Interactive Simulation Modules for Pneumatic and Hydraulic Circuits

Designed and built using Onshape and Simumatik3D for the virtual Parker Hydraulic Trainer (v|PHT). Work funded by the NFPA Curriculum Grant Program.

SAFETY: It is important to follow and obey all rules and regulation when using industrial equipment. As this is a virtual environment, your exposure and risk is minimized but when dealing with real systems, you must wear proper eye protection and wait until your instructor has performed an initial check on the power supply, circuitry and stand before operating the trainer.

Simumatik3D - Introduction and use of the software

Description: Simumatik3D was selected as the software to simulate all the hydraulic components used in the creation of our 5 basic demonstration hydraulic circuits. The software can be downloaded from https://www.simumatik.com and the latest version 1.0.0 of the software was released on 02/05/2018 as shown in Figure 1. The software is free.

About Simumatik3D , version: 1.0.0, 2018/02/05

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This is Simumatik3D

https://www.simumatik.com

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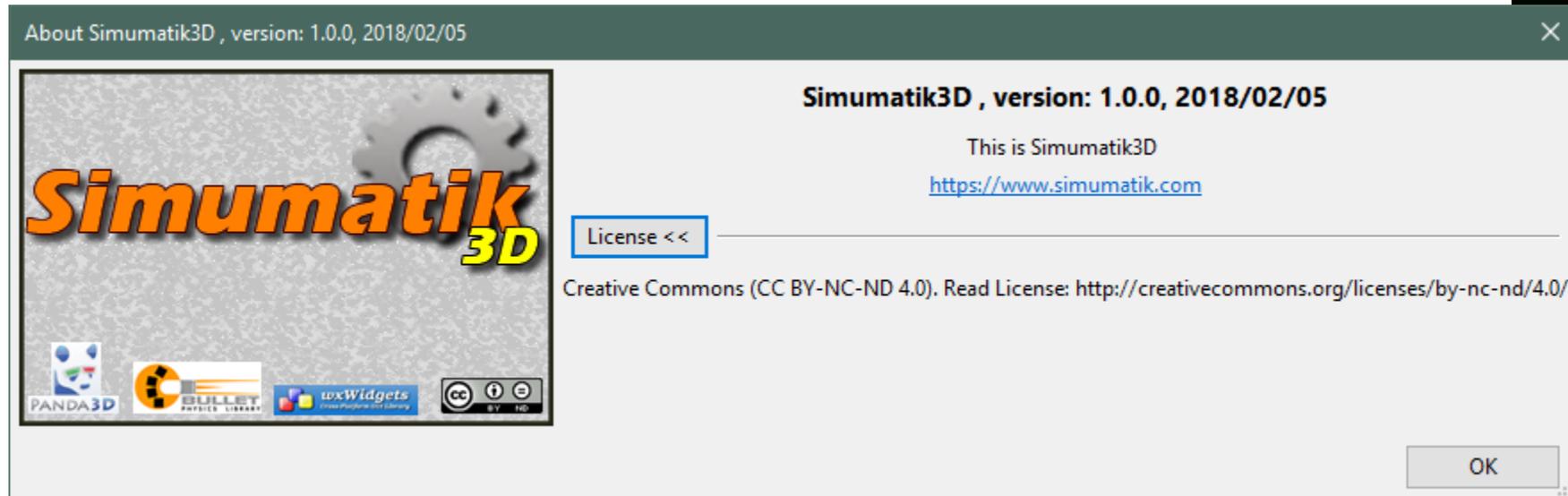
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Figure 1: About Simumatik3D.

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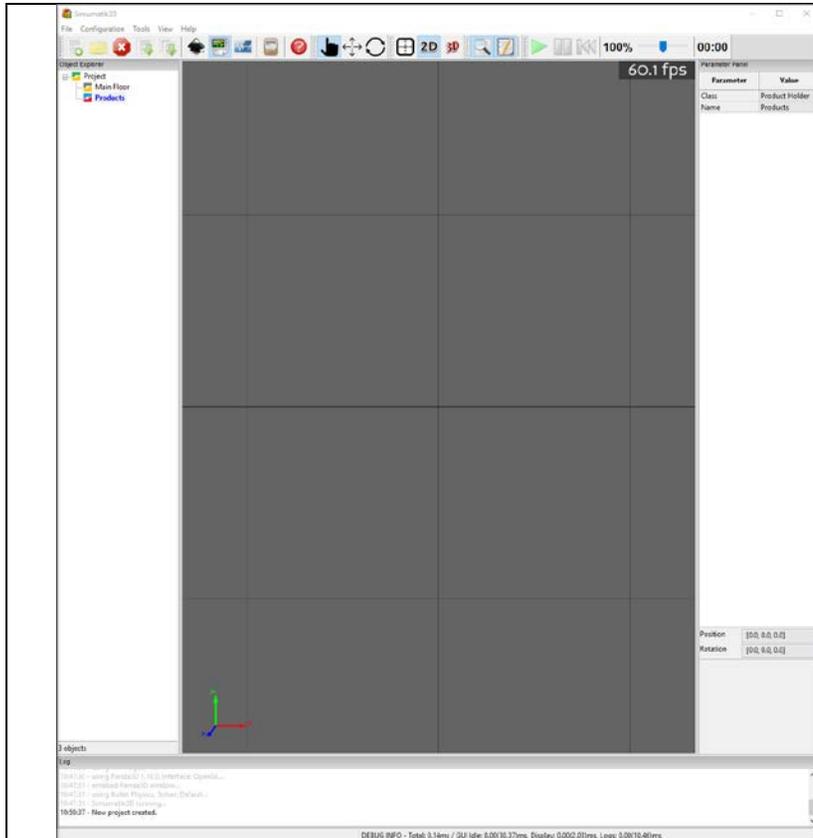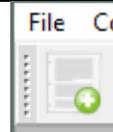
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Figure 2: Main Screen (Menu, Icon Bar and Log window).

To start a new simulation, create a new project from the file menu or use the first icon in the Icon Bar.

This will create an Object Explorer, a Main Grid Window and a Parameter Panel as shown in Figure 2.

Expanding the Project Icon on the Object Explorer by clicking on the plus sign will reveal the Main Floor and Products as the default objects for the project.

Before you can add other objects to your project, select the Main Floor and in the Object Library, select ALL or Base in the pull down to reveal the Group object. Click on the Plus sign next to it.

Notice that you can toggle between 2D and 3D by clicking on their respective icons.

In the Object Explorer, make sure to select the newly created group and in the Object Library pull down select Parker to reveal the Parker Hydraulic Trainer. Click on the Plus sign next to it.

The Parker Hydraulic Trainer should be displayed on the screen but you can only see part of it as the other half is under the Main Floor object. On lower right corner or the lower part of the Parameter Panel you should see Position and Rotation. These are useful to adjust components on the screen.

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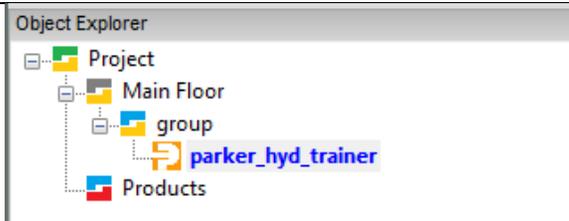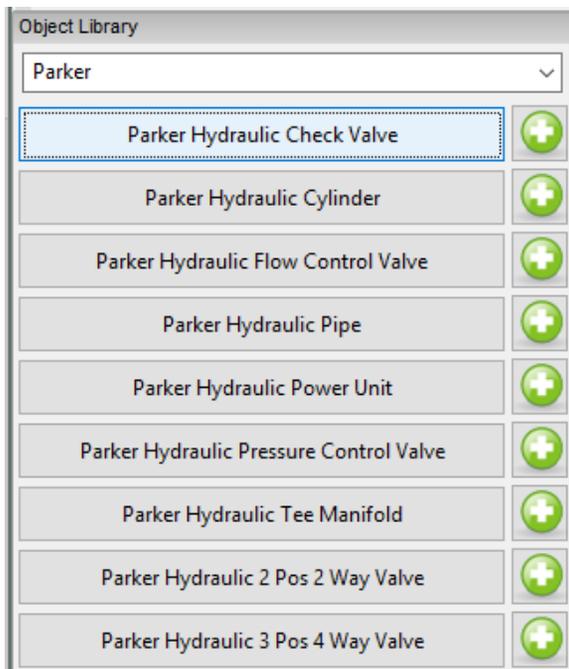
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Figure 3: Object Explorer.

Figure 4: Object Library.

In Figure 3, you can see an expanded view of the Object Explorer shown the newly created group and the parker_hyd_trainer objects.

In Figure 4, you can see the Object Library for the Parker objects that can be used with the Parker Hydraulic Trainer. Each of these objects can be added and mounted on the main panel of the trainer.

To reposition the Parker Hydraulic Trainer on the Main Floor object, make sure you have selected the parker_hyd_trainer object from the Object Explorer and then select the move or rotate icons.

Notice the move arrows (Figure 5) that appear on the screen attached to the parker_hyd_trainer. Click and drag the blue arrow to move the object until the z direction position is around 1.25 meters in the Parameter Panel. Go ahead and enter the 1.25 value as the third parameter on the Position window.
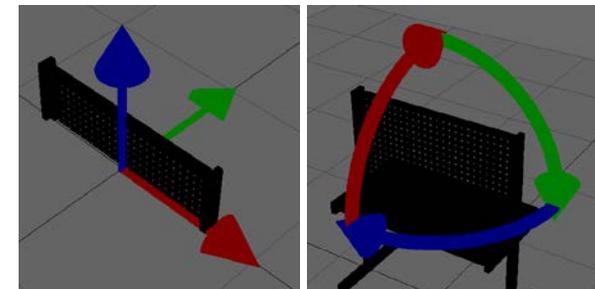

Figure 5: Move and rotate arrows.

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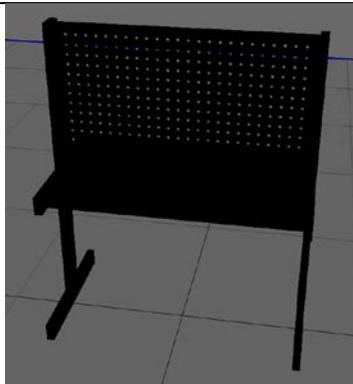
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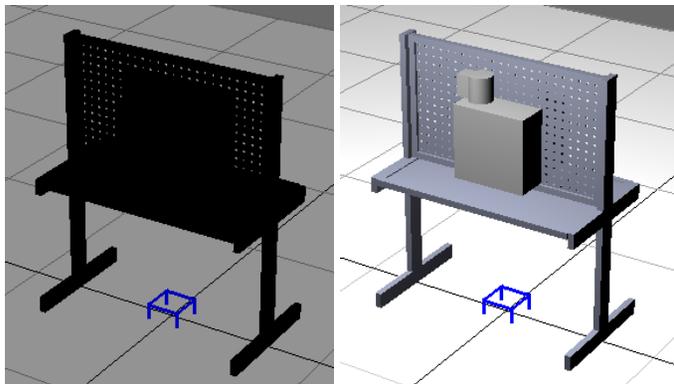

Figure 6: Parker Hydraulic Trainer.

Figure 7: Parker Hydraulic Power Unit without a Point light and with one at a position of (0.0, 1.5, 3.0).

Figure 6 shows the Parker Hydraulic Trainer after it has been repositioned on the screen.

Using the mouse buttons, you can Zoom in and out by scrolling the middle mouse wheel, Pan up/down or left/right using the left mouse button and the right mouse button will bring up a shortcut menu (Figure 8). To Rotate the world, while pressing the control key use the left mouse button.
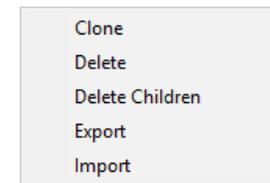

Figure 8: Shortcut menu.

We should add other required objects before we can run a simulation. For example, after selecting the parker_hyd_trainer on the Object Explorer and having the Object Library open to the Parker group of objects, we can select the Parker Hydraulic Power Unit by clicking on the plus sign. The object is then added to the main screen but it may be difficult to see because of the lighting conditions. To fix this, on the Object Explorer select the group object and on the Object Library select Light and add a Point Light object. Select the Move object icon and move the Point light to a desired location where you can see the object clearly. For example, I used position of (0.00, 1.5, 3.0). See Figure 7 for a side by side view of the Power Unit with and without a Point light.

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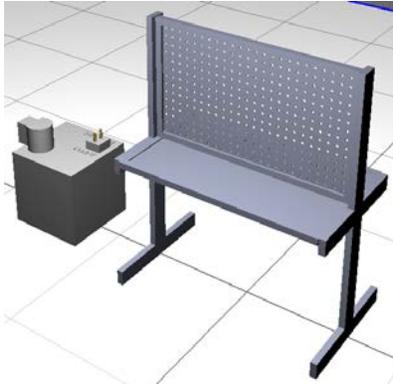
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Figure 9: Newly repositioned Parker Hydraulic Power Unit to position (1.0, 0.5, -0.5).
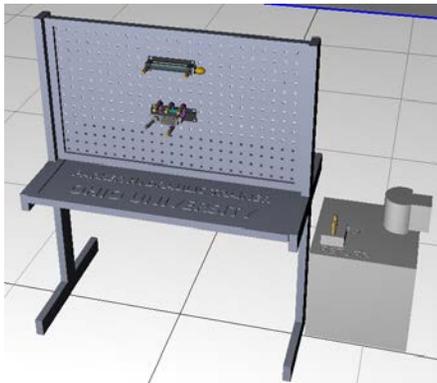

Figure 10: Rearranged view of all components for the basic circuit.

We don't want the Power Unit to be on top of the Trainer. Move it so that it is below the Trainer or to one side of it using the Move object icon or by entering its location on the Parameter Panel. Remember that you have to select the desired object first.

For example, in Figure 9, the location of the Hydraulic Power Unit is at position (1.0, 0.5, -0.5). We chose this position so that the Supply and the Return ports for the Power Unit were closed to the main board of the trainer peg board.

Adding other components to create a circuit. In this example, we are going to create a basic linear circuit based on a 3 Pos 4 Way Valve and Cylinder. Select the parker_hyd_trainer on the Object Explorer and on the Object Library click on the Parker Hydraulic Cylinder followed by the Parker Hydraulic Piston plus signs and then reselect the parker_hyd-trainer on the Object Explorer before selecting the Parker Hydraulic 3 Pos 4 Way Valve plus sign from the Object Library.

Notice that you will have to reposition the objects to make them visible as well as to position them within the Parker Hydraulic Trainer's peg board which used a snapping feature when using the Move object icon. At this point, we hope that you understand how to position the objects and we give you the final position of those objects. Important to notice that we had to manipulate multiple objects in order to achieve our desired view of the circuit including modifying the position of the Point light as shown in Figure 10. On the next page we provide the position of all objects.

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Figure 11: Parker Hydraulic Trainer with Objects for basic circuit.

Objects and their respective positions:

parker_hyd_trainer
Position (0.0, 0.0, 1.25)

parker_hyd_cylinder
Position (0.0, 0.0, 0.25)

parker_hyd_piston
Position (0.0, 0.0, 0.0)

parker_hyd_powerunit
Position (1.0, -0.25, -0.5)

parker_hyd_valve3pos4way
Position (0.0, 0.0, 0.0)

pointlight
Position (0.0, -4.0, 3.0)

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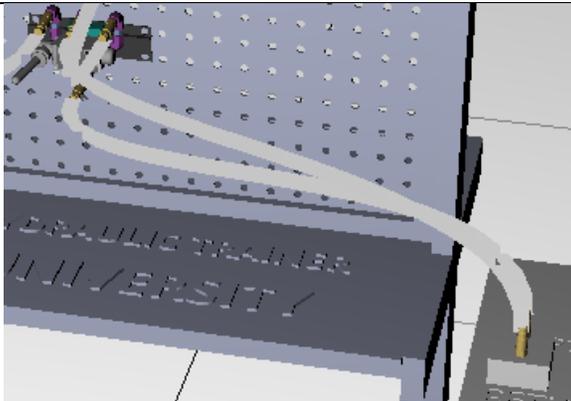
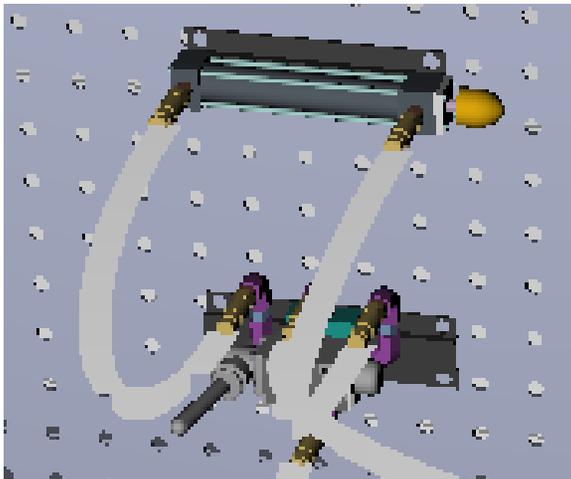## Simumatik3D

Figure 12: Hose_Supply and Hose_Return.

Figure 13: Hose_A and Hose_B.

Select the parker_hyd_trainer object on the Object Explorer and on the Object Library select a Parker Hydraulic Pipe to start making connection between components for the flow simulation and position control of the piston within the cylinder. You can rename the Parker Hydraulic Pipe to "Hose_Supply".

Take a look at the Parameter Panel on the right of the screen and double click on Port A to reveal the Output Selection and select show all or not connected only to look at the available ports. Connect Port A to parker_hyd_powerunit.Port P and then connect Port B to parker_hyd_valve3pos4way.Port P. (Figure 12)

Add another Parker Hydraulic Pipe and rename it "Hose_Return" and connect Port A to parker_hyd_powerunit.Port T and then connect Port B to parker_hyd_valve3pos4way.Port T.

Add two more hoses that connect Ports A and B from the valve to the cylinder and named them "Hose_A" and "Hose_B".

Now that all hoses have been connected and all Objects are in their respective locations, we can start the simulation.

Click on the Play icon to start the simulation. Notice that immediately some of the hoses chance to a blue color. Those are the "Hose_Supply" and the "Hose_Return" indicating that hydraulic fluid is flowing from the pump through the valve and returning to the pump. The valve we selected has a tandem center configuration and it is behaving like the basic linear circuit hydraulic diagram shown in Figure 13.

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Figure 14: Basic Linear Circuit – Tandem Center.

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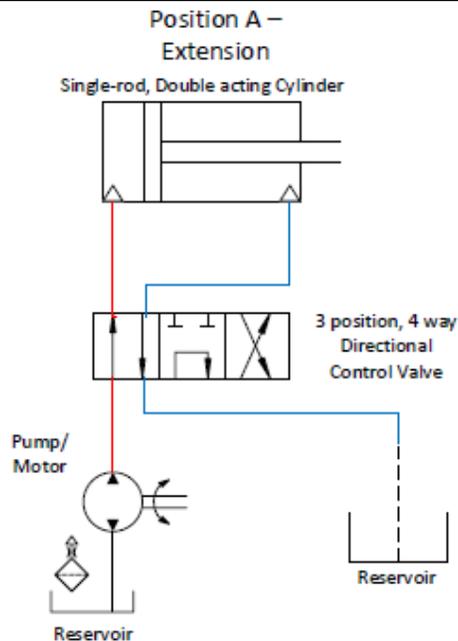
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Figure 15: Basic Linear Circuit – Position A - Extension.

Furthermore, we can now change the position of the valve to the left position in order to extend the piston. Select the valve from the Object Explorer or from the main window and right click to reveal the shortcut menu and select Change Position > Left Position.

While the piston is moving, we observed the color of the hoses change to blue for both Hose_A and Hose_B and at the end of the piston stroke, Hose_A changes to red and Hose_B to white. This is represented as Position A – Extension on the Basic Linear Circuit shown in Figure 15.

Go ahead and explore changing the valve position to Home Position and then to Right Position. Did the piston moved back to its original position? Did the colors changed?

Figure 16 and Figure 17 shows the Extension and Retraction when the valve is moved to the Right and Left Positions respectively.

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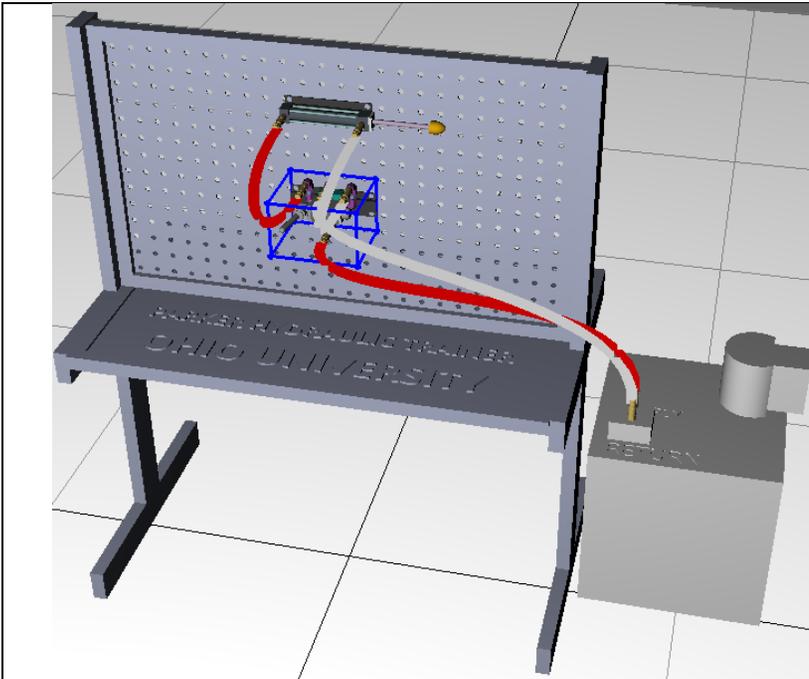
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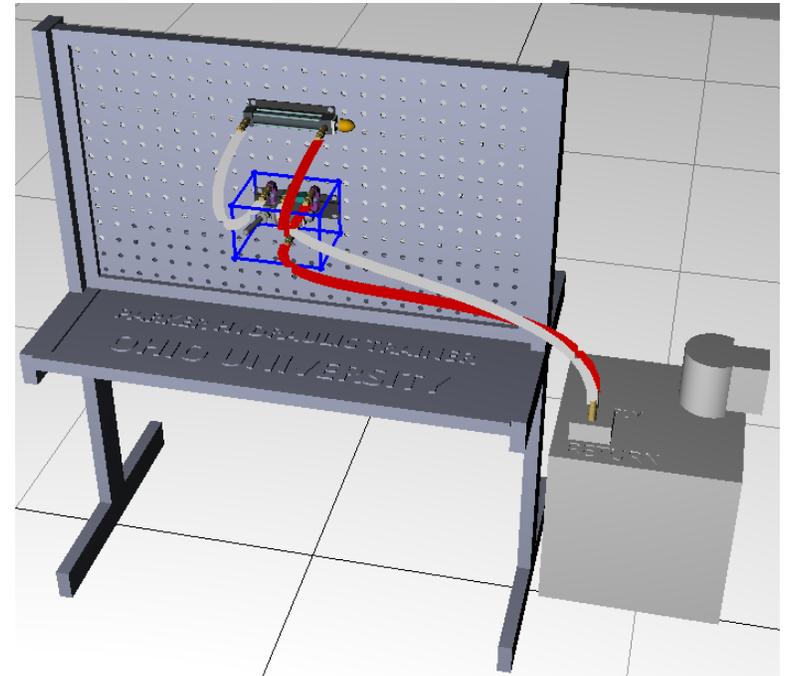

Figure 16: Simumatik3D – Position A - Extension.

Figure 17: Simumatik3D – Position B - Retraction.

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