Lean manufacturing: Capable to promise and kanban job scheduling

This document describes the details of kanban job scheduling in Microsoft Dynamics 365 for Operations. It introduces the concept of sales order taking that uses the capable to promise (CTP) method for delivery date control. It also explains how CTP can be combined with event kanbans to model assemble-to-order or build-to-order scenarios.

White paper
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Lean manufacturing: Capable to promise and kanban job scheduling

Manufacturing industries increasingly rely on configure-to-order, assemble-to-order, or make-to-order principles. The implementation of all these principles involves a challenge: the order confirmation must be validated against the capability to build a customer-specific product variant, but this capability can’t be exactly forecasted. Factors that affect it are the availability of material and the availability of resources. Capable to promise (CTP) checks both material and resource availability, and creates new planned or firmed orders to supply material or finished goods.

Microsoft Dynamics AX offers two components to provide strong support for assemble-to-order and make-to-order strategies. Additionally, when these components are used together with the product configurator, they also provide a great platform for configure-to-order manufacturing.

- Event kanbans.
- CTP, which is a new mechanism for delivery date control. It uses the capability to calculate the expected delivery date based on an update of the dynamic master plan when an order is entered.

Discussions about the use cases and required scenarios revealed that customers and partners require more insight into the mechanisms of kanban job scheduling. In effect, kanban job scheduling involves a simple sequencing per scheduling period. For simple production flow scenarios and single-activity kanbans, the scheduling results are generally self-explanatory. However, more complex scenarios that involve multi-activity kanbans or heavy use of kanban line event kanbans require a better understanding of the scheduling principles and limitations.

Document purpose

This white paper starts by explaining the fundamental mechanics of kanban job scheduling for simple and complex production flow configurations. It then introduces the concept of CTP, and explains how CTP interacts with planned and actual kanban jobs. Finally, this white paper explains how CTP can be combined with event kanbans, and explains important changes that have been made in Microsoft Dynamics AX to better support build-to-order or assemble-to-order scenarios where CTP is used.

This white paper is the third in a series of white papers about lean manufacturing in Microsoft Dynamics AX. It’s assumed that the reader is familiar with the terms and concepts that were introduced in the previous white papers:

- Lean manufacturing – Production flow and activities
- Lean manufacturing – Kanban and pull based manufacturing
**Terminology**

The following table explains the terms that are used in this white paper.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capable to promise (CTP)</td>
<td>At the time of order entry, the process of determining the availability of products, material, and resources that are required in order to fulfill a specific customer requirement.</td>
</tr>
<tr>
<td>CTP explosion</td>
<td>To calculate CTP for a specific demand, the demand is inserted in the dynamic plan, and the derived demands are exploded through all bill of materials (BOM) levels until full coverage of the demand can be reached (according to the parameters of the dynamic plan and the supply policies of the semi-finished products and materials that are involved) and an estimated ship date can be calculated.</td>
</tr>
<tr>
<td>CTP simulation</td>
<td>The process of manually running the CTP explosion from the UI. This simulation can be done for a single line or a whole sales order. In both cases, the user can decide when the result should be transferred to the sales order lines. However, even if the result of the explosion is rejected, any changes that have occurred in the dynamic plan are retained.</td>
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</table>

**Kanban job scheduling**

This first section evaluates the mechanics and functionality of kanban job scheduling in Dynamics 365 for Operations. The content of this section is relevant, regardless of whether CTP is used. It applies to manual scheduling, automatic scheduling through master planning, and scheduling that uses explosion or CTP delivery date control.

To evaluate a scheduling result (that is, a suggested delivery date, in the case of CTP), you must understand these mechanics. When you understand the configuration of the kanban schedule, you’re more likely to get reliable and correct results for planning and order confirmation.

**Finite capacity scheduling for lean manufacturing**

Unlike the finite resource scheduling that the scheduling engine provides for production jobs in Microsoft Dynamics AX, scheduling for kanban jobs doesn’t try to optimize a resource by the hour and minute. The result of the kanban scheduling is the sequence of the scheduled jobs, provided that the first job in the sequence is received first in the assigned period.

The main difference between job scheduling for production orders and job scheduling for kanban jobs in Dynamics 365 for Operations is the implementation of finite capacity control for lean manufacturing. Whereas finite scheduling for production orders tries to optimize capacity loads for individual resources, so that there is a risk of over-optimized resources and increased batch sizes, lean capacity is based on work cell throughput. This approach assumes the concurrent use of various resources within a work cell.
A lean work cell is represented by a resource group that is designated as a lean work cell. Not all resources that are allocated to the work cell are available for finite scheduling of production orders or planned production orders for the period when these resources are assigned to the work cell.

The capacity of a lean work cell in Dynamics 365 for Operations is defined by the following factors:

- The assigned calendar
- The assigned capacity per period
- The throughput capacity model

When the capacity model type in the production flow model is **Throughput**, 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 that has been multiplied by the throughput ratio that is defined for an item in the lean scheduling group.

- **Standard work day period**: The capacity for a work day is defined as the capacity of the length of a standard work day. The standard work day attribute of the calendar is important in Dynamics 365 for Operations. The available capacity is adjusted according to the available time for any day that has a length that differs from the length that is specified in the active calendar.

- **Week or month period**: For the week or month period, it’s assumed that 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 that is available according to the calendar. For a job, the average cycle time of the activity is corrected by the quantity and the throughput ratio of the item, and then loaded on the kanban schedule.

**Note**: Capacity model types can’t 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 that are provided by the work cell have comparable resource consumption. Use the Hours model where the capacity load of individual jobs has high variance that isn’t 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. The jobs are sequenced within the scheduled periods. The sequencing can be done manually on the **Kanban job scheduling** list page. Alternatively, it can be done automatically through the automatic planning that schedules kanban jobs whenever they are created, or when the automatic planning quantity is reached.

**Automatic scheduling of kanban jobs**

If you set the automatic scheduling quantity on the kanban rule, the scheduling of kanban jobs is triggered when kanbans are created. An automatic planning quantity of 1 plans each kanban job directly upon kanban creation. The resulting sequence uses the first pull, first serve principle. If you select an automatic planning quantity that is more than 1, kanban jobs are grouped before planning occurs.

This concept enables kanban sizes to be lower than the actual economic batch sizes. For example, the economic batch size for a specific item (or item family) is 30. You don’t have to create kanbans by using the product quantity, 30. Instead, you can configure the kanban rule so that it has a product quantity of 10 and an automatic planning quantity of 3. Although automatic planning will schedule the kanban jobs for the work cell only when there are three
unplanned jobs, it’s fully transparent to the planner and the shop floor supervisor that there might be two unplanned jobs that are waiting for execution, and that these unplanned jobs must be taken into production either by manually planning them or by creating additional kanbans.

When you use automatic planning of kanban jobs, jobs are allocated to the periods in the order of job creation. To be more precise, jobs are allocated in the order of the automatic planning events that are triggered when the number of unplanned jobs for a kanban rule reaches the automatic planning quantity of that rule with the job creation. Note that, for kanban rules that have multiple activities, automatic job creation is triggered separately per activity and starts from the last activity of the kanban.

When you use CTP, it’s assumed that automatic planning of the event kanban rules is set to 1 for all activities where the capacity of the work cell is relevant for the delivery date. Nevertheless, we recommend that you turn off automatic planning for non-bottleneck activities. To turn off automatic planning, set the automatic planning quantity to 0.

**Manual scheduling**

For manual scheduling, Dynamics 365 for Operations offers the Kanban job scheduling list page. Manual scheduling can be combined with automatic scheduling. You can use the Kanban job scheduling list page to plan and unplan jobs, move them in sequence, or move them from period to period.

Jobs that are based on a kanban rule that has an automatic planning quantity that is more than zero (0) can be manually unplanned. However, those jobs will be replanned when the next automatic planning event occurs, such as when a new kanban is created.

**The kanban job and the activity times**

When a kanban is created, a kanban job is created for each activity of the kanban flow that is related to the kanban rule that triggered kanban creation.

At creation time, the actual job times and the related capacity consumption are calculated for each job. This calculation is based on the following factors:

- The activity times that are configured in the production flow activities:
  - Queue time before
  - Run time
  - Queue time after
  - Minimum activity quantity
- The actual quantity of the kanban job
- The throughput ratio of the product relative to the work cell
The following illustration shows a conceptual view of the calculation of kanban job times.

The following sections explain the data that is calculated when a job is created.

**Due date and time**

The due date and time are derived from the demand date and time that are calculated for the job. For the last job of a kanban, the due date and time are equal to the due date and time of the kanban itself. For all previous jobs, the due date and time are calculated backward, and the calculation considers the activity run times, queue times, and activity constraint times (end-to-start constraint).

The kanban due date and time are determined from demand and depend on the replenishment strategy.

**Fixed quantity kanban**

Typically, a new kanban is created when the previous kanban is registered as empty. The due date and time are calculated at kanban creation, as the actual date and time plus the replenishment lead time that is configured in the kanban rule.

**Scheduled kanban**

The due date and time can be manually defined when a kanban is manually created. When a planned kanban is firmed, the requirement date and time of the planned order are then used as the due date and time. Note that, when planned orders are created for all original demand that doesn’t have time, the requirement time that is configured in the Master planning parameters is used.

**Event kanban**

The due date is based on the demand of the sales line. The time is set from the requirement time that is configured in the Master planning parameters.

**Job run time**

The job run time is calculated as follows:

\[
\text{Job run time} = \text{Activity run time} \times \text{Job quantity} \times \text{Throughput ratio}
\]
If a minimum activity quantity is defined for the activity, and the job quantity is less than this quantity, the minimum activity quantity is used to calculate the run time:

\[ \text{Job run time} = \text{Activity run time} \times \text{Minimum activity quantity} \times \text{Throughput ratio} \]

**Queue times**

The queue times don’t consider actual or minimum activity quantities or throughput ratios. Instead, they are used net as they are defined in the activity when the job is created.

Be aware that the queue times are considered part of the activity time itself. Therefore, the queue time after (see the previous illustration) is **before** the expected receipt date and time and the due date and time.

In general, it’s important that the total activity time (run time plus queue times) not exceed the average available working time of a single scheduling period of the work cell. If you select days as the scheduling periods, it’s usually expected that the average job time will be between one minute and a few hours. Therefore, don’t configure queue times after that are longer than the available working time of an average period, especially for the queue time after.

You can use the queue time before to control the material requirement date and time of an activity. In exceptional cases, this date and time can be longer than the actual planning period to help guarantee that the materials are requested one or two planning periods before the job actually starts.

**Activity time vs. cycle time**

As shown in the previous illustration, the activity time is usually longer than the cycle time of a job. In an implementation of a work cell in the true sense of lean manufacturing, the activity time is **always** longer than the cycle time of a job. Therefore, multiple jobs can be active in the work cell in parallel. The cycle time of an activity defines the interval between two receipts of a standard quantity of product out of the activity.

**Example**

If a work cell delivers 100 pieces in eight hours in units of 1, the required cycle time is calculated as follows:

\[ \text{Cycle time} = (8 \text{ hours} \times 60 \text{ minutes}) \div 100 \text{ pieces} = 4.8 \text{ minutes/piece} \]

In this example, a kanban should be received out of the work cell every 4.8 minutes to fulfill the required takt of the production flow. To make sure that the activity cycle times are in sync with the takt requirements of the production flow, the calculation is based on the takt requirement that is defined on the **Production flow version details** page.

The capacity load is related to the cycle time, not to the activity time of an activity. (For more information about the capacity load, see the next section.)

In the special case where a work cell can’t run multiple jobs in parallel, the cycle time must be configured so that it’s equal to or close to the actual run time of the activity.

In later sections of this white paper, we always assume some degree of parallelism in the work cell.
**Capacity load**

The capacity load of a kanban job is calculated when a kanban process job is created. The calculation depends on the capacity model that is used in the production flow model that is assigned to the work cell of the process job.

**Throughput**

The capacity load is calculated as follows:

\[
\text{Capacity load} = \text{Job quantity} \times \text{Throughput ratio}
\]

**Hours**

The capacity load is calculated based on the activity cycle time, **not on the activity or job run time**. It’s calculated as follows:

\[
\text{Capacity load} = \text{Activity cycle time} \times (\text{Actual job quantity} \div \text{Per-cycle quantity}) \times \text{Throughput ratio}
\]

Note that transfer jobs aren’t scheduled and don’t have a calculated capacity load.

Changes to the cycle time or the throughput ratio after a kanban job is created don’t affect jobs that have been created.

**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 activation, the cycle times of the activities must be recalculated by using the recalculation function of the production flow version. The cycle time calculation uses the following base data:

- Settings for the production flow version on the **Production flow version details** page:
  - Takt unit
  - Average takt time
  - Minimum takt time
  - Maximum takt time

Period for actual cycle time (days) – This parameter describes, in working days, the period 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 effect on the cycle time performance indicator.

- Per cycle unit of measure
- Quantity per cycle
- Activity relations
- Cycle time ratio – This parameter describes the ratio of the cycle times for an activity relation.

Currently, the cycle times of the activities aren’t shown in Dynamics 365 for Operations, except on the **Kanban flow** page for multiple activity flows.
Planning and sequencing of process jobs

Selecting the planning period of the work cell schedule

During manual planning, any period can be selected. However, automatic planning selects the planning period based on the due date of the job as it’s calculated before the automatic planning takes effect. Usually, this due date is the due date that was calculated at the time of creation.

To select the planning period, the system uses the working time calendar to subtract the every part every interval (EPE) of the production flow model that is associated with the work cell capacity from the due date. The system then determines the first period of the work cell schedule that ends on or after the resulting date.

If the period has available capacity for the capacity load of the job, the job is sequenced at the end of the job list for the period. If not enough capacity is available per the capacity shortage policy of the production flow model, the capacity periods that follow are checked until either a period is found that has enough capacity or the planning time fence is reached.

The following illustration shows a schematic kanban schedule that has daily periods. What is visible in the kanban schedule is the part of the job that represents the capacity load that corresponds to the cycle time of the job (shown in green). The total activity time of the job is hidden (blue plus green).

![Schematic Kanban Schedule]

Note that, because the scheduling is based on the due date (that is, it’s based on the planned receipt date), and the capacity load is reduced to the cycle time, the required start time of a job could be in the previous scheduling period. However, lean scheduling in Dynamics 365 for Operations doesn’t calculate or show the required start time of a job.

Every part every interval

The EPE is a lean key performance indicator (KPI). It describes the ability of a work cell to do enough changeovers per interval to produce every scheduled part of a production plan in a given interval, provided that the required takt is still maintained. Note that the time model of the lean activities excludes the setup and changeover times. Typically, these times aren’t part of a scheduling model but must be considered in the calculation of overall takt time.
Example

A work cell must produce an average of 12 different products. Additionally, the average changeover requires 30 minutes. The planner has calculated that, to maintain the required takt, no more than four changeovers should be done per day. Therefore, the work cell will require three days to produce all 12 products in the production plan. In other words, the EPE is three days.

The scheduling of kanban jobs considers the EPE by trying to plan every job $n$ days earlier if the EPE is set to $n$ days. However, the scheduling doesn’t optimize the plan to reduce the number of changeovers. Basically, the reason is that the system doesn’t have detailed information about the changeover times and requirements.

If the due date is April 26, and the EPE is three days, the job will be scheduled in the first period that has available capacity, starting on April 23. EPE calculates only work days.

In relation to CTP, note that an EPE that is more than 0 (zero) can be used together with event kanbans but not scheduled kanbans. The reason is that the EPE isn’t considered when planned orders are calculated. When scheduled kanbans are used, the CTP explosion and delay calculation are based on the planned orders. Therefore, unless the inventory lead times exclude the EPE period, EPE should always be 0 (zero) when CTP is used together with scheduled kanbans.

For event kanbans that have automatic firming, the situation differs. Because these kanbans are firmed before the explosion is run, the EPE is applied before the explosion. In this scenario, an EPE period might help level production against material disruption.

Calculations that are based on the planning result

When a job has an assigned sequence in a scheduling period of a work cell, the following calculations are triggered.

Expected receipt date and time

Based on the sequence of the job in the period, and the cycle times of the activity, an expected receipt date and time are calculated. Note that this behavior isn’t an attempt to reintroduce finite scheduling into kanban job scheduling. Instead, it’s an attempt to estimate the actual receipt time for visual control and optimized control over material demand.

Due date and time of dependent jobs

Based on the expected receipt date and time, the due date and time of dependent upstream jobs in multi-activity kanban scenarios or kanban line event job scenarios are recalculated.
Scheduling dependent jobs

Dependent jobs can occur in two configurations:

- **Multi-activity kanbans** – For kanbans that cross multiple activities, all jobs are pegged in the sequence of the jobs.
- **Kanban line event kanbans** – Kanban line event kanbans are pegged to their parent. Remember to configure the reservation in the kanban rule to force the pegging to be picked up by master planning.

Between the jobs, the actual activity constraint time of the activity relation in the production flow version is calculated. The user can maintain and change the activity constraint times of an existing activity relation.

The following illustration shows a conceptual view of the activity constraint times for dependent jobs.

After job 2 is scheduled, the estimated receipt date and time are calculated based on the sequence of the job in the kanban schedule of the work cell. If the estimated receipt date and time that are calculated are before the due date and time of job 2, the recalculation of the due date and time of the upstream dependent jobs (job 1 in this example) will be triggered.

\[
\text{Due date/time (job1)} = \frac{\text{Estimated receipt date}}{\text{Time (job 2)}} - \text{Total activity time (job 2)} - \text{Activity constraint time}
\]

All calculations are done within the working times of the calendars of the work cells.

Note that the recalculation of the due date and time of job 1 will **not** automatically cause job 1 to be replanned.

Scheduling dependent work cells

The scheduling logic for dependent jobs, like all lean scheduling, is based on the calculated due date of the job when the planning event is triggered. Lean scheduling supports only sequencing in a period, not scheduling for a specific hour. Therefore, there is no easy way to schedule dependent jobs in a row throughout multiple work cells.

The dependencies are documented by updating the due date and time of the jobs whenever the plan for the parent job is changed. In the creation and automatic planning scenario, the jobs go through two different states:

- At job creation, the due date and times of all jobs are calculated backwards, based on the due date and time of the last job. For sales event kanbans, the due date and time of the sales line are used.
- After job creation, the jobs are automatically planned when the automatic planning quantity is reached. (Note that automatic planning for a work cell is triggered only when the automatic planning quantity is reached for every work cell. We will assume that automatic planning is set to 1, and that all jobs are planned, as
recommended for CTP.) During automatic planning, the due dates and times of the upstream jobs are recalculated based on the expected receipt date and time of the downstream jobs. The expected receipt date and time are determined from the sequence of those jobs in the schedule.

In previous versions of Dynamics 365 for Operations, the material requirement date and time for all jobs were always set to the beginning of the working day.

For example, in a multi-activity kanban, job 1 is followed by job 2. Job 2 is planned, and the material requirement dates for job 2 are recalculated based on the job’s new expected receipt date and time. Next, the due date and time of job 1 are recalculated based on this material date and time. Job 1 now has an accurate due date and time for automatic planning.

Because of the mechanics of planning, it can’t be guaranteed that a job will be scheduled before its due time. This limitation might be considered a gap. To address this gap, the job must be rescheduled to the previous period if the expected receipt date and time that are calculated after scheduling are after the original due date and time. A solution to must also consider the case where no capacity is available in the previous work cell. Overall, we consider this issue an advanced scheduling issue. We recommend that you use activity constraint times to model the normal buffer times that are required in order to accommodate the effect that we just described. Additionally, we strongly recommend that you minimize the modeling of production flows where many activities have a very tight dependency.

The following illustration shows the scheduling of dependent work cells.
When the jobs are scheduled for work cell 2, the due dates and times for the jobs in work cell 1 are updated by using the following calculation:

\[ \text{Due date and time (job 1)} = \text{Material requirement date and time (job 2)} - \text{Activity constraint time (act 1/act 2)} \]

In the preceding illustration, this calculation is represented by the red arrows.

Based on the resulting due dates and times, the jobs are now scheduled in work cell 1. Depending on the availability of work cell 1, the job might be scheduled late relative to its due date and time. On the Kanban job scheduling list page, and in the job lists in the kanban process and transfer boards, this situation will be shown through a visual warning on the kanban symbol. However, no action that is immediately created or any other system reaction warns the user about the possible conflict. If the delay is more than a day, the next master planning run will create action messages for the jobs, unless the jobs update inventory.

In the following example, we will use the term \textit{unbalanced schedule} for a schedule that contains dependencies that are scheduled too late.

**Example of an unbalanced configuration**

Depending on the configuration of activities, a lack of advanced scheduling cycles that can help mitigate unbalanced scheduling results might cause scheduling conflicts to be created for dependent jobs.

There can be many reasons why the configuration of a production flow or the related supply policies don’t match the required throughput. We have already discussed the importance of setting planning and scheduling fences so that they are in sync with the lead times of the products.
The following illustration shows an example of an unbalanced production flow configuration. It's intended to show how important it is that the activities of a production flow run on a common takt to produce balanced cycle times. Otherwise, the kanban schedule easily fails to deliver balanced results.

In the example, the activity that is run on work cell 1 has a longer cycle time than the activity on work cell 2. Therefore, jobs that are scheduled on work cell 1 will systematically be late to fulfill the demand from work cell 2. The first job in the example might still be on time, because the activity constraint time is long enough. However, the second job will already be late, as will be the third job.

Activities in a production flow that run slower than the required takt require mitigation, such as a parallel alternative activity. These activities might also require longer activity constraint times to buffer the disruptions in the flow that are caused by the different takt times.

**Schedule from date on the Kanban job scheduling list page**

Forward scheduling of kanban jobs that is triggered by delays is based on a basic scheduling function that moves planned kanban jobs to later periods. The Schedule from date function on the **Kanban job scheduling** page also lets you access this basic capability.
The following illustration shows the **Schedule from date** button on the **Kanban job scheduling** page.

The function becomes available after you select one or more jobs on the board. When you click **Schedule from date**, the following dialog box appears.
By default, the Date field is set to the current date. However, you can enter any future date.

![Schedule forward from date](image)

By default, the value in the Capacity shortage reaction field is taken from the production flow model that is associated with the work cell. However, you can select a different reaction.

After you select a new date, the selected jobs are planned to the available capacity, starting from the selected date, as shown in the following illustration.

![Schedule from date function](image)

Note that the jobs will always be added at the end of the planning periods.

Unlike automatic planning, the Schedule from date function lets you schedule jobs beyond the planning fence that is defined in the production flow model.
Edit the activity relations in a production flow

To adjust the end-to-start constraint time or the cycle time ratios of an activity relation, use the Edit function on the activity relations.

To edit activity relations, go to **Production control > Setup > Lean production flows**, select a production flow, select a version, and then open the **Activities** page.

If an existing activity relation is selected, the **Edit** button is available, as shown in the following illustration.

When you click **Edit**, the **Edit activity relation** dialog box appears, as shown in the following illustration. You can use this dialog box to edit the constraint and the cycle time ratio.
Changes that you make to the activity constraint time don’t immediately affect existing jobs. However, the changes are considered when new kanbans are created that have built-in activity dependencies.

- Multi-activity kanbans use the activity constraint time to calculate the time that is required between the material requirement date and time of the parent and the due date and time of the child.
- Kanban line events use the activity constraint time to calculate the time that is required between the material requirement date and time of the parent and the due date and time of the child.

If you change the cycle time ratio, you must run the Recalculate function for the production flow version to recalculate the cycle times of the upstream activities.

**Material date calculation for kanban jobs – Period vs. job base**

The material date calculation is based on the actual job schedule. When a job is sequenced into the schedule, the material date and time are calculated based on the expected receipt date and time of the job.

**Introduction to CTP**

In the first of the five lean principles that were formulated by Womack and Jones, *customer value* is defined as delivering what customers want, when they require it, where they require it. To satisfy this principle, CTP delivery date control was added to Dynamics 365 for Operations.

CTP is a planning philosophy that requires a sophisticated set of planning policies and parameters, because planning isn’t done as a batch process by a planner. Instead, planning is done implicitly at the time of order entry. Therefore, CTP requires that the planning and scheduling provide reliable and reproducible results. All supply and scheduling policies and exceptions must be fully modeled in the solution, and accurate maintenance of the data is critical to the business’s success. It’s just as critical that the user receive an understandable explanation of the scheduling results, especially during the phase where the supply and scheduling policies are configured.

Dynamics 365 for Operations supports CTP by combining the following basic capabilities that are explained in more detail in later sections.

- The dynamic plan:
  - Configuration of the dynamic plan
  - Pegging, marking, and reservation
  - Delays
  - Demand explosion on the dynamic plan
- Delivery date control on sales order entry
- Scheduling trace tool

In brief, CTP is enabled by running the demand explosion for the sales lines and then using the resulting delay to set the confirmed shipment dates.
The dynamic plan

Master planning in Dynamics 365 for Operations is designed to let you use multiple dependent or independent plans to schedule for different purposes. The parameters, horizons, and planning fences for each plan can differ, depending on the plan’s purpose.

Two plans have a special function in Dynamics 365 for Operations:

- **Static plan** – This plan is the primary plan for a legal entity and contains the operative plan. The static plan can be updated in a batch run for regeneration or net change. At the end of a static regeneration run, a net change run helps guarantee that orders that occurred during the regeneration run are picked up.

- **Dynamic plan** – This plan is originally created as a copy of the static plan at the end of master planning. However, the dynamic plan is updated at every update of the actual transactions in the related company. For example, the dynamic plan is updated when sales orders are entered, when inventory or production journals are created or posted, or when kanban jobs are created or reported.

You can use the same plan for the static plan and the dynamic plan, provided that all planning parameters are the same. This capability is enabled by the underlying plan versions. Plan versions enable a plan to be regenerated in a new inactive version while the last active version is still operative and fully visible to the user.

After a new version is fully generated, it will be referenced as the active version. The old version will be deleted.

This model works well for conventional and manual scheduling processes, provided that a production planner is aware of the master planning job. However, this model can cause issues when CTP is used, because sales orders might cause important changes to the dynamic plan, but these changes might not be considered when regeneration of the static plan runs in parallel. Even for the net change run at the end of the static plan, the net change could come to a different delay than the original CTP explosion and cause an action message for the sales order, if actions are active.

Planned orders and firming

Planned orders are the central elements of any plan in Dynamics 365 for Operations. Planned orders can be of four types:

- Planned purchase order
- Planned production order
- Planned transfer order
- Planned kanban

Planned orders are generated by master planning or explosion, based on the supply policies that are configured for the product. Planned orders represent planned supply, and are specific to a plan and plan version.

The planned orders of a plan represent a possible solution to provide supply to the actual demand that is determined by the plan. A planner can modify, delete, or approve the planned orders that master planning generates. Additionally, a planner can add planned orders.
A planned order can be firmed manually, or firming can be triggered by a Firming fence. When a planned order is firmed by either method, an order that corresponds to the order type is created. The original planned order is deleted from the plan and replaced by the firmed order. Here are the corresponding firmed orders:

- Purchase order
- Production order
- Transfer order or transfer journal
- Kanban

These orders are now real transactions that exist independently of a specific plan.

When a plan is regenerated, a new version is created based on the firmed orders and the actual demand. Approved planned orders are also taken over to the new plan version. Therefore, when regeneration occurs, all non-approved planned orders are removed. They might be replaced by new planned orders that are created based on the demand and the supply policies that are effective at the time of regeneration.

This behavior has implications for CTP. The system will try to use a new set of planned orders to cover all calculated confirmed order dates that are based on non-approved planned orders.

It’s a strategic decision whether you will use automatic firming of planned orders when CTP is applied. The Firming fence of a product must be at least the purchase lead time plus the safety margin to help guarantee that ordering doesn’t occur too late. The Firming fence should always be longer than the Freeze fence.

The Freeze fence blocks master planning from creating new planned orders within the fence. When regeneration occurs, only firmed orders and approved planned orders will remain inside the Freeze fence. All other planned supply will be pushed to the future.

**Pegging, marking, and reservation**

Within a plan, supply and demand are pegged according to the supply policies. In a balanced plan, all demand is pegged to some supply, and all supply except fixed quantity kanbans is pegged to demand.

When a plan is re-created, all reservations and markings that represent the firm pegging are transferred to the new plan version as pegging. Demand is then pegged to available supply in the sequence of demand (BOM-level, date/time). If not enough supply is found, new planned orders are created and are pegged to the demand that caused the planned orders to be created.

CTP explosion uses the same mechanism. The new demand from the sales order is pegged against available supply. If no supply is available, new planned orders are created based on the supply policies of the product. These planned orders are pegged to the demand that is derived from the new sales order line. If the requested date can’t be met, the delay is used to calculate a new proposed delivery date for the sales order line.
Delays (previously known as futures dates)

When planned orders are first created, they use the due date and time from the original demand as the requirement date and time.

If the requested date for an order or planned order can’t be met based on the supply policies, the expected delay is calculated. If the plan is set up so that new receipt dates are calculated based on delays, delays are then propagated downstream through the pegging tree and up to the initial sales orders. This functionality is the backbone of the CTP calculation.

The delay calculation is active only if it has been enabled in the coverage group, if a Calculated delays time fence is active. The check boxes on the plan (Add delay to requirement date) should also be selected.

Demand explosion on the dynamic plan

When new sales orders, production orders, or kanbans are created, new demand is injected into the dynamic plan. To account for the effects of this new demand, Dynamics 365 for Operations can run a demand explosion on it. Although this explosion will change the dynamic plan, the changes are limited to the effect that the new demand has on the plan.

Usually, the demand explosion is run manually, unless one of the following conditions is true when sales orders are entered:

- CTP delivery date control is used.
- The Explosion reservation option is enabled.

You can view the result of the demand explosion on the Explosion page, as shown in the following illustration.
With you click **Update**, an update of the explosion is triggered. The following illustration shows the parameters for updating the explosion.

For performance reasons, an automatic explosion run that uses CTP will disable the trace and won’t recalculate BOM levels. Therefore, in an environment where many new products or product variants are introduced every day, or where many engineering changes occur that affect the BOM levels on products that are sold by using CTP, it’s critical that you run the recalculation of BOM levels after the changes are applied. Otherwise, planning results might be incorrect.

**Configuration of the dynamic plan**

The static and dynamic plans must be created as a master plan at **Master planning > Setup > Plans > Master plans**. After the plan is created, you must declare it as a dynamic plan in the company’s Master planning parameters, at **Master planning > Setup > Master planning parameters**.

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![Image of a Dynamics AX interface showing the configuration of a dynamic plan](image-url)
The following illustration shows the configuration of the dynamic plan on the **Master plans** page.

The following discussion will focus on the attributes of the dynamic plan that affect the behavior of CTP.

Be aware that, whenever the dynamic plan is first re-created based on the re-creation of the static plan, the settings of the static plan will be used. The updates that are initiated by the explosion or transaction update in the dynamic plan will then be based on the settings of the dynamic plan.

**General**

The following illustration shows the **General** FastTab of the **Master plans** page.
To be functional on CTP, the dynamic plan must include on-hand inventory and inventory transactions. If resource capacity on production jobs and planned production orders must be considered, you must enable finite capacity. Forecasts and sales quotations aren’t mandatory.

**Override on hand**

By default, when supply is pegged to sales order demand, master planning tries to peg the supply that is closest to the demand. If you place a sales order that has seven days of sales lead time, it might not be pegged against actual on-hand inventory. Instead, it might be pegged to a purchase order that will arrive in three days. The **Override on hand** option and **Consume on-hand inventory** field on the dynamic plan let you control this behavior.

The following illustration shows the options for overriding on-hand inventory in pegging.

If you set **Override on hand** to **Yes**, the **Consume on-hand inventory** field becomes available.

If you set **Consume on-hand inventory** to **Before all other supply**, all demand is pegged to available on-hand inventory before it’s pegged to other supply (supply that is on order). Therefore, the sale of on-hand inventory is always promoted. This setting make sense if customers typically want their shipments as quickly as possible.

If you set **Consume on-hand inventory** to **After all other supply**, the system tries to peg the latest possible supply to demand to minimize excess inventory. We recommend this setting if customers typically place their orders for specific dates in the future, and don’t expect or accept early fulfillment. In this type of scenario, you should also consider setting the positive days to a low value (a maximum of double the inventory lead time).

**Time fences**

Time fences describe the length, in days, of the planning periods for the dynamic plan. They are originally defined in the product supply policies (coverage group and item coverage), but you can override them for the dynamic plan.

The following illustration shows the **Time fences in days** FastTab on the **Master plans** page.
By overriding time fences for a plan, you can limit the performance of order entry when CTP is used. The longer the fences are, the more time sales order entry requires in order to update the plan. However, there is low value to updating a dynamic plan 200 days ahead if the average inventory and sales lead times of the products are only a few days.

On the other hand, it might be a good idea to set a Freeze fence for the dynamic plan if the company has a policy that no production should be injected by new sales order for the current day or the current week.

The Firming fence should be handled as carefully as the Freeze fence. The Firming fence will cause planned orders to be firmed during the explosion of sales demand. Note that, with the exception of event kanbans, no firmed orders are automatically removed or reduced when sales demand is reduced. Therefore, the Firming fence should be used only very deliberately in relation to CTP.

Note that CTP won’t work unless an Explosion fence and a Calculated delays fence cover the required CTP planning period. Again, it’s expected that these fences will originally be defined per coverage group of the product. Therefore, you should not usually have to override the dynamic plan.

**Calculated delays**

The following illustration shows the **Calculated delays** FastTab on the **Master plans** page.

Each of the four planned order types has an **Add the calculated delay to the requirement date** option. Therefore, by setting each option, you can define how the delay in the plan version is interpreted:

- **Yes** – The delay is added to the requirements date. In other words, the delay is accepted, and a new base date is calculated for the planned demand. Because this behavior typically applies when CTP is used in the order creation process, the option should be set to **Yes**. In this case, the planned order won’t have any actions, because according to the new plan, it fulfills its demand on the correct date. Additionally, for production orders, transfer orders, and kanbans, the explosion of dependent demand will now be calculated based on the postponed demand, not the original order date. If the plan for production orders is calculated based on finite capacity, we recommend that you set this option to **Yes** for planned production orders to make sure that materials and pre-production aren’t ordered or staged before the resources are actually available.

- **No** – The original requirement date will remain. If actions are active, the planned order will receive an action to indicate to the planner that the delay should not be accepted. Instead, the planner should negotiate an earlier supply with the supplier. Note that a delay in the plan might be caused by a lead time or other attribute in the supply policies that can be negotiated for a specific case. For CTP, a planner should rarely have to renegotiate the plan after sales order entry if the order taker accepted the date that CTP proposed. For planned purchase orders and planned transfers, delays are usually created based on the lead times. Therefore, you can set this option to **No** if a planner wants to take action based on the related action messages.
Product supply policies that influence CTP

In Dynamics 365 for Operations, master planning relies on a set of supply policies that can be associated with the products. The example in the following illustration shows most of the supply policies for a released product. These supply policies include the coverage group, the default order settings, and the item coverage.

![Image of Dynamics 365 for Operations interface]

Coverage group

The coverage group is used to group products into scheduling categories. It contains the basic set of supply policies that is used in master planning. The coverage group can be associated with three hierarchies:

- **General coverage group** – The default coverage group is defined in the Master planning parameters.
- **Released product** – Each released product can be associated with a coverage group.
- **Item coverage** – On the item coverage, you can override the coverage group for a specific coverage dimension and product.

In the coverage group, the initial fences, the negative days, the action messages, and the Calculated delays time fences are defined. Coverage groups are created and maintained at **Master planning > Setup > Coverage > Coverage group**.

Almost all settings of the coverage group affect CTP. However, there are some mandatory settings that you should consider:

- **Calculate delays** must be selected.
- A Calculated delays time fence must be defined. The Calculated delays fence that you select should be approximately as long as the longest possible lead time that is set for a sales product. Except for that fence, no correction or calculation of a delay should be required, because a product should always be able to be produced. Note that, if you extend the fence to years for security reasons, you will affect performance when you explode larger sets of forecast data.
• When you use CTP with scheduled kanbans, you should define a Firming fence if the work cell capacity should influence the CTP result.

• For products that are covered by event and fixed quantity kanban rules, the Firming fence should be 0 (zero), because these replenishment strategies don’t depend on firming of planned orders by master planning. For scheduled kanbans, the Firming fence is an important instrument. Therefore, we recommend that you have a separate coverage group for products that are covered by scheduled rules, and for kanbans that are covered by fixed quantity or event rules. This approach also makes sense from other perspectives of planning. Typically, products that are replenished by using fixed quantity kanban rules have relatively short inventory lead times. Therefore, you can also set the other planning fences to relatively short horizons. In this way, you effectively reduce scheduling lead times.

**Default order settings**

Default order settings for released products can be defined at the company level, and then overridden or refined at the site level.

Again, the majority of attributes for the default order settings affect the CTP result. These attributes include the default order type, the various lead times, and order quantities. These attributes also let you override the default method for delivery date control. Therefore, you can configure CTP for a specific set of products.

**Item coverage**

On the item coverage, you can override many settings from the coverage group and the default order settings for an item and a specific coverage dimension. The attributes are grouped, and you can override them by group that is affected.

Consider using item coverage only for exceptions, because maintenance can become cumbersome. As a best practice, you should create relevant coverage groups, because you can more effectively scale changes to these groups than specific settings per item.

**Kanban rules**

Kanban rules are the most granular type of supply policies. They are also the only type that goes beyond the coverage dimensions, because kanban rules always go down to the level of the WMS location.

For a detailed introduction to kanban rules, see the Lean manufacturing – Kanban and pull based manufacturing white paper.

In relation to CTP, the behavior of the various replenishment strategies for kanban rules differs, as described in the following sections.
**Event kanbans**

CTP is often related to make-to-order scenarios. Therefore, the event kanban is the obvious match to this requirement. If kanban creation is set to **Automatic** in the event settings of the kanban rule, the kanban is created before the explosion. When automatic planning is turned on for the kanban rule, the kanban jobs are also planned for the periods before the explosion is run.

You should also consider the maximum product quantity that might split demand into multiple kanban, and that might let you distribute a single order over multiple periods. We recommend that you set maximum sales order quantities and maximum product quantities in kanban rules to help prevent the system from being overloaded by incorrect quantity input.

**Scheduled kanbans**

This replenishment strategy should be used in combination with CTP if minimum quantities must be considered during production, and if minimum production quantities are less than minimum sales order quantities. If no minimum quantity is set in the kanban rule, you should consider using an event rule instead.

When you use CTP with the scheduled replenishment strategy, the CTP explosion creates planned kanbans for uncovered demand and runs the initial futures calculation, based on the planned orders. Scheduled kanbans can be created based on these planned kanbans if a Firming fence is active for the product and the requested location. Note that planned kanbans don’t load capacity on the work cell. Therefore, capacity isn’t considered when the first part of the CTP calculation (before the firming) runs.

Again, make sure that an automatic firming quantity is set, so that the work cell capacity is included in the CTP result.

**Fixed quantity kanbans**

This replenishment strategy is used for relatively stable demand or to cover safety stock. When stable demand is covered, the kanban quantity should be in sync with the inventory lead times. Demand that can’t be covered by actual kanbans must create additional planned orders. These planned orders don’t load capacity on the work cell schedule. Therefore, infinite capacity is assumed for those orders.

**Delivery date control on sales order entry**

To help guarantee the accuracy of orders in the order creation process, Dynamics 365 for Operations supports the order taker by providing delivery date control during order entry and order change.

The following delivery date control methods are supported:

- **Sales lead time** – New order lines must be outside the sales lead time.
- **ATP** – Available to promise.
- **ATP and issue margin** – ATP plus issue margin.
- **CTP**
Configuring delivery date control

The default settings for delivery date control are configured on the **Shipments** tab of the **Accounts receivable parameters** page, as shown in the following illustration.

These settings are used to enter default values on sales orders and sales order lines. However, default order settings that are configured for the released products override these settings.
The parameters that are used in delivery date control can be configured per product on the Sales order FastTab of the Default order settings page for the product, as shown in the following illustration.

In this example, there will be no sales lead time when the product is sold, but CTP delivery date control will always be used. Note that, when you use CTP, a sales lead time is still applied to determine the default requested dates during order entry, before delivery date control is run. This behavior might cause unnecessary delays if products are on hand or available in the short term and ready to be shipped. When you use CTP, the inventory lead times, purchase lead times, and issue margins should be used primarily to control the minimum time that is required in order to provide supply that isn’t available. The sales lead time should be used only as a type of default Freeze fence for sales order entry. Eventually, it should be combined with a real Freeze fence in the supply policies. Otherwise, the order taker can manually override the sales lead time by manually updating the requested dates.

Creating sales orders that use delivery date control

When a sales order is created, the initial run of delivery date control, together with the requested ship and receipt dates, is set on the Delivery FastTab in the Create sales order dialog box. For the sake of simplicity, all examples in this white paper have 0 (zero) transport days, so that ship and receipt dates are identical. Note that delivery date control always calculates the ship dates. When the ship dates are changed, the receipt dates are updated. During this update, the transport times that must be applied for the delivery address and delivery mode are considered.
The following illustration shows the shipping details on the **Delivery** FastTab of the **Create sales order** dialog box.

The **Delivery date control** value is taken from the Accounts receivable parameters. The **Requested shipping date** field is preset to the current date plus the default sales lead time that is set up in the Accounts receivable parameters.

Default values for the requested dates are entered on the sales lines when they are created. The following illustration shows the **Delivery** tab for the sales lines.
After a product is selected on a sales line, the settings might be overridden by the default order settings of the product, as shown in the following illustration.

If the site is changed, delivery date control and requested dates might be overridden again, based on the site-specific order settings. When the line is saved, the delivery date control method is run to check the feasibility of the requested ship date.

If the result of the CTP simulation allows for confirmation, the requested ship and receipt dates are entered as the confirmed ship and receipt dates, as shown in the following illustration.
If the requested date can’t be met, the **Available ship and receipt dates** dialog box appears. This dialog box lists the possible delivery dates, as shown in the following illustration.

The user can now click a button to take appropriate action:

- **Disable dlv. date control** – Ignore the warning, and update the delivery date control method of the sales line to **None**. No confirmed date will be calculated or changed. Note that any changes that the CTP simulation has applied to the dynamic plan will **not** be reverted if you disable delivery date control now. In particular, note that planned orders might have been firmed.

- **Update confirmed ship date** – This actual is the usual action when the customer agrees to a later date. In this case, both dates (the original requested date and the confirmed date) are accurately documented, and can be used for statistical process control and KPIs.

- **Update requested ship date** – This action is an unusual action to take during order entry. Use this button when the customer agrees to a later delivery date, and also agrees to make this date his or her own date. In this case, if an earlier shipment becomes possible later, the information about the original customer date is lost.

- **Cancel** – Ignore the result, and leave the original requested dates and the original delivery date control method on the sales order line. If you try to change or save the line again, the same delivery date control will be run, and the **Available ship and receipt dates** dialog box will appear again, unless the planning issue isn’t resolved. Note that, if you cancel the result, any changes that the CTP simulation has applied to the dynamic plan will **not** be reverted.
After the order line is created, the order taker can change the delivery date control method on the **Delivery** tab of the sales line, as shown in the following illustration.

Delivery date control is run again, and if the requested date still can’t be met, the **Available ship and receipt dates** dialog box appears again, as shown in the following illustration.

Notice that the dialog box shows the actual requested and confirmed ship dates. Once again, the user can take appropriate action as required.
**Explosion form and explanation**

The delivery date control dialog box shows the possible delivery dates and the resulting lead time. However, this information doesn’t give the order taker any hint about why a specific date is suggested. To analyze the result of the CTP simulation in detail, you should use the **Explosion** page. To open this page, for a sales line, click **Product and supply > Requirements > Explosion**. The following illustration shows the **Explosion** page.

![Explosion page](image)

Note that the confirmed ship date is used as the requirement date for the calculation.
You can rerun the explosion to validate that the result is up to date. For example, in the following illustration, the explosion has been updated so that a trace is used.

You should rerun the explosion in the following situations:

- You require a more detailed explanation. In this case, use a trace when you rerun the explosion.
- The BOM levels aren’t calculated correctly, and dependent demand isn’t shown in the explosion. (Unfortunately, this situation usually causes a date that is better than expected. Therefore, the order taker might not be aware of the issue.)
- Marking and reservations should be reconsidered.
When a trace is enabled, the **Explanation** tab of the **Explosion** page contains a detailed log of the last explosion process, as shown in the following illustration.

```
  Coverage planning
      nat1
          Issue must be covered: Type=Sales order. Dimension=[Site 2, Warehouse 24]. Requirement date=06/20/2016 00:00:00. Quantity=-2
          Receipt found: Type=On-hand. Dimension=[Site 2, Warehouse 24]. Requirement date=01/01/1900 00:00:00. Quantity=1000. Uncovered quantity=1000
          Issue pegged to receipt: Quantity=2. Remaining issue quantity=0
    Delays
      nat1
          Setting delayed date for issue 000784 based on receipt
          Initial receipt delayed date=06/20/2016 00:00:00
          Delayed date for receipt 06/20/2016 00:00:00 less than already set delayed date 05/20/2016 00:00:00 so no change applied
  Action message
      nat1
          Calculating action quantity and days for receipt: Reference=, Type=On-hand. Dimension=[Site 2, Warehouse 24]
          Initial uncovered receipt quantity=-998
          Adding action quantity=0 and settings days based on delayed date 06/20/2016 00:00:00 from issue 000784. Action days=0, quantity=-998
          Action quantity -998 but the settings do not allow action increase/decrease. changing to zero
```


**Safety stock vs. fixed quantity kanban**

In master planning, all demand is pegged to available supply. This rule also applies to demand that is created to refill safety stock and demand that is based on a forecast.

In a CTP environment, it’s expected that actual demand that is based on sales orders will have priority over demand that is created to refill safety stock or demand that is based on a forecast. However, in Dynamics 365 for Operations, this priority isn’t considered.
Therefore, when you use CTP, we recommend that you not define minimum stock in the item coverage rules. Instead, use fixed quantity kanbans to model safety stock. The following illustration shows a side-by-side comparison of safety stock and fixed quantity kanbans.

![Safety Stock and Fixed Kanbans](image)

Both methods use the same strategy to calculate the safety stock levels, based on historical and future demand:

- Minimum stock levels can be recalculated through the safety stock calculation “journal.”
- Fixed quantity kanban rules can be recalculated through the kanban quantity calculation.

There are two major differences between these methods:

- When you use fixed quantity kanbans, the replenishment of safety stock is usually synchronized with the bin quantities of the products in the supermarket. Refills are triggered by the empty kanban signal that is usually done manually when a bin is emptied. Therefore, the reorder process can be split into small portions. Keep the lean principles in mind, and try to model the smallest possible bin sizes. (The bin sizes are defined through the product quantity in the kanban rule.) Depending on the replenishment lead times, for a safety stock of 150 you should define three kanbans of 50 or six kanbans of 25 instead of one kanban of 150. The replenishment of safety stock is triggered.
- The demand for fixed quantity kanbans isn’t represented by an issue transaction in the plan, but only by the kanban rule. Therefore, the receipt transactions of the fixed quantity kanbans aren’t pegged to a demand of the “safety stock” type. Unless an actual demand occurs, the fixed quantity kanban receipts aren’t pegged and can be used to cover demand from CTP orders.

**The importance of sales lead times for better CTP results**

Typically, for a make-to-order scenario, it’s assumed that some activities must be completed before a sales order can be shipped. For these activities, CTP is based on the availability of material and resources. Therefore, it should be clear that a make-to-order product can be shipped on the day of order entry only in very lean organizations. Many lean organizations define an average sales lead time that is targeted to 99 percent on-time delivery. That sales lead time can be a week or, in mature organizations, one or two days.

Therefore, when order lines are entered, CTP delivery date control always applies the sales lead time to the requested date before the actual CTP calculation occurs.
To help guarantee the quality of the plan, we recommend that you introduce and maintain sales lead times to prevent orders from being taken and promised too early. From a performance perspective, the fewer delays that are calculated in the upstream process, the faster the calculation will be. This statement is especially true when you use event kanbans, because you will have to cancel and replan delayed jobs to apply the delays.

For example, product P has two components, A and B. Product P has a sales lead time of one day when it’s sold. Component A is available on hand, and is pegged to the planned order for product P through a kanban or production order. Component B is missing, and a new planned purchase order is created that has a lead time of four days. Therefore, the planned order for product P has a delay of four days. The pegging to component A was created on the assumption of a delivery date in one day. This pegging still remains, even if the new due date enables component A to be used from a supply that might occur four days later.

**Running delivery date control for all lines of a sales order**

To minimize the cost of logistics and material handling, many customers want all items of a sales order to be shipped together on a single date. To help you calculate the first possible delivery date for all lines of a sales order, Dynamics 365 for Operations provides a new Confirmed delivery dates function. The button for this function is located on the **Sell** tab of the Action Pane on the sales order page, as shown in the following illustration.
When you click **Confirmed delivery dates**, a dialog box appears, where you can select the parameters for the calculation and define which calculation results should update the sales order lines. The following illustration shows the **Calculate confirmed delivery dates** dialog box.

This calculation doesn’t open a selection dialog box for every line that is calculated. However, it updates any sales lines that are within the period that is specified by the **Latest confirmed ship date accepted** field. CTP results that are outside that period won’t update the sales order lines. Instead, the result is shown in the Infolog for the job.

You can override the delivery date control method that was selected for this calculation during order entry. In fact, we recommend that you not do an initial CTP run for all sales lines during order entry. Instead, you should set the delivery date control method to **None** or **Sales lead time** when order entry is done. Then, after all sales lines are created, run the calculation by using CTP delivery date control. If you want to rerun CTP on any order change after the calculation, set the **Update delivery date control** option to **Yes**. The new delivery date control method is then updated for all calculated sales lines. In this way, you help guarantee that changes to the sales lines will cause CTP to check the sales lines again.

If **Allow multiple deliveries** is set to **Yes**, every sales line is calculated individually to its best delivery date. If this option is set to **No**, the best delivery date for all sales line is determined, and this date is then assumed for all sales lines.
If **Update confirmed dates** is set to **Yes** for the sales order, the sales order header is updated with the best possible confirmed delivery date for all lines. This option is usually used when **Allow multiple deliveries** is set to **No** and only one delivery date is determined.

If **Update confirmed dates** is set to **Yes** for the sales lines, the sales lines are updated with the new confirmed delivery date if the calculated date is equal to or before the **Latest confirmed ship date** value, and if the sales line doesn’t have confirmed ship and receipt dates. If the lines already have confirmed dates that have been entered manually or by a previous run of delivery date control, you can allow or prevent overrides of these confirmed dates by using the **Allow overwriting of confirmed dates** option.

After you run the calculation, one or more messages explain the actions that were taken on the affected order lines. To open the Infolog, click the **Message details** link in the calculation message that appears after the calculation is completed. The following illustration shows the Infolog that contains a detailed report of confirmed delivery date calculation.

If all the update options are set to **No**, you can use the **Confirmed delivery dates** function to simulate a delivery date control calculation without doing any updates. In this case, you just produce the message details about the dates that can be confirmed for each order line. Note that, when you use CTP and allow automatic firming of planned orders, this simulation might create firm orders if the receipt date of a planned order is within the Firming fence. As we mentioned in earlier sections, you should be careful when you use the Firming fences in relation to CTP. Additionally, you should set **Action fences** that are at least as long as the Firming fences to capture the reduction or delete actions that the planner performs on firmed orders. CTP and event kanbans.

**Combining CTP delivery date control with kanban supply**

Companies that want to remain competitive in an agile market require a lean transformation process that helps them deliver products that are assembled to order/built to order (and often also configured to order) within a short and predictable lead time.
At the time of order entry, the CTP functionality gives order takers accurate information about the availability of the products, material, and resources that will satisfy a specific customer demand.

CTP delivery date control helps by verifying the requested ship date on a sales line. It might also update the confirmed ship date on the sales line.

To enable this functionality, we extended the existing delivery date control by adding a CTP option that triggers a master planning explosion. The returned delay is then used as the suggested ship date. This functionality works best if there are short Firming fences on all planned order types.

**Planned orders of the Kanban order type**

In Dynamics 365 for Operations, planned kanban orders don’t have information about the available capacity of the work cell. Therefore, CTP calculations that are done by using planned orders of the Kanban type won’t be based on finite resource availability, even if enough resources are available in the work cells.

**Using scheduled kanbans together with CTP**

When you use scheduled kanbans, you must consider a couple of points in relation to CTP:

- When you use scheduled kanbans together with automatic firming, it’s essential that no forecast be included in the dynamic plan. Otherwise, the forecast could create planned orders and be firmed.
- After the scheduled kanban is firmed, and the sales line is changed or deleted, the demand in the plan must be manually corrected based on the action messages from Master planning. If the customer date is changed, a new delay can’t be applied to the existing kanbans. Otherwise, new scheduled kanbans could be created and firmed, even though the originals aren’t removed.

**Using fixed quantity kanbans together with CTP**

When you use fixed quantity kanbans together with CTP, it’s essential that the kanban quantities be well calculated. Additionally, the kanbans must always be able to be supplied within the inventory lead time. Be aware that, even if kanbans have no scheduled jobs, it’s assumed that they will be supplied on their due date and time at the latest. Therefore, all lead times in the default order settings and item coverage, and the replenishment lead times of the kanban rules, must be well maintained and continuously validated.

**Combining CTP with event kanbans**

When you combine CTP with sales and kanban line event kanbans, all event kanbans are created before the explosion. If a delay is calculated for a kanban job, the job is rescheduled the initial creation and CTP explosion.
Scenario

The following illustration shows the activities and products for this scenario.

Product A is built from product B. Sales event kanbans use activity 2 to produce product B to order. Activity 2 applies CTP delivery date control.

Product B is built from product C. Kanban line even kanbans use activity 1 to produce product B to order.

When product C is purchased, it has a lead time of 10 days.
On February 1, 2013, Susan, the sales order taker, creates a sales order. The customer wants a receipt date of February 5, 2013 (5.2.2013). The default order settings for product A enter the correct warehouse and CTP delivery date control in the sales order. When Susan saves the line, the CTP process starts by creating the event kanbans, as shown in the following illustration.

During kanban creation, the activities are automatically planned based on the automatic planning quantity of 1 in the kanban rules. The job for activity 2 is planned first and gets a scheduled date of February 5, 2013 (5.2.2013). The estimated receipt date is set, and the estimated receipt time is calculated based on the sequence of the job in the schedule.

The due date and time of the job for activity 1 are updated based on the expected receipt date and time of the job for activity 2.

The job for activity is then planned based on this new date and time. When the job is planned, the estimated receipt date and time are calculated, and the material requirement dates of the job are updated based on this expected date and time.
The explosion is started, runs down the pegging tree, and finally creates a planned purchase order, as shown in the following illustration.

The explosion uses the dates and, eventually, the times that are registered in the inventory transactions of the jobs. Note that the explosion uses only these transactions, not the original data of the jobs or the kanban schedule. Therefore, small deviances might occur between the kanban schedule and the master planning result, especially because the time isn’t stamped on the transaction for all transaction types.

If activity 1 is configured so that **Update on-hand** is set to **No**, the event chain will be broken for CTP, and the explosion won’t calculate down to the material.

Based on the purchase lead time of 10 days, the purchase order gets a futures date and delivery date of February 15, 2013 (15.2.2013). Because the **Use delay as requirement date** flag is set in the plan configuration, the requirement date is set to February 15, 2013 (15.2.2013). Therefore, no action is created.
The delay of the planned purchase order is handed up to the first kanban job. The following illustration shows the update of kanban job 1.

**Phase 3:** Explosion is running
The Job for Activity 1 is delayed to 18.2.2013
Consequence: It is unplanned and planned again for 18.02.2013

When the delay is applied to the kanban, the job is rescheduled by the Schedule from date function. The delay, February 18, 2013 (18.2.2013), is used as a parameter. After rescheduling is completed, the estimated receipt date of job 1 is recalculated.

The new estimated receipt date of job 1 is handed up to the second job, and the job is rescheduled accordingly. The following illustration shows the update of kanban job 2.

**Phase 4:** Explosion is running
The Job for Activity 2 is delayed to 19.2.2013
Consequence: It is unplanned and planned again for 18.02.2013
When the delay is applied to the kanban, the job is rescheduled by the Schedule from date function. The delayed date, February 19, 2013 (19.2.2013), is used as a parameter.

Finally, the sales order is updated. The following illustration shows the update of the sales order line.

Based on the calculated delay, the first possible delivery date is calculated as February 19, 2013 (19.2.2013), and the delivery date control dialog box appears. The line for 19.2.2013 (the first possible delivery date) is selected, and the user can confirm this selection by clicking **Update confirmed ship date**. The confirmed ship date is set to February 19, 2013 (19.2.2013), and the confirmed receipt date is calculated by adding the expected transport time, which is based on the delivery addresses and the mode of delivery.

**Limitations for CTP and kanban job scheduling**

In this last section, we will highlight a set of limitations that you must consider when you implement a business strategy that uses CTP planning together with Dynamics 365 for Operations. Some of these limitations might be covered by solutions from independent software vendors (ISVs). We hope to address these topics in future releases, and we welcome feedback about the relevance and priority of the related scenarios.

**Transfer jobs can’t be scheduled**

In Dynamics 365 for Operations, kanban transfer jobs and transfer orders aren’t related to a resource and capability model. If there is no transport resource context, scheduling relies mainly on the due dates. In the actual implementation, the due date and time of a transfer job indicate the schedule of that job.
Forecast and safety stock pegging blocks available supply

In master planning, all demand is pegged to available supply. This statement is also true for demand that is created to refill safety stock and demand that is based on a forecast.

In a CTP environment, it’s expected that actual demand that is based on sales orders will have priority over demand that is created to refill safety stock. This priority was introduced in the Fall 2016 release of Dynamics 365 for Operations. The demand for safety stock is now pegged after all other demand. However, depending on the setting of negative days and minimum order quantities, safety stock might be refilled only when the next ordered or forecasted demand is due.

To prevent forecasted demand from blocking supply in CTP, we recommend that you run the dynamic plan without a forecast, as a separate plan that uses a shorter horizon than the static plan. You should adjust the Action fence of the dynamic plan to avoid, or at least minimize, the creation of action messages for supply that was created for forecasted demand. (See also the Finite resources and planned order horizon section.)

When you use CTP, we recommend that you not define minimum stock. Instead, use fixed quantity kanbans to model safety stock. For details, see the Safety stock vs. fixed quantity kanban section.

Intercompany CTP

When intercompany planning is activated, the explosion of demand includes information about planned orders that might be supplied from another company. However, the dynamic plan of the supplying companies isn’t updated during the explosion. Therefore, although CTP considers planned and ordered supply from intercompany suppliers, it can’t explode and update through multiple levels of the supply chain at the time of order entry.

In the Fall 2016 release, new intercompany ATP functionality was introduced. The order taker can now decide whether to use a specific source of supply for a sales order line. The available sources of supply include sources in other legal entities. If the requested item is planned by using CTP in the sourcing company, an intercompany CTP scenario can be modeled. In that case, note that the update of the dynamic plan persists even if the order taker decides to use a different source of supply.

Rescheduling kanbans on repeated CTP explosion

Automatic rescheduling of kanban jobs on explosion occurs only at order entry, not when any change or manual explosion occurs that might require a new plan that is based on material shortage. To implement a permanent update, you require a new policy that enables CTP to overrule any manual planning. You should consider this scenario for all order types. (See the next section.)

Rescheduling other firm orders on CTP explosion

The only firm order that can be rescheduled by a delay is the event kanban or a scheduled kanban. All other order types (production order, transfer order, or fixed quantity kanban) remain at the actual scheduled date. This behavior might prevent eventual material shortage on these firm orders from creating a delay for the sales order itself. Therefore, the order taker might not become aware of the shortage.
To mitigate this issue, you should firm orders at the latest possible time. Actions should be activated, and the planners must react in short terms to the material shortage on firmed orders.

Quality of the dynamic plan

One big issue when CTP is used is the fact that the dynamic plan isn’t consistently updated on all types of demand or supply changes. In particular, changes in supply, such as deletions of a transfer order, under-reporting of a production order, or overconsumption of material, aren’t immediately reflected in the dynamic plan. Currently, daily regeneration of the dynamic plan is required when CTP is used, if substantial changes in supply occur daily. As an alternative, we recommend manual updates of the plan after important updates are done on supply.

Finite resources and planned order horizon

When you use finite resources for production orders or batch orders in combination with CTP, we recommend that you exclude forecasts from the dynamic plan. In this way, you help guarantee the availability of resources when new orders are entered. When you run a regeneration with finite resources on a master plan, resources might be allocated to planned orders that are created from forecast demand. This allocation will prevent CTP from allocating the resources for planned orders that are based on sales order entry that uses CTP. Therefore, we recommend that you configure the dynamic plan that don’t include forecasts when you use CTP with heavy aspect of finite resources.

As an added benefit, regeneration of the dynamic plan will be much faster when forecasts aren’t used. Therefore, you must periodically run regeneration of the static plan for procurement planning. A dynamic plan that doesn’t have forecasts should be used only for supply of the pull-to-order type, not for replenishment planning.

Note that this restriction doesn’t apply to the use of kanbans. Planned kanbans in master planning have no impact on finite resources, because they aren’t booked against the work cell schedule.

Conclusion

The combination of CTP and event kanbans provides even stronger support for build-to-order scenarios in Dynamics 365 for Operations.

An obvious downside of using CTP in combination with a Firming fence is that, if orders are changed or sales orders are canceled, the orders that were created during the CTP process require manual revision. Although the Actions framework supports these manual revisions, there is risk of overproduction or purchase of excess inventory. By using event kanbans that are instantly adjusted to the order changes, you mitigate that risk. Therefore, you provide an improved solution to deliver what the customer requires when he or she requires it with keeping overall stock levels low.

In the Fall 2016 release, the treatment of safety stock in combination with CTP is improved. Additionally, now that the intercompany ATP functionality has been introduced, the use of CTP in the supplying company can add more value.

However, some scenarios that are related to CTP will still require future improvement before CTP can be more universally used.
Additionally, it should now be obvious that, to implement CTP in a way that accurately supports business processes you must do more than just switch the default delivery date control method to CTP. The business processes and related supply policies must be aligned, and the scenarios should be well tested. Change management must be extended to help guarantee that new products and engineering changes include the configuration and periodic update of the supply policies. A successful process depends on the use of KPIs about on-time delivery and on mature management of action messages.

Successful use of CTP (for example, order entry) depends on the quality of master data, such as lead times, Firming fences, default order settings, and all other supply policies.

Finally, be aware that manual exceptions and management decisions to overrule the policies might prevent a successful implementation of CTP. If the plan that is created (the confirmed order date) isn’t frozen at order entry for most sales order lines (after consideration of the usual influencing factors) CTP might not be the right solution, because it simulates a precision that the organization can’t fulfill.
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