Learn to simulate human tasks, conduct ergonomic analyses, optimize workstation layouts and validate manual assembly sequences

Process Simulate Human

Tutorial

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Process Simulate Human

Process Simulate is a powerful planning tool. It can be used to build, animate, analyze and refine assembly facilities and operations.

This tutorial focuses on the human functionality within Process Simulate. We will touch on anthropometric scaling, simulation creation, and ergonomic analysis. There is a breadth of other human features which are not covered in this tutorial. To learn more, you are encouraged to explore the *Human* toolbar, and consult the help documentation for additional details.

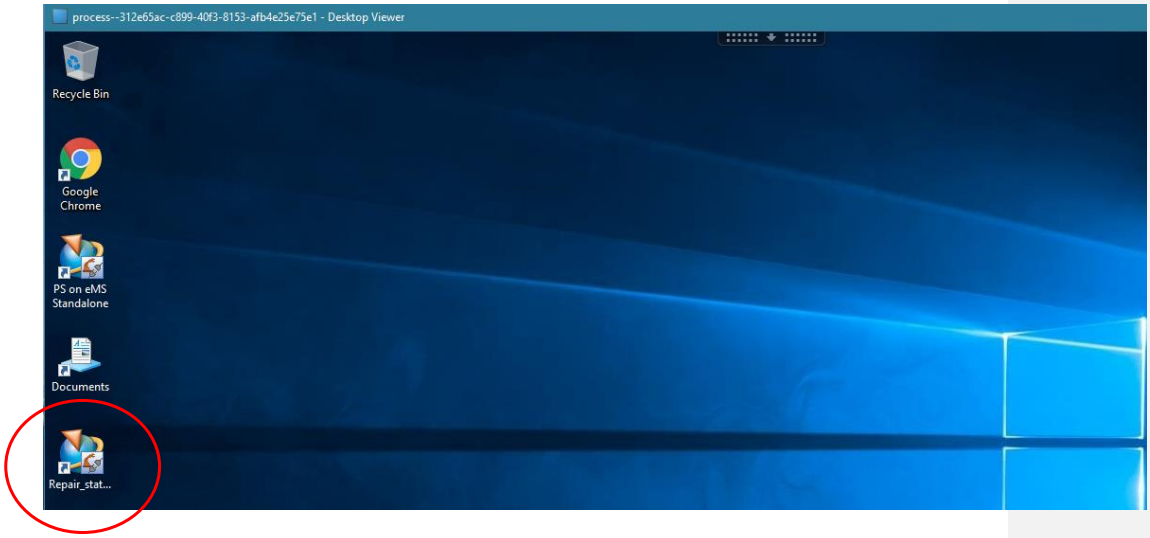
There is more…

Human users don't just use the tools on the Human toolbar. They also rely on capabilities found in the other toolbars. For example, *Modeling* allows you to insert or create geometry, apply kinematics to a part, label items, and create measurements, to name a few features. The *View* toolbar allows you to customize your application setup, access different viewers, section the scene, apply true shading, and more.

Opening Process Simulate on the Virtual Lab

To begin the tutorial, you will need to launch *Process Simulate Human*. From the Desktop icons, find the one titled **Repair Workstation.psz.**

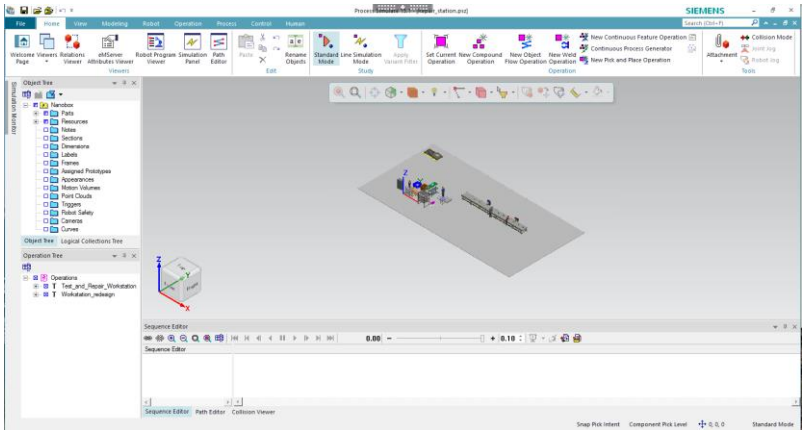
Double click this icon to launch the application.



Allow a moment or two for the application to open…

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Once you see the application shown below, you can get started on the tutorial!



Getting Familiar with Process Simulate…

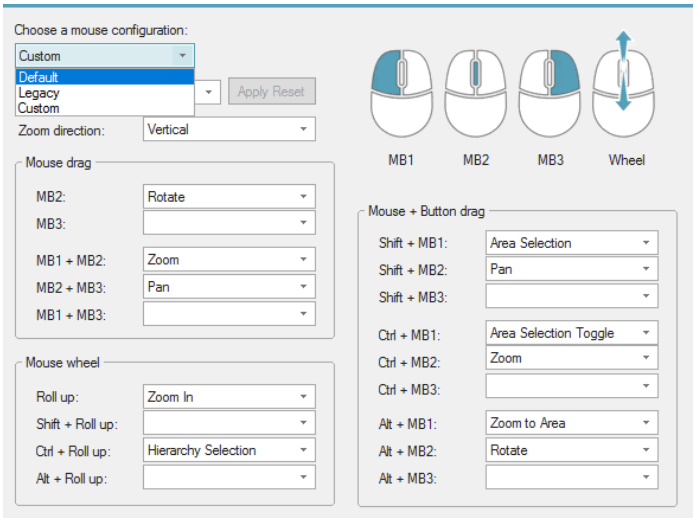
Before we get started, there are a few useful hints to help navigate within the scene and relocate parts and humans.

Navigating the Scene

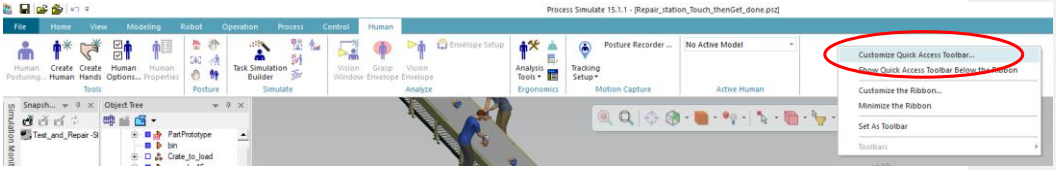
First, lets change our scene perspective. Hover your mouse within the graphics viewer and use the mouse settings described below to update your view.

(all you need to do is hold down a mouse button(s) and move your mouse)

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To access this menu, right click on a blank section of the toolbar, and click on **Customize Quick Access Toolbar**. You can customize the mouse settings if you wish.



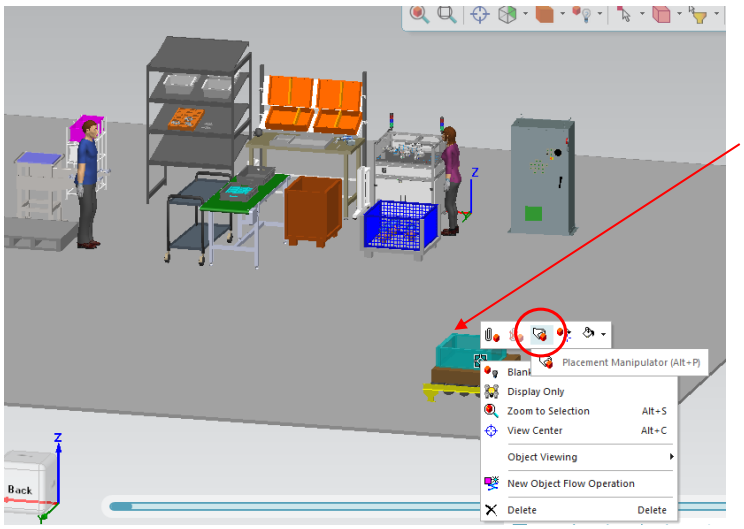
Placement Manipulator

Throughout the tutorial, we will frequently use the *Manipulator*. First let's look at how it works…

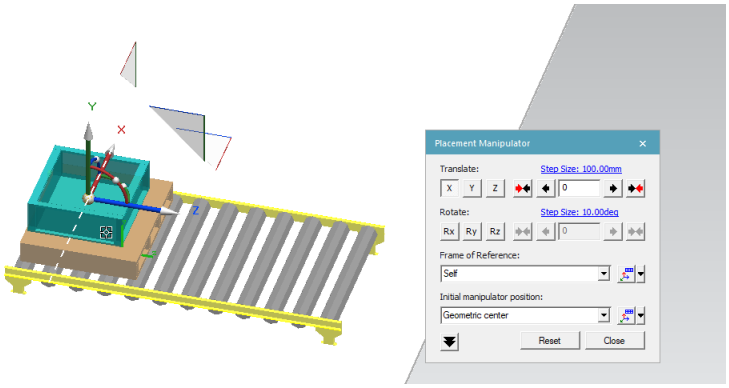
In the scene, there is a bin off to the side, use your mouse to hover over the bin and right click to access a menu.

Click on the Placement Manipulator icon. 

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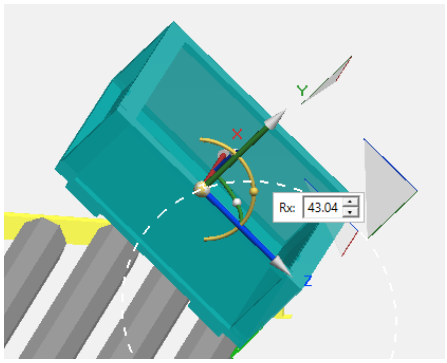
With the *Placement Manipulator* dialog open, you will see a manipulator glyph appear in the scene.



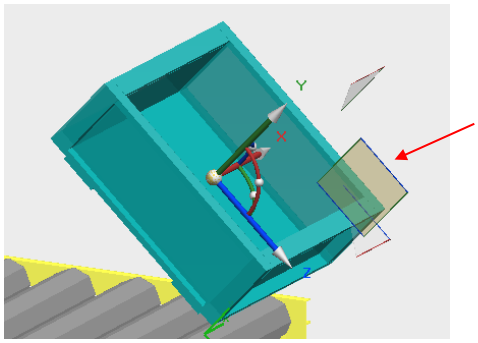
Place your mouse over the blue arrow, hold your mouse button down, and drag the bin to the back of the roller table. Try each of the arrows translate the bin in each X, Y, Z directions.

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Use the arcs of the arrow glyph, to rotate the bin.



Use the planes of the glyph to move the bin in 2 directions at once.

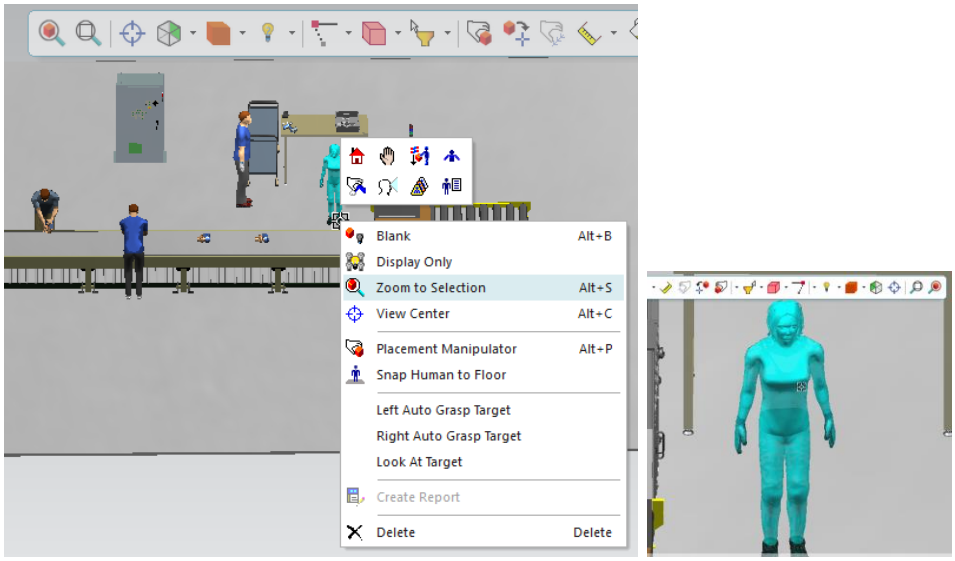


When done exploring, click **Reset** from the *Placement Manipulator* dialog. Then **Close**. This will return the bin to its original location.

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Zoom to Selection

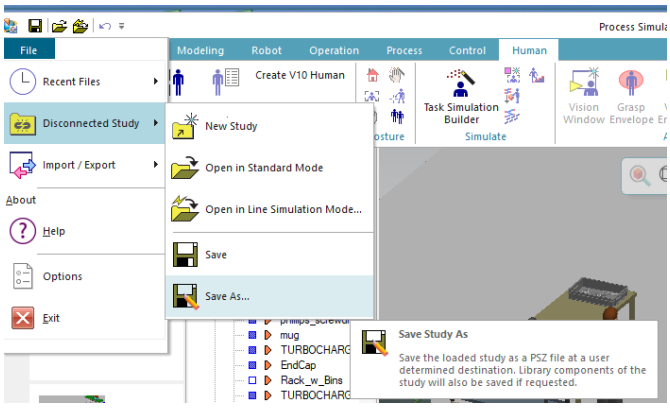
You can select (highlight) a human or object in the scene and use the **Zoom to Selection** function to fit the select item to the screen size. This is an easy way to navigate close to the item you're interested in, without using several mouse manipulations.



Saving

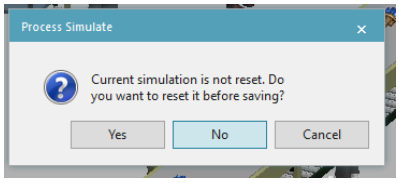
You are encouraged to save your work often. If your session is interrupted for some reason, it is helpful to have a recently saved session file to return to.

To Save, go to **File** -> **Disconnected Study** -> **Save As**….



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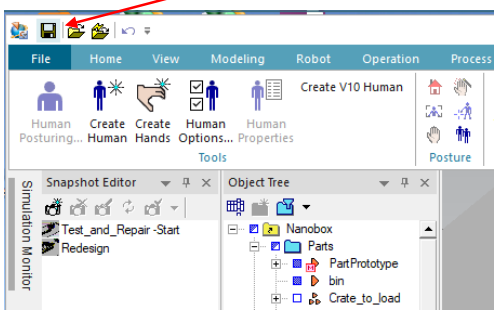
If you are in the middle of building a simulation, you may see a prompt appear asking if you wish to reset the simulation. Choose *No*.



You will be prompted to choose a location to save files. You can save your work to this machine and will have access to it for the duration of your trial period.

> Note: You must remain active during the trial period. If 7 days of inactivity are detected, your working files will be removed.

After the first save, you can use the shortcut Save icon in the top left corner to quickly save your updates.



Its time to get started!

Evaluation of an Offline Test Station for Turbocharger Seals

In our example, we are designing an off-line test and repair station for a turbocharger assembly line. A workstation layout has been proposed by the engineering team. We are going to simulate and evaluate the manual process used to test and repair the housing seals. The facility is in China, and our goal is to ensure that the steps can be safely performed by the workers.

Knowing Your Target Population

When designing parts or processes, it is useful to know something about the people who will interact with your designs. For example, if designing a workstation, you may consider if there will be both male and female workers, and if the facility is in a specific geographic region. This information helps you to choose the human figure sizes that best represent your population.

In our example, the facility is in China and the working population consists of both male and female workers.

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From within the viewer, click to select the female figure (Jill), then from the *Human* toolbar, click **Human Properties**.

Make the following selections:

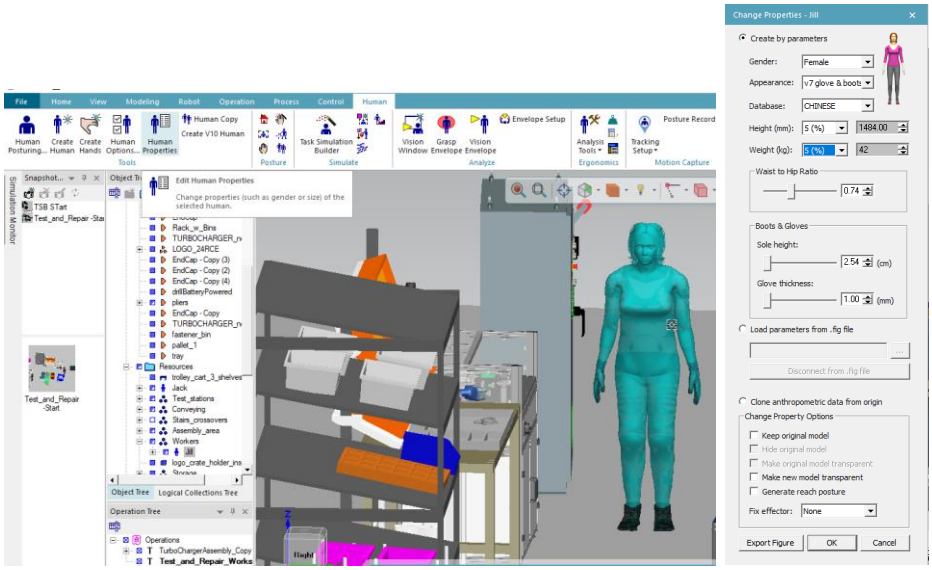
Database: Chinese

Height: 5 (%)

Weight: 5 (%)

All other options can remain as-is. When done, click **OK**.

In your scene you will see Jill adjust in size. She now reflects the size of a 5th percentile Chinese female in stature and weight. The small female was chosen to ensure that working heights and reaches within the workstation can be safely performed, even by the smallest worker.



Now we will adjust the male figure. From within the viewer, click to select the male (Jack), then from the *Human* Toolbar, click **Human Properties**.

Make the following selections:

Database: Chinese

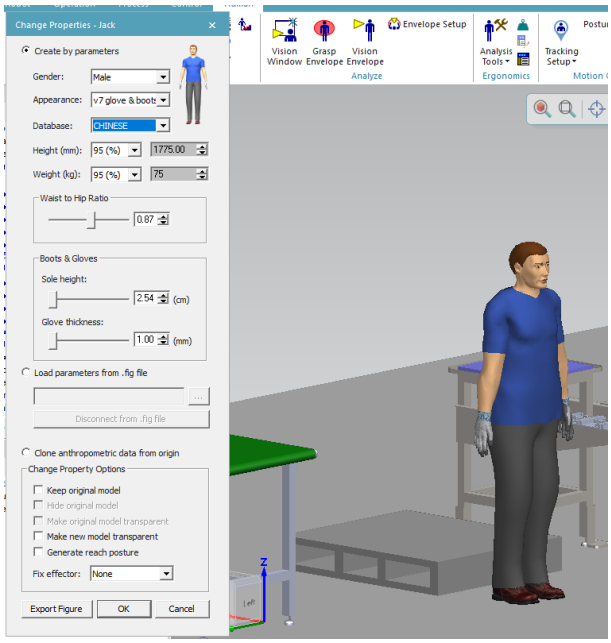
Height: 95 (%)

Weight: 95 (%)

All other options can remain as-is. When done, click **OK**.

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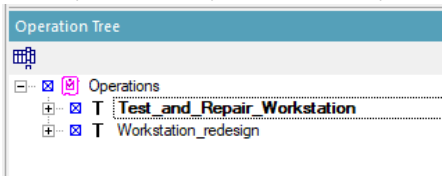
In your scene you will see Jack adjust in size. He now reflects the size of a 95th percentile Chinese male. The large male was chosen to ensure that working surfaces are not too low and that there is enough head and hand clearance to accommodate even the tallest worker.



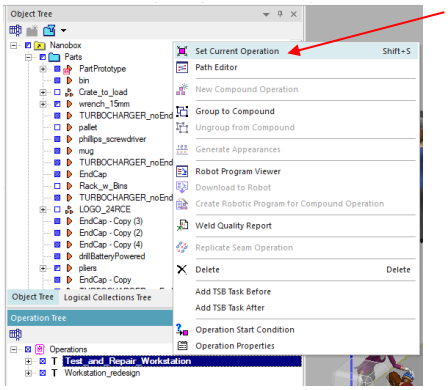
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View before you *Do*…

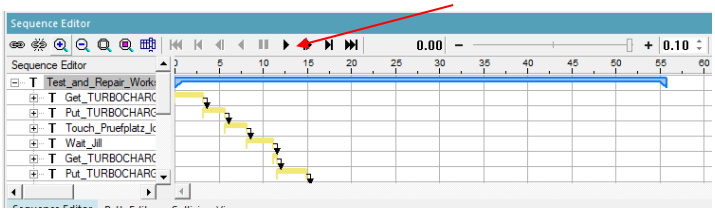
In the Operation Tree, you will find a completed simulation called Test_and_Repair_Workstation.



Once you have worked your way through this tutorial, your simulation will look similar. If you wish to get a visual of the simulation before starting your work, go to the *Operation Tree*, right click on **Test_and_Repair_Worstation**. Select **Set Current Operation**.

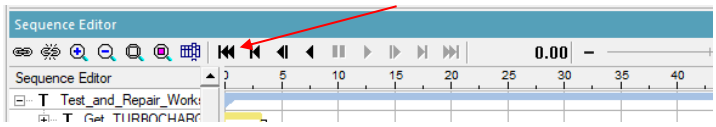


From the *Sequence Editor*, use the **Play** button to start the simulation.



You may wish to spin the scene, so you can watch the simulation from different viewpoints.

When the simulation has finished playing, press the button to **Jump the Simulation to Start.**

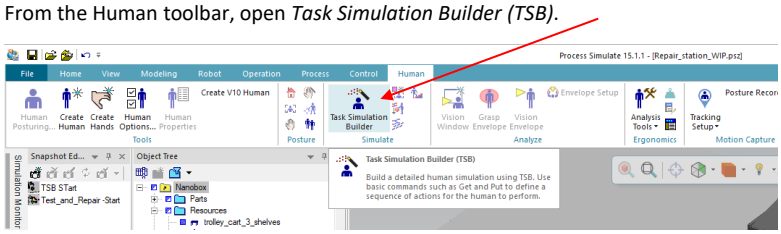


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Creating a New Simulation

You will use the *Task Simulation Builder* to create your own simulation.

From the Human toolbar, open *Task Simulation Builder (TSB)*.

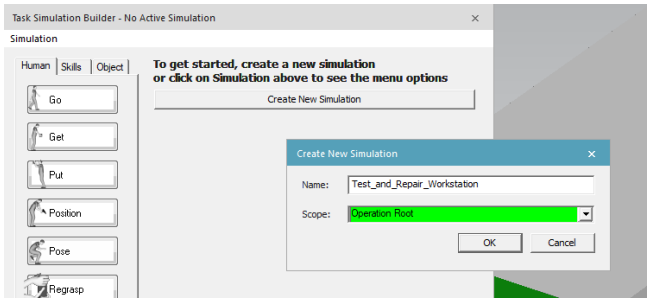


Go to the *Simulation* menu, click on **Create New Simulation**.



Another dialog will open. Select a **Name** for your simulation. Confirm the **Scope** is set to 'Operation Root'.

Click **OK**.

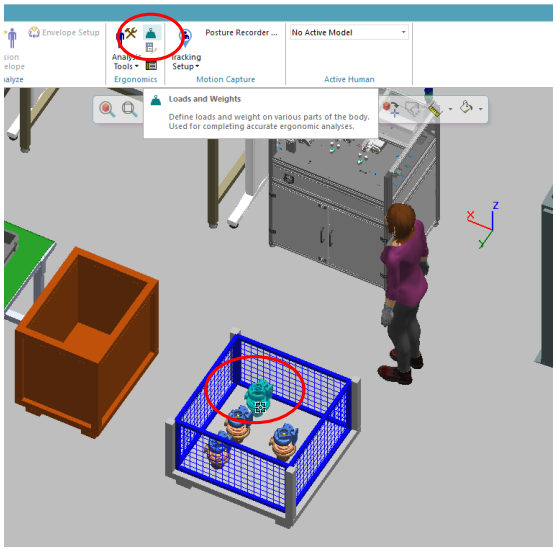


Defining Object Weights

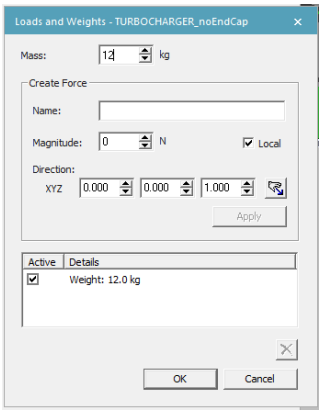
The humans in this study will be required to pick up and manipulate the turbo-charger. Once a simulation is created, we can run a series of ergonomic studies to help us determine if the work elements are safe. To do this, we need to account for the weight of each part and any other forces the worker will exert.

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To define the weight of the turbo charger, click on the part from within the scene (choose the one shown below), and then pick the **Loads and Weights** icon from the *Human* toolbar.

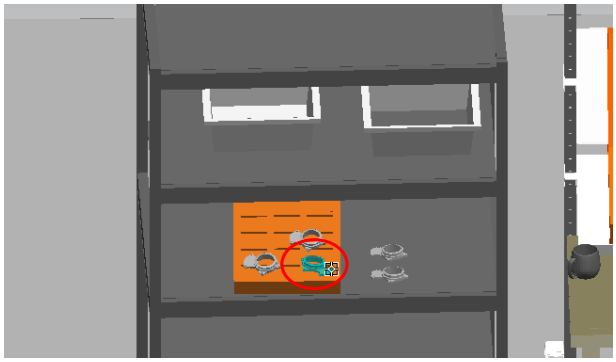


The *Loads and Weights* dialog will open. Next to **Mass** enter [12] kg. Then click **OK**.



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There are several End Caps on the supply shelf. From the scene, use your mouse to click and highlight the one shown in the image below.



Then click the **Loads and Weights** icon.

For the endcap, you will define both the weight of the part (1kg), as well as the force required to manually snap the end cap onto the turbo-charger (45N).

Next to **Mass**, enter [1].

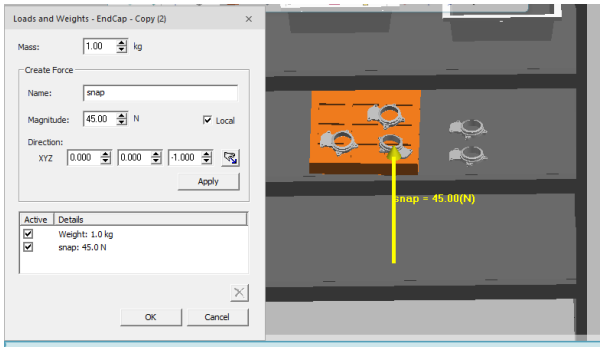
Next to **Name**, enter [snap].

Next to **Magnitude**, enter [45].

Next to **Direction** (xyz), update the values to read: [0] [0] [-1]

Click **Apply**.

Click **OK**.

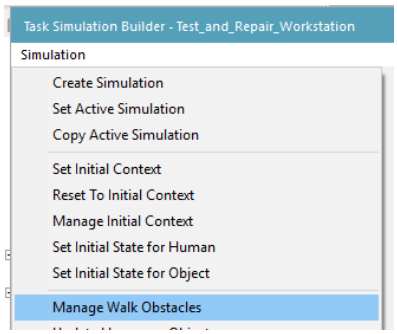


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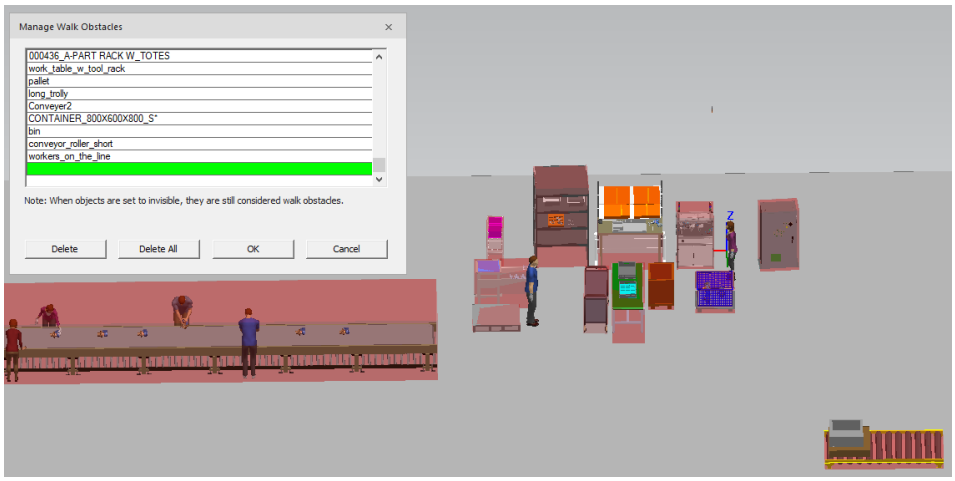
Defining Walk Obstacles

Walk path planning is automatic in the software. The planning looks for the shortest route to get from point A to point B, however, obstacles cannot be automatically detected. Therefore, you need to tell the system which objects in the scene should be avoided when moving about. Once defined, the walk planning will account for these objects and avoid them.

From *TSB*, go to the *Simulation* menu and click on **Manage Walk Obstacles**.



From the scene, click on each object that is touching the ground. Once added to the obstacle list, the item will by highlighted in the scene with a red box over it (highlighting will turn off after obstacle definition is done).



Click **OK** when done.

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Simulating the Work Steps

We can now begin to put the human into motion…

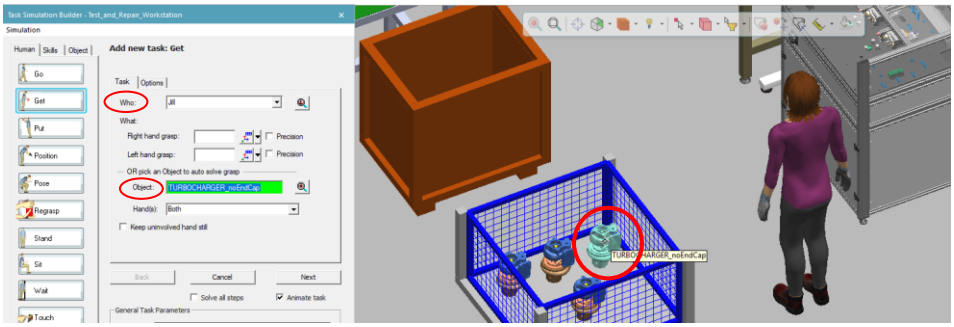
The bin next to Jill contains several turbochargers that need to be tested for broken seals. First, we are going to simulate Jill picking up a turbocharger and placing it in the inspection booth.

From the *Task Simulation Builder* dialog, click on the **Get** button to create a new task.



From the dropdown next to **Who**, select *Jill.*

Click on the field next to **Object**, then, from the scene click on the turbocharger closest to Jill in the scene.

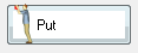


Click **Next**.

You will see Jill walk to the Bin. Click **Next** again and you will see Jill reach down to grasp the charger.

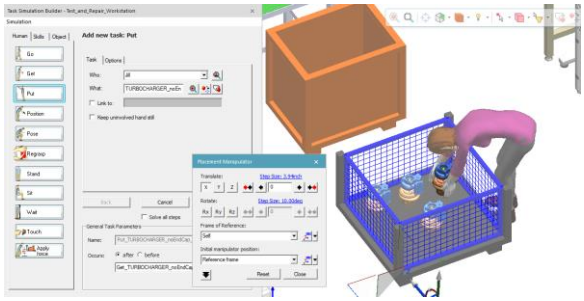
Click **Done**.

From the Task Simulation Builder, click on the **Put** button.

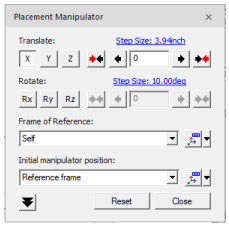


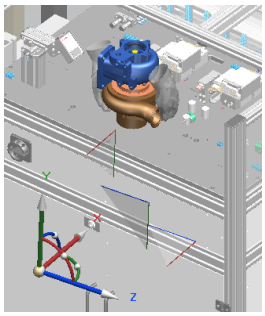
This will open a *Placement Manipulator* dialog.

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Use the manipulator to drag the turbocharger into the test station. Notice that hand glyphs appear on the charger so you know how the human will carry it and thus be able to position it realistically.





Click **Close** from the *Placement Manipulator* dialog when done.

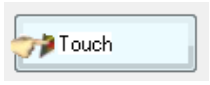
From the *TSB* dialog, click **Next**. Jill will pick up the charger and walk to the test unit.

Click **Next** again. Jill will place the charger down into the test unit.

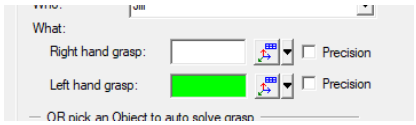
Click **Done**.

*Note: using the **Next** buttons allows you to animate and review each part of the simulation step-by-step. You can fine tune the simulation as you go to avoid the need for edits later on. For more rapid simulation, you could also choose to click **Solve all steps,** which would create the full task at once.

Click **Touch** to create a new task.



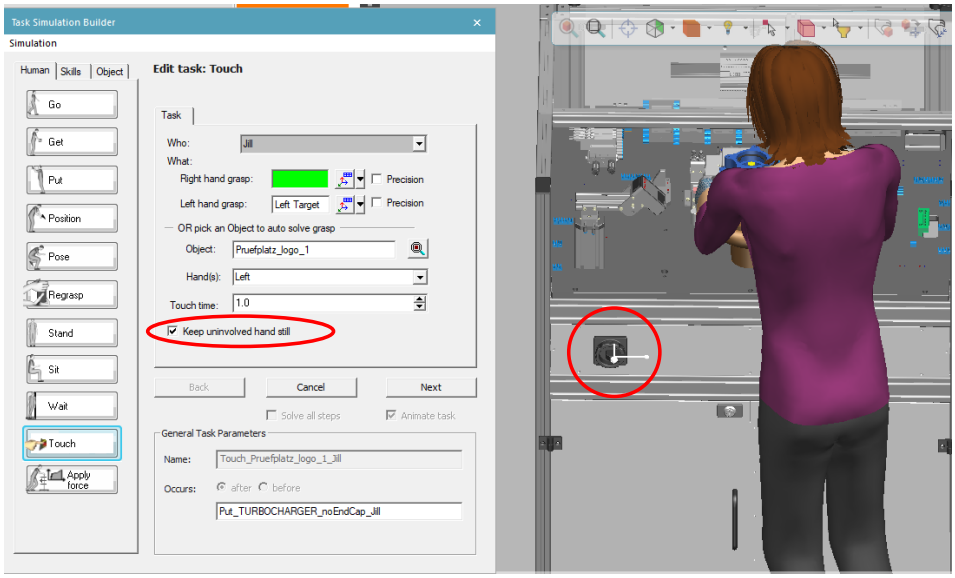
Place your cursor in the field next to **Left hand grasp** so the field is highlighted in green.



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In the scene, use your cursor to click the center of the button on the test machine.

Then, chick the option to **Keep uninvolved hand still**.

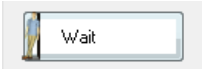


Click **Next**. Then click **Next** again. You will now see Jill reach out to press the button with her left hand.

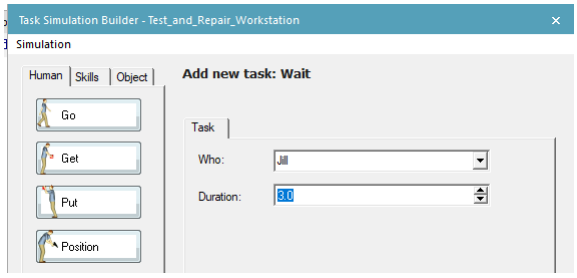
Click **Done**.

It takes 3 seconds to test the seals for leaks.

Click **Wait** to create a new task.



Update the **Duration** field to [3].

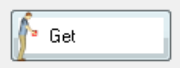


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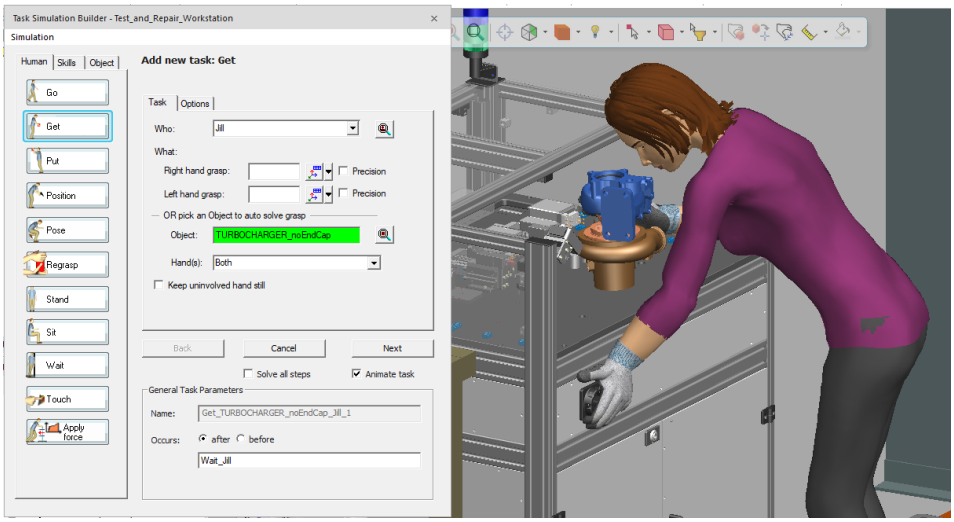
Click **Done**.

In this scenario, the test machine indicated that there is a leak in the seal and the turbocharger requires a new endcap. Next Jill will bring the turbocharger to the workbench and replace the endcap.

Click **Get** to create a new task.



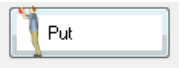
Click next to the **Object** field. Once highlighted green, click on the turbocharger from within the scene.



Click **Next**, then **Next** again. Jill will adjust her posture, so she is grasping the charger with both hands.

Click **Done**.

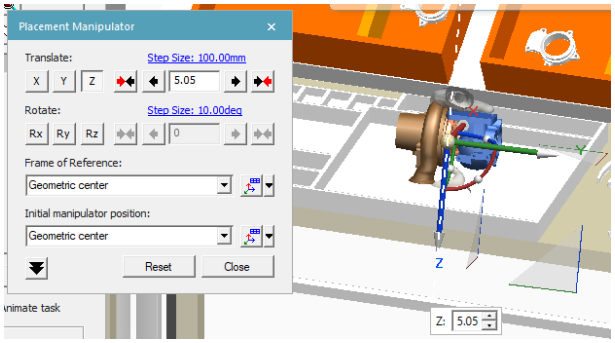
From the Task Simulation Builder Dialog, click on the **Put** button.



This will open a *Placement Manipulator* dialog.

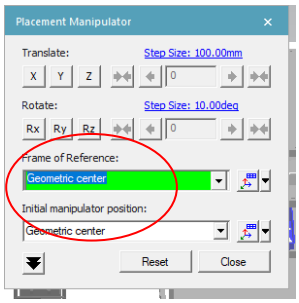
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Use the manipulator to place the turbocharger on the tray that is sitting on the workbench.



Turn the turbocharger on its side.

> Note the easiest way to rotate the charger, is to first move it (translate) to the workstation, then in the *Placement Manipulator* dialog, change the **Frame of Reference** and the **Initial manipulator position** options to [Geometric center]. With these settings you can now use the manipulator to rotate the charger, in its current location.



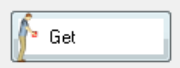
When done, **Close** the *Placement manipulator* dialog.

From the *TSB* dialog, click **Next**, **Next**, **Done**.

Now Jill will need to walk to the supply shelf and select a new end cap to assemble to the turbocharger.

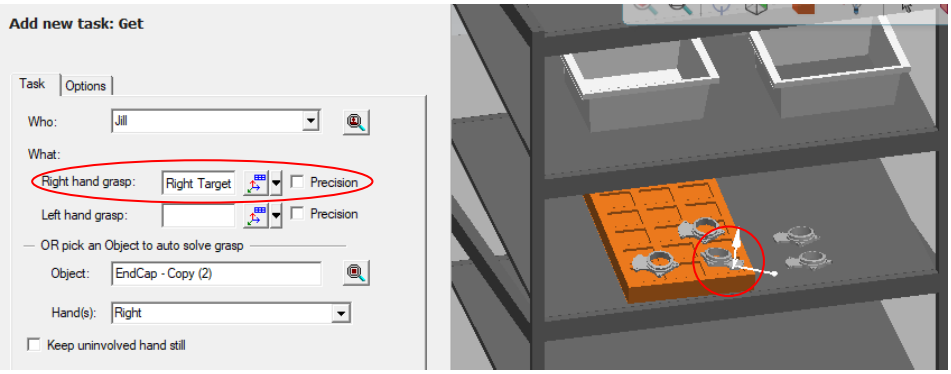
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Click **Get** to create a new task.



Next to Right Hand Grasp, click to highlight the field, then click on the end cap near the front of the shelf.

Commented [RU(SMRSE1]: Point out that the palm will be aligned with the picked spot. The arrow indicates the orientation



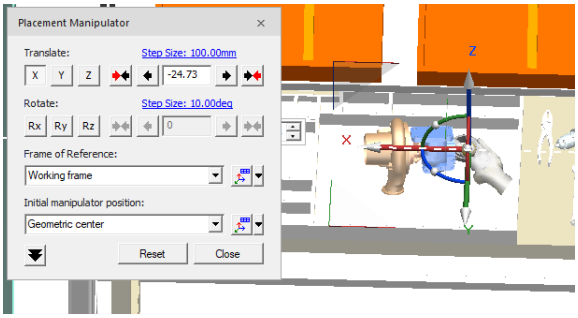
Click **Next**, **Next**, **Done**.

From the Task Simulation Builder, click on the **Position** button.



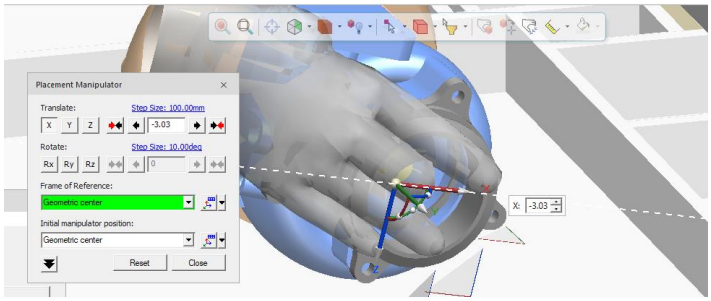
This will open a *Placement Manipulator* dialog.

Set the **Frame of Reference** to [Working Frame], and drag the end cap so that it is near the top of the charger.



Set the **Frame of Reference** to [Geometric Center] and align the holes of the end cap with the holes of the turbocharger. *This can take some fine-tuning and is often more time consuming for novice users. It will get quicker with practice!

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Close the Manipulator. In *TSB*, click **Next**, **Next**, **Done**.

Jill should now be standing at the workstation, with one hand holding the end cap in place.



The end cap must be snapped into place, so it is fully assembled. To simulate this, we will add an ApplyForce task. Earlier in this tutorial we assigned weights and forces to objects in the scene. These loads can be automatically applied to the human, when an ApplyForce tasks is created. The impact of the loads on the worker will be analyzed later using the Ergonomic Analysis tools.

From the Task Simulation Builder, click on the **ApplyForce** button.



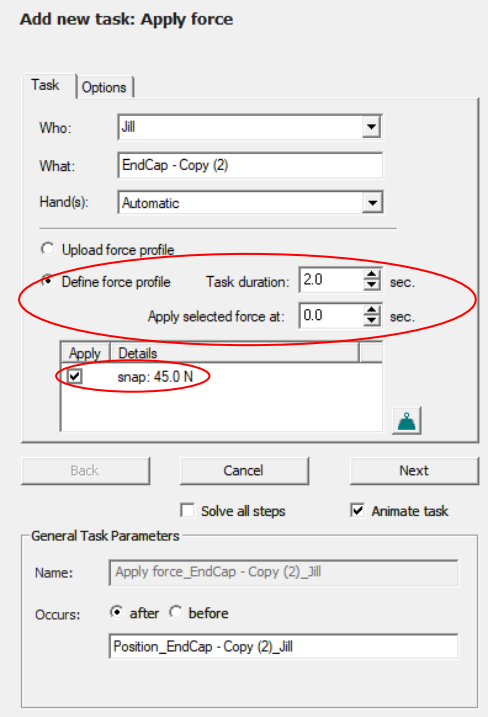
In the *TSB* dialog:

Set the **Task Duration** to [2] seconds.

Set **Apply selected force at** [0] seconds. This will apply the force immediately when the task starts.

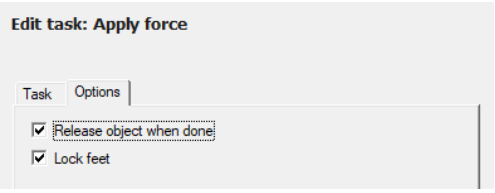
From the Force table, **click the checkbox** next to the *snap: 45.0 N*

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Go to the *Options* tab.

Check **Release object when done**.



Click **Next**. You will see Jill's posture update to reflect the change expected when generating a 45N lateral exertion.

Click **Done**.

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We need to tell the simulation system that the end cap is now attached to the turbocharger.

From the *Task Simulation Builder* dialog, switch to the **Object** tab.

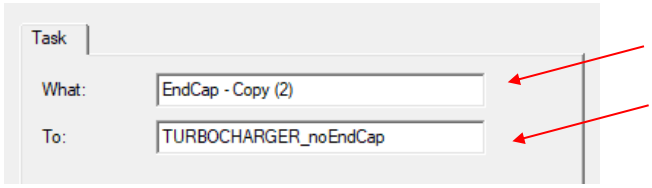


Click on **Attach**.

Next to *What:* confirm the selected object is [EndCap – Copy (2)]

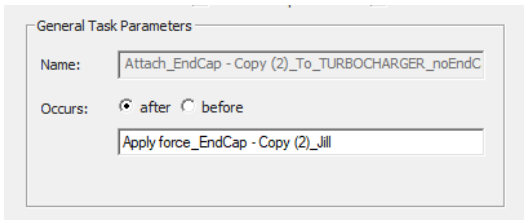
In the **To**: field, click to highlight, and then from the scene, select the turobochager that was just repaired.

The field should now read: [TURBOCHARGER_NoEndCap].



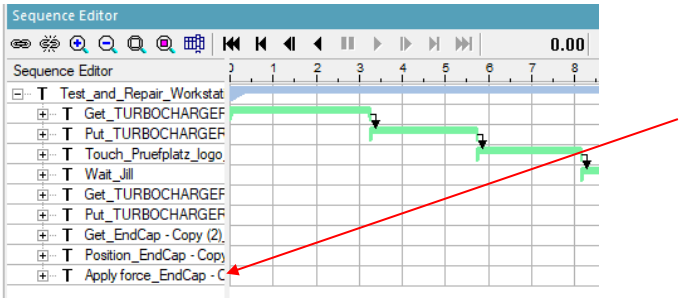
At the bottom of the dialog, confirm that the attach will occur after the task called:

[Apply force_EndCap – Copy (2)_Jill]



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If the *Occurs* after field reads a different task name, click in the field to highlight, then from the *Sequence Editor*, click on the last task (ApplyForce) to fill in the field.

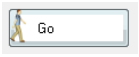


Then click **Done**.

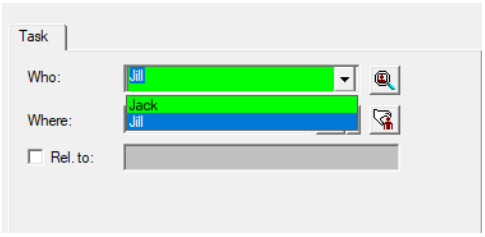
This will attach the End Cap to the Charger, after the ApplyForce task.

Now that the leak in the turbocharger has been repaired, Jill's work is complete, and she can move on to test the next charger. The other worker in the repair station is responsible for collecting the refurbished parts and returning them to the line.

From the *Task Simulation Builder*, return to the *Human* tab, and click on the **Go** button.

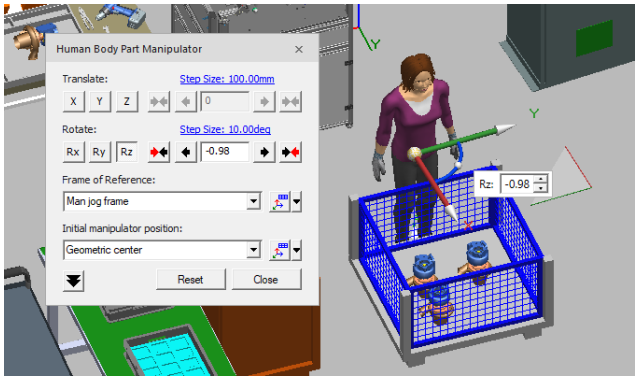


From the dropdown menu, next to **Who**, confirm that Jill is the selected human.



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Use the manipulator to move Jill so she is standing in front of the bin.

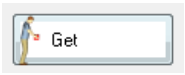


Close the *Human Body Part Manipulator*.

From the *TSB* dialog, click **Next**, then **Done**.

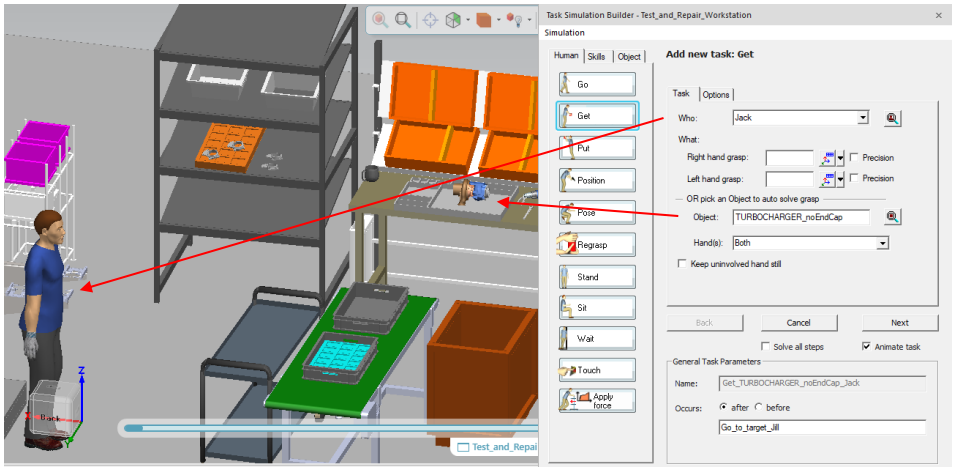
Now Jack will collect the repaired turbocharger…

From *TSB*, click **Get** to create a new task.



Select [Jack] from the **Who** dropdown.

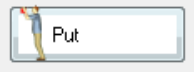
Next to *Object*, highlight the field, and select the [turbocharger] from the workbench in the scene.



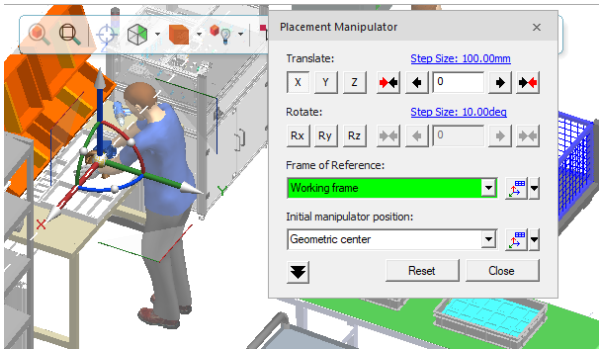
Click **Next**, **Next**, **Done**.

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From *TSB*, click on the **Put** button.



In the *Placement Manipulator* dialog, set the **Frame of Reference** to [Working Frame].



Drag the turbocharger over to the trolley.

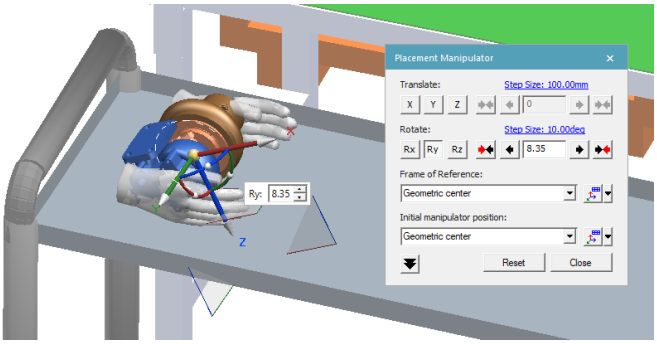


You will notice that the hand glyphs on the charger are pointed inward, which would create an awkward posture for Jack, when placing the charger.

In the *Placement Manipulator* dialog, set the **Frame of Reference** to [Geometric center]. And rotate the charger so the hands are facing the opposite direction.

> Note – you may need to find tune the final position of the turbocharger on the trolley, checking to be sure it is sitting right on the surface (not 'floating' in the air).

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Close the *Placement Manipulator*.

In the *TSB* dialog, click **Next**, **Next**, **Done**.

From the *Task Simulation Builder* dialog, switch to the **Object** tab.

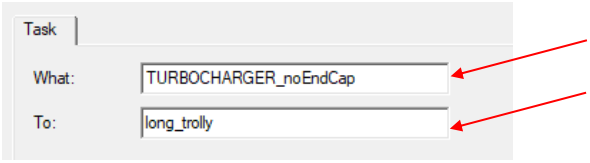


Click on **Attach**.

Next to **What***:* confirm the selected object is [TURBOCHARGER_noEndCap]

In the **To**: field, click to highlight, and then from the scene, select the trolley.

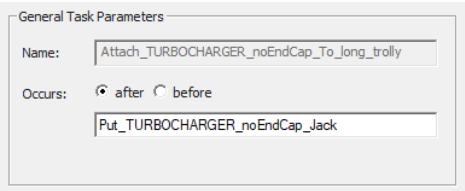
The field should now read: [long_trolly].



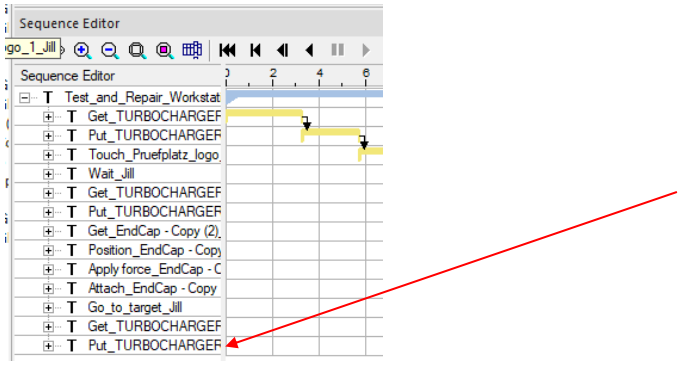
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At the bottom of the dialog, confirm that the attach will occur after the task called:

[Put_TURBOCHARGER_noEndCap_Jack]



If the **Occurs** after field reads a different task name, click in the field to highlight, then from the *Sequence Editor*, click on the last task (Put_TORBOCHARGER) to fill in the field.



Then click **Done**.

This will attach the Charger to the trolley, so that when the trolley is moved, the turbocharger will go with it.

From the *Task Simulation Builder* dialog, switch to the **Skills** tab, and click on **Use device**.



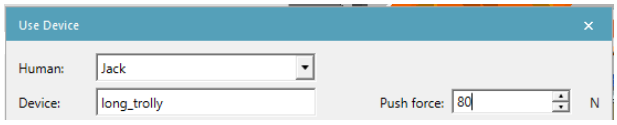
A new *Use Device* dialog will appear. Now we'll set up a task for Jack to push the trolley over to the main assembly line.

Next to **Human**, confirm [Jack] is selected.

Next to **Device**, click in the field to highlight, then select the [long_trolly] from the scene.

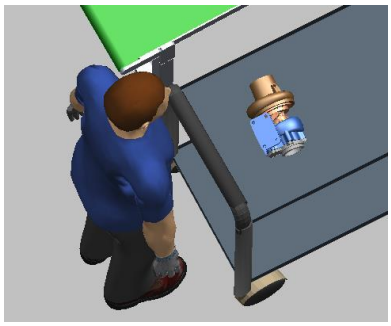
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Next to **Push Force**, enter [80].

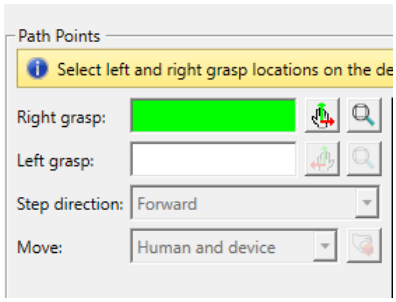


Now we will tell the system, where Jack will place his hands on the trolley to push it.

Spin the scene so you have a clear view of the trolley handle.



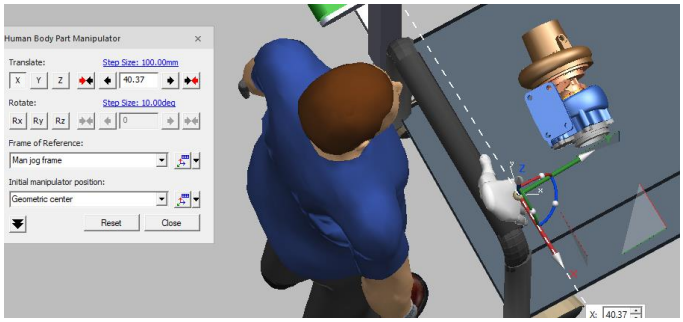
From the *Use Device* dialog, click the field beside **Right grasp**, to highlight the field.



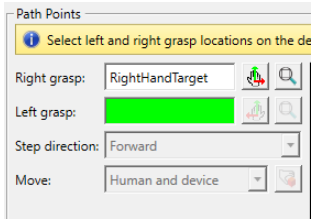
From the scene, click the top part of the trolley handle, on the right side. The spot you click is where Jack will place his palm to grasp the handle. A hand glyph will appear where you click, and automatically wrap around the handle. You can use the *Human Body Part Manipulator* to fine tune the position of the hand, relative to the handle.

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When done, the hand glyph should look similar to the image below… representing a realistic grasp posture, for Jack.



From the *Use Device* dialog, click next to **Left grasp**, to highlight the field.



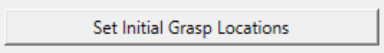
From the scene, click the top part of the trolley handle, on the left side. A second hand glyph will appear where you click. Use the *Human Body Part Manipulator* to fine tune the position of the hand, relative to the handle.

When done, the two hand glyphs should be placed like those seen in the image below.

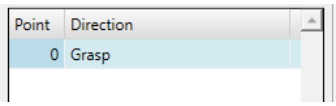


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Click **Set Initial Grasp Locations**

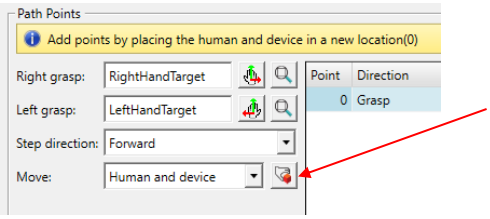


You will see the table to the right populate with Point '0'



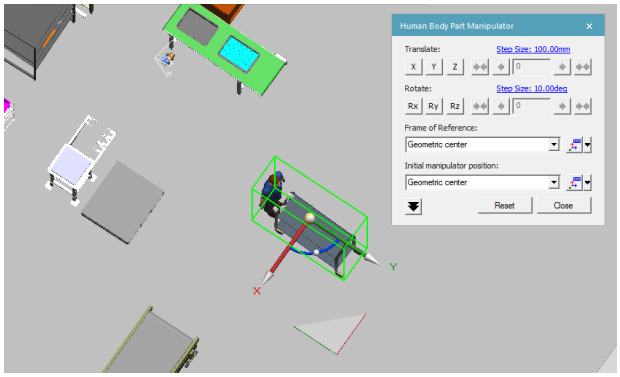
Confirm **Step Direction** is set to [Forward].

Confirm **Move** is set to [Human and Device], then click on the manipulator icon 

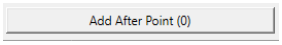


In the scene, you will see a green box appear around the human and the trolley. The manipulator can now be used to relocate the pair to their next location.

Note, that based on the selections made, the human will walk using forward facing steps.

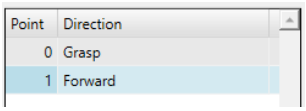


Click Add After Point (0)



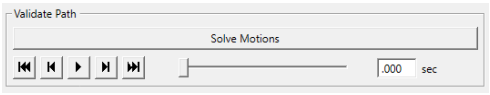
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Another point will be added to the table.



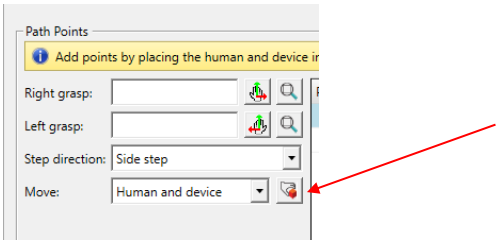
Once at least 2 points have been defined, you can preview the motions. Click **Solve Motions**.

Then hit the **Play** button  to see Jack push the cart to the next point.

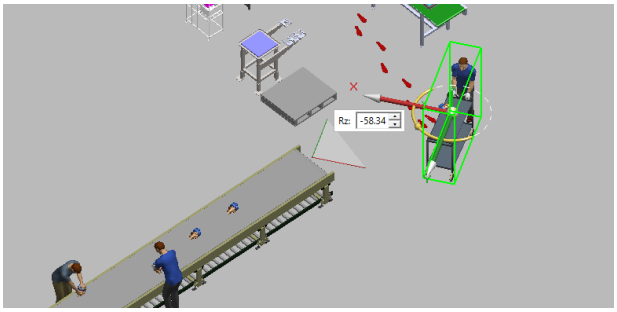


Set the **Step** direction to [Side step].

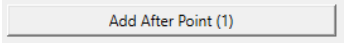
Confirm Move is set to [Human and device], then click the manipulator icon.



Rotate the pair so that Jack is facing toward the main assembly line, as shown below.



From the Use Device dialog, click **Add After Point (1)**.

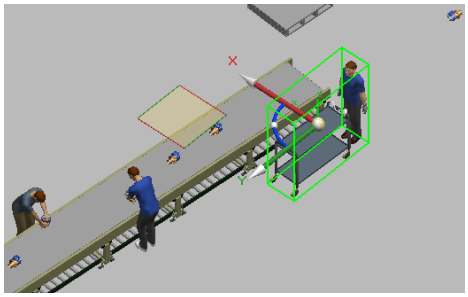


Switch the Step direction back to [Forward].

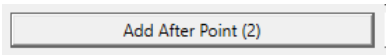


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Use the manipulator to move Jack and the trolley beside the main assembly line, as shown below.

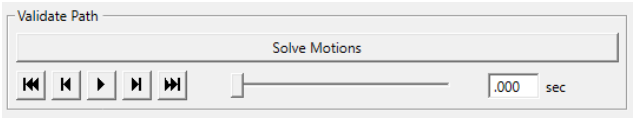


From the Use Device dialog, click **Add After Point (2)**.



Click **Solve Motions**.

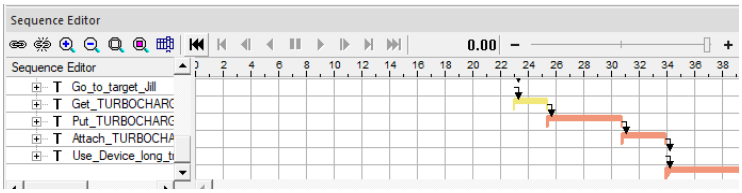
Click **Play** to see Jack push the cart to its final location next to the main assembly line.



In the Use Device dialog, click **OK**.

The simulation is now complete!

Press the **rewind** button in the *Sequence Editor*, to reset the simulation to the start.



In the *Sequence Editor*, click **Play**.

Replay the simulation a few times, changing your perspective in the scene.

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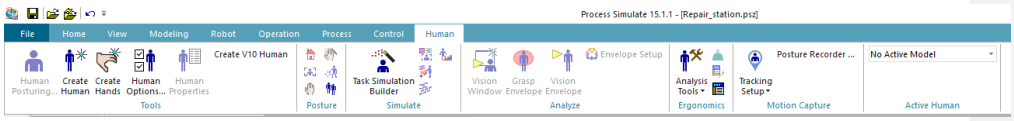
Creating Ergonomic Reports

Now that we have simulated the job requirements, it is possible to analyze the various tasks, considering factors such as:

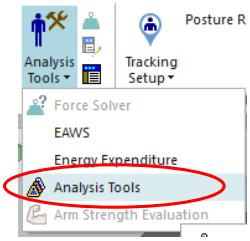
- Ease of reach
- Accessibility of parts and tools
- Lifting requirements
- Assembly forces
- Awkward postures
- Lines of sight
- Time inefficiencies

In this part of the tutorial, we will simply create the reports. The following section will highlight the main purpose for each tool and focus on the results.

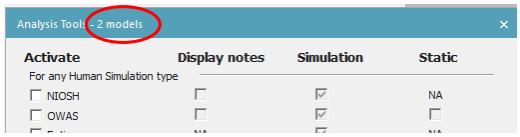
From the *Human* toolbar, click **Analysis Tools**.



Select **Analysis Tools** again.



Confirm that the *Analysis Tools* dialog header reads '2 models'. We are going to activate a variety of Ergonomic Assessments. With '2 models' noted, it means the analysis reports will be generated for both the Jack and Jill models in our study.



Note 1: if the header reads Jack or Jill, it means you had a human selected in the scene when you opened the dialog.

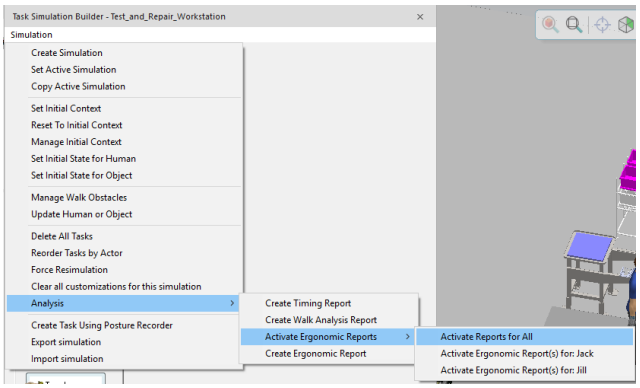


Close the dialog. From the scene, click somewhere off the human. Now open the *Analysis Tools* dialog again.

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Note 2: you can also access Reporting from the TSB dialog…

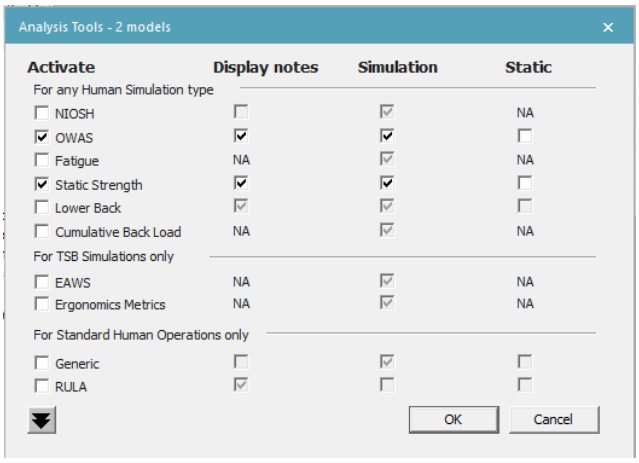
From the *Task Simulation Builder* dialog, go to **Simulation** -> **Activate Ergonomic Reports** -> **Activate Reports for All**.



In the *Analysis Tools* dialog, place a check beside:

OWAS
Static Strength
Ergonomic Metrics

For each, check under the headings: Activate | Display notes | Simulation



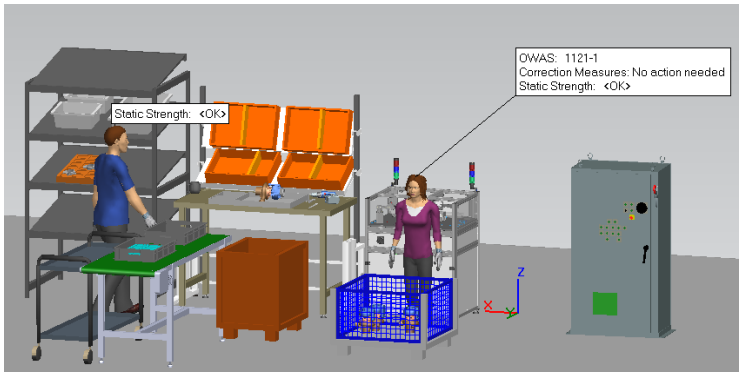
Note: In the Dialog above, there is an analysis called “Ergonomics Metrics”. This tool offers a comprehensive analysis approach; summarizing posture, force, reach, walking, carrying, lifting data, and more. The report generation relies on a formatted Microsoft Excel Macro to

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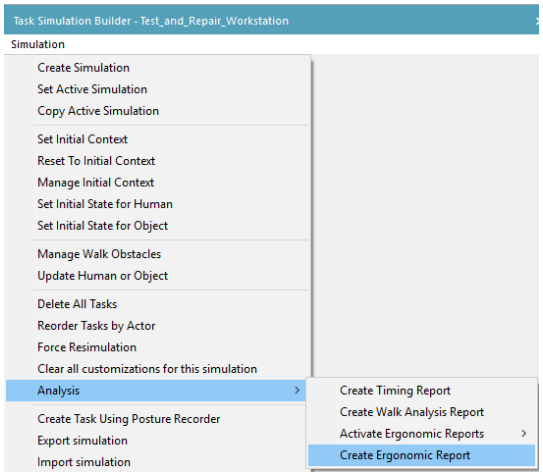
graphically summarize results in a meaningful way. We are unable to access the Excel macro as part of the Process Simulate trial set up. While the formatted report cannot be generated for our tutorial, the results contribute valuable information to our overall analysis. As such, you will find details from the Ergonomics Metrics report included below.

Click **OK**.

If you replay the simulation, you will see the newly placed note above each figure update in real time, with ergonomic data. This can help to discover issues while viewing a simulation and can be a powerful way to communicate identified risk factors to others.

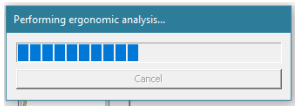


From the *Task Simulation Builder* dialog, go to **Simulation** -> **Analysis** -> **Create Ergonomic Report**.

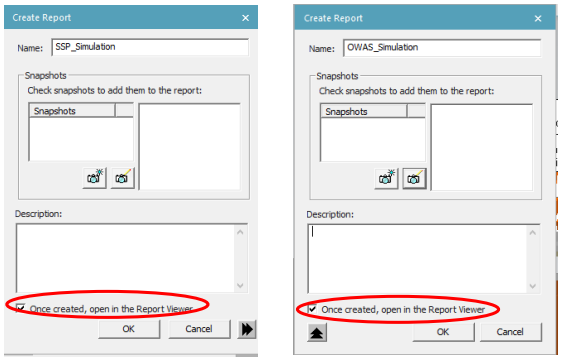


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A status bar will appear, to note that the analyses are being performed. This may take a moment.



Two dialogs will appear for the *OWAS* and *Static Strength* (SSP) analysis tools. In each, check the option to… **Once created, open in report viewer**



Note: in the dialogs above you can customize the report names, add a description, and use the Snapshot functionality to add images to the report.

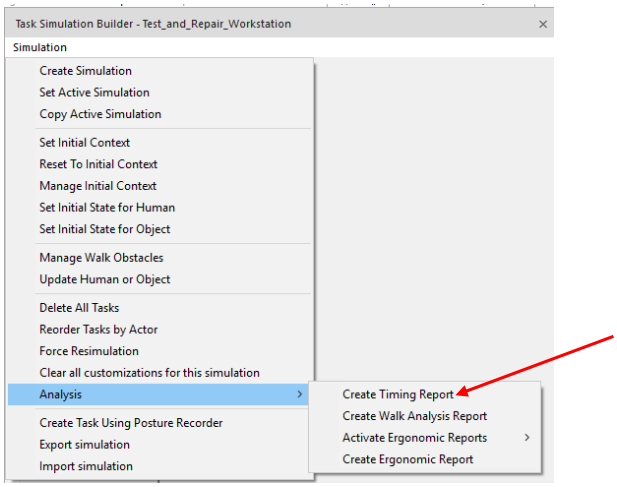
Click **OK** in each dialog.

The report viewer will automatically open, displaying the analysis results.

There are 2 additional reports which can be generated to highlight task timing information and walk patterns during the work cycle.

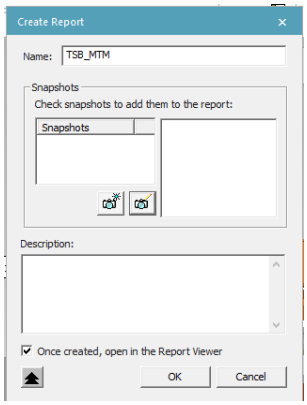
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Go to the *Task Simulation Builder* dialog, click on **Simulation**, then **Analysis -> Create Timing Report**



In the *Create Report* dialog, check the option to **Once created, open in Report Viewer**.

Click **OK.**



Then, go to the *Task Simulation Builder* dialog, click on **Simulation**, then **Analysis -> Create Walk Analysis Report**

In the *Create Report* dialog, check the option to **Once created, open in Report Viewer**.

Click **OK.**

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Evaluating the Work Demands

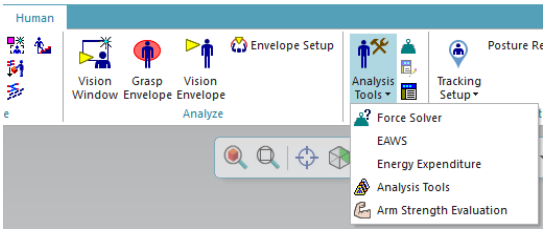
Now that we have created a series of reports, it is time to learn a bit about each analysis approach and review the results.

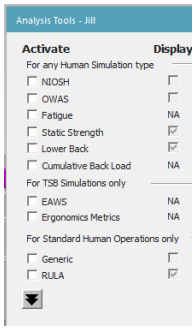
The table below offers a brief description of each analysis tool. Additional details can be found in the main Process Simulate help documents, Accessible from **File – Help**.

Strength Prediction (SSP)	Helps to evaluate the percentage of a population that has the strength to perform a task based on posture, exertion requirements and anthropometry. SSP can be used to evaluate single postures, as well as jobs in real-time, providing a frame by frame output of joint torque and angle data along with feedback on mean strength and percent capabilities.
OWAS	The Ovako Working Posture Analysis (OWAS) was first developed for the steel industry in Finland, OWAS offers a method to evaluate working postures for the neck, trunk, arms and lower body. A corrective action score is assigned to the posture to determine the urgency of pursuing protective measures.
Ergonomics Metrics Report	This tool measures the physical demands of a work cycle, considering both essential and non-essential tasks. Variables considered by this approach include: time spent in various postures, percent of a work cycle spent reaching overhead, carrying, and lifting, total energy consumption and low back loading. Data is also collected for total number of walk steps, reach and hand travel distances.
Timing Report	The Methods-Time Measurement is a time study system that identifies the basic motions within a manual operation. It can be used to help optimize productivity. The Timing Report provides a breakdown of each task into individual actions and assigns the applicable MTM timing code to each.
Walk Analysis	The walk analysis tabulates the steps taken by a human throughout a simulation. The walk path is graphically displayed within the work cell or scene to help with process and work cell design. It is a visual compliment to the information in the Timing and Ergonomics Metrics reports.

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Note: For this tutorial, we have only exercised a sub-set of analysis approaches. Process Simulate Human includes a comprehensive tool suite to study human processes. These can be seen on the *Human* Ribbon, in the **Analyze** and **Ergonomics** groups. And are explained in the Help documents.



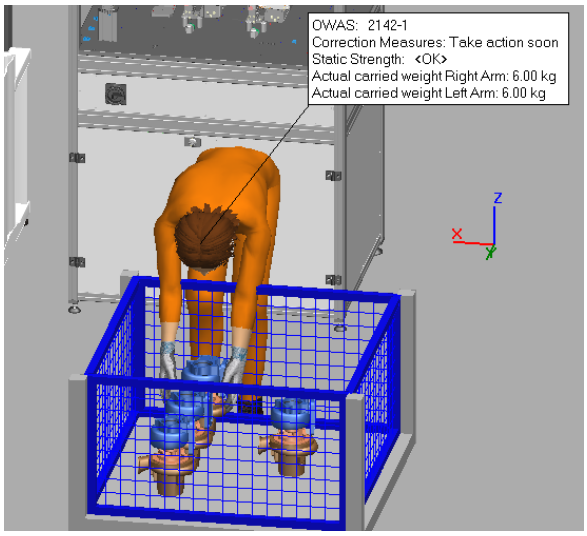


The ergonomic analysis reports can be used identify improvement opportunities for the test and repair workstation. Two examples are outlined below. You can open the applicable report as we walk through each and confirm that you're able to locate and interpret the supporting evidence.

In this tutorial, we will focus on the Analysis results for Jill only. At the end of this section, you're encouraged to review the results for Jack and determine if additional improvement opportunities exist for his work tasks.

Improvement Opportunity 1:

Considerable trunk flexion (forward bending) is needed for Jill to lift the turbocharger from the bin.



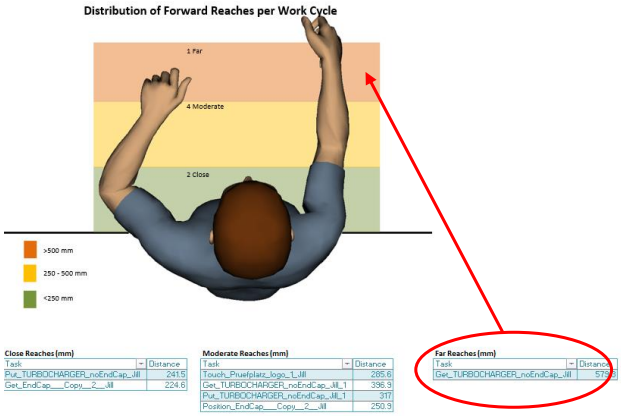
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Evidence:

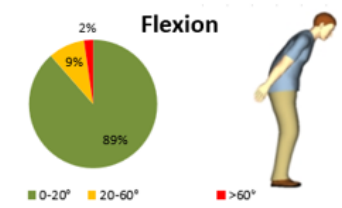
OWAS flagged the bending action of the GET/PUT tasks when Jill is reaching into the bin. A score of 3 in OWAS recommends that corrective measures are taken as soon as possible to minimize injury risk.

Time (Sec)	Operation	Object Weight (kg)	Action Category	Code Posture Combination Back	Arms	Legs	Load	-	Head
0	Get_TURBOCHARGER_noEndCap_Jill_Walk	0	1	1	1	2	1	-	1
0.03		0	1	1	1	7	1	-	1
0.97	Get_TURBOCHARGER_noEndCap_Jill_Turn_Body	0	1	1	1	2	1	-	1
1.87	Get_TURBOCHARGER_noEndCap_Jill_Bend_And_Reach	0	2	2	1	2	1	-	1
2.2		0	3	3	1	4	1	-	1
3.3	Put_TURBOCHARGER_noEndCap_Jill_Arise_From_Bend	12	3	3	1	4	2	-	1
3.87		12	2	2	1	2	2	-	1
4.07		12	1	1	1	2	2	-	1

The Ergonomics Metrics Report has also identified the reach to Get a turbochager from the bin as “Far”, which is outside the recommended work zone.



In addition, this report also shows that severe trunk flexion occurred during the simulation.



Improvement Opportunity 2

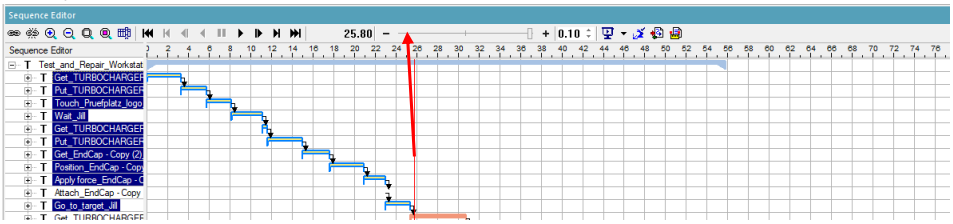
Jill is required to move between 4 stationary points within the workstation to collect or test parts. This requires considerable walking, which suggests that the workstation layout has not been optimized. In addition, most of the walking involves carrying parts.

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* It is important to note that when optimizing a work cell, care must be taken to ensure operators still have enough rest and recovery time to avoid increased injury risk.

Evidence:

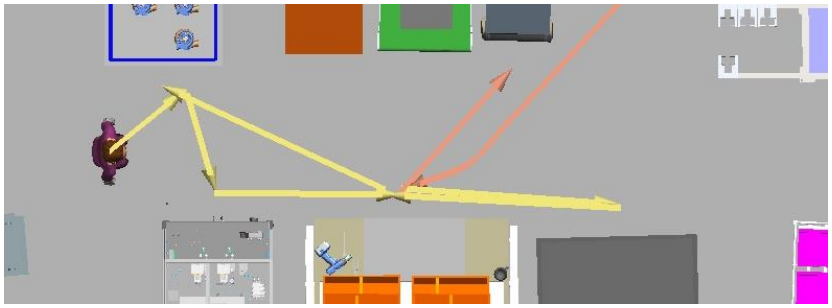
The time Jill spends to get, test and repair a turbocharger is approximately 25 seconds. This can be seen in the *Sequence Editor*. Highlighted tasks are those performed by Jill. Time is diplayed along the top of the *Sequence Editor*.



The TSB Walk report, shows that 6 tasks involve walking, which take up to 10.6 seconds of the cycle.

Jill			
Task	Walk Duration (sec)	Walk Distance (m)	Code
Get_TURBOCHARGER_noEndCap_Jill	1	0.8	W3FT
Put_TURBOCHARGER_noEndCap_Jill	1	0.8	W3FT
Put_TURBOCHARGER_noEndCap_Jill_1	1.8	1.4	W5FT
Get_EndCap___Copy__2__Jill	2.1	1.7	W6FT
Position_EndCap___Copy__2__Jill	2.3	1.8	W6FT
Go_to_target_Jill	2.4	1.9	W6FT
Totals	10.6	8.5	-

The walk patterns can also be visualized in this report.

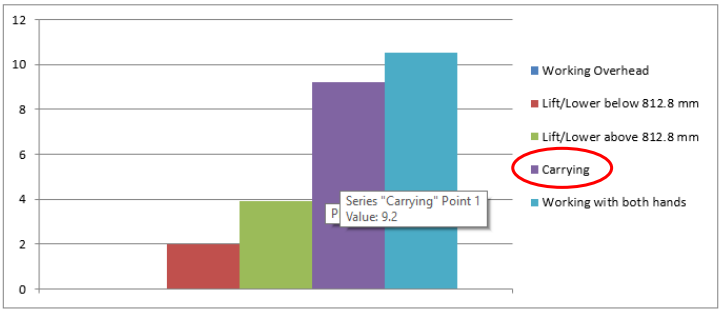


The Ergonomic Metrics Report shows that Jill is carrying for 9.2 seconds. Given the Turobocharger weight of 12 kg, this may exceed the recommended guidelines for Metabolic Energy Expenditure, if repeated several times a day.

> Note: If details are known about the number of cycle repetitions and hours of work, a metabolic energy expenditure analysis can be performed in Process Simulate.

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Percent of Work Cycle spent:



What about the Static Strength Analysis?

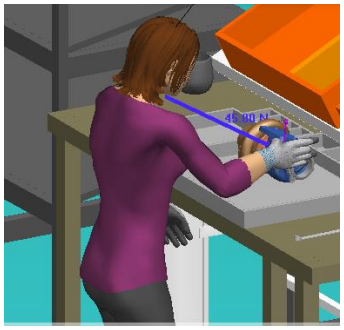
Whenever force exertions are present, the Static Strength (SSP) analysis can be used to confirm that the human has enough strength to perform the task.

To replace the endcap onto the turobocharger, Jill is required to exert a 45N assembly force. SSP results show that this exertion does not cause an increased risk of injury, and has confirmed that no change is required for this particular task.

TECNOMATIX STATSTRENGTH(Test_and_Repair_Workstation, Jill)

Name of report:	SSP_Simulation_Jill
Date of creation:	October 16, 2019 / 10:23
Human Model:	Jill
Gender:	female
Height %:	5
Weight %:	5
Database:	CHINESE

According to the current filter settings there is no data to present in this report. To modifiy filter settings - press edit report in the the report toolbar.



Considering Design Alternatives

Using the analysis results, you can consider ways to improve the workstation layout. The two main criteria to consider are:

1. Reduce trunk flexion for Jill when lifting the turbochargers from the Bin
2. Decrease the time spent walking and carrying.

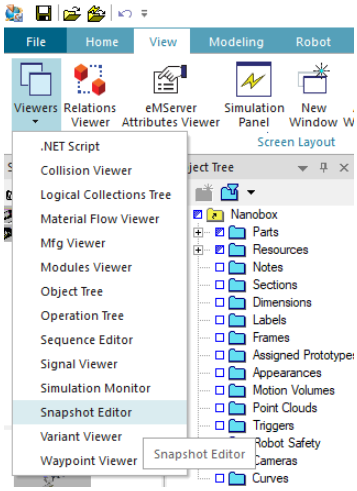
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There are several ways to eliminate the risk factors noted above. Using the skills you have acquired from this tutorial, you can now rearrange the furniture in the workspace and try to achieve a better workstation layout….

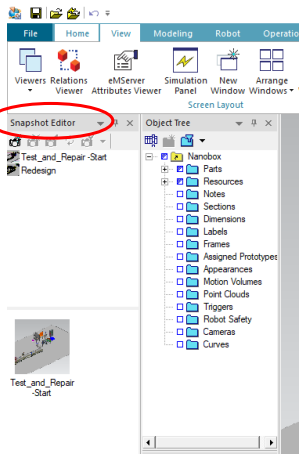
As an alternative, you can also review the simulation titled Workstation_Redesign, listed in the Operation Tree.

Before doing so, we're going to access a Snapshot of the workstation layout that is proposed as a redesign.

From the *View* Toolbar, go to **Viewers** -> **Snapshot Editor.**



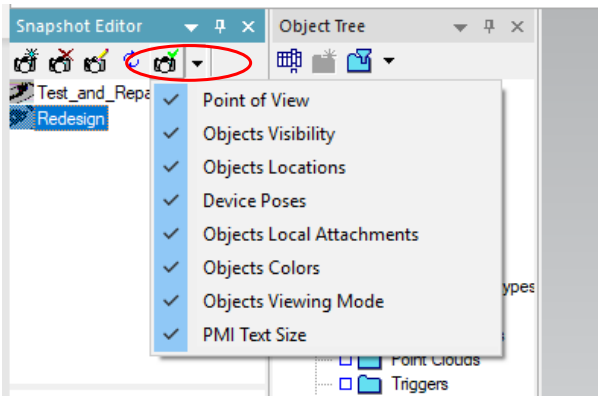
You will see a new menu added to your layout, called Snapshot Editor.



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A snapshot can be used to store scene details, such as object positions, colors, visibility states, and more. For this tutorial, a snapshot was taken before and after the workstation was redesigned, to preserve both states.

Click on Redesign, then in the *Snapshot Editor*, open the dropdown arrow next to the **Apply** icon .



Click to place a checkmark beside each option in the list. With all items checked, the snapshot will include all information captured at the time the snapshot was taken.

In the *Snapshot Editor*, double-click on the **Redesign** snapshot.

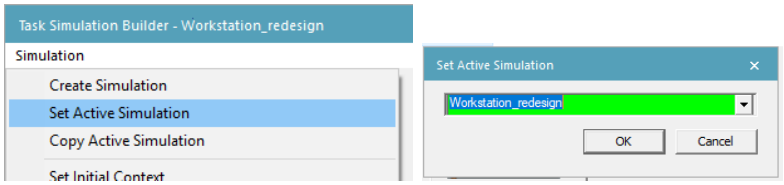
You will see the scene update.



From the *Human* toolbar -> *Task Simulation Builder*, go to *Simulation* - > **Set Active Simulation**.

In the pop-up, choose [Workstaion_redesign]. Click **OK**.

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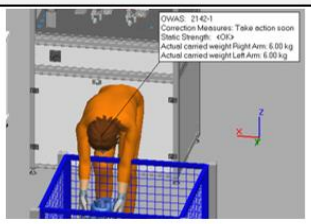
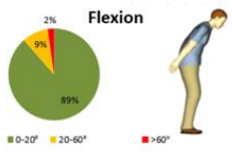
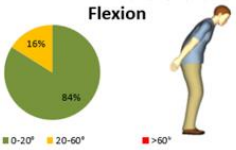
Use the *Sequence Editor* to **Play** the simulation.

Confirming Process Improvements

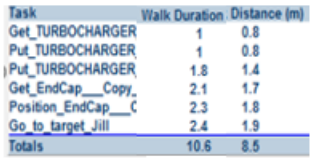
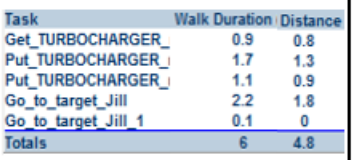
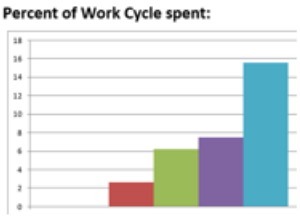
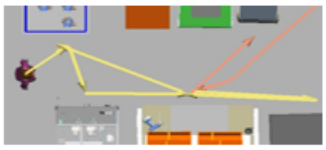
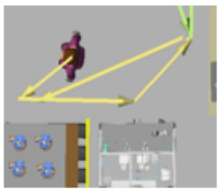
Using the new workstation design, ergonomic analyses should be re-run to confirm that improvements were made, and injury risk was reduced. In addition, analyses can verify that no new issues were introduced with the redesign proposal.

Below is a comparison of analysis outcomes for the original and redesigned workstations. This confirms that both trunk flexion and time spent walking and carrying were reduced.

You can run these reports live in the software to review analysis results in detail.

Improvement Opportunity		Before	After
Significant Trunk Flexion while Lifting Turbocharger from Bin	OWAS Score	 Category 3: Take action soon	 Category 2: Action may be needed in future
	Ergonomic Metrics Report: Maximum Trunk Flexion Angle	 Severe flexion while lifting charger (>60 degrees)	 Trunk flexion never exceeds moderate (20-60 degrees)

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Improvement Opportunity		Before	After
Significant Time Spent Walking and Carrying	Walk Analysis: Time spent Walking	 10.6 seconds / 8.5 meters	 6 seconds / 4.8 meters
	Ergonomics Metrics Report: Time spent carrying	 5.1 seconds	 2.8 seconds
	Walk Analysis: Visual inspection of walk path		

Congratulations! You have successfully completed the Process Simulate Human tutorial. You should now have familiarity with the basics of simulation creation and human analysis.

We have only touched on a sub-set of the functionality within Process Simulate, and hope you take some time to explore other features within the software, using the Help menu to guide you.

Some other commonly used options for human studies include:

Human Posturing Dialog and AutoGrasp

Posture library – full body and hand postures

Disembodied hands for hand clearance studies

Reach zones

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Vision Envelopes

Create Solids (Modeling - Geometry)

Create Dimension (Modeling - Note)

Dynamic Clipping Planes (View – Section)

… to name a few

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