

Microsoft Dynamics® AX 2012

# Lean Manufacturing: Kanban and Pull Based Manufacturing

White Paper

This whitepaper introduces a variety of kanban and pull based manufacturing scenarios and how they can be supported with lean manufacturing for Microsoft Dynamics AX 2012.

Date: July 2011

<http://microsoft.com/dynamics/ax>

Conrad Volkmann, Senior Program Manager, Manufacturing

Send suggestions and comments about this document to [adocs@microsoft.com](mailto:adocs@microsoft.com). Please include the title with your feedback.



# Table of Contents

<b>Introduction.....</b>	<b>4</b>
Purpose of this document.....	4
<b>Concepts: kanban and replenishment strategies.....</b>	<b>5</b>
Kanban—the definition .....	5
Circulating cards .....	5
Single use kanbans and electronic kanban—all types .....	5
Single usage kanbans .....	5
Priority kanbans.....	5
Kanban schedule .....	5
Replenishment strategy and kanban type.....	6
Manufacturing .....	6
Withdrawal .....	6
Replenishment strategies .....	6
Fixed quantity kanbans.....	6
Single usage kanbans.....	7
Production forecast/schedule related kanbans .....	7
Event kanbans.....	7
Reconciling master scheduling and lean manufacturing .....	8
Finite capacity scheduling for lean manufacturing .....	9
Production flow and activity validations.....	10
<b>Kanban boards .....</b>	<b>11</b>
The Kanban schedule board .....	11
Automatic scheduling of kanban jobs.....	11
Manual scheduling .....	11
The Kanban schedule board .....	12
Lean scheduling groups .....	12
Unplanned jobs .....	13
Displaying the kanban schedule.....	13
Size of the kanban symbol in the schedule .....	15
Moving jobs in the schedule .....	15
The schedule alert symbol .....	16
Automatic refresh .....	16
The kanban board for process jobs.....	17
The job list.....	20
Job details .....	21
Job and job status registration .....	22
Picking list .....	22
Pegging .....	23
Information and process FastTab on the right side .....	23
Registration .....	23
Messages.....	23
Cycle time performance indicator.....	24
Transfer jobs.....	25
Kanban quantity overview—finished goods.....	25
Kanban quantity overview – material .....	26
Job icon legend .....	26

Automatic refresh .....	27
The Kanban board for transfer jobs .....	28
Filtering jobs on the Kanban board for transfer jobs .....	28
Working with transfer jobs .....	29
Job status registration .....	30
Update picking list .....	31
<b>Replenishment strategies .....</b>	<b>31</b>
Fixed quantity kanbans – the circulation principle .....	31
Kanban quantity calculation .....	31
Scheduled kanbans .....	32
Event kanbans.....	32
The sales event .....	33
The kanban line event .....	33
The BOM line event.....	34
Pegging event processing .....	35
The minimum stock event.....	35
<b>Lean supply policies - the kanban rules .....</b>	<b>36</b>
Configuration of kanban rules.....	36
Filter kanban rules: .....	37
Activities, kanban flow and production flow .....	38
The product selection .....	38
Quantities .....	38
Kanban cards .....	39
Configuration of events .....	40
<b>Manufacturing scenarios with kanbans .....</b>	<b>40</b>
Single process activity production scenario.....	40
Kanban creation .....	42
Scheduling .....	43
Production process—start and complete.....	44
Consumption and empty kanban handling units .....	46
Single transfer activity replenishment scenario .....	48
Simple process and put-away transfer scenario .....	49
Multiple process activity kanbans .....	52
Scheduling multiple process activity kanbans .....	53
Manufacturing .....	53
Kanban supplying or consuming semi-finished products.....	53
Scheduling .....	54
Manufacturing, transactions and material consumption.....	54
<b>Kanban and vendor integration.....</b>	<b>55</b>
Kanban and purchase orders – purchase kanbans .....	55
Detailed process .....	55
Simplified process with periodic purchase orders .....	55
Conclusion .....	56
Subcontracting .....	56
Consignment stock.....	56
<b>Conclusion .....</b>	<b>57</b>

---

## Introduction

*Pull* is one of the five lean principles introduced by James Womack and Daniel Jones in *Lean Thinking: Banish Waste and Create Wealth in Your Corporation* (Jones and Womack, 1996).

Kanban is one of the possible implementations of a pull solution. Other possible implementations are Drum Buffer Rope (DRP) and Constant Work in Progress (CONWIP). All pull solutions have a common trait: a pull signal is needed to trigger supply for a specific demand. In most cases a kanban signal—as a physical card or an electronic signal—is used to convey this signal.

In Microsoft Dynamics AX 2012, pull is implemented based on a kanban framework to plan, track and execute based on pull signals.

This framework that is based on pull signals covers most of the possible variants of pull based manufacturing and supply chain management (SCM) solutions.

The ultimate lean goal—the single piece flow with zero inventories—is obtainable. Many industries have been able to replace build-to-stock or supermarket scenarios with assemble-to-order scenarios that support single piece flow. Lean manufacturing for Microsoft Dynamics AX 2012 provides a powerful new instrument to support the following scenarios: kanban production and replenishment based on events.

## Purpose of this document

This document gives an overview of how to use the kanban framework in Microsoft Dynamics AX 2012 to support lean manufacturing and pull based manufacturing scenarios. It introduces the concepts of kanbans as signals and kanban rules as supply policies.

Lean manufacturing for Microsoft Dynamics AX 2012 is a set of new features that allow an almost infinite set of applications depending on your requirements. This document provides a small set of ideas and application examples that illustrate how to model pull scenarios. This document also attempts to raise the level of interest and curiosity to try additional scenarios.

## Concepts: kanban and replenishment strategies

This section introduces the concepts that have been used to model the lean manufacturing in Microsoft Dynamics AX 2012. Most of them were supported by lean manufacturing for Microsoft Dynamics AX 2009, however partially by using different terms.

### Kanban—the definition

*Kanban* is the Japanese word for “card”. It represents a pull signal that is related to a handling unit of a specific item or an item family, combined with manufacturing and/or transport instructions. The kanban information is conveyed by simple visual devices in the form of cards, balls, carts, containers, and so on. It can be applied to both material and product flow within a site and material flow between suppliers and customers, or any partners of the supply chain.

### Circulating cards

For a *circulating kanban*, printed cards are reused and are physically circling between the item origin and the point of consumption. After defining the kanban quantity, the cards that are needed are printed once. Fixed circulating cards can move between item origin and point of consumption multiple times in one day. This principle is mostly applied for locations on one site that have a physical proximity to replenish a cell supermarket out of the main material warehouse or another work cell.

### Single use kanbans and electronic kanban—all types

For most kanban processes, a specific card is not reused. When a kanban is reported as empty, a replenishment signal is created for the item origin and a new kanban is created. The signal is then usually transferred electronically. This is achieved by inserting the card in the kanban schedule of the cell (manufacturing), transferring an electronic data interchange file (for example, for subcontractors, vendors and physically remote sites) or by simply printing the new card on a printer that is located at the item origin, often next to the physical kanban board. The practice of transferring a kanban back to the item source as an electronic signal instead of the physical card is known as *electronic kanban*. The related cards are called *reused cards* or *lost cards*.

### Single usage kanbans

During the planning process, a production planner can create additional single usage kanbans that are based on fixed quantity kanban rules or by duplication of an existing fixed quantity kanban.

### Priority kanbans

In the kanban schedule board any existing kanban can be modified to priority, raising the priority of this kanban. The priority attribute is printed on the kanbans and is displayed as a special Icon in the kanban board and the kanban schedule. For circulating kanbans the priority status is reset to normal, when the card is returned to the item origin in the next cycle.

When priority kanbans create component kanbans, the component kanbans also have the priority property.

### Kanban schedule

The kanban schedule sequences the kanbans by the jobs of a cell and takes care that the cell is not overloaded for a specific production period.

To sequence the kanbans, two attributes are linked to the kanban job:

- Production period (date from the WorkCalendarDate)
- Sequence within the period.

The kanban schedule is displayed and modified in the kanban scheduling board and in the job list of the kanban board for process jobs.

## Replenishment strategy and kanban type

To define the replenishment strategy for a specific kanban rule, the kanban type is set to either **Manufacturing** or **Withdrawal**.

### Manufacturing

A kanban of type Manufacturing is assigned to a process that adds value. The kanban is assigned to a resource group with the role of a work cell and it is here that the value is added.

Manufacturing kanbans relate to at least one process activity. The first activity of a manufacturing kanban must be a process activity. A process activity can be followed by a transfer or another process activity.

### Withdrawal

A kanban with the type Withdrawal creates a pure transfer job. It is based on a single transfer activity. It is used to move a kanban of a specific item between supermarkets, warehouses and production locations. Withdrawal kanbans do not add value.

## Replenishment strategies

Replenishment strategy















Kanban Type	Make to Stock				Make to Order		
	Fixed Quantity	Variable Quantity					
		Single use	Minimum On-Hand	Scheduled	Sales Event	Component (BOM)	
						Prod BOM Line	Kanban Line
Manufacturing							
Withdrawal							

Figure 1: Matrix of kanban types and replenishment strategies that build the kanban framework

### Fixed quantity kanbans

Fixed quantity kanbans can be applied in all areas where demand for an item is stable over a period of time. Based on the average consumption per day, the replenishment lead times and the security factors the needed kanban quantity can be calculated. In fact, a fixed quantity kanban is a build to stock scenario. Depending on the turnover rate of a kanban rule fixed quantity cycles can come very near to pull scenarios, especially when low lead times apply or the kanban quantity comes close to one.

A fixed quantity kanban rule relates to a fixed number of bins. This means that the number of active kanbans is constant. Whenever a kanban is consumed (emptied), a new kanban of the same type is recreated.

Fixed quantity kanbans are often used with fixed circulating cards, but can also be used with single use cards.

As fixed quantity kanban is a make to stock scenario.

### **Single usage kanbans**

Single usage kanbans can be used to cover additional demand to level specific exceptional demand. Single usage kanbans are always based on fixed quantity rules, therefore no specific rules need to be created for this replenishment strategy. Instead, the kanbans themselves have a flag marking them as manual.

### **Production forecast/schedule related kanbans**

To supply products that have a less stable demand such as a periodic demand, a scheduled kanban strategy might be more appropriate. The planner determines demand from the sales forecast, actual demand or the supply forecast and creates a supply schedule that covers the demand. In combination with the scheduling capabilities of master scheduling in Microsoft Dynamics AX, the process can be based on a manual scheduling or on automated scheduling that uses firming horizons.

Possible scenarios for scheduled kanbans are:

- Creation of kanbans based on minimum stock or on min/max keys
- Creation of kanbans in relation to demand or supply forecast, for example for seasonal demand
- Creation of kanbans for actual demand (build to order) where the average batch size (product quantity of the kanban rule) is higher than the average demand per sales order or picking list.
- Mixed mode environments. After a resource group is converted to a lean work cell, we recommend that you load additional demand (for example, a batch production for a night shift) in the form of scheduled kanbans, instead of loading production orders for the resources in parallel to the lean jobs.

Based on the firm horizon of the production forecast, master planning automatically creates the kanbans that are required to cover the related issues. The kanban creation is based on a kanban rule for a firmed horizon. A production planner can also manually create scheduled kanbans.

Scheduled kanban rules replace target kanban rules from previous versions of lean manufacturing for Microsoft Dynamics AX.

### **Event kanbans**

Event kanbans are a typical build to order scenario. Event kanbans are specific to a single demand from sales orders, production orders or kanbans.

Event kanbans are only created out of the related demand, so event kanbans belong to the category Make to order. The related issues are created when creating sales lines, when issuing picking lists in production or by means of BOM explosion during master planning. The different event types include:

- Sales order – Pull from customer
- Components – Pull to production order or kanban through BOM explosion
- Pull to production order
- Pull to kanban job

Every pull signal creates one or more kanbans. The event types are described in more detail below.

### ***Sales order***

This use case creates the pull for final assembly, packaging or shipping out sales orders.

When a sales order has been entered completely, the order processor finishes the process by converting the sales order to pull signals. The conversion can be either implicit or explicit, and is guided by the settings of the Sales event kanban rules that apply to the item and warehouse she is selling from.. In other words: she creates the kanbans needed to produce or withdraw the goods to satisfy the customer order.

To create pull signals out of a sales order, the sales order lines quantity may need to be split by handling unit size (=maximal quantity of bin) to more than one kanban. The sales order-based event kanbans have detailed information about the customer, the order, additional contract data, and the shipping destination to the shop floor or logistics. If a sales line is split to multiple cards, a number sequence (1 of 3, 2 of 3 ...) is printed on the cards.

### ***BOM line event: pull to production order***

In a mixed mode environment, a picking list, based on a production order, is created to withdraw material from warehouses or other upstream processes. If the warehouse or the upstream process is controlled by event kanbans, the picking list creates the related replenishment kanbans (manufacturing or withdrawal) of the related item source. To create pull signals based on a picking list, the picking quantity may need to be split by handling unit size to more than one kanban. The pull from traditional production is an important part of the mixed mode environment (the coexistence of classical and lean organization within one site).

### ***Kanban line event: pull to kanbans***

Similar to a picking list, the creation of kanbans that pull components to kanbans is used to pull the required material to a downstream manufacturing process. This is only needed when the material is varies by event and a high number of variants are required. Otherwise, a fixed quantity kanban environment is recommended.

This process is particularly important when working with subcontractors. For example, a production planner has to take care that the subcontractor is always provided with the correct amount of material according to the kanbans that he is working on. Again, in a fixed quantity kanban environment, this is rather simple. However, in an event environment with many variables, this process requires a stable process.

### ***Events triggered from minimum on-hand inventory***

Whenever on-hand inventory is reduced for an item on a coverage dimension that is covered by an event kanban rule, a check whether inventory has fallen under the minimum stock is performed. If inventory falls under the minimum stock, an issue is created and the kanban rule is triggered to create the kanbans to cover the issue.

## **Reconciling master scheduling and lean manufacturing**

Lean manufacturing can be introduced in different ways. While some companies start with the lean philosophy and try to apply the lean principles value stream by value stream, others take a more local approach and start from specific work cells where resources and the demand structure allow or even require a lean approach.

Even in a company totally devoted to lean manufacturing, master scheduling is not by definition obsolete because a certain amount of scheduling and forecasting is needed in most manufacturing businesses.

The master scheduling engine of Microsoft Dynamics AX could be called a pure implementation of the pull principle. The issue transactions created by customer demand, forecast and production demand

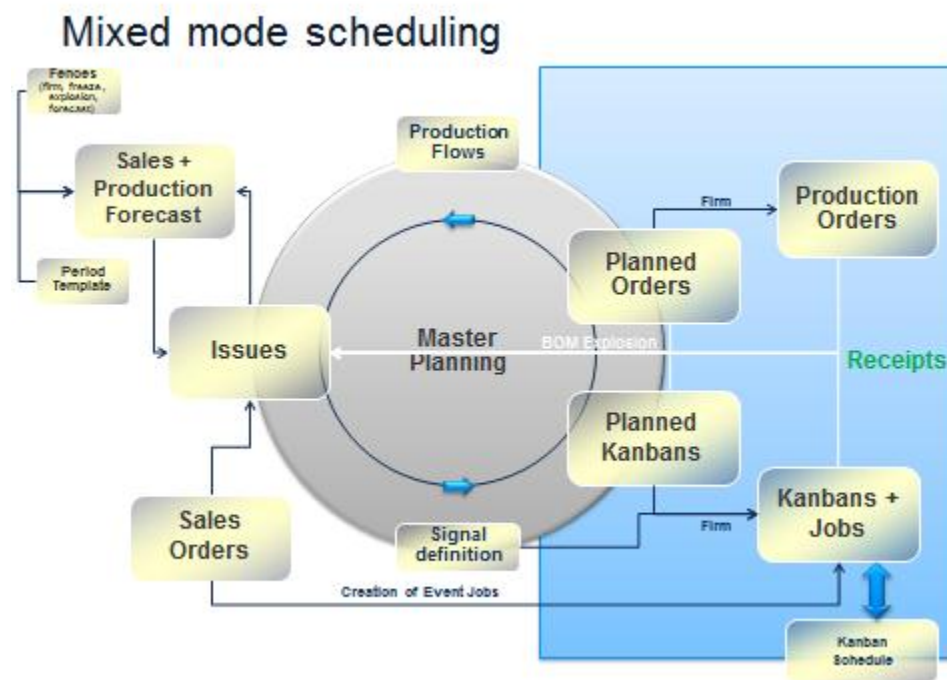


(otherwise called BOM explosion) are pegged against existing receipt transactions (supply) from planned or firmed production orders, transfer orders and the new kanban transaction types that were introduced in Microsoft Dynamics AX 2012.

For all uncovered demand, new planned orders are created by using parameters such as minimum and maximum order size or by using the coverage code that allows grouping of issues by period.

The planned orders are created specifically for the pre-defined order type that is preset in the default order settings. Otherwise planned orders are created by using the item coverage settings. This allows definition by site or warehouse:

- Planned production order
- Planned transfer order
- Planned purchase order
- Planned kanban (new in Microsoft Dynamics AX 2012)
- Production kanban – BOM explosion creates kanban line issues
- Withdrawal kanban – Creates kanban transfer issues



**Figure 2: Overview of the mixed mode scheduling process**

The creation and maintenance of planned orders of type kanban is very similar to planned production orders (for production kanbans) or transfer orders (for withdrawal kanbans). To determine the details of the planned supply, the planned kanban relates to an active kanban rule, describing the production flow and activities needed to supply or replenish the needed item at the given location.

### **Finite capacity scheduling for lean manufacturing**

The primary difference between production orders and production kanbans in lean manufacturing for Microsoft Dynamics AX 2012 is the implementation of finite capacity control for lean manufacturing. While finite scheduling for production orders tries to optimize capacity loading for single resources—

with the risk of over-optimizing single resources and building increasing batch sizes—lean capacity is based on work cell throughput. This assumes a concurrent use of various resources within a work cell.

A lean work cell is represented by a resource group that is flagged to play the role of a lean work cell. This property makes all resources allocated to the work cell unavailable for finite scheduling of production orders or planned production orders for the time that these resources are assigned to the work cell.

The capacity of a lean work cell in Microsoft Dynamics AX is defined by:

- The assigned calendar
- The assigned capacity per period
  - Throughput capacity model:

With this model type, the capacity of a work cell is defined as a quantity per period. The periods are: a standard work day, a week or a month. The kanban schedule is loaded with the job quantity multiplied by the throughput ratio defined for an item in the lean scheduling group.
  - Standard work day period:

The capacity for a work day is defined as that of the length of a standard work day. The standard work day attribute of the calendar is new to Microsoft Dynamics from the AX 2012 release onwards. The available capacity is adjusted according to the available time for any day that has a different length to that given in the active calendar.
  - Week or month period:

For the week or month period, it is assumed that the variances in capacity are accounted for in the weekly or monthly capacity. No adjustments are made based on the calendar.
  - Hours capacity model:

The available capacity of the work cell is the time available according to the calendar. For a job, the average cycle time of the activity—corrected by the quantity and the throughput ratio of the item—is loaded on the kanban schedule.

**Note** Capacity model types cannot be changed or mixed for a work cell. Use the Throughput model wherever the loaded quantity is a clear indication of the available capacity and the items provided by the work cell have comparable resource consumption. Use the Hours model where the capacity load of single jobs has a high variance—not caused by quantity variance—or where many different units of measure are used.

The capacity periods of a work cell can be selected as days or weeks. Within the scheduled periods the jobs are sequenced. The sequencing can be done manually on the kanban scheduling board or automatically through the automatic planning, that schedules kanban jobs whenever the kanban jobs are created or when the automatic planning quantity is reached.

## Production flow and activity validations

The kanban production flow activity rules are verified upon activation of a production flow version or upon request using the validation function of the version the production flow dialog. Any violation of active rules will prevent a production flow version to be activated. It produces an InfoLog message that reports the specific rule and the type of violation. The check of kanban rules is only one of multiple steps of the production flow version verification method.

The rules are also checked when defining or modifying a kanban rule.

## Kanban boards

Lean manufacturing is visual. The users working in lean manufacturing want to be empowered to understand the situation of supply and demand so they are able to take their own decisions. In lean manufacturing for Microsoft Dynamics AX 2012, planning and execution of lean manufacturing is done by using one or more of the common kanban boards:

- Kanban scheduling board – Allows for the scheduling of the kanban process jobs in periods by work cell and can be used as an andon board in work cells showing the overall load and progress. An andon board displays quantity overviews to make the planning and execution status of the work cell visible to the team.
- Kanban board for process jobs – Is used to prepare, start and complete kanban process jobs in a work cell. Material can be received in the work cell and sent out to the next work cell on the same board.
- Kanban board for transfer jobs – Is used to transfer and receive material, semi-finished and finished products managed by kanban rules.

### The Kanban schedule board

Microsoft Dynamics AX 2012 introduces a new visual tool to schedule kanban jobs for a work cell: the kanban scheduling board. The board gives a visual overview of a selected number of periods and allows the planner to sequence jobs and control the capacity usage of the cell.

### Automatic scheduling of kanban jobs

The scheduling can be triggered automatically by setting the automatic scheduling quantity on the kanban rule. An automatic planning quantity = 1 plans each kanban job directly upon creation. This leads to a sequence according to the first pull – first serve principal. When you select an automatic planning quantity of greater than (>) 1, kanban jobs are grouped before planning.

This concept allows reducing kanban sizes below the actual economic batch sizes. For example, assume that the economic batch size for a specific item (or item family) is 30. Instead of creating kanbans with the product quantity 30, the kanban rule can be configured with product quantity 10 and automatic planning quantity = 3. While automatic planning will only schedule the kanban jobs for the work cell when 3 unplanned jobs exist, it is fully transparent to the planner and the shop floor supervisor that there might be 2 unplanned jobs waiting for execution and that it is necessary to take these unplanned jobs into production by either manually planning the jobs or by creating additional kanbans.

### Manual scheduling

For manual scheduling, Microsoft Dynamics AX 2012 introduces the kanban scheduling board. Manual scheduling can be combined with automatic scheduling. Jobs can be planned, un-planned, moved in sequence or moved from period to period with the kanban scheduling board. Jobs based on a kanban rule with automatic planning of greater than (>) zero (0) can be manually un-planned. However, they will be re-planned when the next automatic planning event occurs, for example when a new kanban is created.

## The Kanban schedule board

The Kanban schedule board combines an overview of the next N scheduled periods for the work cell with a kanban quantity overview control that shows the scheduling and execution situation of all kanban rules that are related to the work cell:

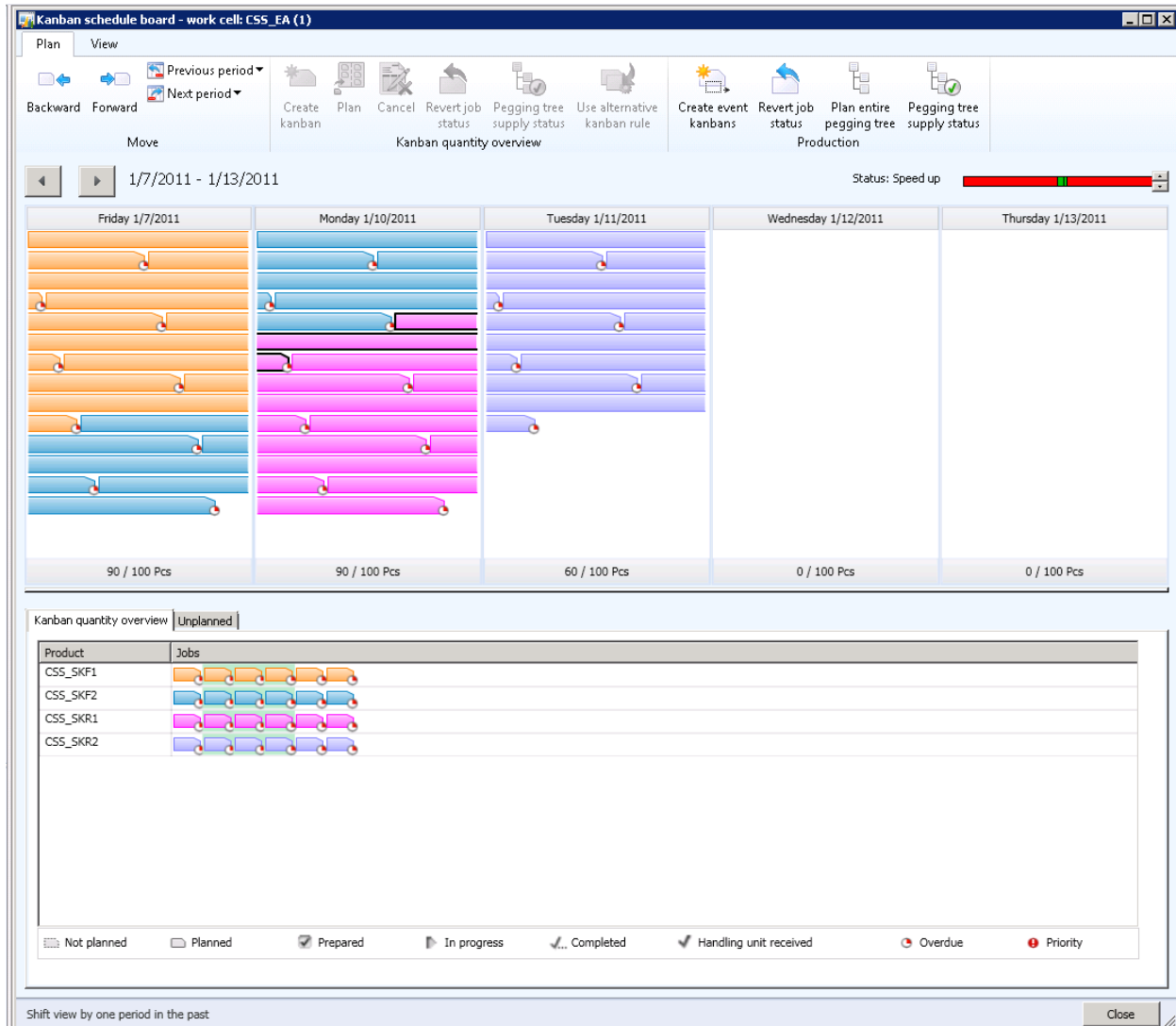


Figure 3: Example of the kanban scheduling board

## Lean scheduling groups

Each color represents a lean scheduling group. Lean scheduling groups can be freely defined as generic groups or as groups that belong to a single work cell.

Items and dimensions can be freely assigned to the scheduling groups. In our example of a Painting cell, the schedule group represents a color of the product. In work that is driven by specific tooling requirements, items might be grouped by tool requirement while a packaging work cell probably groups items as per packaging templates.

The use of colors for lean scheduling groups is optional but recommended. It improves visibility of the status of the plan. In our example, we have used colors to indicate what is produced on which day.

## Unplanned jobs

To get a fast overview of unplanned kanban jobs the planner selects the Unplanned FastTab. This variant of the kanban quantity overview control filters on kanban jobs and kanban rules that are not planned and only show the unplanned jobs.

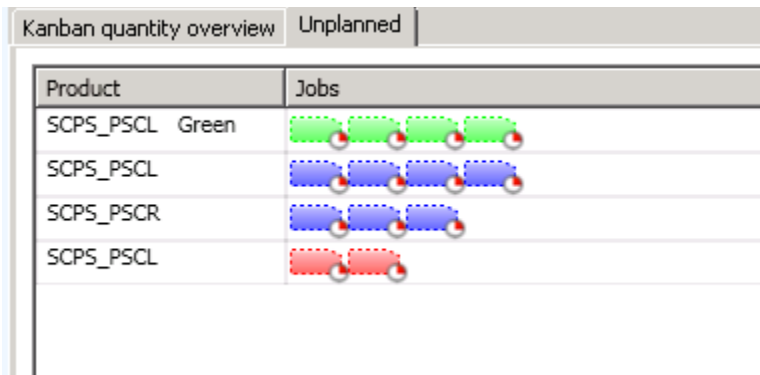


Figure 4: Kanban quantity overview for unplanned jobs

To plan jobs the planner can either:

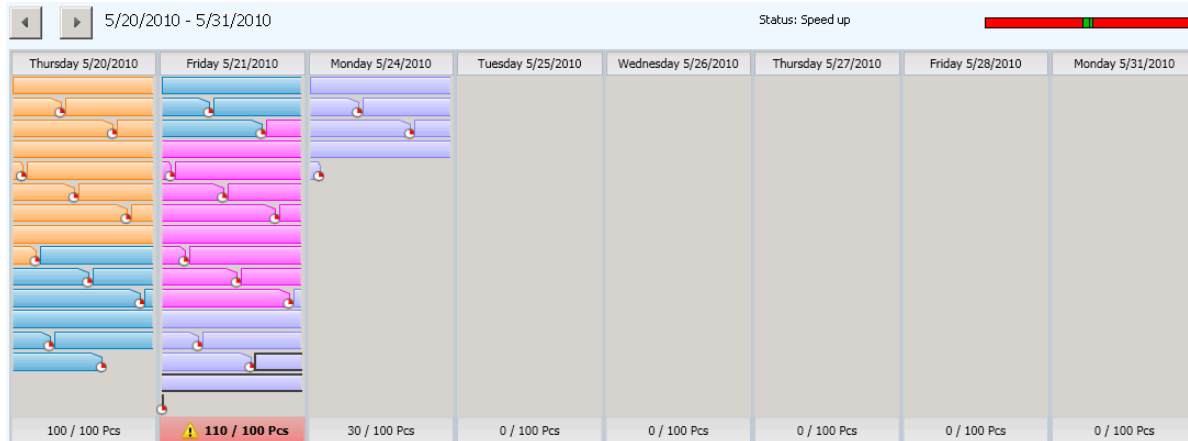
- Select one or multiple jobs and drag them to a specific period
- Select one or multiple jobs and click the **Plan** button to place each job into a planning period according to its due date. Some jobs may be placed in future planning periods. These jobs are not visible on the schedule board unless you change the view to display the particular future periods.

## Displaying the kanban schedule

The kanban schedule is displayed as a variable number of scheduling periods. When setting up the work cell capacity the period type for the kanban schedule of the work cell can be set to days or weeks as a property of the production flow model. The periods are shown as columns, similar to the days or the weeks in the calendar in Outlook.

When opening the kanban schedule board for a work cell, the first period shown is either the first period in the past that has un-completed jobs, or the current period.

The following example shows the schedule with 8 days. The board only shows periods that have working days according to the calendar. The periods and the kanban symbol sizes are automatically sized to the maximum available or the loaded capacity of any of the displayed periods.



**Figure 5: The scheduling area in the Kanban schedule board**

At the bottom of each period the scheduled and available capacity for each period are displayed. Depending on the selected model type for the work cell, the capacity is displayed in hours and minutes or quantity with a unit of measure. If a period is overloaded, as in the second period of our example, a visual warning is given to the planner. A period can be overloaded manually or it can be overloaded by setting the capacity shortage reaction of the production flow model to **Add to requested period**.

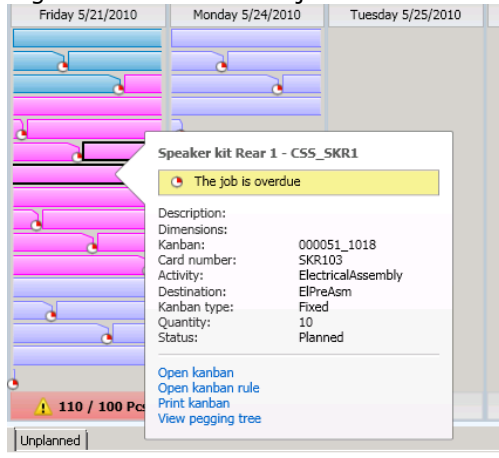
In the kanban schedule you can only schedule jobs for a single period. You cannot schedule jobs over multiple periods. Therefore, you should define the maximum product quantities for kanbans based on the capacity that is available during a kanban schedule period, for example, the quantity of product that can be produced within a week. In addition, the product quantity of the kanban should correspond to the quantity of a single handling unit—the quantity per bin or pallet.

If you use small maximum product quantities for scheduled and event kanban rules, you can level and distribute quantities for a single demand, for example, a sales order line, over multiple periods.

If the product quantities that you use would require multiple scheduling periods, multiple handling units, or multiple registrations in inventory, then you must use batch production orders instead of kanbans.

**Note:** We recommend that you organize kaizen events to bring batch sizes down before you try to implement this requirement on a lean manufacturing system.

Right click on a kanban job in the schedule to display the details of the job.



**Figure 6: Kanban details on right click**

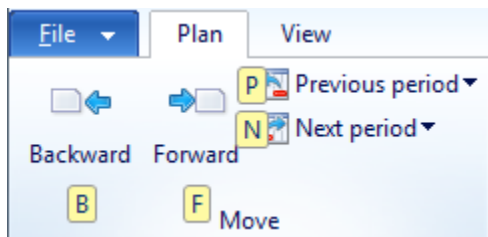
More details can be viewed by opening the Kanban details form.

### Size of the kanban symbol in the schedule

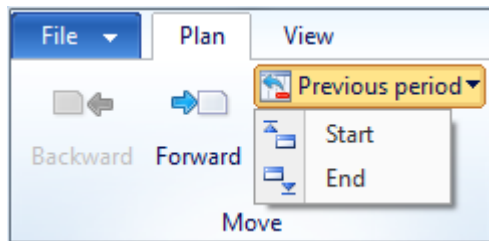
The size of the kanban symbol corresponds to the relative schedule consumption of the job in the work cell. This is calculated by the job quantity multiplied with the throughput ratio of the item defined in the lean scheduling group.

### Moving jobs in the schedule

Jobs can be moved in the schedule by using drag and drop or the keyboard.



**Figure 7: Action Pane keyboard controls to move jobs in the schedule**



**Figure 8: Action Pane keyboard controls, period sub-menu**

To use the keyboard, select one or multiple jobs and use the Move functions in the Action Pane:

- **Backward**  
Moves the selected jobs back in the sequence of the actual period (inactive if the jobs are the first jobs in the period).

- **Forward**  
Moves the selected jobs forward in the sequence of the actual period (inactive if the jobs are the last jobs in the period).
- **Previous period**  
Moves the selected jobs to the previous period. Select from the sub-menu if the jobs should be moved to the start or end of the target period.
- **Next period**  
Moves the selected jobs to the next period. Select from the sub-menu if the jobs should be moved to the start or end of the target period.

To use a keyboard, you can use the Action Pane keyboard shortcuts:

- To move forward, press Alt P, M, F.
- To move the selected jobs to the start of the next period, press Alt P, M, N, S.
- To navigate from one period to the next press Tab.
- To select a job within a period, use the cursor keys. Press Shift plus the cursor keys to select multiple jobs.

### The schedule alert symbol

A kanban job symbol in the schedule or in the kanban quantity overviews can have a schedule alert symbol overlay:



**Figure 9: Example of kanban symbols with alert overlay**

This can be caused by schedule-related issues, for example:

- The job has a due date in the past (overdue).
- The job is assigned to a scheduling period that would not deliver the job on the due date and time.
- After running the **Pegging tree supply status** function:
  - One of the upstream jobs pegged to the selected job is not planned yet or will not be delivered on time.
  - Open the pegging tree details form to view all upstream kanbans and jobs in order to analyse the details of the plan.

### Automatic refresh

By setting a refresh cycle time to the kanban scheduling board, it can be ensured that even users that do not interact with the board every minute always have an accurate view of the schedule, quantity overviews and the cycle time performance.

**Note** In this mode, the kanban board can be used as an andon board work cell.



## The kanban board for process jobs

This release of Microsoft Dynamics AX includes role-based user interfaces that take into account different interaction perspectives, skills, and technologies. Specifically for the shop floor in lean manufacturing, three user profiles have been evaluated through extensive customer field research. This research included visits to a variety of manufacturing companies in Europe, the United States, and Canada, and included the following roles:

- The shop floor supervisor. This role needs a complete overview of what happens in a specific work cell. This role also decides on priorities and sequences of jobs.
- The waterspider. This role replenishes supermarkets on the shop floor, prepares handling units and picks material for kanbans or production orders, puts away finished products or moves semi-finished products to the next work cell or supermarket.
- The machine operator / shop floor worker. This role reports the start and end of jobs.

In reality, these three roles often have some overlap. Depending on throughput and importance, waterspiders have been found to be dedicated for a single work cell or for a group of work cells. Some lean organizations remove the system interaction for the machine operators and use the waterspiders to report the finished goods.

Many companies with excellent implementation of lean manufacturing have established shop floor operations based purely on physical kanbans and kanban boards or heijunka boxes. The finished products are registered on the production system once they leave a cell or a production flow. The target is to minimize system interaction to a minimum.

Introducing kanban as an entity in MRP—often called an electronic kanban—combines the strength of both philosophies:

- The simplicity of the kanban organization – the physical flow of handling units triggers the flow of the related information.
- The concreteness and simplicity of a physical kanban board or heijunka box representing a work cell schedule.
- The transparency of an integrated system, that allows visibility of the situation of a specific cell, without the necessity of having to walk down the shop floor.
- The accuracy of an electronic kanban schedule for the consumers of the supplied goods.

The result of this research is a new user interface for lean manufacturing that combines all requirements for the three manufacturing roles into a single, configurable and scalable user interface: the kanban board:

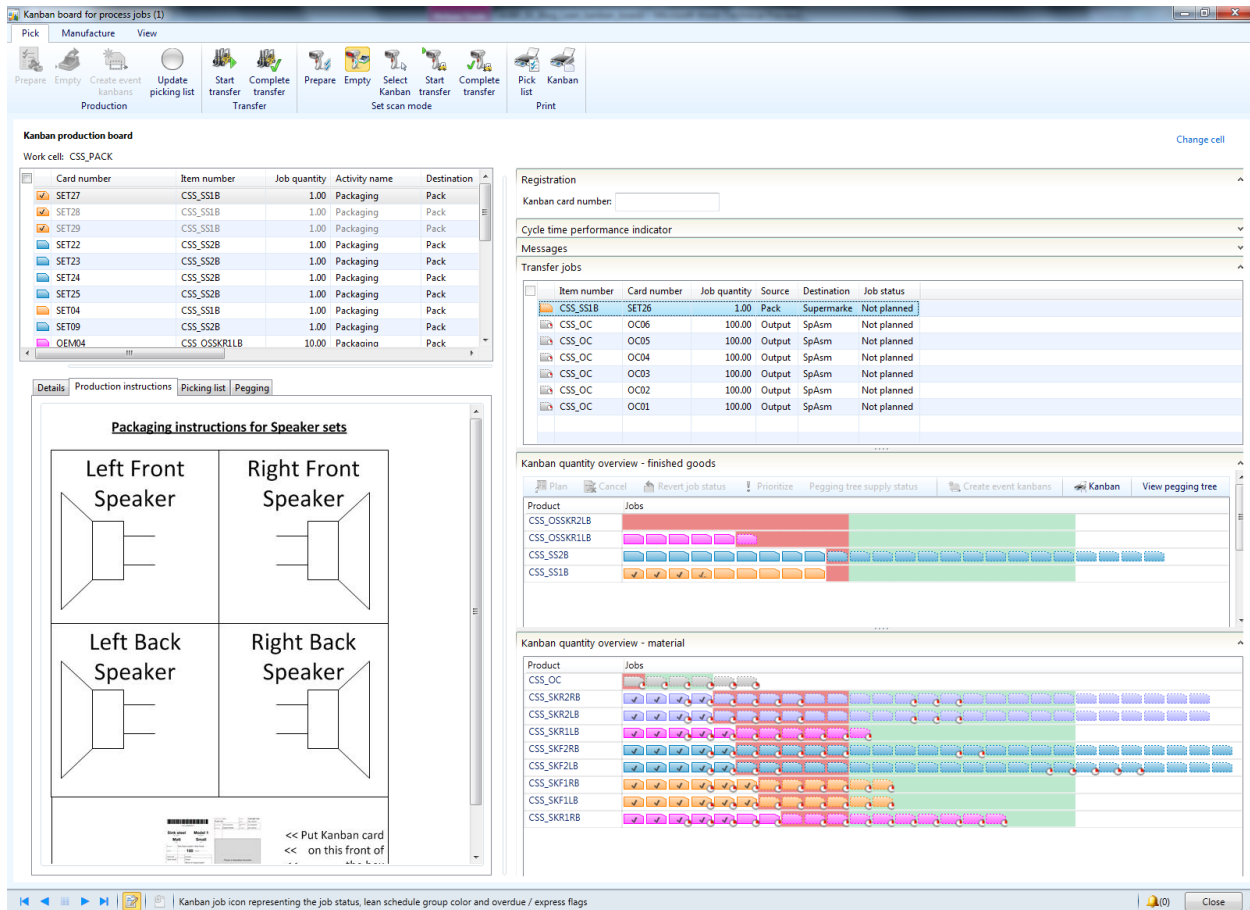


Figure 10: Example of the Kanban board for process jobs with multiple FastTabs opened

The kanban board consists of a number of controls—some dependent, some independent—that can be opened or closed on demand according to the information requirement of the specific user. The status of the FastTabs—size, open, close and so on—is remembered and persisted for each user when leaving the board and used as initial settings in the next session.

**Kanban board for process jobs - work cell: CSS\_EA (1)**

Pick Manufacture View

Prepare Empty Update picking list Start transfer Complete transfer Prepare Empty Select kanban Start transfer Complete transfer Create event kanbans Pegging tree supply status Pegging tree overview Pick list Kanban Print

Production Transfer Set scan mode Pegging Print

**Kanban production board** Change cell

Work cell: CSS\_EA

Card number	Item number	Job quantity	Activity name	Destination	Job status	Planned period	Schedule group
SKF101	CSS_SKF1	10.00	ElectricalA...	ElPreAsm	Planned	1/7/2011	Speaker set ...
SKF102	CSS_SKF1	10.00	ElectricalA...	ElPreAsm	Planned	1/7/2011	Speaker set ...
SKF103	CSS_SKF1	10.00	ElectricalA...	ElPreAsm	Planned	1/7/2011	Speaker set ...
SKF104	CSS_SKF1	10.00	ElectricalA...	ElPreAsm	Planned	1/7/2011	Speaker set ...
SKF105	CSS_SKF1	10.00	ElectricalA...	ElPreAsm	Planned	1/7/2011	Speaker set ...
SKF106	CSS_SKF1	10.00	ElectricalA...	ElPreAsm	Planned	1/7/2011	Speaker set ...
SKF201	CSS_SKF2	10.00	ElectricalA...	ElPreAsm	Planned	1/7/2011	Speaker set ...
SKF202	CSS_SKF2	10.00	ElectricalA...	ElPreAsm	Planned	1/7/2011	Speaker set ...
SKF203	CSS_SKF2	10.00	ElectricalA...	ElPreAsm	Planned	1/7/2011	Speaker set ...
SKF204	CSS_SKF2	10.00	ElectricalA...	ElPreAsm	Planned	1/10/2011	Speaker set ...
SKF205	CSS_SKF2	10.00	ElectricalA...	ElPreAsm	Planned	1/10/2011	Speaker set ...
SKF206	CSS_SKF2	10.00	ElectricalA...	ElPreAsm	Planned	1/10/2011	Speaker set ...
SKR101	CSS_SKR1	10.00	ElectricalA...	ElPreAsm	Planned	1/10/2011	Speaker set ...
SKR102	CSS_SKR1	10.00	ElectricalA...	ElPreAsm	Planned	1/10/2011	Speaker set ...
SKR103	CSS_SKR1	10.00	ElectricalA...	ElPreAsm	Planned	1/10/2011	Speaker set ...
SKR104	CSS_SKR1	10.00	ElectricalA...	ElPreAsm	Planned	1/10/2011	Speaker set ...
SKR105	CSS_SKR1	10.00	ElectricalA...	ElPreAsm	Planned	1/10/2011	Speaker set ...
SKR106	CSS_SKR1	10.00	ElectricalA...	ElPreAsm	Planned	1/10/2011	Speaker set ...
SKP201	CSS_SKP2	10.00	ElectricalA...	ElPreAsm	Planned	1/11/2011	Speaker set ...

**Details** | Production instructions | Picking list | Pegging

**Kanban job**

Card number: SKF101  
 Item number: CSS\_SKF1  
 Product name: Speaker kit Front 1  
 Job quantity: 10.00  
 Job status: Planned  
 Schedule group: Speaker set  
 Activity name: ElectricalAssembly  
 Warehouse: SpProd  
 Destination: ElPreAsm  
 Due date/time: 1/10/2011 11:55:17 pm

**Product dimensions**

Configuration:  
 Size:  
 Color:

**Registration**

- ▶ Cycle time performance indicator
- ▶ Messages
- ▶ Transfer jobs
- ▶ Kanban quantity overview - finished goods
- ▶ Kanban quantity overview - material
- ▶ Job icon legend

Change the work cell used to filter the kanban board 0 Close

Figure 11: Example of the Kanban board for process jobs with all optional FastTabs closed

## The job list

The central control on the kanban board is the job list. It shows the process jobs that are assigned to a selected work cell in the scheduled sequence. The job list can be further restricted by the view parameters of the job details:

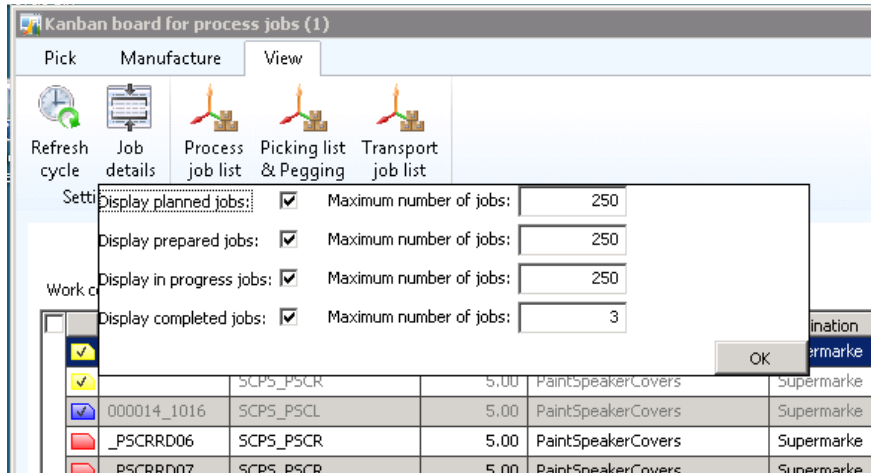


Figure 12: Job details settings to filter the kanban board by job status

By restricting the number of displayed jobs, the operator is more focused on the sequence of the selected jobs.

The jobs can be selected manually or automatically in the job list. By default, the next job in the sequence gets selected, when the previous job has been completed. The manual selection can be done through

- Mouse
- Keyboard
- Scanner (Barcode or RFID (Radio Frequency Identification)) through the built in scanning functionality

## Job details

Once a job has been selected in the job list the details of the job are shown in the lower pane:

Details		Production instructions	Picking list	Pegging
Kanban job		Inventory dimensions		
Card number:	SET27	Configuration:		
Item number:	CSS_SS1B	Size:		
Product name:	Speaker set 1 Blue	Color:		
Job quantity:	1.00	Site:		
Job status:	Completed	Warehouse:		
Schedule group:	Speaker set	Batch number:		
Activity name:	Packaging	Location:		
Destination:	Pack	Pallet ID:		
Due date/time:	9/1/2010 11:59:59 pm	Serial number:		
Warehouse:	SpProd			

Figure 13: Job details tab in the kanban board for process jobs

The production instructions tab displays a related document or picture that contains instructions or information related to the product or process for the machine operators:

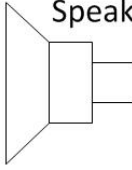
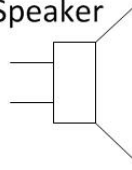
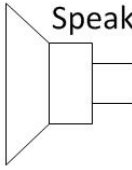
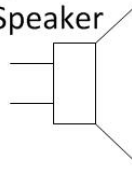

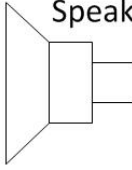
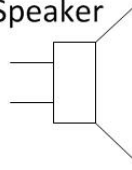
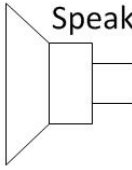
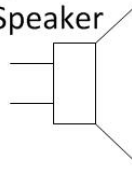
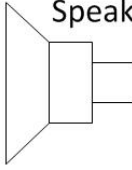
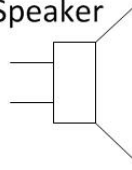
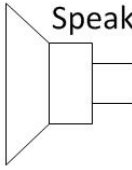
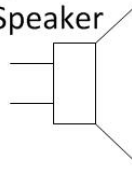
Details	Production instructions	Picking list	Pegging				
<p><b>Packaging instructions for Speaker sets</b></p> <table border="1"><tr><td><b>Left Front Speaker</b> </td><td><b>Right Front Speaker</b> </td></tr><tr><td><b>Left Back Speaker</b> </td><td><b>Right Back Speaker</b> </td></tr></table> <div><p>&lt;&lt; Put Kanban card &lt;&lt; on this front of &lt;&lt; the box</p></div>				<b>Left Front Speaker</b> 	<b>Right Front Speaker</b> 	<b>Left Back Speaker</b> 	<b>Right Back Speaker</b> 
<b>Left Front Speaker</b> 	<b>Right Front Speaker</b> 						
<b>Left Back Speaker</b> 	<b>Right Back Speaker</b> 						

Figure 14: Production instructions tab in the kanban board for process jobs

## Job and job status registration

For each kanban, one or more jobs are created. Job creation depends on how many activities a kanban is supposed to flow through. For each job the kanban board allows the registration of the following statuses:

- Prepare – the waterspider has picked the material and has prepared the handling unit for production
- Start – the production process has started
- Complete – the production process has been completed

The only mandatory registration is Complete. You can complete a job that has not been registered as prepared or started, and these statuses will also be updated.

The registration can be done by either pressing a button or scanning the barcode of the kanban cards.

## Picking list

When one or multiple jobs are selected, the picking list displays the sum of material to pick for the selected jobs. The supply status shows the availability of material for the picking list lines. You can print the picking list as an attachment to a kanban card. You can also print the picking list as a separate document, and it shows an aggregated view of the material to pick.

The picking list displays the material to be picked for one or multiple selected jobs and an indication of the availability of the material:

### Kanban production board

Work cell: CSS\_PACK

<input type="checkbox"/>	Card number	Item number	Job quantity	Activity name	Destination	Job status
<input checked="" type="checkbox"/>	SET27	CSS_SS1B	1.00	Packaging	Pack	Completed
<input checked="" type="checkbox"/>	SET28	CSS_SS1B	1.00	Packaging	Pack	Completed
<input checked="" type="checkbox"/>	SET29	CSS_SS1B	1.00	Packaging	Pack	Completed
<input checked="" type="checkbox"/>	SET22	CSS_SS2B	1.00	Packaging	Pack	Planned
<input checked="" type="checkbox"/>	SET23	CSS_SS2B	1.00	Packaging	Pack	Planned
<input type="checkbox"/>	SET24	CSS_SS2B	1.00	Packaging	Pack	Planned
<input type="checkbox"/>	SET25	CSS_SS2B	1.00	Packaging	Pack	Planned

### Details Production instructions Picking list Pegging

<input type="checkbox"/>	Item number	Quantity	Source type	Unit	Supply status
	CSS_SKR2RB	2.00	Item	Pcs	
	CSS_SKR2LB	2.00	Item	Pcs	
	CSS_SKF2RB	2.00	Item	Pcs	
	CSS_SKF2LB	2.00	Item	Pcs	

Figure 15: Picking list tab in the Kanban board for process jobs

When the preparation is registered, the inventory transactions are posted for material where on-hand is tracked and the flushing principle equals Start. Registration of tracking dimensions of either batch or serial numbers or the picking from special locations or pallets can be done either with the Update picking list button or through a WMS picking process by using output orders.

## Pegging

When using kanban line events to pull material to a work cell, the created kanbans are displayed in the Pegging tab. The pegging overview lists the kanbans that are required for a selected job as well as the handling unit status of the pegged kanbans. We recommend that you use withdrawal kanbans based on kanban line events for material that has to be picked at or transferred from remote or centralized warehouses.

### Kanban production board

Work cell: CSS\_PACK

	Card number	Item number	Job quantity	Activity name	Destination	Job status	Due date/time
<input checked="" type="checkbox"/>	SET27	CSS_SS1B	1.00	Packaging	Pack	Completed	9/1/2010 11:59:5
<input checked="" type="checkbox"/>	SET28	CSS_SS1B	1.00	Packaging	Pack	Completed	9/1/2010 11:59:5
<input checked="" type="checkbox"/>	SET29	CSS_SS1B	1.00	Packaging	Pack	Completed	9/1/2010 11:59:5
<input type="checkbox"/>	SET22	CSS_SS2B	1.00	Packaging	Pack	Planned	9/1/2010 11:59:5
<input type="checkbox"/>	SET23	CSS_SS2B	1.00	Packaging	Pack	Planned	9/1/2010 11:59:5
<input type="checkbox"/>	SET24	CSS_SS2B	1.00	Packaging	Pack	Planned	9/1/2010 11:59:5
<input type="checkbox"/>	SET25	CSS_SS2B	1.00	Packaging	Pack	Planned	9/1/2010 11:59:5

Details	Production instructions	Picking list	Pegging
<input type="checkbox"/>			
	SKF2LB17	CSS_SKF2LB	Car speaker PF
	SKF2RB17	CSS_SKF2RB	Car speaker PF
	SKR2LB17	CSS_SKR2LB	Car speaker PF
	SKR2RB17	CSS_SKR2RB	Car speaker PF

Figure 16: Pegging tab in the Kanban board for process jobs

The handling unit status of the pegged kanbans indicates whether the kanbans are:

- Received. All jobs are completed and available to be consumed.
- Assigned. One of the jobs of the kanban is prepared or in process.
- Not assigned. The first job of the kanban is not started nor is it prepared to start.

## Information and process FastTab on the right side

On the right of the kanban board for process jobs a number of FastTabs are available to display complementary data and support specific processes. When open, FastTabs consume computer resources when the board is refreshed. Therefore we recommend that you close any FastTab that is not needed.

When closing the board, the status of the open or closed FastTab will be remembered in the session data and the board will be restored with this status on next usage.

## Registration

When using a barcode or RFID scanner, we recommend that you open the **Registration** FastTab to see the scanned kanban card IDs. Wrong or unreadable card IDs can be manually corrected or typed in. Registration is triggered by use of the Return or Tab keys.

## Messages

The kanban board does not display error messages in a separate InfoLog window, but displays the messages in the Message FastTab. To see any messages, the Message FastTab must be open. When the kanban board is closed and reopened, message history is deleted.

## Cycle time performance indicator

For each production flow version the cycle time requirements can be defined in the production flow version details. Based on these settings, the average cycle time requirement is calculated for each activity of the production flow on validation, activation or recalculation—when parameters change after activation— of the version.

The cycle time performance indicator displays the actual calculated cycle time for the defined cycle time period in relation to the boundaries defined in the production flow version.

The cycle time performance indicator is usually applied in production environments where many small jobs are registered synchronously to production, such as in a single piece flow. It gives an indication to the workers and managers of a work cell about the actual performance of the cell.

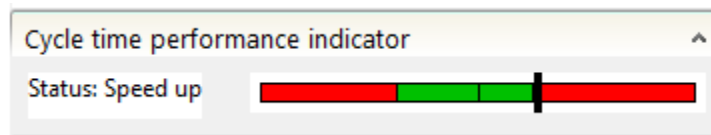


Figure 17: Cycle time indicator at low speed

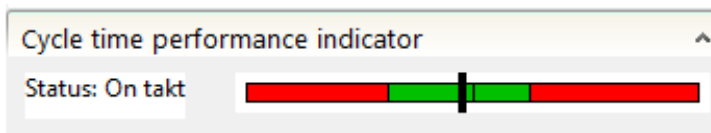


Figure 18: Cycle time indicator on target takt

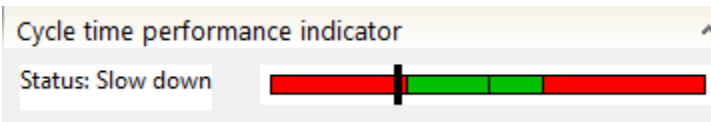


Figure 19: Cycle time indicator on high speed

The cycle time performance indicator is only active if a work cell is unique to one production flow activity. For a work cell that executes activities for multiple production flows, cycle time requirements cannot be calculated, so the control is inactive.

### Setting up the cycle times for activities

The cycle times for the activities of a production flow are calculated when a production flow version is activated. When any of the parameters are changed after the activation, the cycle times of the activities have to be recalculated by using the recalculation function of the production flow version. The base data for the cycle time calculation are:

- Settings for the production flow version in the Production flow version details form:
  - Takt unit
  - Average takt time
  - Minimum takt time
  - Maximum takt time
- Period for actual cycle time (days)  
Describes the period in working days that is used to calculate the actual cycle time.

$$\text{Actual cycle time} = \frac{\text{Total output quantity (period)}}{\text{Working time (period)}}$$



Any change to this parameter will have an immediate impact on the cycle time performance indicator

- Per cycle unit of measure
- Quantity per cycle
- Activity relations
  - Cycle time ratio  
Describes the ratio of the cycle times for an activity relation

Currently in Microsoft Dynamics AX 2012, the cycle times of the activities are not displayed in the UI except in the kanban flow form for multiple activity flows.

## Transfer jobs

When a work cell is replenished by withdrawal kanbans or when the process activity is followed with a put-away transfer job, the active transfer jobs are displayed in a grid in the Transfer jobs FastTab. The jobs can be selected and registered as started or complete in this control. A registration mode start or complete transfer can also be set.

This FastTab supports the work of a waterspider dedicated to a specific work cell. The waterspider can control transfer in, transfer out, and the picking processes in a single UI, filtering on all transactions that are related to the selected work cell.

For a Machine operator, the Transfer jobs FastTab should be kept closed.

## Kanban quantity overview—finished goods

The kanban quantity overview controls give a visual indication on the on-hand, supply and demand status of the kanban rules related to the selected work cell.

The finished goods overview displays the kanban rules for products that are supplied by the work cell. For each kanban rule, all active jobs are shown with a sorted by job status. Shortages that can be spotted at a glance are:

- Minimum alert quantity: if a kanban rule does not have enough completed, started or planned kanban jobs, the background of the minimum alert quantity is turned into red.
- If a planned kanban job is overdue, it gets a time alert symbol.



Figure 20: Kanban quantity overview for finished goods

The kanban rules are sorted by urgency, the most urgent kanban rule is displayed on the top of the overview. The shop floor supervisor can use the quantity overview control to plan incoming jobs based on the urgency and priorities.

The waterspider and machine operators can decide on the sequence of execution based on possible shortages/alerts.

### Kanban quantity overview – material

The kanban quantity overview for material displays the kanban rules that are supplying material that is consumed by the selected work cell.

The form provides shop floor workers with overview of the supply situation and the on-hand inventory in the supermarkets in order to make priority and picking decisions:































Kanban quantity overview - material	
Product	Jobs
CSS_CSF	    
CSS_CSS	    
CSS_CSB	    
CSS_CSR	    
CSS_AMP1	    
CSS_AMP2	    

Figure 21: Kanban quantity overview for material

### Job icon legend

In the different controls of the kanban board, kanban jobs are represented with icons that reflect the job or the handling unit status. Overdue or priority jobs are marked with an overlay icon. The colour of the jobs represents the lean scheduling group of an item. Scheduling groups can be defined for items globally or for an item in relation to a specific work cell.









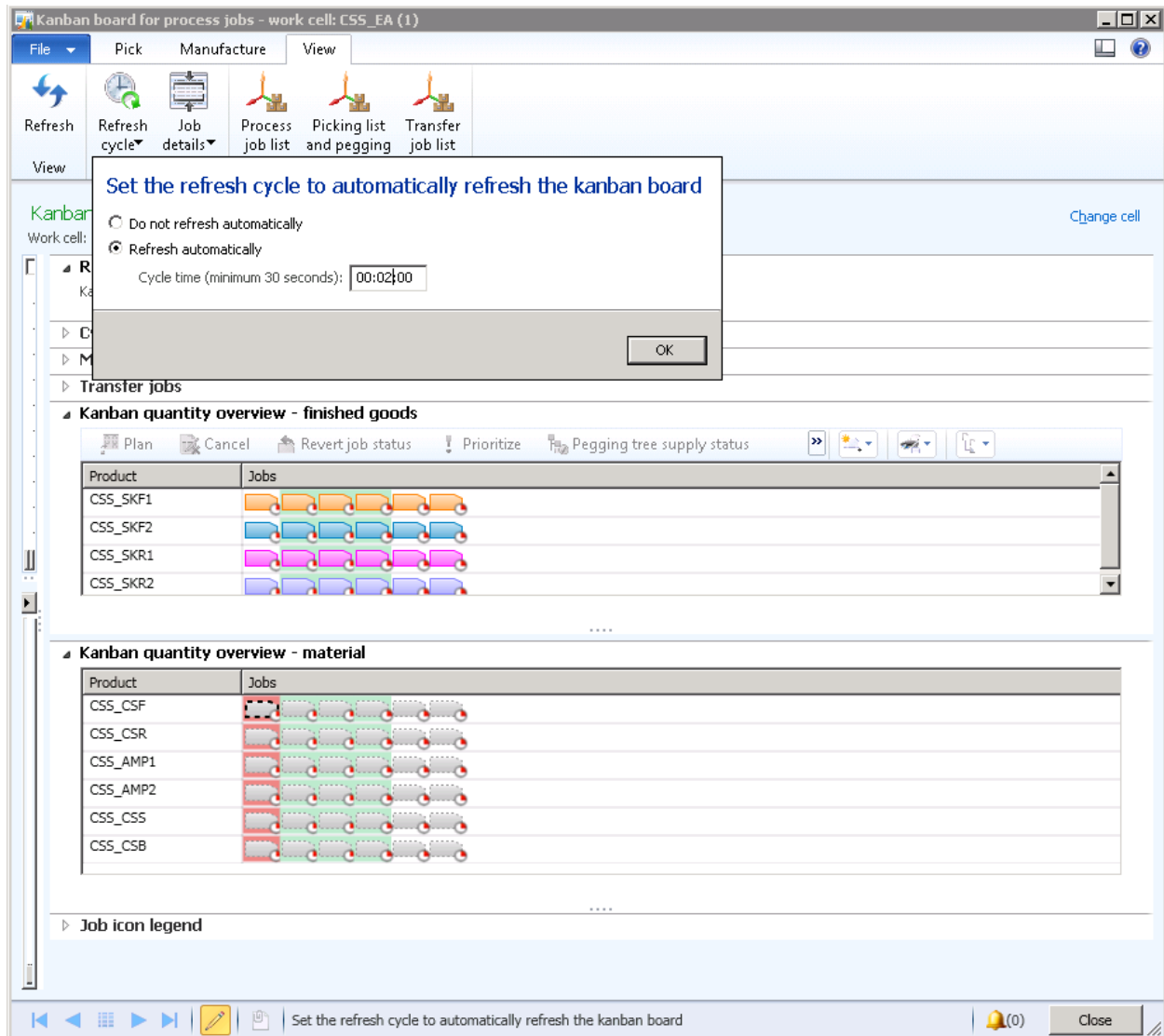
Job icon legend			
 Job not planned	 Job prepared	 Handling unit received	 Overdue
 Job planned	 Job in progress	 Job completed	 Priority

Figure 22: Job icon legend in the kanban boards

## Automatic refresh

By setting a refresh cycle time for the kanban board, even users that do not interact with the board frequently can have an accurate view of the background information, quantity overviews and the cycle time performance.

In this mode, the kanban board can be used as an andon board.



**Figure 23: Kanban board configured as an andon board with the automatic refresh setting set to every 2 minutes**

## The Kanban board for transfer jobs

The Kanban board for transfer jobs is designed for warehouse workers and waterspiders that need to perform the following tasks:

- Replenish kanban supermarkets
- Pick for kanban transfers
- Receive kanban transfers
- Ship kanbans to other sites or subcontractors

As with the Kanban board for process jobs, the Kanban board for transfer jobs provides the following functionality:

- Shows all needed information for the transfers
- Can be set up to automatically refresh
- Remembers the filtering options for a terminal

### Filtering jobs on the Kanban board for transfer jobs

When the Kanban board for transfer jobs is opened for the first time on a terminal, the filtering dialog is opened by default.

**Filter transfer kanban jobs (1 - ceu)**

**Filter jobs**

Select criteria for filtering the kanban transfer jobs

Production flow: Car speaker PF

Activity name: ReplenishElectricalComponents

**Transfer from**

Site:

Warehouse:

Location:

**Transfer to**

Site:

Warehouse:

Location:

OK Cancel

Figure 24: Filter dialog for the Kanban board for transfer jobs

The filter can be set for one or more of the following three groups:

- **Production flow**  
Select a production flow. You can also choose as an option a transfer activity within the production flow to filter on transfer jobs of a single production flow or a specific activity.
- **Transfer from location**  
Select a transfer from location by specifying Site and/or Warehouse and/or WMS Location. Choose this filtering option to start transfers from a selected site, warehouse or WMS-Location.
- **Transfer to location**  
Select a transfer to location by specifying Site and/or Warehouse and/or WMS Location. Choose this filtering option to start or complete transfers for a specific destination.

**Filtering on job status:**

The screenshot shows the 'Job list parameters' dialog box. It has three tabs: 'Job list parameters', 'Transfer job list', and 'Picking and event kanban list'. The 'Job list parameters' tab is selected. The dialog title is 'Job list - limit display'. It contains three rows of settings:

Job Status	Maximum number of jobs
Display not planned jobs: <input checked="" type="checkbox"/>	250
Display in progress jobs: <input checked="" type="checkbox"/>	250
Display completed jobs: <input checked="" type="checkbox"/>	3

An 'OK' button is located at the bottom right of the dialog.

**Figure 25: Job list parameters to filter on job status in the Kanban board for transfer jobs**

If a user is only responsible for starting or completing transfers, filtering on job status allows you to reduce the number of views for relevant jobs. You can filter on the following statuses:

- **Display not planned jobs**  
Enter the number of not planned jobs that should be displayed
- **Display in progress jobs**  
Enter the number of jobs in progress that should be displayed
- **Display completed jobs**  
Enter a number of completed jobs that are shown at the top of the list. The most recently completed jobs are displayed.

## Working with transfer jobs

In Microsoft Dynamics AX, lean manufacturing transfer jobs can have the following states:

- **Not planned:**  
All transfer jobs have this initial status when they are created. In Microsoft Dynamics AX 2012, transfer jobs can be in a not planned state, which implies that they cannot be allocated to a resource. To be consistent with process jobs, this status is called Not planned.

- **Started or In progress:**  
A transfer job that is started is picked and the transfer is in progress. However, in Microsoft Dynamics AX 2012 a kanban transfer job, similar to a transfer journal, only posts the inventory transactions for issue and receipt on completion of the transfer job. A job in progress therefore may have un-posted issue transactions. Usually, in lean scenarios this status would be skipped. However, the status adds value and should be used if the start and completion of the transfer jobs is done by different users with a time delay as it improves visibility on the kanban boards.
- **Completed:**  
The transfer is completed and all transactions are posted.

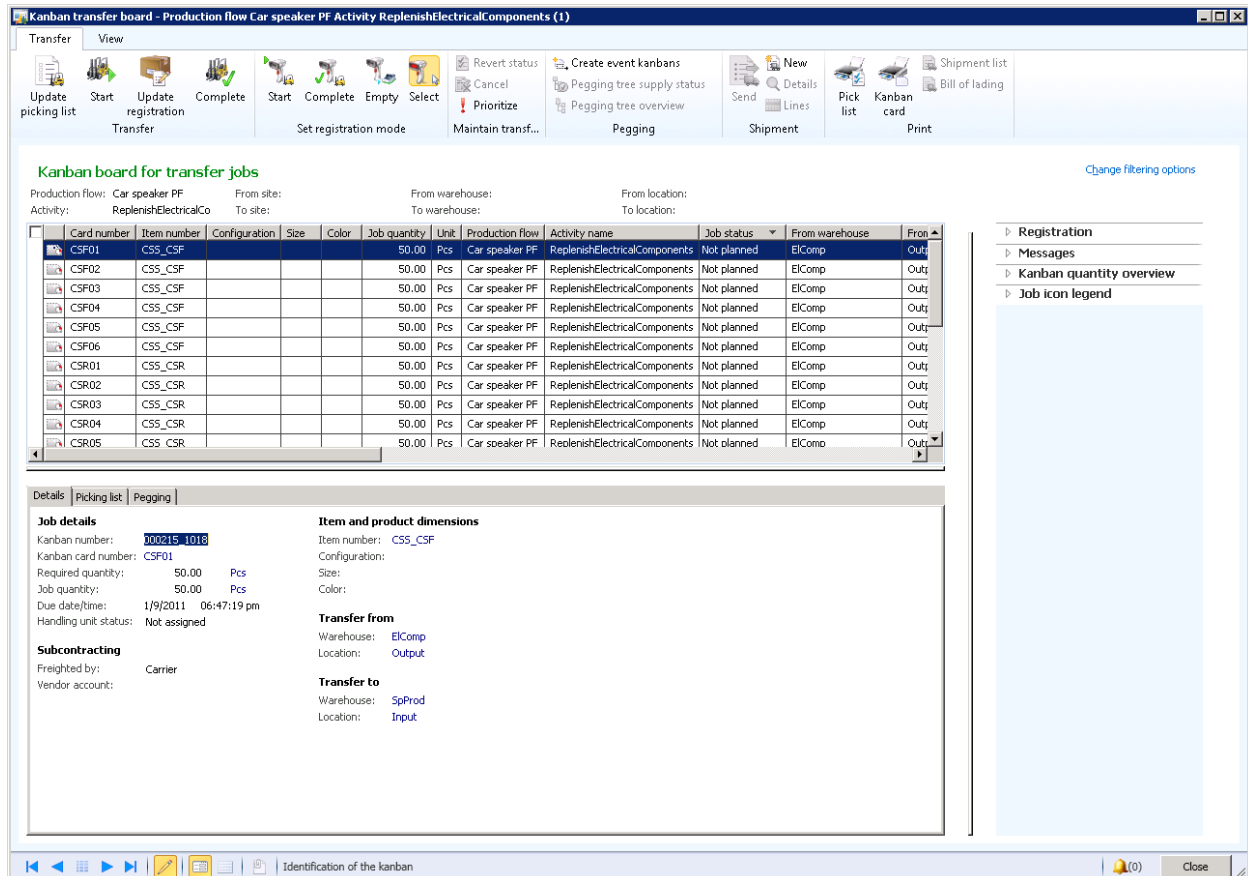









Figure 26: Example of the Kanban board for transfer jobs with all optional FastTabs closed

## Job status registration

Job status changes are registered on the kanban board for transfer jobs manually or by barcode, using the registration mode.

If enabled in the kanban rule, the job quantity of the transfer can be changed directly in the job list, if the job is not started, as shown in Figure 27.

	Card number	Item number	Configuration	Size	Color	Job quantity	Unit	Pr
	CSF01	CSS_CSF				50.00	Pcs	Car
	CSF06	CSS_CSF				50.00	Pcs	Car
	CSF05	CSS_CSF				50.00	Pcs	Car
	CSF04	CSS_CSF				50.00	Pcs	Car
	CSF03	CSS_CSF				34	Pcs	Car
	CSF02	CSS_CSF				50.00	Pcs	Car
	CSR02	CSS_CSR				50.00	Pcs	Car

**Figure 27: Changing transfer quantities in the Kanban board for transfer jobs**

If the quantity is changed outside of the variances allowed in the kanban rule, an error message is opened in an InfoLog form.

### Update picking list

For transfer jobs that pick from inventory, the button Update picking list opens the manual picking form. In this form you can:

- Change the WMS location to pick from
- Assign batch or serial numbers for material traceability
- Update the reservation

## Replenishment strategies

### Fixed quantity kanbans – the circulation principle

Fixed quantity kanbans are pre-created according to the required kanban quantity. The handling units with the finished items are usually moved to a supermarket or to a picking area. When a handling unit is registered as empty, a new instance of the kanban is created to replenish the consumed item.

A planned kanban based on this replenishment strategy cannot be manually firmed. This is because kanbans are only re-created based on consumption. The initial number of kanbans is defined manually or it is calculated based on the kanban quantity calculation.

### Kanban quantity calculation

Determining the kanban quantity of a fixed quantity rule is one of the most important tasks of kanban planning. Microsoft Dynamics AX 2012 provides the capability to calculate the kanban quantity that is required to cover the expected demand by taking into account historical demands, forecasts, or actual demands, and the replenishment lead time.

The kanban quantity calculation is based on demand that occurs during periods that are relative to a specific calculation date or periods that are seasonal. The calculation can be done for the current date or a calculation date in the near or far future. Based on the calculation you can create kanban rules that will become effective on the current date or a future date.

#### ***Kanban quantity calculation policies***

In Microsoft Dynamics AX 2012, a kanban quantity calculation policy is used to define the parameters for the kanban quantity calculation and for group kanban rules that are usually calculated together due to seasonal or other practical aspects. The kanban quantity calculation policy is then associated with the kanban rules and used to perform the kanban calculation.

A kanban rule can be associated with multiple kanban calculation policies.

### **Kanban quantity calculation**

A kanban quantity calculation is created based on calculation policies. The generation of the calculation proposal lines adds all kanban rules to the calculation that are associated to the policy and that are valid at the rule active as of the date of the calculation. The user can add additional kanban rules to the calculation or remove calculation proposal lines at any time during the calculation process. The calculation determines the average demand during the calculation periods and calculates the proposed kanban quantity for each kanban rule. The calculation can be repeated. When the calculation result is plausible, the kanban rules are updated. If there is a kanban rule that has an effective date for the Rule effective date and time, the kanban rule is updated with the new kanban quantity. Otherwise, a new kanban rule is created which replaces the original rule at the Rule effective date and time.

### **Scheduled kanbans**

The behavior of the scheduled replenishment strategy in master scheduling is very similar to that of the production orders. Kanbans are created by firming planned kanbans manually or by using a firming fence. The scheduled principle is used for items or variants that are produced in a lean work cell, and whose demand is created from forecast, customer or dependent demand. The production strategy for items supplied with scheduled kanbans is usually not build to order. The scheduled replenishment strategy should be applied when items should not be produced without explicit demand and when the minimum batch sizes cannot be reduced to a single piece flow. The following master scheduling parameters are typical, but not mandatory, for items that use the replenishment strategy of scheduled kanbans:

- The minimum inventory order size is greater than 1
- The coverage code is set to Period

**Note:** The coverage code Period configures master scheduling to group multiple requirements of a single item or item variant to a single planned supply for defined periods of *n* days.

### **Event kanbans**

The best implementations of lean manufacturing are often driven by a common pain point that appears to be a global trend: the proliferation of item variants to satisfy customer expectations. This trend makes it difficult to hold inventory on the final product level without the risk of holding excess inventory. Even worse is the need to depreciate or expense products that have been kept in the final product stock but cannot be sold due to material expiry or engineering changes.

The need to remove or at least reduce this huge waste of money and resources usually leads to the cleanest implementations of lean manufacturing. Final assembly, packaging and shipping activities are streamlined and aligned to the targeted sales lead time to allow shipping the product out of final assembly within a very short lead time, usually days or few weeks. Many companies start by targeting a sales lead time of one week, and freezing the kanban schedule for the current week. Some industries – such as just in sequence (JIS) in the automotive industry – reach lead times of 2.5 hours from call-off to shipment for a final assembly and sequencing process.

**Note:** This requirement lies beyond the functional scope of master scheduling, even if some implementations of Microsoft Dynamics AX run net-change master scheduling every thirty minutes.

The new lean manufacturing framework of Microsoft Dynamics AX 2012 allows definition of kanban rules with the replenishment strategy event. The creation of event kanbans based on this strategy is triggered by a source requirement. The new kanban is then pegged to the source requirement.

The event kanbans replace the previously released modules of Lean order schedules - Build to order (LOS-BTO) and the Pull to order (PTO) kanbans that were part of Lean Manufacturing for Microsoft Dynamics AX 2009.



## The sales event

The sales event is triggered by the creation or a change of a sales line. The sales line can be created or changed manually, through Enterprise Portal or by using the sales creation services of Microsoft Dynamics AX.

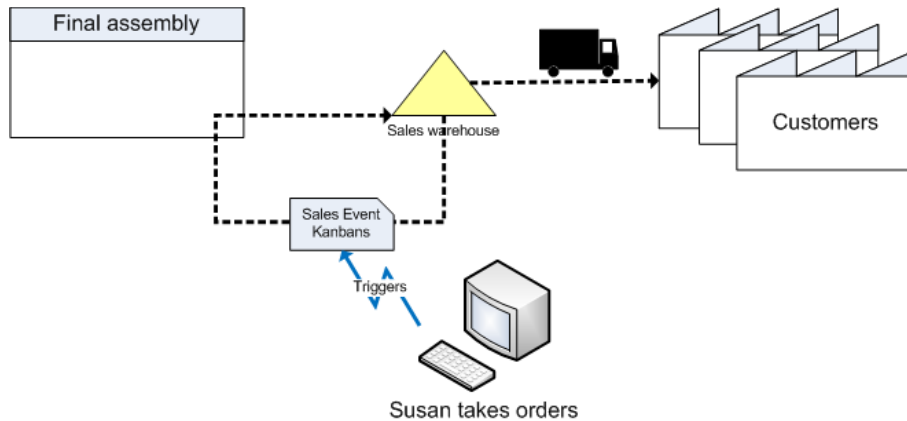


Figure 28: Example of a production flow with sales event kanbans

Each sales line creates one or more kanbans to fulfil the related demand, based on the maximum product quantity defined in the kanban rule that corresponds to the maximum handling unit size.

The kanban cards printed for sales event kanbans contain customer and customer order references and can be used as shipment labels for the handling units.

## The kanban line event

Kanban line events can be created to pull from a pre-processing activity. In the following example, a lean work cell assembles painted parts (B) to finished products (A).

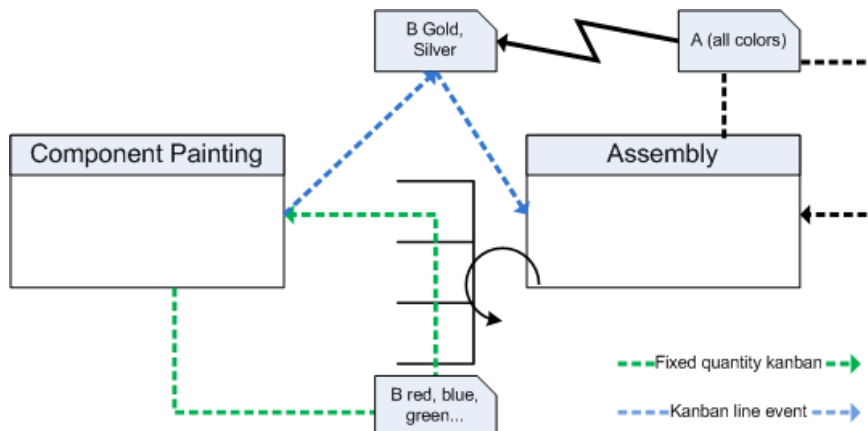
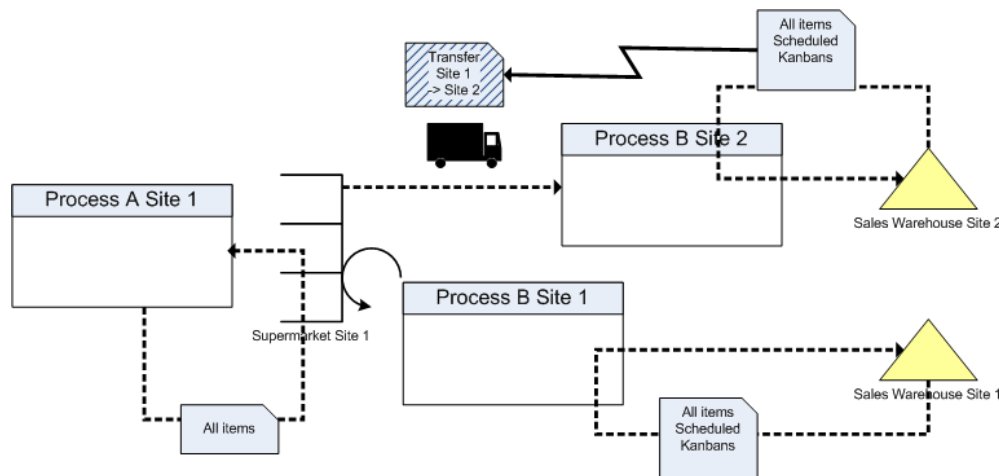


Figure 29: Example of a production flow with kanban line events triggering manufacturing kanbans

The kanbans for A can be of any replenishment strategy—fixed, scheduled or event. While all standard colours—red, green or blue—are picked from a supermarket that is replenished as fixed quantity kanban, the special colours—gold and silver—create event kanbans.

Another application of kanban line events is the transfer of material to a production location. In the following example, we are assuming that products are produced on two sites (1 and 2). The related components are produced on site 1 and stored in a supermarket. While process B on site 1 can directly pick from the supermarket, the material for process B on site 2 needs to be transferred to site 2.



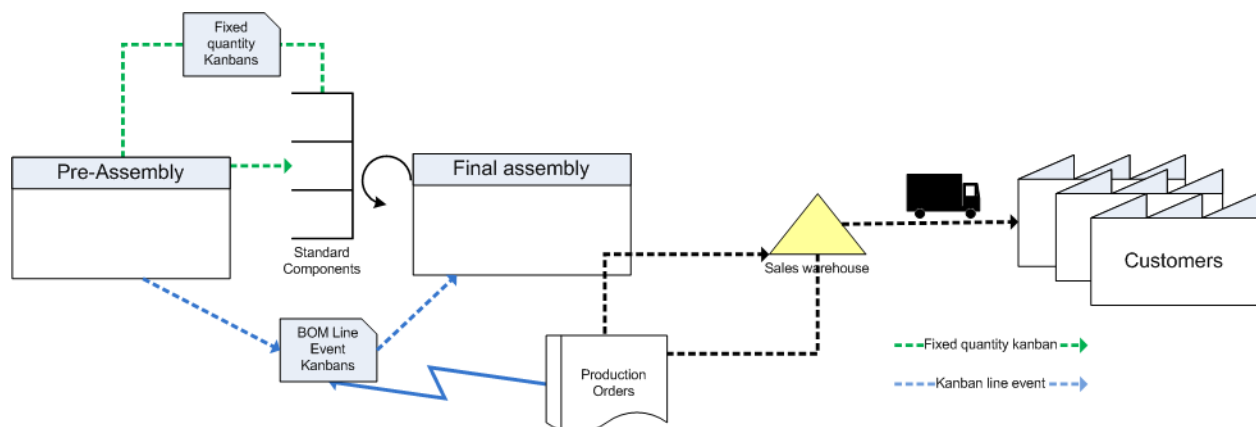
**Figure 30: Example of a production flow with kanban line events triggering withdrawal kanbans**

By defining a kanban line event withdrawal rule for the transfer from site 1 to site 2 for the item relation, all transfer kanbans are created for all BOM lines of items in Process B on Site 2.

The related kanban transfer jobs can be grouped to consolidate shipments with non kanban material that needs to be transferred to site 2.

### The BOM line event

Like kanban lines, where the picking or transfer issues of a kanban trigger other kanbans, a production order can consume material that is supplied by lean manufacturing. Again, this can happen by picking from a supermarket or by creation of a BOM line event kanban that pulls material to the production order.



**Figure 31: Example of a production flow with BOM line event kanbans**

On the estimation of the production orders for the final assembly, the BOM Line event kanbans are created and loaded on the pre-assembly work cell.

The kanban rule can enforce a consistent reservation to ensure that the components supplied by event kanbans are automatically reserved for the source of demand; in this case, a production order.

## Pegging event processing

In different application scenarios the volume of kanbans that are created based on events can be in a range of few event kanbans per day—where event kanbans only cover exceptions—to multiple kanbans per minute. To find the right balance between actual requirement view in the work cells and performance load each event definition on a kanban rule defines the kanban creation policy:

- **Automatic**  
The event kanbans are created with the source of demand. On the creation of sales order lines, the correspondent event kanbans are directly created, allowing the work cell or warehouse to take immediate action on the new demand. This setting is recommended, when execution is expected to happen on the same day.
- **Batch**  
Instead of the event kanbans, a pegging requirement is created. A recurring batch process that is independent of master scheduling processes all new pegging requirements. This light-weight process can be set up in the background specific to selected production flows or activities ensuring an appropriate reaction time for every application scenario.
- **Manual**  
When event processing is an exception. The exceptional process is selected based on priority and capacity considerations, a sales order line or a kanban can be manually selected to create event kanbans.
- **Automatic with capable to promise (CTP)**  
Finite capacity control for lean manufacturing is based on the throughput capacity of the work cell. This option allows for a combination of a sales order event creation with a CTP check. If the created kanban jobs cannot be allocated to the period that corresponds to the requested shipment date of the sales order line, the delivery date control dialog is opened after the creation of the sales line and selection of the confirmed shipment date based on the availability in the kanban schedule is then possible.  
Kanban schedule CTP can be run combined with or independent of master scheduling and CTP based on master schedule explosion.

## The minimum stock event

When running master scheduling in Microsoft Dynamics AX, additional planned orders are created whenever minimum on-hand is reached. For a lean manufacturing application that surveys minimum on-hand of important parts, this might easily lead to a delay of a day until the signal for replenishment reaches the replenishing work cell. The pegging event processing in lean manufacturing for Microsoft Dynamics AX 2012 checks minimum inventory for selected kanban rules and creates the needed kanbans to replenish instantly.

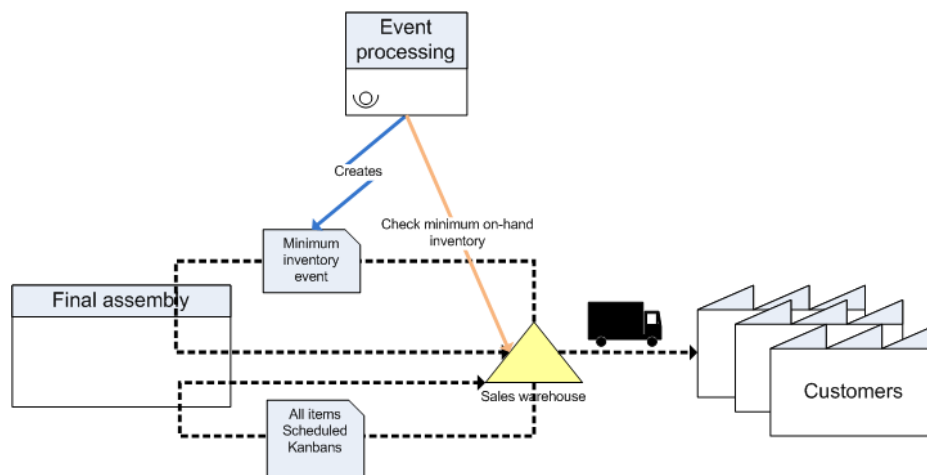


Figure 32: Example of a production flow using minimum stock events

## Lean supply policies - the kanban rules

The production flows that define the structures of lean manufacturing are, by definition, independent of the products supplied by a production flow. To assign a specific replenishment strategy and the related parameters to a product for a specific production flow a kanban rule needs to be configured.

This chapter describes the structure of kanban rules and the process of kanban rule configuration.

## Configuration of kanban rules

All kanban rules are configured in a single simple list and details form:

[illegible]

**Figure 33: Kanban rules configuration dialog**

The list can be filtered on different criteria. The selected kanban rule can be configured using FastTabs. The kanbans FastTab displays the active/all kanbans related to the selected rule, depending on the selected filter on the FastTab.

## Filter kanban rules:

With the Filter button in the Action Pane, the main filter of the kanban rule form can be set to one of the following values:

- Production flow:  
Only show kanban rules that relate to a specific production flow
- Last activity name:  
Only show kanban rules that relate to a kanban flow that ends with the selected activity
- Show only active rules:  
Filters all kanban rules out of the list that are not active at the actual date and time

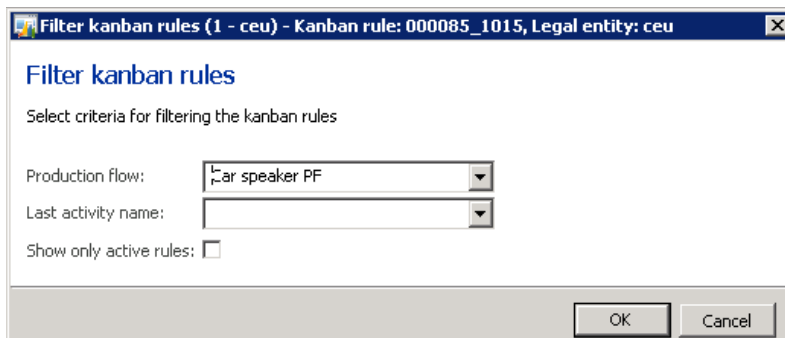


Figure 34: Filtering kanban rules by production flow or activity

To filter on a product or item allocation key, position the cursor in the product or product family field in the details FastTab and set the filter through right click:

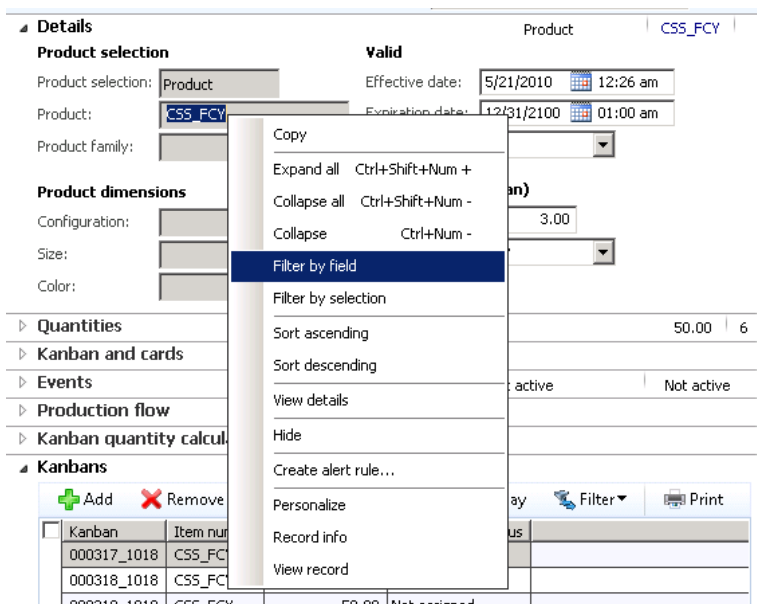


Figure 35: Filtering kanban rules by product

## Activities, kanban flow and production flow

A kanban rule must be related to one or multiple activities of a production flow.

- Single activity kanban rule:  
Select the first activity and clear the option **Multiple activities**.  
Kanbans created for this kanban rule will have a single job. The status of the kanban handling unit and the job status are tied together.
- Multiple activity kanban rule:  
Select the first activity, select the option **Multiple activities** and select the last activity.  
You must use the lookup select the activities. The filter only shows activities that are downstream to the first activity that has been selected.  
When the last activity is selected, the kanban flow selection form opens up and requires the generation and selection of a kanban flow.  
The kanban flow consists of the activities that are needed to supply the product. When the production flow has multiple possibilities to relate the first activity to the last activity, the generation of kanban flows might have multiple results.

The output location of the last activity of the kanban flow is also known as the supplied location. This location—displayed as warehouse and WMS-location in the Production flow FastTab —has a special impact. The supplied location is used by master scheduling to identify the replenishment strategy and production flow that is used to supply a kanban supplied product. It is also used by the event processing to create pegging events.

## The product selection

To determine which kanban rule relates to which product, you need to configure a product selection for a kanban rule. The product selection is relevant for master scheduling, pegging event processing and for manual kanban creation, to determine, which kanban rule is valid to supply which product and product variant. For fixed quantity kanbans, a specific single product variant has to be assigned. For scheduled and event kanbans, a single kanban rule can be valid for a single product variant, multiple variants or for all products supplied to a specific location:

- Single product variant:  
This kanban rule is valid for only one single product variant. It needs a specific item ID. All mandatory product dimensions of the product have to be specified.  
Fixed quantity kanban rules can only be specified for a single product variant
- Multiple/all product variants:  
The kanban rule needs a specific item ID. The product dimensions are optional. If a product dimension is empty, all product dimensions are valid for this kanban rule.  
This is usually applied when event or scheduled kanban rules are used in combination with product configurator. In this case, the configuration dimension of the kanban rule is left empty.
- Product families—item allocation keys:  
In kanban rules, item allocation keys are used as product families. For scheduled or event kanban rules the item allocation key specifies the product variants that are valid for the kanban rule.
- All products and variants:  
A scheduled or event kanban rule with this property applies to all products that are required to supply out of the supplied location of the kanban rule, that have planned order type kanban for this location.

## Quantities

In the Quantities FastTab of the kanban rule form you can specify all quantity definitions of the kanban rule.

### ***Product quantities***

The product quantities relate to the quantity per kanban handling unit

- **Default quantity:**  
This is the target quantity of each kanban based on this rule. For fixed quantity kanbans, this field is mandatory. For manual and scheduled kanbans, this is the default quantity.  
On creation of a fixed quantity rule related to an item, default the fixed quantity out of the standard order quantity of the inventory order settings of the item
- **Minimum and Maximum product quantity:** for event kanbans usually the quantity required for a specific order is used as Product quantity. By a minimum and maximum product quantity this behaviour can be limited to a minimum and maximum product quantity. If i.e. a sales order line has a higher quantity than the maximum product quantity per handling unit, multiple kanbans need to be created in order not to exceed the maximum product quantity per bin. If a minimum product quantity is defined and the requested quantity is lower than minimum, the kanban is created with the minimum quantity.
- **Allow deviating quantity:** If this group is activated, the finished quantity can deviate from the product quantity. It needs to be within the minimum / maximum report finished quantity. If a deviating lower quantity is reported, the job is still finished. The deviating quantity only applies to the good quantity, not the error quantity. If no deviating quantity is defined the good quantity needs to be exactly the quantity delivered. The error quantity can be any quantity.

### ***Kanban quantity:***

The kanban quantity defines the number of active kanban handling units that can exist at any specific point in time.

- **Fixed number:** Fixed number assigned to a fixed quantity kanban. This is the constant number of active kanbans related to this Kanban rule.  
The fixed number is only active on fixed quantity kanban types.
- **Automatic planning quantity:** Defines the number of unplanned kanbans that trigger an automated planning of the kanbans in the kanban schedule. If the automatic planning quantity is zero(0), no automated planning is done when a kanban is created. If the automatic planning quantity is one (1), every kanban is planned upon creation.
- **Maximum planned jobs:** Maximum number of jobs that can be planned through automatic planning. This is a security setting to overload a work cell with excess demand and thereby block the available capacity for more important demand.
- **Alert boundary minimum:** The alert boundary minimum is synonym to a minimum stock. It relates to the number of active kanbans received (status ended) at the final receipt location but not emptied. The alert boundary is only shown visually on the kanban quantity overview in the kanban board. The alert kanban quantity is reached when the actual number of ended but not emptied kanbans is equal the minimum or maximum alert kanban quantity.
- **Alert boundary maximum:** The alert boundary maximum is synonym to a maximum stock. It relates to the number of active kanbans received (status ended) at the destination but not emptied. The alert boundary is shown visually on the kanban quantity overview in the kanban board.

### **Kanban cards**

The Kanban cards FastTab is used to configure the cards related to a kanban rule. In the planning process, kanban cards are used to identify demand on a kanban board. In the manufacturing process, the kanban card represents the job. In the supermarkets and logistics operations, kanban cards identify the handling units resulting out of specific kanbans.

Kanbans can either use single usage cards (also known as lost cards) or circulating cards. Circulating cards are reusable cards. While single usage cards have to be printed during the planning, production or shipment process of a specific kanban, circulating cards are usually printed in preparation for a production line or a new item.

Lean manufacturing for Microsoft Dynamics AX supports both principles, single usage and circulating cards. The number sequences of each kanban rule can be freely chosen with the limitation that it is not possible to create multiple kanban cards with the same card ID on a single instance of AX.

Kanban card IDs are used to scan in the kanban boards and are therefore printed with barcodes on the kanban card.

### Configuration of events

The Event Configuration FastTab is used to configure the valid events of an event kanban rule. It is not active for scheduled or fixed quantity replenishment strategies.

## Manufacturing scenarios with kanbans

This section describes the kanban rule and kanban job aspects of production scenarios. For information about how to configure activities and production flows, see the whitepaper [Lean Manufacturing: Production Flows and Activities](#).

### Single process activity production scenario

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.

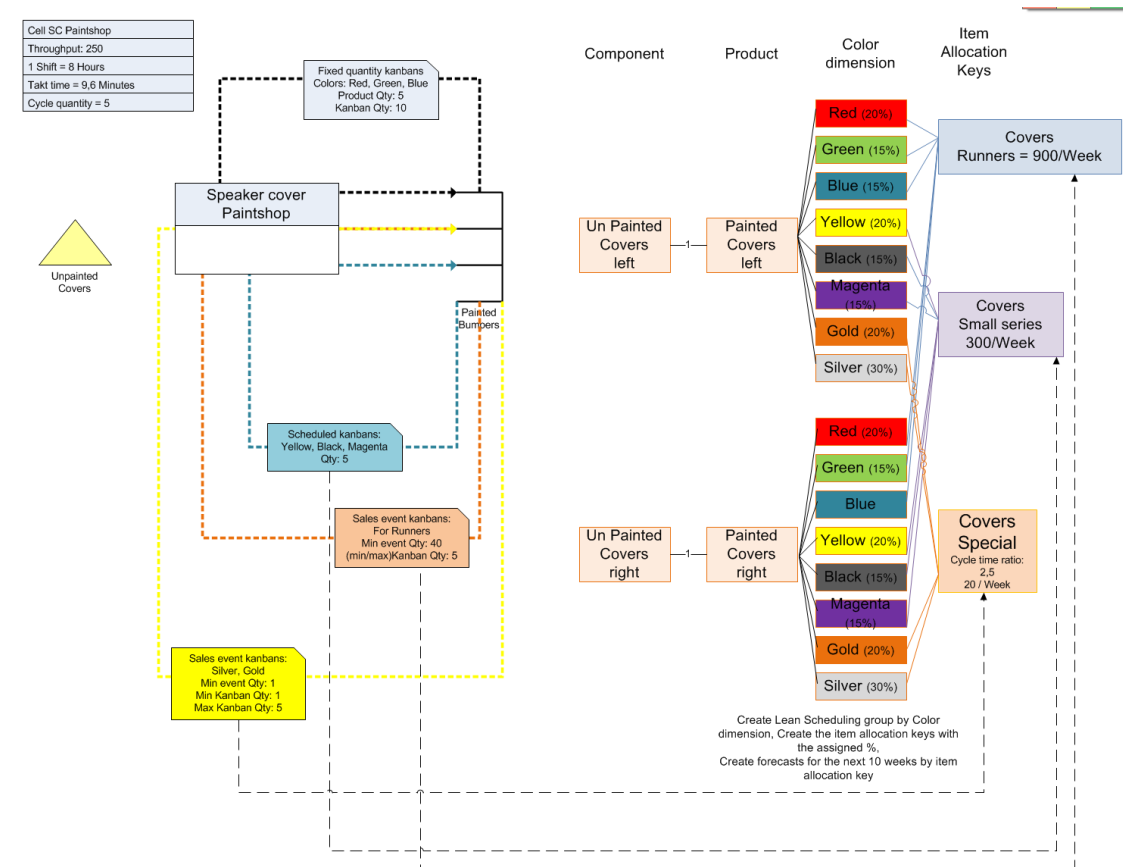


Figure 36: Production flow - single process activity from demo data



---

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.

This example in the demo data includes the following replenishment strategies:

- A. Fixed quantity kanban rules for the runner colors red blue and green
- B. One scheduled quantity kanban rules for small series colors yellow, magenta and black
- C. One sales event kanban rule for the special colors gold and silver
- D. One sales event kanban rule for runners, triggered for sales orders lines of 40 pieces or above

## Kanban creation

The primary difference between the different replenishment strategies is how kanbans are created. In this example, the kanban creation happens according to the four kanban rules:

- A. Fixed quantity kanban rules for the runner colors red blue and green:  
The kanbans are create with the creation of the kanban rule and pushed to the production process.
- B. One scheduled quantity kanban rules for small series colors yellow, magenta and black:  
The kanbans are created based on demand. This could be sales orders or sales forecast or internal demand. The kanban creation is a result of the planning process.  
When using delivery date control CTP or manual explosion of a sales line, the system can be configured to firm the planned orders and create the related when the user interacts with the sales line.
- C. One sales event kanban rule for the special colors gold and silver:  
The kanban rules are configured to automatic creation, resulting in the creation of kanbans with the creation of the sales line.
- D. One sales event kanban rule for runners, triggered for sales orders lines of 40 pieces or more:  
Creation of sales orders for the color red, blue or green for quantities of 40 or more trigger additional kanbans.

## Scheduling

The planner plans the paint shop based on the kanban quantity overview that shows the actual situation in the work cell:

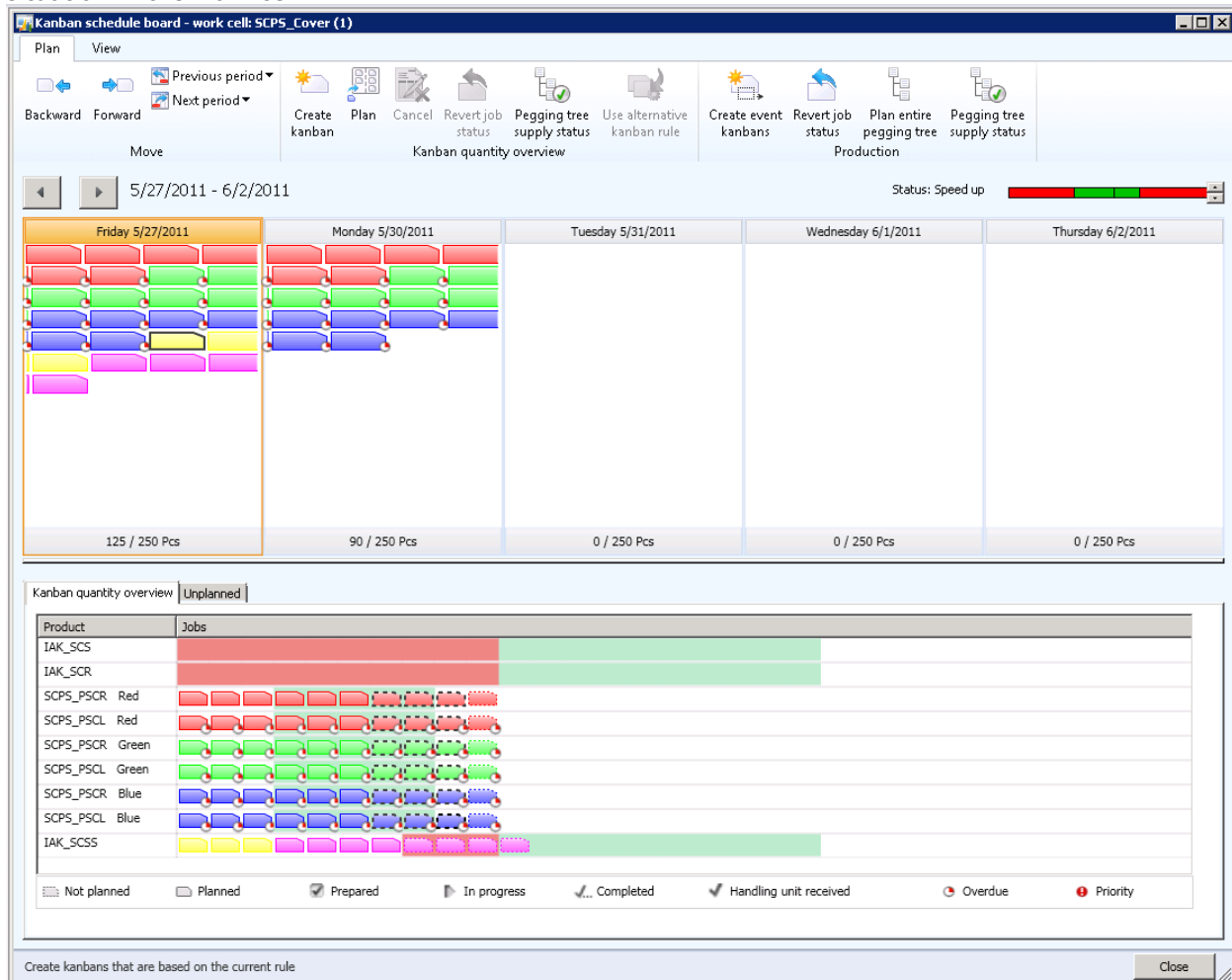


Figure 37: Kanban schedule board in the single activity demo scenario

The planning process defines the planned sequence of production.

## Production process—start and complete

The paint shop starts painting the red jobs. This is done by selecting all red jobs in the job list:

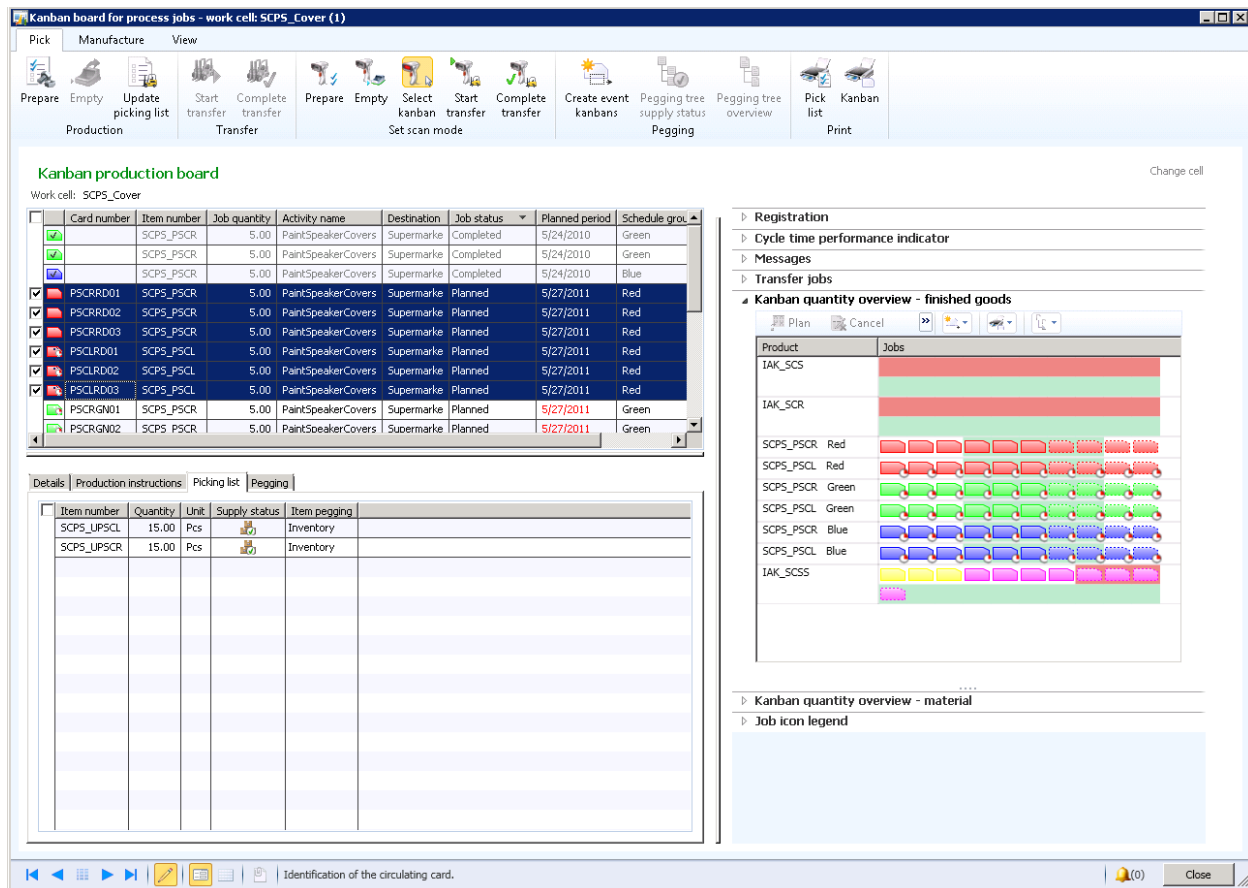


Figure 38: Picking list view on multi selection in the Kanban board for process jobs

When you select multiple jobs in the kanban board for process jobs, the Picking list tab is opened. It shows the material to pick for the selected jobs as well as the availability of the material. The start process is optional. However, for this application it seems reasonable to register jobs on start and complete in order to have an indication of what color is actually painted in the paint shop.

The paint shop operator now starts the jobs with the start function:

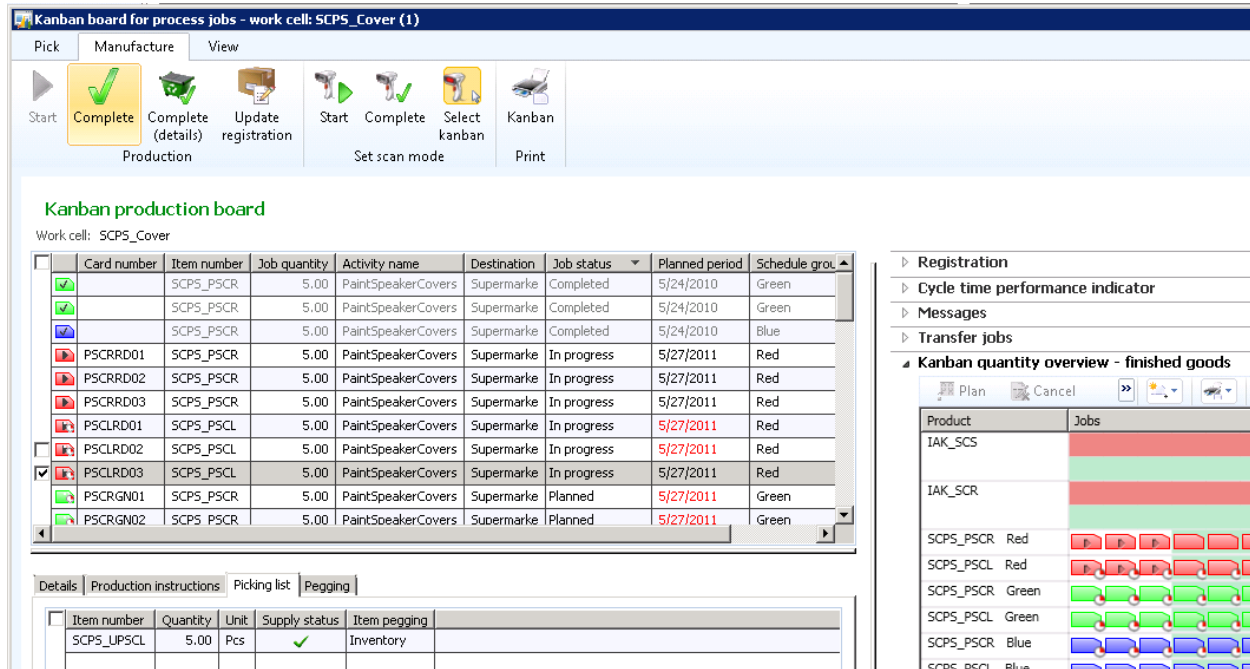


Figure 39: Kanban board for process jobs displays jobs in progress

After completion of the painting for red, the jobs are selected again and completed. The red covers are now available in the supermarket:

#### ▲ Kanban quantity overview - finished goods

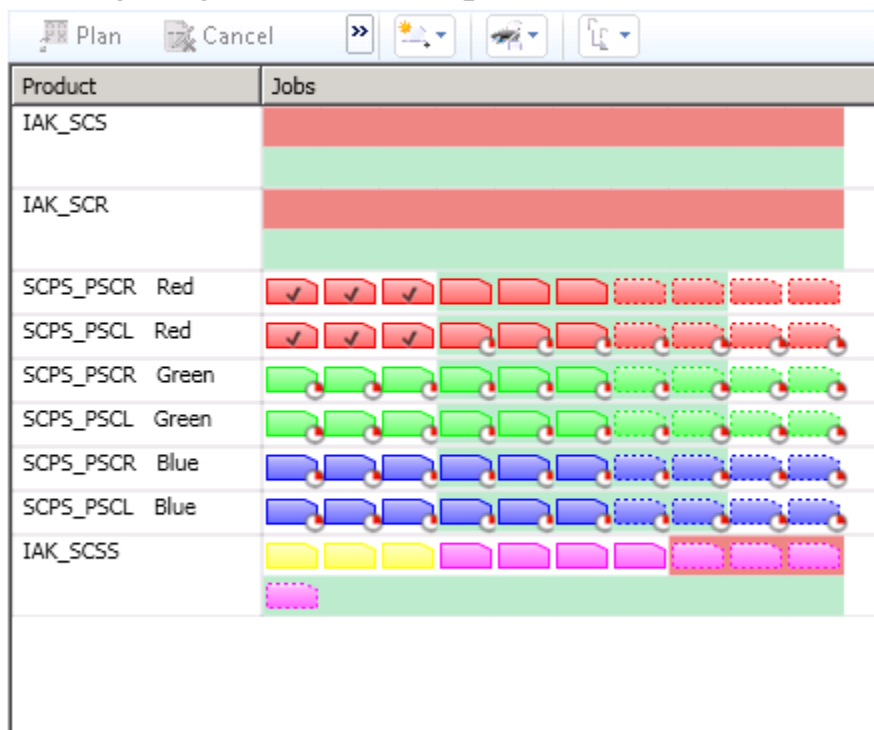


Figure 40: The kanban quantity overview after jobs have been completed

## Consumption and empty kanban handling units

When a handling unit is emptied in the supermarket, the waterspider scans the kanban card on the kanban board:

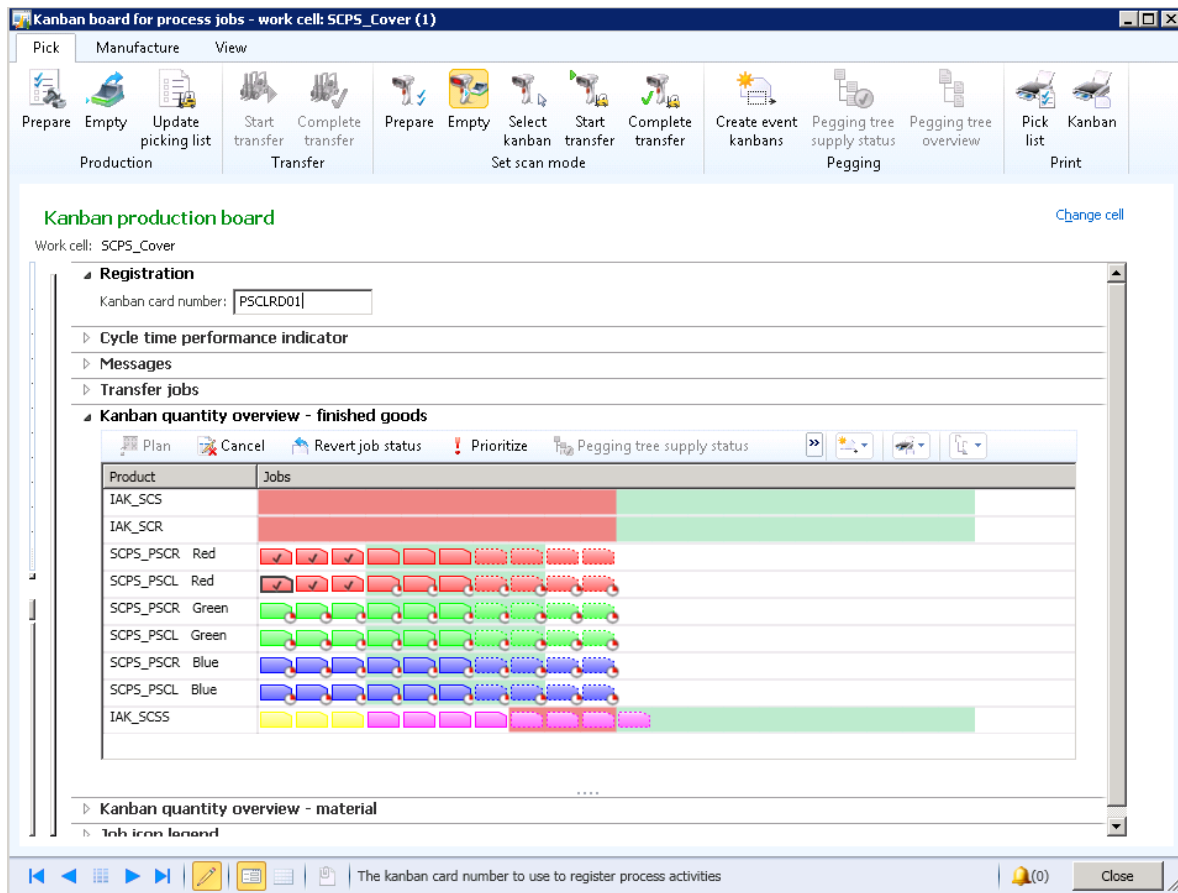


Figure 41: Kanban board for process jobs in scanning mode to empty kanban handling units

As a result of the empty kanban signal on this fixed quantity kanban, a new kanban is created. Due to the setting for automatic planning of the kanban rule, the system plans the newly created kanban into the next available period:

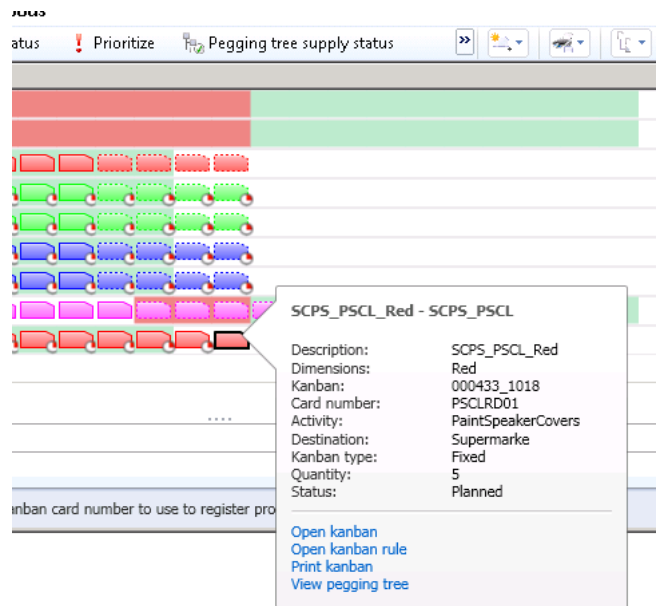


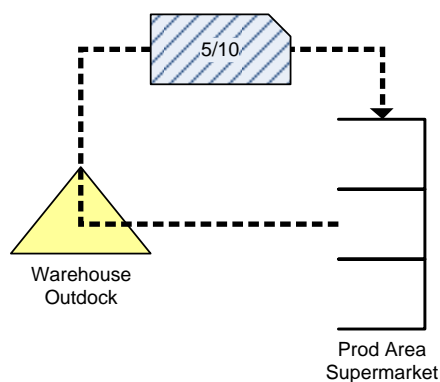
Figure 42: Kanban created and planned when handling unit is registered as empty

## Single transfer activity replenishment scenario

A typical problem solved with kanban is the replenishment of supermarkets at the production lines or work cells. This is typically applied for all types of material that is required at many work cells and replenished out of a warehouse. The warehouse itself can be replenished by purchase or its own production, by production orders, or again through kanban.

When modeling the transfer activity for the production flow, it is important to define the warehouse and WMS-Location breakdown and to consider the default order settings as well as item coverage settings to support scheduling.

Once the transfer activities have been modeled, you can create kanban rules that reference a transfer activity. The relation of kanban rules and activities ensures that the transfer jobs will be created and posted according the configuration of the production flow. Withdrawal kanbans always relate to a single activity.



**Figure 43: Fixed quantity withdrawal kanban, 5 kanbans with product quantity of 10**

Withdrawal kanbans can be of one of the replenishment strategies: fixed quantity, scheduled or event. The described scenario is usually implemented through fixed quantity kanbans. The same transfer activity can be used for multiple kanban rules, covering different items and situations.

The replenishment of withdrawal kanbans can be done through the kanban board for transfer jobs or—if replenishing a lean work cell—through the kanban board for process jobs.

The only parameters that are not available for withdrawal kanbans in the kanban rules are the parameters related to automatic planning. Microsoft Dynamics AX 2012 does not model capacity for transport resources. Accordingly, kanban transfer jobs cannot be scheduled or planned.

Depending on the definition of the items and the configuration of the Warehouse to pick from, a transfer job can create output orders. Output orders can be used to pick from inventory and to create shipments and print Bill of Ladings for the shipments. This assumes that the transport from the warehouse to the supermarket requires a carrier.



## Simple process and put-away transfer scenario

The simplest case of a multi-activity kanban is the simple process and put-away. This is especially useful when the manufacturing process is performed at a different physical location, for example a different site than the final consumption. The production flow for this scenario is modeled as a process activity with a following transfer activity.

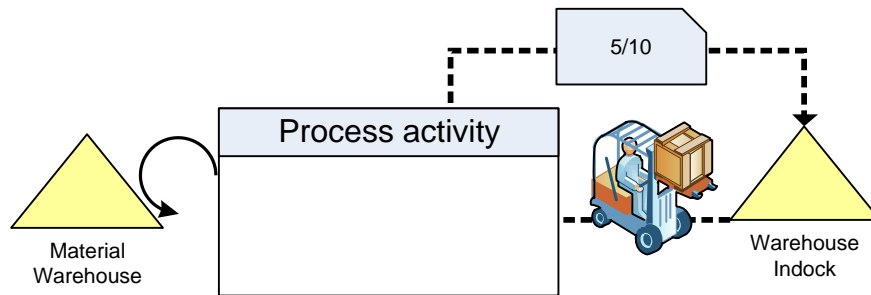


Figure 44: Example of a production flow with put-away transfer activity

The transfer related to a process activity can be completed directly from the kanban board for process jobs. Once the process job is completed, the related transfer is displayed in the list of transfer jobs:

**Kanban board for process jobs - work cell: CSS\_PACK (1)**

File Pick Manufacture View

Prepare Empty Update picking list Start transfer Complete transfer Prepare Empty Select kanban Start transfer Complete transfer Create event kanbans Pegging tree supply status Pegging tree overview Pick list Kanban Print

Production Transfer Set scan mode Pegging

**Kanban production board**  
Work cell: CSS\_PACK

Card number	Item number	Job quantity	Activity name	Destination
OEM01	CSS_OSSKR1LB	10.00	Packaging	Pack

**Registration**  
Kanban card number:

**Cycle time performance indicator**

**Messages**

**Transfer jobs**

Item number	Card number	Job quantity	Source	Destination	Job status
CSS_OSS...	OEM01	10.00	Pack	Supermarke	Not planned
CSS_OC	OC04	100.00	Output	SpAsm	In progress
CSS_OC	OC03	100.00	Output	SpAsm	Not planned
CSS_OC	OC02	100.00	Output	SpAsm	Not planned
CSS_OC	OC01	100.00	Output	SpAsm	Not planned

**Details** | Production instructions | Picking list | Pegging

**Kanban job**

Card number: OEM01  
Item number: CSS\_OSSKR1LB  
Product name: OEM Spare Speaker kit Rear 1 L  
Job quantity: 10.00  
Job status: Completed  
Schedule group: Blue  
Activity name: Packaging  
Warehouse: SpProd  
Destination: Pack  
Due date/time: 5/30/2011 11:10:00 pm

**Product dimensions**

Configuration:  
Size:  
Color:

Kanban job icon representing the job status, lean schedule group color and overdue / express flags

Close

**Figure 45: Reporting transfer jobs in the Kanban board for process jobs**

The transfer job can only be completed if the dependent process job has been completed as well.

On the Kanban board for transfer jobs you can see the status of the process activities as a summary on the Picking list tab:

**Kanban board for transfer jobs**

Production flow: Car speaker PF      From site:      From warehouse:

Activity: MoveToSalesWareho      To site:      To warehouse:

<input checked="" type="checkbox"/>	Card number	Item number	Configuration	Size	Color	Job quantity	Unit	Production flow	Act
<input checked="" type="checkbox"/>	OEM01	CSS_OSSKR1LB				10.00	Pcs	Car speaker PF	Mo
<input checked="" type="checkbox"/>	OEM02	CSS_OSSKR1LB				10.00	Pcs	Car speaker PF	Mo
<input checked="" type="checkbox"/>	OEM03	CSS_OSSKR1LB				10.00	Pcs	Car speaker PF	Mo
<input checked="" type="checkbox"/>	OEM04	CSS_OSSKR1LB				10.00	Pcs	Car speaker PF	Mo
<input checked="" type="checkbox"/>	OEM05	CSS_OSSKR1LB				10.00	Pcs	Car speaker PF	Mo

....

Details   Picking list   Pegging

<input type="checkbox"/>	Item number	Configuration	Size	Color	Quantity	Unit	Supply status	Item pegging
	CSS_OSSKR1LB				10.00	Pcs		Kanban
	CSS_OSSKR1LB				40.00	Pcs		Kanban

Figure 46: Picking list and supply status in the Kanban board for transfer jobs

The supply status is available for one of the five selected transfer jobs.

In the Pegging FastTab, the details of the dependent jobs can be seen:

**Kanban board for transfer jobs**

Production flow: Car speaker PF      From site:      From warehouse:      From location:

Activity: MoveToSalesWareho      To site:      To warehouse:      To location:

<input checked="" type="checkbox"/>	Card number	Item number	Configuration	Size	Color	Job quantity	Unit	Production flow	Activity name	Job status	From warehouse
<input checked="" type="checkbox"/>	OEM01	CSS_OSSKR1LB				10.00	Pcs	Car speaker PF	MoveToSalesWarehouse	Not planned	SpProd
<input checked="" type="checkbox"/>	OEM02	CSS_OSSKR1LB				10.00	Pcs	Car speaker PF	MoveToSalesWarehouse	Not planned	SpProd
<input checked="" type="checkbox"/>	OEM03	CSS_OSSKR1LB				10.00	Pcs	Car speaker PF	MoveToSalesWarehouse	Not planned	SpProd
<input checked="" type="checkbox"/>	OEM04	CSS_OSSKR1LB				10.00	Pcs	Car speaker PF	MoveToSalesWarehouse	Not planned	SpProd
<input checked="" type="checkbox"/>	OEM05	CSS_OSSKR1LB				10.00	Pcs	Car speaker PF	MoveToSalesWarehouse	Not planned	SpProd

....

Details   Picking list   Pegging

<input type="checkbox"/>	K...	Card number	Kanban	Item number	Pegged quantity	Good quantity	Job quantity	Unit	Activity	Handling unit status	Job status
<input checked="" type="checkbox"/>		OEM01	000413_1018	CSS_OSSKR1LB	10.00	10.00	10.00	Pcs	Packaging	Assigned	Completed
<input checked="" type="checkbox"/>		OEM02	000415_1018	CSS_OSSKR1LB	10.00	0.00	10.00	Pcs	Packaging	Not assigned	Not planned
<input checked="" type="checkbox"/>		OEM03	000417_1018	CSS_OSSKR1LB	10.00	0.00	10.00	Pcs	Packaging	Not assigned	Not planned
<input checked="" type="checkbox"/>		OEM04	000419_1018	CSS_OSSKR1LB	10.00	0.00	10.00	Pcs	Packaging	Not assigned	Not planned
<input checked="" type="checkbox"/>		OEM05	000421_1018	CSS_OSSKR1LB	10.00	0.00	10.00	Pcs	Packaging	Not assigned	Not planned

Figure 47: The pegging tab in the Kanban board for transfer jobs

The combination of process and transfer is especially useful to model alternative kanban rules for alternative points of consumption that are supplied out of a single process activity:

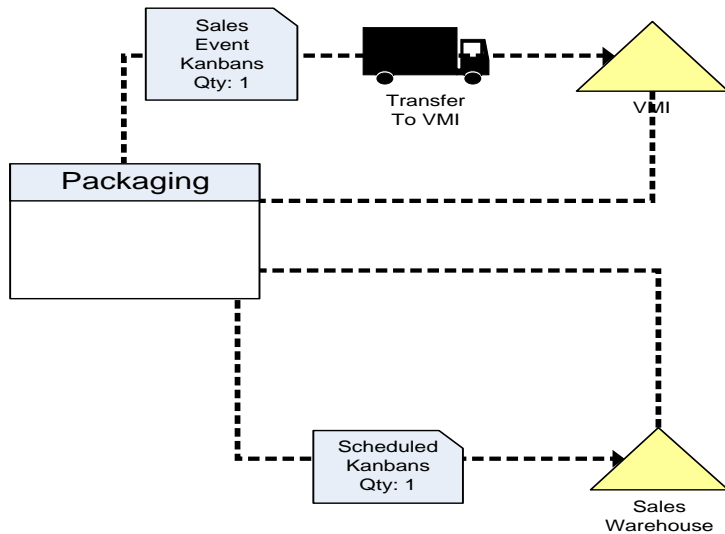


Figure 48: Alternative kanban rules for different supply branches

The packaging jobs of the kanbans delivered through the vendor managed inventory (VMI) and kanbans delivered through the sales warehouse are both loaded to the same packaging work cell and perform the same activity. At the output location of the work cell the appropriate transfers are started.

A kanban rule that consists of a process and a subsequent transfer activity is a manufacturing kanban. Depending on the **Update on-hand receipt** property of the process activity, the transfer can post to inventory or not. The combination is also possible for semi-finished products.

## Multiple process activity kanbans

Kanban rules can be configured to use multiple process activities in a sequence:

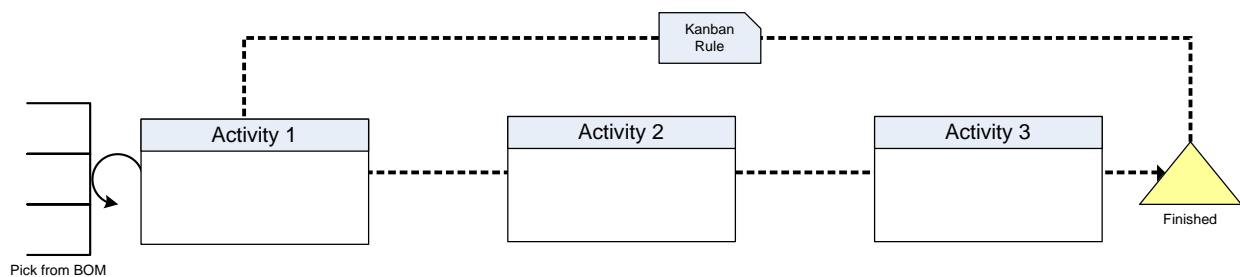


Figure 49: Example of a production flow using multiple process activity kanbans

Detailed requirements for the configuration of the activities and production flow are described in the white paper [Lean Manufacturing: Production Flows and Activities in Microsoft Dynamics AX 2012](#).

The kanban rule would be configured with Activity 1 as the first activity and Activity 3 as the last activity. The kanban flow selection would have the flow Activity 1 > Activity 2 > Activity 3, provided that Activity 2 is configured to consume and to output semi-finished material. The kanban rule is of type Manufacturing. Other than that, no additional restrictions occur on the creation of kanban rules. Kanban rules that are configured with multiple process activities can be of any replenishment strategy and for events, of any event type.

When a kanban is created, three process jobs are created. The due date and time of Activity 3 is the original due date and time of the kanban. Based on the activity times—runtime plus queue times—of each activity and the end-start constraints of the activity relations, the due date and time of activity 2 and activity 1 are calculated backwards.

### Scheduling multiple process activity kanbans

If a kanban rule is set to automatic scheduling, all activities are scheduled, starting with Activity 3 and planning upstream.

For manual scheduling on the kanban scheduling boards, two options are possible:

- Scheduling Activity 3 on a kanban scheduling board of the related work cell and then scheduling Activity 2 and Activity 1 by using the function **Plan entire pegging tree**.
- Scheduling of all activities independently.

### Manufacturing

In a multiple process activity kanban it is necessary for all jobs to be completed exactly in the sequence of the production flow. The status of the upstream jobs are visible in the pegging tab of the kanban board for process jobs, in the job list of the kanban details form, or in the kanban pegging tree form.

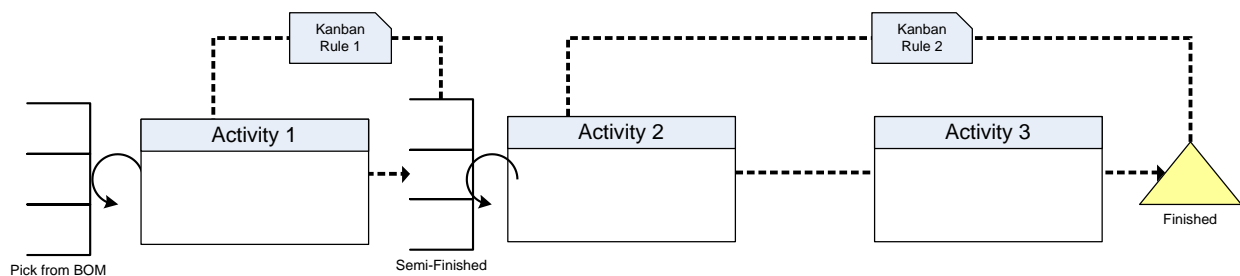
Assuming that Activity 1 picks from an inventory location, does not pick semi-finished products, and does not consume from WIP, the preparation of jobs for Activity 1 would lead to the deduction of material from inventory for the flushing principle Start.

Assuming that Activity 3 receives the finished product to inventory, the completion of the activity would lead to the deduction of material from inventory for the flushing principle Finish.

If a kanban rule allows deviating quantities, it is possible to register deviating quantities on any job of the kanban. It is also possible to report error quantities on any job. However, only on the last activity would the flushing principle Finish lead to material consumption on error quantities.

### Kanban supplying or consuming semi-finished products

For the same production flow as in the previous example, the definition of kanban rules could be done differently:



**Figure 50: Example of a production flow using kanbans that output semi-finished products to a supermarket**

The same product is now produced with 2 different kanbans. This scenario is usually chosen if the first activities which produce to a supermarket reference a fixed quantity kanban rule (in this case Activity 1). Activity 2 now consumes a semi-finished product from a supermarket.

Kanban rule 2 allows all replenishment strategies. Kanban rule 1 allows only fixed quantity kanbans or kanban line event.

It is possible in to create kanban rule 1 with replenishment strategy kanban line event, but this would be the same as creating a kanban rule that spans all 3 activities. However, there might be scenarios where kanban Rule 2 is a scheduled or event rule for many products and multiple different kanban rules for Activity 1 would have different replenishment strategies for different products.

### **Scheduling**

Kanban rule 1 and 2 can be configured independent of each other, with or without automatic planning.

Activity 2 can be entirely planned from Activity 3 by using the **Pegging tree planning** function. This function can be found in the Kanban schedule board, the Pegging tree overview form, or the Kanban details form. Activity 1 can only be planned through this function if kanban rule 1 is a kanban line event rule.

### **Manufacturing, transactions and material consumption**

If kanban rule 1 is a fixed quantity kanban rule, the kanbans for kanban rule 2 are independent of the status of kanbans for kanban rule 1. However, it is helpful to use the kanban quantity overview for material on the work cell for Activity 2 to see the availability of material based on the kanban job status of kanban rule 1.

The kanbans for kanban rule 1 will deduct inventory for material with the flushing principle Start on preparation of the jobs for Activity 1.

The kanbans for kanban rule 2 will deduct inventory for material with flushing principle Finish when jobs for Activity 3 are completed and receive the finished product to inventory (or to WIP, depending of the configuration of Activity 3).

Other than this, no further transactions are posted to inventory throughout the complete process.

## Kanban and vendor integration

### Kanban and purchase orders – purchase kanbans

Microsoft Dynamics AX 2012 does not have a special implementation of purchase kanbans. To pull material from vendors, withdrawal kanbans are used that pull material from the inbound dock to the point of consumption. The planned order type for the warehouse that is associated with the inbound dock is Purchase order; the planned order type for the warehouse of the point of consumption is set to Kanban.

MRP converts the issues of the withdrawal kanbans to planned purchase orders and, depending on the firming fences, to purchase orders.

#### Detailed process

This results in the following process for Purchase kanbans for fixed quantity kanbans:

- Preparation
  - Configuration of the kanban rule, item coverage and scheduling parameters
  - Create circulating kanban cards—if applied
  - Create initial kanbans
- Repetitive process
  - Run master scheduling, convert kanban issues to purchase orders.  
Depending on the coverage code, multiple kanbans for the same products are grouped to a single planned order and subsequently to a single purchase order line. Alternatively, when using the coverage code Requirement, planned purchase orders and purchase order lines are created for a withdrawal kanban.
  - Send purchase order to vendor.  
The options that are available to publish the purchase order to the vendor include mail, fax, email, EDI and Enterprise Portal.
  - Send the kanban cards to the vendor
    - Send the current circulating cards or pre-printed physical cards
    - Send electronically (for example, email)
  - Vendor confirmation process
  - Product receipt on item arrival at the dock
  - Completion of the withdrawal kanban jobs on receipt at the point of consumption/production supermarket
  - Scan or register empty handling units. This results in creation of new kanbans and jobs for kanbans of the replenishment strategy fixed quantity
- Invoicing and closure (per shipment)
  - The invoicing is done per shipment and is based on the receipts posted to the purchase orders.
  - Close purchase orders with deviating quantities. In the kanban process, all purchase order lines that have only been partially delivered will be closed because the next delivery will be triggered by the next empty kanban.

#### Simplified process with periodic purchase orders

A vendor that supplies parts on a daily basis based on a purchase agreement and a service level agreement may ship multiple times a week, or even multiple times a day. In this scenario, the purchase process has no value for the overall process because the vendor ships based on the kanban signals and without the need for an explicit purchase or sales process and confirmation.

The approach in Microsoft Dynamics AX 2012 simplifies this process even further:

- Preparation

- Configure the kanban rule, item coverage and scheduling parameters
- Create a purchase agreement (if needed)
- Create a purchase order for a periodic demand (for example, a monthly demand)
- Create circulating kanban cards (if applied)
- Create initial kanbans
- Repetitive process
  - Run master scheduling, convert kanban issues to purchase orders. Depending on the coverage code, Period or Requirement, multiple kanbans for the same products are grouped to a single purchase order line or a purchase line by kanban is created
  - Send the kanban cards to the vendor
    - Physically (for circulating cards or pre-printed physical cards)
    - Electronically (for example. email)
  - Product receipt on item arrival at the dock
  - Completion of the withdrawal kanban jobs on receipt at the point of consumption or production supermarket
  - Scan or register empty handling units -> create new kanban jobs
- Invoicing and closure (once pre invoicing period, for example, once a month)
  - Post invoices on the complete quantity delivered per period
  - Closure or adjustment of the open periodic purchase order is only needed when the forecasted quantity per period is not reached. As the purchase order is not relevant for planning at the vendor, this adjustment is optional.

## Conclusion

The pull approach in the ERP purchase process is designed to support pull purchasing and supports this scenario with and without kanbans. Using kanbans to pull from the inbound dock allows the implementation of purchase kanbans by using normal purchase orders to carry demand, delivery and invoicing information. This approach allows the full range of purchase operations including EDI integration or usage of enterprise portal for the vendor to view and update the purchase information.

Also, periodic purchase orders and invoices are now fully supported. This further simplifies the process for high frequency deliveries.

## Subcontracting

The subcontracting process has been described in detail in the white paper [Lean Manufacturing: Production Flows and Activities in Microsoft Dynamics AX 2012](#). As with purchase kanbans, the material flow is well separated from the purchase process. Kanban rules and kanban jobs that relate to subcontracting activities do not behave differently in scheduling and manufacturing execution. Once a purchase order line is related to a kanban job, the details of the purchase order line are shown in the kanban details form.

When kanban jobs that relate to service purchase orders are changed, or manual changes to the purchase orders are made, it is verified that the relation between the kanban job and the purchase order line is consistent. If necessary, a warning or error message informs the user that the modification might lead to inconsistencies between the production status and the purchase status.

## Consignment stock

Consignment stock is inventory that is owned by a vendor unless it is pulled out of the supermarket or purchase warehouse. In other words, the material is only paid on consumption.

Microsoft Dynamics AX 2012 does not have an explicit implementation of consignment stock. However, the special capabilities of production flows, WIP and subcontracted activities can be used to model a consignment stock.



The following process models a consignment stock:

- Preparation
  - Create a production flow with 2 transfer activities:
    - T1 - Transfer to consignment stock (dummy)  
Update on-hand on pick equals yes  
Update on-hand on receipt equals no
    - T2 - Transfer from consignment stock  
Create and assign one or multiple service items that trigger the purchase process and payments  
Update on-hand on pick equals no. In this case the value of picked products is deducted from WIP when kanbans are received.  
Update on-hand on receipt equals yes
    - Create withdrawal kanban rules to pull from consignment stock with activity T2
      - All replenishment strategies, whether they are fixed, scheduled or event, are possible.
      - Create kanbans and kanban cards for fixed quantity rules
    - Calculate the standard cost of the items pulled from consignment stock. In this situation, the full product cost should be subcontracted work, as no material components can be determined.
- Repetitive process
  - Create scheduled / Event kanbans based on actual demand
  - Create the purchase orders for the payment items and initiate the purchase process with the vendor
  - Post the receipt of the payment items. The subcontracting integration to production flow posts the value of the receipt to the WIP account of the production flow
  - If needed, start the transfer jobs, visualize that the kanban job is ready to be completed and then use the kanban quantity overviews to track the stock level of material in the consignment stock
  - Complete the transfer job that pulls material from WIP whenever material is needed. WIP is deducted at standard cost, consisting of 100% subcontracting work.
- Invoicing and period end
  - Post invoices for the payment items. Deviations of invoices and receipts are posted as variances to the production flow.
  - Run backflush costing to determine the variances per period—if any.

The only considerable overhead of this process is the need for a dummy activity plus the service products that are needed to implement the purchase process by using the activity based subcontracting functionality. Another improvement could be a job that starts the transfer jobs on posting receipts of the related purchase order lines.

## Conclusion

Lean manufacturing in Microsoft Dynamics AX 2012 has a new foundation that provides an open architecture that supports different methods of manufacturing for different industries and various production and replenishment strategies.

It also allows for 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 have 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.

U.S. and Canada Toll Free 1-888-477-7989

Worldwide +1-701-281-6500

[www.microsoft.com/dynamics](http://www.microsoft.com/dynamics)

This document is provided “as-is.” Information and views expressed in this document, including URL and other Internet Web site references, may change without notice. You bear the risk of using it.

Some examples depicted herein are provided for illustration only and are fictitious. No real association or connection is intended or should be inferred.

This document does not provide you with any legal rights to any intellectual property in any Microsoft product. You may copy and use this document for your internal, reference purposes. You may modify this document for your internal, reference purposes.

© 2011 Microsoft Corporation. All rights reserved.

Microsoft, Microsoft Dynamics, the Microsoft Dynamics logo, Microsoft SQL Server, and Windows Server are trademarks of the Microsoft group of companies.

All other trademarks are property of their respective owners.

**Microsoft**