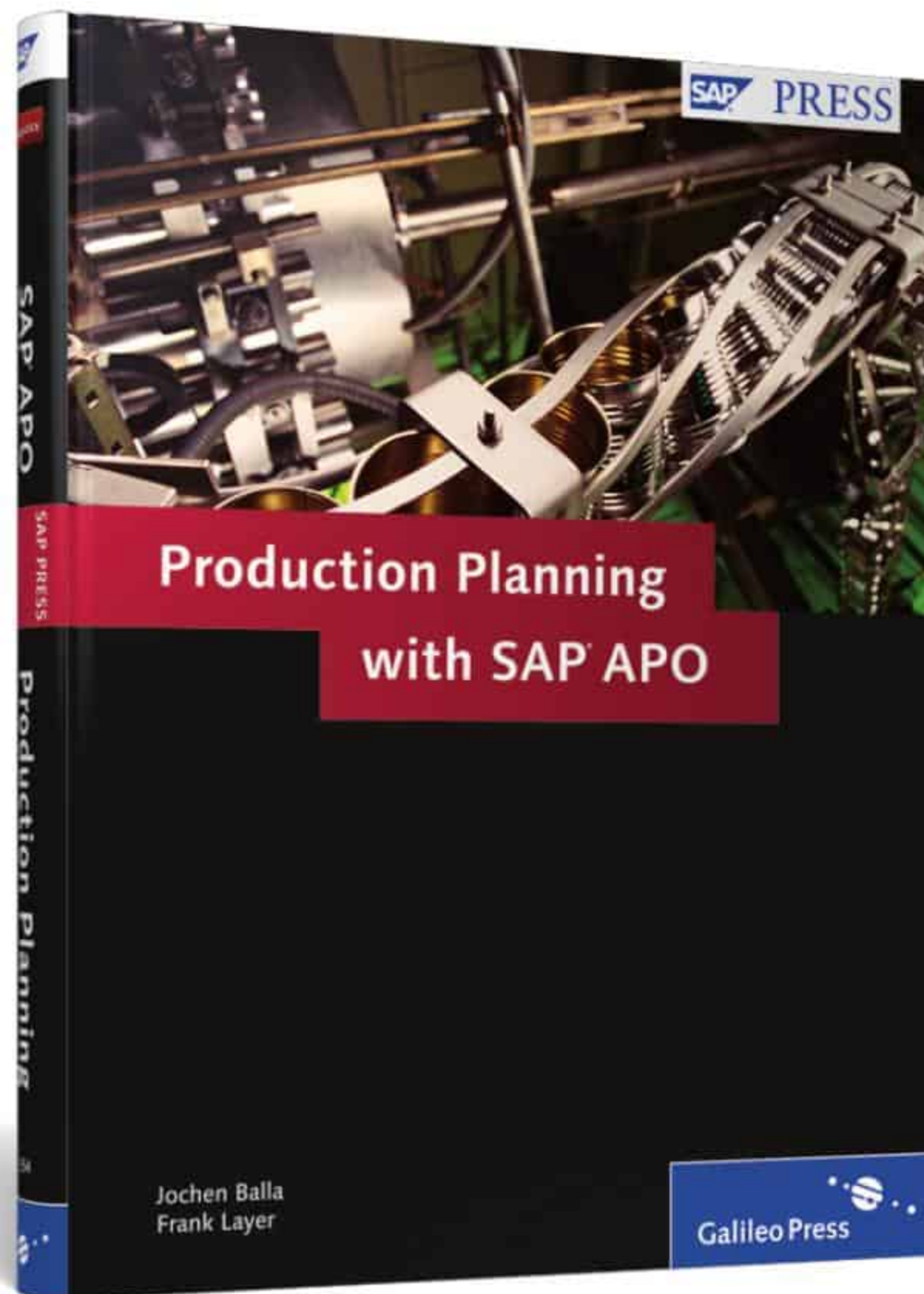


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Production Planning with SAP® APO



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Contents at a Glance

1	An Overview of Planning with SAP SCM	17
2	An Overview of Production Planning with SAP ECC and APO-PP/DS	23
3	The APO Core Interface	47
4	Master Data	105
5	Basic Functions of Production Planning	135
6	Tools to Evaluate and Process Planning	217
7	Advanced Processes in APO-PP/DS	269
A	Transactions and Menu Paths	349
B	SAP Notes on APO-PP/DS	363
C	Heuristics	375
D	Abbreviations	387
E	The Authors	389

Contents

Introduction	13
1 An Overview of Planning with SAP SCM	17
1.1 SAP SCM	17
1.2 SAP APO	19
2 An Overview of Production Planning with SAP ECC and APO-PP/DS	23
2.1 Production Planning Functions	23
2.1.1 Material Requirements Planning	24
2.1.2 Multilevel Planning	27
2.1.3 Material Planning and Capacity Planning	29
2.2 Advanced Production Planning with APO-PP/DS	32
2.2.1 Requirements Planning with Exact Times	33
2.2.2 Descriptive Characteristics	33
2.2.3 Simultaneous Quantity and Capacity Planning ...	34
2.2.4 Production Planning Runs with Several Steps ...	34
2.2.5 Pegging and Control of the Material Flow	35
2.2.6 Determining the Source of Supply and Cost-Based Planning	37
2.2.7 Advanced Alert Handling	39
2.2.8 Advanced Options in Capacity Planning	41
2.2.9 Simple Options for Enhancement with Custom Functions and Heuristics	44
2.3 Planning in SAP APO and Execution in SAP ECC	44
2.4 Summary	46
3 The APO Core Interface	47
3.1 Design of the CIF	47
3.1.1 Plug-In	48
3.1.2 Connecting the Systems Using RFC	51
3.1.3 APO-Specific Settings	54

3.2	The Principle of Master Data Transfer	60
3.2.1	Initial Transfer of Master Data	63
3.2.2	Transferring New APO-Relevant Master Data	75
3.2.3	Change Transfer of Master Data	77
3.3	The Principle of Transaction Data Transfer	87
3.3.1	Transaction Data in ECC and APO	88
3.3.2	Initial and Change Transfers for Transaction Data	89
3.3.3	Transfer of Transaction Data from APO to ECC ...	92
3.4	CIF Monitoring	95
3.4.1	The Principle of qRFC	96
3.4.2	Tools for Troubleshooting Transfer Errors	99
3.4.3	Eliminating Transfer Errors	101
3.5	Summary	103
4	Master Data	105
4.1	Mapping Principle	105
4.2	Locations	106
4.2.1	Transferring Plants and Distribution Centers	107
4.2.2	Storage Location MRP Areas	109
4.2.3	Customers and Vendors	110
4.2.4	External Procurement Relationships and Transportation Lanes	112
4.3	Products	114
4.3.1	Header Data	116
4.3.2	ATP Settings	116
4.3.3	Requirements Settings	117
4.3.4	Lot Size Settings	118
4.3.5	Additional Settings	120
4.4	Resources	121
4.4.1	Resources in APO	121
4.4.2	APO Resource Data	123
4.5	Production Data Structures and Production Process Models	124
4.5.1	PPM, RTO, PDS, and APO Releases	124
4.5.2	Release-Dependent Notes for RTO or PDS	125
4.5.3	PPM and PDS Structures	127

4.5.4	Transfer from ECC	129
4.6	Mass Changes to APO Master Data	132
4.7	Summary	134

5 Basic Functions of Production Planning 135

5.1	Basic Settings	135
5.1.1	CIF Integration	135
5.1.2	Global Settings	136
5.1.3	Planning Procedure	138
5.2	Independent Requirements	142
5.2.1	Sales Orders	142
5.2.2	Planned Independent Requirements in APO	144
5.2.3	Requirements Strategies	148
5.2.4	Reducing Planned Independent Requirements ...	153
5.2.5	Descriptive Characteristics	153
5.3	The Planning Procedure	156
5.3.1	Interactive Planning	157
5.3.2	Production Planning Run	159
5.3.3	Capable-to-Match (CTM)	163
5.4	Heuristics	164
5.4.1	Product Heuristics	166
5.4.2	Heuristics for Flow Control	171
5.4.3	Service Heuristics	173
5.5	Example of a Complete Planning Run	174
5.6	Firming	176
5.6.1	Manual Firming	176
5.6.2	Firming Based on a Firming Period	178
5.7	Net Requirements Calculation and Lot Sizes	180
5.7.1	Net Requirements Calculation	180
5.7.2	Lot Size Calculation	182
5.8	Determining the Source of Supply	183
5.8.1	Procurement Types	183
5.8.2	Automatic Determination of the Supply Source	185
5.8.3	Interactive Sourcing	187
5.9	Scheduling	189
5.9.1	Scheduling for External Procurement	189

5.9.2	Scheduling for In-House Production	189
5.9.3	Planning Strategy	192
5.9.4	Finiteness Level	198
5.9.5	Alternative Resources	200
5.9.6	Scheduled Planned Orders	202
5.10	Pegging	202
5.10.1	Dynamic Pegging	204
5.10.2	Fixed Pegging	207
5.10.3	Safety Stocks in SAP liveCache	208
5.11	Setup Times in Planning	209
5.12	Product Interchangeability	211
5.13	Executing Planning in ECC	214
5.14	Summary	215

6 Tools to Evaluate and Process Planning 217

6.1	Order Views	217
6.1.1	Entering the Product View	218
6.1.2	Structure of the Product View	218
6.1.3	Using the Product View	220
6.1.4	Customizing the Product View	221
6.2	Product Planning Table	222
6.2.1	Entering the Product Planning Table	223
6.2.2	Structure of the Product Planning Table	223
6.2.3	Using the Product Planning Table	224
6.2.4	Customizing the Product Planning Table	227
6.3	Product Overview	228
6.3.1	Entering the Product Overview	229
6.3.2	Structure of the Product Overview	229
6.3.3	Using the Product Overview	230
6.4	Detailed Scheduling Planning Board	231
6.4.1	Entering the Detailed Scheduling Planning Board	231
6.4.2	Structure of the Detailed Scheduling Planning Board	233
6.4.3	Using the Detailed Scheduling Planning Board ...	234
6.4.4	Settings for Detailed Scheduling Strategies	238

6.4.5	Support of Interactive Planning with Detailed Scheduling Heuristics	248
6.4.6	Customizing the Detailed Scheduling Planning Board	249
6.5	Resource Planning Table	251
6.5.1	Entering the Resource Planning Table	251
6.5.2	Structure of the Resource Planning Table	252
6.5.3	Using the Resource Planning Table	253
6.5.4	Customizing the Resource Planning Table	254
6.6	PP/DS Optimizer	254
6.6.1	Basics of PP/DS Optimization	254
6.6.2	Entering the Optimizer	255
6.6.3	Structure of the Evaluation View of the Optimizer	256
6.6.4	Parameterization of the Optimizer	257
6.7	Alert Monitor	263
6.7.1	Entering the Alert Monitor	263
6.7.2	Structure of the Alert Monitor	263
6.7.3	Using the Alert Monitor	265
6.7.4	Customizing the Alert Monitor	266
6.8	Summary	267

7 Advanced Processes in APO-PP/DS 269

7.1	Finite Planning with the Planning Run	270
7.1.1	Finite Requirements Planning	270
7.1.2	Finite Planning as Multi-Step Procedure	271
7.2	Setup-Optimal Sequencing with the PP/DS Optimizer ...	285
7.2.1	The PP/DS Optimizer as an Interactive Planning Tool	285
7.2.2	Sample Process for Interactive Setup Optimization	286
7.3	Capable-to-Promise (CTP)	295
7.3.1	Prerequisites for the CTP Procedure	296
7.3.2	CTP Process	296
7.4	Planned Material Flow	304
7.4.1	Fixed Material Flow Using Pegging ATP	305

7.4.2	Fixed Material Flow Using the Material Requirements Planning	307
7.4.3	Fixed Material Flow to Support the Optimization	307
7.4.4	Fixed Material Flow to Support the CTP Procedure	309
7.5	Multi-Resource Planning with the Wave Algorithm	310
7.5.1	Prerequisites for the Multi-Resource Planning ...	310
7.5.2	Multi-Resource Planning Process	311
7.5.3	Alternative to Multi-Resource Planning	318
7.6	Integration of Variant Configuration	319
7.6.1	Overview of the Procedures with SCM APO Integration	320
7.6.2	Basic Prerequisites for the VC Configuration under SCM APO	322
7.6.3	Scenario 1: Make-to-Order Production with VC Configuration without Characteristic-Based Forecasting	328
7.6.4	Scenario 2: Make-to-Order Production with VC Configuration and Characteristic-Based Forecasting	332
7.7	MRP-Based Detailed Scheduling	343
7.8	Summary	346

Appendices 347

A	Transactions and Menu Paths	349
B	SAP Notes on APO-PP/DS	363
C	Heuristics	375
D	Abbreviations	387
E	The Authors	389
	Index	391

Production planning follows the same basic principles in both SAP ECC and SAP APO. In this chapter, you'll learn about planning with the two systems. We'll also discuss the advanced options available to you with SAP APO.

2 An Overview of Production Planning with SAP ECC and APO-PP/DS

Production planning in APO-PP/DS uses the same processes that are familiar to the SAP ECC system. It is based on master data records, specifically plants, material masters, bills of material (BOM), and routings (in PP) or master recipes (in PP-PI). Planning results in planned orders, which are converted into manufacturing orders for executing production. These may be either production orders (in PP) or process orders (in PP-PI).

Repetitive Manufacturing (REM) is also possible, whereby production is executed on the basis of planned orders.

2.1 Production Planning Functions

PP/DS is short for *Production Planning and Detailed Scheduling*. Of course, the objectives of this kind of planning did not originate with SAP APO. Production planning in SAP ECC pursues the same objective, that is, consistent, capacity-based planning. In SAP ECC, these functions are found under *Material Requirements Planning (MRP)* and *Capacity Requirements Planning (CRP)*.

PP/DS, MRP, CRP

The basic principles of planning in SAP APO and SAP ECC are outlined below, followed by a discussion of the advanced options in SAP APO.

2.1.1 Material Requirements Planning

MRP procedure The goal of Material Requirements Planning (MRP) is to ensure material availability in good time and in sufficient quantities. Two different procedures can be used:

► **Material Requirements Planning**

In this case, procurement planning is controlled by material requirements. The requirements consist of sales orders, planned independent requirements, dependent requirements, and so on. Planning is based on backward scheduling from the requirements date to ensure on-time availability.

► **Consumption-Based (Reorder Point) Planning**

In this case, materials planning is based on consumption. Reorder point planning simply checks whether the available stock has fallen below a defined threshold value or reorder point. Whenever this happens, procurement is planned with forward scheduling.

As you can see, the two procedures are essentially different. Consumption-based planning is usually used for only low-value, non-critical materials (consumable material, for example), while MRP is used for precise planning. Consumption-based planning only plays a secondary role in the context of advanced planning in APO-PP/DS.

MRP type In SAP ECC, you define the MRP procedure in the MRP TYPE field in the material master. Typical entries in this field are "PD" for MRP or "VB" for reorder point planning. However, both these entries are irrelevant for planning materials in APO. If a material is planned in APO, it must not be planned again in SAP ECC. So, you should select the entry "X0" as the MRP type to exclude it from planning in SAP ECC.

There is no MRP type in the APO product master. Planning in SAP APO is essentially "requirement-driven" (that is, it is based on the MRP procedure described above) unless a different procedure is explicitly chosen by applying a corresponding heuristic.

The starting point for MRP is a requirement for a material in a plant. As a rule, this requirement is in the future. We proceed from the following assumption:

Material A is required in quantity B on date/at time C in plant D.

Think of how this applies to a sales order, for example. However, dependent requirements resulting from in-house production can also be formulated in this way.

With backward scheduling for material A in plant D, a suitable procurement element is generated in such a way that the availability date of this element corresponds to the requirements date. The start date of procurement precedes the availability date, and the procurement lead time represents the time interval between these two dates (backward scheduling).

Backward
scheduling

Scheduling of a procurement element depends on the procurement type:

Procurement Types

► **In-House Production**

A routing and a BOM or master recipe is required to produce a material in-house. The in-house production time is the sum total of the durations of the individual operations, plus any additional floats/time buffers.

► **External Procurement**

If you want to procure a material from an external vendor or to transfer your stock from another location, you must schedule a delivery time.

In the system, these two procurement types correspond to the entries "E" for in-house production and "F" for external procurement on the MRP 2 view of the material master (see Figure 2.1). If you enter "X" here, both procurement types are permitted, but planning initially assumes in-house production.

You can define the procurement type more precisely by specifying the special procurement type (SPECIAL PROCUREMENT field). For example, you can configure external procurement as a stock transfer from another production location. With external procurement, you can define a vendor-specific delivery time and factor this in your planning.

Special
procurement

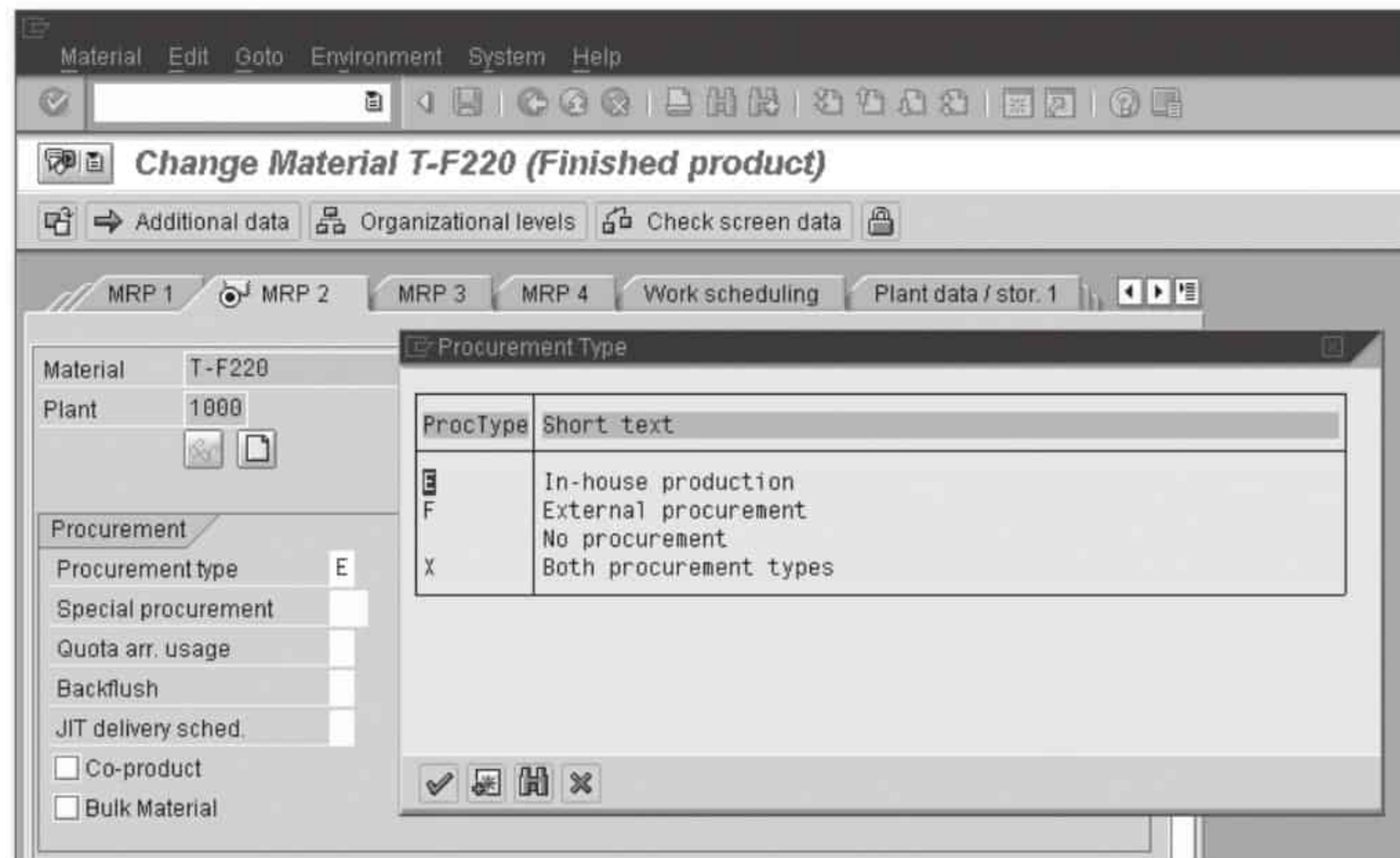


Figure 2.1 ECC Transaction "Change Material Master" (Transaction Code MM02, Material Master View "MRP 2" with Field Selection for Procurement Type)

Finish and production dates

With in-house production, various dates and times can be defined. The SAP ECC manufacturing order contains both production dates and basic order start and finish dates. Floats separate these dates: The float before production separates the order start date and the production start date, while the float after production comes between the production finish date and the order finish date (see Figure 2.2).

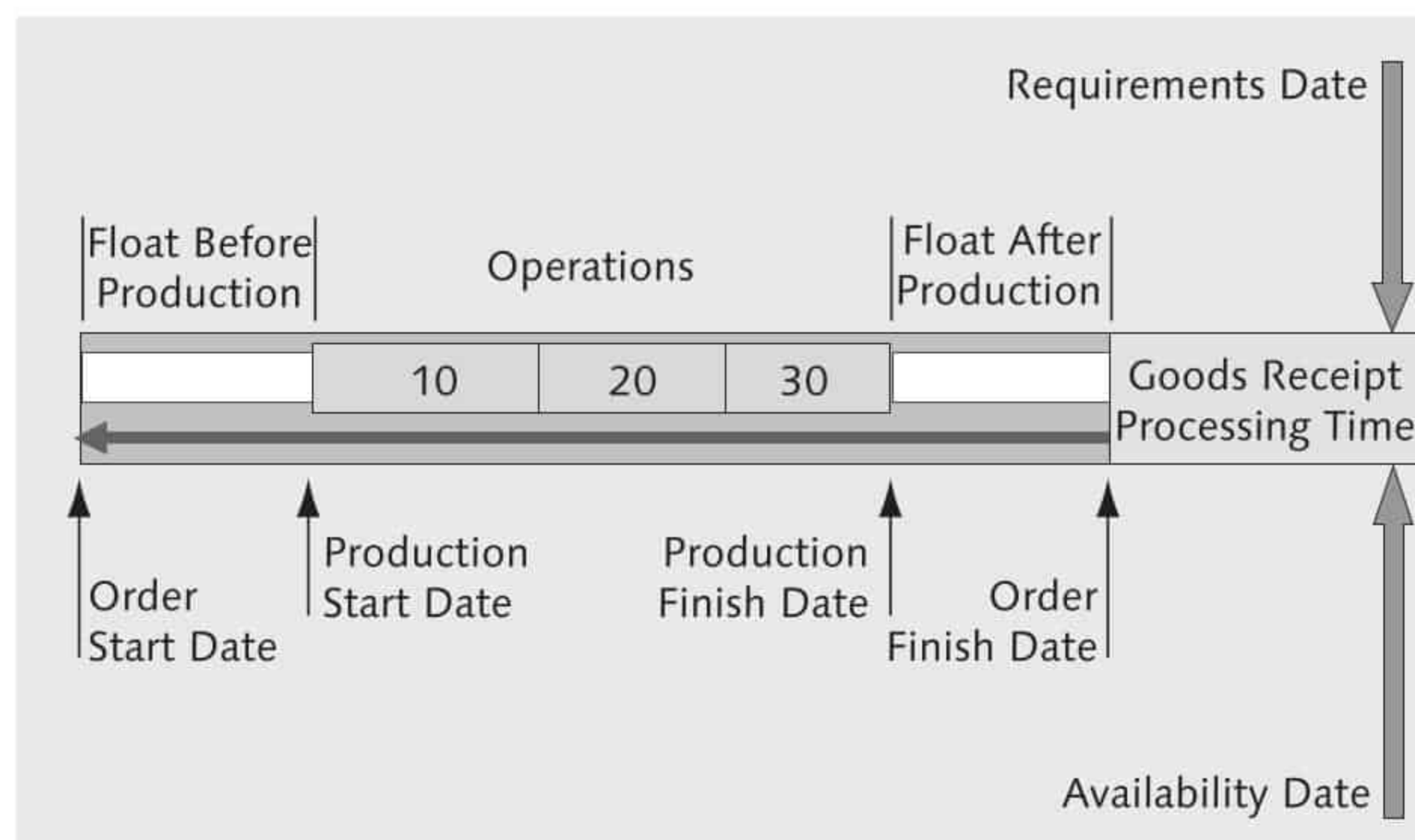


Figure 2.2 Dates in Planned Orders and Manufacturing Orders in SAP ECC

In this context, we must point out the following basic difference between SAP ECC and SAP APO: APO-PP/DS ignores the float before production and the float after production, and APO orders don't contain basic order start and finish dates. So, always enter a scheduling margin key (for example, AP1) with a float before production and float after production both equal to zero for materials that are planned in SAP APO (see Figure 2.3).

SAP ECC and SAP APO – differences in scheduling

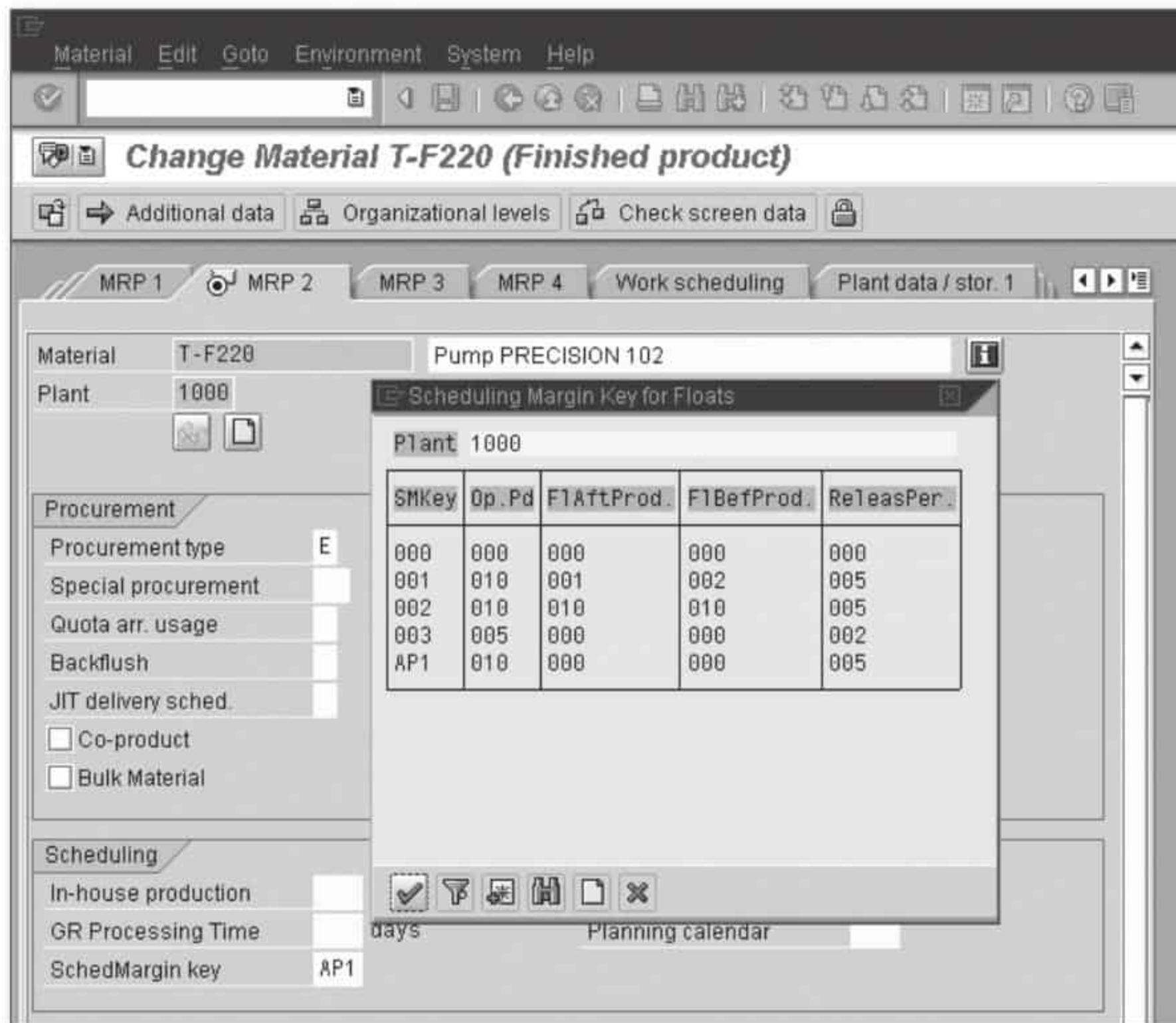


Figure 2.3 ECC Transaction "Change Material Master" (Transaction Code MM02, Material Master View "MRP 2" with Field Selection for Scheduling Margin Key)

2.1.2 Multilevel Planning

With in-house production, you generally use multilevel planning, where the material is produced from other materials that must be available in time for the production process.

You can refer to the *BOM* for information about the required materials. Because a BOM item may be the header of another BOM, planning may encompass several BOM levels. The objective of multilevel planning is to create procurement elements at the right time across all relevant

BOM explosion

BOM levels (see Figure 2.4). The procurement dates for the assemblies and components are calculated from the BOM structure using backward scheduling from the requirements date of the finished product. This enables operation-specific material staging.

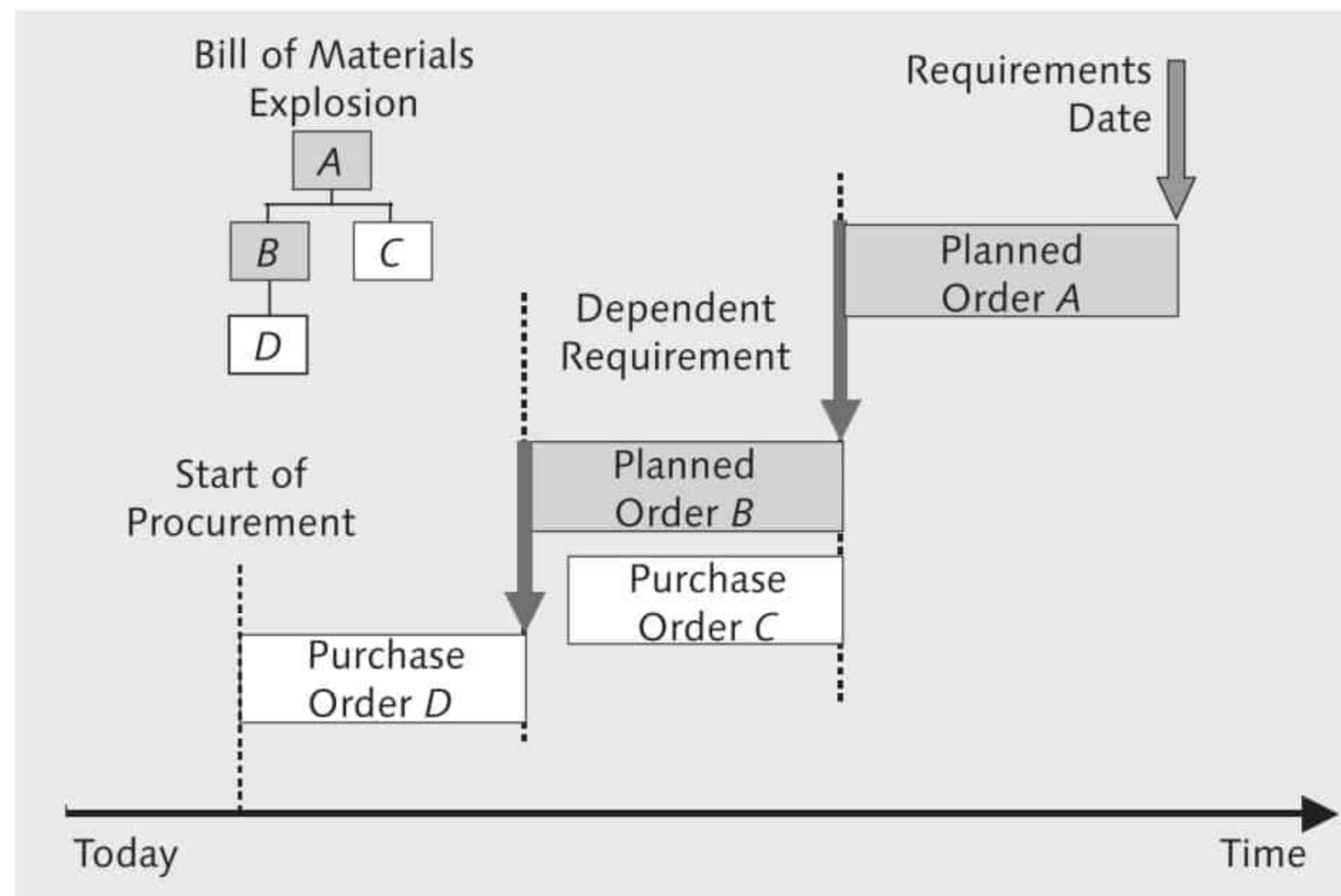


Figure 2.4 Dates in Multilevel Production — Total Replenishment Lead Time and In-House Production Time

Usually backward scheduling

Multilevel planning uses backward scheduling from the requirements date for the finished product. So, the start dates for procurement of the required assemblies and components are calculated to ensure that production of the finished product can start on time. The sum total of these times is referred to as the *total replenishment lead time*. This is distinct from the *in-house production time*, which refers only to the time taken to produce individual materials.

Problems may occur with your procurement plan if the requirements date is less than the end of the total replenishment lead time in the future. With backward scheduling, this corresponds to a situation in which the start date for assemblies or components (or even for the finished product) would have to be in the past.

Forward scheduling and scheduling delays

Because the system does not create orders in the past, *forward scheduling* is generally used in this situation. With forward scheduling, the

start date of the relevant order is the current date, while the end date is scheduled in the future as the start date plus the lead time of the order. This kind of order is delayed because the requirements date that triggered the order (think of a secondary requirement, for example) cannot be covered in time.

In SAP ECC requirements planning, *exception messages* usually alert you to this kind of problem. These messages indicate that procurement of a material will be delayed.

Occurrence of Scheduling Delays

These delays typically occur in lower-level assemblies, while procurement of the finished product still appears to be on schedule. The exception message is not usually propagated to the relevant finished product. It is the MRP controller's responsibility to identify problematic supply chains using these exception messages and to solve the problem, for example, by changing procurement elements manually or by finding alternatives in the procurement process.

[+]

2.1.3 Material Planning and Capacity Planning

In material planning, procurement elements are created with dates that correspond to the requirements situation. This type of planning is based on the individual in-house production times or delivery times of the materials in question.

With externally procured materials, you have to assume that the planned vendor will be able to deliver within the planned delivery time. If in doubt, confirm this with the vendor. You may find that you will need to switch to another vendor with a different delivery time.

The situation is more complex for materials produced in-house. In this case, material planning uses the *MRP II concept*. This means that material planning is initially based on infinite production capacities, with capacity planning following in a second, separate step. When an order is created, there is no check to determine whether the required work centers or resources are available for the relevant period or are already fully occupied by another production process.

MRP II

Available capacity Capacity planning comprises the following steps: The *available capacity* at the work centers (or resources (in PP-PI)) is established. For example, it is established that work center A is available for 40 hours each week.

Capacity requirement The orders (planned orders or manufacturing orders), on the other hand, have certain *capacity requirements*, resulting from the routing (or master recipe (in PP-PI)). The routing can be broken down into operations. Each operation is assigned a work center, where it can be executed.

[Ex]

Determining the Capacity Requirement

For example, operation 10 requires work center A for 10 minutes for each piece of the finished product. So, work center A is required for 50 minutes if you have an order with an order quantity of five pieces.

An order contains not only the planned production start and end dates, but also the operations dates, including details of the required production resources, and, in addition, it formulates the corresponding capacity requirement.

Capacity planning The goal of *capacity planning* is to ensure that orders can be executed, in other words, that work centers are available when required. Capacity planning compares the capacity requirement with the available capacity. Because a work center may naturally be required by different orders for completely different finished products, this comparison is usually carried out as work center-specific.

Scheduling To ensure that a certain order can be executed at a certain time at a specific work center, the order is *scheduled*. A production resource can only be reserved by an order using *scheduling*. Scheduling can be performed interactively in a capacity planning table (or detailed scheduling planning board in SAP APO) for individual orders, or it can be executed automatically as a background job. Problems associated with capacity planning can be extremely complex. For example, orders may involve several operations that require different resources. Successful scheduling of one operation at a resource may conflict with the dates of the other operations, and so on.

Bottleneck resources So, capacity planning is restricted to the planning of the *bottleneck resources*. You must assume that no more than one resource from the routing actually needs to be checked for scheduling conflicts, and have to

trust that the remaining operations in the order will work. This focus on bottleneck resources is an important principle in capacity planning and is also integral to ensuring an executable production planning process in the context of APO-PP/DS.

If a check is performed to determine the existing production resource load, that is, to determine whether capacity is available or has already been reserved by another order, this is referred to as *finite scheduling*. The availability checked in this instance is *finite*. If this check is not performed, this is referred to as *infinite scheduling*, whereby the available capacity is assumed to be *infinite*.

Finite and infinite scheduling

Finite capacity planning generally results in date shifts because time gaps must be found when the bottleneck resources can be scheduled. If a date is brought forward, the availability date of the order is delayed as a result. The deadline of the requirements date of the finished product is missed. If, on the other hand, the order is moved to a later point in time (backward), the secondary requirements dates for the materials required for production are also delayed, with the result that the receipt elements cannot cover these requirements in time. In short, capacity planning generally impacts the requirements plan (see Figure 2.5).

Interaction with requirements planning

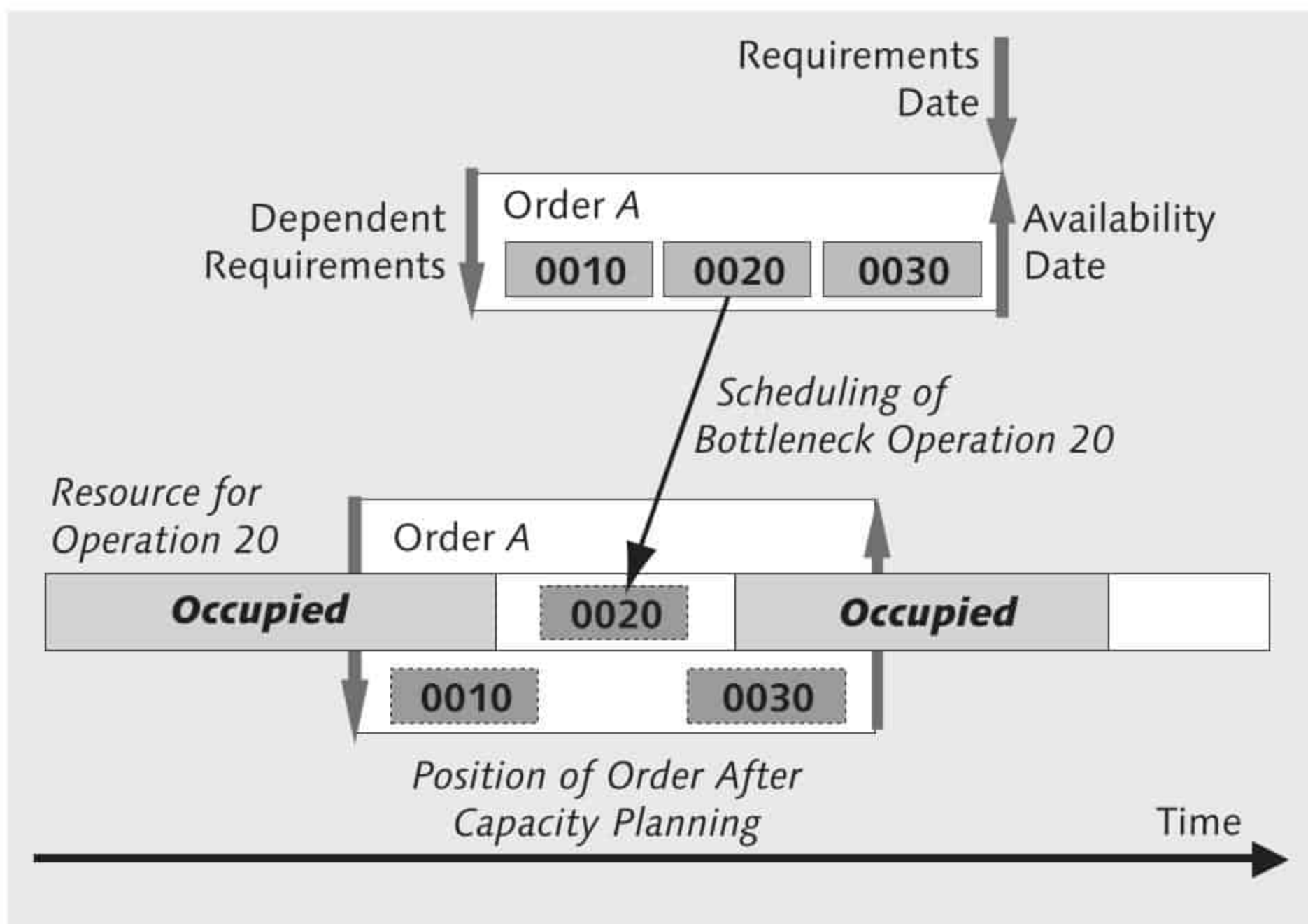


Figure 2.5 Capacity Planning for the Bottleneck Resource of an Order

Operation 0020 shown in Figure 2.5 is executed using the bottleneck resource. The total order is based on the bottleneck resource, which means that the availability date and secondary requirements have to be shifted.

You will need to react to these shifts with a new requirements plan, with which any new orders are generated with the scheduled requirement, and so on.

Material requirements planning and capacity planning are thus closely interwoven. The goal of production planning is to take into account these interdependencies and to create a consistent procurement plan.

Firming To facilitate the planning process, the production plan is often *firmed* in the short term after capacity planning is completed. Individual orders or all orders can be firmed in a defined *planning time fence*. Firming means that the dates and quantities of the orders cannot be changed automatically; however, they can still be changed manually. The component requirements used for an order can also be firmed. This is useful if the required components are manually changed for an order in a way that deviates from the BOM explosion, with the result that a new BOM explosion is no longer possible.

2.2 Advanced Production Planning with APO-PP/DS

The previous section discussed the basic principles of production planning with SAP systems, which apply equally to ECC-MRP and APO-PP/DS. Even if you use APO-PP/DS, you still need to make the basic settings for the production planning process in SAP ECC, so that you can then systematically enhance planning with the functions in SAP APO. This section illustrates the advanced planning options that are available in APO-PP/DS.

Added value of APO-PP/DS APO-PP/DS offers an extremely wide range of additional processes and options. In practice, any one of the points discussed below would be enough to justify using APO-PP/DS — you don't have to use all of the functions simultaneously. Indeed, a gradual and selective enhancement of the core processes is often much more useful.

The master data used for planning in APO-PP/DS is usually transferred from SAP ECC but has different names and a different structure than the master data that exists in ECC. In this chapter, you'll learn about the different types of master data in SAP APO in the context of the CIF transfer.

4 Master Data

In a system group, in which SAP APO is connected with SAP ECC via the Core Interface, ECC is generally considered as the system that “maintains the master data.” But, APO must provide the planning-relevant master data locally for advanced planning. In the following sections, we'll describe the central basic principles for master data management with regard to APO-PP/DS.

4.1 Mapping Principle

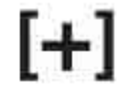
In most cases, the master data in APO is not identical to the master data in ECC. For example, material masters in ECC are transferred to APO as product masters, while production versions with routings and BOMs appear in APO as production process models or production data structures, and so on. During the CIF transfer, the settings made in ECC are processed by the CIF and mapped to the corresponding settings in APO.

APO master data generally has a less complex structure than master data in ECC. You maintain APO master data using the `MASTER DATA` menu option in APO, and often only require a single transaction to do so. While ECC has a separate menu for material masters, for example, all settings and actions relating to the product can be made in the same transaction in APO.

The CIF transfer of APO master data may include the transfer of ECC customizing settings. For example, a plant (which is typically selected in

Transfer of
customizing
settings

an integration model) is defined in customizing in ECC and transferred to APO as a master data record.



Basis Customizing vs. Application Customizing

Customizing settings of the *ECC basis* (such as factory calendars, units of measure, etc.) can be transferred to APO using customizing transport requests, because the settings in the SAP SCM basis correspond to a large degree to those in ECC.

ECC application customizing, in contrast, cannot be transferred to APO. Explicit exceptions to this rule are ATP customizing and various other ECC customizing documents, which can be selected in an integration model.

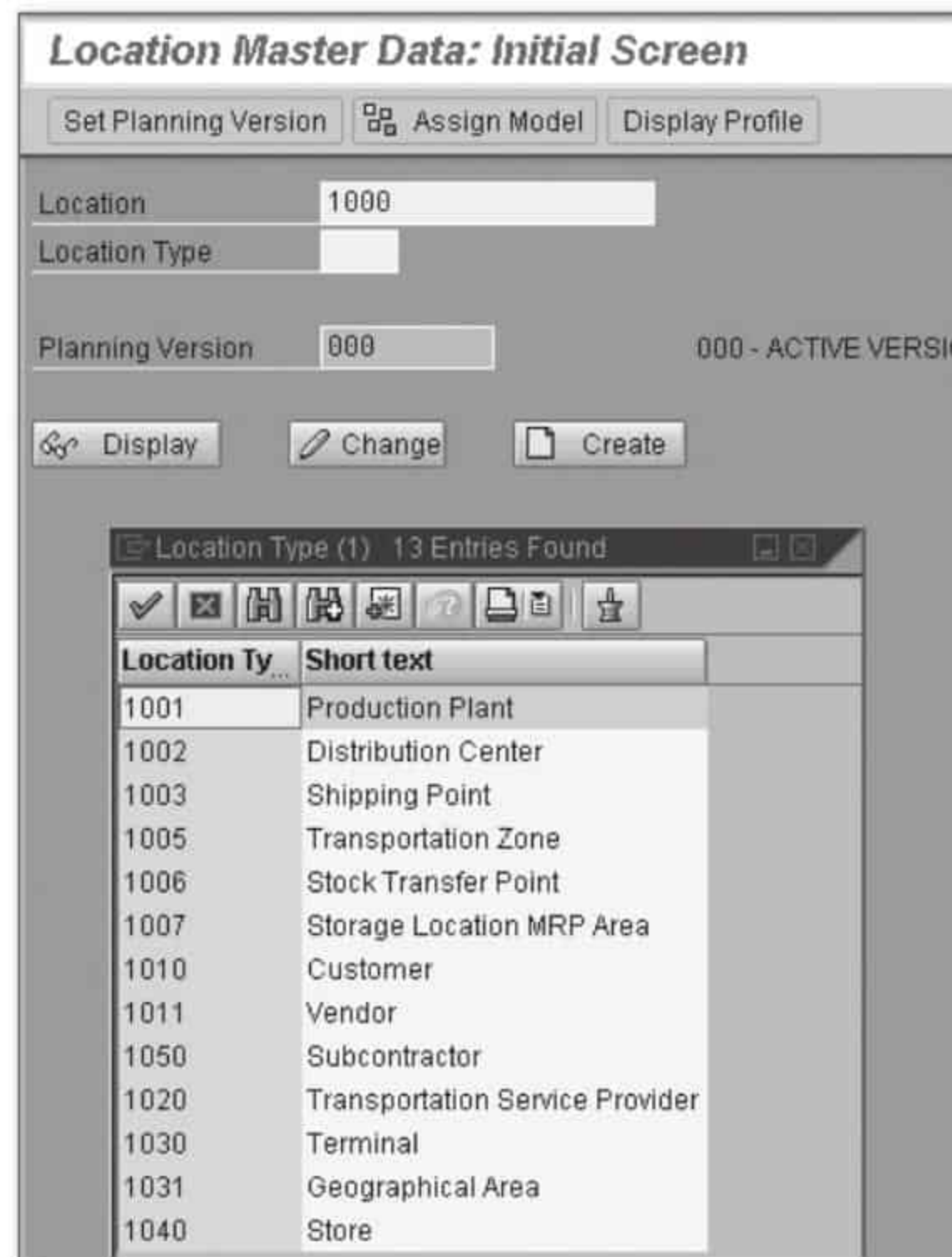


Figure 4.1 "Location" Transaction in APO, Transaction Code /SAPAPO/LOC3, with Field Selection for Location Type

4.2 Locations

Plants, distribution centers, customers, and so on

Plants, distribution centers, MRP areas, customers, and vendors in ECC are mapped in APO as locations with different location types (see Figure 4.1). All locations have the same basic structure but differ from each other at a

more granular level, based on their location type (for example, additional views are available for certain location types in location maintenance).

Table 4.1 shows exactly how ECC master data is mapped to location types in APO during the CIF transfer:

ECC Data	APO Data Location with Location Type
Plant	1001 – Production plant
Distribution center	1002 – Distribution center
Storage location MRP area	1007 – Storage location MRP area
Customer (with transportation zone)	1010 – Customer
	1005 – Transportation zone
Vendor	1011 – Vendor

Table 4.1 Transfer of ECC Data as APO Locations with a Corresponding Location Type (Excerpt)

4.2.1 Transferring Plants and Distribution Centers

Plants are defined using the DEFINE, COPY, DELETE, CHECK PLANT setting in the enterprise structure customizing settings in ECC (see Figure 4.2).



Figure 4.2 "Define, Copy, Delete, Check Plant" Customizing Setting in ECC, Detailed Information for a Plant

Plant If a plant is contained in an integration model, it is transferred to the SAP SCM system as a LOCATION with LOCATION TYPE 1001 (PRODUCTION PLANT). The basic settings for the plant, such as name, address data, time zone, and regional assignment, are transferred (see Figure 4.3).

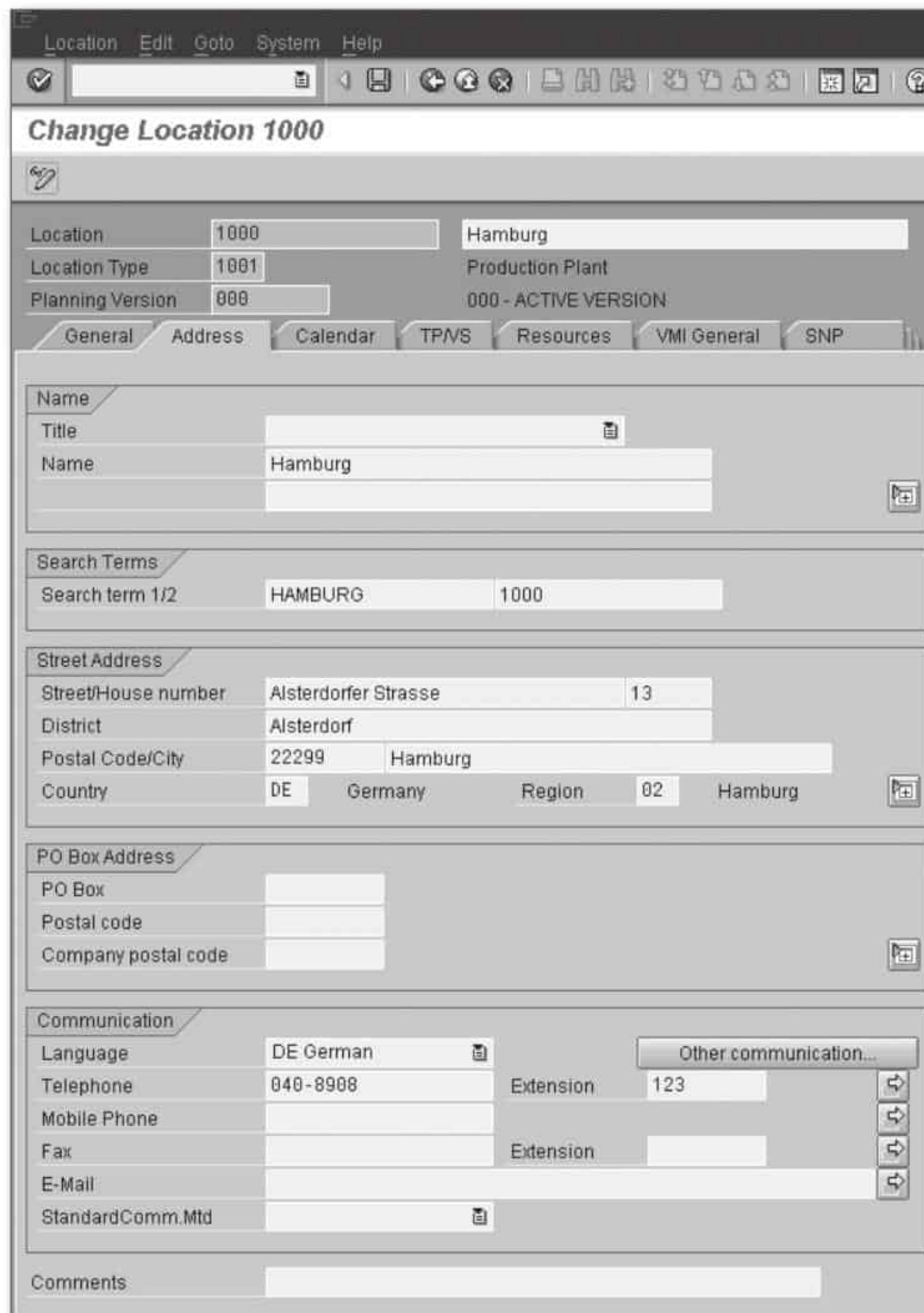


Figure 4.3 "Location" Transaction in APO, Transaction Code /SAPAPO/LOC3, Changing a Location with Location Type 1001, "Address" View



Data Structures in ECC and APO

The data structures in the two systems are not identical. For example, you can define the form of address keys (Mr., Mrs., and so on) in ECC customizing, while these keys are predefined in APO. They can only be transferred if the form of address keys is known in APO.

In addition, the APO location contains a range of APO-specific settings, which must be defined in APO. Also, the short description of locations, unlike those of ECC plants, can be maintained in more than one language.

CIF change transfers are not possible for plants. If APO-relevant data in a plant changes, the changes must be maintained separately in both systems.

A distribution center (DC) in ECC is simply a plant that is assigned the additional attribute DISTRIBUTION CENTER. This attribute was originally developed with SAP R/3 Release 4.0 for *Distribution Resource Planning* (DRP) functions, and the corresponding setting must therefore be made in DRP Customizing (in the MAINTAIN ASSIGNMENT OF NODE TYPE – PLANT customizing step in the basic settings for DRP).

The plant is not changed from a functional standpoint (a different icon merely appears in the graphical applications of DRP).

DRP ECC Functionality

Due to its limited functional scope, the DRP ECC functionality is rarely used in real life. Since SAP R/3 Release 4.0, it hasn't been developed any further in SAP R/3 and ECC.

A powerful cross-plant distribution resource planning was not developed until the release of APO-SNP.

[+]

If you transfer plants to APO that are defined in ECC as distribution centers, these plants are transferred to location type 1002 (distribution center). The transfer of the individual ECC plant settings is exactly the same as for production plants.

4.2.2 Storage Location MRP Areas

As of R/3 Release 4.5, ECC has MRP areas that can be used to differentiate planning. Besides mandatory plant MRP areas (type 1), you can also define storage location MRP areas (type 2) and subcontractor MRP areas (type 3) below the plant level in the customizing settings for material requirements planning.

MRP areas

► **Storage location MRP areas**

If storage location MRP areas are selected in an integration model, they are transferred to APO as location type 1007, and their plant assignment is preserved. The receiving storage location contained in storage location MRP areas is also transferred to APO as a corresponding sublocation (see Figure 4.4).

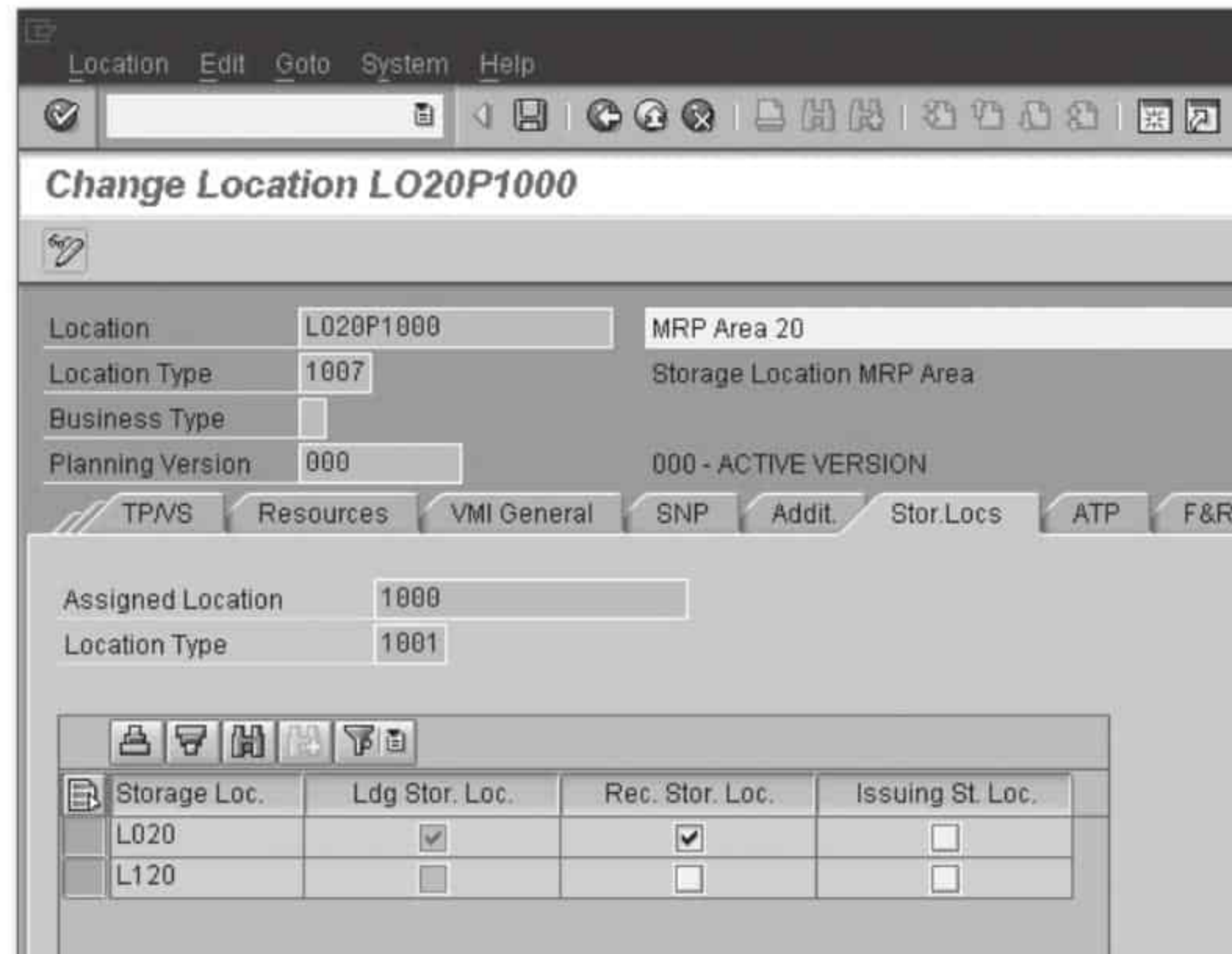


Figure 4.4 "Location" Transaction in APO, Transaction Code /SAPAPO/LOC3, Changing a Location with Location Type 1007, "Storage Locations" View

► **Subcontractor MRP areas**

Subcontractor MRP areas *cannot* be transferred to APO as such. Instead, the vendors themselves are transferred as locations.

MRP area segments

The plant MRP data in an ECC material master may include *MRP area segments* (on the MRP 1 view), which are used for planning with MRP areas. If a material with MRP area segments is included in an active integration model, the MRP area data is also transferred. A location product is then created in APO for each relevant MRP area, in addition to the location product of the plant.

4.2.3 Customers and Vendors

Customers

Customers are maintained as sales and distribution master data records, which can be transferred to APO for planning as locations with location

type 1010. However, this is only necessary if the customer location is explicitly required for planning (for example, for transportation planning for the customer). In normal production planning, this is not usually required, and an ECC sales order can be transferred to APO without the customer.

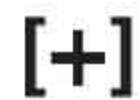
If the customer contains a transportation zone in ECC, an additional corresponding location with location type 1005 is automatically transferred with the customer.

Customers, like vendors (and unlike plants), are transferred to APO with leading zeros. For example, ECC customer 4711 appears in APO as location 0000004711.

The screenshot displays the SAP APO 'Change Location' transaction in the 'Address' view. The window title is 'Change Location 0000003000'. The location is '0000003000' with name 'C.E.B. New York' and location type '1011'. The planning version is '000'. The address view shows: Name 'C.E.B. New York', Search term 'CEB', Street address '7890 Broad Street', Postal code '23459', City 'New York', Country 'US', and Region 'NY'. The communication section shows language 'EN English' and fields for Telephone, Mobile Phone, Fax, and E-Mail.

Figure 4.5 "Location" Transaction in APO, Transaction Code /SAPAPO/LOC3, Changing a Location with Location Type 1011, "Address" View

Vendors Vendors are maintained as purchasing master data records, which can be transferred to APO as locations with location type 1011 (see Figure 4.5). Vendors must be transferred to APO if planning of vendors is explicitly required as part of supply source determination.



Customers and vendors with identical names

The following point is particularly relevant for the transfer of customers and vendors: A location must be identified by a unique name in APO. This also applies if the location types differ. In other words, two locations cannot have the same name in APO, even if they have different location types.

This means that if a customer and vendor have the same number in ECC (for example, customer 1000 and vendor 1000), either the customer or the vendor must be renamed in the APO inbound queue using a customer exit. Conflicts with production plants do not usually occur, because plants are transferred without and customers and vendors are transferred with leading zeros in their names.

4.2.4 External Procurement Relationships and Transportation Lanes

External procurement relationships can be transferred to APO in the form of purchasing info records, delivery schedules, and contracts. They are mapped as corresponding external procurement relationships for purchasing management in APO. Before you transfer external procurement relationships, you must ensure that the references will be recognized in APO. Specifically, the source location (of the vendor), the relevant product, and the target location (the plant in which the product is to be procured) must exist in APO.

Opportunity costs for planning The transfer of data to APO includes the planned delivery times defined in ECC and the purchase prices, including scale prices where relevant (see Figure 4.6). These prices can be used as opportunity costs for planning in APO, so that the most favorably priced supply source can be selected for a specified lot size from several possible supply sources.

Subcontracting If you intend to use subcontract procurement processing for procurement, the relevant data can be transferred to APO using the CIF transfer.

To do this, assign the production version with the subcontracting bill of materials to the supply source in ECC and select the SUBCONTRACTING PPM or PDS object in addition to the supply source in the integration model.

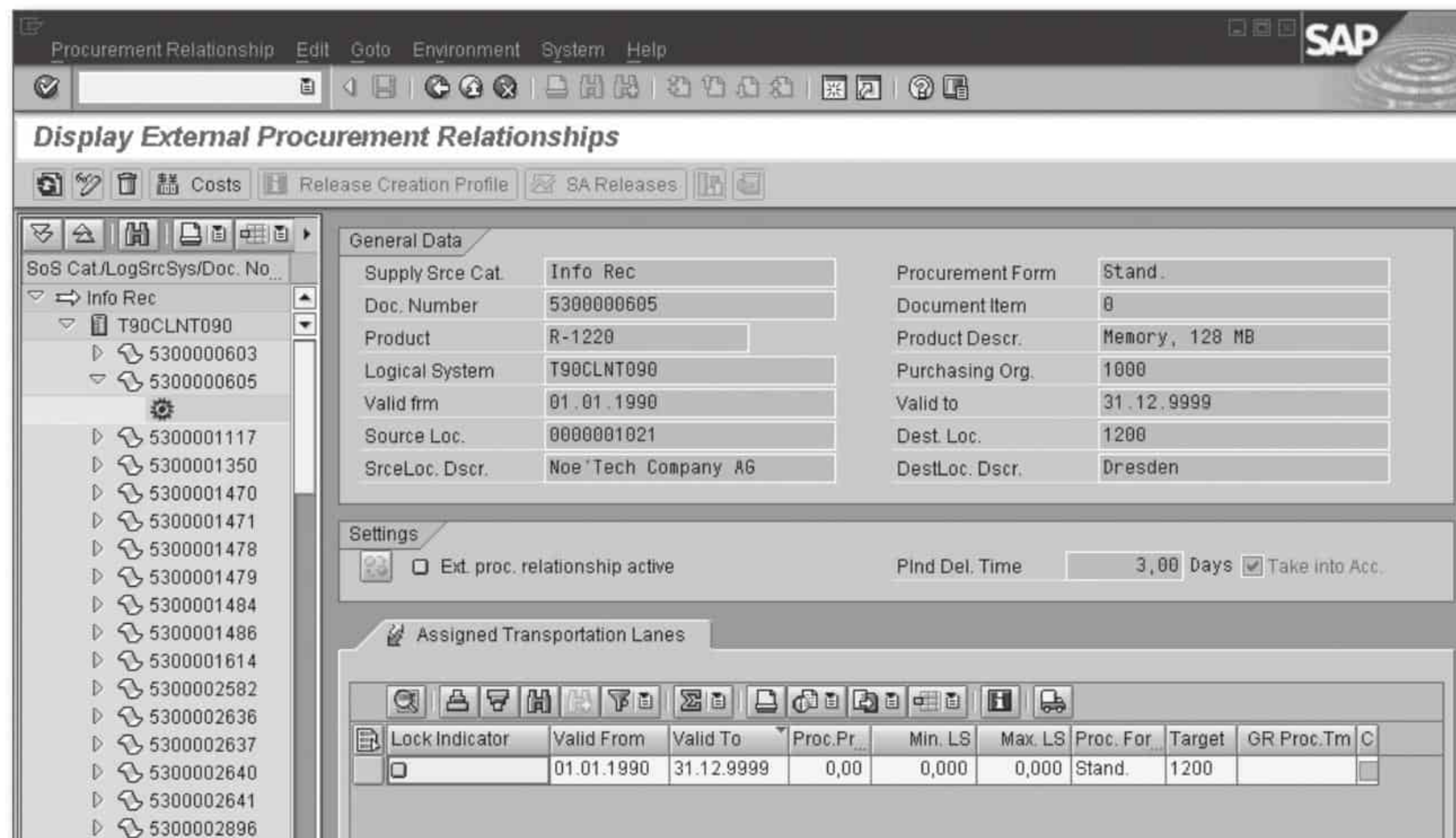


Figure 4.6 "External Procurement Relationships" Transaction in APO, Transaction Code /SAPAPO/PWBSRC1, Displaying a Purchasing Info Record

Quota arrangements cannot be transferred from ECC and must be created in APO. APO does not contain source lists. However, individual external supply sources can be deactivated in APO, which will exclude them from automatic supply source determination.

Quota arrangement and source list

A transportation lane indicates that a product in APO can be procured from another location. It may also contain additional information about the duration of transportation, itinerary, and means of transport, all of which play no role in APO-PP/DS but are relevant for TP/VS or SNP-TLB. The other location may be an alternative internal location (for example, a different production plant), or an external location (for example, an external vendor).

Transportation lanes

[+] **Transportation Lane**

With the CIF transfer of an external procurement relationship, a corresponding transportation lane is automatically created, so you usually do not have to maintain any additional data for APO-PP/DS processes.

Special
procurement type

As of SAP APO 4.0, stock transfers between different plants or distribution centers, as defined with a special procurement type in the ECC material master, can also be automatically transferred to APO as corresponding transportation lanes using the CIF transfer. Any existing transportation lanes that were created manually are not overwritten in this case.

4.3 Products

ECC material masters are transferred to APO as product masters. Provided that they are not renamed using a customer exit, the APO product has the same number as the ECC material.

[+] **Length of the APO Product Number**

The length of the APO product master number can be defined in APO customizing (DEFINE OUTPUT DISPLAY OF PRODUCT NUMBER). By default, an 18-digit product number is used as in ECC.

Product
description

In APO, as in the material master in ECC, the product description can be maintained in multiple languages, and all languages are transferred from ECC. Like the material master in ECC, the product master in APO is divided into several different views. The data in these views falls into one of the following categories:

- ▶ *Header data* (PROPERTIES, UNITS OF MEASURE, CLASSIFICATION tabs) is of a general nature and is not specific to any one location.
- ▶ *Planning data* for a product (DEMAND, LOT SIZE, PP/DS TABS, and so on) is location-dependent.

A product in a specific location is also referred to as a *location product*. Products are maintained in APO in the PRODUCT transaction in the APO master data (see Figure 4.7).

Index

A

Absolute optimum, 255
Accessibility, 251
Action at scheduling error, 244
Activate sequence-dependent setup activities, 249
Active model, 82
Active planning version, 82
Active strategy, 194
Active version, 334
Activities, 233
Additional fields, 120
Additional status, 267
Advanced planning, 19
Alert, 40, 248, 253
Alert-based planning, 40, 225
Alert management, 266
Alert Monitor, 40, 224, 225, 230, 236, 263
Alert notification engine, 267
Alert object type, 267
Alert profile, 220, 264
Alerts, 222
 redefine, 265
Alternate resource, 238
Alternative mode, 237, 247, 260
Alternative procurement source, 269
Alternative production data structure, 310
Alternative resource, 199, 226, 235, 269, 314, 315
Alternative work center, 260
Analytical solution, 255
Anonymous make-to-stock, 148
APO master data, 61
 mass maintenance, 132
APO-PP/DS, 32
APO product number, 114
APO-relevant, 77
APO resource, 83
APO-specific data field, 62

APO target system, 55
Application customizing, 106
Application errors, 95
Ascertaining planned independent requirements, 173
Assembly planning flag, 334
Assignment mode, 148
ATP
 category, 136
 check, 117, 296
 customizing, 116, 296, 298
Automated Planning, 271
Automated production control, 256
Automatic determination of the source of supply, 185
Automatic mode selection, 244, 247
Automatic planning, 226
Availability check, 296
Availability situation, 230
Available capacity, 237, 238, 253
Available to Promise (ATP), 295

B

Background processing, 261
Backlog, 253
Backlog removal, 248
Backlog rescheduling, 254
Backorder processing, 307, 309, 310
Backward planning, 239, 277
Backward scheduling, 25
Backward with reverse, 239
BAdI, 58
Basis customizing, 106
Block limit, 244
Block planning, 243
BOM, 27
Bottleneck, 286
Bottleneck resource, 30, 231, 259, 286, 289, 310
Bottleneck workstation, 276

- Bottom-up planning, 271
 - Breaks, 191
 - BSG, 57
 - Bucket, 242, 304
 - Bucket-finite, 241, 245
 - Bucket-oriented CTP, 296, 304
 - Bucket oriented planning, 242, 254
 - Business system group, 57
 - Button profile, 254
 - By period, 182
- C**
-
- Calendar, 262
 - Campaign, 243
 - Campaign optimization, 261
 - Campaign requirement, 241, 243
 - Capable to Match (CTM), 163
 - Capable-to-Promise (CTP), 270, 295
 - Capacities Requirements Planning (CRP), 387
 - Capacity availability, 262
 - Capacity leveling, 254, 279
 - Capacity load, 231
 - Capacity planning, 30, 222, 231, 234, 238, 251
 - Capacity requirement, 30, 220, 226, 235
 - Capacity requirements planning (CRP), 18
 - Capacity situation, 222, 226
 - Category, 88
 - Category group, 148
 - CBF table, 336
 - CDP configuration, 319
 - Change fixing/planning intervals, 249
 - Change material master, 184
 - Change mode, 220
 - Change pointer, 79
 - Change transfer, 62, 77
 - Change transfer of master data, 77
 - Characteristic, 145, 323, 329
 - Characteristic-based forecasting, 319, 321, 334, 339
 - Characteristic combination, 334, 337
 - Characteristic evaluation, 305
 - Characteristics-dependent planning, 319, 321
 - Characteristics management, 324
 - Chart, 233, 236, 253, 256
 - Chart selection, 223, 224, 251
 - Check control, 305
 - Checking group, 297
 - Checking horizon, 307
 - Check instructions, 297, 298
 - Check mode, 142, 296, 305
 - maintain*, 143
 - CIF, 47
 - CIF cockpit, 101
 - CIF comparison/reconciliation function, 102
 - CIFCUS, 79
 - CIFMAT, 79
 - CIFMTMRPA, 81
 - CIFSRC, 79
 - CIF transfer, 129
 - CIFVEN, 79
 - Class management, 324
 - Class system, 319
 - Clipboard, 252
 - Close slots, 240
 - Collective access, 228, 229
 - Collective display, 228
 - Collective requirements, 149, 152
 - Communication errors, 96
 - Compact scheduling, 245
 - Comply with block planning, 244
 - Configuration characteristic, 322
 - Configuration-dependent setup, 269
 - Configuration profile, 326
 - Configuration schema, 319
 - Consider Maximum Intervals, 245
 - Consider safety stock requirements in SAP liveCache, 209
 - Consider time buffer (pegging), 241, 246
 - Constraint, 231, 235, 239, 247, 254, 255
 - Constraint programming, 261
 - Constraint propagation, 262
 - Consumption, 342
 - Consumption-based planning, 24

- Consumption group, 154
 - Context menu, 251, 252, 253
 - Context of an order, 202
 - Continuous input and output, 167
 - Control parameter, 165
 - Conversion, 220, 342, 345
 - flag*, 214
 - of Orders*, 214
 - rule*, 150
 - Costs, 260
 - Cross-location view, 227
 - Cross-order relationship, 245
 - CRP, 23
 - CTP check, 243
 - CTP confirmation, 301
 - CTP scenario, 240
 - Current date, 242
 - Current modes, 242
 - keep*, 247, 242
 - Customer, 110
 - Customer exit, 58
 - Customer requirements class, 296
 - Customer requirements type, 296
 - Customer's required date, 249
 - Customizing, 221, 227, 233, 236, 249, 250, 254, 257, 266
- D**
-
- Database, 220
 - Database alert, 267
 - Data channel, 96
 - Data structure (ECC and APO), 108
 - Data view, 339
 - Date, 262
 - Date alert, 204
 - Date and time entry, 235
 - Date fixed, 177
 - Date/time violation, 236
 - Days' supply, 219, 230
 - type*, 222, 227
 - Deallocation, 235, 345
 - Deallocation costs, 256
 - Define activities for mass processing, 147
 - Define finiteness level for resources, 198
 - Degree of freedom, 262
 - Delay, 248, 259, 264
 - Delay costs, 258, 259
 - Deletion flag, 81
 - Delivery time, 25
 - Demand planning book, 334
 - Demand Planning (DP), 19
 - Dependencies, 325, 326
 - Dependent operation, 245, 248
 - Deployment, 227
 - Descriptive characteristics, 33, 154
 - Desired date, 242
 - Detailed planning heuristic, 248
 - Detailed scheduling function, 273
 - Detailed scheduling heuristic, 231, 236, 248, 253, 271
 - Detailed scheduling planning board, 222, 226, 227, 231, 233, 249, 250, 288
 - Detailed scheduling strategy, 234
 - Determining the source of supply, 183
 - Diagram area, 233
 - Diagram section, 251
 - Direction of interchangeability, 211
 - Disaggregation key figure, 335
 - Display operation in work area, 253
 - Display period, 253
 - Distribution definition, 56, 92
 - Distribution plan, 227
 - Distribution Resource Planning (DRP), 109
 - Downtime, 253
 - DP, 387, 388
 - Drag-and-drop, 235, 252, 253
 - DS strategy, 234
 - profile*, 237
 - DS view, 194
 - Dynamic exception
 - alerts*, 222
 - condition*, 317
 - message*, 220, 225, 226
 - Dynamic pegging, 204, 246, 248
 - Dynamic setup, 259

E

Earliest date, 242
 Eliminate transfer error, 101
 Elimination of transfer errors, 101
 End of Horizon, 255
 End run at the first solution, 261
 Enhanced backward scheduling, 249
 Error, 225, 264
 Error-tolerant scheduling, 244, 247
 Evaluation tool, 217
 Exact solution to a problem, 254
 Exception-based planning, 225, 317
 Exception group, 229
 Exception message, 29, 39, 219, 225, 230, 235, 240, 253, 263
 Execute the integration model, 67
 Expert view, 194
 Explain result, 261
 Extended selection, 223, 227, 229
 External capacity, 84
 External procurement, 25, 185
 relationship, 112

F

Factorial, 255
 Feasible plan, 226, 247
 Feasible production plan, 304, 306, 317
 Feasible production program, 235, 282
 Feasible solution, 262
 Field selection, 251
 Filter object, 90
 Find slot, 235, 238, 239
 Finish date, 26
 Finite, 234
 Finite capacity, 242
 Finite forward planning, 239
 Finite MRP run, 270
 Finiteness level, 198, 243, 247, 260
 Finite planning, 199, 269
 Finite requirements planning, 193, 270, 301, 311
 Finite resource, 197, 239
 Finite scheduling, 31

Finite strategy, 270
 Firming, 32, 176
 Firming date, 178
 Firming horizon, 178
 Fixed costs, 260
 Fixed date, 144
 Fixed lot size, 182
 Fixed material flow, 305, 307
 Fixed pegging, 207, 246, 248, 304
 Fixing interval, 236, 249, 253
 Flexible planning, 18
 Float after production, 26
 Float before production, 26
 Follow-up rescheduling, 248
 Forecast, 334
 Forecast segment, 219
 Forward scheduling, 28
 Fragmentation, 303, 309
 Function, 161

G

GATP, 387
 General selection options for materials, 64
 Generate Pegging Areas, 162
 Genetic algorithm, 262
 Global ATP, 19, 296
 Global parameters and default values, 94, 136
 maintain, 137
 Goods issue time, 189
 Goods receipt time, 189
 Graphic object, 251

H

Hard constraint, 262
 Heuristic, 141, 164, 220, 222, 226, 227, 249, 255
 Heuristically, 262
 Heuristic for flow control, 171
 Heuristic profile, 158, 248
 Heuristics package, 170

Highlighting, 236
 Horizon, 255, 261

I

Ignore error, 71
 Inactive version, 334, 340
 Inbound queue, 60
 Incremental data transfer, 72
 Individual/collective flag, 333
 Individual customer requirement, 152
 Industry solution, 21, 322
 Industry-specific process, 261
 Infinite, 234
 Infinite planning, 193
 Infinite scheduling, 31, 239, 240
 Infinite sequencing, 240
 Information, 225, 264
 Inheriting fixed pegging, 208
 In-house production, 25, 28
 Initial dialog, 255
 Initial transfer, 62
 Input firmed, 177
 Insert operation, 235
 Integration model, 63, 89
 Activate, 68
 Create, 63
 Delete, 76
 Execute, 66
 Interactive demand planning, 340
 Interactive detailed scheduling, 248
 Interactive optimization, 255
 Interactive planning, 157, 234, 248, 255
 Interactive setup optimization, 285
 Interactive sourcing, 187
 Interruptibility of activities, 262
 Inventory management, 233

K

Key figure, 145, 258, 334
 aggregation, 335
 attribute, 339

L

Layout, 222, 227, 230, 233, 251
 Lean manufacturing, 222, 223, 310
 Line-loading planning, 226
 Line utilization planning, 311, 318
 List area, 253
 liveCache, 21
 Location, 106, 190
 Location product, 217
 Location type, 107
 Log, 236, 261, 314
 Log Deactivated Material Masters, 68
 Logical unit of work, 98
 Loser products, 193
 Lot-for-lot, 182
 Lot size, 118, 168
 settings from heuristic, 182
 procedure, 167
 Low-level code, 162, 273, 284, 311, 314
 alignment, 274
 method, 270, 271, 275
 LTP, 18, 387
 LUW, 98

M

Maintain conversion rules, 150
 Maintain heuristics, 165, 207
 Maintain Interchangeability Group, 213
 Maintain proportional factors manually, 338
 Maintain strategy profile, 194
 Make span, 258, 259
 Make-to-order production, 152
 Make-to-order segment, 219
 Make-to-stock strategy, 298
 Manual planning, 235, 253
 Manual postprocessing, 284
 Manual sequencing, 248, 284
 Manufacturing order network, 344
 Mapping principle, 105
 Mass changes to APO master data, 132
 Mass conversion, 220
 Mass data, 228

Mass rescheduling, 247
 Mass selection, 228
 Master data, 105
 maintenance, 124
 Master recipe, 30
 transfer, 131
 Material availability, 262
 Material requirements planning, 24
 Material variant, 320
 Maximum delay costs, 258, 259
 Maximum integration model, 72
 Maximum interval, 245
 Maximum lot size, 183
 Maximum runtime, 261
 Message types, 79
 Middle-out planning, 271
 Minimize runtime, 248
 Minimum lot size, 183
 Mixed MRP flag, 320
 Mixed resource, 82
 MM, 17, 387
 MM02, 184
 Mode, 239, 242, 244
 Mode costs, 259, 260
 Model, 82
 Model and planning version
 management, 136
 Mode priority, 195, 201
 Monitoring, 95
 MRP, 18, 23, 387
 MRP-based detailed scheduling, 343
 MRP element, 222
 MRP flag, 333
 MRP II concept, 29, 271
 MRP list, 228
 MRP planner, 222
 MRP type, 24, 65
 MRP type X0, 65
 Multi-activity resource, 82
 Multilevel costs, 186
 Multiple loading, 236
 Multi-resource, 241
 Multi-resource planning, 310, 311, 314

N

Navigation area, 233
 Navigation structure, 223, 252, 253, 289
 Navigation tree, 222, 227
 Net change planning, 161
 Net requirements calculation
 (documentation), 180
 Network alert, 206
 Network display, 233, 236, 251
 Network view, 291, 294
 Non-availability, 295, 296, 307, 309
 Non-working time, 235, 243, 253
 Number range, 136, 267, 301, 302

O

Objective function, 258
 Offset, 189
 Offset time, 192, 239, 242
 Online transfer, 78
 Open selection criteria, 75
 Operation, 233, 234
 insert, 239, 284
 squeeze in, 235
 Operation from behind
 append, 240
 Operation list, 236, 253
 Opportunity cost, 112
 Optimization, 256, 272, 288
 concepts, 254
 horizon, 255, 259, 261
 objective, 259
 parameter, 256, 257
 procedure, 261
 profile, 227, 249, 255, 256, 257,
 261, 280
 result, 254
 run, 255
 Optimized setup, 231
 Optimizer, 175, 231, 253, 280, 285
 Optimizing lot-sizing procedure, 167
 Optimum, 255
 Order, 220, 233
 Order-internal relationship, 195, 245,

246, 247
 Order list, 236, 251
 Order liveCache, 21
 Order priority, 259, 269, 285
 Order processing, 217
 Order report, 35, 204
 Order structure, 239
 Order view, 217, 222
 Outbound queue, 60
 Outlet, 244, 247, 314
 Output firmed, 176
 Overall lead time, 259
 Overall planning, 272
 Overall production costs, 258
 Overall profile, 227, 231, 238, 249, 263
 Overlap, 253
 Overload, 222, 226, 236, 240, 279

P

Parallelize, 69
 Parameterization, 257
 Parisian parking, 239
 Pegged requirement, 35
 Pegging, 202, 248, 305
 area, 202
 ATP, 305
 consider, 305
 network, 202
 overview, 217
 relationship, 36, 202, 254, 235
 requirements, 204
 strategy, 204
 structure, 246
 Performance, 233
 Period factor, 182
 Periodic change transfer, 78
 Periodic planning, 227
 Periodic product view, 222
 Periodic view, 253
 Period of adjustment, 174
 Period-oriented, 253
 plan, 254
 planning, 222, 223
 Period profile, 254
 Permutation, 254
 Phase-out control, 211
 PI, 17
 Pick-and-drop, 252, 253
 Plan explosion, 183
 Planned delivery time, 189
 Planned independent requirements, 144
 Planned order quantity, 237
 Planning, 219
 Planning adjustment, 153
 Planning area, 334
 Planning board profile, 233, 251
 Planning book, 338
 wizard, 338
 Planning date, 253, 229
 Planning direction, 235, 239, 240, 243, 253
 Planning file, 161
 display, 162
 Planning group, 163, 229
 Planning in an active version, 321
 Planning in an inactive version, 321
 Planning interval, 249
 Planning log, 254
 Planning mode, 193, 238, 240, 247
 Planning object, 275, 278
 structure, 334
 Planning of shortage quantities, 167
 Planning of standard lots, 166
 Planning package, 212
 Planning period, 223, 253
 Planning procedure, 138, 236, 284
 maintain, 139
 Planning product, 152
 Planning profile, 334
 Planning-related minimum interval, 241, 245
 Planning reservation, 161
 Planning result, 231
 Planning run, 229
 Planning strategy, 192
 Planning submode, 245, 247
 Planning table, 223, 334
 Planning versions, 82
 Planning with final assembly, 149, 298
 Planning without final assembly, 149, 333
 Planning with planning product, 152

- Plant, 108
 - Plant stock, 298
 - Plug-in, 48
 - PP, 18
 - PP/DS, 387
 - alert*, 266
 - alert profile*, 225, 264
 - bucket capacity*, 242, 304
 - horizon*, 160
 - Optimizer*, 226, 236, 254, 255, 285, 306, 309, 317
 - PP-Firmed, 177
 - PPM change transfer, 85
 - PP strategy profile, 238
 - PP view, 194
 - Primary resource, 313
 - Prioritization, 267
 - Priority, 143, 173
 - Priority category, 264
 - Process heuristic, 306, 307
 - Processing indicator, 230
 - Process-related minimum interval, 245
 - Procurement date, 220
 - Product, 114, 233
 - alert*, 206
 - allocation group*, 322
 - description*, 114
 - heuristic*, 157, 166, 220
 - hierarchy*, 152
 - interchangeability*, 211
 - interchangeability groups*, 211
 - inventory*, 233, 236
 - Production calendar, 190
 - Production costs, 258, 260
 - Production data structure, 85, 116, 124, 223
 - Production Data Structure (PDS), 125
 - release-dependent notes*, 125
 - Production date, 26
 - Production in a different location, 184
 - Production line, 311
 - Production list, 226
 - Production order, 215, 220
 - Production overview, 236
 - Production planner, 223, 263
 - Production planning, 23
 - Production Planning/Detailed Scheduling (PP/DS), 19, 23
 - Production planning run, 159, 160, 255, 270, 271
 - Production process, 231
 - model*, 85, 116, 124, 185, 223, 388
 - Production program, 225, 226
 - Production quantity, 236, 237, 238
 - Production rate, 313
 - Production version, 37, 312
 - Product overview, 228
 - Product planning table, 222, 224, 230, 287, 314
 - Products, 229
 - Product stock, 251
 - Product view, 217, 218, 230
 - periodic*, 224, 225, 315
 - Profile, 221, 227, 251
 - Profile maintenance, 250
 - Propagation range, 161, 222, 227, 233, 249, 260
 - Proportional factor, 335, 339
-
- Q**
-
- qRFC-Alert, 101
 - qRFC Monitor, 99
 - Quantity alert, 204
 - Quantity planning, 237
 - queued Remote Function Call (qRFC), 96, 388
 - Quota arrangement, 113, 318
 - Quotation heuristic, 318
-
- R**
-
- Receipts view, 217
 - Reconciliation, 271
 - Redirection of exception messages, 266
 - Reducing planned independent requirements, 153
 - Reduction of lead time, 245
 - Regenerative planning, 235, 238
 - Relationship, 235, 239, 241, 248, 254, 284

- Release sales planning to SNP, 146, 156, 157, 158
 - Removal of backlogs, 249
 - Reorder point method, 137
 - Repetitive manufacturing, 310
 - Report, 236
 - RAPOKZFX*, 74
 - RCIFIMAX*, 72, 76
 - RCIFMTDE*, 68, 76
 - Representative, 266
 - Requested delivery date, 143
 - Requested quantity, 143
 - Required date, 239, 240
 - Requirement ascertainment horizon, 174
 - Requirement check, 150
 - Requirement class, 142
 - Requirement coverage element, 248
 - Requirement date/time, 231, 235, 239
 - Requirement planning, 240
 - with exact times*, 33
 - Requirements strategy, 117, 142
 - Requirement type, 142
 - Requirement view, 217
 - Reschedule, 226, 253, 277
 - Rescheduling, 231, 234, 235, 238
 - Resource, 82, 121, 197, 223, 231, 233
 - Resource assignment, 249
 - Resource buffer, 260
 - Resource category, 121
 - Resource chart, 289
 - Resource load, 226, 236, 253
 - Resource overload, 225
 - Resource overload alert, 198
 - Resource planning table, 250, 251
 - Resource pool, 252
 - Resource schedule plan, 233
 - Resource selection, 232
 - Resources in APO, 121
 - Resource situation, 233
 - Resource time buffers, 246
 - Resource utilization, 253
 - planning*, 310
 - Resource view periodic, 224, 226
 - Reuse mode, 167
 - Reverse, 240
 - Reversing the planning direction, 247
 - RFC, 51
 - RFC connection, 51
 - Right mouse button, 238
 - RIMODAC2, 76
 - RIMODDEL, 76
 - RIMODGEN, 76
 - Rounding profile, 183
 - Rounding value, 183
 - Routing, 30
 - Row format, 251
 - RTO, 388
 - Rules-based availability check, 297
 - Runtime, 261, 262
 - Runtime Object (RTO), 125, 388
 - release-dependent notes*, 125
- ## S
-
- Safety days' supply, 180
 - Safety stock, 180, 208
 - Safety time, 180
 - SALE, 51
 - Sales order, 142, 298
 - SAP APO, 19
 - SAP APO customizing, 221
 - SAP ECC, 17
 - SAP for Mill Products, 322
 - SAP_MRP_001, 172
 - SAP_MRP_002, 172
 - SAP Note
 - 217210*, 130
 - 321474*, 122
 - 329733*, 122
 - 487166*, 180
 - 604878*, 126
 - 617281*, 212
 - 617283*, 212
 - 698427*, 208
 - 704583*, 208
 - SAP_PP_002, 141, 166, 180
 - SAP_PP_003, 141, 166
 - SAP_PP_004, 166
 - SAP_PP_005, 166
 - SAP_PP_007, 166

- SAP_PP_010, 173
- SAP_PP_011, 208
- SAP_PP_012, 173
- SAP_PP_013, 166
- SAP_PP_014, 173
- SAP_PP_015, 174
- SAP_PP_018, 208
- SAP_PP_019, 207
- SAP_PP_020, 174
- SAP_PP_C001, 166
- SAP_PP_CTP, 141
- SAP_PP_I001, 212
- SAP R/3, 17
- Schedule Sequence, 248
- Schedule slippage, 277
- Scheduling, 30, 189, 231, 234, 235
- Scheduling at block limits, 244
- Scheduling attempt, 234
- Scheduling error, 247
- Scheduling margin key, 27
- Scheduling offset, 242
- Scheduling on the required date, 239
- Scheduling operations, 248
- Scheduling problem, 248
- Scheduling sequence, 195, 235, 242, 248, 249, 285
- Scheduling state, 236
- SCM Queue Manager, 100
- SD, 17
- Search area, 262
- Search for gaps, 196
- Search procedure, 262
- Selection, 232
- Selection condition, 325
- Selection criteria, 263
- Selection rule, 218, 222
- Selection variant, 263
- Sequence, 235, 238, 239, 262
- Sequence-dependent setup activity, 249
- Sequence-dependent setup time, 241
- Sequence planning, 253, 254
- Sequencing, 226, 231, 242, 251, 284, 293
- Service heuristics, 173
- Set, 233
- Set requirements strategy, 148
- Setup activity, 209, 249, 311
- Setup-condition-dependent setup time, 285
- Setup costs, 258, 259
- Setup key, 209
- Setup matrix, 209, 269, 285, 286, 290
- Setup optimization, 288, 289, 291
- Setup sequence, 285
- Setup-status-dependent setup time, 259
- Setup time, 209, 235, 258, 259, 285
- Set user parameters, 92
- SFC, 17, 388
- Shift, 226
- Shop floor control, 226
- Shop floor papers, 256
- Shortage, 180, 225, 230
- Shuffler, 233, 252
- Simultaneous quantity and capacity planning, 34, 270, 318
- Single-activity resource, 82
- Single level costs, 186
- Single resource, 239, 241
- SM59, 52
- SNP, 388
- SNP Optimizer, 254
- Soft constraint, 262
- SOP, 18, 388
- Sorting sequence, 242, 284
- Source of supply, 244
- Special procurement key, 184
- Special procurement type, 114
- Special stock, 218
- Specified date, 242
- Stable forward scheduling, 249
- Stage numbering, 273, 284
algorithm, 174
- Standard optimization profile, 262
- Start of Horizon, 255
- Start of Optimized schedule, 256
- Status information, 233
- Stock available for MRP, 180
- Stocking, 332
- Storage location MRP area, 109
- Strategy profile, 194, 249
- Strategy setting, 235, 237
- Subassembly forecast, 149
- Subassembly planning, 320
- Subcontracting, 112

Submode, 245
 Subprofile, 232
 Substitution orders, 212
 Super BOM, 325
 Super routing, 326
 Supersession chain, 211
 Supply Chain Management (SCM), 17, 18
 Supply Network Planning (SNP), 19
 Surplus, 230

T

Table area, 233
 Table-oriented, 251
 Target host, 52
 Temporal termination criterion, 248
 Temporary requirement, 300
 Termination criterion, 248, 255, 261, 262
 Threshold value, 264
 Time buffer, 191
 Time constraint, 235, 239
 Time-continuous capacity, 242
 Time-continuous CTP, 296, 298
 Time decomposition, 260
 Time factor, 191
 Time interval between activities, 191
 Timeliness, 292
 Time profile, 160, 233, 249
 Time relationship, 262
 Time series liveCache, 21
 Time series object, 335, 337
 Time window, 255
 Toolbar, 251
 Top-down planning, 271
 Total delays, 259, 292
 Total of the delay costs, 258
 Total of the mode cost, 259
 Total of the setup costs, 258
 Total of the setup times, 258, 288
 Total replenishment lead time, 28, 320
 Trade-off, 260
 Transaction codes
 /SAPAPO/MC90, 147
 BD50, 79
 BD61, 79
 CFC2, 99
 CFC9, 77
 CFM1, 63, 64
 CFM2, 68
 CFP1, 79
 CFP1, 79
 CFP4, 85
 CR02, 84
 CURTO_CREATE, 86
 /INCMD/UI, 212
 PIMG, 50
 /SAPAPO/C4, 56, 92
 /SAPAPO/C5, 93
 /SAPAPO/C41, 99
 /SAPAPO/CDPSB0, 161
 /SAPAPO/CDPSC11, 165, 207
 /SAPAPO/CSP1, 155
 /SAPAPO/LOC3, 190
 /SAPAPO/MC90, 156
 /SAPAPO/MD74, 153, 154
 /SAPAPO/MVM, 138
 /SAPAPO/RES01, 197
 /SAPAPO/RRP3, 144
 /SAPAPO/RRP_NETCH, 162
 /SAPAPO/SCC03, 185
 /SAPAPO/SDP94, 145
 Transaction data, 89
 integration, 88
 Transfer customizing, 105
 Transfer distribution centers, 107
 Transfer new APO-relevant master data, 75
 Transfer of planning results, 136
 Transfer plants, 107
 Transportation lane, 112

U

Undo, 236, 254
 Usage probability, 321, 339
 User settings, 221, 227
 Use-up strategy, 211
 Utilization rate, 191

V

Validity area, 247
Validity periods for orders, 243
Value assignment, 330
Variable costs, 260
Variable heuristic, 157, 220
Variable view, 231, 232
Variant configuration, 319
 Characteristic propagation, 322
Variants, 223
VC configuration, 319
Vendor, 112
Viable production plan, 269, 272
Visualization profile, 222, 227, 329

W

Warning, 225, 264
Wave algorithm, 310, 315
Weighting criterion, 260
Weighting factor, 258, 339
Window technique, 260
WIP list, 236
Work area, 232, 233, 249, 253
Work center, 30, 82
Work in progress, 236
Worklist, 252, 261