STUDENT TRAINING GUIDE

Manufacturing Process Planning

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Manufacturing Process Planning

Overview

You will learn about the Aras application Manufacturing Process Planning (MPP), especially how manufacturing engineers can create and manage Manufacturing Bills of Materials (MBOM) while concurrently maintaining Work Instructions for the factory operators.

Objectives

- Describe the benefits of using Aras MPP
- Describe the Aras Manufacturing Process Planning (MPP) application
- Add items to a process plan
- Create a phantom assembly
- Create a sub-process plan
- Modify an MBOM
- Add items to the Work Instruction
- Add items to the Workbench and use them

The Challenge

- Disconnected Engineering / Manufacturing data and processes
    - Manual MBOM authoring
    - No EBOM / MBOM reconciliation
    - No MBOM / Process Plan synchronization
    - No Process Plan / Work Instruction integration
    - Digital thread with As-Designed to As-Planned traceability is not maintained
- Unmanaged manufacturing data everywhere
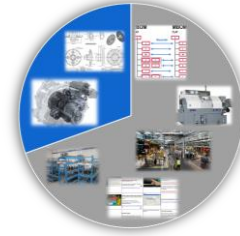
(EBOM = Engineering BOM, MBOM = Manufacturing BOM)
(Process Plan = sequence of operations including steps)

The Challenge

Traditionally in an organization, engineering and manufacturing tend to be disconnected as well as their relevant processes. On the manufacturing side, the Manufacturing Bill of Materials (MBOM) process is a tedious process with no relationship to the Engineering Bill of Material (EBOM). In addition, the disconnection leads to huge reconciliation issues between the Engineering Bill of Materials and the Manufacturing Bill of Materials. There is no synchronization between the MBOM and the Process Plan because they are often authored separately. Moreover, although the Process Plan provides input for Work Instructions, the two often have no real integration. Instead, it tends to be a serial process.

All of these challenges lead to huge traceability gaps between the As Designed and the As-Planned Bill of Materials. If there is a change on the engineering side, there is no real process for manufacturing to get informed of the change until much later; so, the MBOM, Process Plan, and Work Instruction are often out-of-date.

Finally, the data itself tends to be all over the place, in different systems, unmanaged, and in different formats.

Aras Manufacturing Process Planning

- Manufacturing Process Planning [MPP] is built on the Aras PLM Platform and integrates Product Development and Manufacturing Engineering activities
- Concurrent authoring of Process Plan, Work Instruction, & MBOM
- Automatic EBOM/MBOM Reconciliation
- Resolve Location Specific Process Plan and MBOM structures
- Conflict Resolution
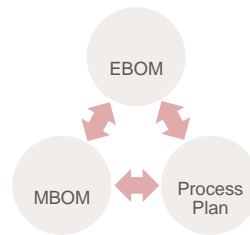
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Manufacturing Process Planning (MPP)

Aras Manufacturing Process Planning integrates manufacturing data and processes in PLM. It also enables users to derive an MBOM from the EBOM and automatically displays part consumption indicators for easy reconciliation.

MPP includes a graphical interface to concurrently author Process Plans, MBOMs, and Work Instructions. Concurrent authoring means that users can start anywhere and changes are reflected across all the views. Additionally, MPP has conflict resolution for data saves allowing multiple users to edit different levels of the multi-level MBOM at the same time.

Manufacturing BOMs

- Version controlled MBOM derived from the EBOM
  - Drag and drop restructuring
  - Concurrent Process Plan and MBOM creation
- EBOM/MBOM reconciliation
  - Real-time, automatic reconciliation indicators
  - Account for Quantity Split, Increase etc.
  - Account for Phantoms, Consumables etc.
  - Report EBOM parts not consumed in MBOM
  - View make/buy, consumed part rev and version change status
- Plant-specific MBOMs (and Process Plans)
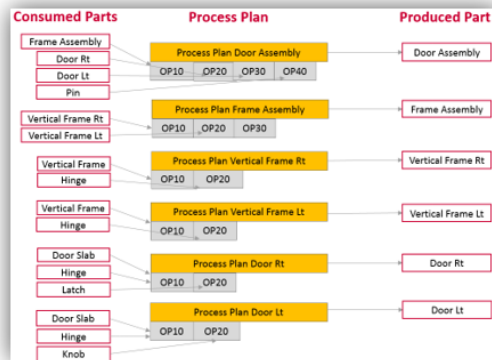
Part Number	Name	Type	Qua...	Ope...	Planned	Part Status	Reconcili...
993584872	Liftgate Power Door Lock Actuator Assy	Assembly	1				
9874586assy	Latch to Latch Actuator	Phantom	1	5	☐		
T308M28	T30 Screw	Component	2	10	☐		☑
6MJDx12MOD	Flat Washer	Component	5	10	☐		☑
9874586	Door Latch Actuator, liftgate	Component	1	10	☑		
9874556	Latch Assy Wiring Harness	Component	1	20	☐		
9874746	Latch cover panel	Component	1	40	☑		
00469901	Screws Philips Head #4	Component	2	40	☐		
52818618	Washer - Flat	Component	1	168	☐		☑

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Manufacturing BOMs

As you create the Process Plan, the MBOM is concurrently created. The MBOM and the Process Plan should be created at the same time because you should define the end item as you author the Process Plan including the required parts. The tying together of the MBOM with the Process Plan helps improve efficiencies and maintain accuracy of manufacturing data.

The ability to reconcile parts between the MBOM and the EBOM helps the manufacturing engineer understand if the parts are consumed correctly and if the quantities assigned are correct or are under-consumed or over-consumed. Reconciliation provides real time indicators in the form of icons and font colors so you can see the reconciliation between the MBOM and the EBOM.

Finally, because your Process Plans can be different, you can create plant specific MBOMs as well as plant specific Process Plans.

Process Plans

- Version controlled Process Plans
  - With Operations, Steps
  - Consume Parts, Utilize Resources
  - Reference Documents, Skills, etc.

- Workbench
  - Drag and drop items to detail out the Process Plan
  - Add additional information

Process Plans

MPP allows for version controlled Process Plans. Each Process Plan can be very detailed, including:

- Sequence of operations with detailed steps,
- Parts consumed by the operation,
- Resources required for the operations,
- Required reference documents,
- Skills required for the operations.

All of this detailed information can be added to a Process Plan. In addition, you can have parent Process Plans with each assembly in a separate Sub-Process Plan. Finally, MPP includes a Workbench so you can easily drag and drop elements into the Process Plan.

Work Instructions (WI)

- Process Plan and
  Work Instruction authoring
  - Synchronizes Process Plan items
    with work instructions
  - You can author from the WI view
  - You can include text, media and tabular content
- You can publish the visually rich WI
  to the web or as a PDF
- Displays Alternates and Substitutes
  of consumed parts, where appropriate

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Work Instructions (WI)

As mentioned earlier, Aras MPP includes concurrent authoring of a Process Plan and its corresponding Work Instruction. When you add information to the Process Plan, it is also added to the Work Instruction at the same time. Furthermore, apart from what is automatically generated by concurrent authoring, you can add other elements such as additional text, media, and tabular content that provides for richer content. Finally, you can electronically distribute the Work Instruction by publishing it as a PDF or HTML file.
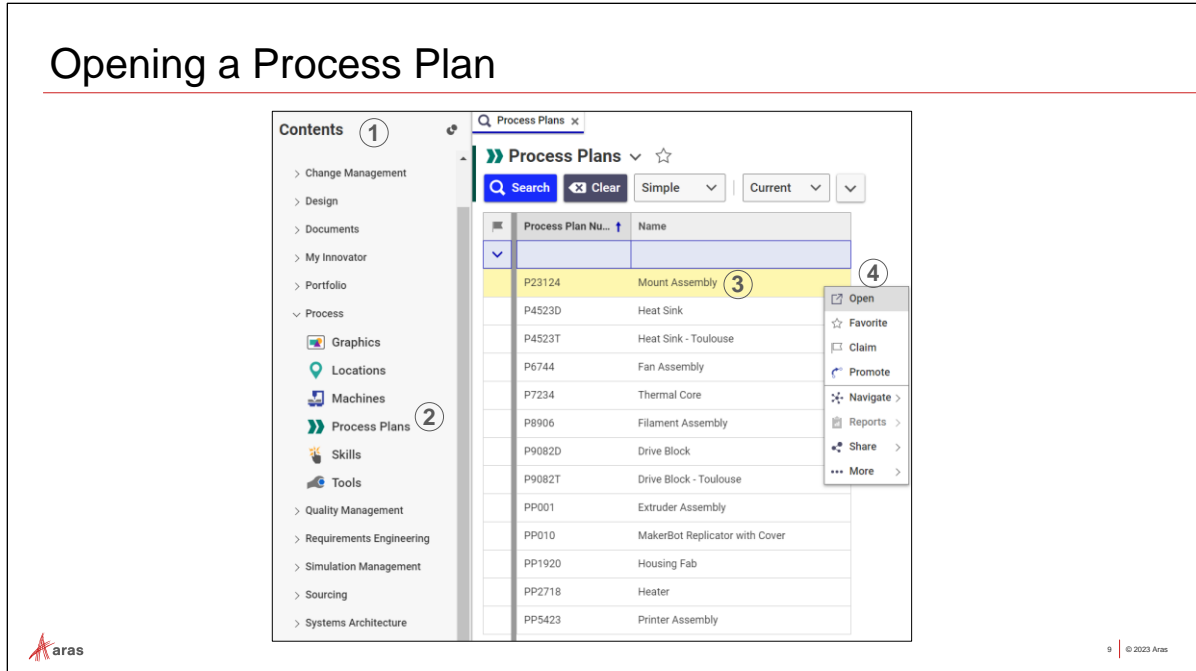
Opening a Process Plan

①	Table of Contents
②	Access to Process Plans Item Panel
③	Search results within the Process Plans search grid
④	Right click on a Process Plan to access the Context menu

A Process Plan is defined against a specific part assembly. Parts are assigned directly to the Process Plan as the Produced Part or they are added to the assembly through individual steps. The EBOM and MBOM views display the parts related to the Process Plan as well as their consumption by the Process Plan. Opening a process plan for editing allows you to make changes and prevents changes by anyone else in the system by "locking" it until you are done.

Try it … Open a Process Plan for Editing

For the examples in this session, we work with the Process Plan **P23124** (Mount Assembly).

1. Login to Aras Innovator as Mike Miller with Username "mmiller" and Password "innovator".
2. In the TOC, navigate to Process > Process Plans.
3. Run a search for Process Plans, then right click the **P23124** Process Plan and click Open from the context menu.

Process Plan (Form view)

The Form View of the document displays when the document is opened. The Form View contains the following fields:

① **Process Plan Number**
Required. Enter a number for the Process Plan.

② **Revision**
The major revision of this document. MPP documents are versioned and can be included in the Aras PLM change management process. An Aras Administrator defines the major revisions of a document.

③ **State**
Each MPP document is assigned a life cycle which can then be used as part of the Aras PLM change and release process. The current state of the document is shown in this field.

④ **Produced Part**
You must select an assembly, the produced part for each process Plan. When you add the produced part, the system adds the EBOM for the part and copies it into the MBOM.

⑤ **Locations**
Use the Locations field to add plant locations. A process plan and a work instruction can be specific to one or more locations.

⑥ **Sidebar**
The Process Plan view, the MBOM, and the EBOM are accessible from the sidebar.

Adding Items
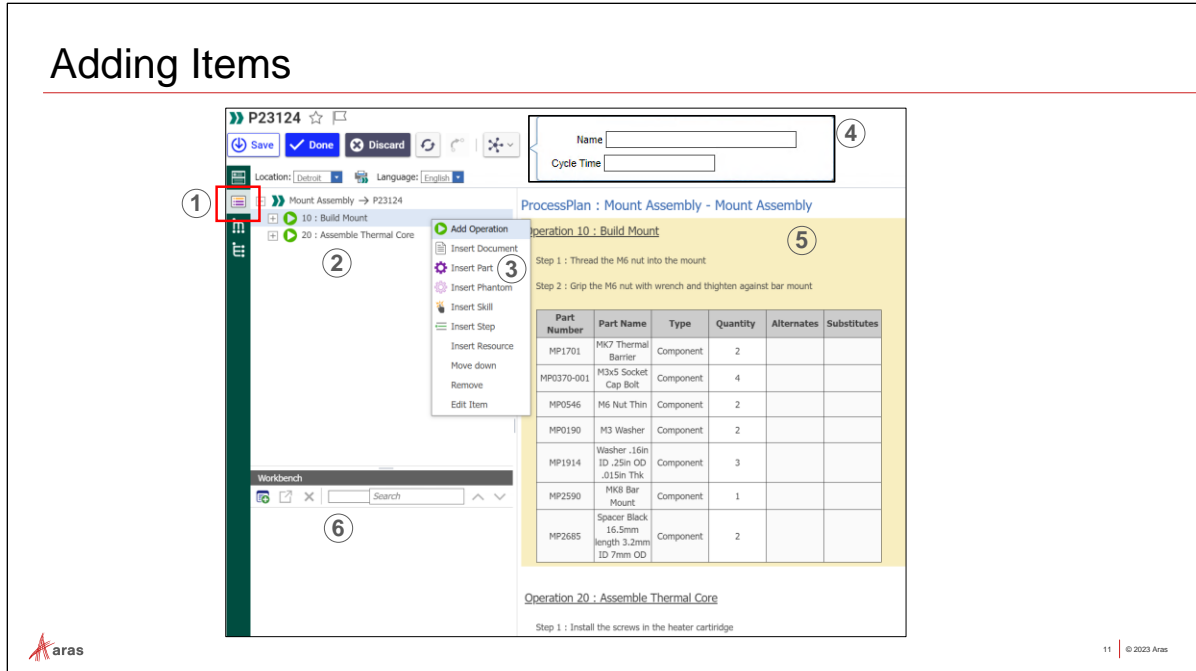
Adding Items

You can add elements to both the Process Plan and the Work Instruction by right clicking in the Process Plan's Hierarchical Tree (left pane) or by right clicking in the Work Instruction (right pane).

Note:

These are the usual steps for adding new elements.

①	Access the Process Plan Hierarchical Tree view and the Work Instruction panes from the Innovator sidebar.
②	The process plan (displayed as a Hierarchical Tree in the left pane) is a sequence of operations, steps, consumed parts, tools and machines, documents, and skills. You can also create an assembly, which has its own sub-process plan.
③	Right clicking an element in the Hierarchal Tree, displays a context menu for adding additional elements.
④	You can also add additional elements to the Work Instruction to enhance the steps to aid the technicians on the shop floor. (Set Up and Cycle times are in minutes.)
⑤	The Work Instruction, right pane, is concurrently created and elements are concurrently added to the work instruction as you create the process plan.
⑥	The Workbench, discussed later, is below the process plan.

Try it … Add Items to a Process Plan

In this exercise, you add an operation and two steps to an existing process plan.

1. Click Edit on the **P23124** Process Plan. Then click 'Show Process Plan' from the sidebar.
2. Right click on Operation 20 in the Process Plan view's Hierarchical Tree.
3. From the context menu, select Add Operation.

   Notice the new operation number is determined by the system administrator. You can leave it as the number 30.

4. In the pop up window, enter the information as follows:

Operation Number	30
Name	Test Thermal Core
Description	Run standard Thermal Core test
Setup Time (in minutes)	.5
Cycle Time (in minutes)	2.5

5. Press the Enter key or click elsewhere, outside of the pop up window to accept the values. Notice that items added to the process plan are concurrently added to the work instruction ⑤.
6. Right click on the new operation 30 and click to select Insert Step:

Name (Step 1)	Turn on and set the multi-meter
Cycle Time (Step 1)	.5

Remember to press the Enter key or click elsewhere, outside of the pop up window to accept the values.

7. Right click on Step 1 and click to select Add Step for Step 2, as follows:

| Name (Step 2)	Use multi-meter to test the Thermal Core
Cycle Time (Step 2)	2.5

Remember to press the Enter key or click elsewhere, outside of the pop up window to accept the values.

8. Save the Process Plan.
   Notice that the work instruction is also updated with the new operation and steps.

Note:

You can also right-click a process plan item in the Work Instruction pane and use the context menu to add items to the Process Plan hierarchical tree pane.

Adding a Phantom Assembly
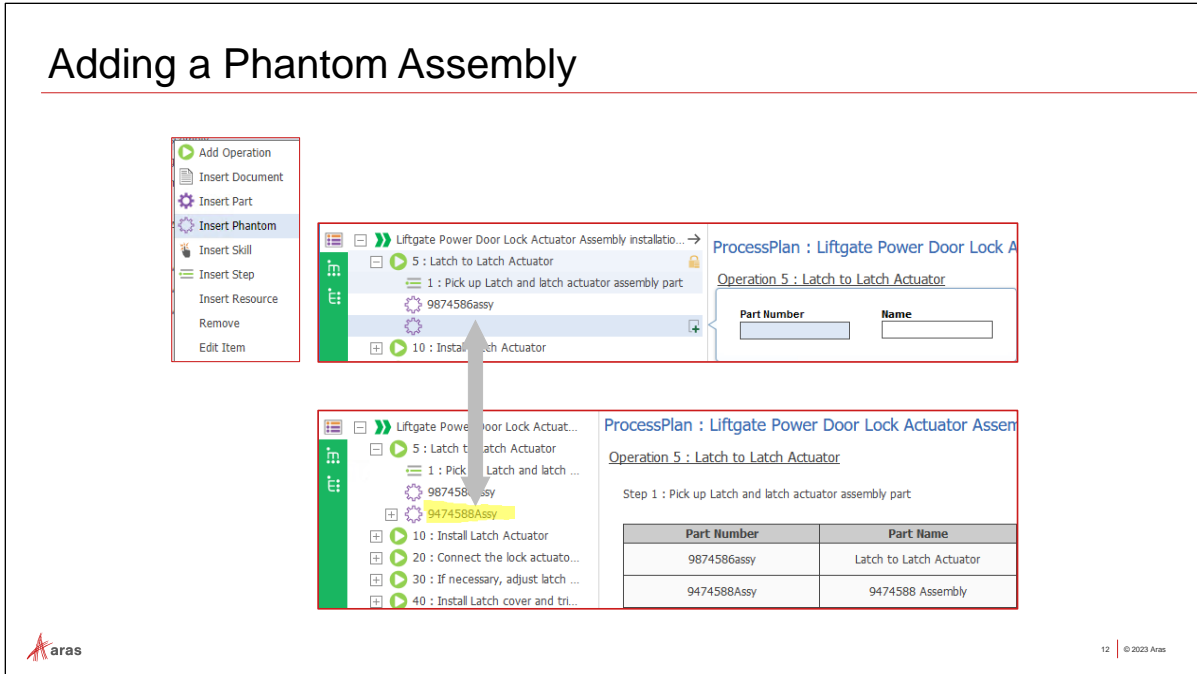
Adding a Phantom Assembly

A phantom assembly is a non-stocked assembly that lets you group together material needed to produce a subassembly. Phantom Assemblies are added as new Part Numbers to the process plan and the work instruction. The (assembly) part is also added to the MBOM. Remember, the added phantom assembly displays in the MBOM because all of your data is synchronized as you work.

Try it … Add a Phantom Assembly

In this exercise, you add a phantom assembly.

1. In **P23124** Process Plan, right-click Operation 30 and select Insert Phantom from the context menu.
2. In the fly-out window, enter the following information:

Part Number	9474588FanAssy
Name	9474588 Fan Assembly

3. Press the Enter key to accept the values.
4. Click the Save button.

Note:

In addition to the process plan, the phantom assembly also concurrently displays in both the Work Instruction and the MBOM.
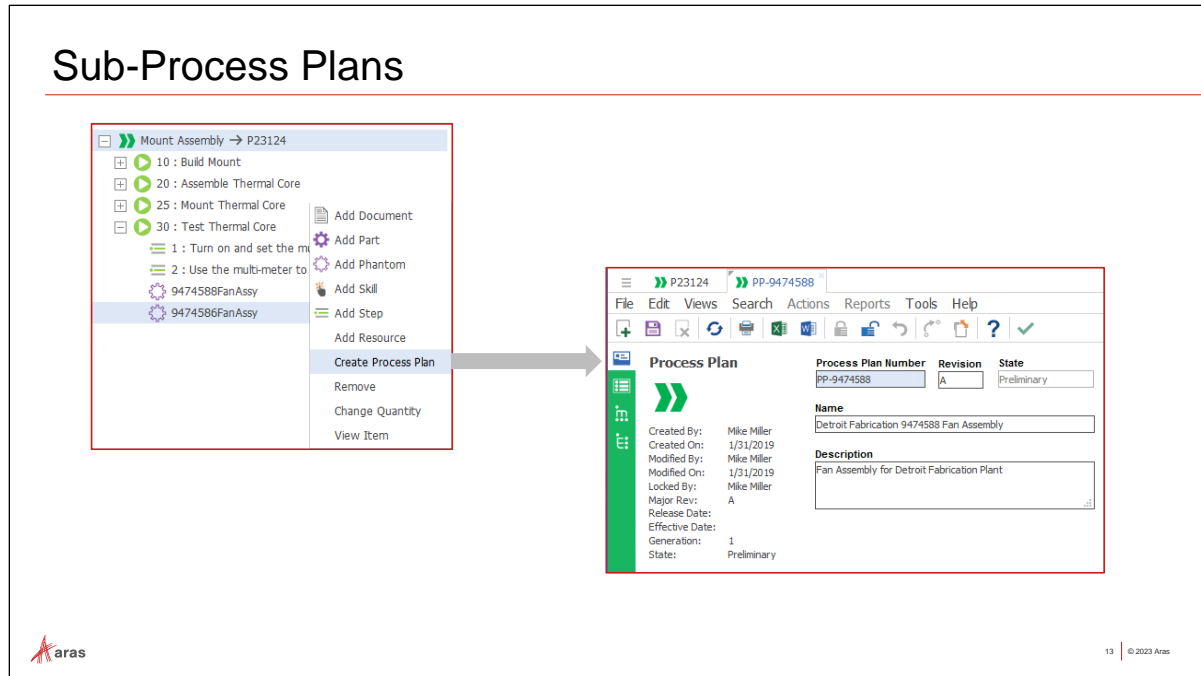
Sub-Process Plans

Any part or assembly, including phantom assemblies can have its own process plan, referred to as a sub-process plan. There are no restrictions on the number or levels of sub-process plans. Also, more than one person can concurrently edit different parts of a process plan.

The Sub-Process plan is, initially, specific to the location of the (Parent) Process Plan. Once created, you can access the Sub-Process plan either from the (Parent) Process plan or from the TOC.

Try it … Create a Sub-Process Plan

In this exercise, you create a Sub-Process Plan for the Detroit location for the phantom assembly.

1. In the Process Plan's Location drop down list, ensure that you are on the Detroit Location.
2. From the Process Plan's Hierarchical tree, right click phantom assembly **9474588FanAssy** and select Create Process Plan from the context menu.

Notice that a new process Plan opens for editing in its own tab in Aras Innovator. This Sub-Process plan is created for the Phantom Assembly you selected for the current location (Detroit).

3. Fill the values as follows:

Process Plan Number	PP-9474588
Name	9474588 Fan Assembly
Description	9474588 Fan Assembly

4. Click the Save button.
5. Click to open the Locations tab of the Relationship grid. Notice this Sub-Process Plan is only used at the Detroit location.
6. Click Done and close this Sub-Process Plan.
7. Click Done, but do not close, the (Parent) Process Plan.
8. In the Hierarchy Tree, expand the Phantom Assembly to see the new Sub-Process Plan.
9. Now switch locations to the Toulouse location and notice the Phantom Assembly does not have the new Sub-Process Plan.
10. Switch back to the Detroit Location.
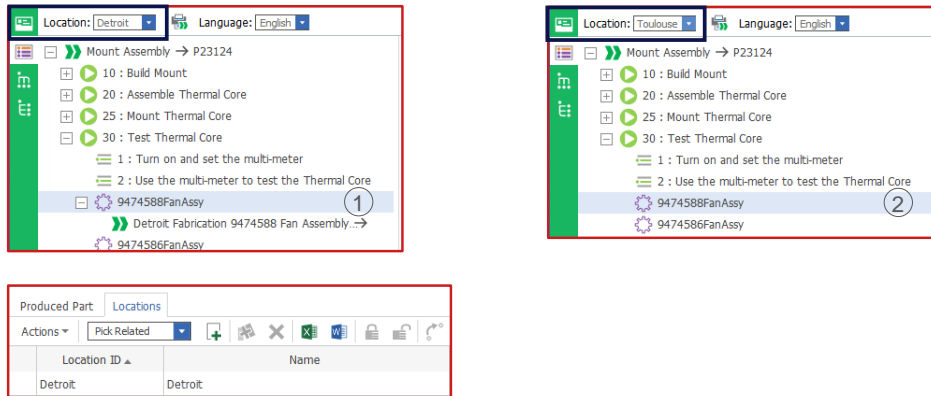
Location Specific Sub-Process Plans

Location specific sub-process plans are useful when different locations might have slightly different processes for a specific part or phantom assembly. In this example, Process Plan 9474588FanAssembly is specific to the Detroit location.

You can also add any Sub-Process plan to any additional locations.

Try it … Add a Sub-Process Plan to an additional location

In this exercise, you add the Sub-Process Plan you created earlier, to the Toulouse location.

1. Ensure you are on the **P23124** (Parent) Process Plan and verify the location is Detroit.
2. Expand the Phantom Assembly: **9474588** Fan Assembly.
3. Right mouse click on its Sub-Process Plan **PP-9474588** and click to select View Item from the context menu.
4. Open the Sub-Process plan for editing.
5. Open the Locations tab of the Relationship grid.

    Please note that you might have to first move the Relationship grid up to view it.

6. Click on Add Locations button and select Toulouse in the Search dialog window.
7. Click Done and close the Sub-Process Plan.
8. Now, back in the (Parent) Process Plan, switch to the Toulouse location.
    You should now see the Sub-Process plan at both the Detroit and the Toulouse locations.
9. Close the (Parent) Process Plan.

Note:

You can also view any Sub-Process Plan using the TOC.

The EBOM View

Click the **Show EBOM** button from the sidebar ① to view the EBOM. The EBOM view has two additional columns that differ from the usual Innovator EBOM: Part Status and Reconciliation Status ②. MPP uses these two columns to show the real time reconciliation between the EBOM and the MBOM. While the EBOM View for the process plan is not editable, it is dynamic. As you add, remove or edit parts in the MBOM, the Part Status and the Reconciliation Status columns the system dynamically updates the EBOM.

The following table depicts the icons used to show reconciliation status between the EBOM and the MBOM.

Overconsumed Quantity
The MBOM contains more than the EBOM.

Partially Consumed Quantity
The MBOM has only consumed some of the EBOM quantity.

Split Quantity
The quantities are split in the MBOM, used in several different places.

Not Accounted in MBOM
An EBOM part is not used in the MBOM. This is the starting state for all parts when the process Plan is first created.

New Version

There is a newer version/generation of the part available in the EBOM

New Revision
The EBOM requires a newer version than what is in the MBOM.

In the picture, above, notice the red line ③ in the EBOM view, through MP2938, an assembly. A red line appears if a sub-assembly in the EBOM is not consumed in the MBOM, but the children Parts of that sub-assembly have been consumed in the MBOM. The EBOM View depicts the assembly's parts by showing the consumed children of the assembly and how they are consumed in the MBOM.

Try it … Open the EBOM view

In this exercise, you look at the EBOM view for the produced part of the process plan.

1. Open the **PP010** Process Plan (MakerBot Replicator with Cover).
2. Using the sidebar, click the Show EBOM button.
3. Expand the **MP2954** Extruder (Assembly) part.
4. Move the mouse cursor over the icons in the Reconciliation Status column.
5. When you finish viewing the EBOM, return to the Process Plan view by clicking the Show Process Plan button in the sidebar.

The MBOM view

You open the MBOM View for the process plan by clicking Show MBOM button from the sidebar. Like for the EBOM view, two columns have been added to the MBOM View to help with EBOM reconciliation: Part Status and Reconciliation Status. MPP uses these two columns to show the real time reconciliation between the EBOM and the MBOM.

The MBOM is editable. You can edit the Quantity or the Operation for each part. When you change the quantity of a part on the MBOM, the Reconciliation is automatically adjusted to reflect the edited quantity and the work instruction is also updated. And as you add parts to the process plan or to the work instruction, the MBOM also gets updated with the added part.

The following table (repeated from the previous slide) depicts the icons used to show reconciliation status between the EBOM and the MBOM.

Overconsumed Quantity
The MBOM contains more than the EBOM.

Partially Consumed Quantity
The MBOM has only consumed some of the EBOM quantity.

Split Quantity
The quantities are split in the MBOM, used in several different places.

Not Accounted in MBOM
An EBOM part is not used in the MBOM. This is the starting state for all parts when the process Plan is first created.

New Version

There is a newer version/generation of the part available

New Revision
The EBOM requires a newer version than what is in the MBOM.

Note:

The MBOM has an additional column: Planned. The systems checks this field when a Process plan is created for a sub-assembly.

Try it … Modify the MBOM

In this exercise, you change the quantity required for a part in the MBOM and then view the changed quantity on the Work Instruction.

1. Edit the **PP010** Process Plan.
2. Ensure the Location is set to Detroit.
3. Open the MBOM View for the process plan by clicking the Show MBOM button from the sidebar.
4. Expand the part: **P5423** (Printer Assembly).
5. Expand the part: **MP2954** (Extruder).
6. Expand the part: **P8906** (Filament Assembly).
7. Change the Quantity of part **MP1914** (Washer .16in ID .25in OD .015in Thk) from 1 to 2, and then press the Enter key.
8. Click the Save button and return to the Process Plan view.

Try it … View the Concurrent Change

Now we will view the concurrent change in the sub-Process Plan's work instruction.

Note:

You will be opening the sub-Process Plan P8906 related to the sub-assembly where a consumed part's quantity was changed in the last try-it.

1. From the TOC, open the **P8906** Process Plan (Filament Assembly) for viewing.
2. Click the Show process Plan button on the sidebar.
3. Expand the sub-process plan's Operation 20, Assemble Hardware.
4. Click on Step 1: Assemble hardware on filament.
5. In the Work Instruction, look at the Parts list below the highlighted Step and in the parts table. Notice that the work instruction is now also showing a quantity of 2 for the MP1914 part.
6. You can close **P8906** Process Plan.

Editing the Work Instruction
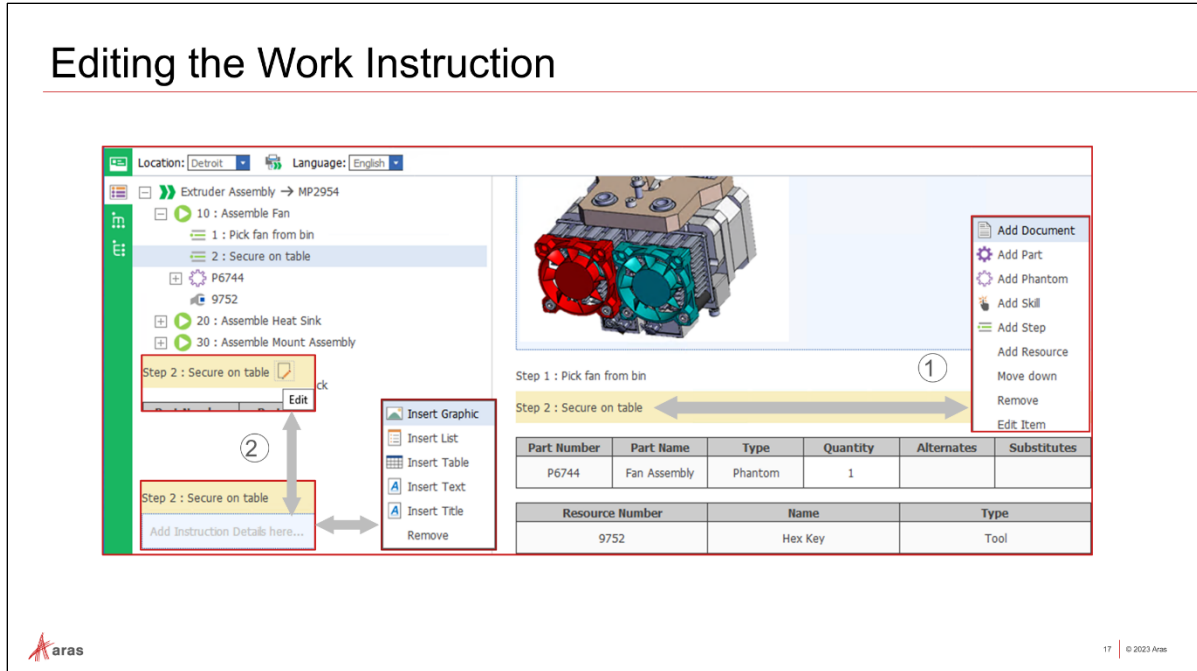
Editing the Work Instruction

As you learned, items added to the process plan are concurrently added to the work instruction and vice versa: process plan items added to the work instruction are concurrently added to the process plan. Add process plan items to the work instruction ① by right clicking a process plan item preceding the location for the new item.

Most items added in the hierarchical tree will also appear in the Work Instruction if they are interesting for the factory floor operators (e.g., Parts, Tools). Skills will not appear on the Work Instruction.

You can also add additional information to enhance the work instructions for the factory floor. As shown here, you can add additional graphics, lists, text, and titles. To add additional information to the Work Instruction, ② move the mouse over the item where you want to add it. When you do, an Edit button displays. Clicking the Edit button creates an empty (blue-gray) field. Right click the new field and click to choose an element from the context menu.

Try it … Add additional items to the Work Instruction

In this exercise, you add additional items to the Work Instruction.

1. From the TOC, perform a simple search, and open **PP5423** Process Plan (Printer Assembly) for editing.
2. From the sidebar, open the Process Plan view.
3. For operation 10: Assemble Printer, in the Work Instruction (the right pane), move the mouse cursor over Operation 10 until you see the Edit button at the end of the text, and click the Edit button. Notice the Work Instruction adds a blue-gray field for adding additional information to the work instruction.
4. Right click in the blue-gray field and select Insert Graphic from the context menu.
5. Click Add Item, then in the search dialog – Graphic window, search for and select BuildPlatform – Shaded, BuildPlatform - 301 by selecting it, and then click OK.

Notice the new graphic is added to the Work Instruction.

6. Click the Save button.
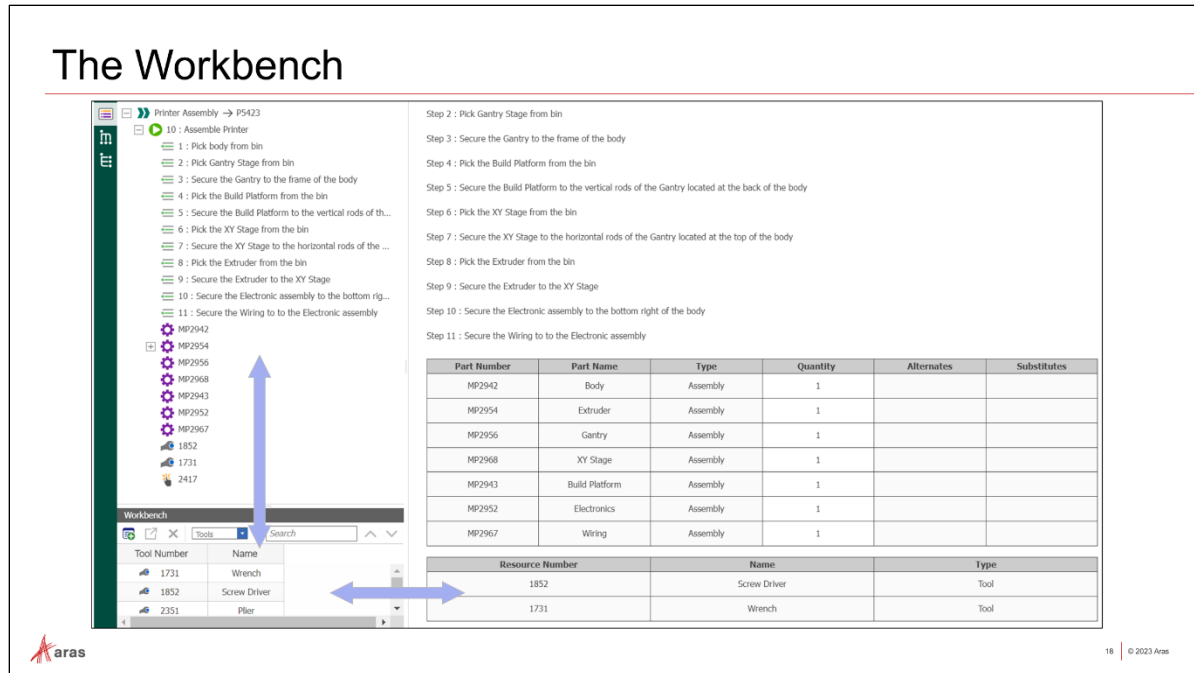
The Workbench

The Workbench pane displays below the Process Plan View's Hierarchical Tree (In the left pane). The workbench can include Parts, Tools, Machines, Documents, or Skills. Use the Workbench to add parts, graphics, machines, skills, and tools to the process plan. Parts are automatically loaded into the workbench from the EBOM. Items can be dragged and dropped from the workbench into the Process Plan's Hierarchical Tree.

Note:

The Workbench is a non-persistent view, except for 'Parts' which shows the EBOM.

Try It … Add items to the Workbench

Because the Workbench is a non-persistent view, in this exercise, you add items to the workbench.

1. Ensure **PP5423** Process Plan is locked for editing (from the previous exercise).
2. In the Workbench view, there is an empty drop down list field.
   Click the drop down list button and click to select Tools.
3. In the Workbench view, click the Add Items button to open the Search Dialog – Tool window.
4. In the Search dialog – Tool window, click to select (Ctrl + a) all four tools (Wrench, Screw Driver, Plier, and Hex Key), and click OK.

   Notice, the four tools are added to the Workbench.

5. Again, click the Workbench drop down list button, select Skills and add the two technicians.

Note:

Recall that the Workbench is non-persistent and items added to the workbench are not saved.

Try it … Add items to the Process Plan from the Workbench

In this exercise, you add a tool and a skill from the Workbench to the process plan.

Note:

As you drag and drop Workbench items into the (left pane) Hierarchical Tree, the system displays "Insert Item into…" text for each Operation as you move up the Hierarchical Tree.

1. In the Workbench, ensure that Skills is still selected in the drop down list from the previous exercise.
2. From the Workbench, click, hold, and drag the **2417 Technician 1** skill from the Workbench up to Operation 10 in the Process Plan's Hierarchical Tree until you see "Insert Item into…".

Notice the 2417 Technician 1 skill is added to the Operation 10 in the Process Plan's Hierarchical tree. Also notice that Skills are not added to the Work Instruction.

3. Click the Save button.
4. Again, set the Workbench drop down list to Tools.
5. Drag and Drop the **Wrench** tool, on to Operation 10.

Notice the 1731 Wrench tool is added to the Operation 10 in the Process Plan's Hierarchical tree. Also notice that the tool is also added to the Work Instruction.

6. Click Done, then close the **PP5423** process plan.

That concludes the exercises for this course. After saving your work, you can close all open tabs.

Summary

In this unit, you learned about Manufacturing Process Planning including Process Plans, Work Instructions, the Workbench, and concurrent updates to the Work Instruction and the MBOM.

You should now be able to:

- Describe the benefits of using Aras MPP
- Describe the Aras Manufacturing Process Planning (MPP) application
- Add items to a process plan
- Create a phantom assembly
- Create a sub-process plan
- Modify an MBOM
- Add items to the Work Instruction
- Add items to the Workbench and use them

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