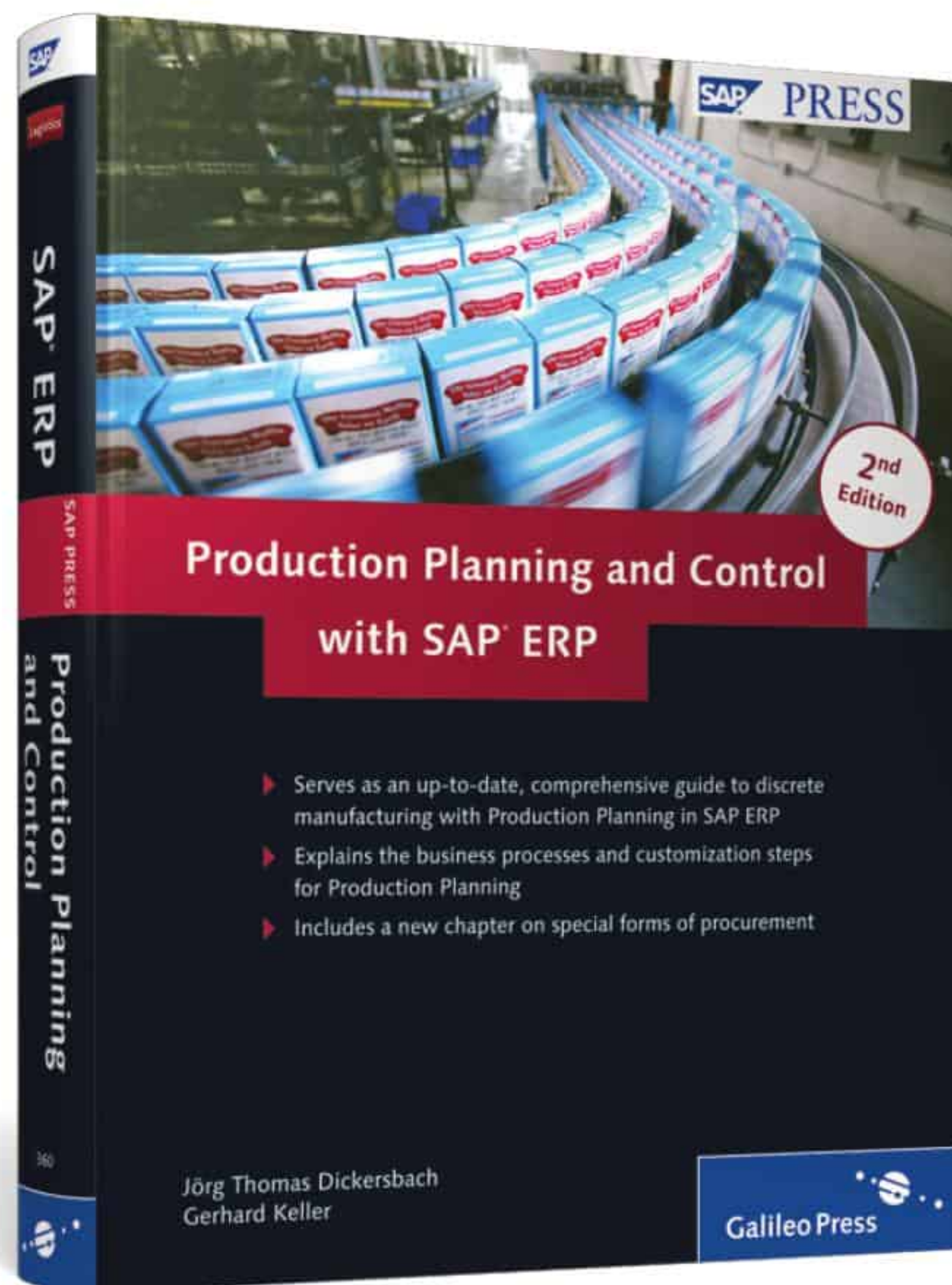


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## Production Planning and Control with SAP® ERP



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*The production planning and control functions of SAP ERP are contained in the PP functionality. The most important PP processes are sales and operations planning, demand management, material requirements planning, long-term planning, production order creation, production order execution, and capacity requirements planning.*

## **3 Production Planning and Control in SAP ERP**

### **3.1 PP in the Context of SAP ERP**

The main features of SAP ERP are as follows: an extensive range of business functions, a high level of modularity alongside close integration of individual modules, support for international requirements in the form of country-specific functions (such as Payroll, which is available in various country versions with the relevant statutory conditions and tax requirements), multi-lingualism, and the ability to run on a range of platforms.

SAP ERP is based on a three-tier client-server architecture and can be subdivided into two main work areas: the basis and the application. The purpose of the basis layer is to design the business applications separate from the system interfaces of the operating system and the database and communications systems, and to ensure that business transactions are executed quickly and efficiently. The application layer contains the implemented solutions that support the enterprise's business requirements.

SAP ERP consists of business application modules that can be used both individually and in combination with each other. SAP's delivery strategy is to deliver the complete system to the customer and then to activate the required functions and business processes on-site and according to the customer's requirements. The disadvantage of this strategy is that the

individual customer requires an over-dimensioned computer configuration at the start of the implementation process. An advantage is that it is easier to activate functionalities in production operations from the existing range of solutions than it is to deliver them retroactively.

SAP ERP can be subdivided into three main areas: *Accounting*, *Human Resources Management*, and *Logistics*.

**Accounting** *Accounting* maps business transactions in accordance with their financial value and is responsible for planning, controlling, and monitoring the value flow within the enterprise. It is subdivided into financial accounting and managerial accounting, according to the addressee group. Managerial accounting consists of cost accounting and activity accounting; its purpose is to provide the decision makers in the enterprise with quantitative information. Financial accounting is structured in accordance with statutory regulations; enterprises use it to comply with requirements for disclosure with regard to external parties, in particular tax authorities and investors. The main components that support the tasks of accounting are Financial Accounting (FI), Investment Management (IM), and Controlling (CO). The software is further subdivided into corresponding sub-modules.

**Human resources management** *Human Capital Management* (HCM) is divided into the areas of personnel planning and development, and personnel administration and payroll. Personnel planning and development supports the strategic utilization of staff by providing functionality that enables the enterprise to systematically and qualitatively manage its staff. Personnel administration and payroll comprises all administrative and operational human resources activities.

**Logistics** *Logistics* in the business context structures the flow of materials, information, and production from the supplier through production to the customer. The SAP ERP logistics application modules enable enterprises to plan, control, and coordinate their logistical processes on the basis of existing integrated data and functions across department boundaries. The integration of the individual application modules in SAP ERP prevents unnecessary and time-consuming multiple entries on the part of the staff who process business logistics transactions. Likewise, the integration of quantity-based processing steps includes the value-based side of

the business transaction and thus fulfils the requirements of accounting. Logistics contains the following individual application functionalities: *Sales and Distribution (SD)*, *Materials Management (MM)*, *Production Planning and Control (PP)*, *Quality Management (QM)*, *Project System (PS)*, and *Plant Maintenance (PM)*.

The PP link in this chain deals with quantity-based and time-based product planning and controls the production process. Besides its master-data maintenance functions, the PP functionality supports all quantity-based and capacity-based production planning and control steps. Production planning and control comprises various planning concepts, such as MRP II and kanban, and various production types, such as production by lot size, make-to-order production, variant production, repetitive manufacturing, and process manufacturing.

The various modules are closely interconnected due to integrated data retention, the internal flow of documents, and the functional integration of the software. This interconnectivity enables many possible scenarios: a production planning process can be triggered by Sales and Distribution; Production Planning can create a purchase requisition (in MM); a production confirmation within the plant data collection process can trigger a value-based update in Controlling and Human Resources Management in order to calculate salaries. Likewise, the high degree of integration between the software means that the recording of goods movements in the execution of a production order can be based on quantity and values (Keller, 1999, pp. 67–115).

The several thousand of SAP ERP customers in the various industries and countries have different requirements of production planning. These requirements are reflected in the customer's system by parameterizing the relevant functions in a process known as Customizing. In this process, the required functions are set in accordance with the requirements of the industry, the product range, the production procedure, the product structure, and organizational and legal requirements. Chapters 6 to 13 use process modules to describe the most important function settings.

It is essential for the proper functioning of the system that you set and maintain the required basic data correctly. Chapter 5, Master Data, describes in detail the basic data required for production planning. The

focus there is on describing the basic data for production planning execution in companies with discrete manufacturing.

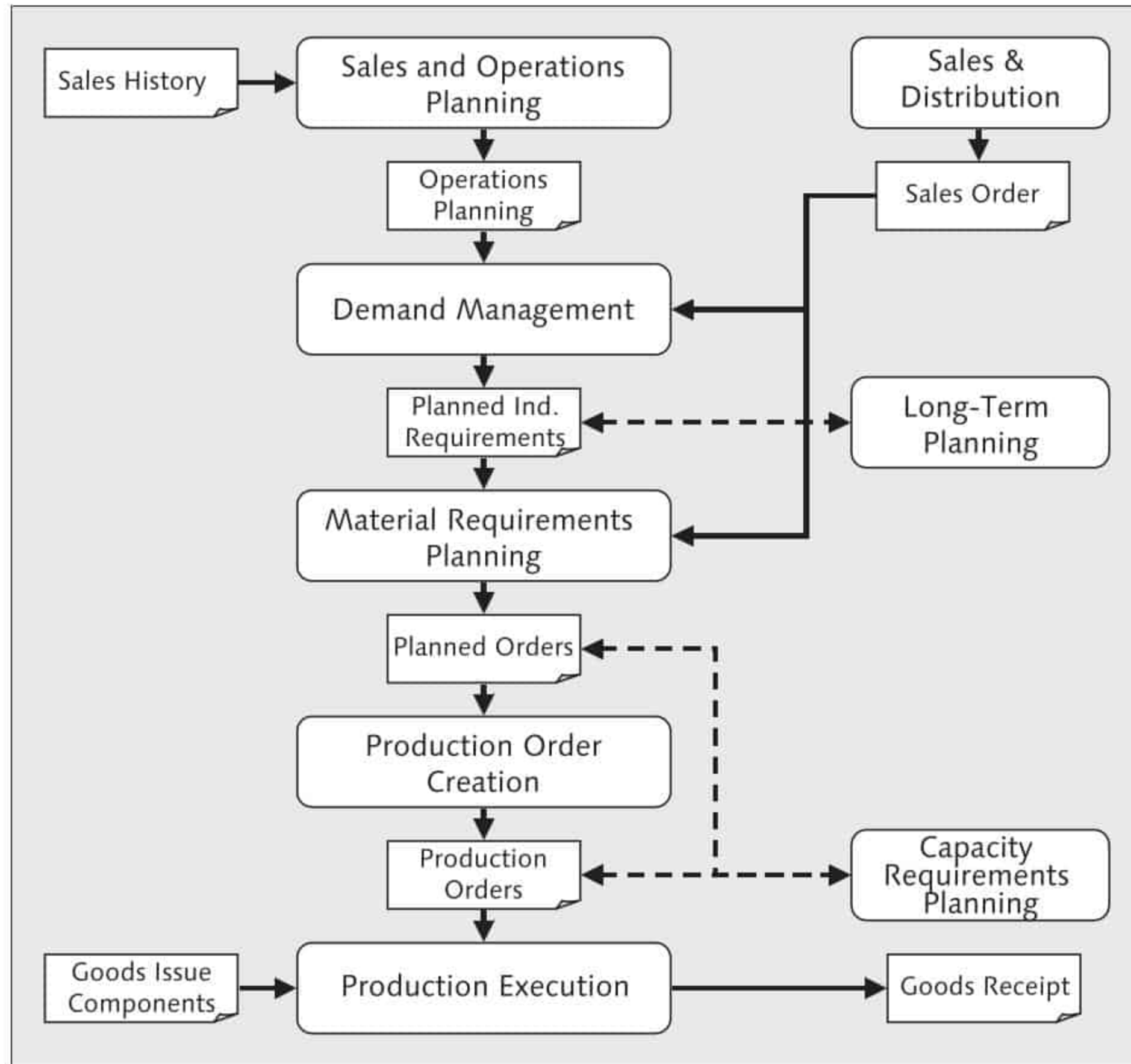
### 3.2 Processes in Production Planning and Control

Processes in production planning and production control comprise the following main areas:

- ▶ *Sales and operations planning* for determining the quantities to be produced
- ▶ *Material requirements planning* to calculate net requirements and component requirements, taking into account scrap and lot sizes
- ▶ *Capacity requirements planning* for detailed production planning, taking into account available capacities
- ▶ *Production control* to control and record the production process (create production documents, record confirmations)

These four areas represent the scope of the process only roughly. Figure 3.1 shows a detailed overview that explicitly illustrates the process modules that we will deal with in detail in subsequent chapters, along with their most important input and output values.

Sales and operations planning	Sales planning, also referred to as demand planning, covers future requirements without considering stocks and available capacities. The sales history often serves as a basis for sales planning. Operations planning uses the results of the sales-planning process to plan the production quantities, and takes initial stocks and capacities into account on a general level.
Demand Management	Demand management aligns sales planning with the customer requirements in accordance with the planning strategy, and thus calculates the independent requirements for production.
Material Requirements Planning	Material requirements planning is the central function of production planning. It calculates requirement coverage elements for all MRP levels, based on the demand program, and taking into account lead times, lot sizes, and scrap quantities.



**Figure 3.1** Process Overview: Production Planning and Control

Long-term planning is basically a simulation of material requirements planning. It can examine how a change in planned independent requirements would affect capacity utilization, stocks, and external procurement. Long-term planning is also suitable for short-term simulations.

Long-Term  
Planning

The central factor in controlling and recording the production process is the production order. This chapter describes how the production order is created—whether by converting a planned order or by means of interactive creation—and the functions that are executed in this process, such as master-data selection, scheduling, and availability checking.

Production  
Order Creation

Capacity requirements planning schedules in detail the worklist, which usually consists of the processes for created or released production orders. Capacity requirements planning delivers a production sequence that is feasible from the capacity viewpoint.

Capacity Planning

**Production Execution** While the previous processes dealt with production planning, *production execution* is concerned with how the actual production as specified in the production order is recorded and controlled, from material withdrawal to order confirmation to storage and invoicing.

Chapters 6 to 13 cover these processes in detail.

### 3.3 Production Types

The *production type* characterizes the frequency with which a product is produced in the production process. The frequency with which production of identical or similar products is repeated and the production quantity of production orders are typical characteristics that determine the production type. Production organization is closely related to production type because the production type often significantly affects the structure of the production process. Thus, the *flow manufacturing* production type, for example, implies the production of large quantities of identical product types or products. At the same time, flow manufacturing ensures that the production equipment is arranged in accordance with the organizational form of flow manufacturing. A typical example is the assembly of cars in the automobile industry. The degree of product standardization and the depth of the product structure also often affect the actual production type used. This is why various forms of production types, implicitly including production organization, have arisen from the basic theoretical types (mass production, repetitive manufacturing, small-lot production, make-to-order production). The following are important production types (Keller/Curran, 1999, pp. 137–154):

- ▶ Discrete Manufacturing
- ▶ Repetitive manufacturing
- ▶ Process Manufacturing
- ▶ Kanban
- ▶ Engineer-to-Order Production

These types are briefly explained in the following sections. In this book, we restrict ourselves to discrete manufacturing because this is the most common type of production.

### 3.3.1 Discrete Manufacturing

*Discrete manufacturing* (also called shop floor production) describes the production of a product on the basis of production orders. Discrete manufacturing is used if the products in question change frequently, if the pattern of demand is very irregular, and if production is workshop-oriented in character. A range of master data is required for discrete manufacturing; the most important are the material, bill of material (BOM), work center, and routing (see Chapter 5).

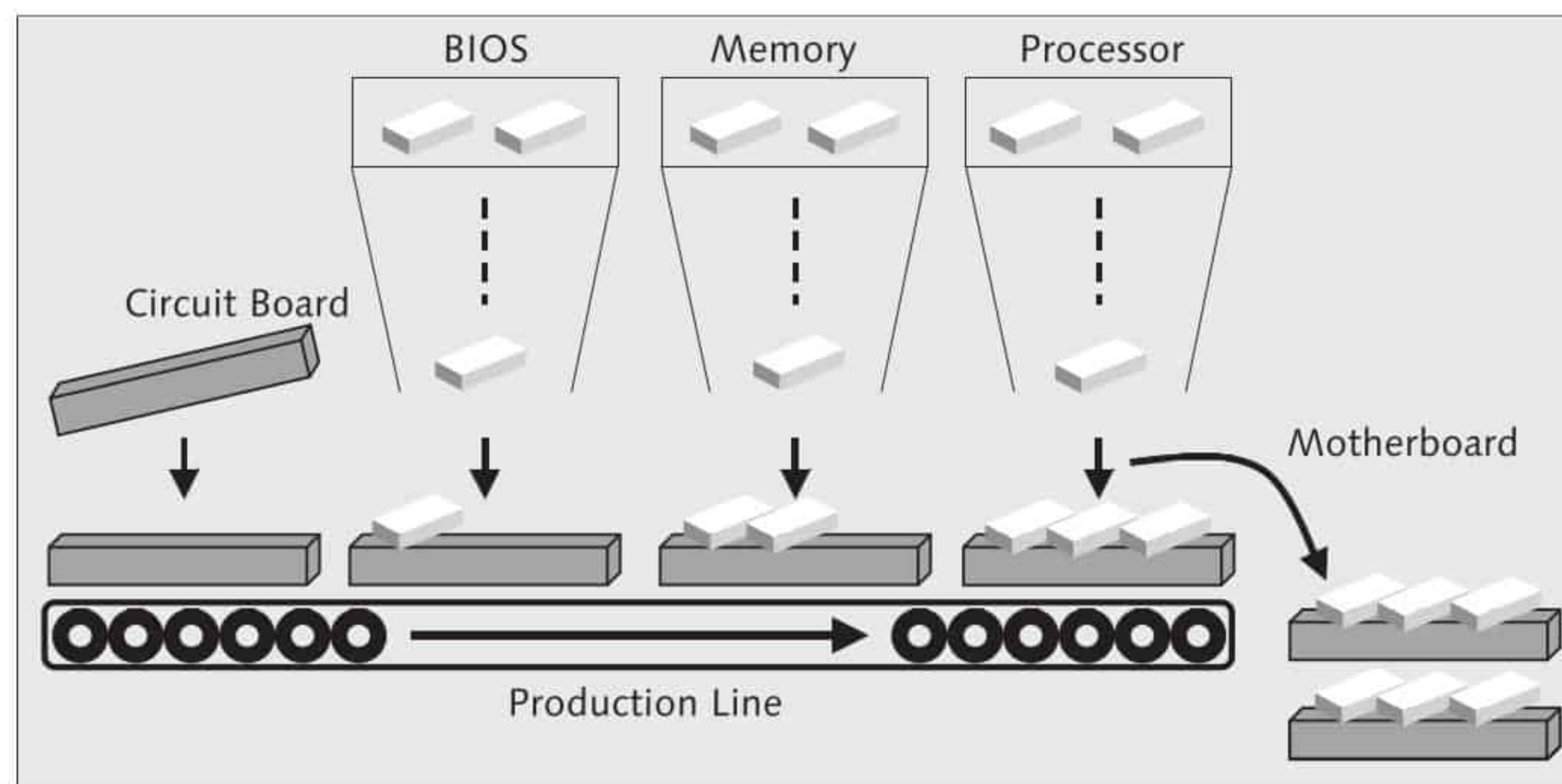
Discrete manufacturing starts when a production order is created and processed. A production order is created either manually or when a planned order that was created in the production and procurement planning process is converted. A production order is a request to the production department to produce or provide products or services at a specific time and in a specific quantity. It specifies the work center and material components to be used for production. The creation of a production order automatically creates reservations for the required material components. Purchase requisitions are created for externally procured material components and services, and capacity requirements are created for the work centers at which the order will be executed.

Production orders are released on the release date, provided that the required materials and capacity are available. The relevant documents in the production order can be printed to prepare for the execution of the production order. The capacity situation can be evaluated and any required capacity leveling can be carried out in any phase of production order processing, although this is usually done before production starts. The components required to produce the products are read out from the production order, and the goods issue is posted. The product is then produced on the basis of the production order. The finished quantity and the services provided are then confirmed back to the production order. The product is put into storage and the goods receipt is posted. Finally, the production order is settled.

### 3.3.2 Repetitive Manufacturing

*Repetitive manufacturing* is characterized by the interval-based and quantity-based creation and processing of production plans (in contrast to

single-lot and order-based processing). With repetitive manufacturing, a certain quantity of a stable product is produced over a certain period of time. The product moves through the machines and work centers in a continual flow, and intermediate products are not put into intermediate storage. Figure 3.2 illustrates this concept using the example of motherboard production.



**Figure 3.2** Producing a Motherboard on a Production Line

The work required for production control with repetitive manufacturing is significantly reduced compared to single-lot and order-based production control, and the entry of actual data is simplified.

Repetitive manufacturing is suitable for a variety of industries, such as branded items, electronics, semiconductors, and packaging. Repetitive manufacturing also can be used for pure make-to-stock production. In this case, production has no direct connection to a sales order. The requirements are created in the demand management process, and the sales orders are supplied from stocks. Sales order-based production—for example, in the automobile industry (Geiger/Kerle, 2001, pp. 69–95)—can also be implemented using the methods of repetitive manufacturing. In this case, production is directly related to the sales order or is triggered directly from the sales order.

Master data  
in repetitive  
manufacturing

The most important forms of master data in repetitive manufacturing are as follows:

- ▶ Material
- ▶ Production version
- ▶ BOM
- ▶ Production line
- ▶ Rate routing

The main differences between this data and the master data for discrete manufacturing are briefly described later.

If a material is to be produced by means of repetitive manufacturing, it has to be flagged accordingly in the material master. This is done in the SAP system in the MRP 4 view by setting the REPETITIVE MANUFACTURING flag.

A *repetitive manufacturing profile* is also assigned to the material. This profile determines the type of planning and confirmation. It specifies, among other things, whether reporting points will be used, whether production activities will be posted to the cost collector for material confirmations, whether a decoupled confirmation will be used, whether a backflush will be carried out for the entry of actual data, and which transaction types will be used.

Repetitive  
manufacturing  
profile

Because there are different BOMs and routings for a material, depending on the production process, a *production version* is used to specify which BOM and which routing are to be used to produce the material. The alternative BOM for the BOM explosion, the plan category, the task list group, and the group counter for assignment to the plans also are specified in the production version. The production version also specifies the lot size for which the production version is valid. It is important to set the REPETITIVE MANUFACTURING ALLOWED flag. There can be one or many production versions for a material, and there has to be at least one production version in repetitive manufacturing. The MRP 4 view is used to create the production version for a material.

Production version

The costs incurred in repetitive manufacturing are posted to a *product cost controller*. In the process of entering actual data, the material costs and production costs are added to the product cost controller. Costs are subtracted from the product cost controller when a goods receipt, for

Product cost  
collector

example, is posted. The product cost controller is created for a material within a plant in a specific production version.

- Backflush** The BOM for the material to be produced specifies what quantities of which components are required for production. In repetitive manufacturing, not every goods issue is recorded at the same time as the physical withdrawal of the material from stock. Usually, component usage is automatically posted only when the finished product is received (*backflush*). To backflush, a storage location is specified in every BOM item, and the backflush is carried out from this location.
- Production lines** Work centers in repetitive manufacturing are called *production lines* (see Section 5.4, Work Center) because the product moves through the machines in a continuous flow, and the machines are usually spatially arranged in a line. These can be simple production lines, which often consist of just one work center, or complex production lines, which consist of several work centers. The individual processing stations are set up as individual production lines and are grouped into a line hierarchy. A production line determines the available capacity of the processing station and is assigned to a single cost center.
- Rate routings** In repetitive manufacturing, routings are known as *rate routings*. A rate routing contains the processes required to produce the material. Because the same product is produced over a long period of time in repetitive manufacturing, very simple routings can be used, often containing just one process. This kind of process specifies the production rate, which in turn specifies the quantity per time unit that is produced on the line (for example, 100 items per hour).

In repetitive manufacturing, the planned orders for a material that result from the production and procurement planning process are managed in a planning table. In these tables, the planner can schedule the production quantities on the assembly lines. In repetitive manufacturing, we use the term *run schedule quantity* instead of planned orders (see Figure 3.3).

In repetitive manufacturing, the components are supplied anonymously to the production line. This can be done very easily using the pull list. The components required on a production line for a specific period can be calculated in the pull list. The missing quantities that are detected can be replaced by means of direct stock transfers, for example, from the central warehouse to the production location.

Capacity Data	Unit	Due	9/4/2006	
Line 1	%	0	100	
Requirement	h	0	16	
Available Capacity	h	16	16	16
Line 2	%	0	0	150
Requirement	h	0	0	24
Available Capacity	h	16	16	16

Material Data	Unit	Due	9/4/2006	
Material A				
Requirements	PCS		100	
Available Quantity	PCS	200	200	200
Line 1 Production	PCS		100	50
Line 2 Production	PCS			50
Not Assigned	PCS	0	0	0

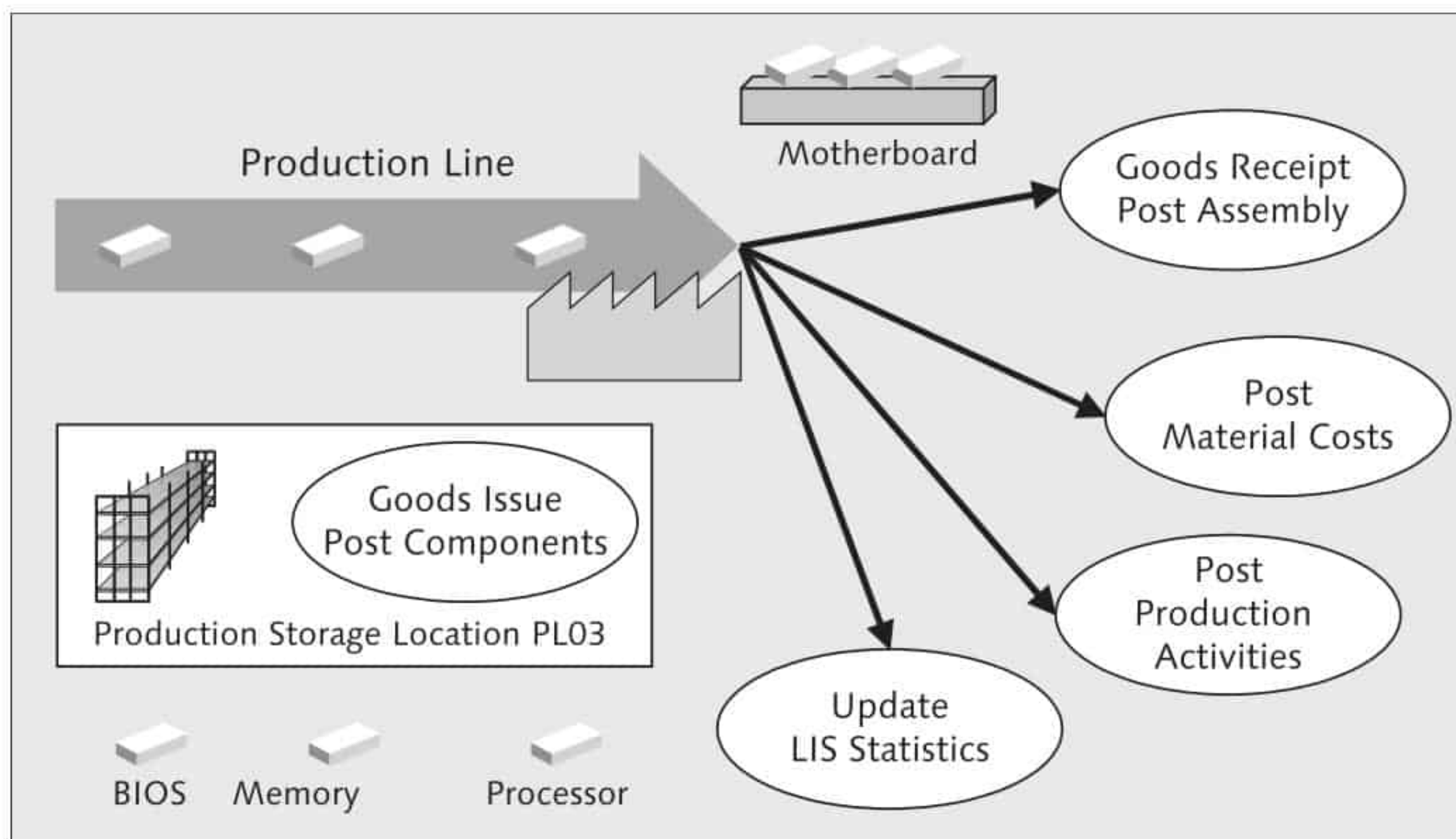
This section allows you to monitor the capacity utilization on the different production lines.

This section allows you to assign quantities to the production lines.

Assignment Mode

**Figure 3.3** Planning Table in Repetitive Manufacturing

The production of the product usually takes place in a continuous flow along the production line. Entry of actual data is carried out at regular intervals for each finished production quantity. Component use and production activities are automatically posted when the finished product is received. In the case of longer production lead times, actual data can also be recorded along with reporting points within the production line, in order to post consumption data more promptly (see Figure 3.4).



**Figure 3.4** Actual Data Recording in Repetitive Manufacturing

### 3.3.3 Process Manufacturing

*Process manufacturing* is characterized by batch-oriented and recipe-oriented production of products or co-products in the process industry. Process manufacturing is used mainly in the following industries: chemicals, pharmaceuticals, food and luxury foods, and process-based electronics (Datta, 2001, pp. 145–172). A number of processes can be used in process manufacturing. These are described below.

Continuous production	<i>Continuous production</i> is the name given to a process in which production runs within a specific period in an ongoing procedure. Material components are continuously supplied to the production line, and the finished product is continuously produced. The plant and machinery are continuously and fully in use, so partial orders and partial allocations cannot be handled.
Discontinuous production	In <i>discontinuous production</i> , as the name suggests, the products are not produced in a continuous process. Instead, the material components are provided and weighed out as required for each step of the procedure. The same line can be used to produce multiple products.
Regulated production	<i>Regulated production</i> is used if the product quality requirements are very specific, or if legal regulations apply, such as the Good Manufacturing Practices (GMP) overseen by the U.S. Food and Drug Administration (FDA). Examples of this process can be found in the pharmaceuticals industry and certain parts of the food and cosmetics industries. In regulated production, orders can be created only with approved recipes. If changes need to be made to master recipes, these are subject to change administration procedures. Filling processes that are separate from and take place after the actual production process can also be handled in process manufacturing. Loose goods (bulk) are moved from production and held in intermediate storage containers until they are filled. This production type supports complex filling procedures and simple manual filling procedures. Process orders that are created on the basis of a filling recipe are a prerequisite for the filling process.

The central master data elements in process manufacturing are the *material*, the *BOM*, the *resource*, and the *master recipe*.

Process manufacturing starts when a *process order* is created and processed in accordance with a master recipe. A production order is created either manually or when a planned order that was created in the production planning process is converted. A production order is a request to the production department to produce or provide products or services at a specific time and in a specific quantity. It specifies the resource and material components that are to be used for production. The creation of a production order automatically creates reservations for the required material components. Purchase requisitions are created for externally procured material components and services, and capacity requirements are created for the resources at which the order will be executed. Production orders are released on the release date, provided that the required materials and capacity are available. At the time of release, an automatic batch-determination process can be run for components that are subject to a batch management requirement. The relevant documents in the production order can be printed in order to prepare for the execution of the production order.

Process order

The capacity situation can be evaluated and any required capacity leveling can be carried out in any phase of the production order-processing process, although this is usually done before production starts. Production can now begin, with or without the use of process management. If process management is used to execute a process order, this serves as the interface between the SAP system and process control. The flexible structure of this interface makes it possible to connect automated, semi-automated, and manually controlled plant and equipment to the production process.

Once the process order or the relevant phases of the process order is released for production, control recipes are generated from the process instructions in the process order. *Control recipes* contain all the information required for the process control function to execute a process order. Next, either the control recipes for the process control system themselves or the control recipes in the form of process instruction (PI) sheets are sent to the relevant process operator. In the latter case, the process instructions are expressed in natural language so that the process operator can display them on-screen and process them.

Control recipes  
and process  
instruction sheets

The process data that results from the execution of the process order is sent back to the SAP system or is transferred to external function modules for further processing, or both. This data is transferred from the process control function to the various recipients by means of the process-coordination interface with the help of process messages. A material consumption message, for example, causes a goods issue to be posted for a component.

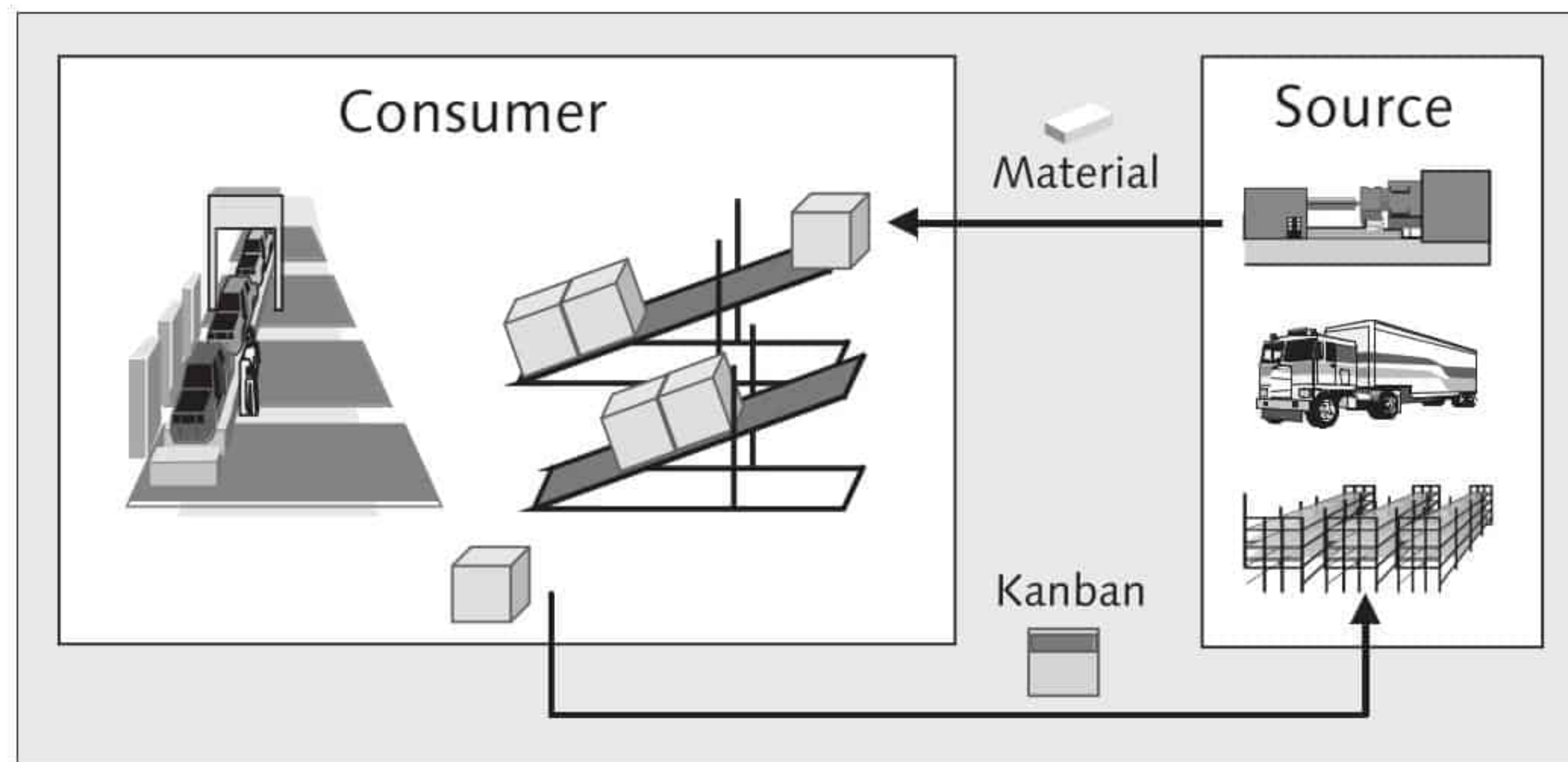
If a process order is executed without process coordination, the material components required to produce the finished product are withdrawn for the process order, and the goods issue is posted in the inventory management menu. The required finished product is then produced in accordance with the process order. The quantities created and the products produced are confirmed to the process order, the finished product is put into storage, and the goods receipt is posted.

In the invoicing process for a process order, the actual costs incurred for the order are assigned to one or more recipient objects (such as the finished material or a sales order). The process data documentation process creates lists of production-relevant and quality-relevant data that can be optically archived. We draw a distinction here between order logs and batch logs. Order logs contain all the quality-relevant SAP data that is created for a process order, while batch logs contain all the quality-relevant data having to do with producing a batch. The structure, content, and processing of batch logs comply with the international standards defined in the GMP guidelines for the pharmaceuticals and food industries.

### 3.3.4 Kanban

*Kanban* is a procedure for production control and material flow control that avoids time-consuming requirements planning and implements requirements-oriented production control. With kanban, a material is produced or procured only when it is actually required. A specific quantity of the components required to produce a material are stored on-site in containers. When a container is empty, this component is replenished according to a pre-defined strategy (in-house production, external procurement, or stock transfer). In the interval between the request for replenishment and the delivery of the re-filled container, the other con-

tainers simply do the work of the empty one. Figure 3.5 illustrates the basic principle of kanban.



**Figure 3.5** Basic Principle of Kanban

The replenishment process is largely automatic in the kanban procedure, which greatly reduces the amount of manual posting work required. Also, the kanban process reduces stock levels, as only components are produced that are genuinely required. The material is not pushed through the production process as specified by an overall plan; rather, it is requested by one production level (consumer) from the previous production level (source) as needed.

With kanban processing, the plant is divided into *production supply areas* (PSAs). The components required for production are stored in these PSAs and various work centers can take what they need from the PSAs. A kanban control cycle is defined in order to specify how a material should be obtained within a PSA. The control cycle defines a replenishment strategy for the material that specifies, for example, whether the required material is to be produced in-house or procured externally. The control cycle also specifies the number of containers in circulation between consumer and source and the quantity per container.

Production  
supply areas

*Replenishment strategies* specify how a material component should be replenished and which of the following replenishment elements should be created for this purpose:

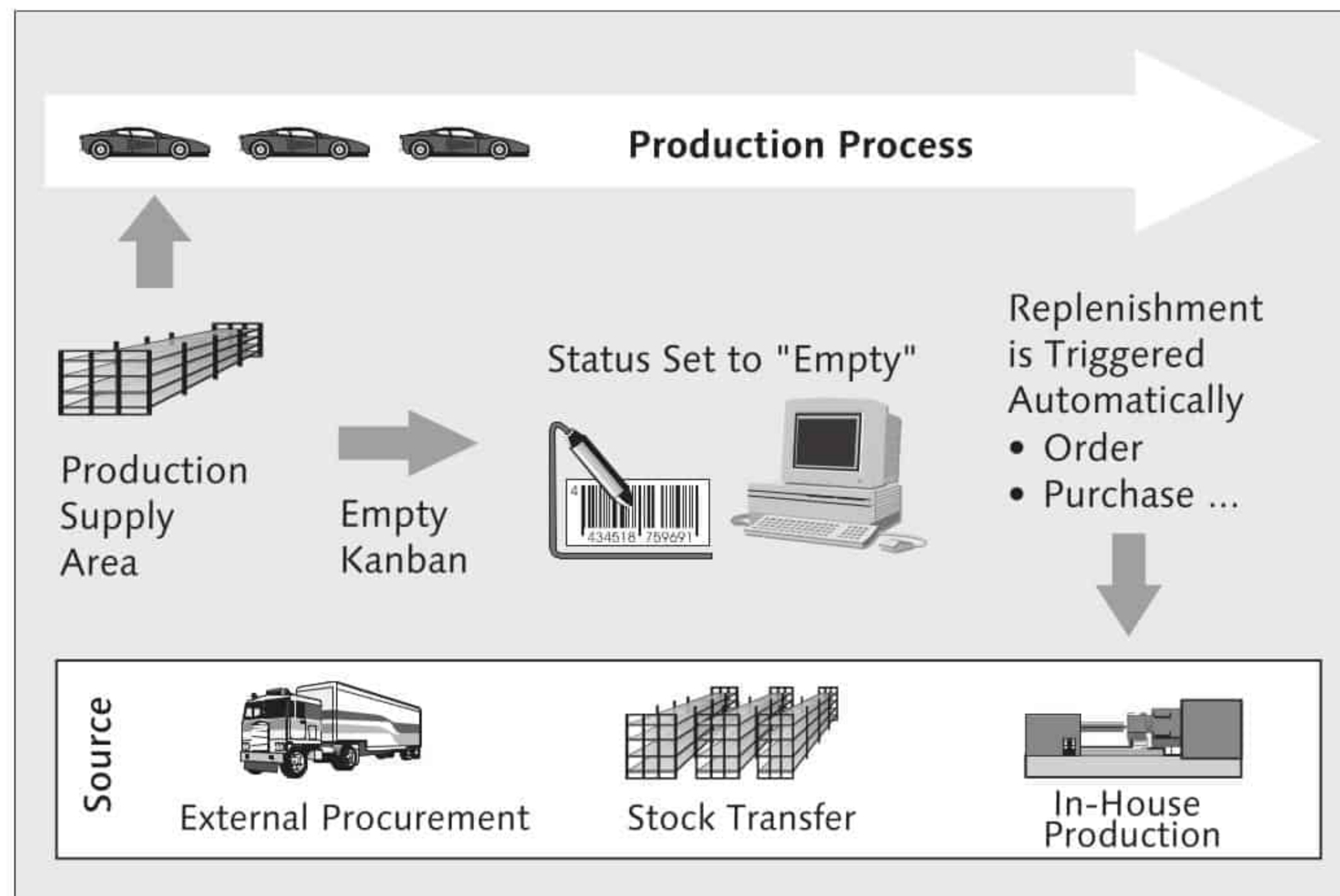
Replenishment  
strategies

- ▶ In-house production
  - ▶ Manual kanban
  - ▶ Replenishment with run-schedule quantity
  - ▶ Replenishment with production order
- ▶ External procurement
  - ▶ Replenishment by order
  - ▶ Replenishment with schedule agreement
  - ▶ Replenishment with summarized just-in-time (JIT) call
- ▶ Stock transfer
  - ▶ Replenishment with reservation
  - ▶ Replenishment with direct transfer posting
  - ▶ Replenishment by transport requirements of warehouse-management (WM) administered storage location

Replenishment with kanban is very simple. First, a material is produced at a machine. The components required to produce it are available on-site in containers, ready for withdrawal. If one of these containers is empty, the source that is responsible for its replenishment has to be informed. If kanban processing without SAP system support is being used, the consumer sends a card (by courier, for example) to the work center (source). The card contains the information about which material is required, in what quantity, and where it should be delivered to. The process gets its name from the Japanese word for these cards (kanban). The source can now produce or procure the material and then re-fill the container (see Figure 3.6).

If kanban processing with SAP ERP system support is being used, the containers are managed in the system and have a specific status. Once the last component is withdrawn from a container, the status of that container is simply changed from "full" to "empty." This status change is the kanban signal and it can be set by passing a barcode reader over the card attached to the container. It is also possible to have the system display the containers in a production area in the form of a kanban table and to make the status change there. The kanban signal now triggers the replenishment process and creates—for example—a production

order in accordance with the replenishment strategy. The source then processes the production order and the finished material is transported back to the container. The status of the container is set to "full" again (via barcode or kanban table), and the goods receipt for the material is posted with reference to the procurement element. The SAP system also supports other kinds of kanban procedures besides the classic procedure described above.



**Figure 3.6** Kanban Signal

While in the classic kanban procedure the user sets the container to "empty" using a barcode or a kanban table, thus triggering the kanban signal, in the kanban procedure with a quantity signal the user or a plant data-collection system enters the relevant withdrawn quantities into the system. As soon as the quantity in the container equals zero or drops below a specific threshold value, the system automatically changes the status.

Unlike classic the kanban procedure, where the number of containers and their quantities are fixed in advance, in the event-driven kanban procedure a container is created only when required. The required quan-

tity is then entered directly. Once the replenishment has been made, the container is deleted.

Kanban can also be used for production supply with the use of anticipatory material requirements planning. The replenishment elements in this case are created by a material requirements planning run. However, the replenishment elements function as a preview for the source; they do not directly trigger production or procurement. The setting of the kanban container to full or empty controls only the flow of material itself and the actual production process. Confirmations and goods receipts are usually posted without reference to the kanban process.

### 3.3.5 Engineer-to-Order Production

Experience has shown that conventional production processes are not particularly successful for complex make-to-order production processes.

The production orders used for the MRP II system are scheduled and handled separately without any coordination support between processes of different production orders. For example, process 25 of production order A-100 cannot start until process 10 of production order B-50 has started. Therefore, engineer-to-order production uses network techniques for scheduling and coordinating processes and cost accounting.

MRP II uses the BOM to split up the production of the finished product into smaller units, while engineer-to-order production divides the overall production process into work packages, which are specified in a work breakdown structure (WBS). There is not always a one-to-one correspondence between these structures and the units defined in the BOM.

MRP separates technology, maintenance, and other customer-specific activities from production. Engineer-to-order production, on the other hand, requires that production-specific and non-production-specific processes be handled together.

Another difference between MRP II and engineer-to-order is that standard costs are used for MRP II, while actual costs are used for engineer-to-order production.

Classic network systems are not very suitable for production management. They do not support inventory management, material requirements planning, or scheduling and tracking tasks within the factory. What engineer-to-order production needs is a system that combines the best of both procedures. You need a solution that can execute production orders, inventory management, and material requirements planning, like MRP II, and also handle task coordination, budget planning, and actual cost calculation.

You also need a system for processing complex production processes for industry, such as those for aircraft, ships, and large machines. A significant part of the lead time and added value of these product types is not taken into account in production-based processes such as design, work scheduling, and order costing.

For these reasons, engineer-to-order production uses work breakdown structures and networks. A WBS is a hierarchical model of the tasks that need to be carried out in a project and is the basis for the organization and coordination of the project. It contains the work, the time, and the costs that are associated with every task. A provisional WBS is created for the preparatory planning stage (that is, during the tender procedure). It then can be extended dynamically during the lifetime of the project.

Work breakdown structure

*Networks* are used to model detailed processes, such as the staff, capacities, materials, production resources, tools, and services required for the project. Networks also can describe extensive relationships between processes. They are connected to the WBS and thus provide an extra level of detail for representing the overall structure of the work.

Network

The starting-point is to set up a *project structure* in order to create a customer quotation. Once the project structure has been set up, detailed cost plans are developed and integrated into the budget. Based on the level of detail, plans are developed from bottom to top, while budgets are developed from top to bottom. Capacities are also checked, and the project details are combined to form a customer quotation. A sales order can be created as a special order type with project reference (project order). The project is then released for project structure plan-driven and network plan-driven processing. Down payments, invoice payments, and any other customer payments are assigned to the relevant WBS element.

Project structure

Costs and material withdrawals are posted directly to the network or WBS elements. The system monitors the availability of the budgeted funds. The costs are invoiced at regular intervals or at the close of the project, either to the general ledger, the cost center, or directly to the revenue calculation system.

The finished products are listed in the sales order and are managed using the make-to-order production scenario. Production orders are created either manually or automatically by the system. These orders are then linked to the relevant WBS element. Thus, production is controlled by conventional production orders, and the actual production costs and milestones are posted to the relevant assigned WBS element.

*The structure of the company is modeled with the organizational structures of the SAP ERP system. For the area of production planning and control, the organizational units of Company Code, Plant, and Storage Location are the most important. A different type of organizational element is represented by the different types of planners that represent individuals within the company and are linked to the areas of responsibility.*

## 4 Organizational Structures

### 4.1 Meaning of Organizational Structures

For German-speaking countries, Nordsieck (1972) characterized a company's organizational structure by the design of the structural and process organizations that mutually determine each other.

*Organization modeling* deals with a company's structural organization, unlike the process organization, which deals with the logical time structuring of the work processes. To manage complex social structures, as represented by companies with their many employees, it is necessary to subdivide these structures into manageable units. Organization modeling therefore refers to the mapping of a company's organizational structure into the structures of a standard application system. The organization model describes the organizational units, their structural relationships, and the users of an information system (Keller, 1993, p. 626). These organizational structures are shown using organization charts.

Structural  
and process  
organization

The traditional approach to organizational structuring places the main emphasis on the structural organization (Kosiol, 1962). It considers the association of basic task-sharing, functional, and organizational elements such as the job, instance, and management of an organizational structure, and the associated relationships between the individual elements. Jobs, as the smallest action unit of a company, either arise from the combination of the same tasks at the work object and differing performance

tasks, or they consist of the same performances for differing objects. Instances combine the management tasks of different jobs into a higher job (Wöhe, 2008).

The job classification as the design product represents the relationship between the jobs as a hierarchical structure, in that it links these together from the point of view of the authority. We can derive different structural types that express, on the one hand, the ranking ratio with the formal information flow and communication flow within the organization and, on the other hand, the development of organizational forms as a reaction to changing market conditions. These forms include line organization, functional organization, team organization, object-oriented models, and matrix organization.

**Line organization** Within each *line organization*, a specialist disciplinary superior is uniquely assigned. Each job is linked to all superior instances through a single decision, information, and communication line. The benefits of this are a simple organizational design, a precise delimitation of competencies, and a precise assignment of responsibility and communication relationships. However, you will notice the adverse effects of overloads on the superordinate instances because jobs of the same rank are linked to each other through the superordinate instance.

**Functional organization** *Functional organization* provides for a specialization of management. Here, the principle of the work distribution is also applied to the management tasks. Instances should have specialized knowledge from which a multiple chain of command for subordinate jobs is derived; that is, with this type of command and control, individual or multiple jobs each have several direct superior instances. Because the requirements for the management's expertise increase as areas of responsibility grow, it is useful to define the area of responsibility: unclear terms of reference lead to responsibility conflicts. The fundamental idea behind functional organization is the correlation of the formal decision-making responsibility with the professional competence (specialist knowledge) in an instance.

**Team organization** *Team organization* unites the advantages of the clear competence and responsibility definition of the line system with the advantages of the specialization of the functional organization. Staff positions are established

that are neither instances nor executing jobs, but rather management supports. Here, the tasks of decision preparation, control, and specialist consulting are performed without the decision-making authority.

*Object-oriented models* are also referred to as divisional organizations, branch organizations, or business area organizations. With these models, the company is structured according to an object characteristic or by a category, for example, a product. Companies design their organizational structure according to the object principle, by forming categories by product, product group, market, customer, or region. A category organization develops with similar business divisions that group the operational functions under responsible management. Thus, the business divisions are given a profit responsibility in the sense of a profit center; that is, they are managed like companies in the company.

Object-oriented  
models



In *matrix organization*, elements of the function orientation such as design, production, and development, and elements of the object orientation such as material, markets, and customers are joined together, generating synergy effects. For project management or product management, different projects or products thus form the elements of the object orientation. This organizational model shows that we are turning away from strictly hierarchical pyramid models through the use of multi-dimensional arrangements, with holistic project tasks becoming increasingly important.

Matrix  
organization

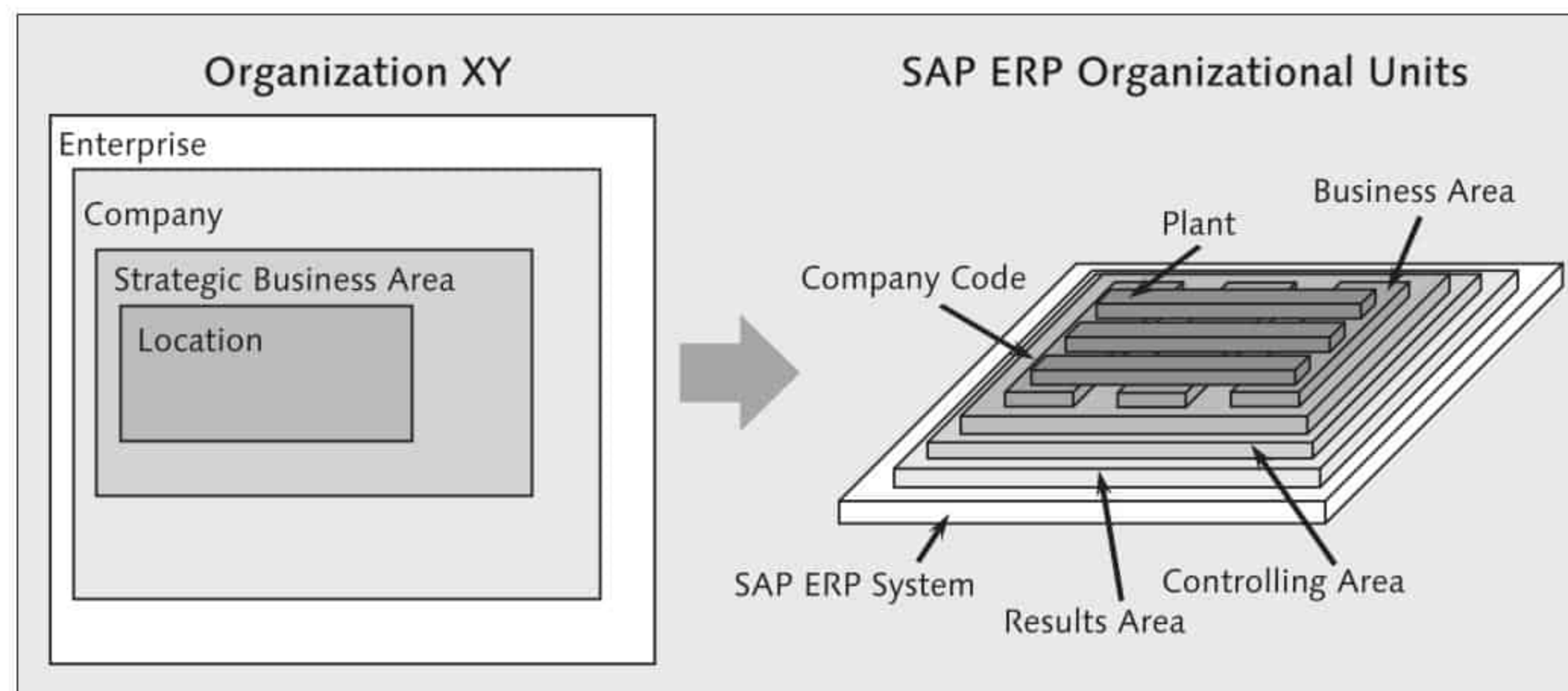
## 4.2 Organizational Structure Overview in SAP ERP

The structure of a company can be mapped by different organizational units for accounting, logistics, and human resources management. Organizational units help to depict a company's structural and process organization.

The complexity of the company structure can be mapped by the multiple relationships of the SAP ERP organizational units. In some cases, there are several possibilities for displaying an issue in the SAP ERP system. For instance, a company can consist of several legal entities, for each of which separate, individual financial statements must be prepared at the end of the financial year.

The internal arrangement of companies is defined, among other things, by the responsibility for particular customer or product groups, which are grouped into strategic business areas. The activities within a business area can be distributed across several companies. Finally, a location can be used by several companies and within various business areas. To map a company, you first need, as a minimum, an SAP ERP system in which all accounting and logistics functions are shown.

Profitability analysis is performed in the results area in the SAP ERP system. The cost-center and cost-element accounting are performed in the controlling area. Finally, the company code controls financial accounting and legally represents the enterprise. The creation of internal financial statements for the business areas is supported by the business divisions, and the individual locations are described by plants. Figure 4.1 shows an example of how company structures can be depicted in the SAP system. The human resources functions have no effect on the arrangement of the logical SAP ERP organizational units.



**Figure 4.1** Mapping a Real Organization in Logical SAP ERP Organizational Units

The key organizational elements of the SAP ERP system will be described below. In addition to the organizational elements for the production logistics, we also will discuss the most important overall organizational units.

In the context of *production planning and control*, the company code, the plant, and the storage location are the most important organizational units. Figure 4.2 shows their dependencies.

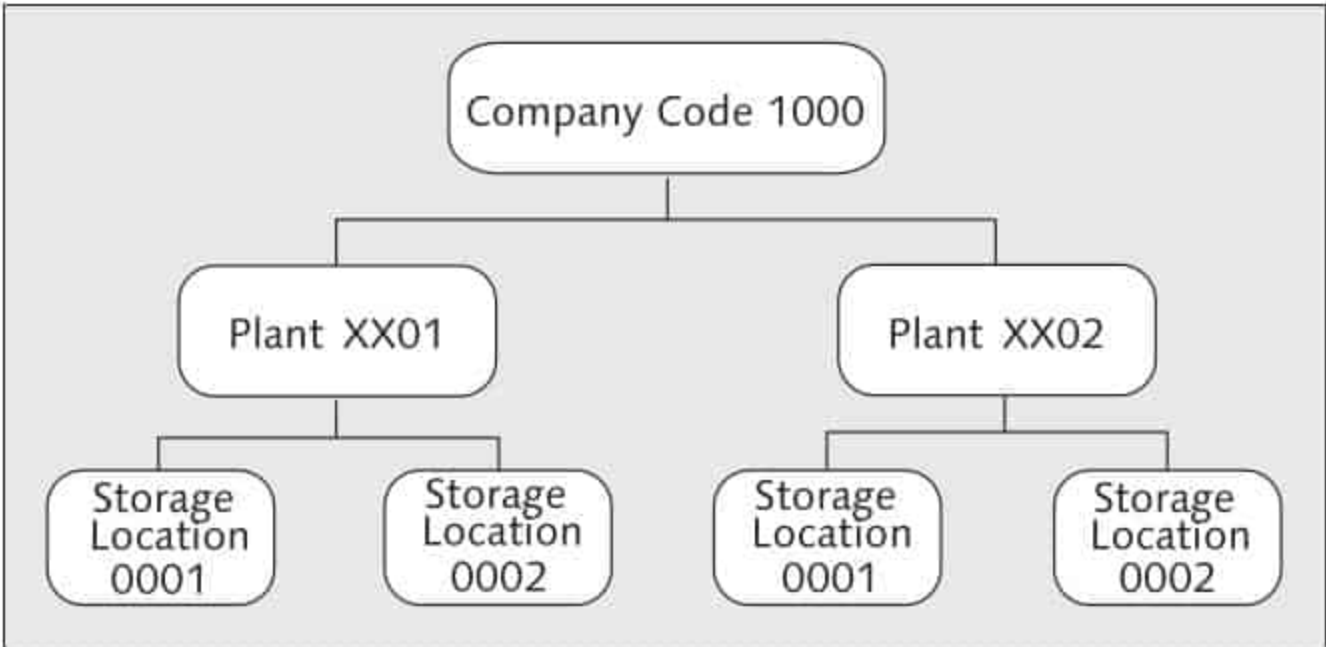


Figure 4.2 Organizational Structures for Production Planning and Control in SAP ERP

A plant is always uniquely assigned to a company code, which can contain several plants. Each plant can contain several storage locations. A storage location is already defined with a plant reference, which means that the name of the storage location is only unique within a plant. All organizational structures are assigned to a client in SAP ERP.

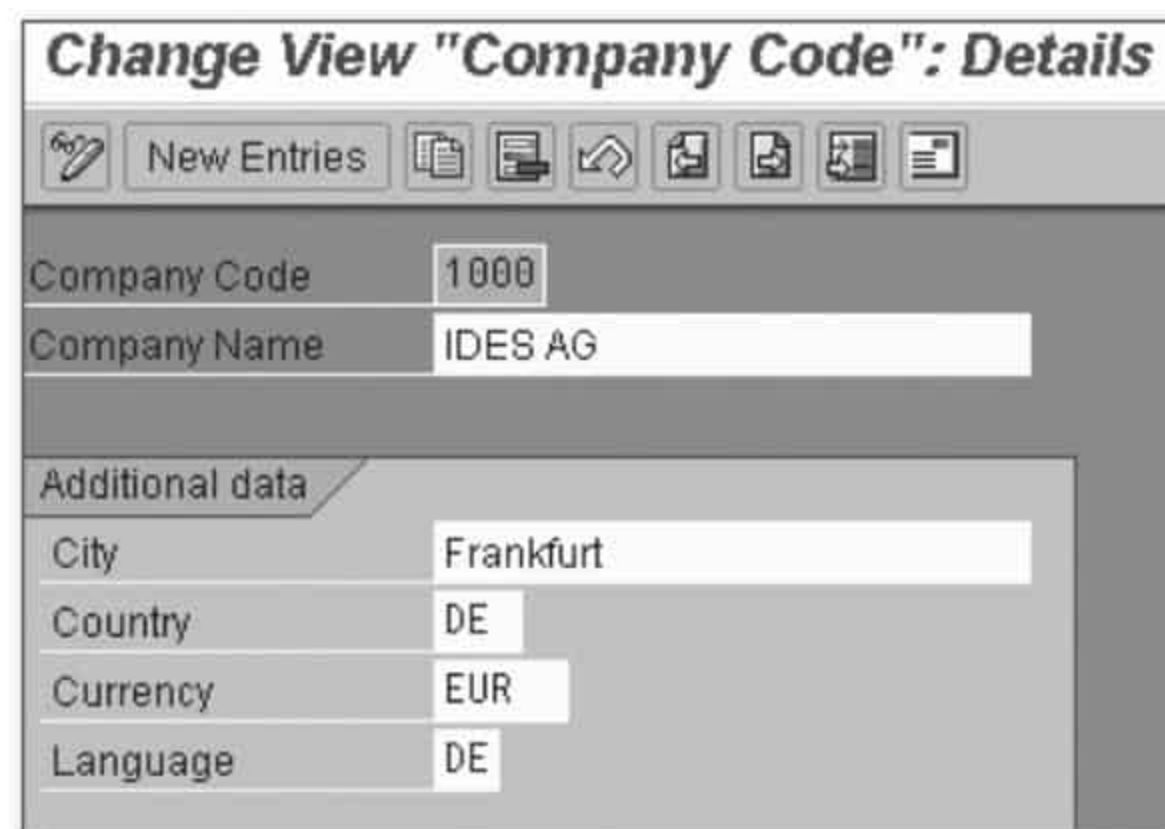
The client is a unit that is organizationally self-contained and also self-contained in terms of commercial law and data technology, within a SAP ERP system; it has separate master records and an independent set of tables. It represents the highest element of the SAP ERP organizational structure. The additional organizational elements and the master and transaction data are created and managed within a client. Often the client represents a concrete company or a group, within which there are several independent company units. An SAP ERP system can contain several clients, that is, logical units. A user always logs on to the SAP ERP system with his or her user ID in a client (see Figure 4.3).

Client



Figure 4.3 Logging On to the SAP ERP System

**Company code** The *company code* is an organizational unit for accounting that is used to map independent units for which accounts are prepared in line with legal requirements. The legally prescribed balance sheets and income statements are prepared at the level of the company code. A company that has activities in several countries will require a company code to be set up for each country. The company code is defined with the Customizing Transaction EC01 and only contains CITY, COUNTRY, CURRENCY, and LANGUAGE (see Figure 4.4). Most objects are directly or indirectly linked to the company code.



Change View "Company Code": Details	
Company Code	1000
Company Name	IDES AG
Additional data	
City	Frankfurt
Country	DE
Currency	EUR
Language	DE

**Figure 4.4** Company Code

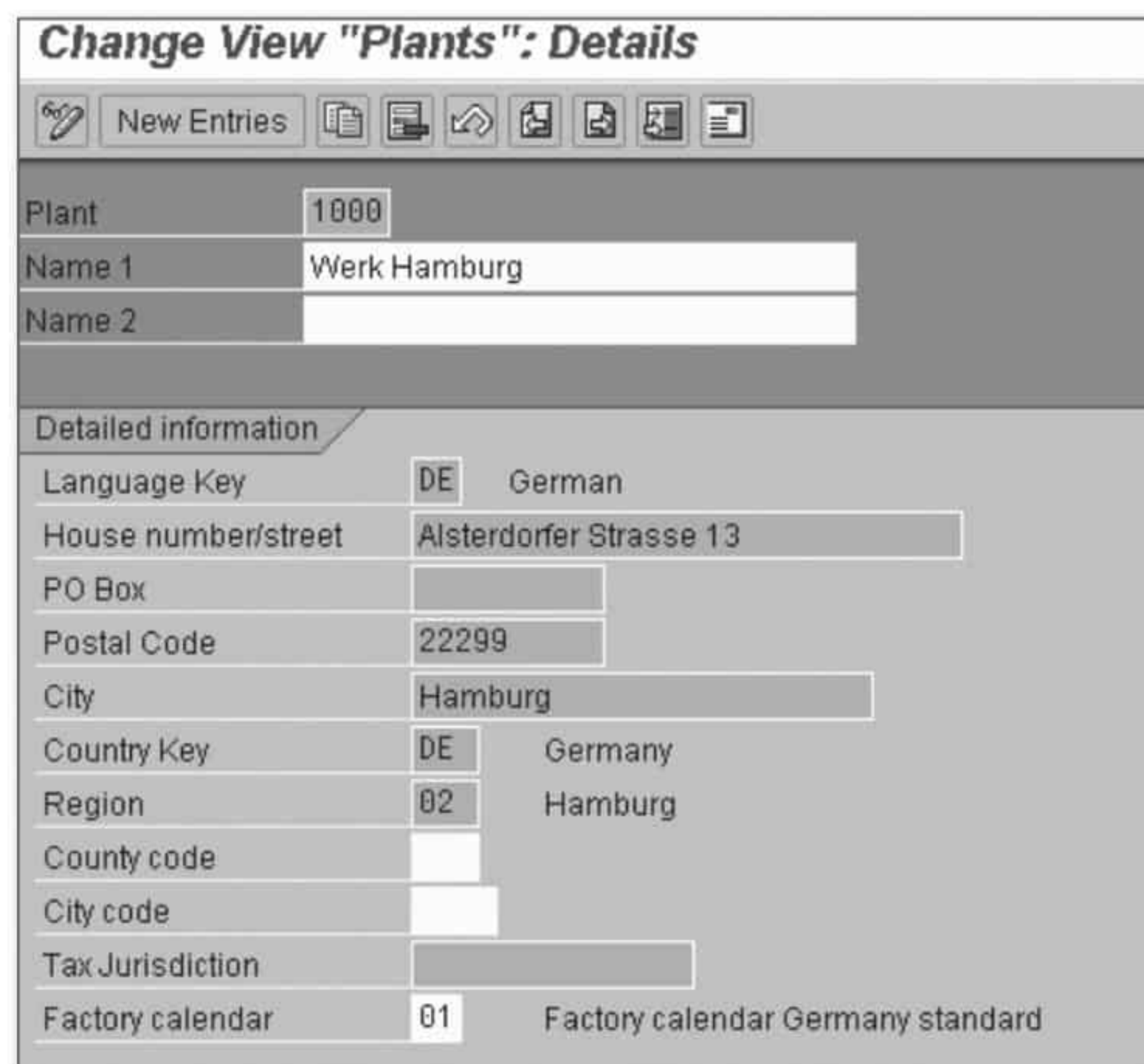
**Plant** A *plant* is an organizational unit within logistics. Different production locations are mapped with the plant in SAP ERP. The company can be classified here from the point of view of production, procurement, maintenance, and planning. The plant can be, for instance, an operating site or a subsidiary within a company. It organizes the tasks for the production logistics, and it can be a physical production site or the logical grouping of several sites in which materials are produced or goods and services are provided. The following tasks, among others, are performed at this level:

- ▶ Inventory management
- ▶ Evaluation and physical inventory of stocks
- ▶ Demand management and production planning

- ▶ Production control
- ▶ Requirements planning

A plant can have various purposes. As a maintenance plant, it contains the maintenance objects that are physically located in this plant. The maintenance measures to be performed are laid down within a maintenance planning plant. As a retail site, it provides goods for distribution and sale.

Plants belong to exactly one *company code*. A company code can represent several plants. From a logistical point of view, the plant is the central organizational unit and is maintained with Customizing Transaction EC02 (see Figure 4.5).



Change View "Plants": Details		
Plant	1000	
Name 1	Werk Hamburg	
Name 2		
Detailed information		
Language Key	DE	German
House number/street	Alsterdorfer Strasse 13	
PO Box		
Postal Code	22299	
City	Hamburg	
Country Key	DE	Germany
Region	02	Hamburg
County code		
City code		
Tax Jurisdiction		
Factory calendar	01	Factory calendar Germany standard

**Figure 4.5** Plant

As well as the address, the organization structure PLANT contains the FACTORY CALENDAR, the meaning of which is discussed in more detail in Chapter 11, *Production Order Creation*, in the context of scheduling. The assignment of PLANT to company code is performed using Customizing Transaction OX18 (see Figure 4.6).

**Change View "Assignment Plant - Company Code": Overview**

New Entries

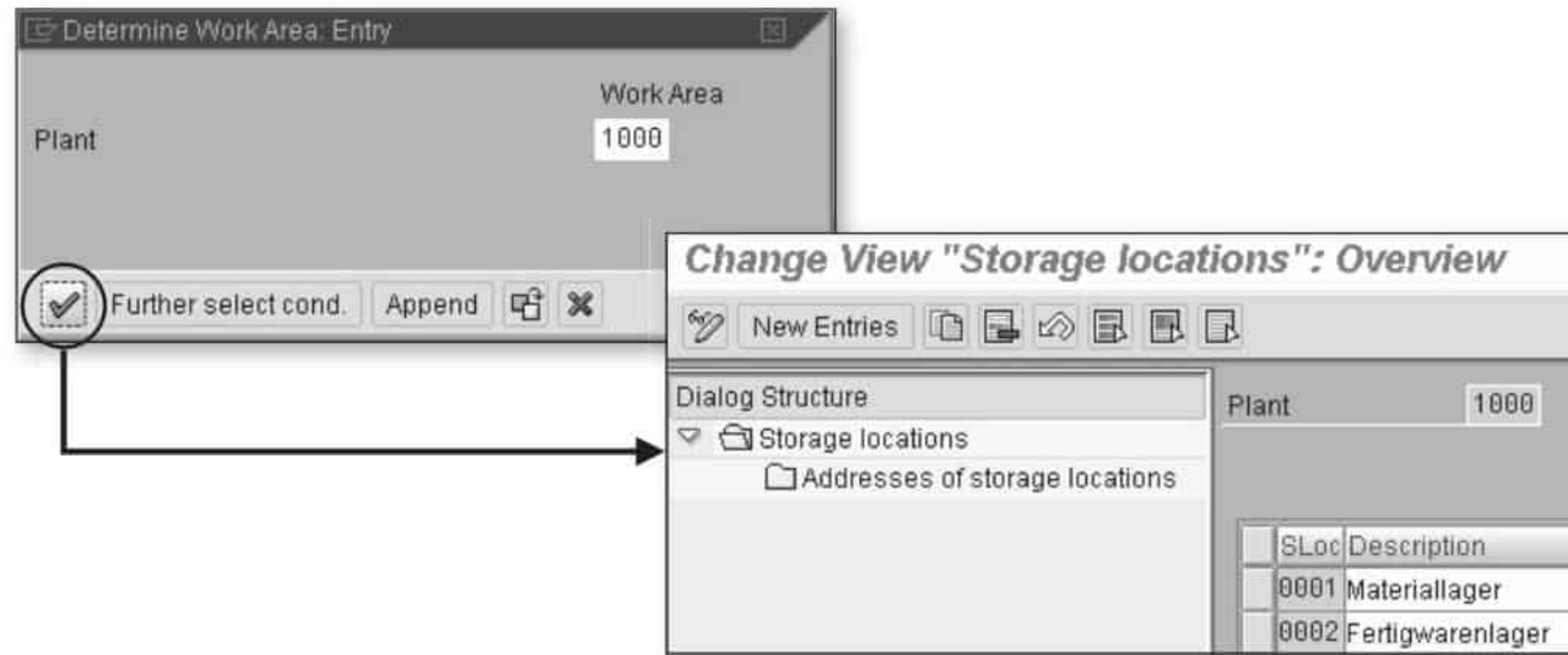
Assignment Plant - Company Code

CoCd	Plnt	Name of Plant	Company Name	Status
1000	1000	Werk Hamburg	IDES AG	

**Figure 4.6** Assignment "Plant" to Company Code

**Storage Location**

Several storage locations can be defined within a plant. A *storage location* is the place where materials are physically stored. Different materials may be stored at one storage location. Storage locations are maintained plant-specifically with Customizing Transaction OX09, as shown in Figure 4.7.



**Figure 4.7** Plant-Specific Maintenance of Storage Locations

### 4.3 Planners in Design and Work Scheduling

The tasks of *Design* focus on the development, setup, and structure of the products. From the point of view of production planning, the creation of the *Bill of Material (BOM)* is the most important design task. *Work scheduling* plans the machines and processes for the production and is thus closely linked to the maintenance of the master data *work center* and *routing*. Table 4.1 lists the relevant planners in SAP ERP, which are responsible for the master data, and the areas to which they belong.

Area	SAP ERP Planner	Master Data
Design	Lab/design office	BOM
Work scheduling	Work center supervisor	Work center
	Planner group	Routing

**Table 4.1** Assignment of the Areas to the SAP ERP Planners and the Master Data

The *work center supervisor* and *planner group* are plant-dependent settings; for example, the work center supervisor 001 in plant XX01 is a different person than the work center supervisor 001 in plant 1000. In contrast, the *laboratory/design office* is unique throughout the plant. The roles listed in Table 4.1 are maintained with the following Customizing paths:

- ▶ Design office: PRODUCTION • BASIC DATA • BOM • GENERAL DATA • SET UP LABORATORY/DESIGN OFFICE
- ▶ Work center supervisor: PRODUCTION • BASIC DATA • WORK CENTER • GENERAL DATA • DEFINE SUPERVISOR
- ▶ Planner group: PRODUCTION • BASIC DATA • WORK CENTER • GENERAL DATA • SET UP PLANNER GROUP

#### 4.4 MRP Controller, Capacity Planner, and Production Scheduler

While the planners listed in Section 4.3 are responsible only for the maintenance of master data, production planning, and control fall into the task area of the following planners: *MRP controller*, *capacity planner*, and *production scheduler*. These three planners correspond to the roles that SAP sees for production planning and control. Several, or even all, roles can be assigned to one person in a company.

These roles are significant primarily because they allow the fast selection of planning objects according to responsibility.

The *MRP controller* is responsible for production planning, that is, for the quantitative coverage of the requirements. The area of responsibility covers the creation of procurement proposals and the monitoring of material availability. Operations planning also often falls into this area

MRP Controller

of responsibility. In the short term, the transition to the tasks of the production scheduler is smooth because postponements lead to only brief shortages due to irregularities or disruptions in production.

MRP controllers are maintained with the Customizing path PRODUCTION • REQUIREMENTS PLANNING • MASTER DATA • DEFINE MRP CONTROLLER and contain the name and the contact data of the corresponding person (see Figure 4.8).

The screenshot shows the SAP 'Change View MRP Controllers: Details' interface. It features a title bar with the text 'Change View "MRP Controllers": Details' and a toolbar with icons for 'New Entries', 'Save', 'Print', 'Back', 'Forward', 'Refresh', and 'Help'. The main area is divided into several sections:

- Plant:** XX01 Werk Hamburg
- MRP Controller:** X01 Xaver
- Telephone:** 123456
- Missing parts message at goods receipt:** Recipient Name
- Accounting organizational area:** Business Area, Profit Center
- Recipient for mail to MRP controller:** Recipient type, Recipient

**Figure 4.8** MRP Controller

**Capacity planner** The job of the *capacity planner* is to schedule production operations in such a way that they fulfill the following conditions:

- ▶ They are feasible in terms of capacity
- ▶ As far as possible, no delays arise with respect to customer requirements or subsequent production operations
- ▶ Production costs remain low (setup times can increase due to the sequence of the operations, or unfavorable work center utilizations may arise)

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