** You will notice in the dialog box the following values.



We will now correct these values to coincide with the corrected CAD model by changing all values to zeros. Click **Apply**.



The coordinate system is now moved to coincide with the actual position in the station which also happens to be the attachment point of our tool geometry.

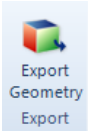


9. Attach the tool geometry to the robot to see the difference. Now it should attach correctly.
10. Detach it again.

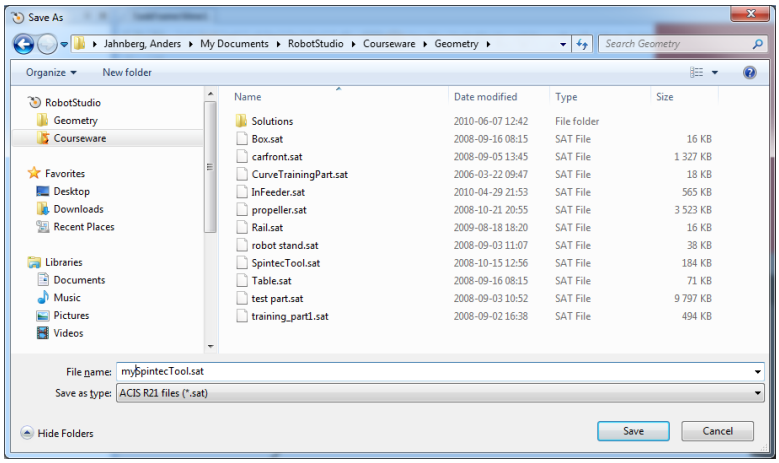
Exporting the Geometry

Now we will export the geometry with a new name for later use.

11. In the **Export** group of the **Modify** tab which is visible after selecting SpintecTool in the browser, click **Export Geometry**. (Also available from context menu.)



12. In the **Save As** dialog change the name to *mySpintecTool*.
13. Click the **Save** button.



14. Make the robot visible again.

Learn more

Click the **Help** button in the top right corner of RobotStudio.

See the help section	for information about
Introduction >Terms and Concepts >Libraries, geometries and CAD files	Definitions and overview of the geometry and library system in RobotStudio.

2.5. Creating a tool

Overview

In this exercise we will create a tool from the CAD file saved in previous exercise and save it as a library component. To do this we will import a geometry representing the tool. From this geometry we specify a **Tool Center Point** (TCP) and some other parameters. When the tool is finished we will save it as a library component and attach it to the robot.

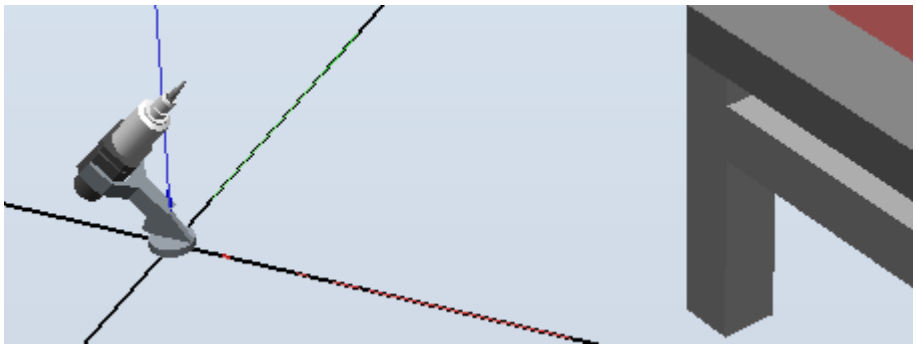
Preparing the geometry

Note! After creating a tool the geometry will no longer be editable and cannot be used for creating tools again. This means that it is a good practice to make a copy or export the geometry to file before creating the tool, if you do not already have one.

1. Unpack the **Pack&Go** file **TaskFrame.rspag** from *Courseware\Stations* unless the station is still open.
2. Import the geometry my*SpintecTool.sat* from the Courseware folder unless it is already imported.

A geometry for the tool is now imported to the station and placed at the origin of the world coordinate system. Note that this is the geometry we fixed in the local origin exercise. If necessary there is a correct copy in the Solutions folder.

3. In the **Layout** browser right click the robot and uncheck **Visible**.

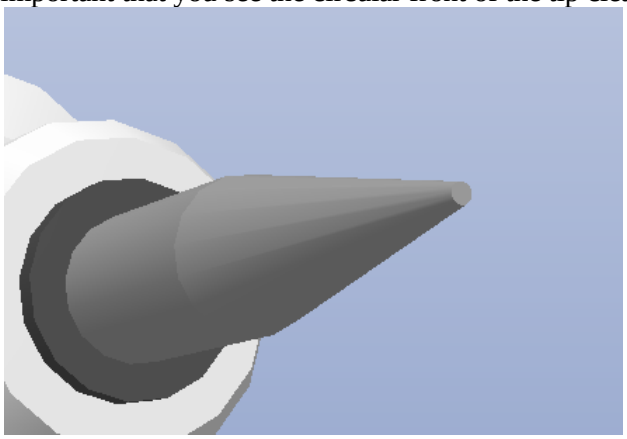


Click in the Graphics to remove the red marking and the robot will now be invisible and you can see the tool on the floor. In the Layout browser the node for the robot is marked with a magnifying glass , indicating that it is not visible in the Graphics window

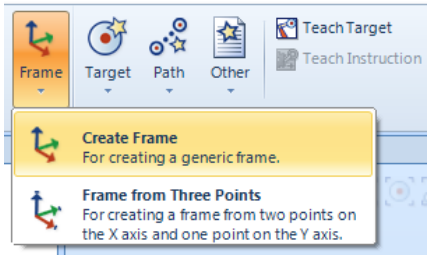
Creating a reference frame

To simplify the later TCP definition we will start by creating a reference frame.

1. Zoom and rotate the station so that you get a clear view of the tip of the tool. It is important that you see the circular front of the tip clearly.

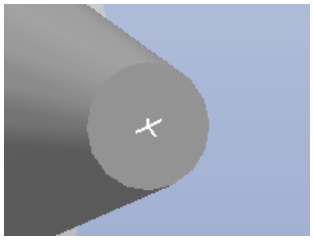


2. On the **Home** tab click the **Frame** drop-down and select **Create Frame**.



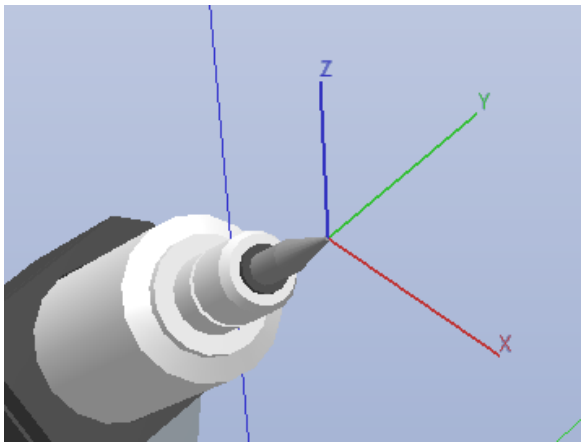
3. In the Graphics window select **Surface Selection** level and **Snap Center**.

4. In the dialog click in the **Frame Position** field and then in the Graphics window click on the tip surface.



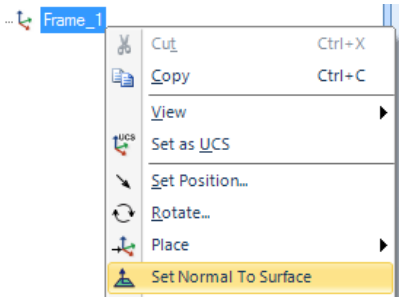
The snap goes to the center of the surface as our selection level and snap mode.

5. Click the **Create** button.

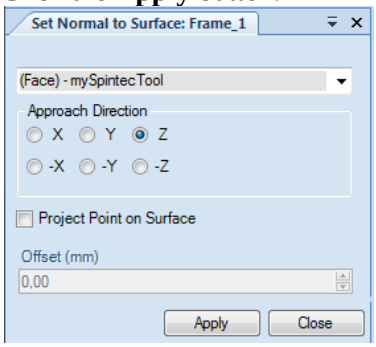


As we did not define an orientation it mimics the world coordinate system. Now we will use the graphics to get the angle of the tool.

6. In the **Layout** browser right click *Frame1* and select **Set Normal to Surface**.



7. In the **Set Normal to Surface** dialog click the top field and then in the Graphics window click the tip surface.
8. Click the **Apply** button.



Since the default definition of the approach direction is positive Z it points out of the surface.

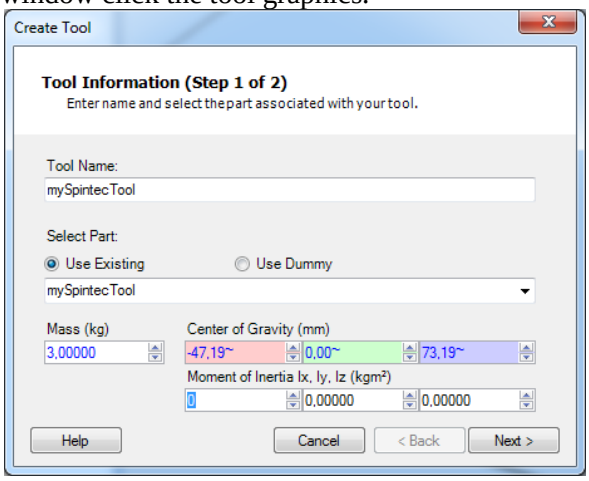
Creating the new tool

Now that we have both graphics and frame we will use these to create a tool.

1. In the Mechanism group of the **Modeling** tab click the **Create Tool** button to start the wizard.

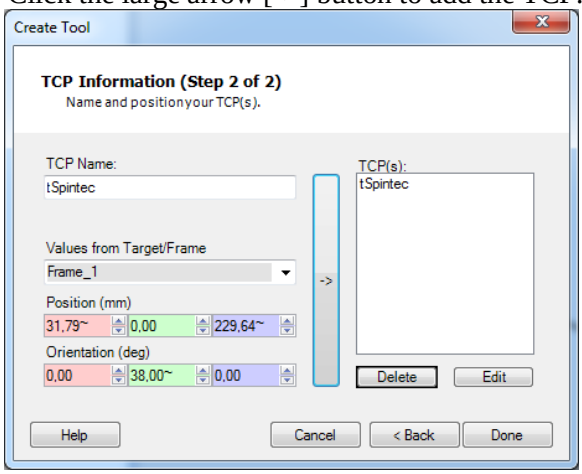
2. In the **Create Tool** wizard in the **Tool Name** field enter *mySpintecTool*.
3. To select a part click the **Use Existing** button and in the drop-down list select the *mySpintecTool* part.
4. Type in 3kg as mass.
5. In the Graphics window select **Part Selection** level and **Snap Gravity**.

6. In the **Create Tool** dialog click in the **Center of Gravity** field and then in the Graphics window click the tool graphics.

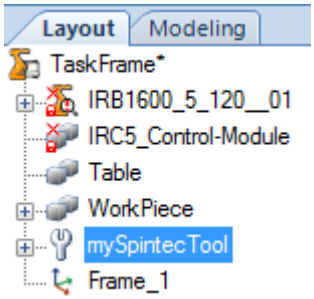


Note that snap gravity assumes that the object is of the same density when calculating the center of gravity. You can also type in moment of Inertia but there is no RobotStudio functionality for this so you have to get the data externally.

7. Click the **Next** button.
8. In the **TCP Name** field enter *tSpintec*.
   This is the name of the tooldata that will be used in RAPID
9. In the **Values from Target/Frame** click the field and then on *Frame_1*.
10. Click the large arrow [->] button to add the TCP.



11. Click the **Done** button.



In the Layout window we can see that the geometry part has been replaced by the tool mechanism. But that the frame remains.

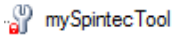
12. In the **Layout** browser right click the *Frame_1* frame and select **Delete**.

Saving the tool as a library component

Saving the tool as a library component makes it available for use in other stations as well. It also means that if you update the library then all stations using the library will be updated the next time you open them.

1. In the **Layout** browser right click the tool *mySpintecTool* and select **Save as Library** from the **Modify tab**.

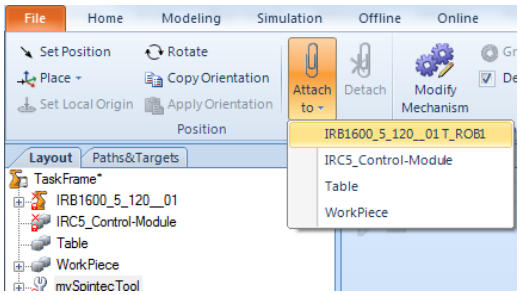
2. In the **Save As** dialog enter *\Courseware\Libraries\mySpintecTool*.



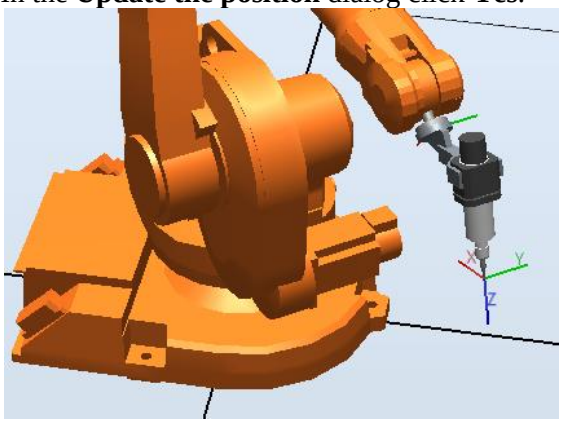
Note the small floppy disk that shows that the tool now is a library file.

Attaching the tool to a robot

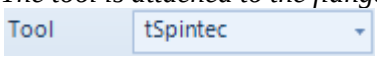
1. Right click in the Graphics window and select **View All**.
   The station now zooms out so that all objects are visible.
2. In the **Layout** browser right click the robot and make it visible again.
3. Attach the tool to the robot.



4. In the **Update the position** dialog click **Yes**.



The tool is attached to the flange of the robot.



5. **Save** the station as *\Courseware\Stations\MyStation_NewTool.rsstn*.

2.6. Task Frame

Overview

Now we have created a new tool that we will use when executing the path on the new work piece. Working in RobotStudio requires understanding about several different coordinate systems. In this chapter we will learn how to work with the Task Frame. As these concepts will follow through the whole training materiel, it is very important to understand the differences between these, as mentioned below.

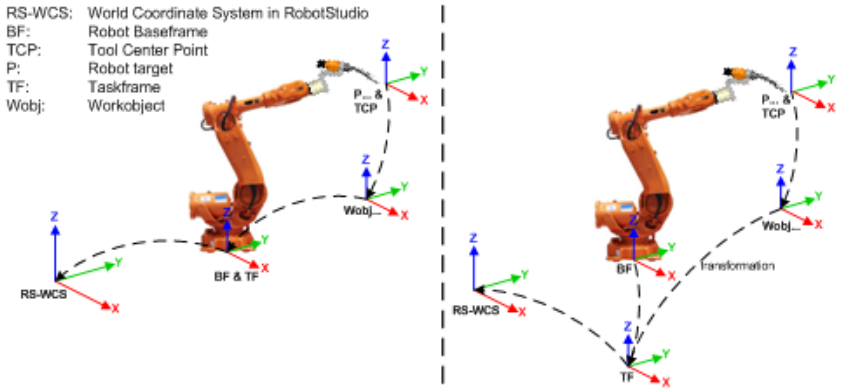
Definition!

RobotStudio World Coordinate System (RS-WCS): The world coordinate system represents the entire station or robot cell in RobotStudio. This is the top of the hierarchy to which all other coordinate systems are related.

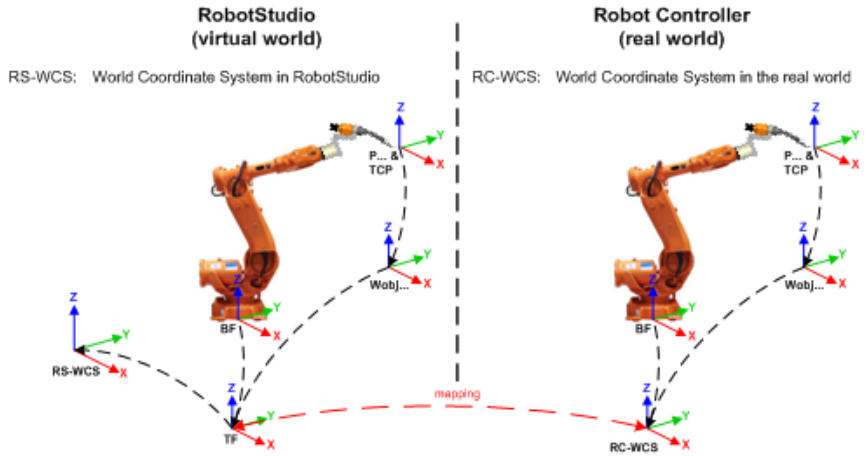
Baseframe (BF): Each robot in the station – both in RobotStudio and real word - has a base coordinate system which is always located at the base of the robot.

Taskframe (TF): Taskframe represents the origin of the robot controller coordinate system (RC-WCS) in RobotStudio. On multimove systems, taskframes help to originate different tasks on each of which different robots can operate independently.

The below picture shows the difference between baseframe and taskframe. In the left picture, the taskframe is located at the same position as the robot baseframe. In the right picture, the taskframe has been moved to another position.

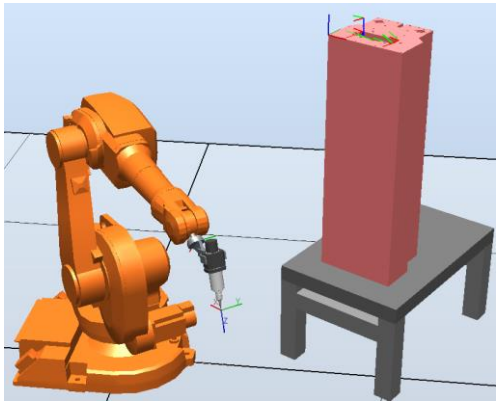


Here you can see how a task frame in RobotStudio environment is mapped to the robot controller coordinate system in the real world, e.g. in a shopfloor.



Moving the TaskFrame

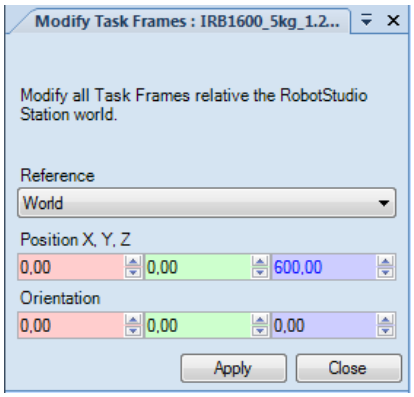
1. Open the station from the last exercise (*MyStation_NewTool.rsstn*), unless it is already open.



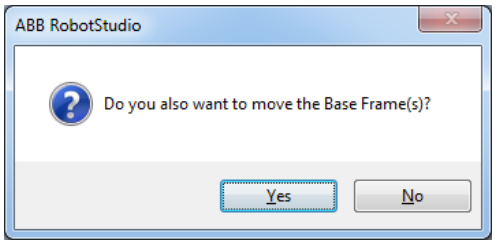
*As we can easily see in this station, we will not be able to execute the path on top of the work piece without moving the robot. This can be done on two ways; either by moving the **BaseFrame** of the robot or moving the **TaskFrame** of our controller. To avoid **BaseFrame** values in the controller we will change the **TaskFrame** which is the recommended way. The recommendation is to only modify the **BaseFrame** values when required, such as in **MultiMove** Systems or working with external axes. Later in the course we will see situation where this is required.*

2. Import the geometry **Stand.sat** from the *\Courseware\Geometry* folder.
3. In the **Controller** tab select the system and click on the **Task Frames** button.

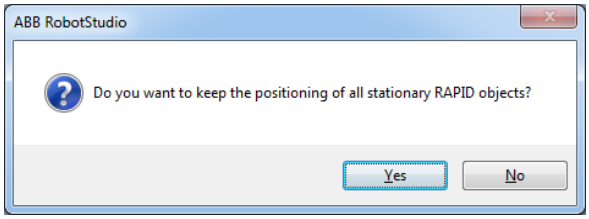
4. In the **Position XYZ** fields enter **0, 0, 600** with world as reference.



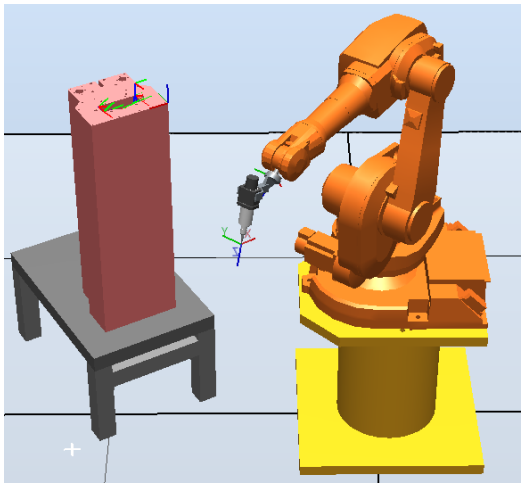
5. Click on the **Apply** button.
6. As you do not want to have an offset to the **BaseFrame**, answer **Yes** on the question *"Do you also want to move the base frame(s)?"*



7. As a workobject including targets is pre-created in this station which we do not want to move the same distance, answer **Yes** on the question *"Do you want to keep the positioning of all stationary RAPID objects?"*



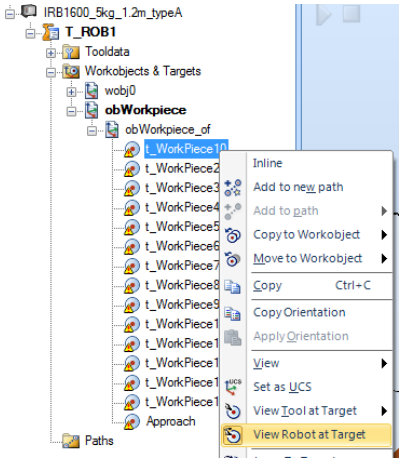
The robot is now moved up on the robot stand, with all target locations kept.



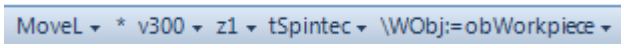
Making thefinal adjustments

Now we will make sure the robot can reach the targets and run auto configuration to set suitable axes configurations

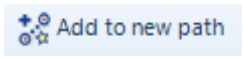
1. Activate **View Robot at target** and step through all the targets in the workobject, *obWorkPiece*.



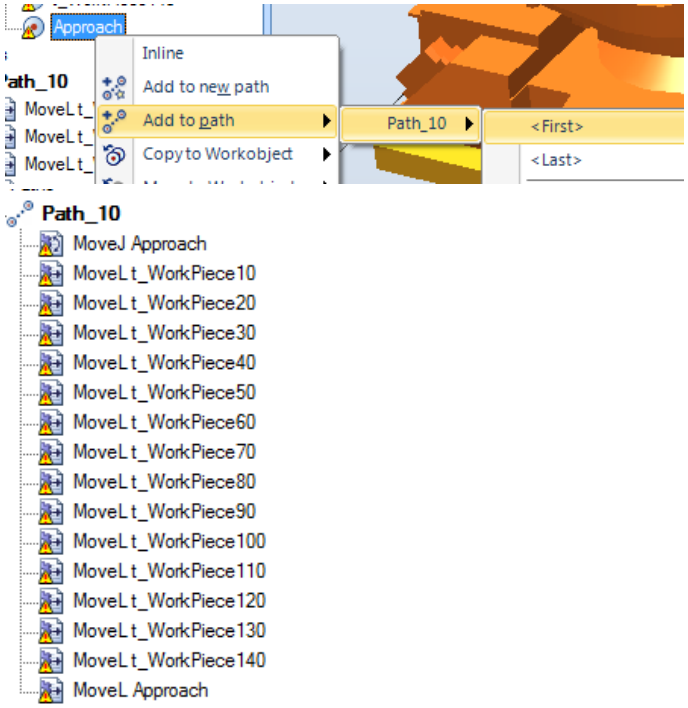
2. As all targets seems to be possible to reach, de-activate **View Robot at target** again.
3. Set **MoveL** as active template from the toolbar with parameters as below.



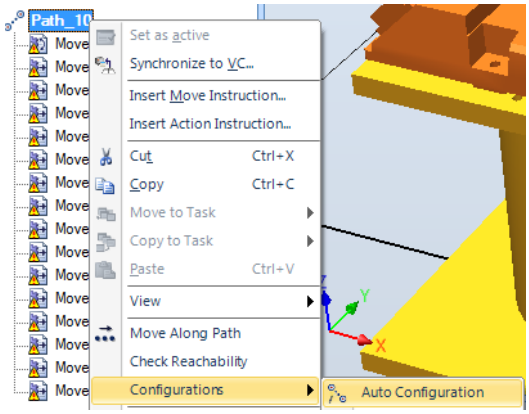
4. Multi-select all targets and add them to a new path by clicking Add to new path from the **Modify** tab.



5. Add the Approach target also as first instruction. This time, set **MoveJ** as active template.



6. Run Auto Configuration to set the axes configurations. Either from the context menu of the path or the **Modify** tab.



7. As configuration for the first target, select (0,0,-1,0). Press **Apply**. Now the configurations for the rest of the targets are calculated.
8. Now use your knowledge from earlier parts of this course, to setup and run a simulation. You need to first synchronize the path to the VC and then setup the simulation.
9. Save the station as *MyStation_NewPath.rsstn*.

Learn more

Click the **Help** button in the top right corner of RobotStudio.

See the help section	for information about
Coordinate Systems	The different coordinate system used

ABB AB
Robotics Products
SE-721 68 Västerås
Sweden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