Microsoft Dynamics® AX 2012

Lean manufacturing: Production flows and activities

White Paper

This paper introduces production flows and activities and shows how they are used in Lean manufacturing for Microsoft Dynamics AX 2012 to model the lean organization of a company. Its goal is to help Microsoft Dynamics AX consultants and managers who are responsible for production, costing, or supply chain understand the range and scalability of the functionality of Lean manufacturing for Microsoft Dynamics AX 2012 by providing a collection of independent scenarios.

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Microsoft Dynamics

Table of Contents

Introduction

Microsoft Dynamics AX 2012 introduces a new architecture that allows a new way of modeling lean manufacturing based on production flows that consist of process and transfer activities. Lean manufacturing for Microsoft Dynamics AX 2009 introduced two different concepts to support pull and flow: pull to order (PTO) kanbans and lean order schedules (LOS). Lean manufacturing for Microsoft Dynamics AX 2012 reconciles these two approaches in a single architecture. Production flows help you to model and version lean production scenarios and to keep material flow and cost consistent.

We highly recommend that before you attempt to implement Lean manufacturing for Microsoft Dynamics AX 2012, you invest time in learning the principles, goals, and methods of lean manufacturing. Successful implementation of lean manufacturing depends more on the maturity of the lean organization of a company and the knowledge of consultants than it does on the software tools used to implement it.

All examples of production flows in this document are described by using the notation of value stream mapping. The examples were created by using the Value Stream Map stencil in Microsoft® Office Visio®. The graphical representation of production flows in value stream mapping notation is not part of the functionality of Microsoft Dynamics AX 2012. To learn more about value stream mapping and the related graphical notation refer to the book *Learning to See* by Rother and Shook, published by the Lean Manufacturing Institute.[1]

Document purpose

This paper introduces production flows and activities and shows how they are used in Lean manufacturing for Microsoft Dynamics AX 2012 to model the lean organization of a company. Its goal is to help Microsoft Dynamics AX consultants and managers who are responsible for production, costing, or supply chain understand the range and scalability of the functionality of Lean manufacturing for Microsoft Dynamics AX 2012 by providing a collection of independent scenarios.

[1] Rother, Mike, and John Shook, *Learning to See*, version 1.3. Cambridge, MA: The Lean Enterprise Institute, 2003

Terminology

Lean manufacturing terms:

Term	Definition
activity occurrence	A sequence of tasks that human and operations resources perform at specific times and locations between the start and end of an activity.
backflush costing	A method of accounting for or costing materials that you have used to produce an item.
circulating card	A reusable card that signals process and transfer activities as it circulates between the material's point of origin and its point of consumption.
cost accumulation method	The method that is used to maintain and aggregate cost accounts in order to determine the transformation cost and its allocation.
kanban	In lean manufacturing, a pull signal that represents demand and triggers process and transfer activities for a unit of a specific item or item family.
takt time	In lean manufacturing, the time that it takes to produce one unit of a product.
value stream	In lean manufacturing, an operating unit that owns one or multiple production flows that describe the activities and flows needed to supply a product, goods, or a service to the consumers of the product.
work cell	In lean manufacturing, a resource group that is assigned to execute a process activity flow.

Production flows in lean manufacturing

A lean manufacturing scenario is more than a mere agglomeration of unrelated kanban rules or material-supply policies. In fact, the flow of material and products through work cells and locations for a specific production or supply scenario can be described as a sequence (or a small network) of tightly related process and transfer activities collectively called a *production flow*.

In production scenarios that are based on production orders, material is issued to a specific production order. During a sequence of operations that are based on bills of materials (BOMs) and routes, products are created and finally received at the supplied location. The throughput time of production orders varies in ranges of minutes to weeks. In production scenarios that are based on production orders, material is issued to a specific production order. During a sequence of operations that are based on bills of materials (BOMs) and routes, products are created and finally received at the supplied location. The throughput time of production orders varies in ranges of minutes to weeks. Production orders and batch sizes that are too big are partially responsible for long lead times and the resulting excess inventory. Companies usually implement lean manufacturing to reduce lead times and excess inventory.

To reduce delivery lead times and excess inventory between work centers caused by batch production, lean manufacturing introduces kanban replenishment and supermarkets in manufacturing and warehouse replenishment. This usually disrupts the production to partially independent kanban cycles. In a production order, a semi-finished item can only be produced when the job for the finished item is created. In a kanban scenario, the semi-finished items are usually produced before the job for the finished items even exists or the variant of the finished item that will be needed is yet to be determined. Therefore, a cost allocation for the finished item is impossible at the time of the production of the semi-finished product. The replenishment of a kanban for a semi-finished product is not triggered by an order for a finished product any more.

To re-establish a production and cost context for the various kanban scenarios proposed in Microsoft Dynamics AX 2012, activity-based production flows are introduced as the backbone of lean manufacturing. All kanban rules refer to this predefined structure. The activity-based model allows the setup of a wider range of scenarios than supported by previous versions of Lean manufacturing for Microsoft Dynamics AX, without adding complexity for the shop floor workers because all scenarios use the same activity-based user interface.

Semi-finished products (non BOM levels)

In previous versions of Microsoft Dynamics AX, kanban rules could not be set up for semi-finished products. A common mitigation for this issue was to introduce additional BOM levels that would result in a non-lean explosion of BOM levels and inventory transactions. Lean manufacturing for Microsoft Dynamics AX 2012 integrates kanbans for inventoried products and semi-finished products in a single framework, offering a unified user experience for all cases.

Semi-finished concepts are discussed in detail in the Semi-finished section.

Products and material in work in process (WIP)

The reduction of batch sizes down to the ideal state of a single piece flow in lean manufacturing can cause a dramatic increase of inventory transactions if each picking process or kanban registration causes transactions for the consumed items. The production flow architecture allows the transfer of material to the production flow with withdrawal kanbans in storage or transport handling unit sizes. The value of the issued material is added to the work in process (WIP) account related to the production flow—similar to material that is issued to a production order. The same principle can be applied for products and semi-finished products, unless they are created, transferred, or consumed within a production flow. Once the products are posted to inventory, the WIP account of the production flow is deducted by the related standard cost.

WIP is discussed in detail in the Work in process (WIP) section.

Value streams and value stream mapping

The architecture of Lean manufacturing for Microsoft Dynamics AX 2012 is inspired by the five lean principles formulated by Womack and Jones in their book *Lean thinking*: customer value, value stream, flow, pull, and perfection.[2] The approved method for implementing lean manufacturing solutions in the physical world of manufacturing is value stream mapping (VSM) introduced by Rother and Shook in their book *Learning to See* (cited earlier).

The result of the value stream mapping process, the future state value stream, which is the result of the value stream process described by Rother and Shook, can be modeled in Microsoft Dynamics AX 2012 as a production flow version. All processes of the value stream are modeled as process activities. Movements or transfers can be modeled as transfer activities if the transfer status has to be registered or if an integration to inventory picking or consolidated shipments is required.

The value stream itself is modeled as an operating unit in Microsoft Dynamics AX 2012. This allows you to use the value stream as a financial dimension.

Costing for lean manufacturing based on the production flow

Lean manufacturing disrupts the traditional cost concepts of job costing because the context of a production order is not available. In Lean manufacturing for Microsoft Dynamics AX 2012, you can use the production flow as the cost accumulator. Cost of material, semi-finished, and finished products is tracked per item and cost group. WIP is tracked per production flow.

Costing for lean manufacturing in Microsoft Dynamics AX is based on the costing framework for standard cost. This requires that finished products and material are set up for standard cost so that they can be used in the lean manufacturing context.

Lean manufacturing for Microsoft Dynamics AX 2012 allows you to calculate the standard cost of a product based on the production flow and the kanban rules, making lean manufacturing completely independent of routes. However, you can still calculate items based on routes and produce them through lean manufacturing.

The concepts of dynamic material consumption that are introduced with Lean manufacturing for Microsoft Dynamics AX 2012 make costing independent of BOM line quantities and scrap factors, and they allow you to accurately report consumption without having to report quantities by job.

The periodic consolidation of the cost for a production flow, the backflush costing, recalculates the actual cost of material and the products in WIP, based on the status of kanban jobs, and the handling units in the production flow allow you to determine variances for the products supplied by the production flow.

Costing concepts for lean manufacturing will be discussed in detail in the Costing for lean manufacturing section.

Continuous improvement

To better support continuous improvement, the production flows are implemented in time-effective versions. This allows you to copy an existing production flow version, including all related kanban rules, to a future version of the production flow, and to model the future-state production flow before you validate and activate it for production. Existing kanbans from old production flow versions are automatically related to the new version to ensure a seamless material flow on the transition date and beyond.

Continuous improvement concepts will be discussed in detail in the Production flow versions section.

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[2] Womack, James P.; Daniel T. Jones. Lean Thinking. Free Press, 2003

Simplicity

One can debate whether an implementation of lean manufacturing has to be very simple to set up for users to be successful. In previous versions for Lean manufacturing for Microsoft Dynamics AX, this was one of the applied principles. However, for more advanced requirements, a framework that is too simple leads to usability restrictions and, in the worst case, to inconsistencies and redundancies. For the implementation of Lean manufacturing for Microsoft Dynamics AX 2012, we have chosen the *production flow and activity* approach that allows you to model simple and complex production scenarios in a single, scalable architecture.

A closer look at the activity-based concept reveals a new simplicity for the users who really need it—the shop floor and logistics workers. By reporting against activity-based jobs instead of inventory transactions, a unified user interface for all lean manufacturing variants transfers the business complexity from the user interface to where it belongs—the production flow as the backbone of lean manufacturing.

Mixed-mode manufacturing

Lean manufacturing is fully integrated with Microsoft Dynamics AX 2012 and can be used in combination with, and concurrent to, all supply, production, and sourcing strategies such as:

- Production orders
- Batch orders (Process industries)
- Purchase orders
- Transfer orders

Microsoft Dynamics AX 2012 introduces a new planned order type kanban that allows scheduling for kanban execution to be activated by item or by item and coverage locations (site/warehouse).

Production flows, activities, and kanban rules define the supply policies for lean manufacturing. They are not needed for other sourcing strategies.

Microsoft Dynamics AX 2012 allows the usage of different production strategies for the same item in the same company on the same site.

An item supplied through multiple production strategies on a single site requires a common standard cost context for all replenishment strategies. Lean manufacturing requires a standard cost setup for all finished products and materials used in a production flow.

Simple production flows

This section introduces many different types of basic production flows. These basic production flows may occur in many cases where lean manufacturing and kanban are implemented for the first time. These simple examples also provide an introduction to the core principles of the production flow and activity architecture of Lean manufacturing for Microsoft Dynamics AX 2012.

According to Rother and Shook, a production flow has to be defined from "door to door," and not just as a single activity. Lean manufacturing is not supposed to introduce local optimizations, but should look at production flows from an end-to-end perspective. However, there are a number of good reasons to look at simple production flow examples:

- It is easier to understand the concepts and capabilities with simple models.
- In an ideal setup, all operations needed to produce a product are performed in a single work cell, so they can be collapsed into a single-process activity.
- Implementing Lean is a journey and it is not expected that a company will convert everything at once. It is valid for a first implementation of Lean manufacturing to focus on specific product families or work cells and then progress from there.

Single-process activity production flow

The simplest production scenario for lean manufacturing is a production flow in which all the operations are grouped in a single-process activity in a single work cell. The demo data for Microsoft Dynamics AX 2012 contains the following example of this type of production flow, as shown in Figure 1.

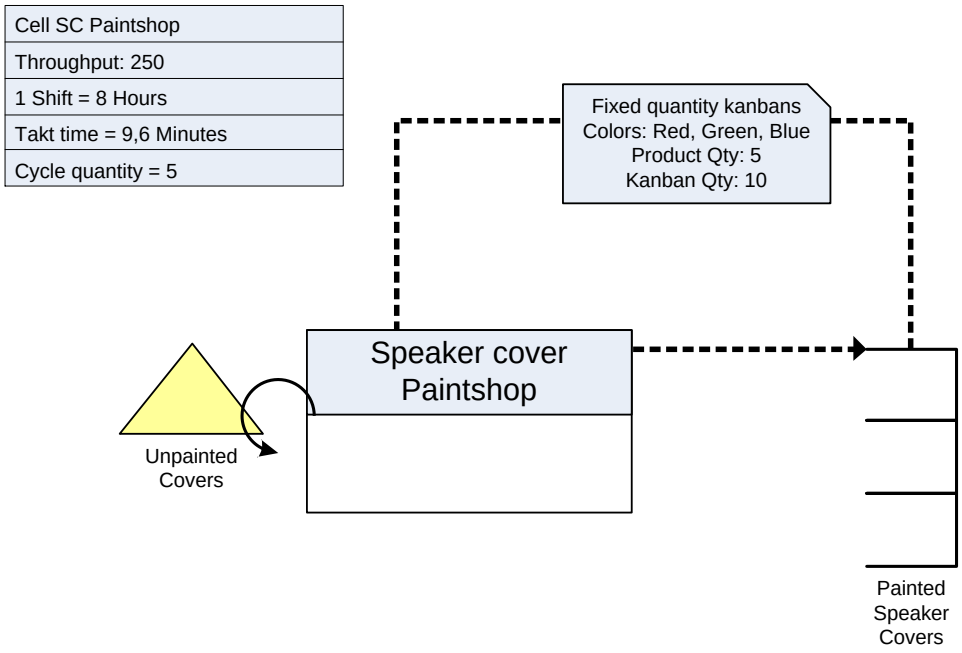

Figure 1: Single-process activity production flow from Microsoft Dynamics AX demo data

In this example, the speaker cover paint shop is picking unpainted covers from a warehouse. The painted covers are supplied to a supermarket where they can be picked for other manufacturing processes or for sales.

The production flow is set up for the general activity titled "Painting." This activity will cover all item variants (colors), and the specific painting process that is applied, assuming that it happens in the same group of resources at the same physical location. The activity times and cycle times for a production flow activity are initially set for an average process. For each output item for each work cell, a throughput ratio can be defined that represents the relative resource consumption compared to the default runtime and cycle time.

Defining a work cell

In Microsoft Dynamics AX, work cells are modeled as resource groups. When resource groups are marked to be used as work cells, additional validations are made when the resource group is created.

To define a work cell for lean manufacturing in Microsoft Dynamics AX 2012, the following steps must be performed:

1. The production flow model must be defined for a category of work cells that have a similar behavior in capacity load. The most important property to decide on is the model type, which can be set to the throughput or the hours model.
2. A working calendar corresponding to the work cell must be set up, and it must have a property of a standard workday.

3. The sites, warehouses, and locations must be created in the inventory breakdown.
4. A resource group must be created:
    - The resource group must be marked to act as a work cell. This prevents resource scheduling from loading resources allocated to the resource group when running finite capacity scheduling.
    - Input and output warehouses and locations must be specified.
    - A runtime cost category must be defined for the work cell if direct labor is tracked in costing.
    - A calendar must be assigned to the work cell.
    - The work cell capacity must be defined.
    - For work cells managed by a subcontractor, a resource of type Vendor must be assigned to the work cell.

Creating a production flow

To map a lean manufacturing scenario to Microsoft Dynamics AX, a production flow must be defined. The production flow defines the organizational context of a manufacturing scenario and relates to accounting and costing. The relations of the production flow to the production group, financial dimensions and value stream are needed to create and post financial transactions for kanban jobs.

The production flow must have the following settings:

- A unique name.
- A description.
- A legal entity that owns the operations in the production flow.
- An operating unit of type Value stream that can be configured to be used as a financial dimension.
- A production group that defines the set of accounts that are used for the financial postings related to the production flow. The most important accounts are the WIP and Offset accounts that are the basis of variance calculation for the production flow.
- Optional. The setting of the financial dimension for the production flow.

Creating a version for the production flow

The activities of a production flow are organized in time-effective versions. A simple production flow usually needs only one version. The time effectiveness allows you to set up versions for the future or to set an expiry date on a production flow version if the version or the complete production flow is discontinued at a certain point in time.

To start modeling the production flow activities, a production flow version must be created. The version details specify the takt requirements of the production flow. These are used at activation to calculate the actual cycle time requirements of each activity in the production flow. For a single-activity production flow, the takt requirements of the production flow version are equal to the cycle time of the activity.

Creating a process activity

Once a version is created, activities can be defined for the production flow. They are automatically associated with the version that they are created for.

You create a production flow activity by using the activity wizard. Different wizard pages are displayed based on the selected settings.

Create a production flow activity for a process activity for a single-activity production flow:

1. Create a new activity by clicking **Production control** > **Setup** > **Production flow** > **Version** > **Activities** > **New version activity** > **Create new plan activity**

    a. Assign a name.

    b. For Activity type, select Process.

    Set a process quantity, assuming that the activity is normally performed for a quantity > 1 and that the runtime would be the same, no matter what the actual job quantity is.
    For the purpose of this example, let us assume that the painting machine can paint 10 covers with one operation and that the runtime would be valid for 10 paints.

    c. The operating unit is, by default, the value stream. It can be any operation unit that is within the hierarchy of the value stream.

2. Click **Next** and then click **Create process activity**.

    a. Select the work cell that performs the process activity.

    b. Select the **Update on hand receipt** check box.

    All material that is consumed and all products that are supplied by a production flow must be registered in inventory. For a single-activity production flow, this means that the activity must update inventory on picking and on receipt.

3. Click **Next** and then click **Assign picking activities**.

    The default picking activity is automatically created for the input location of the selected work cell. For the default behavior, the pre-created picking activity is confirmed. Picking activities can still be added or modified, even if the production flow version is active.

    a. Update on hand:

    When picking from the specified location, inventory is updated.

    For a single-activity production flow, this option has to be selected.

    b. Register scrap:

    When selected, the scrap factor set on the BOM lines is applied on backflushing.

4. Click **Next** and then click **Assign activity time**.

    The activity time can be specified for the activity time types. The activity times can be modified after creation:

    a. **Queue time before** (Optional) – Time the material should be available before the process activity starts.

    b. **Run time** (Mandatory) – Time it takes to execute the activity on average. For each output item, the runtime of a specific job is calculated, depending on the job quantity and the throughput ratio of the output item.

    c. **Queue time after** (Optional) – Time it takes to make the products produced with the activity available for the next activity or for shipment.

    d. All activity time types are added up in order to calculate the throughput time of the activity. Based on the due date of a kanban job, the throughput time is used to determine the issue time for the material. The queue times are not taken into account on cost calculation, only in scheduling.

5. Click **Finish**.

For a single-activity production flow, no more interactions are needed. With the creation of the activity, you can now create kanban rules that use the activity. However, to create kanbans, the production flow version needs to be activated.

Validation and activation of the production flow version

To check the consistency of the activities and kanban rules of a production flow version, you can run a validation. This can be done at any state before or after activation. For a single-activity production flow, validation is of low importance.

During validation, material consumption and product supply of a production flow must be posted to inventory, just as in a production order. The first and last activities of the production flow are checked to make sure that **Update on hand** is activated on pick or on receipt. This is why a single-activity production flow must have **Update on hand** activated on both.

Before kanbans can be created for activities of a production flow version, the version needs to be activated. If no errors are found, activating runs a validation and activates the production flow version.

Single-transfer activity production flow

One of the basic applications of kanbans is to replenish purchased material in supermarkets in production, no matter if the production is performed based on production kanbans or production orders.

In Figure 2, a simple production flow for this application consists of a single-transfer activity.

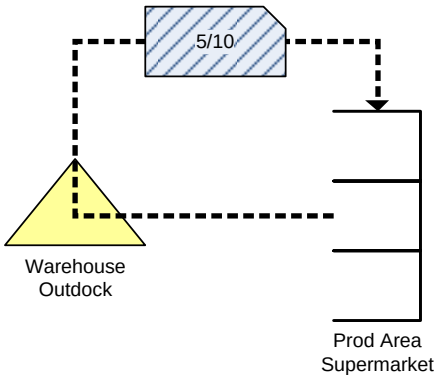

Figure 2: Example of a withdrawal kanban that replenishes a supermarket

Creating a transfer activity

You create a production flow activity by using the activity wizard. Different wizard pages are displayed based on the selected settings.

A transfer activity describes the transfer from a specific location A to a location B, and it is valid for all products that are transferred.

Create a transfer activity for a process activity for a single-activity production flow:

1. Create a new activity by clicking **Production control** > **Setup** > **Production flow** > **Version** > **Activities** > **New version activity** > **Create new plan activity**
    a. Assign a name.
    b. For the Activity type, select Transfer.
    c. Set a process quantity, assuming that the activity is normally performed for a quantity > 1 and that the runtime would be the same, no matter what the actual job quantity is. Transfer activities usually consume the same transport time, no matter whether a bin is full or half full.

For transfer activities, the process quantity should therefore be set to the maximum quantity per bin.

d. The operating unit is, by default, the value stream. It can be any operation unit that is within the hierarchy of the value stream.

2. Click **Next** and then click **Create transfer activity**.

   a. Optional: If the transfer activity is used to replenish a work cell or transfers products produced by a work cell, you can select the work cells. This will default to the locations associated with the work cells.

   b. Product type: The **Finished product** check box must be selected (default).

      A single-transfer activity in a production flow can only be used to transfer finished products. Selecting semi-finished would result in an error at the validation of the production flow version.

   c. The **Update on hand on receipt** and the **Update on hand on pick** check boxes must both be selected (default).

      A single-transfer activity in a production flow must update on hand on pick and on receipt. Clearing either check box would result in an error on validation of the production flow version.

3. Click **Next** and then click **Assign transfer locations**.

   If work cells have been selected, the locations can be preset from the work cells. *Transfer from* and *transfer to* locations must be defined as:

   a. Warehouse

   b. Location

   Lean manufacturing for Microsoft Dynamics AX 2012 requires a specific location to set up a transfer. This is independent of the definitions of the locations in the storage dimension groups of the items. Any type of location is valid for the *from* and *to* locations. If shipments or output orders should be used, the *from* location must be of type Outdock. (The special behavior of the type kanban supermarket will be discussed in the Kanban supermarkets section.)

4. Click **Next** and then click **Assign activity time**.

   The activity time can be specified for the activity time types. The activity times can be modified after creation:

   a. **Queue time before** (Optional) – Average time to consider in planning before a transfer is executed. If a transfer between two locations only happens once a day and the standard workday is 8 hours, this should be set to 8 hours to make sure planning makes material available for transfer in time.

   b. **Runtime** (Mandatory) – In this case, the pure transfer time, that is, the time it takes a truck or a forklift to drive from the *from* location to the *to* location. For internal replenishments this is the time it takes the warehouse worker to transfer a pallet from a warehouse to a supermarket, or from one work cell to the next.

   c. **Queue time after** (Optional) – Average time needed to make material available for the next activity or a shipment process after the transfer.

5. Click **Finish**.

For a single-activity production flow, no more interactions are needed. With the creation of the activity, you can now create kanban rules that use the activity. However, to create kanbans, the production flow version needs to be activated.

Validation and activation of the production flow version

To check the consistency of the activities and kanban rules of a production flow version, a validation can be executed. This can be done at any state before or after activation. For a single-activity production flow, the validation is of low importance.

Material consumption and product supply of a production flow must be posted to inventory, just as in a production order. The first and last activities of the production flow are checked to make sure that **Update on hand** is activated on pick or on receipt. This is why a single-activity production flow must have **Update on hand** activated on both.

Before kanbans can be created for activities of a production flow version, the version needs to be activated. If no errors are found, the activation executes the validation and activates the production flow version.

Two-activity production flow: process and transfer

A work cell for lean manufacturing usually has an input and output location. Depending on the physical layout of a plant, a transfer is needed to move the output products of a work cell to the next cell, to a warehouse, or to a supermarket.

If the transfer is done by a forklift driver or a water spider that has to take care of many cells, the production flow can be modeled with a process activity and a subsequent transfer activity. When the process activity is completed, the related transfer activity is shown with supply status *available* on the transfer board.

A transfer is needed if the output warehouse or the location of the work cell for the process activity is not identical with the final point of consumption, which in Figure 3 is the location warehouse Indock.

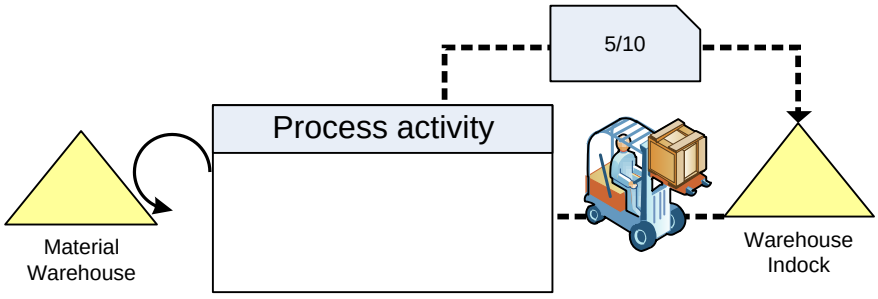

Figure 3: Example of process activity and subsequent transfer activity

Creating the activities

Create the process activity and the transfer activity as described in the Single-process activity production flow and Single-transfer activity production flow sections earlier in this paper.

As you create the activities, consider that a valid variant would be to vary the **Update on hand** settings of both activities. It is possible to configure the process activity to **Update on hand on receipt** = **No**, and the transfer activity to **Update on hand on pick** = **No**. In this case, the completion of the process activity would not post the created product to inventory. The product would only be shown in inventory after the transfer to the warehouse was completed.

Creating an activity relation

If a production flow version has more than one activity, the sequence and structure of the activities in the production flow version has to be defined before the version can be activated. You perform this definition by adding activity relations.

To create a relation:

1. In the **Production flow version activities** form, select the process activity, open the **Successors** FastTab, and then click **Add**.

   The **Activity relation** form opens. The previously selected activity is preset as predecessor.

2. Select the appropriate successor activity. In this example, select the transfer activity.

3. Add an End-Start constraint between the activities:

   a. Click the group **Constraint** and enter the time and time unit for the constraint. A constraint is needed if the successor activity cannot start immediately after the predecessor due to a specific relation of the activities. (If the constraint is not due to the relation but to one of the activities, this should be defined as a queue time of the activity instead.)

   b. If the processes overlap (that is, the second process starts before the first is completed), a negative constraint is possible. Consider that for lean manufacturing, in which the production flow is tracked by the physical flow of the handling units assigned to the kanban signals, an overlap is quiet unusual. Instead of modeling overlaps, you should consider splitting the maximum kanban product quantities. The constraint of the activity relation is added to the throughput time of the kanban flow that is used to schedule the demand of material in the material warehouse.

4. Define a cycle time ratio.

   For a production flow version, an average takt time can be defined. The takt applies to the last activities of the production flow. In our case, this is the transfer activity. The cycle time ratio is used to calculate the cycle times of the upstream activities, which in our case is the cycle time for the process activity.

   In our simple example, we assume that the cycle time ratio is 1 (the default value). This is often the case when multiple activities are grouped to one kanban, which includes the assumption that for each process activity, exactly one transfer activity is performed. However, for throughput and capacity reasons, the cycle time ratio can be other than 1.

5. Click **Close.**

Validation and activation

Activity relations need to be validated and activated. Without a valid activity relation between all activities of a production flow version, the validation and activation will fail with an error. The same happens if the **Update on hand** settings of activities that are connected with a relation do not match.

Two-activity production flow: pull from warehouse to process activity

Another typical example of a two-activity production flow uses a transfer activity to pull material from a warehouse to a process activity.

This setup allows users to pull material on demand from a warehouse or another production unit to a specific process activity. This setup is used if the preparation process for process activities needs explicit transfer from different locations or if a variable consumption of the process activity must be reported (for example, component must be measured or weighted).

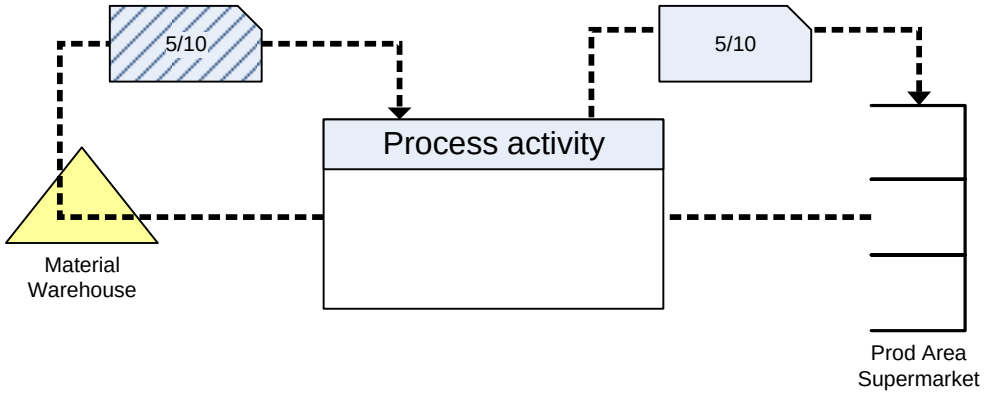

Figure 4: Example of transfer activity between a warehouse and process activity

Creating the activities

Create the process activity and the transfer activity as described in the Single-process activity production flow and Single-transfer activity production flow sections earlier in this paper.

As you create the activities, consider that an alternative setup would be to configure the receipt of the first activity—in this case, the transfer activity—**to Update on hand receipt** = **No**. In this case, instead of moving the material to another warehouse or location, the material would be deducted from inventory and posted to the WIP account of the production flow. The actual consumption would be declared when the withdrawal kanban that has moved the material to the production flow is registered as empty.

For this configuration, the picking activity of the process activity must also be configured to **Update on hand** = **No**.

Picking activities

A process activity that consumes material based on BOM lines can have one or multiple picking activities. The picking activities are used to configure the inventory update for the picking process for a specific location or for an item at a specific location.

The relevant parameters are as follows:

- **Update on hand**:

  Control if the picking line of a process kanban deducts inventory or not.

- **Register scrap**:

  Include the scrap factor of the BOM line when a BOM line has the **Flushing principle** = **Finish**.

When are multiple picking activities needed?

- If material is picked from different warehouses, there should be a picking activity per warehouse with the related default location to pick from.
- If material for a single activity is picked from different types of locations, for example, kanban supermarkets, the **Update on hand** principle can be different for different items consumed in the same process.
- To set a specific picking location for a specific item and warehouse. (However, you cannot use a picking activity to define a different warehouse to pick.)

At first glance, this sounds complicated. In fact, it is rather simple because usually a process activity should pick all material from the same location with the same **On hand update** configuration, which requires only a single picking activity with no item-specific settings.

Creating an activity relation

Create the activity relation as described in the previous Creating an activity relation section earlier in this paper.

Validation and activation

Validate and activate as described in the previous Validation and activation section earlier in this paper.

When validating the activity relations, the **Update on hand** configuration of the transfer has to match the picking activity for the supplied warehouse and location of the transfer. An exception to that rule is the location type kanban supermarket. A transfer to a kanban supermarket usually updates **On hand on receipt**. However the picking activity must be set to **Update on hand** = **No**. The deduction of inventory in locations of a type kanban supermarket happens when the kanbans are registered as empty.

Extended production flow scenarios

This section describes extended production flow scenarios including multiple-activity production flows, and production flow inventory and storage concepts.

Multiple-activity production flows

According to lean principles, a production flow should not be modeled for single activities or machine groups, so as to avoid a design that does not result in an overall flow and leads to excess inventory between the single flows.

True flow is implemented if zero inventories exist between two activities. The output of one work cell (for example, stamping) moves to the following work cell (for example, assembly), without being piled or stored. Stamping only provides output if the assembly work cell is capable of consuming it. When the assembly stops, the stamping stops as well (after having filled the maximum buffers).

In value stream notation, true flow is expressed by a direct pull line.

Figure 5: Example of flow in value stream notation

Depending on required processes, small buffers (also known as supermarkets) can be established. A supermarket has a limited amount of space for each item. The upper limit is expressed in the maximum alert quantity of the kanban rules. When more kanban handling units are received at the supermarket, the kanban quantity overview marks the excess kanbans with a red background.

In the value stream notation, small buffers are expressed with the supermarket symbol.

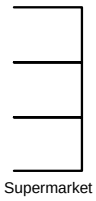

Figure 6: Example of small buffer in value stream notation

Wherever it is not possible to establish true flow, material needs to be inventoried between two activities. Inventory that breaks a true flow is modeled with the inventory symbol.

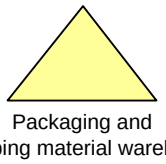

Figure 7: Example of inventory in value stream notation

Figure 8 describes a multiple activity production flow for the creation and delivery of sinks.

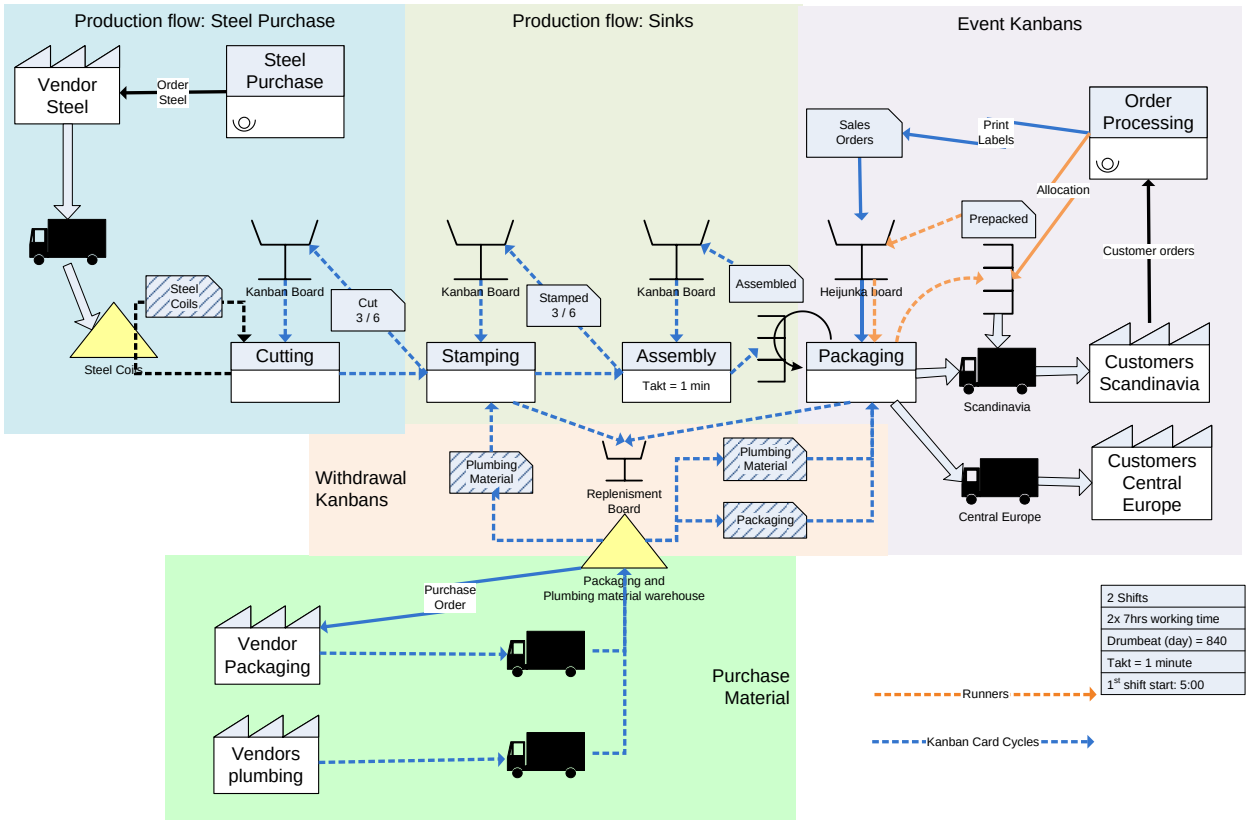

Figure 8: Multiple activity production flow for creating and delivering sinks

Sites, warehouses, and locations

Lean manufacturing in Microsoft Dynamics AX 2012 models all locations of a production flow as Warehouse Management System (WMS) Locations, the lowest level of the inventory breakdown. For the production flow execution process, it is not really important to which warehouse a location is assigned. However, if the warehouse is the lowest level of the inventory breakdown that is visible to master planning, the warehouse model of a production flow depends on the expected planning functionality. The location model of a production flow reflects the physical material flow. The more locations that are modeled, the more transfers or dedicated registration activities that may be needed. Consider that moving material on the shop floor is non-value adding and should be avoided wherever possible. The more you can reduce the number of locations the better.

Limitations in Microsoft Dynamics AX 2012:

- In Microsoft Dynamics AX 2012, production flows cannot be set up across a legal entity (company).
- In Microsoft Dynamics AX 2012, the cost context for an item is always established by site.

Material warehouses:

The point of consumption of a material warehouse that is assigned to a transfer or picking activity is usually a location of type Outdock. With manual picking or picking route, this location can be overwritten or distributed to multiple locations.

Supermarkets:

A supermarket usually consists of a single WMS-Location. Because supermarkets are usually physically placed on the shop floor and are to be replenished by withdrawal kanbans or transfer orders, the supermarkets of a production flow should be grouped to their own warehouse per site.

Input location of a work cell:

The input location of the work cell is the default location that is used to pick material for an activity. The location can be a simple buffer, a supermarket, or an Outdock of a material warehouse.

Output location of a work cell:

The output location of a work cell is the default location where all output of the cell is put when coming out of the work cell. This can be a simple buffer, the input location of the following work cell, a supermarket, or an Indock or Outdock of a finished goods warehouse.

Finished goods warehouses:

Indocks are used to move the output of an activity to a finished goods warehouse.

Outdocks and shipments to customers or cross site:

In a build-to-order scenario with true flow, the output of the last activity would probably go directly to the Outdock or a specific shipment zone that would not require an additional picking process to ship to a customer. The same applies to products that have to be transferred to other sites.

Sequential activities

A common example of a flow that consists of sequential activities is the classic production or assembly line. A sequential activity flow can be used for any product that is built activity by activity.

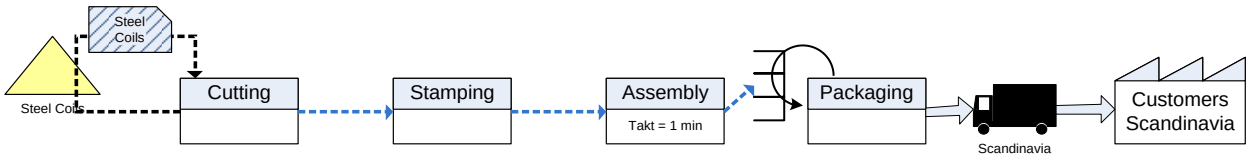

Figure 9: Sequential activity flow

To build a finished product for a customer, all activities have to be processed and completed. The production flow requires a fix sequence.

A production flow would not be a flow if it contained activities that are not related to the other activities of the flow.

Therefore, validation of a production flow version checks whether all activities are related, before the version can be activated.

Optional activities

Optional activities are activities that are only needed for specific products, but need a considerable amount of time or specific – limited – resources, so they cannot be grouped to a single activity.

Figure 10 describes a branch of a production flow with optional activities. All products produced by this production flow go through the activity Striking, depending on the kanban rules and the selected kanban flow per rule.

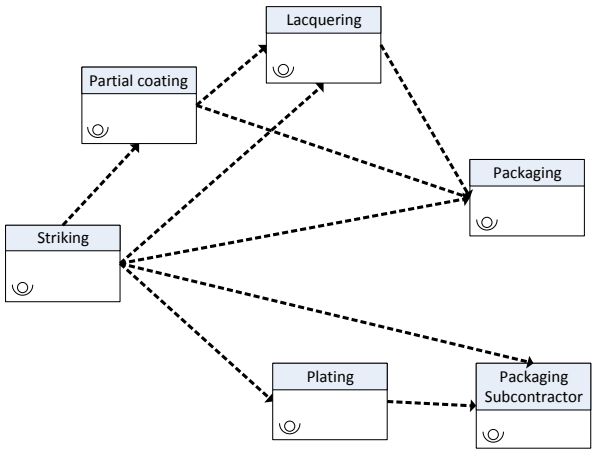

Figure 10: Production flow with optional activities

Let us assume that the products for this production flow are produced with a single kanban rule that spans over multiple activities. The first activity of all kanban rules is striking. The last activity is either packaging or packaging subcontractor.

You can select the following kanban flows, based on this production flow:

- Striking > Packaging
- Striking > Partial coating > Packaging
- Striking > Lacquering > Packaging
- Striking > Partial coating > Lacquering > Packaging
- Striking > Packaging subcontractor
- Striking > Plating > Packaging subcontractor

Alternative activities

Alternative activities are activities that can supply the same product by using different activities. In Figure 11, the coating of the products can be done in an internal work cell or by a subcontractor. Because the subcontractor needs to be supplied with the output of the milling activity, an additional transfer activity is modeled. This illustrates that, in many cases, an alternative activity is not the same activity performed with a different resource.

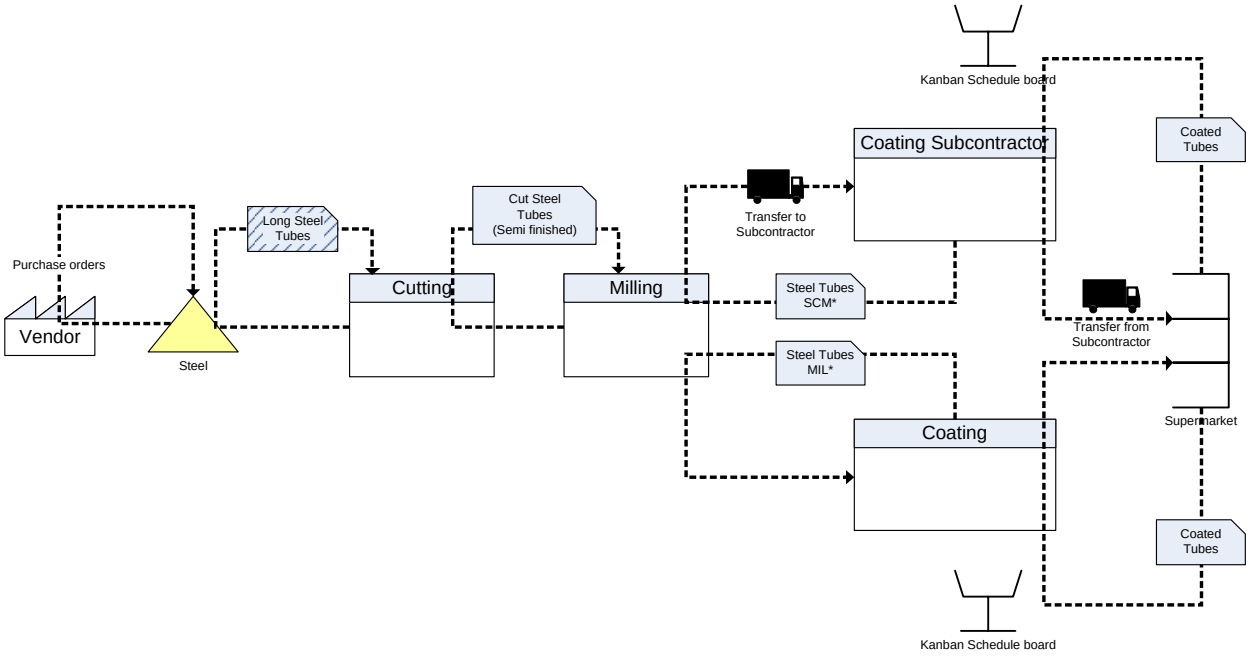

Figure 11: Multiple activity production flow for creating and delivering sinks

The resulting subflows for the alternative branches from milling to supermarket would be:

Milling > Coating

and

Milling > Transfer to subcontractor > Coating subcontractor > Transfer to supermarket

Parallel activities

Parallel activities in a production flow are different activities providing different output that are processed at the same point in time and contribute to the same finished product.

Figure 12 shows a common example: a production flow that has activities that start from different, independent branches, but that all result in one related activity.

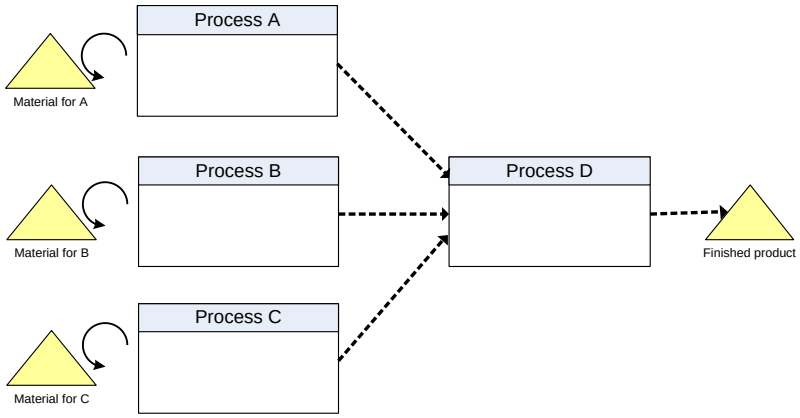

Figure 12: Production flow with parallel activities that start from independent branches

In Figure 13, the output of Process A is needed for Process B and C, which both are needed to complete Process D.

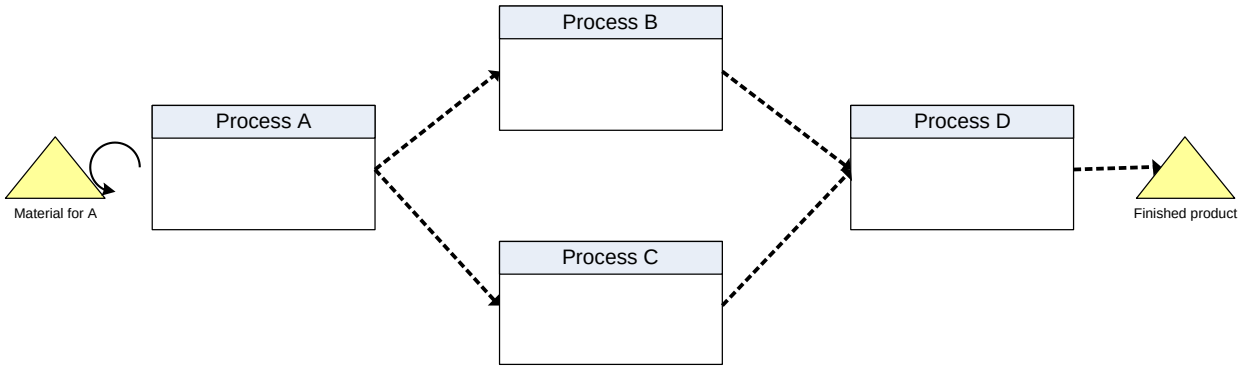

Figure 13: Production flow with parallel activities

This latter case is better known in the process industries, where processes can have main products, co-products, and by-products. Production orders and process kanbans have only one main output product. Co-products and by-products can be modeled with a negative BOM quantity. It is not possible to create a pull for a co-product, but it is possible to create a flow.

A new option for Lean manufacturing for Microsoft Dynamics AX 2012 is modeling Process A to output either semi-finished products or products in WIP. Both options will be further explored in the section Production flow activities, inventory, and storage concepts.

Activity cycle times

The activity cycle times can be used in two different contexts: work cell capacity in hours, and cycle time performance control for Lean manufacturing for Microsoft Dynamics AX 2012.

The activity cycle times (average, minimum, and maximum) for each activity are calculated based on the takt settings of the production flow version (in the **Production flow version details** form). The initial calculation is done on validation and activation of the version, but it can be recalculated with the recalculation function at any point in time. However, the cycle time for a kanban job is calculated on job creation. The recalculation of the activity cycle times will not affect existing jobs.

Work cell capacity in hours

If the work cell capacity is set to a capacity model that uses hours instead of throughput, the load of a single job for a specific activity is calculated as follows:

Capacity load (Job) = Cycle time (Activity) * Throughput ratio (product)

The capacity model in hours is used when different products have a huge variance in capacity consumption for the same activity; therefore, a throughput quantity corrected with a huge throughput ratio might give a wrong visual impression of the planned output.

The capacity load is configured in the production flow model associated with the work cell capacity of the resource group.

Cycle time performance control

Independent of the capacity control of a work cell, the average cycle times of a work cell can be used to monitor the performance of a work cell:

- Cycle time performance indicator:

  The kanban scheduling board and the kanban board for process jobs allow the display of the cycle time performance indicator. Based on the calculated cycle time per activity and the minimum and maximum cycle time boundaries, the indicator shows the actual cycle time calculated, based on the reported jobs during the period for actual cycle times—in other words, the last *n* days.

- Cycle time history:

  The cycle time history of a production flow version displays the actual cycle times per period for the output of the production flow. Because it uses period templates, you can drill into any level of detail, from a month to single days.

Calculation of activity cycle times

The activity cycle times are calculated based on takt time and cycle time ratio as follows:

Takt time	Average/minimum/maximum takt time of a production flow version. The takt is the average time elapsed between completing of two jobs of the cycle time quantity for finished products in the production flow. For a production flow that has only one end activity, the cycle time of the activity is equal to the takt. If the production flow has more than one activity that outputs finished products, the cycle time of each activity is calculated based on the capacity ratio of the work cells associated to these activities.
Cycle time ratio	When creating a relation between two activities in a production flow version, a cycle time ratio has to be defined. Ratio 1 is synonymous with having the same cycle time for the upstream and downstream activity. Ratio 2 describes an activity relation where the upstream activity has to process two cycles to feed one cycle of the downstream activity.

The cycle time of any activity is calculated by:

$$Cycle\ time = \frac{1}{\sum(\frac{CycleTimeRatio\ (ActivityRelation)}{CycleTime\ (downstream\ Activity)})}$$

Activity cycle time example

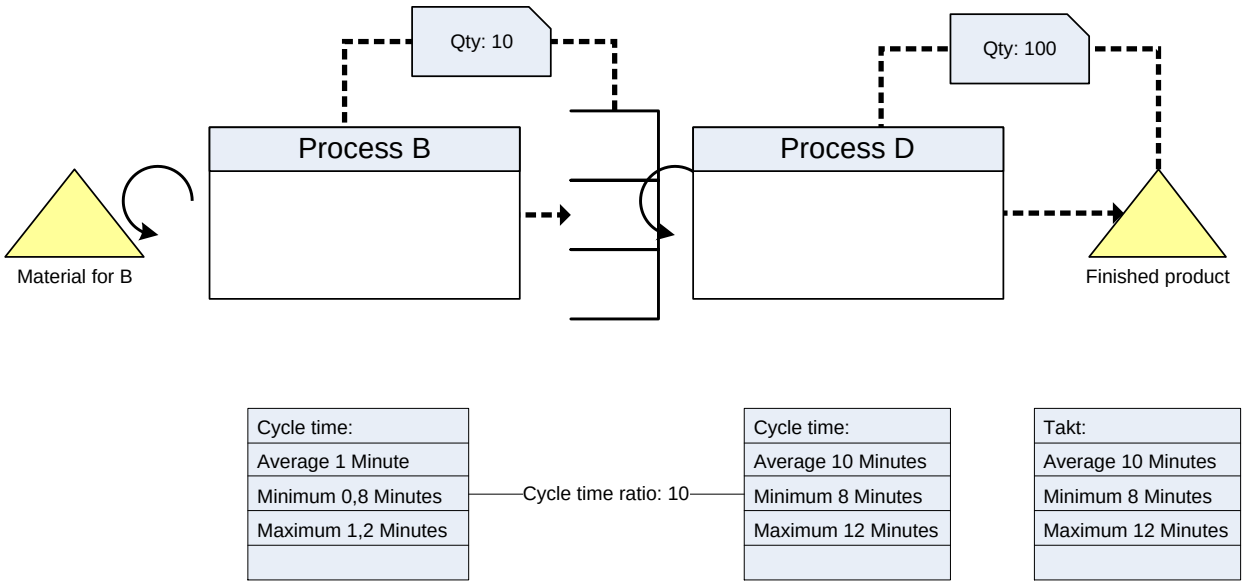

Figure 14: Activity cycle time example

Assume that Process D supplies pallets of 100 pieces and Process B produces boxes of 10. The average takt of the production flow is set to be 10 minutes. Because 10 activities for Process B are needed for one Process D, the cycle time ratio is set to 10. On validation/recalculation of the production flow, the cycle time for the process activity is calculated to 1 minute.

Validation of activity cycle times against work cell capacity

At the validation and activation of a production flow version, the calculated activity cycle times are verified against the capacity of the assigned work cells. If the capacity needed to support the average cycle time is higher than the available capacity of the work cell, an error message is displayed.

Production flow inventory and storage concepts

Enterprise resource planning (ERP) systems in general and Microsoft Dynamics AX in particular have a dependency on inventory transactions. Inventory transactions are used for planning, execution, tracking and tracing, and costing of production and logistic operations. Lean manufacturing for Microsoft Dynamics AX 2012 introduces new types of transactions for kanban jobs to fully support the integration of lean manufacturing in master planning.

Because a fixed constraint of kanban jobs to inventory transactions would restrict the usage of lean manufacturing principles and would add unnecessary complexity in some application cases, Lean manufacturing for Microsoft Dynamics AX 2012 introduces an activity model that allows a seamless combination of the following scenarios:

- Kanban jobs can update inventory.
- Kanbans can be used for semi-finished products that do not have their own BOM level.
- Material and products can be managed in WIP using kanban jobs to:
- Transfer material from inventory to WIP

- Transfer material, semi-finished, or finished products inside WIP
- Receive finished products from WIP to inventory
- Material consumption can be reported by handling unit, by job consumption, or by BOM backflushing.

In Microsoft Dynamics AX, activities of a production flow can be configured for a specific behavior for the inventory updates for:

- Pick – Configures the inventory behavior on consumption. Process activities allow the configuration of multiple picking activities that define the inventory update behavior by warehouse or by picked item.
- Receipt – Configures the inventory behavior on the receipt (when the job is completed).

Update on hand

The default behavior of an activity is **Update on hand**. For each job of the inventory, transactions are created.

- **Update on hand on receipt** = **Yes**

  A receipt transaction is created for the due date of the kanban job. When the job is planned on the kanban scheduling board, the planned receipt date is updated according to the assigned planning period.

- **Update on hand on pick** = **Yes**
  - Transfer:

    An issue transaction is created for the transferred item on due-date – Activity times.

  - Process:

    The BOM explosion creates issues per item in the BOM that matches a picking activity that has **Update on hand on receipt** = **Yes** at the due-date – Activity times.

The creation of the related transactions gives master scheduling full visibility of the kanban jobs, based on activities that update on hand.

Activities of the production flow must have **Update on hand** activated when they are supplying material to or consuming material from a costing boundary:

- Activities at the start or end of the production flow
- Activities that transfer material between sites

These conditions are validated either at the creation of the activity or at the validation of the production flow.

Tracking and tracing

In Lean manufacturing for Microsoft Dynamics AX 2012, tracking and tracing using batch or serial numbers is restricted to kanban jobs that update inventory. The traceable context is established by the inventory transactions.

WMS integration

Integration into WMS functionality, output orders, and shipments are restricted to kanban jobs that update inventory.

Semi-finished

Production orders allow reporting of jobs on an operation level. With each finished operation, the product reaches a different state of a semi-finished product; however, this status is not registered on inventory unless the last operation of a production order has been completed and the next BOM level

is reached. Semi-finished products that do not represent a BOM level are usually identified by the product ID of the next BOM level and the last completed operation.

With Lean manufacturing for Microsoft Dynamics AX 2012, this concept can now be applied to production with a kanban.

In the production flow in Figure 15, three activities are needed to assemble material from the BOM lines to a finished product:

- Activity 1 picks the BOM lines and outputs semi-finished.
- Activity 2 picks semi-finished products from Activity 1 and still outputs semi-finished.
- Activity 3 picks semi-finished products from Activity 2 and outputs finished products. The next BOM level is reached.

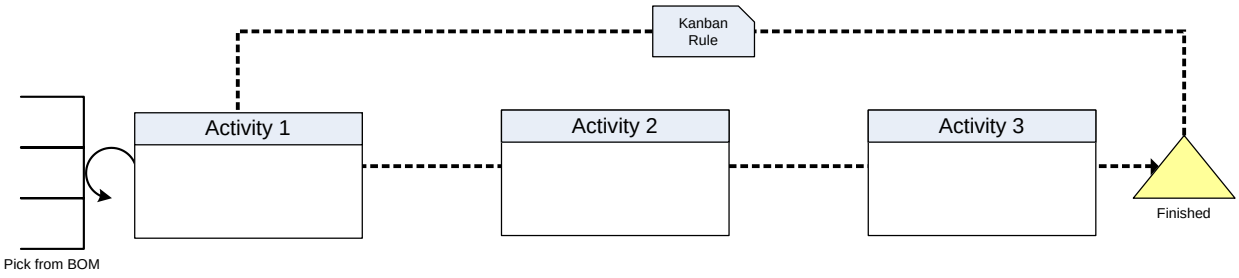

Figure 15: Production flow with semi-finished products

The product pick and receipt properties of the activities in the production flow are responsible for this behavior. An activity that outputs semi-finished in a production flow shows this behavior for all products, independent of its BOM structures.

Activity 2 and Activity 3 do not show picking lines on the kanban board, because in Microsoft Dynamics AX 2012, activities that consume semi-finished products have no picking activities.

How to configure process activities for semi-finished by using the activity wizard

You can create a process activity by using the activity wizard as described in the Creating a process activity section earlier in this paper. After selecting the work cell, set the product properties for receipt and pick for the activities as follows:

- Activity 1:
  Update on hand receipt = **No**. This activates the group **Semi-Finished**.
  Semi-finished – receipt = yes
  Semi-finished – pick = no. The *no* setting allows you to configure picking activities with update on hand yes or no

- Activity 2:
  Update on hand receipt = **No**. This activates the group **Semi-Finished**.
  Semi-finished – receipt = yes
  Semi-finished – pick = yes. Selecting *yes* means that no picking activities are created when semi-finished is picked.
- Activity 3:
  Update on hand receipt = **Yes** or **No**
  Semi-finished – receipt = no
  Semi-finished – pick = yes. Selecting *yes* means that no picking activities are created when semi-finished is picked.

Activities can only be related if the receipt and pick properties of the activities match the same product type. If the product type does not match, an error message is displayed when you try to relate the activities. Once an activity is related to another activity, the product properties are locked down to read-only and cannot be changed.

Multiprocess activity kanbans

Multiprocess activity kanbans are new to Lean manufacturing for Microsoft Dynamics AX 2012. They allow you to create kanbans that have multiple process activities. To select a kanban flow with multiple process activities, the process activities must have the semi-finished configuration.

A multiprocess activity kanban must begin with a process activity. Then, transfer and process activities can be mixed. Transfer activities can transfer products or semi-finished products; however, they can never change the product property.

The concept of semi-finished allows the introduction of registration to kanbans, down to a single operation; however, this is not recommended. Every activity has to be planned and reported. You should keep the number of activities to the minimum that really require reporting and make sure that the registrations are supported by barcode or RFID.

Kanbans that supply semi-finished

The architecture of activities supplying semi-finished allows the introduction of yet another variant for production. A kanban rule can be configured to supply a semi-finished product to a supermarket.

In Figure 16, the kanbans for Kanban rule 1 supply the supermarket for semi-finished products. The kanban job for Activity 1 has kanban line transactions for the material, but no receipt transaction. Semi-finished products are, by definition, accounted in WIP, but are not visible in inventory. This includes that they are invisible to master scheduling.

Instead of being grouped with Activity 3, Activity 2 could be configured with its own kanban rule as well.

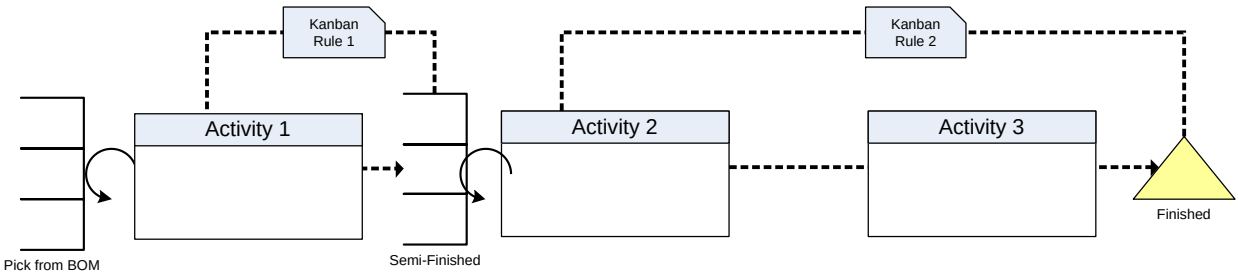

Figure 16: Kanban rule that supplies semi-finished products

Work in process (WIP)

A production flow must be related to a production group. In the production group, the WIP accounts for the production flow are specified. We recommend that you create a single WIP account per

production flow, because the backflush costing functionality that closes the costing period for all production flows calculates the variances as the difference of the WIP value before and after backflush costing for each production flow.

Just as for production orders, material or products that are picked from inventory for an activity of a production flow are added to the WIP account of the production flow at its standard cost. This requires the activity to be configured as **Update on hand on pick** = **Yes**.

Products that are received from the production flow to inventory are deducted from WIP at their standard cost. This requires that the activity be configured as **Update on hand on receipt** = **Yes**.

So far, the behavior is similar to the behavior of production orders, except that the production flow builds WIP and variances for all products and materials consumed in or received from the production flow, whereas a production order tracks WIP and cost for a single product. When kanbans are used to produce subassemblies to supermarkets, material and labor is consumed for many finished products without the possibility of tracking and reporting overconsumption and underconsumption to a single finished product.

In many cases, the level of detail that an ERP system claims to support is inaccurate because the information collected on the shop floor does not provide this level of detail. Complicated distribution algorithms are then applied to mitigate the systematic reporting errors. Still, the reported numbers often suggest more accuracy than, in reality, is actually provided.

Lean manufacturing for Microsoft Dynamics AX 2012 introduces three additional features to ensure that consumption and receipt quantities correspond to the actual physical flow and eliminate systematic errors based on the calculated average of overconsumption or underconsumption:

- Products supplied by a production flow activity stay in WIP.

  By configuring an activity to **Update on hand on receipt** = **No** but not marking it as receipt semi-finished, completing the activity will result in a handling unit filled with the product. Still the product will not be posted to inventory; it stays in WIP. This has the following advantages:

  - The received product is visible only to the production flow, not to inventory or master planning. It cannot be used to cover demand from other production flows.
  - If the product is consumed by a downstream activity in the same production flow, the registration of the product consumption is independent of BOM lines, but it only corresponds to the emptying of material handling units.
  - Half-filled handling units do not suggest availability in inventory.

- Material can be directly transferred to WIP with a transfer activity.

  In many cases, material that has been issued to a specific production flow does not need to be shown in on hand; it should be reserved and not "disturb" master scheduling any further. The transferred material is added to WIP. Whenever the kanban handling unit is registered as empty, the value is release from WIP and accounted as consumed.

  The transfer activity needed for this process must be configured as follows:

  - Transfer products (not semi-finished).
  - **Update on hand on pick** = **Yes**.
  - **Update on hand on receipt** = **No** (value is added to WIP).
  - The transfer activity has no predecessor in the production flow, but needs a successor.
  - The successor needs a picking activity with **Update on hand** = **No** for the specific material or for the complete warehouse.

- Products (that is, by-products or co-products), unconsumed material, and scrap can be transferred out of the production flow at their standard cost.

Whenever a handling unit of a product is transferred out of the production flow, WIP is deducted by the standard cost of the related product. This configuration has no dependencies to any BOM structure; it simply follows the physical material flow.

Example:

The example in Figure 17 shows how scrap material can be returned to a material warehouse through a transfer activity. The transfer activity registers boxes of scrap at their actual weight. In the foundry, the scrap is identified by its own product number, which is used in the BOM of the refining process.

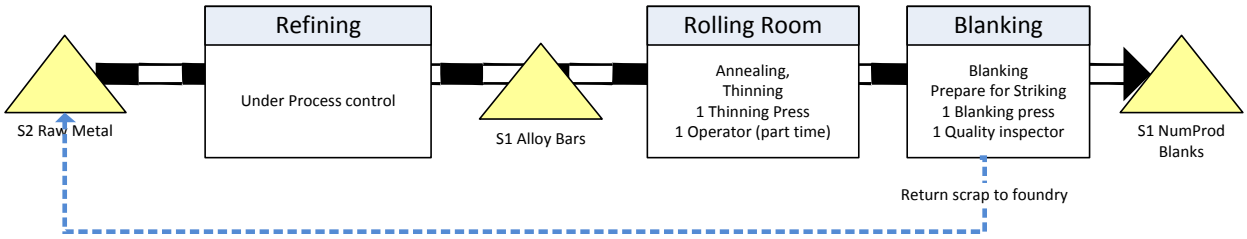

Figure 17: Returning scrap material through a transfer activity

The transfer activity needed for this process must be configured as follows:

- Transfer products (not semi-finished).
- **Update on hand on pick** = **No** (Value is deducted from WIP).
- The transfer activity needs a predecessor (in this case Blanking) with **Update on hand on receipt** = **No**. This implies that any products received from Blanking stay in WIP. If the warehouse NumProd.Blanks need to be booked to inventory, an additional transfer is needed to move the products out of WIP.
- **Update on hand on receipt** = **Yes.**
- The transfer activity has no successor.

Example Contoso: Car speaker production flow

The Microsoft Dynamics AX 2012 demo data for the fictitious company Contoso contains the following example of a production flow that uses products in WIP.

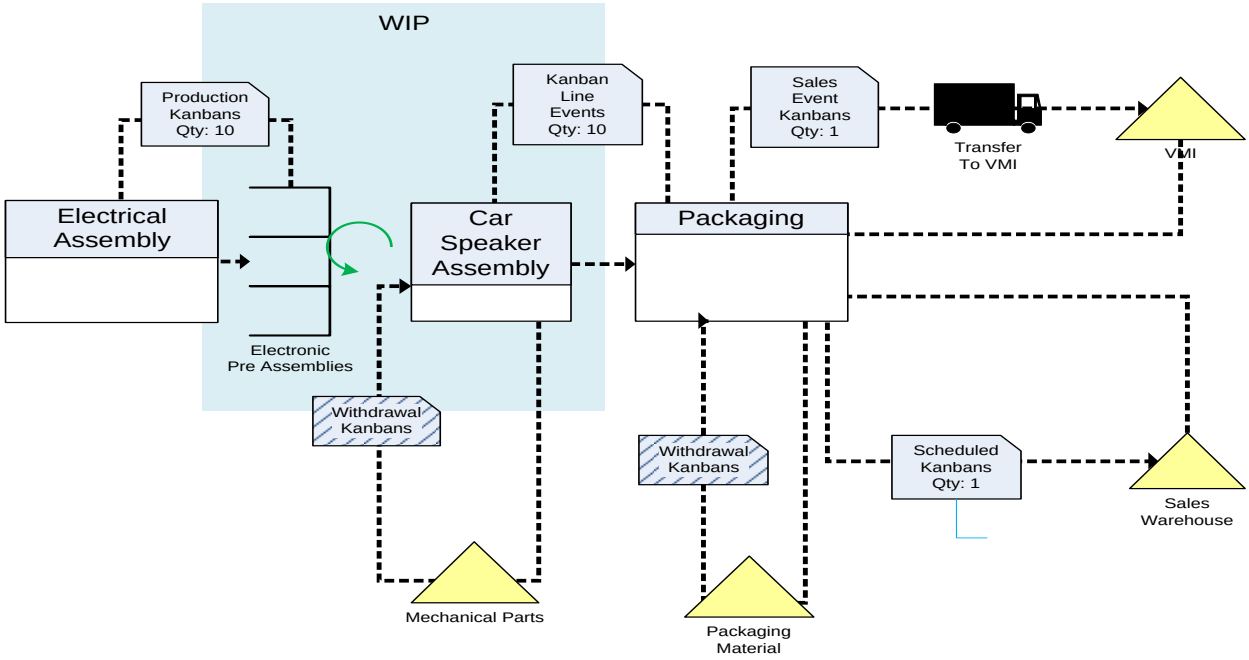

Figure 18: Contoso car speaker production flow

The activity for Electrical assembly supplies a supermarket in WIP. The parts are not posted in inventory.

The mechanical parts are moved from a warehouse to the Car speaker assembly work cell. The value goes to WIP.

The activity for Car speaker assembly posts material to WIP.

Kanban supermarkets

We have described the following methods for registering material consumption related to lean manufacturing from inventory:

- Deduct according to the BOM line quantity.
- On preparation of a kanban
- On start of the first activity of a kanban (forward flushing)
- On completion of the last activity of a kanban (backflushing)
- Transfer to WIP. Deduct WIP with registration as empty.

With the kanban supermarket, another option is available. A kanban supermarket is a special type of WMS-location that has the inventory deduction policy set to "on empty of the material handling unit."

This type of supermarket should be used for material that is inventory controlled in the supermarket but that will not be deducted by inventory backflushing, manual picking, or transfer processes.

From a costing point of view, this behavior is similar to a supermarket in WIP with the exception that on hand is shown in the supermarket.

When kanban supermarkets are used in picking activities, the **Update on hand on pick** property of the picking activity must be set to **No**.

Variable consumption

For kanban jobs based on process activities, the picking list lines are created based on the actual activity or the selected BOM on the creation of the jobs. The used BOM version can be totally replaced, unless the job is unplanned.

You can use the following approaches to enable variable consumption:

- **Flushing principle** = **finish** in the BOM Line:

  Use this approach for backflushed material: The actual consumption of kanban picking lines with **Flushing principle** = **finish** is recalculated when the job is completed, which calculates the total consumption needed for the actual reported goods plus the error quantity of the finished product.

  It can be defined per picking activity, whether the scrap factors are considered in the final consumption calculation or not.

- Using a withdrawal kanban with a kanban line event:

  We recommend that you use a withdrawal kanban with a kanban line event to pull material to an activity and report individual consumption, because transfer activities allow an individual reporting of the transferred quantity. We further suggest that you configure this activity with **Update on hand on receipt** = **No**.

Advanced business scenarios

This section discusses costing for lean manufacturing, subcontracting, and tool replenishment.

Costing for lean manufacturing

Costing for lean manufacturing allows the production flow to use the cost accumulation method, *backflush costing*. In the backflush costing method, the direct materials consumed are accumulated in the production flow's WIP cost account, using the Inventory model group standard cost. This means that the products received from the production flow are deducted from WIP at their standard cost.

Periodic backflush costing determines the effective value of WIP to the end of the period, based on the kanban handling units and the kanban job status. The deviation between the effective values and the actual WIP values per cost group and item are accounted for and displayed as variances.

Costing for lean manufacturing setup

To enable costing, you must perform the following steps:

- Assign WIP accounts for the production group and the production flow.

  In the production group, specify the WIP accounts for the production flow. We recommend that you create a WIP account per production flow because the backflush costing for production flows calculates the variances as the difference of the WIP value before and after backflush costing for each production flow.

- Assign cost category to resource group.

  Assign a cost category to the runtime category of the work cell. To determine variances by activity, create a cost category per work cell.

  The cost categories for setup and quantity are not considered in costing for lean manufacturing. The WIP accounts per resource group are ignored in backflush costing.

  For subcontracted activities, no cost category is needed. The cost group assigned to the active service is used instead.

- Assign cost groups.

  To enable a segmentation of the cost contribution in a production flow, cost groups need to be assigned by cost group type as follows:

  - Direct material cost group:

    The direct material cost group identifies the material category for costing. The cost group allows an aggregated view on cost, WIP, and variances by direct material.

  - Direct manufacturing cost group:

    The direct manufacturing cost group captures the direct operational resource cost contribution to the production flow. The cost group allows an aggregated view on cost, WIP, and variances by direct manufacturing cost.

  - Indirect cost group:

    The indirect cost group is used to calculate the indirect cost contribution to the production flow. The indirect cost group allows an aggregated view of cost, WIP, and variances by indirect cost

  - Direct outsourcing cost group:

    The direct outsourcing cost group allows an aggregated view on cost assigned to WIP and determines the cost variances of the subcontracted services.

  - Finished product cost group:

The finished products cost group identifies the product category for costing. The cost group allows an aggregated view on cost, WIP, and variances by product category.

The standard cost for products is calculated with the cost calculation based on the BOM and either production flow and kanban rules, or route.

- Build a costing sheet for a finished product:

The costing sheet models the cost structure for the company and is built by using the cost groups to classify the cost.

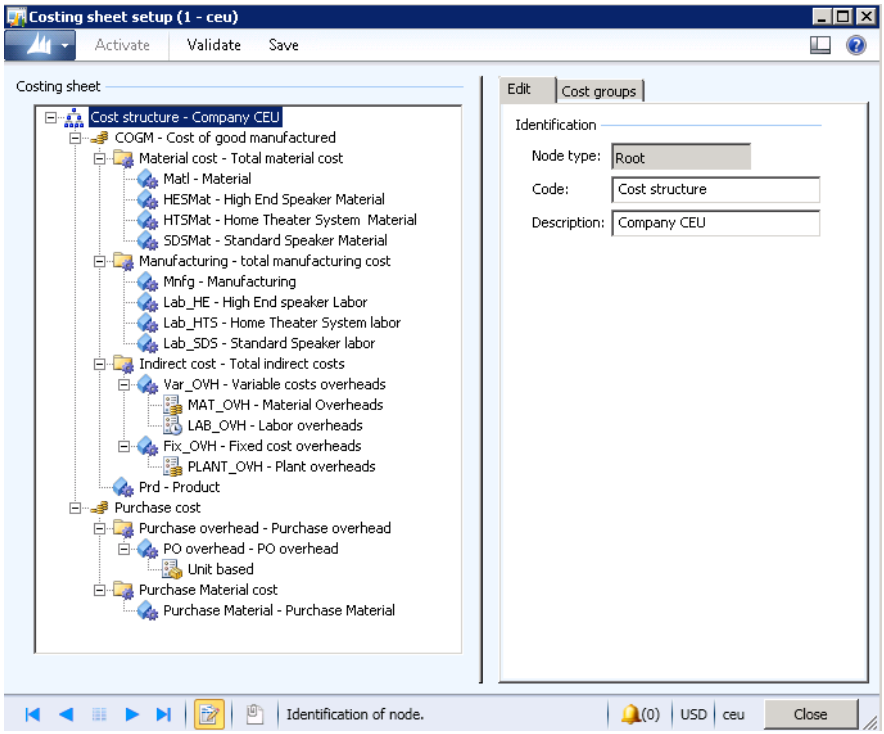

Figure 19: Costing sheet

The costing sheet is called by different forms to display cost information.

In the costing sheet, you can also define the formula for how to calculate the indirect cost. The calculation formula can be based on quantities, weight, volume, or value.

- Define a costing version.

In a costing version, the company defines how the cost should be maintained. A costing version can contain a set of standard cost records or a set of planned cost records, based on the costing type that is assigned to the costing version. The costing version used for costing for lean manufacturing must be based on standard cost.

- Assign an Inventory model group for released products.

All products related to the production flow need to be assigned to an Inventory model group with Inventory model group standard cost. Standard cost is maintained per site and activated by **As of date**. For product masters, you can configure for product masters, if the cost is maintained per variant or per product master.

Subcontracted services are, by definition, non-inventoried services, and have no Inventory model group. To cost a subcontracted activity correctly, it is important that the service activity

belongs to an Inventory model group where the **Inventory policy** is set to **Stocked product = False**.

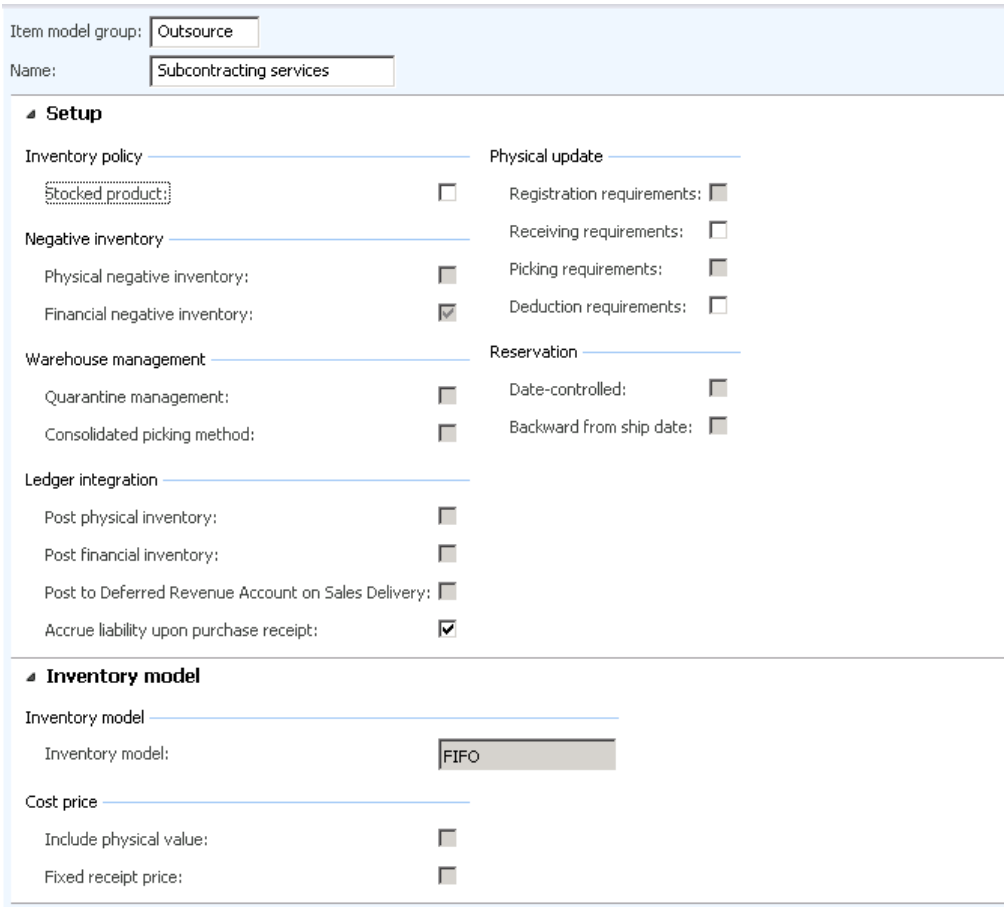

Figure 20: Inventory model group settings

For the cost calculation for output products based on production flow, a standard cost must be maintained for the services related to subcontracted activities.

The cost group assigned to the services is used to determine the cost variances of the subcontracted activity.

Cost calculation for lean manufacturing

For products supplied out of a production flow, the BOM calculation must be used, based on either a production flow or a route version. The BOM calculation calculates the cost of a product and the related breakdown to the resources and material needed to build the product. The deduction of the WIP account of the production flow is done with the breakdown of a product by item and cost group.

T..	Item/Resource	Operation	Level	Cost group	Consumption	Unit	Total cost price per unit	Total sales price per unit	Net weight per unit	Log
	CSS_SKF1		0	CS_Prd_EA	1.00	Pcs	6.57	6.57	0.00	
	CSS_CSF		1	CS_Mat_EL	1.00	Pcs	1.23	1.23	0.00	
	CSS_CSS		1	CS_Mat_EL	1.00	Pcs	0.00	0.00	0.00	
	CSS_CSB		1	CS_Mat_EL	1.00	Pcs	2.66	2.66	0.00	
	CSS_EA		1	CS_Wrk_EL	0.08	Hours	2.08	2.08	0.00	
	MAT_OVH		1	Var_OVH	3.89	USD	0.39	0.39	0.00	
	LAB_OVH		1	Var_OVH	0.08	Hours	0.08	0.08	0.00	
	PLANT_OVH		1	Fix_OVH	5.97	USD	0.12	0.12	0.00	

Figure 21: BOM calculation

Cost calculation based on production flow

Lean manufacturing for Microsoft Dynamics AX 2012 is independent of routes. The cost calculation for products supplied out of a production flow can be done based on the production flow itself. To be able to calculate products supplied out of a production flow, a kanban rule needs to be created that documents how the product is supplied out of the production flow.

If a product can be supplied out of multiple production flows at the same site at the calculation date, the production flow can be selected for the BOM calculation. The default production flow can be configured per item in the **Default production flow** form.

If multiple kanban rules exist for the same product in the same production flow that is active at the calculation date, the calculation picks the first kanban rule that is active for the calculation.

Cost calculation based on route

A calculation based on the route is as valid as the calculation based on a production flow; however, it does not use the costing for lean manufacturing functionality. The route should use resource requirements for resource groups and use the same work cells, or at least the same cost categories, to avoid systematic variances. Cost categories for setup and quantity should be avoided. It adds no value to calculate the cost in a more granular breakdown than can be provided by lean manufacturing backflush costing.

Which is the better option for calculating the cost?

To determine whether production flow or route is the better option for calculating the cost, consider the results of the cost breakdown. The version that comes closer to reality and results in fewer variances is the better option. In a lean manufacturing environment where a product is supplied by a single production flow and a single kanban rule, the calculation is probably more accurate based on the production flow. However, a product that can be supplied by lean manufacturing and production orders on the same site or that can have multiple production flows or multiple kanban rules in the same flow might be more accurately calculated on a route version that is specifically built for cost calculation, and not by using the production route version as such.

To calculate products with subcontracting, use the production flow calculation. In Microsoft Dynamics AX 2012, the cost models for subcontracting with production orders and subcontracting in lean manufacturing are not compatible.

Lean manufacturing introduces a new cost group type, Direct outsourcing, to calculate subcontracted services.

Material consumption

When material is consumed from inventory to WIP, the cost of material is added to WIP at its actual standard cost for a cost group. This happens when:

- Kanban issues are posted for kanban picking lines that update inventory.
- Transfer jobs are completed that update inventory on pick, but not on receipt (Transfer to WIP).

Receiving products from the production flow

Products that are received from the production flow are deducted from WIP. Products are received from the production flow when:

- Process jobs are completed that have **Update inventory on receipt** = **Yes.**
- Transfer jobs are completed that update inventory on receipt, but that have **Update inventory on pick** = **No** (Transfer from WIP to inventory).

This option allows receipts of any products out of a production flow, independent of BOM and route configuration, simply by following the physical flows. This is especially suitable to receiving by-products, co-products, or scrap out of a production flow and correcting the cost balance of the production flow in WIP accordingly.

The following example illustrates a production flow that has a transfer activity that returns the scrap metal to the raw material warehouse. The withdrawal kanban has a kanban quantity that corresponds to the number of containers that are circulating to collect the scrap of the Blanking process. This can be either a single bin or a two bin kanban. To avoid an explicit empty registration of the kanbans for scrap, the "register empty" policy of the kanban rule can be set to "When handling units are received."

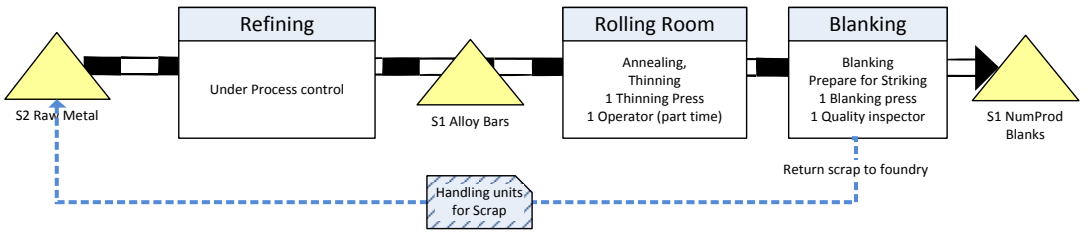

Figure 22: Production flow with transfer activity

Products in WIP

The WIP model of lean manufacturing in Microsoft Dynamics AX 2012 allows managing the material, semi-finished, and finished products that are part of WIP through the kanban handling unit status of **Assigned** or **Received**:

- **Assigned**

A kanban with the handling unit status of **Assigned** can have consumed material that is accounted in WIP.

- **Received**

A kanban with the handling unit status of **Received** that refers to a last activity that has **Update inventory on receipt** = **No** represents a full handling unit of a product or a semi-finished product that is not registered to inventory.

Note: Material in WIP is not visible on inventory-on-hand overviews, but is visible on kanban-quantity overviews.

Consuming products in WIP

Products in WIP are consumed when the corresponding kanban handling units are emptied. This does not result in an active costing transaction, but takes effect on the next backflush costing because the emptied kanban handling units are no longer accounted as on hand, and are therefore calculated as consumed within the period.

Automatic empty registration
Kanban handling units can either be assigned (= in process), received (= full) or emptied; there is no partial emptying. This makes it important to limit the product quantities of a kanban to a quantity inferior to the consumption per period to allow an accurate registration of consumption. Products that are moved to the shop floor in big batches that cover days or weeks of demand should be kept in inventory instead of being managed in WIP.

Scheduled or event kanbans can be set to "Automatic empty registration" in the kanban rule as follows:

- When handling units are received.

  The receipt of handling units declares the material as consumed when the last job of the kanban is completed (default for scheduled kanbans). For fixed quantity kanbans, this option is only recommended for single bin kanbans, because the option returns the card to the source of demand whenever a kanban is received at the final destination.

- When source requirement is registered.

  Source requirement registration is only available for event kanbans—it is the default for them. When used with WIP, this approach is useful to keep WIP clean, because kanbans for components in WIP are automatically emptied—and thereby consumed from WIP—when the parent kanban is prepared.

Backflush costing

Backflush costing should be run to periodically value the WIP and to produce an end-of-period status. In backflush costing, all production flows of the legal entity are used in the same batch run. The backflush period is defined by an end date. It is not possible to post new transactions to a date on which a backflush costing calculation has been run.

Backflush costing executes the following steps:

1. Determines production flow unused quantities as of the period end date.

   After the backflush costing, the unused quantities at the date of the costing run are displayed in the **Unused quantities** dialog box.

2. Calculates the production flow's net realized usage over the period.
3. Clears the work in process from the realized resource consumptions and products.
4. Calculates production variances to standard cost for the period, as follows.

   For consumed components within the period:

   - The net realized quantities of material consumed by the production flow over the period are financially updated. Backflush costing processes the individual inventory transactions according to first in, first out (FIFO) to financially post the physically updated transactions of the production flow, up until reaching the net realized quantities for the period.
   - Backflush costing splits inventory transactions.
   - Unused quantities are calculated based on the status of active kanban jobs and kanban handling units in production flow. These quantities remain in WIP as "Physically updated."
   - Net realized usage quantities are posted as "Financially updated" during backflush costing.
     - For production completed quantities of the period: The inventory transactions for the completed quantities for the period are financially updated.
     - For conversion cost: The applied conversion cost transactions (route transactions) recorded for the period are financially updated.
   - All direct manufacturing cost is financially updated.

- All indirect costs, excluding the indirect costs that result from unused quantities, are financially updated.

5. Calculates the production variances to standard cost. The variance is calculated per cost group.

Example of costing for lean manufacturing

A production flow in the fictitious company Contoso produces painted covers at a standard cost of one dollar ($1) with the following cost breakdown:

Cost category	Cost in dollars
Direct material (1 unit per finished product)	0.1
Indirect cost (200% of direct material)	0.2
Direct manufacturing (one hour chroming labor per finished product)	0.7

Backflush costing is initiated when Contoso's painted covers production flow has initiated two kanbans of 50 units of covers, when one kanban of 50 units of painted covers has been reported as completed at the end of the period, and when three kanbans of 50 units of raw material has been replenished.

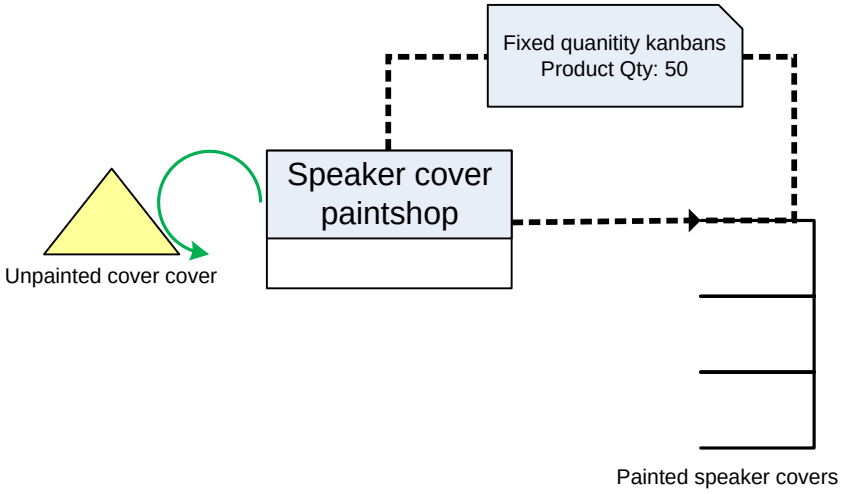

Figure 23: Production flow with transfer activity

This flow results in the cost transactions show in Figure 24.

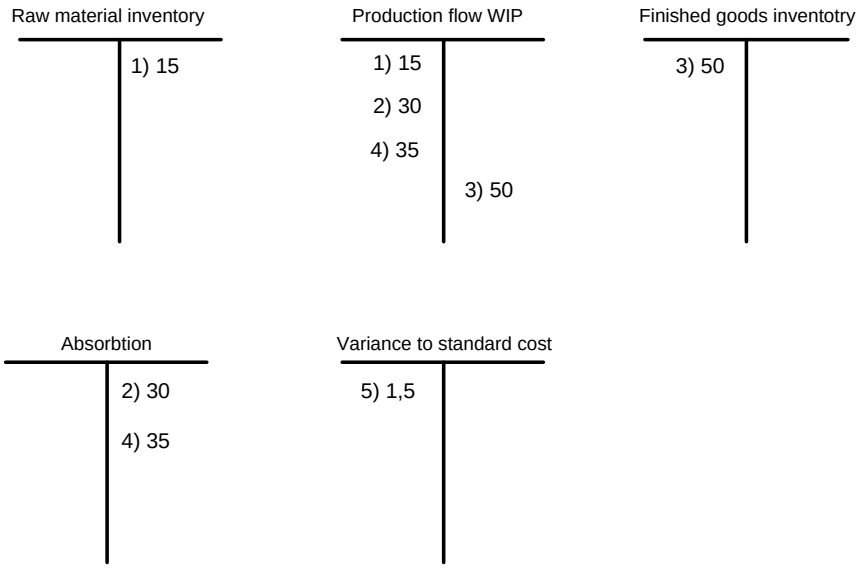

Figure 24: Cost transactions

1. Direct material:	2. 3 kanbans for 50 units at standard cost $0.1
3. Indirect cost:	4. 200% of direct material
5. Direct manufacturing:	6. 50 hours of chroming labor for the finished goods at $0.7
7. Finished goods:	8. 50 units at standard cost $1
9. Backflush costing :	10. Variance to standard cost at $1.5

Backflush costing details:

Unused quantities and quantities in process at the period end:

- 45 units of unpainted covers are still in in the production flow
- 50 units of painted cover are still in process in the production flow

Cost contribution from the 95 units of unpainted covers still in in WIP by the period end:

- Direct material = $9.5 = 95 units of unpainted covers at standard cost $0.1
- Indirect cost = $19 = 200% of $9.5

The realized cost for the period is $51.5.

- Realized direct cost for the period = 150 units at 0.1 – $9.5 (unpainted covers) = $5.5
- Realized indirect cost for the period = 200 % of $15 – $19 (indirect cost unpainted covers) = $11
- Realized direct manufacturing cost = $35

The output of the period is $50.

- 50 units of painted covers left at standard cost $1

This gives a variance to the standard cost of $1.50.

- The realized cost for the period is $51.50 - 50 units of painted covers left at standard cost $1

Subcontracting

In Microsoft Dynamics AX 2012, there are now two approaches for subcontracting: production orders and lean manufacturing. The new solution models the subcontracting work as a service that is related to an activity of a production flow. A new cost group type, Direct outsourcing, has been introduced, and the subcontracting services are no longer part of a BOM. The cost accounting of subcontracted work is completely integrated in the new costing for lean manufacturing solution of Microsoft Dynamics AX 2012.

Production flow with subcontractors

The basic principle of a production flow does not change when activities are subcontracted. Material still flows between locations, process activities convert material to products, and transfer activities move material or products from one location to another. In Microsoft Dynamics AX 2012, locations and work cells can be modeled as vendor-managed by assigning the vendor account to a warehouse or to a resource of a resource group.

Based on these capabilities, Lean manufacturing for Microsoft Dynamics AX 2012 does not need any specific features to support the material and products flow. All possible scenarios that involve vendors as providers of production or transport services can be modeled based on the new architecture of production flow and activities.

Figure 25 illustrates a simple production flow with a subcontracted activity based on fixed quantity kanbans.

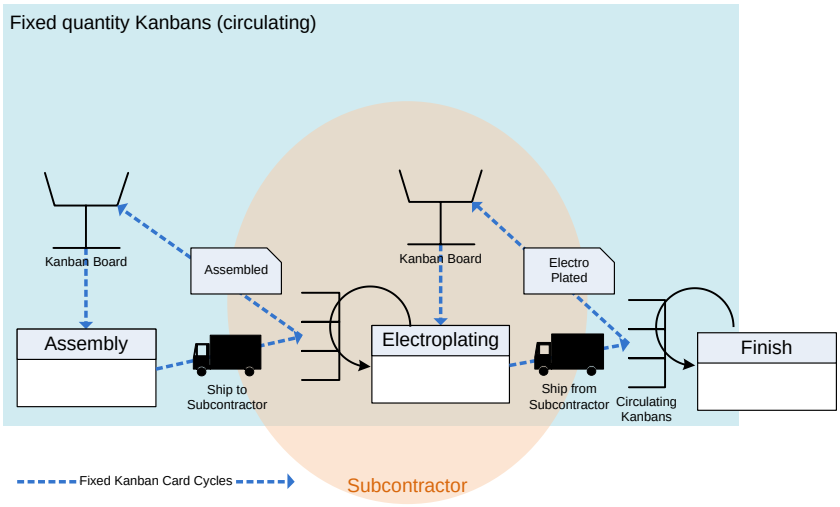

Figure 25: Simple production flow with subcontracted activity

In this example, the subcontractor works out of a supermarket located at the subcontractor. When handling units are emptied at the subcontractor, the kanban cards are returned with the next shipment to the assembly cell, and then the supermarket at the subcontractor is replenished. The transfers to and from the subcontractor can be modeled as explicit transfer activities to support a picking and shipment process. If an explicit registration is not needed to support the physical transport, the transfer activities can be left out.

Figure 26 shows a production flow in which a subcontracting work cell can be used for coating of steel tubes as an alternative to a company doing the operation itself.

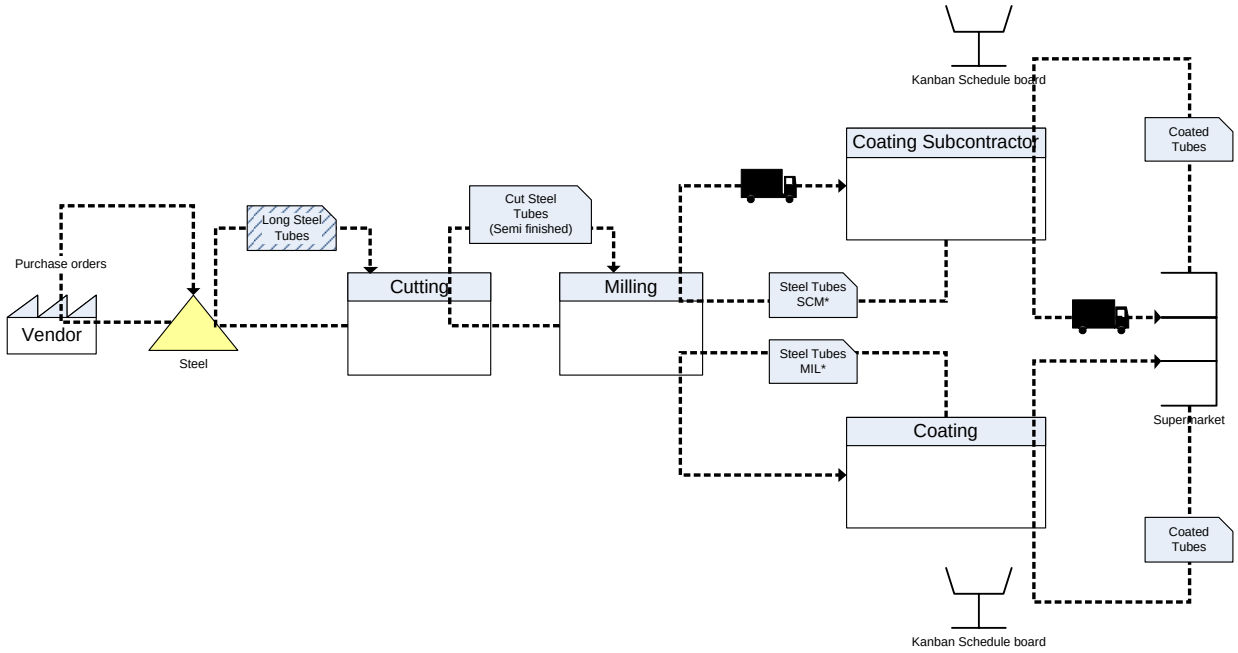

Figure 26: Complex production flow with subcontracted activity

The subcontractor is used to load balance the overall capacity of the production flow. Assume this production flow is modeled with scheduled kanban rules. The planner schedules and load levels both work cells on demand with the kanban scheduling board, and monitors the consolidated supply schedule for the supermarket in the new **Supply schedule** form. To optimize the subcontractor's work on the kanban schedule board, a function to convert kanbans to the alternative kanban rule allows the planner to reschedule a kanban that was originally created for internal production to the alternative work cell. In fact, the subcontracted nature of the work cell has no impact on the production flow. The same working principle would apply for two parallel internal work cells or for two subcontracted cells.

As any other activity in a production flow, subcontracted activities can consume and supply inventoried, non-inventoried (WIP), and semi-finished material and products. The processes to schedule and execute subcontracted activities are the same in all cases, and are identical to the processes done for internal work.

The purchase process for subcontracted activities (services)

In Microsoft Dynamics AX 2012, the purchase process for subcontracted activities is now based on the scheduling and execution registration of the kanban jobs based on the physical material flow. At the same time, the purchase process is an independent process and allows adjustment of the purchase documents manually in every step of the purchase process. Figure 27 illustrates the purchase process for subcontracted activities.

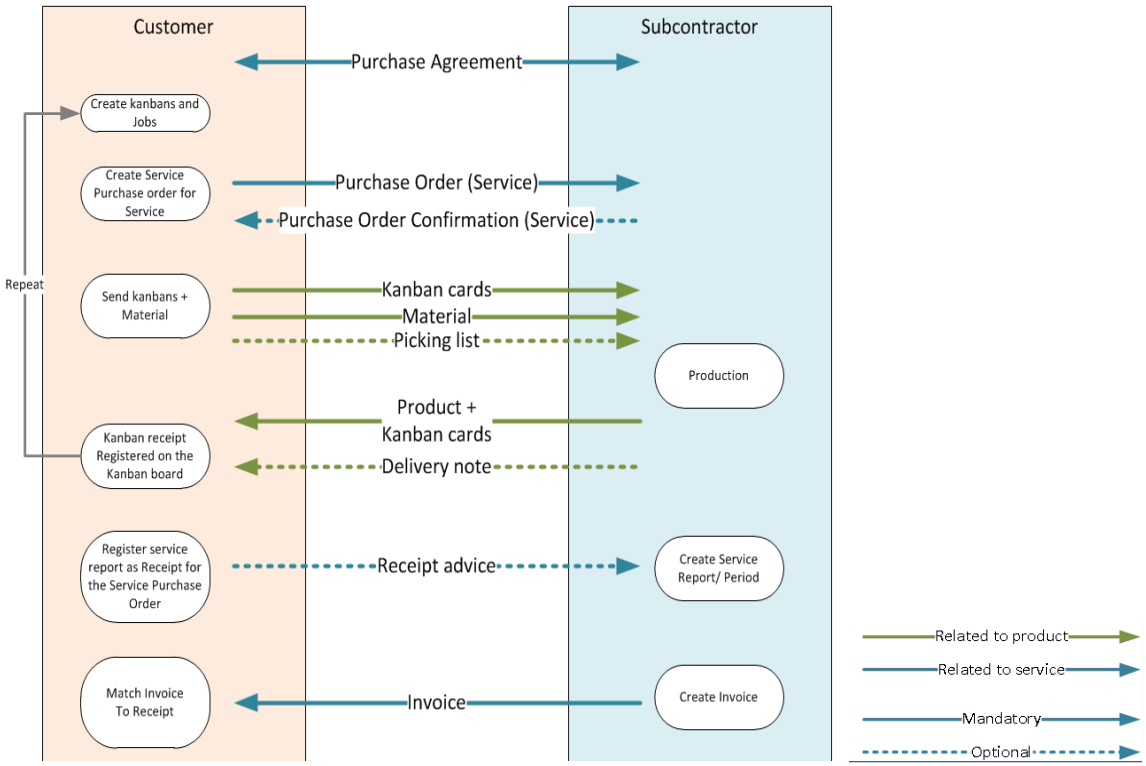

Figure 27: Subcontracting process with purchase order for service pre-delivery

The purchase process for subcontracted activities is as follows:

1. Create a purchase agreement.

   The purchase agreement is created for the service and connected to the activity of the production flow.

2. Create a purchase order.

   A release purchase order can be created for the service, based on the scheduled kanban jobs. Jobs for the same service can be grouped to purchase order lines by day, week, or month. The creation of the purchase order lines can happen at any time after creation of the kanban jobs, even after the fact. This last option is usually selected if the subcontractor provides the services without further notice, based on the kanbans or kanban cards that the subcontractor receives. In this case, deviations between purchase order and invoice can be minimized.

3. Generate kanban cards, material, and picking list to send to the subcontractor to prepare for processing. Based on the detailed modeling of the production flow, the preparation is done on the kanban board for process activities using the picking list plus the preparation function, or on the kanban board for transfer jobs using the picking list plus start or completion.

   For inventoried material, both processes can be supported by a WMS-Picking and Shipment process. On demand, a bill of lading can be created.

4. Generate kanban handling units and kanban cards.

   Cards are returned from the subcontractor after processing, usually including a delivery note that specifies the physical material that *has been shipped. A reference to the provided services is not needed.*

The arrival of the material or product at the customer is registered with the kanban board (process or transfer, depending on the modeled activities) based on the kanban cards.

5. Create a receipt advisory.

   The receipt advisory can be used to replace a packing slip document for the received services. Receipt advisories can be generated based on the completed kanban jobs for the subcontracting activity for a selected period. For each job receipt, advisories are created for the related purchase order line. The receipt advice can be printed and sent to the subcontractor as confirmation of receipt.

6. Generate an invoice.

   The process ends with the invoice of the subcontractor for a period. The invoice match is done against the created receipt advisories. Because the receipt advisories represent the exact physical receipt of material, the 3-way matching is simplified.

Configuration of activities for subcontracting

The following sections describe how to configure activities for subcontracting.

Subcontracted services

The payment item used in activity-based subcontracting has to be a product with the following properties:

- Product type: Service
- Inventory model group: Non stocked

This enforces the use of the FIFO inventory model.

- For cost calculation of the products, a standard cost of the service has to be defined.

To be available for use with activity-based subcontracting, a purchase agreement with the vendor is needed.

Subcontracted process activities

To configure a process activity as a subcontracted activity:

1. Configure a subcontracted work cell.

   To configure a work cell as subcontracted, a resource of type Vendor needs to be created and associated with the work cell (resource group).

   A runtime cost category with cost group type, **Direct outsourcing**, should be assigned to the work cell. The cost categories for setup and quantity are not needed.

2. After a process activity is created and related to a subcontracted work cell, a service needs to be configured for the activity before the production flow version can be activated. This is done in the **Activity details** form.

   For activities associated with a subcontracted work cell, the **Service terms** FastTab is displayed. Add a default service that is valid for all output items to the FastTab. If specific output items need different services or different service calculation parameters (for example, a different service ratio), you can add additional services to the activity.

Subcontracted transfer activities

A transfer activity is configured as a subcontracted activity, depending on the Freighted by selection of the transfer activity:

- **Shipper:**

The activity is subcontracted if the transfer from the warehouse is managed by a vendor (property of the warehouse).

All selected purchase agreements for services must have the same vendor ID as the warehouse.

- **Recipient:**

  The activity is subcontracted if the transfer to the warehouse is managed by a vendor (property of the warehouse).

  All selected purchase agreements for services must have the same vendor ID as the warehouse.

- **Carrier:**

  The activity is subcontracted to any vendor providing the service.

As for process activities, for subcontracted transfer activities, a default service must be configured on the **Service terms** FastTab of the **Activity details** form.

Service quantity calculation

The complete purchase process is based on an item reference for a service, measured in a unit of measure of a service. Services are usually measured in number of services (units) or in time. To calculate the service quantity based on the registered completion of kanban jobs, the following methods can be applied:

- Based on the number of jobs:

One kanban job equals *n* units of service, independent of the supplied product quantity.

In lean manufacturing, one job corresponds to one handling unit.

This calculation method applies to all services that have a fixed-price per handling unit. This usually applies to transfer activities, but can also apply to process activities that process entire handling units.

- Based on the product quantity:

The service quantity is relative to the scheduled/supplied product quantity. The supplied product quantity can be calculated including or excluding error quantities. This calculation method is applied for all cases where the service price per unit of processed product is agreed upon.

- Activity time:

The theoretical activity times are calculated based on the processing time of the activity, the total processed quantity, and the throughput ratio of the processed product. This calculation method is applied for services that are pay-by-the hour and have a variance in time per processed product.

Cost accounting of subcontracted services

With the posting of the receipt advisory or a vendor packing slip on a purchase order created for a production flow (or, in other words, generated based on kanban jobs for subcontracted activities), the value of the receipt is accounted in the WIP accounts of the production flow. Deviations of invoices are also accounted to the production flow. A new cost category for subcontracted work has been introduced in Microsoft Dynamics AX 2012 that allows a transparent tracking of the value of subcontracted work allocated to WIP and consumed per period.

The backflush costing for lean manufacturing at the end of a costing period calculates the actual variances of the products produced out of the production flow during the costing period.

Modeling transfer as subcontracted activity

Transport is usually seen as nonproductive and non-value adding. However, when comparing the cost of subcontracting to internal production, the cost of additional transport activities must be considered.

A production flow that spans over multiple locations and that needs transport services should model the transport cost as part of the cost needed to supply the products to the customer.

Activity-based subcontracting in Lean manufacturing for Microsoft Dynamics AX 2012 allows you to integrate carriers and transport vendors that move material and products between locations of a production flow. Modeling a transfer activity allows the assignment of a carrier or vendor. The transfer activities/job is based on a service and purchase agreement and the same functionally of creating purchase orders and receipt advisories based on the actual transfer jobs is provided, than for subcontracted process activities.

For the first time, Microsoft Dynamics AX supports the BOM calculation including transport services, the creation of related purchase orders, an integrated receipt registration, and the cost integration of transport services into the production flow costing.

Tool replenishment

Accounting for an accurate cost of tools and organizing tool replenishment with master scheduling is a special challenge because the ”consumption” of a tool is usually not proportional to an exact BOM factor and can vary significantly.

Lean manufacturing for Microsoft Dynamics AX 2012 provides an elegant solution for these challenges. Tools are pulled to a work cell with a fixed quantity withdrawal kanban (or a production kanban, if the tool is built in-house). The products using the tool assign the tool in the BOM with a per-series quantity that corresponds to the average endurance of the tool. This allows scheduling demand for the tool on the longer term and enables the calculation of the kanban quantities based on the output product demand (forecast or sales demand).

Tool production and replenishment is usually a side branch of a production flow. Figure 28 describes a side branch of a production flow that provides dies that are used as tools in the striking process of a coin production.

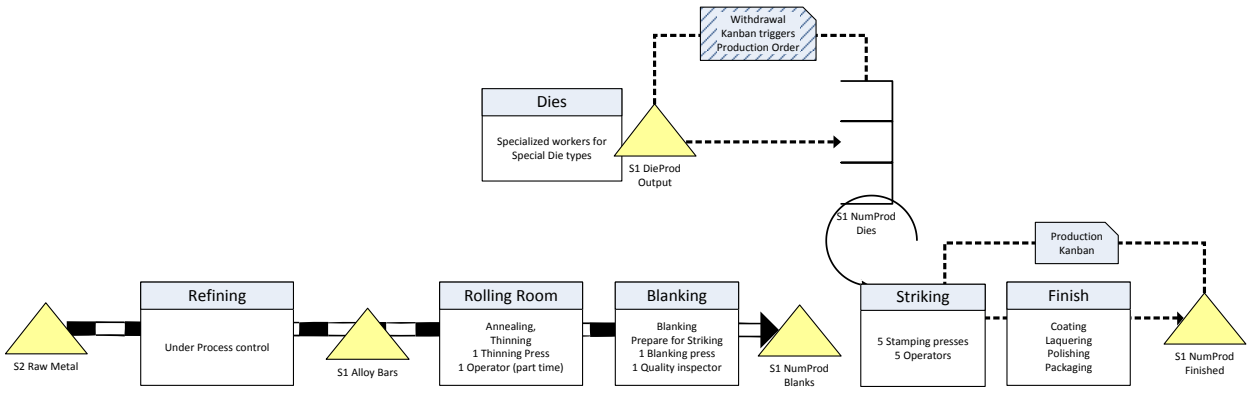

Figure 28: Tool production and replenishment side branch

New tools are only built or purchased whenever a tool is used, which is declared to the system by registering the correspondent kanban as empty, which in turn calls for a new tool. Within the production flow, the tools are not inventory controlled and not backflushed. This requires a picking activity that has **Update on hand** = **No**. Consequently, the kanban rule that supplies the tool to the production flow needs **Update on hand** = **No** in the last activity as well.

From a costing point of view, the tools that correspond to kanbans with handling unit status **Received** are part of WIP and will be listed in the list of unused quantities at the backflush costing. Whenever a tool is registered as consumed (kanban empty), the tool is accounted as consumed.

The tools should have their own cost group to enable breakdown of the tool cost in consumption, result, and variance. Based on the BOM line, the BOM calculation creates a cost component for the tool consumption for each finished product that uses the tool. When the finished products are received from the production flow, the value that corresponds to the tool consumption is deducted from WIP. The backflush costing calculation will compare the consumed tools, per period, to the tool usage according to the finished product receipts, and then calculate the variance for the cost group.

Production flow versions

Continuous improvement of lean manufacturing should not be static. Continuous improvement is an important part of the lean philosophy. An IT system designed for lean manufacturing must support the continuous changes and improvements that the production system in the physical world experiences. The IT system should not limit improvement by design.

In Lean manufacturing for Microsoft Dynamics AX, production flows and kanban rules are organized in date-effective versions. A production flow can have many versions; however, at any one point in time, only one version can be the active version. Draft versions do not need a specific effective/expiry date and time, but can have them.

Production flows and kanban rules are organized in date-effective versions. Any production flow can have many versions; however, at one point in time, only one version can be the active version. Draft versions that you might create do not need a specific effective/expiry date and time, but can have them.

Production flow activities (also referred to as plan activities) are created for a production flow and are automatically assigned to the version that they were created for. If other versions exist, the same activities can be related to any of the other versions of the production flow. Note that the properties of an activity are always the same for all production flow versions. If a different behavior is needed for a new version, you must create a new production flow activity.

Unlike activities, the activity relations and their attributes are part of a production flow version.

Kanban rules are implicitly linked to a specific version of a production flow because the kanban rules are linked to the nodes that relate activities to a specific production flow version. When created, a kanban rule inherits the effective and expiry date of the production flow version. A kanban rule cannot be valid outside the validity period of the production flow version that it relates to.

An expired kanban rule can have a replacing kanban rule that models the changed behavior for the product selection. The replacing kanban rule can be part of either the same production flow version or the next production flow version.

When a kanban rule expires, the active kanbans of the expired rule are counted as kanbans of the replaced rule. When a kanban handling unit for an expired fixed quantity rule is registered as emptied, a new kanban is used for the replaced rule. The circulating cards of the replaced rule are inherited by the replacing rule just the same.

Creating a new production flow version

Supported by date-effectiveness, a new production flow version can be set up before it becomes effective, which gives you the opportunity to model and review the new version. Lean manufacturing for Microsoft Dynamics AX 2012 also allows you to create versions or kanban rules that are effective in the past, which allows you to adjust the ERP model of your production after the fact with accurate date. However, this capability should be used wisely because conflicts might occur if the model of production is changed with immediate effectiveness while production is running.

To make sure that the new version and its related kanban rules connect seamlessly to the old version, follow these steps:

1. In the **Production flow version details** form (**Production control**> **Setup**> **Production flow**> **Version** > **Details**), set the expiry date of the version to the date that the new version is supposed to be activated.
2. Close the version form, and then click the **Add version** button.

   A dialog box defaults to having the new version be active at the exact date and time that the old version expires.
3. Until the new version is activated, the effective and expiry dates of the versions can be modified and are independent of each other. Make sure that you have accurate activity periods for each version before you activate a new version.

When creating a new version of a production flow, you can select one of two options:

- **Copy from version**

  Copies the activity references and activity relations of the selected version to the new version.

- **Duplicate kanban rules**

  Creates replacing kanban rules for each of the kanban rules of the original version.

  If this option is not selected, no kanban rules are created for the new version by default. However, you can still create the needed kanban rules manually by using the **Create replacing rule** function in the **Kanban rules** form. If a new production flow version exists, the effectiveness of the replacing kanban rule automatically defaults to the activity period of the new version.

When the new version has been modeled, it can be activated, independent of its effectiveness date. In fact, we recommend that you activate the version before it becomes effective to make sure that the validation and the setup are correct.

When the version is activated, new kanbans can be created for the kanban rules associated with the new version, which is especially important for fixed quantity kanbans, but which might also apply to schedule and event kanbans that need to be created for future demand.

Deactivating a production flow version

The deactivation of a production flow version is only applicable if the production flow activity is completely stopped and will not be replaced by a new version. The deactivation will update all related kanban rules to expire by the **As of date** and time. The updated kanban rules cannot be reversed by a re-activation of the production flow version; a re-activation of kanban rules would need to be done either manually or by the creation of a new version that duplicates the kanban rules.

A temporary deactivation of a production flow should be modeled by changing the effective and expiry date of the version or of specific kanban rules.

Before a production flow or a kanban rule is deactivated or expires, the related kanban situation should be cleaned up to enable closure for costing, scheduling, and on-hand inventory as follows:

- All kanbans with handling unit status **Assigned** should be completed or reversed.
- All kanbans with handling unit status **Not Assigned** should be deleted (otherwise, they would still be considered by master scheduling as planned receipts).
- All kanbans with handling unit status **Received** should be emptied.

None of the steps above will be performed automatically when a production flow version or kanban rule is deactived or expires.

Conclusion

Lean manufacturing for Microsoft Dynamics AX 2012 is much more than a superficially polished version of Lean manufacturing for Microsoft Dynamics AX 2009. It is a new foundation, providing an

open architecture to support different shades of manufacturing for different industries and different production and replenishment strategies.

It allows the successful and scalable implementation of lean manufacturing for companies that are just starting the lean journey as well as for companies that already have a lean manufacturing history and the ability to grow with the complexity of the modeled production scenarios. The back-end integration in scheduling and costing establishes lean manufacturing as an integrated part of ERP.

Microsoft Dynamics is a line of integrated, adaptable business management solutions that enables you and your people to make business decisions with greater confidence. Microsoft Dynamics works like and with familiar Microsoft software, automating and streamlining financial, customer relationship and supply chain processes in a way that helps you drive business success.

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