# Capacity Planning (PP-CRP)

**Release 4.6C**

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# Icons

| Icon | Meaning |
|------|---------|
| | Caution |
| | Example |
| | Note |
| | Recommendation |
| | Syntax |

# Contents

# Capacity Planning (PP-CRP)

## Purpose

The economic use of resources is an objective for many areas of a company. The component "Capacity Planning" is available in the R/3 System for this purpose.

Capacity planning supports planning in all its phases:

- long-term rough-cut planning
- medium-term planning
- short-term detailed planning

## Integration

Capacity planning is integrated in the following applications:

- Sales and Distribution (SD)
- Production Planning and Control (PP)
- Sales & Operations Planning (PP-SOP)
- Requirements Planning (Master Production Scheduling and Material Requirements Planning PP-MRP/MPS)
- Long-term Planning (PP-LTP)
- Shop Floor Control (PP - SFC)
- Repetitive Manufacturing (PP-REM)
- Process Industries (PP-PI)
- Plant Maintenance (PM) and Service Management (SM)
- Project System (PS)

Capacity planning can be flexibly adjusted to planning demands and to the area of responsibility within the company.

## Features

Capacity planning comprises the following partial components:

- **Capacity evaluation**

  In the capacity evaluation, available capacity and capacity requirements are determined and compared with each other in lists or graphics.

- **Capacity leveling**

  The objectives of capacity leveling are:

– 　　　　Optimal capacity commitment

– 　　　　Selection of appropriate resources

**Capacity Planning (PP-CRP)**

In most applications, you can use two types of planning table (graphical and tabular versions) to display the capacity situation and to carry out capacity leveling.

In some applications such as Repetitive Manufacturing (PP-REM) or Sales and Operations Planning (PP-SOP), there are application-specific planning tables for capacity leveling.

# Calling up the Area Menu for Capacity Planning

## Procedure

In the R/3 area menu choose *Logistics* → *Production* → *Capacity planning*

## Result

You branch to the area menu of capacity planning.

- You can use the menu option **Evaluation** to call up capacity evaluations and the shop floor information system.

- You can use the **Leveling** menu option to branch to capacity leveling for various applications and from various views.

- You can use this menu option to maintain the capacity, shift sequence, shift definition and factory calendar.

- You can use this menu option to maintain the following pegged requirements: production orders, maintenance orders, networks and planned orders.

- With the menu option **Environment** you can maintain work centers, capacities and hierarchies, and access the current stock/requirements list for MRP and MPS.

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# Available Capacity

You can store the operating time and the daily available capacity at a work center in a capacity in the work center. You identify a capacity at the work center using the capacity category. Various capacity categories can be assigned to the work center, for example, a machine capacity or a labor capacity, but each capacity category can only be assigned once.

You can maintain the available capacity of a capacity at the work center or in a capacity that is independent of any work center.

For every capacity in the work center, you can maintain a standard available capacity [Ext.] and several versions of available capacity [Ext.] . The standard available capacity has unrestricted temporal validity.

You can specify available capacities that change over time in the versions of available capacity. You can use any units of measure and intervals of available capacity [Ext.]

The available capacity (see figure below) is determined by:

- Work start and work finish

- Length of breaks

- Rate of capacity utilization

- Number of individual capacities which the capacity consists of
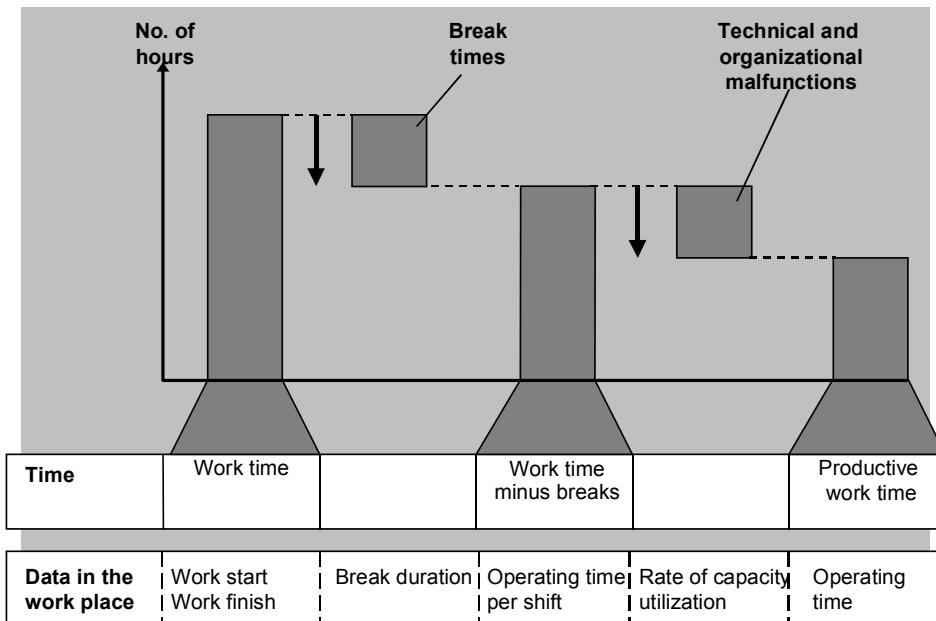


You can simplify the maintenance of available capacities by using shift definitions and shift sequences [Ext.] .

To define the available capacity, you must maintain the following data in the capacity header:

- The grouping, that defines which shift sequences and shift definitions can be used to maintain the available capacity

- The number of the active version of available capacity

- The base unit of measure of the available capacity

- The factory calendar, that is the basis of the available capacity

    If you do not enter a factory calendar, the system uses the default calendar for the plant.

You can find a more detailed description of the maintenance of capacity categories and available capacities in the documentation *PP - Work centers*.

## Which Available Capacity is used in Capacity Planning?

In Customizing for *Capacity planning,* you can specify which version of available capacity should be used for the capacities at the work center. You can make this specification:

- in the selection profile for capacity evaluation

- in the selection profile for capacity leveling

If you do not specify a version of available capacity in these profiles, the version of available capacity is used that is specified as active in the capacity header. If none of the versions of available capacity is marked as active, the system uses the standard available capacity.

## Cumulating Available Capacities

You can cumulate available capacities to a hierarchy work center using work center hierarchies.

To do this, read Cumulating Available Capacities and Capacity Requirements [Page 20]

# Capacity Requirements

Orders generate capacity requirements and thus a load on the resources that are to process them. The following types of orders are relevant:

- Production orders in Shop Floor Control (SFC)

- Process orders in the Process Industries (PP-PI)

- Planned orders in

− Material Requirements Planning (MRP)

− Master Production Scheduling (PP-MPS)

− Long-term Planning (PP-LTP)

− Repetitive Manufacturing (PP-REM)

− Sales and Operations Planning (PP-SOP) for quantities in rough-cut planning

- Maintenance orders in Plant Maintenance (PM)

- Networks in the Project System (PS)

- Sales orders, assembly orders or networks in Sales and Distribution (SD)

Calculating the capacity requirements of an operation for manufacturing a material takes place in scheduling using formulas from the work center. For this, you must enter a formula to calculate the capacity requirements of the operations for each of the three operation segments setup, processing and teardown on the screen *Capacity overview* in work center maintenance. Operations in networks, maintenance orders and process orders are not subdivided into operation segments. Here you specify a formula for the whole operation. If you fail to enter one of the formulas, no capacity requirements are calculated for the relevant operation segment or operation.

The formulas which you can maintain in Customizing contain formula parameters. These can be, for example, standard values from the operation, work center constants or values for production resources/tools (see the figure below).

```
┌─────────────────────────┐          ┌─────────────────────────┐
│      Work center        │          │       Operation         │
├─────────────────────────┤          ├─────────────────────────┤
│  ▣ Formula key          │          │  ▣ Standard values      │
│  ▣ Formula constants    │          │      Setup time         │
│                         │          │      Processing time    │
│                         │          │      Teardown time      │
│                         │          │                         │
│                         │          │  ▣ No. of splittings    │
│                         │          │      . . .              │
└─────────────────────────┘          └─────────────────────────┘
```

**Formulas**

**Setup**     **Processing**     **Tearing down**

**Capacity requirements**
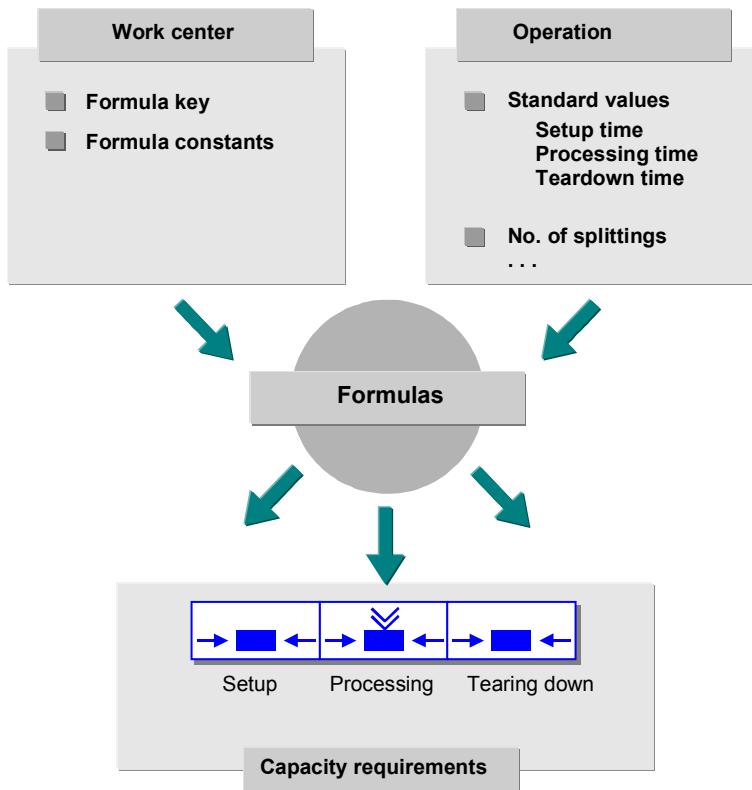
If you use formulas with parameters that refer to standard values, you must enter the standard values of individual operations either in the routing or in the order. For example, if the formula for the operation segment "processing" contains the machine time as a parameter, you must enter the machine time for the quantity in the base unit of measure. In this case as well the system can only calculate capacity requirements if values exist for the various formula parameters.

In capacity planning, you only see the total requirements for an operation for operations with operation segments, not the capacity requirements of individual operation segments.

You can find more information on formulas in the documentation *PP - Work Centers*.

# Distribution of Capacity Requirements

## Use

You use a distribution to specify how the system distributes the capacity requirements of an operation that extends over several days; that is, how much capacity requirement is allocated to the affected capacity type in the work center on each of the days.

You use the distribution for setting capacity requirements *according to periods*, for example:

- In the capacity evaluation

- In the extended evaluation

- In the planning table for capacity leveling

- In repetitive manufacturing (REM)

- In sales and operations planning (SOP)

Here, the relevant information for capacity requirements is per period. The system determines the daily capacity requirement using the distribution and cumulates this periodically to the capacity requirements in the periods.

> Lead time scheduling can determine operation dates, operation duration and capacity requirements for the operations in an order. It does not determine a distribution for the capacity requirements. In the planning table with a continuous display, the system assumes that the capacity requirement of each operation is distributed evenly over the working time of the affected capacity type in the work center. In the case of the applications with capacity requirements displayed over periods, you must define the distribution of the capacity requirements explicitly.

## Features

A distribution is described by a distribution function and a distribution strategy.

### Distribution function

You define the distribution function using basic values. The basic values specify after what percentage of operating time a particular percentage of the capacity requirement for the operation is loaded to the affected capacity type. The system-internal default basic value for a distribution function defines that after 0% of operating time, 0% of the capacity requirements are loaded.

### Distribution strategy

You use the distribution strategy to specify:

- Whether the system is to distribute the capacity requirements between the earliest or the latest start and finish dates of an operation

- Whether the distribution of the capacity requirements is to be discrete or continuous

  The difference in capacity requirements between two basic values of a distribution function that immediately follow one another defines a partial capacity requirement that can be discretely or continuously distributed:

– In the case of the **discrete distribution**, the later basic value defines the day on which the partial capacity requirement is loaded.

– In the case of the **continuous distribution**, the partial capacity requirement is distributed over the days between the two basic values.

- Whether the distribution is based on the Gregorian calendar, the factory calendar or the operating time of the affected capacity type

Based on the distribution function and the distribution strategy, the system determines the operating time that is relevant for the distribution and the dates on which the basic values for the distribution function fall.

### Distribution based on the Gregorian calendar

Here, all the days onto which the operation extends are relevant for the distribution of the capacity requirements, including the days on which the operation starts and finishes. In the case of continuous distribution, the system distributes the partial capacity requirement, which has to be loaded between two basic values, evenly over *all* the days that lie between the basic values. In the case of discrete distribution, the system loads the partial capacity requirement on the day on which the later basic value falls.

An operation extends over 10 days. You defined for the first basic value of the distribution function that after 50% of the operating time, 50% of the capacity requirement should be loaded.

Therefore, using the distribution based on the Gregorian calendar, 50% of the capacity requirements must be loaded after 5 days. In the case of continuous distribution, the system distributes this partial capacity requirement evenly over the 5 days, that is, 10% of the total capacity requirement is loaded on each day. In the case of discrete distribution, the system loads the partial capacity requirement on the fifth day.

### Distribution based on the factory calendar

Here, only those working days onto which the operation extends are relevant for the distribution of the capacity requirements, including the working days on which the operation starts or finishes. In the case of continuous distribution, the system distributes the partial capacity requirement, which has to be loaded between two basic values, evenly over *all the working days* that lie between the basic values. In the case of discrete distribution, the partial capacity requirement is loaded on the day on which the later basic value falls.

An operation extends over 10 days. According to the factory calendar, there are 2 non-working days during this time. You defined for the first basic value of the distribution function that after 50% of the operating time, 50% of the capacity requirement should be loaded.

Therefore, using the distribution based on the factory calendar, 50% of the capacity requirements must be loaded after 4 *working days*. In the case of continuous distribution, the system distributes this partial capacity requirement evenly over these 4 working days, that is, 12,5% of the total capacity requirement is loaded on each working day. In the case of discrete distribution, the system loads the partial capacity requirement on the fourth working day.

**Distribution of Capacity Requirements**

**Distribution based on the operating time of the capacity category.**

Here the daily operating times of the affected capacity category are relevant for the distribution of capacity requirement. In the case of continuous distribution, the system distributes the partial capacity requirement, which has to be loaded between two basic values, over the working days that lie between the basic values, proportional to the *daily operating time* of the capacity category. The discrete distribution is not relevant for the distribution based on the operating time.

> The operation duration determined during lead time scheduling is 80 hours. The affected capacity category has a daily operating time of 8 hours. On the start date, the operation is processed in 2 hours of operating time. The operation finishes on the eleventh day, after 6 hours of operating time. You defined for the first basic value of the distribution function that after 50% of the operating time, 50% of the capacity requirement should be loaded.
>
> Therefore, with a distribution on the basis of the operating time, 50% of the capacity requirements must be loaded after 40 hours of operating time, that is, on the sixth working day after 6 hours of operating time. On the first working day, the system loads 2.5% of the capacity requirement; and 10% on each day from the second to the fifth working day. On the sixth working day, 7.5% are loaded, plus a proportion that comes from the next basic value of the distribution.

# Activities

You define distributions, for example, in Customizing for *Capacity Planning* by choosing *Operations → Capacity requirements*. They are identified using distribution keys.

You enter distribution keys:

- In the options profile [Ext.] for the capacity evaluation

- In the evaluation profile [Ext.] for capacity leveling and the extended evaluation

You can also specify in the profiles that the system uses the distribution key that you enter in the capacities for the work center or in the operations/activities in networks, maintenance orders and process orders.

If you do not specify a distribution key, the system uses the distribution key SAP000. With this distribution key, all of the capacity requirements for an operation are loaded on the start day for the operation.

During the capacity evaluation, you can specify by choosing *Settings → General* that the distribution keys are to be taken from the capacities or from the operations/activities in networks, process orders and maintenance orders.

# Continuous and Discrete Distribution

The distribution of capacity requirements for an operation that extends over several periods is carried out on the basis of a distribution function. Based on this distribution function, the capacity requirements can be distributed continuously or discretely over the periods [Page 14].

The following table shows the basis values of a distribution function. The basic values specify after what percentage of the operating time a particular percentage of the total capacity requirements have to be loaded.

| Operation duration (%) | Cumulated loaded capacity requirements (%) |
|---|---|
| 0 | 0 |
| 10 | 10 |
| 30 | 20 |
| 60 | 40 |
| 80 | 70 |
| 100 | 100 |

**Basic values of the distribution function**

The following graphic shows how the capacity requirements are distributed over the operating time of 10 periods using the distribution function.

## Continuous and Discrete Distribution

**Discrete and Continuous Distribution**
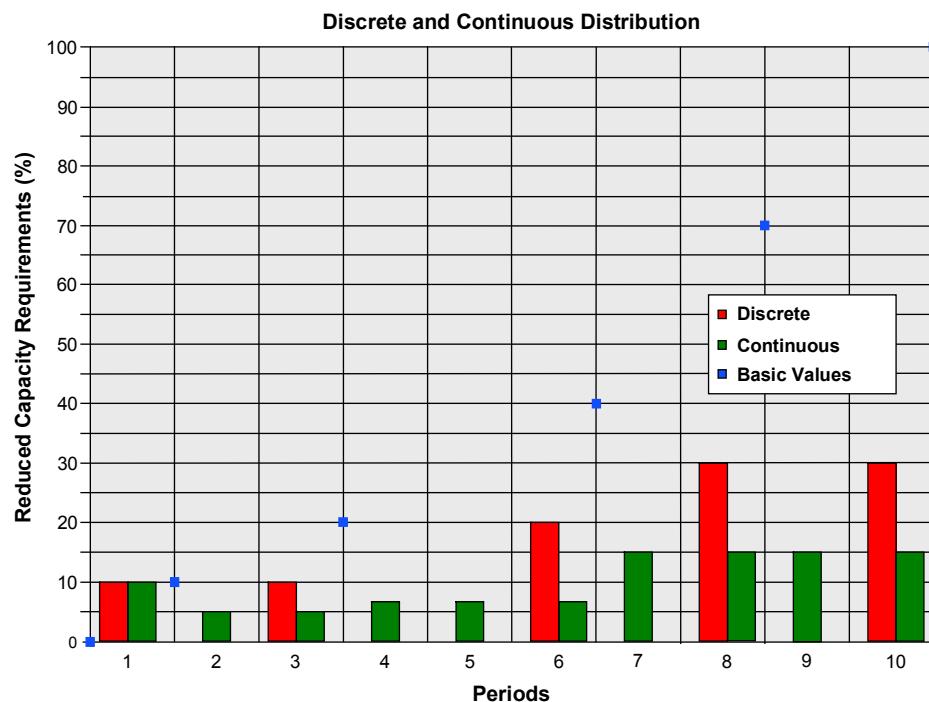
# Distribution of Remaining Capacity Requirements

## Use

After the partial confirmation the remaining capacity requirements are redistributed between the date of the last confirmation, the actual finish date, the scheduled finish date or the forecast date.

## Features

The distribution of the remaining capacity requirements is carried out based on a distribution function that is determined by the distribution function and the remaining capacity requirements.

If the actual finish date is later than the scheduled finish date then all of the remaining capacity requirements are loaded in the period of the confirmation date (actual finish date).

### Determining the distribution function for the remaining capacity requirements

The system derives the degree of completion from the actual capacity requirements (that is, the total confirmed capacity requirements to date) and the remaining capacity requirements.

Degree of completion = Actual capacity requirements/(actual capacity requirements + remaining capacity requirements)

The system uses the degree of completion expressed as a percentage and using the distribution function determines the proportion of the operation duration that should in theory have elapsed. If necessary, linear interpolation between the basic values of the distribution function is possible.

The system places the zero point of the distribution function for the remaining capacity requirements on the basis of this percentage operation duration and the degree of completion. The remaining capacity requirements and the remaining operation duration now correspond to 100%. The basic values of the distribution function are converted accordingly.

> For forward scheduling, the actual finish date functions as a fixed date and in this way also overrides the basic start date of the order. For partially confirmed operations, a remaining duration is calculated using the remaining quantities and the standard values or the forecast values via the formulas of the work center. In the network you can also specify a forecast value for the remaining duration. Alternatively the system can calculate the remaining duration using a forecast finish date in scheduling.

# Cumulation of Available Capacities and Capacity Requirements

## Use

If you want to look at the capacity situation of groups of work centers or production areas instead of the capacity situation of individual production work centers you must cumulate available capacities and capacity requirements.

## Prerequisites

The cumulation of available capacities and capacity requirements takes place using work center hierarchies. You can use hierarchies to represent areas of a company according to your planning needs. You can define work center hierarchies in the area menu *Work centers*. You can find detailed information on work center hierarchies in the documentation *PP - Work Centers*.

## Features

There are different cumulation functions available in capacity planning and in the work center:

- Dynamic cumulation [Page 25]

    This is the cumulation function in capacity planning. You can use this function to cumulate both capacity requirements and available capacities.

- Static cumulation [Page 21]

    This is the cumulation function in the work center. You can only use this function to cumulate available capacities. Of course, you can maintain "cumulated" available capacities manually in superior hierarchy work centers.

## Activities

For performance reasons, it is recommended that for large hierarchies you statically cumulate available capacities in the work center at an early stage in capacity planning. Then you can access the previously cumulated available capacities in capacity planning and only have to dynamically cumulate the capacity requirements.

If the available capacities change then dynamic cumulation of available capacity during capacity planning is more up-to-date. You can also update the statically cumulated available capacities by carrying out the static cumulation again after a change in the available capacities.

# Static Cumulation

## Use

You can use static cumulation in work center maintenance to cumulate available capacities from hierarchy work centers to a superior hierarchy work center.

> The meaning of cumulated available capacities for capacity planning is described in the section Cumulation of available capacities and capacity requirements [Page 20].
>
> You can find an example of a work center hierarchy and of the cumulation of available capacities in the section Cumulation of available capacities [Page 27].

## Features

You execute a static cumulation in the work center when processing a version of available capacity. This is how you determine the available capacity of this version of available capacity. The available capacity maintained to date is overwritten with the available capacity that was generated by the cumulation function.

> You cannot carry out a cumulation in a work center that references a capacity since its available capacity can only be changed by changing the reference capacity.

You can specify on what level of the hierarchy in the branch of the hierarchy under the work center the available capacity is to be cumulated. On this hierarchy level the system groups together the available capacities of the active versions of available capacity with the same capacity category. The operating times of the work centers on the hierarchy level can be different; the longest operating time is used as the operating time.

The system carries out the cumulation per period for the period of time in question. You define this period of time using the start date and the period pattern key [Page 23]. The available capacity per period in the period split results from the averaging and addition of the available capacities of the subordinate work centers in this period.

The cumulation function also generates an available capacity for the period before and after the cumulation period.

- Before the cumulation period the standard available capacity of the capacity category that you are maintaining is valid.

- Following the cumulation period the cumulated available capacity of the last day of the cumulation period is valid.

**Explosion stop**

If the indicator Explosion stop [Ext.] is set for a work center in the hierarchy then its subordinate work centers are not taken account of in the cumulation. The hierarchy is exploded in the branch affected only as far as this work center.

**Static Cumulation**

# Activities

You call up the static cumulation when maintaining the version of available capacity of a work center capacity with *Extras → Avail.cap via hier.*

If a work center belongs to several hierarchies then you can store the cumulated available capacities using the various hierarchies in various versions of available capacity in the work center.

If the available capacity of a subordinate hierarchy work center changes, the cumulated available capacity does not change automatically. If necessary, carry out a static cumulation again.

> In capacity planning you can use dynamic cumulation [Page 25] to cumulate both available capacities and capacity requirements.

# Period Pattern Key

## Definition

A **period pattern key** identifies a length of time that comprises of any number of consecutive time segments. Each of these time segments consists of **periods**. The duration of a time segment is determined by the period type and the number of periods. Typical period types are calendar days or weeks

## Use

The period pattern key is used for

- displaying available capacities graphically [Ext.]

- Cumulation [Page 21] of available capacities using work center hierarchies in work center maintenance

It is created in Customizing for *Work centers* by choosing *Define period pattern key*.

## Structure

In the following graphic you can see an example of a period pattern that has been defined using a period pattern key.
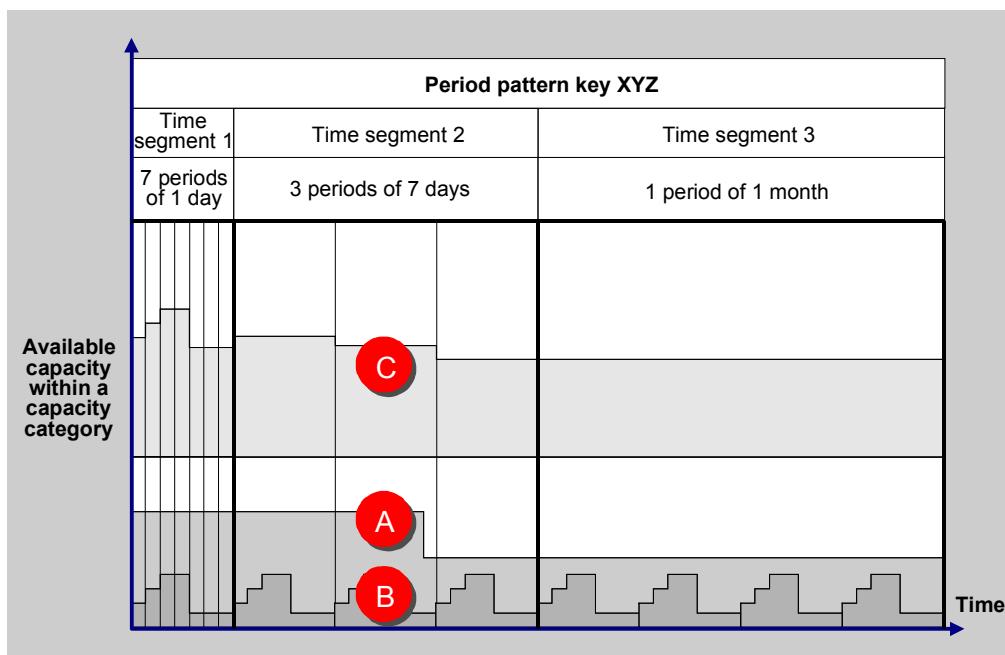


**Cumulating available capacities using the period pattern key**

**Period Pattern Key**

In work center maintenance the available capacities of different capacities are cumulated in the work center hierarchy using the period pattern key. For each period in the time segment defined by the period pattern key, the he available capacities are averaged and added together

In the graphic the available capacities A and B are cumulated in the available capacity C.

You are recommended to use shorter times for the first segments and longer ones for segments that are further in the future. Then you only need a limited number of periods, but have detailed information for the near future.

# Dynamic Cumulation

## Use

You can use dynamic cumulation in capacity planning to cumulate available capacities from hierarchy work centers to superior hierarchy work centers.

You can only carry out a dynamic cumulation in those parts of capacity planning where capacity requirements and available capacities are represented per period, for example in the capacity evaluation or in the tabular version of the planning table in capacity leveling.

> The meaning of cumulated available capacities and capacity requirements for capacity planning is described in the section Cumulation of available capacities and capacity requirements [Page 20].
>
> You can find an example of a work center hierarchy and of the cumulation of available capacities in the section Cumulation of available capacities [Page 27].

## Features

In a dynamic cumulation the system cumulates the available capacities and the capacity requirements for all capacity categories of the work centers that you have selected for capacity planning and that belong to the hierarchy specified. The cumulation is carried out for the whole of the evaluation period on the basis of the period pattern specified.

The cumulated available capacity and the cumulated capacity requirements for a capacity category at a work center are a result of the combination of available capacities and capacity requirements for the same capacity category at the lowest level in the relevant part of the hierarchy branch.

If the indicator Explosion stop [Ext.] is set for a work center in the hierarchy then its subordinate work centers are not taken account of in the cumulation. The hierarchy is exploded in the branch affected only as far as this work center.

### Cumulating available capacities

When cumulating the available capacity, the system summarizes the available capacities in the *active* capacity version into one available capacity and writes it to the *active* version of the corresponding capacity category in the superior work center.  The operating times of the subordinate work centers can be different; the longest operating time is copied to the capacity version for the superior work center as the operating time.

### Cumulating capacity requirements

If capacity requirements have already been assigned to a capacity at a hierarchy work center, in which capacities are cumulated, then these are added to the cumulated capacity requirements.

If you have assigned a pooled capacity to several hierarchy work centers the total capacity requirements for the pooled capacity for every hierarchy work center.

### Distribution according to operating time when cumulating

In the *capacity evaluation*, the system, when distributing according to operating time, distributes the capacity requirements of each operation according to the operating time of the corresponding

**Dynamic Cumulation**

subordinate work center, before it cumulates the capacity requirements of the operations in the superior hierarchy work center.

To ensure that the system executes the distribution during cumulation in the same way in *Capacity leveling with the capacity planning table* and in the *Extended evaluation*, you must set the *Hierarchy explosion* indicator in the selection profile. If you do not set the indicator, the system distributes the capacity requirements for an operation according to the operating time of the subordinate work center. For further information, see Distribution of capacity requirements [Page 14].

## Activities

You can make all the settings for the dynamic cumulation:

- In the evaluation profile [Ext.] for capacity leveling and the extended evaluation

- In the options profile [Ext.] for the capacity evaluation

You can specify whether you want to cumulate available capacities or capacity requirements or both using the hierarchy specified. If you want to work with cumulated data you should cumulate both the capacity requirements and the available capacities. You can create cumulated available capacities in the work center at an early stage in capacity planning using the static cumulation [Page 21]. Then you only need to cumulate the capacity requirements dynamically in capacity planning.

When calling up the capacity evaluation, the extended evaluation or capacity leveling, the system cumulates the available capacities and capacity requirements according to your settings.

During the capacity evaluation, you can also execute a dynamic cumulation of the capacity requirements or available capacities using a hierarchy of your choice by choosing *Settings →
General*. You can also display a hierarchy with *Hierarchy graphic.*

# Cumulation of Available Capacities

If you want to look at capacity load of production areas in capacity planning rather than at the load of specific work centers then you can represent the areas of the business that are relevant to planning in work center hierarchies. You can then cumulate the available capacities and capacity requirements.

The following graphic displays an example of cumulating available capacities.

**Cumulating available capacities in a work center hierarchy**
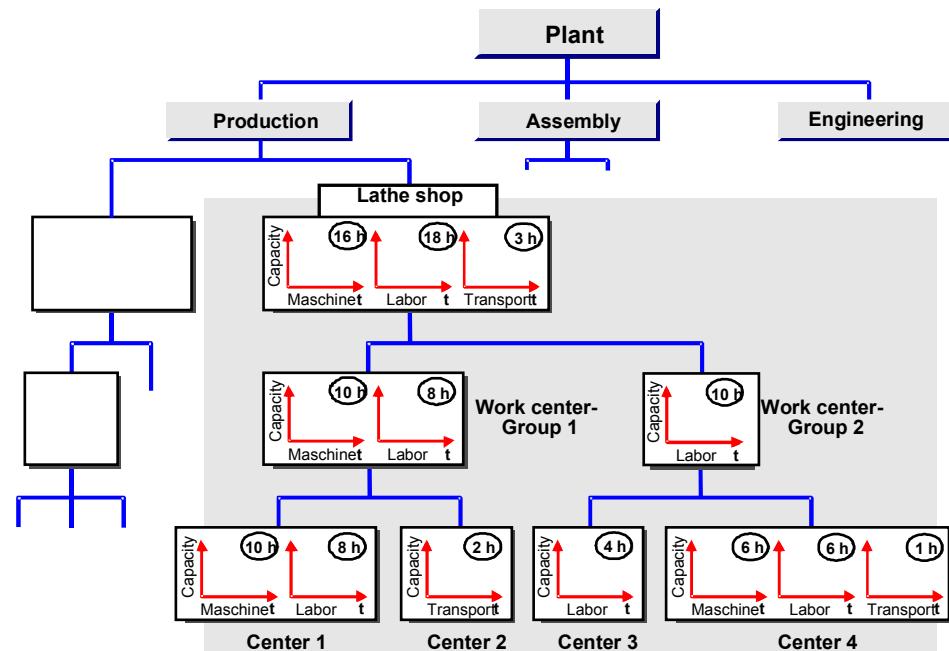


In this graphic the following cumulations are carried out:

- The available capacities "labor" in work centers *center 3 and center 4* were cumulated one hierarchy level higher to the work center *work center group 2.* No cumulation was carried out in this work center for the capacity categories "machine" and "transport" because these capacity categories do not exist in *work center group 2.*

- The available capacities "machine" and "labor" in work centers *center 1* and *center 2* were cumulated one hierarchy level higher to the work center *work center group 1.* No cumulation was carried out in this work center for the capacity category "transport" because this capacity category does not exist in *work center group 1.*

- The available capacities "machine", "labor" and "transport" for work centers *center1* to *center 4* at the lowest level of the hierarchy were cumulated two hierarchy levels higher to work center *lathe shop.*

**Cumulation of Available Capacities**

The system does not cumulate successively from one hierarchy level to the next. The available capacity of the work center *Lathe shop* for example, does not comprise the available capacities of the work centers *Work center group 1* and *Work center group 2*.

# Reduction of Capacity Requirements

## Use

Capacity requirements are reduced by

- Completion Confirmations

- Changing the order status to "technically complete"

- Locking an order (changing the order status to "locked")

- Deletion flag

Capacity requirements are completely reduced by means of the functions: Technically complete and deletion indicator.

## Scope of functions

### Completion Confirmations

During the completion confirmations, for example of production orders, the actual values are entered for the standard values, the quantities and dates in the operation. You can enter forecast values and dates for the standard values.

With the completion confirmation the capacity requirements are also updated. When the operation is finally confirmed the **remaining capacity requirements** are set to zero.

There are two types of partial confirmation:

- **Production order and process order**

  With a partial confirmation the system recalculates the remaining capacity requirements using the remaining quantity. If there are no forecast values then the system carries out calculations using the standard values and the remaining quantity in the formulas for the relevant capacity requirements.

  If there are forecast values for the standard values then the system calculates the formulas with these values.

  With a partial confirmation in the production order you can specify that the setup operation has been completed. Thus the system does not take the setup time into consideration.

- **Network and Plant Maintenance Order**

  For partially confirmed operations in networks and maintenance orders, remaining capacity requirements can be calculated by subtracting the actual requirements value for the network/maintenance order from the total capacity requirements. Alternatively, you can specify a forecast value for work with which the capacity requirements are to be calculated using the formulas.

You can find information on distributing the remaining capacity requirements in Distributing Remaining Capacity Requirements [Page 19].

**Reduction of Capacity Requirements**

## Status Change

As well as a partial confirmation and a final confirmation, the order status "technically completed" affects the capacity requirements. This status results in all the capacity requirements for an order being reduced.

You should read:

- Reducing Split Capacity Requirements [Ext.]
- Deleting Capacity Requirements [Ext.]

# Scheduling

The R/3 logistics system has different types of scheduling:

- In material requirements planning, the basic dates of a planned order are calculated for every BOM level. The system uses the in-house production times in the material master. The planning accuracy is carried out to the day.
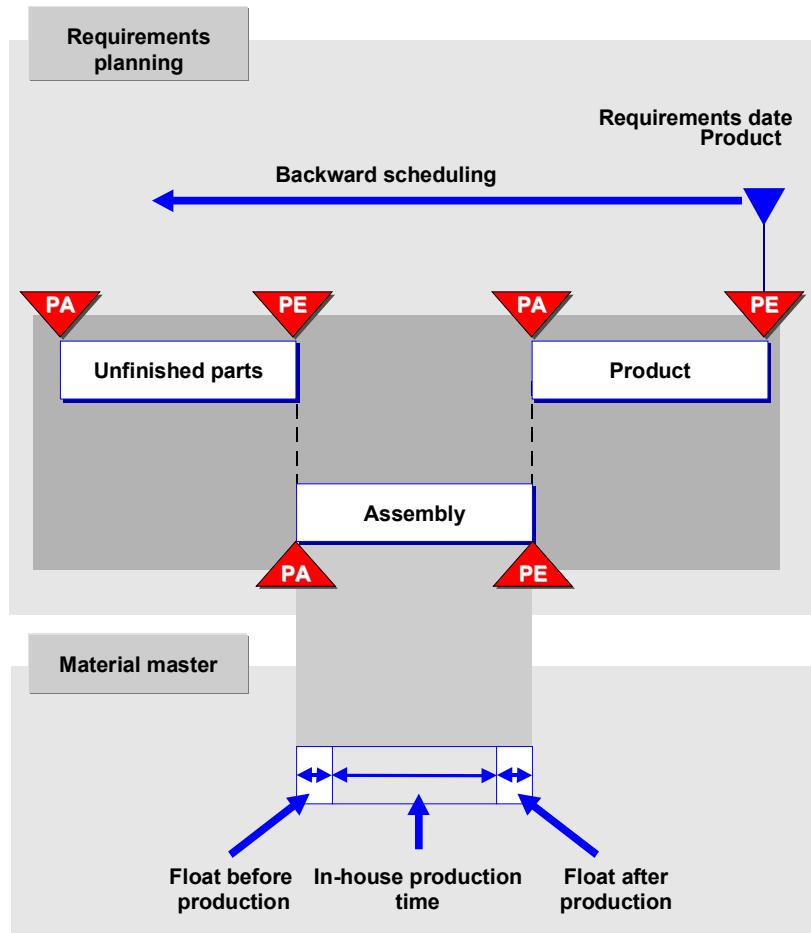


- In Sales and Distribution, the system calculates the basic dates of the sales order such as the packaging/loading date, transport date, and scheduled shipping date. The system uses the desired delivery date specified by the customer as a basis for carrying out backward scheduling.

- The scheduling type used in capacity planning starts with the basic dates that were calculated either in material requirements planning or entered manually by the user. The orders to be scheduled are planned orders, production orders, maintenance orders and networks.

**Scheduling**

# Elements of Scheduling

In scheduling it is important to distinguish between the following:

- *Operations* which describe the individual processing steps in an order

- *Relationships* that specify the sequence in which the operations should be carried out.


You can find more details in:

Elements of Scheduling for Planned Orders and Production Orders [Page 35]

Elements of Scheduling for Networks, Plant Maintenance Orders and Process Orders [Page 34]

# Scheduling Elements for Networks, Plant Maintenance Orders and Process Orders

The activities/operations of networks, maintenance orders and process orders are not divided into segments, as in planned orders and production orders.

You must explicitly maintain relationships for networks and process orders (see the figure below). For maintenance orders you can also explicitly maintain the relationships. They can also be automatically generated by the system in planned orders and production orders.
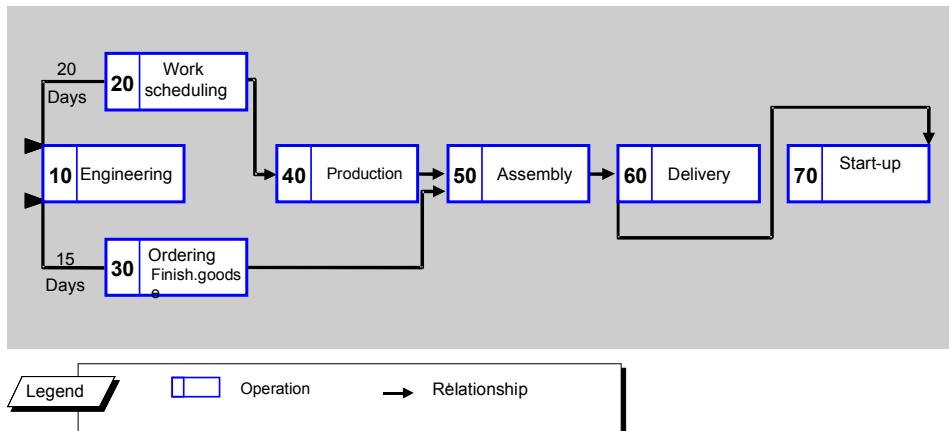


The system generates the relationships for maintenance orders, as for planned/production orders.

# Elements of Scheduling for Planned Orders and Production Orders

Every operation in planned and production orders is divided into operation segments:

- Queue time

- Setup time

- Processing time

- Teardown time

- Wait time

The sum of the setup time, the processing time and the teardown time forms the execution time (see following graphic).
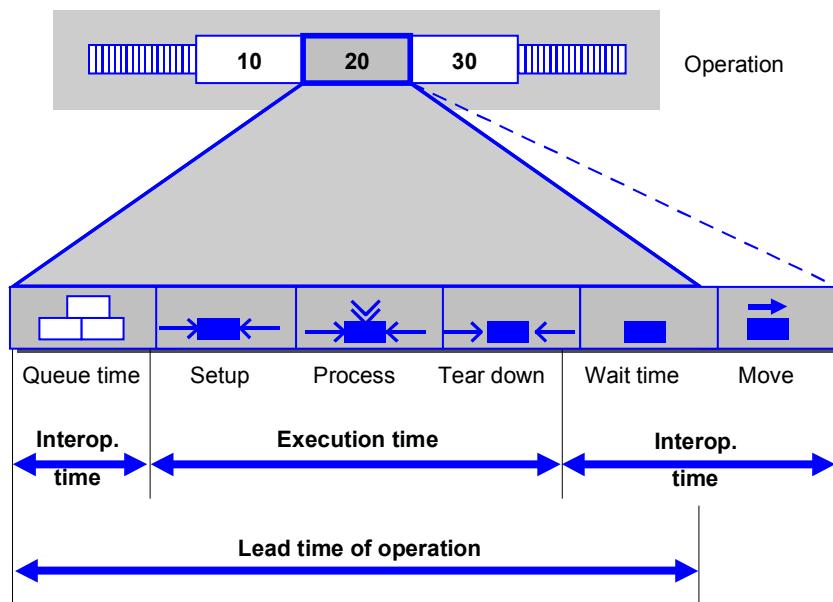


The system calculates dates for all the above operation segments.

The system generates relationships automatically. The system links the operations for every sequence in the order using relationships. It links them in ascending order of operation number. You must explicitly maintain the relationships between the operation sequences.

In planned and production orders the *move time* represents the duration of the relationships.

The system takes the floats before and after production into account for planned orders and production orders. The float before production is between the order start date and the first operation, the float after production between the finish date of the last operation and the order finish date.

# Duration of Operations

## Duration in planned orders and production order

The system calculates the duration of the operation segments *setup, processing* and *teardown* for the production order and the planned order. The system takes the standard values from the operation and places them in the formulas in the work center.

The other operation segments are maintained as follows:

- You can maintain the *queue time* individually for every operation or for the work center as a whole.

- You can maintain the *move time* individually for each operation or define it in the move time matrix in Customizing using the *location group*.

- The *minimum wait time* is a value that you can maintain for each operation.

You can maintain the *delivery time for externally processed operations* individually for every operation.

## Duration in networks and maintenance orders

For an activity/operation in a network/maintenance order, the duration of the operation/activity is calculated using a formula from the work center. The duration of the operation/activity is entered in the formula. If no formula exists in the work center, the duration entered is defined as the duration of the operation/activity.

You can maintain the duration of relationships in the network individually.

## Duration in the process order

The duration of activities in the process order is determined by the dates of the phases that belong to the operation. Scheduling calculates the duration of the phases using the formula in the resource. The standard values from the operation go into the formula.

# Operating Time

The durations of the operations/activities or the time intervals of the relationships are distributed for scheduling over a time axis. Every element of scheduling (operation/activity or relationship) can have its own duration and operating time.

The operating time specifies when work takes place. The calendar used specifies the workdays and the public holidays. In the work center you specify the operating time per workday, based on start time, finish time andbreaks.

The valid operating time is the one defined for the capacity category that is shown on the screen *Scheduling* in the work center. If no operating time per work day is defined then the system uses an operating time from 00.00 to 24.00 as a default.

The following rules apply:

- If the time unit of the duration is smaller than the unit "day", the operating time per workday is used.

- If the time unit of the duration is greater than or equal to the unit "day", scheduling to the day is carried out on the basis of the valid calendar.

## Calendar

The system uses the calendar from the work center. If a calendar is not defined in the work center, the system uses the calendar in the operation/activity or in the relationship. If no calendar is specified there either, then the system uses the Gregorian calendar.

# How Scheduling is Carried Out

In scheduling, the system generates a network structure from the various order structures. This network structure is the same for all order categories. The system lists the operations according to their rank. The start operations (those without predecessors) have the lowest rank. The target operations (those without successors) have the highest rank. All subsequent operations have a higher rank than the operation itself. All operations are scheduled according to their rank.

Starting from the start or finish date of the order, the calculated duration is distributed over the time axis, and the start and finish dates of the operations are calculated. Forward scheduling starts with the order start date. Backward scheduling starts with the order finish date. The operating time or capacity type that you have specified in the work center on the screen *Scheduling* as a scheduling basis is relevant for scheduling an operation. The operating times that you maintain for the individual capacities of scheduling-relevant capacity are only relevant for scheduling splits.

The system schedules the time intervals between the operations using the relationships. With orders that have no relationships, the system schedules the time intervals using the move time. All time intervals of the relationships are considered as minimum time intervals.

## Control key

The system can only schedule operations that have a control key indicating that scheduling is intended. Operations not scheduled have the duration 0 and receive as start and finish date the date of the preceding operation (for forward scheduling) or the start date of the following operation (for backward scheduling).

## Rules for Calculating the Dates

If scheduled dates/times are at work start, work finish or midnight, then the following rules apply:

- Start times are set at the start of work or at 00.00.

- Finish times are set at work finish or 24.00 hours.

- If an operation with duration zero falls on one of these dates, the following special rule applies:

– During forward scheduling, start and finish times are set at the work finish or 24.00.

– During backward scheduling, start and finish times are set at the start of work or 00.00.

  This is necessary so that the finish times are not before the start times.

# Scheduling and Capacity Requirements Calculation

Scheduling is an important tool for calculating capacity requirements. During scheduling, the system determines the start and finish dates for various order categories and writes capacity requirements records. The system carries out scheduling using task lists from various applications, for example:

- Rough-cut planning profiles
- Rate routings
- Routings
- Master recipes
- Networks

> So that capacity requirements can be determined you must specify formulas to calculate capacity requirements in work center and capacity maintenance.

## Scheduling Levels

Scheduling and the calculation of capacity requirements can be carried out in different levels of detail. You can distinguish between the following levels of detail or scheduling levels.

- Rough-cut scheduling
- Production-rate scheduling
- Detailed scheduling

For example, it may be sufficient for rough-cut planning to take the execution time of an operation into account and carry out scheduling and calculate capacity requirements at a rough-cut level. On the other hand, even at the rough-cut level, it can be useful to determine the capacity requirements in detail at the detailed level.

> The capacity load of a production line in repetitive manufacturing is usually determined at production rate level. However, if there is a station within this production line that is also used for the work centers of production orders then it is sensible to carry out capacity planning at the detailed scheduling level for this station.

The following table shows the scheduling levels at which scheduling can be carried out in the various applications.

**Scheduling levels in the various application areas**

| Application | Rough-cut scheduling | Production-rate scheduling | Detailed scheduling |
|---|---|---|---|
|  |  |  |  |
| SOP, LTP, MRP, MPS, SFC, REM | X | X | X |
| PM, PS, PP-PI |  |  | X |

You can specify for each scheduling level the task list type to be used for scheduling in Customizing for capacity planning. You can do this for the various applications see also Parameters for scheduling and capacity planning [Page 42]). In this way you can carry out scheduling at different levels of detail depending on the needs of the business.

Generally, routings are used at the detailed scheduling level, rate routings at production rate scheduling level and rough-cut planning profiles at the rough-cut scheduling level. However, you can use a different task list type from usual for every scheduling level. Scheduling in plant maintenance generally takes place using the routing; a network is always scheduled using a standard network.

You can find more details on scheduling and capacity requirements calculations in the documentation for the specific application areas.

## View of capacity requirements

You can create capacity requirements in various applications, that is, for the different scheduling levels for the various planning levels. Capacity requirements resulting from detailed scheduling, rate-based scheduling and rough-cut scheduling for a product at a particular time in an application exist in the system at the same time and can be viewed separately.

When you convert a planned order to a production order, the system reschedules the production order and deletes the planned order. In this case, the system transfers the capacity requirements for rough-cut and rate-based planning to the production order.

Manually created production orders are scheduled using rate-based scheduling or rough-cut scheduling if you have specified the following in Customizing where you specify the scheduling parameters for production orders for the order category:

- the selection ID for rate-based scheduling or rough-cut scheduling
- the appropriate indicator

Rate-based scheduling or rough-cut scheduling is carried out again if the quantities or the basic dates have changed in the production order.

# Parameters for Scheduling and Calculating Capacity Requirements

The following describes further settings in Customizing that control scheduling and capacity requirements calculations and are valid for various applications.

You can make settings for calculating capacity requirements and scheduling in Customizing for capacity planning in *Operations → Scheduling.* You can define the following:

- Scheduling levels for production orders, planned orders, run schedule headers and orders in Sales and Operations Planning (SOP) and

- Parameters for specifying detailed scheduling for all order categories for which capacity planning is carried out.


You can find more details in:

Scheduling levels [Page 43]

Parameters for detailed scheduling [Page 45]

# Scheduling Levels

In Customizing for capacity planning you can centrally define the following for production orders, planned orders and orders in sales and operations planning (SOP) with the menu options *Operations → Scheduling:*

- Whether scheduling and/or finite scheduling should be carried out and on what level (detailed, production-rate or rough-cut).

- What task lists (for examples, routings, rate routings, rough-cut planning profiles) are to be scheduled and on which scheduling level.

These settings allow you to generate capacity requirements for up to three levels for every order. Every order can be scheduled on every level. The capacity requirements can be evaluated on each of the three levels independently of one another.

> To generate capacity requirements on all three scheduling levels the order has to be scheduled three times. That affects performance. So only set the indicators for those scheduling levels that you want to evaluate.

Three scheduling levels are available for capacity planning:

- **Detailed scheduling**

  Detailed scheduling is controlled by the parameters for detailed scheduling, which you can maintain in Customizing for capacity planning.

- **Production-rate scheduling**

  Rate-based planning is carried out on the basis of production rates. The scheduling instrument for rate-based planning is generally the rate routing. Rate-based scheduling is used mainly in repetitive manufacturing.

- **Rough-cut scheduling**

  Rough-cut scheduling is based on a rough-cut planning profile that contains cumulated data, for example, a work center from a work center hierarchy or a hierarchy root. Rough-cut scheduling is usually used from an SOP or MPS view, especially if it involves planning product groups.

You assign the task list to be used for scheduling (for example, routing, rate routing or rough-cut planning profile) by using a selection ID. By entering the selection ID, you specify the criteria used to determine the task list on which scheduling is based. The system takes the task list usage, task list type and task list status into account.

These control criteria are assigned to the material via the production controller.

> Detailed scheduling is always used for production orders. If you have entered selection ID for rate-based scheduling or rough-cut scheduling for productions orders, a production order is scheduled appropriately if it is created manually (without converting a planned order).

**Scheduling Levels**

> The selection ID assigned to a planned order for detailed scheduling must match that of the production order into which the planned order is converted. When a planned order is converted to a production order, the system reschedules this new production order. The capacity requirements for rough-cut planning and rate-based planning are copied into the production order.

If you have selected indicators for several levels (for example, for the planned order) and if the basic dates have to be adjusted then you must use a key to specify the level on which the basic dates have to be adjusted. This level is scheduled first of all and the basic dates are determined. The other levels must then lie within these basic dates and do not affect the basic dates.

Please note the following points:

- If the indicator for determining the dates is set then the operations are scheduled:

  - With detailed scheduling you can specify the scheduling direction explicitly with the parameters for detailed scheduling.

  - Backward scheduling is used with rough-cut scheduling and production-rate scheduling.

    The other parameters required for scheduling are predefined and cannot be changed.

- If the indicator for calculating capacity requirements is set then capacity requirements records are generated during scheduling. If the indicator is not set then no capacity requirements are generated.

- If only the indicator for calculating capacity requirements is set then the system only calculates capacity requirements. In this case the capacity requirements are distributed over the whole duration of the order for all levels. That means that all the operations are parallel and get the dates of the order.

# Parameters for Detailed Scheduling

In Customizing for capacity planning you can specify parameters to be used in the orders of the various applications in detailed scheduling. You can define parameters for detailed scheduling for the following applications or objects.

- Production orders

- Networks

- Planned orders/Rate routings

- Orders in Sales and Operations Planning

- Orders in Plant Maintenance

- Process orders

The settings for detailed scheduling are only taken into account for planned orders and orders in Sales and Operations Planning SOP in the following case: if, when defining the scheduling levels, you have set the indicator specifying that detailed scheduling is to be carried out.

Which parameters can be maintained depends on the application. In what follows some parameters are described in more detail.

- Scheduling type:

  Scheduling can be carried out as backward scheduling, forward scheduling or scheduling to current date. You can also specify that only capacity requirements should be written. In lead time scheduling, the system switches to forward scheduling if an order start date is calculated that lies in the past. In the field *Past start* you can specify the number of days that the start date may be in the past, before the system switches to forward scheduling.

- Number of days the start date may be in the past: If the start date is more than the specified number of days in the past, the system automatically carries out "today" scheduling.

- Indicator that controls whether the dates should be automatically calculated again when you save: If the dates are not recalculated during saving, the status "Dates not current" is set in the order.

- Indicator that controls whether the basic dates are equated with the scheduled dates if the system calculates a scheduled date outside the basic dates during scheduling.

- Indicator that controls whether the scheduling log is displayed automatically if it contains any messages.

- Maximum reduction level that can be used for reduction during scheduling.

- For production orders, percentage values for reducing the float before production and the float after production for the various reduction levels: The system always reduces the lead time if it cannot calculate dates that lie within the order dates even when it uses the floats before and after production.

You can find more details on scheduling and scheduling parameters in the documents *PP - Production orders, PM - Plant maintenance orders, PS - Project system, PP - Material Requirements Planning*.

# Reduction

## Use

If the dates that the system determines by scheduling an order or collective order lie outside the basic dates it can lead to the lead time being reduced. It uses the reduction measures that you have predefined. Possible reduction measures include:

- Reduction or the order float (floats before and after production)
- Reduction of the queue time and the move time of operations
- Splitting, that is dividing up an operation among several people or machines
- Overlapping, that is partially parallel processing of operations in a sequence
- Reducing the operation durations

The lead time of the order is reduced step by step until the lead time lies within the basic dates or until the maximum reduction step is reached.

## Prerequisites

You make the settings for reduction in Customizing and in the order or in the task lists:

- In Customizing for *Scheduling parameters* you define the following per plant, per order type and per production scheduler:

  - the maximum reduction level
  - the scope of the reduction of the order float in every reduction level

  You can still define these scheduling parameters in order maintenance or task list maintenance.

- You define the reduction strategies in Customizing for *reduction strategies*. They define the selection and scope of the reduction measures in every reduction step for specific operations. In the order or task list you specify a reduction strategy for every operation for which a reduction is permitted.

- In the order or in the task list you define for every operation the data for the operation-specific reduction measures (conditions for overlapping and splitting, normal and minimum move time and queue time).

## Scope of functions

It basically depends on the order category which reduction measures you can define.

| Order category | Possible reduction measures |
|---|---|
| Production orders, planned orders | Order float, queue time, move time, splitting, overlapping |
| Networks | Operation duration |
| Process orders | Order float, operation duration |

**Reduction**

| Sales and operations planning (SOP) | Order float |
|---|---|
| Maintenance orders | No reduction possible |

### Reduction using the critical path

For collective orders, networks or planned orders and production orders with parallel sequences you can use the *reduction type* in Customizing for *scheduling parameters* to specify that the reduction measures are only to be carried out on operations where a reduction of the lead time also leads to a reduction of the overall lead time of the collective order or of the order. Such operations form a "critical path". Operations where a reduction of the lead time does not reduce the total lead time are not reduced. With this reduction type reduction measures are only executed to the extent that is necessary for reducing the lead time. In this way you retain the float times or avoid unwanted splitting or overlapping of uncritical operations.

# Scheduling Partially-Confirmed Operations

There are two ways of scheduling partially confirmed operations:

- The system schedules partially-confirmed operations forwards from the actual finish date. Only the *remaining duration* is regarded as a duration.

  The system calculates the remaining quantity for an operation according to the following formula:

  Remaining quantity = original quantity - actual quantity

  To calculate the duration of the operation segments, the remaining quantity and the forecast values or standard values must be entered into the formula if no forecast values were confirmed.

  After the first partial completion confirmation, the duration for the setup is set to zero. The duration for teardown time is only set to zero at final confirmation.

- Indicator *Shift order*: A control parameter for scheduling can be set in Customizing for confirmations for partial confirmations. This ensures that the order is shifted to a new date, that is, the actual dates of the operations are no longer taken into account. The system then calculates with the *remaining duration* of the operations, starting from the basic dates of the order.

# Scheduling Log

If there are errors in scheduling (such as dates not specified in a calendar or incomplete data), the scheduling run is not interrupted. The errors that arise are written to a scheduling log. The system schedules the order in spite of incomplete data. You can evaluate the log afterwards to analyze the errors and eliminate them.