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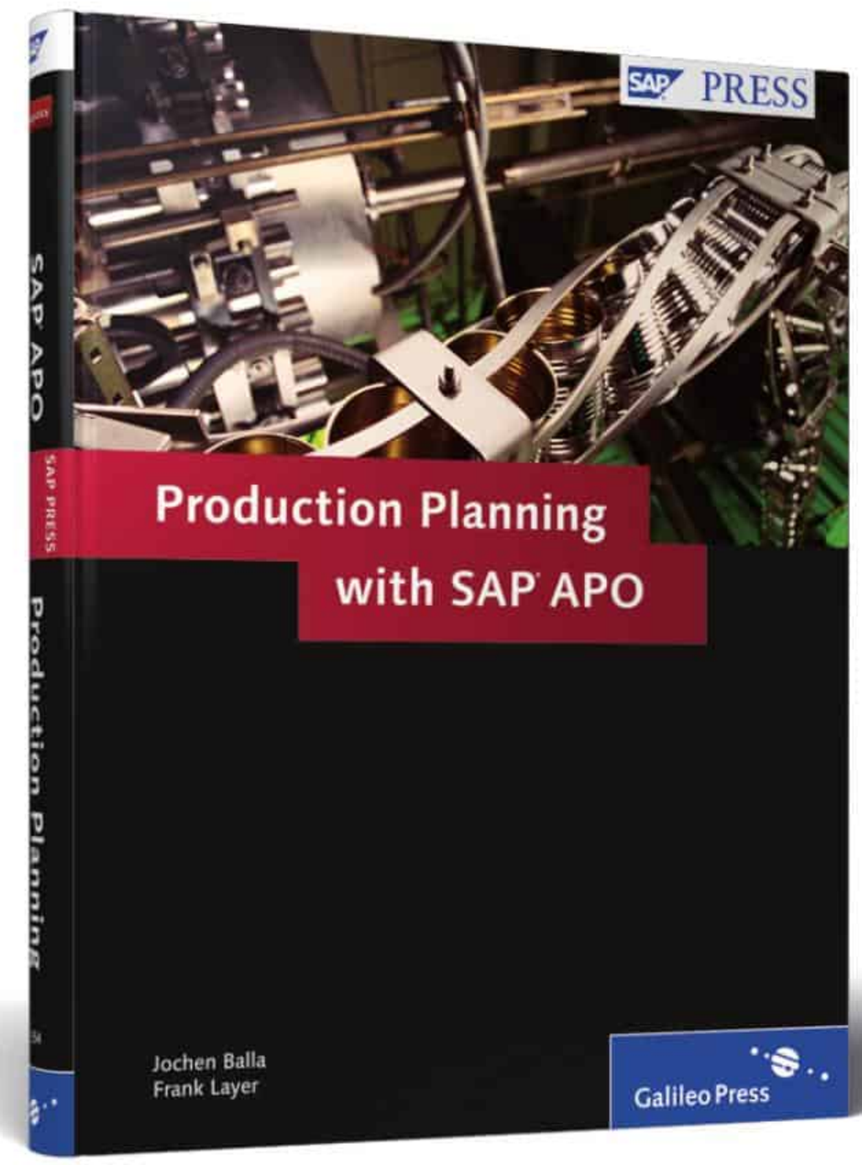
Production Planning with SAP® APO



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Contents at a Glance

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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, MRP, CRP

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*).

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.

Backward scheduling

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).

Procurement Types

Scheduling of a procurement element depends on the procurement type:

- **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.

Special procurement

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.

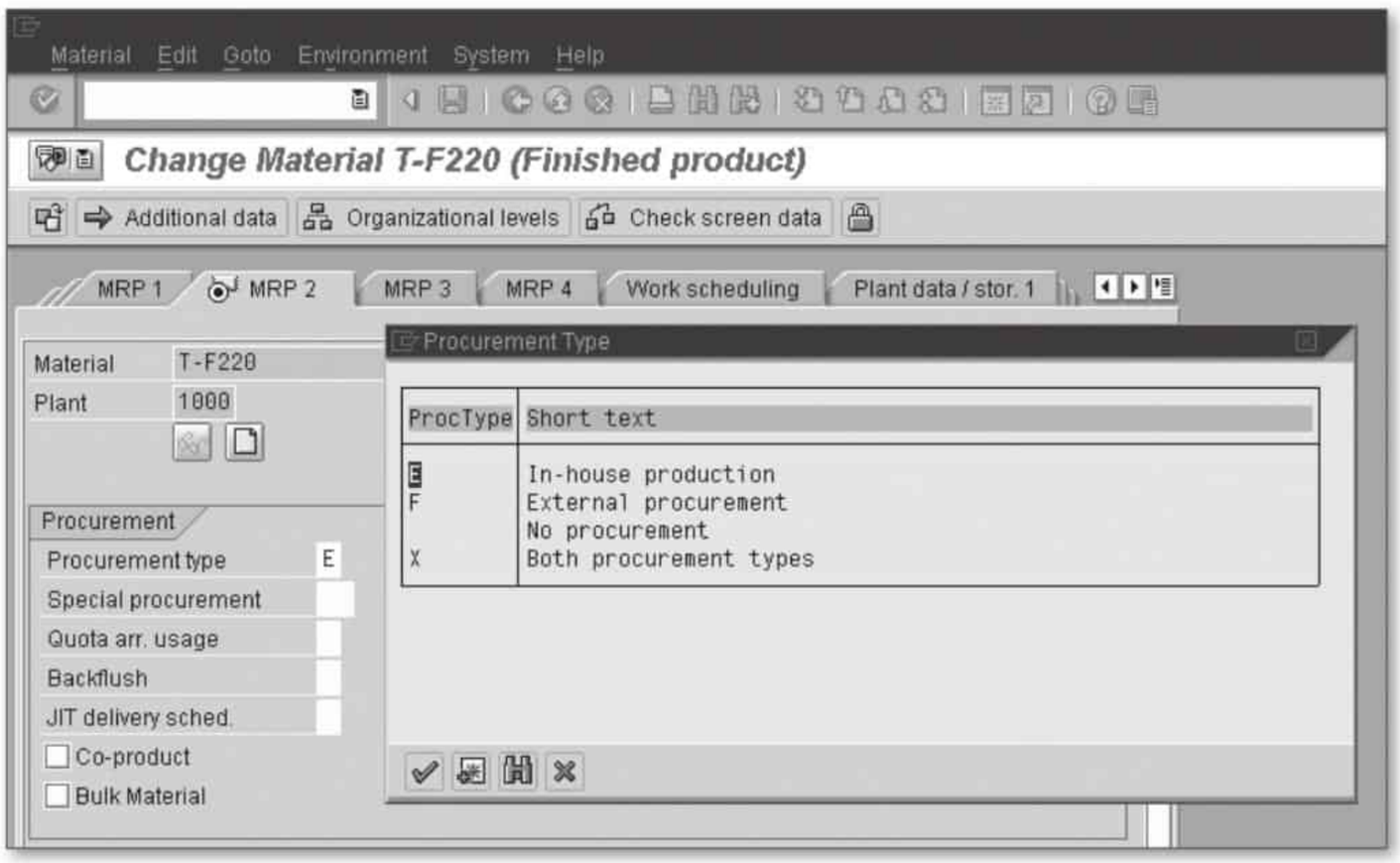

Figure 2.1 ECC Transaction "Change Material Master" (Transaction Code MM02, Material Master View "MRP 2" with Field Selection for Procurement Type)

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).

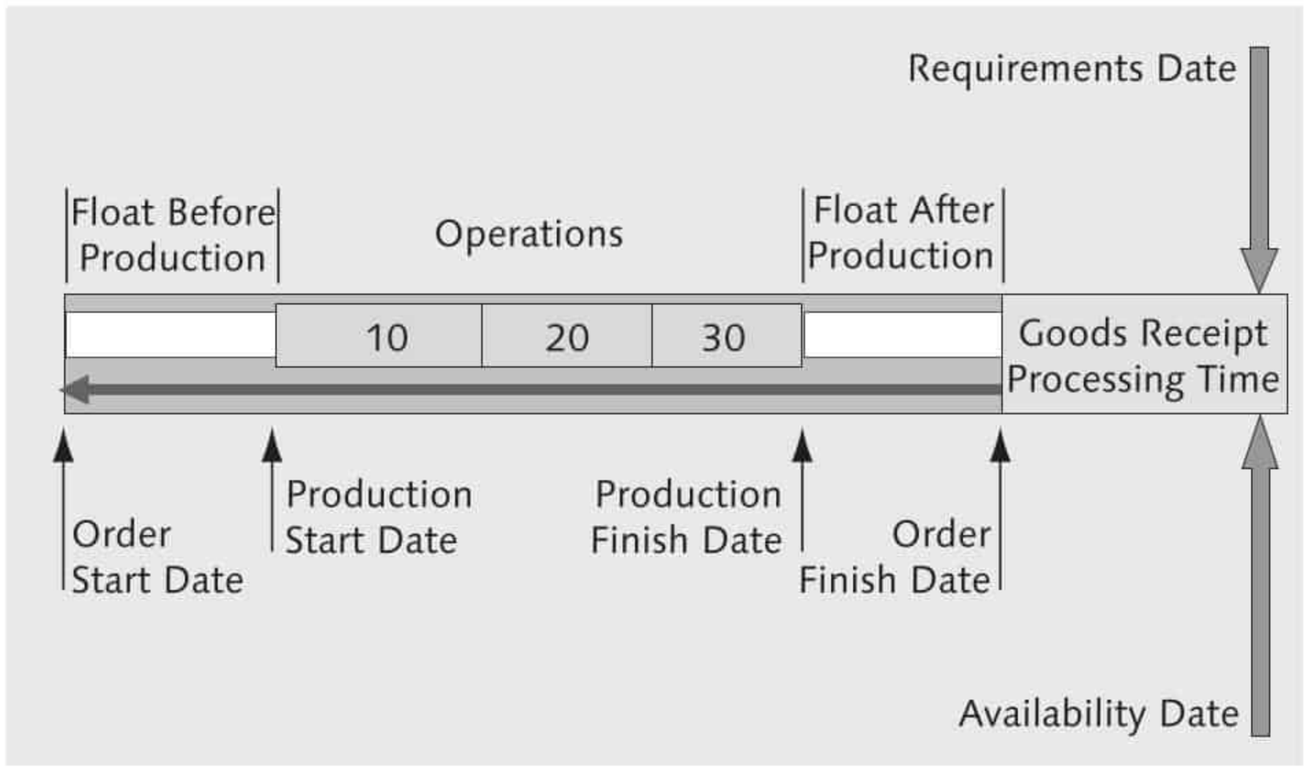

Figure 2.2 Dates in Planned Orders and Manufacturing Orders in SAP ECC

SAP ECC and SAP APO — differences in scheduling

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).

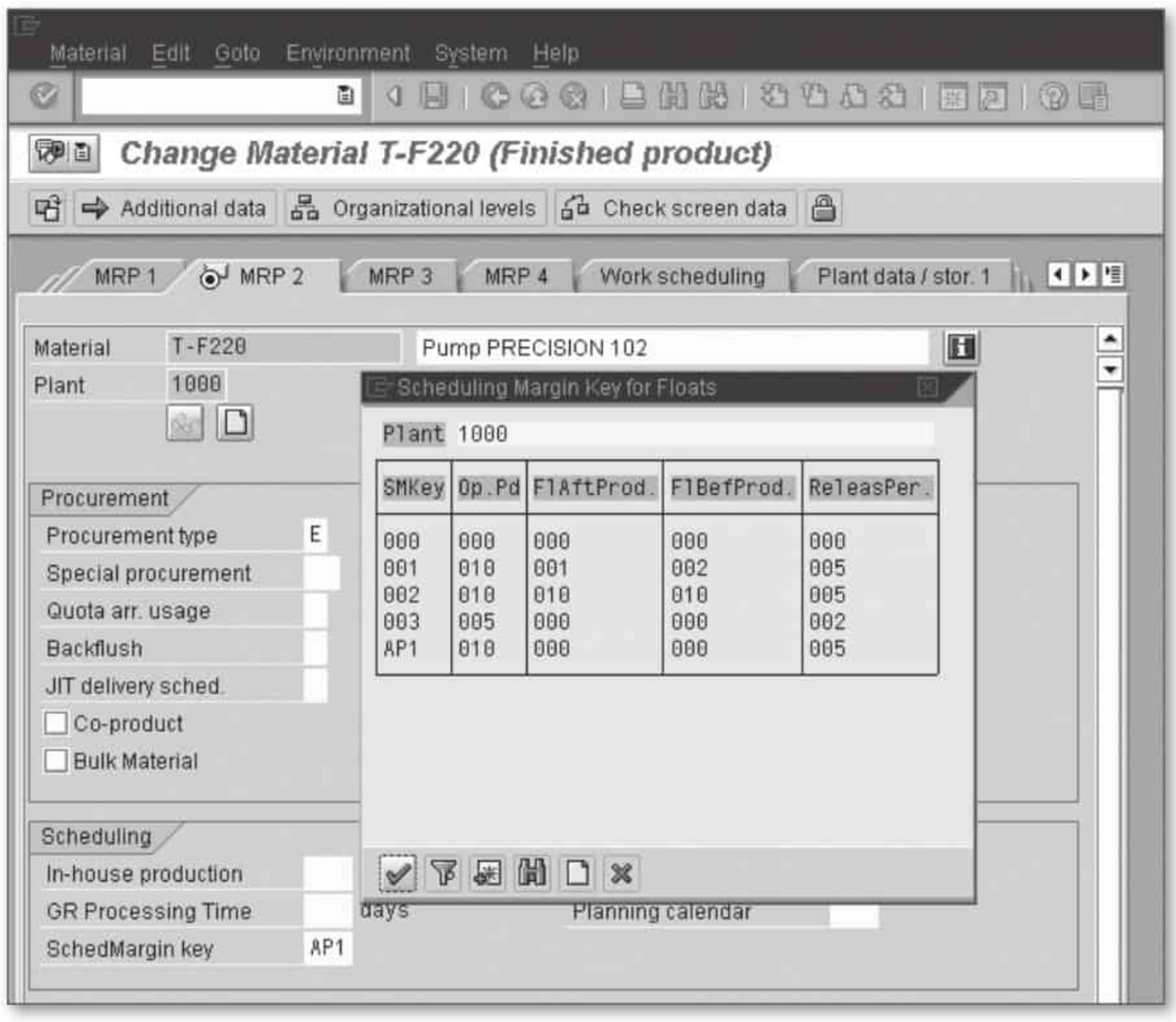

Figure 2.3 ECC Transaction "Change Material Master" (Transaction Code MM02, Material Master View "MRP 2" with Field Selection for Scheduling Margin Key)

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.

BOM explosion

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 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.

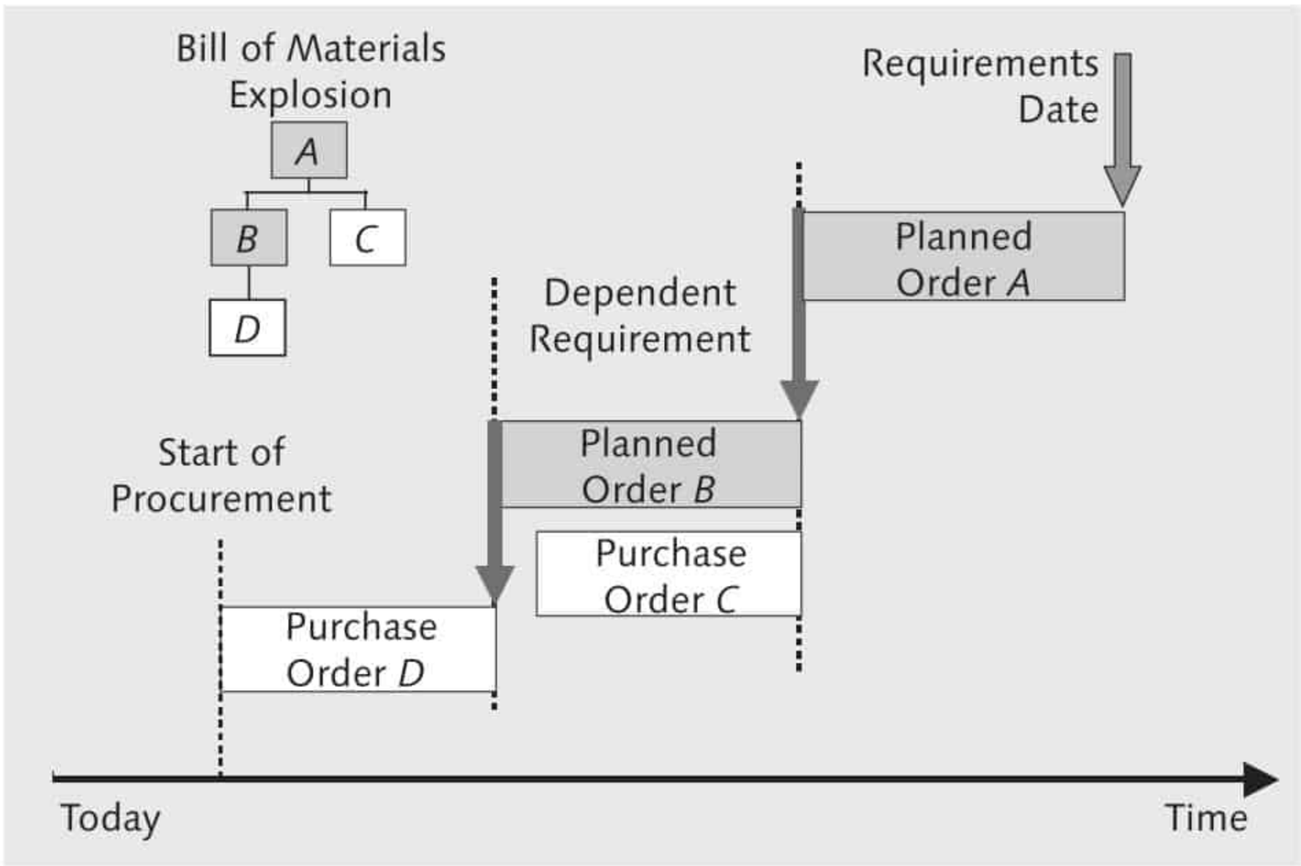

Figure 2.4 Dates in Multilevel Production — Total Replenishment Lead Time and In-House Production Time

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.

MRP II

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.

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.

Finite and infinite scheduling

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*.

Interaction with requirements planning

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).

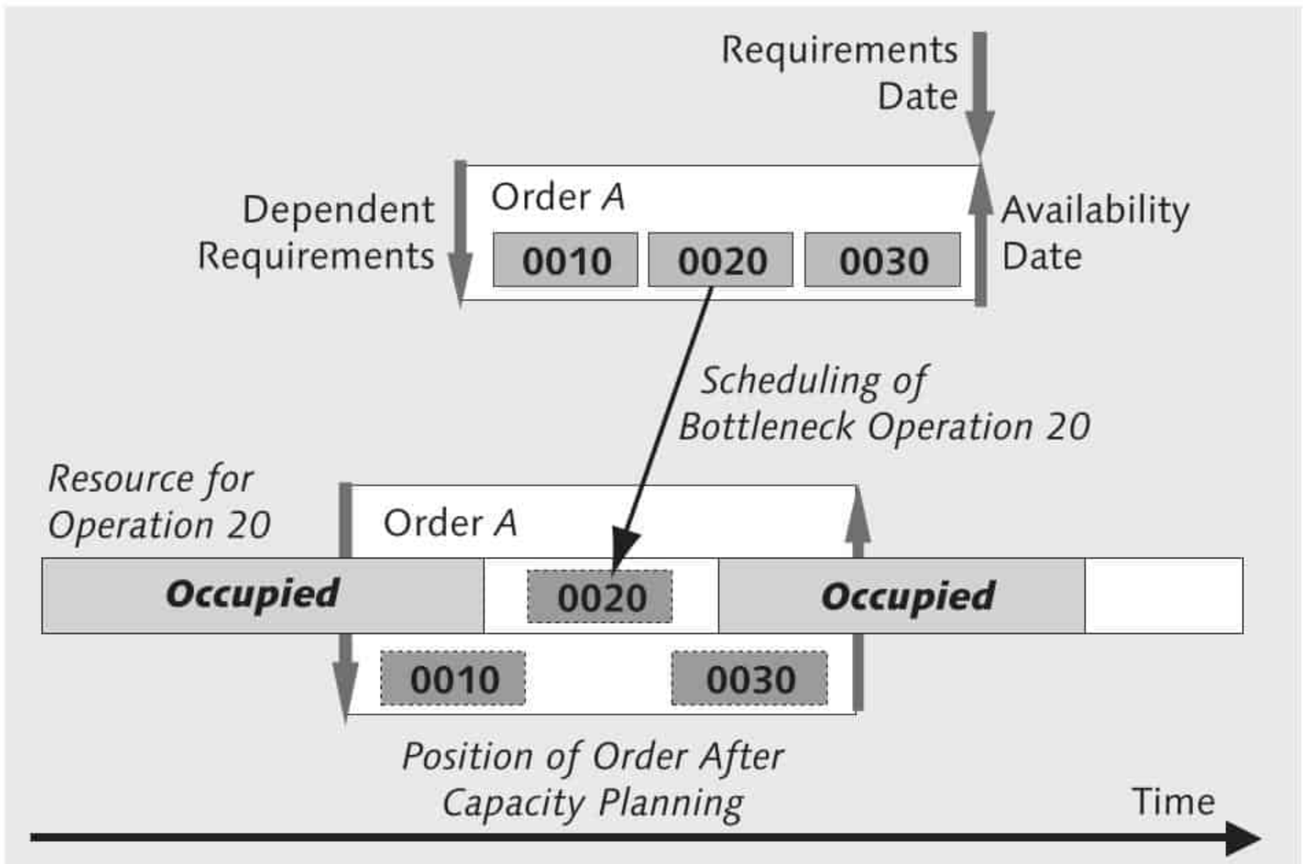

Figure 2.5 Capacity Planning for the Bottleneck Resource of an Order

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.

Transfer of customizing settings

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

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.

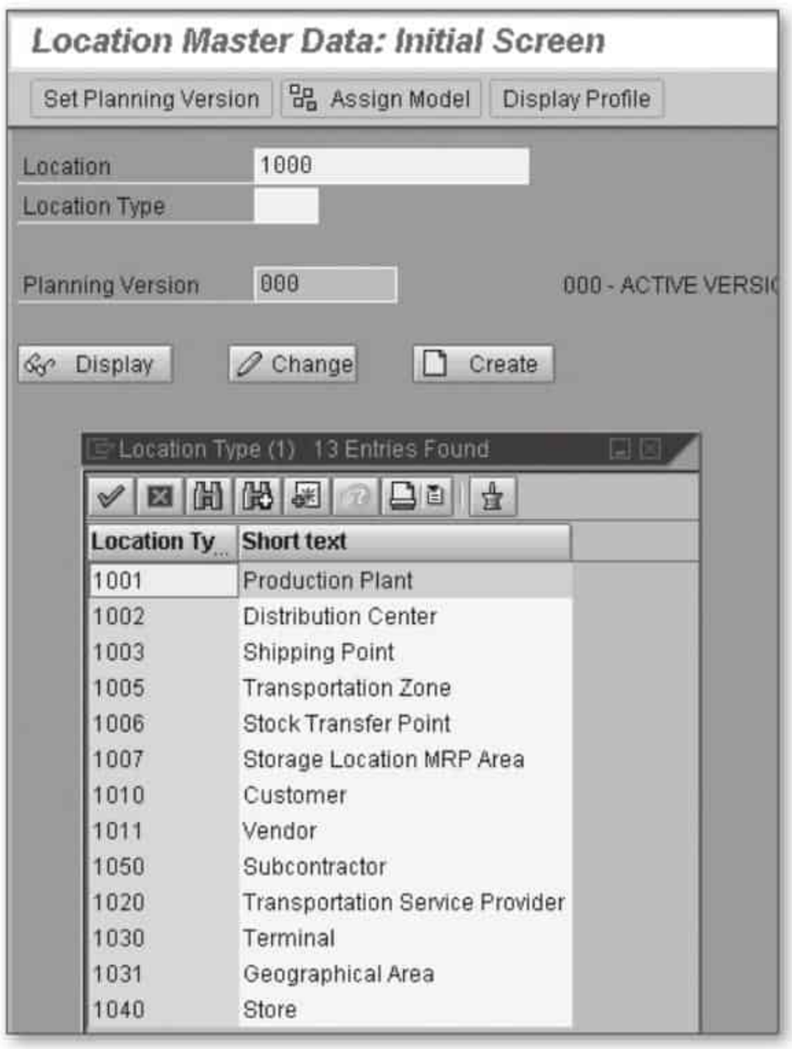

Figure 4.1 "Location" Transaction in APO, Transaction Code /SAPAPO/LOC3, with Field Selection for Location Type

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:

Location types

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).

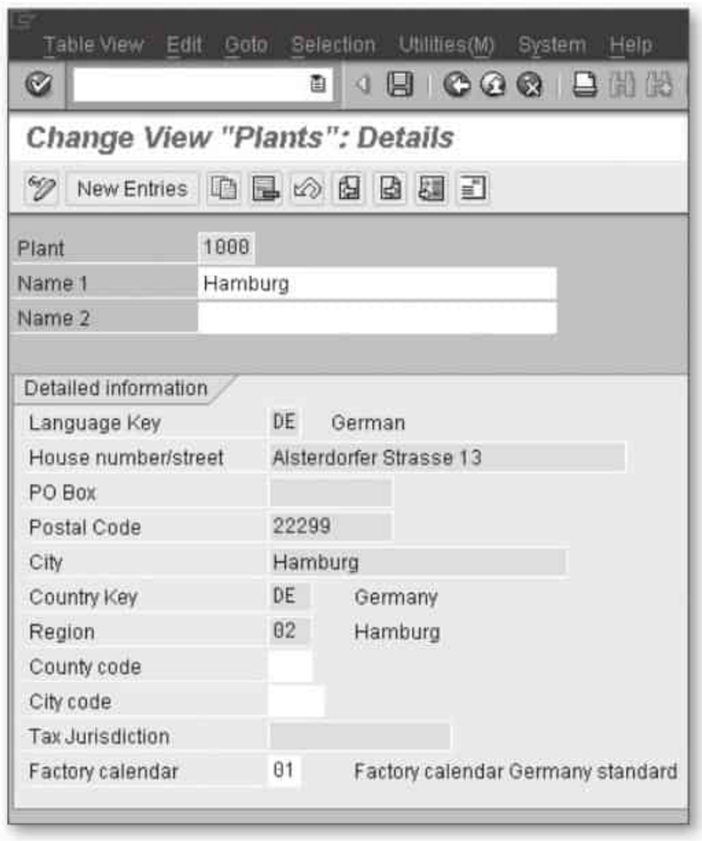

Figure 4.2 "Define, Copy, Delete, Check Plant" Customizing Setting in ECC, Detailed Information for a Plant

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).

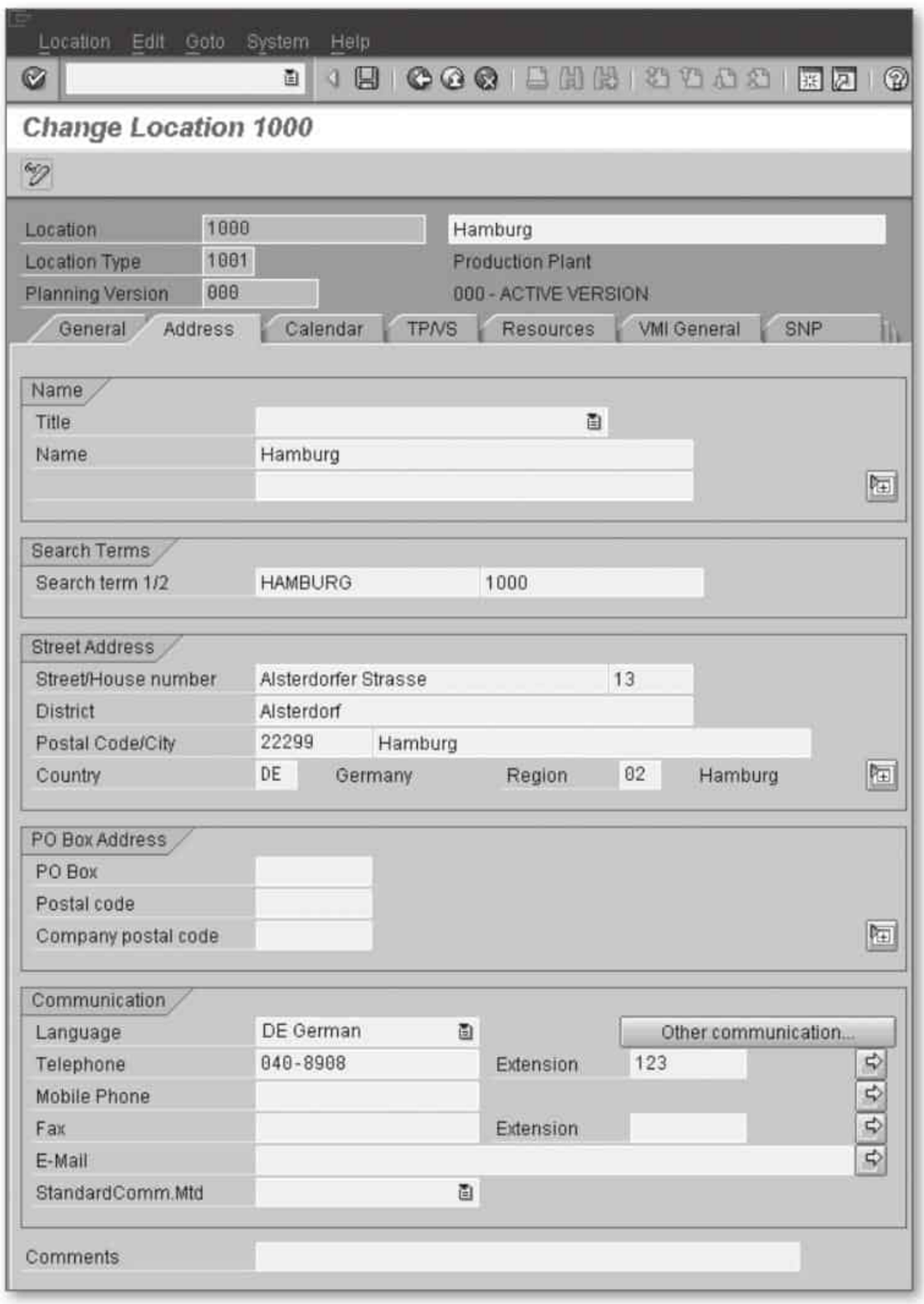

Figure 4.3 "Location" Transaction in APO, Transaction Code /SAPAPO/LOC3, Changing a Location with Location Type 1001, "Address" View

[!]

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.

Distribution center

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

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.

- **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).

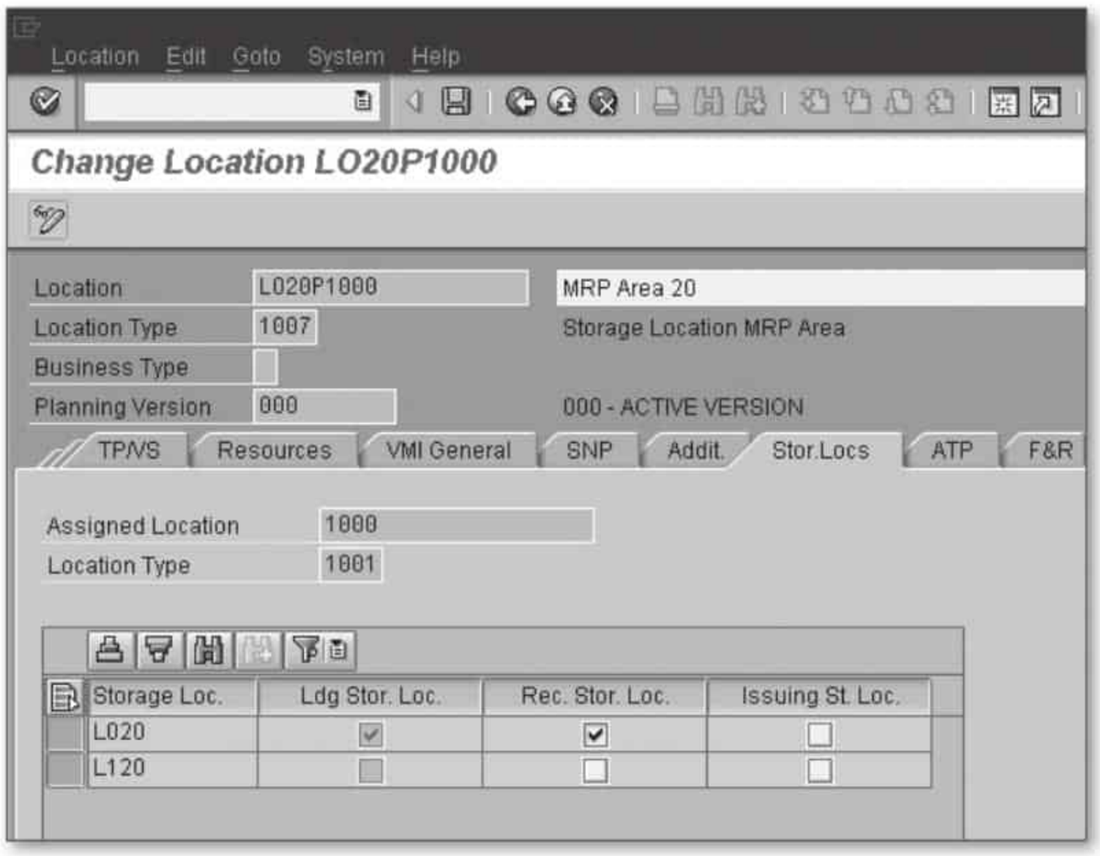

Figure 4.4 "Location" Transaction in APO, Transaction Code /SAPAPO/LOC3, Changing a Location with Location Type 1007, "Storage Locations" View

- **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.

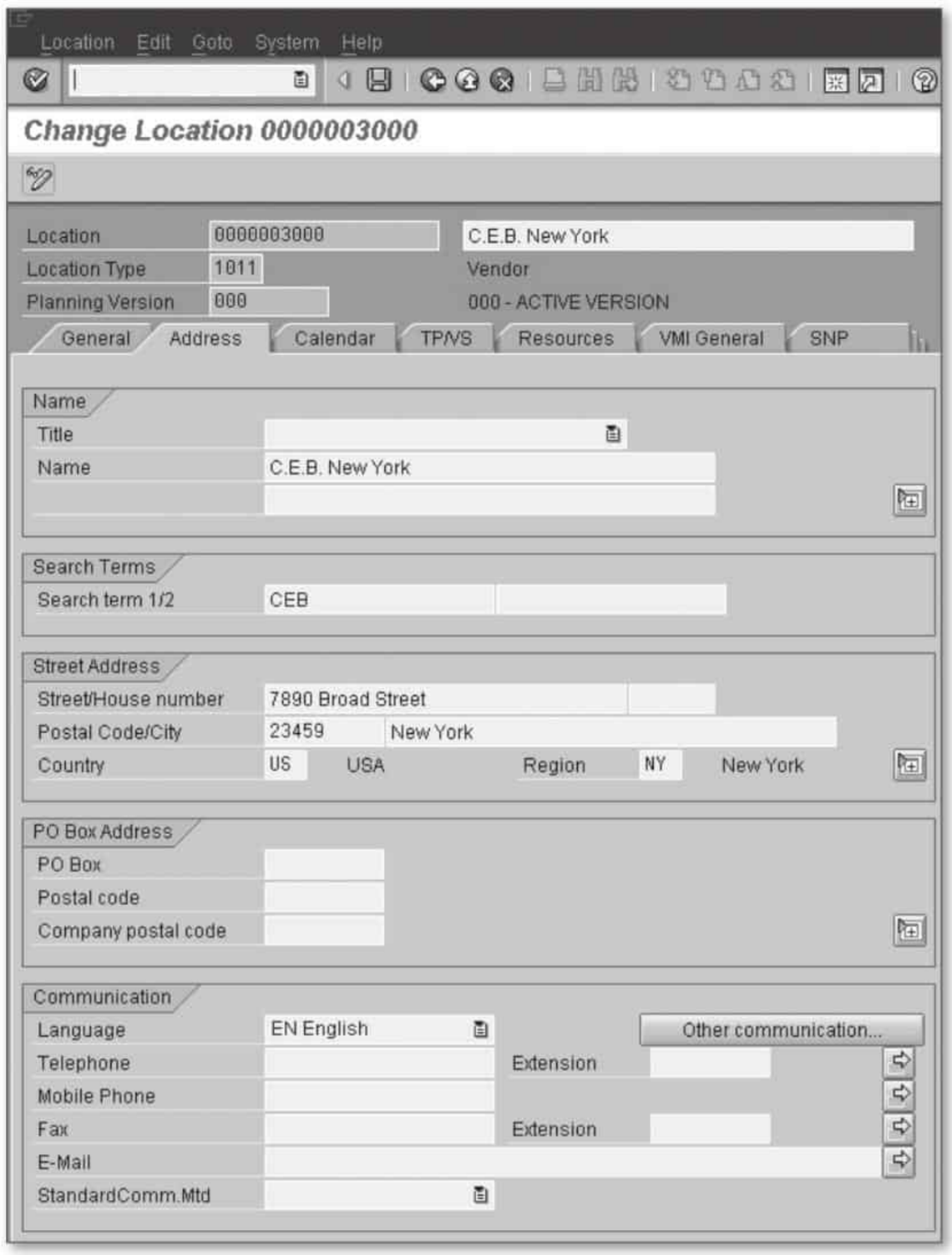

Figure 4.5 "Location" Transaction in APO, Transaction Code /SAPAPO/LOC3, Changing a Location with Location Type 1011, "Address" View

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.

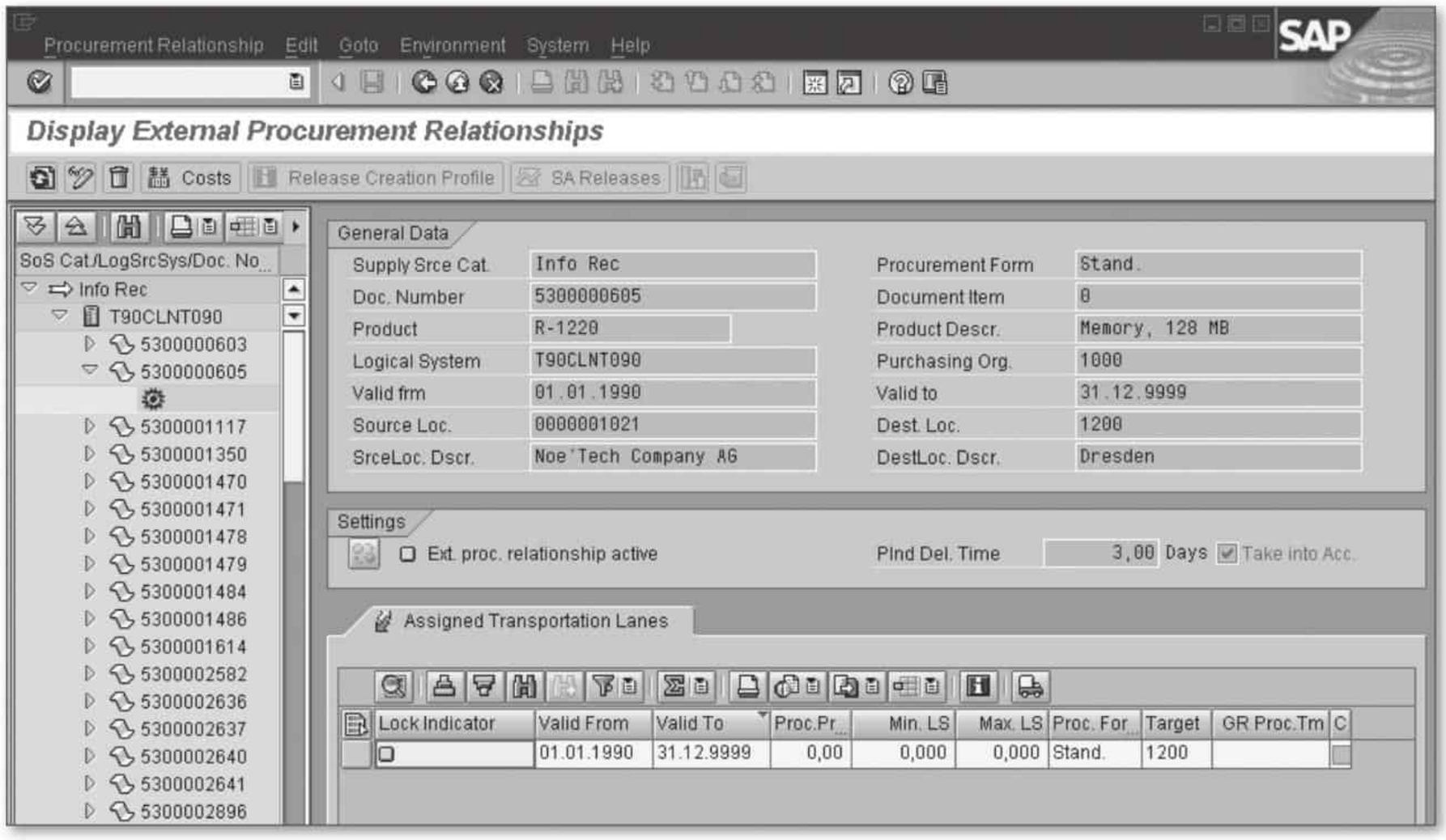

Figure 4.6 "External Procurement Relationships" Transaction in APO, Transaction Code /SAPAPO/PWBSRC1, Displaying a Purchasing Info Record

Quota arrangement and source list

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.

Transportation lanes

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 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).

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