Tips for Mapping Physical Production Operations to the Optimal Manufacturing Type in SAP ECC

by Suhail Jaffari, President, JCG Inc.

SAP offers three manufacturing methods — discrete, repetitive and process — that can be implemented in SAP ERP Central Component (ECC). Each manufacturing approach has its pros and cons. When deciding which manufacturing method to implement, consider the transactional and master data overhead versus the benefit of using the manufacturing method.

It may be advisable to adopt a simpler manufacturing type in your SAP system than the physical process that is carried out on the shop floor, especially if doing so allows for the required data capture while simplifying transactional overhead. As an example, I include a case study of a client implementation in which a decision framework that considers business requirements and system constraints was used to determine the appropriate manufacturing method for the client’s needs.

Characteristics of Discrete, Repetitive, and Process Manufacturing

Before beginning any meaningful review of SAP manufacturing types, I clarify from a business perspective the characteristics of the different manufacturing types.

Repetitive Manufacturing

Repetitive manufacturing involves the production of identical products. A repetitive process typically has some or all of the following properties:

• The steps to build the product are fixed and do not vary.
• Components are typically stored at the manufacturing line and staged from the warehouse based on the anticipated production build schedule.

• The components and labor hours used to build the product are recorded at the end of the manufacturing process. Components and time to make each unit have the same makeup, the calculated
component and labor time are accurate. In an SAP system, this calculation of component and labor consumption is called backflushing. The component and labor time are derived from master data, typically the bill of material (BOM) and routing, respectively.

**Discrete Manufacturing**

Discrete manufacturing involves the production of distinct physical products. Each production unit may be different from the next unit coming down the production line. Discrete manufacturing processes typically have some or all of the following properties:

- A work or production order is created for a single unit or multiple units that are to be produced. The units produced on a production order are the same, but they can be different from those produced on other production orders.

- The components and labor hours used to build the product are recorded against the production order. In the SAP system, this is called a production confirmation. Because a line processes multiple production orders, typically there are more confirmation transactions for a discrete process than backflush transactions for a repetitive process.

- The release of production to the floor typically involves some precursory steps, such as checking component availability, printing production paperwork, informing the operator of what to build, and issuing components to the production order before production starts.

- Discrete manufacturing processes can be controlled by shop floor control systems that track production for each production order by recording the completion of each step. This information often must be sent back to the ECC system to close out the production order by executing a completion confirmation.

**Process Manufacturing**

Process manufactured products are products that, once produced, cannot be broken down back to their constituent components. A baked cookie, for example, cannot be broken down to its constituent components. In discrete and repetitive manufacturing, units can be broken down to their constituent components, an expensive but nonetheless possible option. Process manufacturing has the same characteristics as discrete manufacturing, in addition to the following:

- Process manufacturing uses formulas or recipes, whereas discrete manufacturing uses BOMs. The use of formulas allows for scalability, which is not possible in discrete manufacturing. For example, if you want to manufacture 500 gallons of juice, but only 200 gallons of water are available, it is possible to scale down production to produce fewer gallons of juice. In the discrete environment, consider a bicycle for which only one wheel is available. Clearly it is not possible to scale down to half a bike. Scalability is a key feature of process manufacturing.

- In process manufacturing, the use of formulas or recipes allows for dynamic calculation of material quantities based on their attributes. Consider the manufacture of a pharmaceutical bulk powder that is to be pressed into tablets. Let’s assume that 1,000 kg of the finished bulk requires 50 kg of the active drug at 100 percent purity. If the actual batch of active drug used has a concentration of 95 percent, then 52.63 kg (100/95 * 50 kg) of the active drug should be used for that batch. Depending on the specific properties of the raw materials, a given manufacturing order may end up having a different component requirement quantity than the theoretical quantity specified in the BOM.

**Shop Floor Integration**

The requirement to integrate with a shop floor system can have a large impact on which manufacturing type is adopted. Shop floor systems perform a number of functions, including issuing raw materials, recording yields of finished products, and recording properties of the manufactured product at each stage of production (in-process and final inspection). This data is typically recorded against a manufacturing order. In a typical SAP/shop floor integration, the manufacturing order is sent from the ECC system and subsequent measurements and material movements from the shop floor system are sent back referencing the original manufacturing order.

Therefore, in a repetitive manufacturing process, integration with the shop floor is not possible, because in a repetitive manufacturing process no manufacturing order is generated. There is nothing that can be sent down to the shop floor system.

In SAP repetitive manufacturing, the closest object to a manufacturing order is a planned order. Typically, planned orders represent the quantity to be built. However, sending the planned order to a shop floor system as a substitute for the manufacturing order can be problematic. Planned orders can be deleted very easily, either manually or by a material requirement planning (MRP) run. Also, production-based inventory movements (for example, raw material consumption or finished goods receipts) cannot be posted to planned orders because planned orders are not valid cost objects. Even if the planned order were sent to a shop floor system, there would be no way to tie subsequent inventory movements sent from the shop floor back to the planned order.

Therefore, if a physical repetitive manufacturing process has shop floor integration, it would need to be set up as discrete production in the SAP system to leverage shop floor integration capabilities.

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Master Data and Transactional Setup for Manufacturing Types

The transactional setup required to support the manufacturing types in ECC must be assessed against the capability of the end users, who will be responsible for the data/transactional entry. The results of this assessment invariably provide a direction for which manufacturing type to use.

Master Data/Transactional Setup Repetitive Manufacturing

The master data setup to support a repetitive model requires the creation of four data elements: the BOM, routing, production version, and cost collector. The BOM and routing are standard production planning data elements and do not require further elaboration.

The production version is defined in the material master MRP4 screen of the product (Figure 1). Use transaction code MM02 or menu path Logistics > Materials Management > Material Master > Material Change. The production version defines the BOM and task list (routing) that is used to produce the material and the receiving storage location. This definition is specified for a lot size range. The production version is critical because it is specified during the creation of the cost collector and during the backflush. From a business perspective, the production version can be associated with a physical production line using a 1:1 relationship. If a plant has multiple lines, multiple production versions should be created.

The cost collector is created for the produced material, production version, and manufacturing plant (Figure 2 on the next page). Use transaction code KKF6N or menu path Logistics > Production > Repetitive Manufacturing > Master Data > Product Cost Collector > Process Product Cost Collector. The cost collector functions like a production order that is open for a defined period of time. Technically, the system creates a production order behind the scenes with an order type that allows continual postings without the need for conversion or release steps. The material movements and activity costs associated with the manufacturing are booked to this order.

Use transaction SE16 on table AUFK, the production order header table, to see the cost collector/production order link. In my example, the production process number from Figure 2, 100104210, is associated with the production version defined in the material master MRP4 screen of the product (Figure 1).
with production order 702824 in the AUFNR field (Figure 3).

From an execution perspective, the only transaction performed in a repetitive setup is a manufacturing backflush (transaction MFBF). The backflush transaction requires the input of a produced quantity, production version, and produced material. Upon execution, the transaction determines the components to consume based on the BOM assigned to the production version and the production costs based on the activity standard values defined in the routing. The transaction then determines the cost collector for the production version specified and posts the inventory movements and activity costs to the associated order.

From a planning perspective, a repetitive manufacturing model may also involve the staging of raw materials (transaction code MF60) and capacity leveling, which may be executed using the repetitive planning table MF50 or work center evaluation CM25. However, these activities may also occur in the discrete and process manufacturing models and therefore are not a major consideration when deciding which manufacturing type to use in ECC.

**Master Data/Transactional Setup for Discrete Manufacturing**

The master data setup in the SAP system that supports a discrete manufacturing model is by far the simplest of the three manufacturing types. The master data requires the creation of two data elements: BOM and routing.

The transactional steps for discrete manufacturing are more complex than for repetitive manufacturing because a discrete process allows for making different products on the same line, which requires a separate production order to be created for each run of product. The key transac-

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**Figure 2** Cost collector with production process number 100104210

**Figure 3** Process number/order link
tional steps involved in a discrete setup are as follows:

- Creation of a production order:
  Typically, the production order is created from planned orders generated as a result of MRP.

- Production order release: After the production order is created, a release step must be performed. This allows manufacturing to begin. From a process perspective, the release step serves as a gate to check capacity and component availability and to print paperwork used on the shop floor.

- Goods issue of material: Before production can begin, the input materials must be issued to the order. The raw materials are issued upfront and consumed at the appropriate operation.

- Confirmation: As production is completed, a confirmation must be performed to record the hours used in manufacturing the product. These hours are used by the system to calculate the non-material direct costs of manufacturing. The confirmation can also trigger a material consumption – typically done if a component is always consumed, has a low inventory value, and can be derived based on the bill of material.

- Goods receipt: After production is completed, a goods receipt activity is recorded to receive the product into stock for subsequent shipping or use as raw material for a higher-level assembly.

**Master Data/Transactional Setup for Process Manufacturing**

The master data setup in the SAP system to support a process manufacturing model is by far the most complex of the three manufacturing types. The master data requires the creation of two data elements: BOM and master recipe (equivalent to routing). The complexity arises in the recipe, which, in addition to the data elements of standard routing, includes phases and process instructions.

Phases are the equivalent of sub-operations. They are assigned to an operation and represent the production steps that take place. Phases are allocated to a parent operation and are used as the basis for scheduling, costing, and capacity planning.

Process instructions identify the process steps that must take place at each phase. These process steps could represent recording measurements of operating conditions, reading procedures or instructions, posting inventory movements, or executing quality inspections. Process instructions are assigned to a phase and a control recipe destination. The control recipe destination determines where the instructions are executed, the options being online via Process Instruction (PI) sheets or externally via a process control system.

From a business perspective, the best way to understand the context and use of process instructions is to think of process manufacturing as involving significant checking and monitoring, more so than discrete manufacturing. This extra dimension is handled through the process instructions. For example, in the manufacturing of pharmaceutical tablets, a manufacturing procedure may state that production requires the blending of ingredients for 30 minutes by a suitably trained technician at a room temperature not exceeding 72 degrees Fahrenheit. The process instructions typically contain a request for a temperature reading and a signoff by the user that the blending was executed for 30 minutes. This information is stored as part of the process order and serves as a batch record.

*Figure 4* shows an example of a recipe from the Internet Demonstration and Evaluation System (IDES) system for the

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*Display Master Recipe: Recipe*

<table>
<thead>
<tr>
<th>Recipe Group</th>
<th>Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>H2100</td>
<td>Berlin</td>
</tr>
</tbody>
</table>

* Checkbox indicating that operation 0011 is a phase of operation 0010

**Figure 4** Operation and phases of a master recipe
manufacture of tablets. Use transaction code C202 or follow menu path Logistics > Production-Process > Master Data > Master Recipes > Recipe and Material List > Change. The screen shows the operations and phases in the Oper... column, with phases shown in blue. Each phase is assigned the appropriate process instruction, which defines what is to be done at that phase. Figure 5 shows the instructions for phase 0011. Select the phase in Figure 4 and follow menu path Goto > Process Management > Process Instructions. The instructions show that, at this phase, a signature is recorded (1), a text description of the phase is defined (2), and text instructions are displayed (3).

The transactional steps inherent in the Production Planning-Process Industry (PP-PI) module are the same as in discrete manufacturing, except for four additional steps. The additional steps are as follows:

Control recipe creation: This step occurs after the release of the process order. The control recipe is a snapshot of the process instructions with the appropriate data populated from the process order. Taking the example from Figure 4, phase 0011—Weighing material requires the quantity of raw materials that are charged to be determined and goods issued. The process instruction for a consumption (issue of components to make the finished product) contains data needed to post a goods issue, such as reservation number, reservation item, material, quantity, batch, and storage location. This data can be determined only after the process order is released. The control recipe creation step accomplishes this task. The recipe contains the process instruction and the data fields (characteristics) that make it up. The control recipe creation populates the data fields based on the process order.

To illustrate this, the process instruction TBECONS is a consumption process instruction made up of 18 characteristics (Figure 6). The characteristic 110 is the material for which the consumption will be posted (1). This instruction is generated when the control recipe is created for all components assigned to the phase that have a reservation.

Control recipe transmission: The control recipe contains the instructions that have been defined for each process order or phase combination. These instructions can be executed by an end user or by a shop floor control system (process control). Whether the process instructions at a phase are processed by a user or an external system is determined by the control recipe destination, which is defined in the master recipe for each phase. This data is copied into the process order and used to determine where the control recipe is sent.

In addition, in Figure 6, instructions for component consumption are automatically generated.

Process control execution – PI Sheet: If the process control is user-based, then the appropriate data requested in the process instruction must be entered. In an SAP system, this is performed through the PI sheet. The PI sheet is generated when the control recipe is transmitted and the destination is defined as the PI sheet. The PI sheet is executed through transaction code CO58. A PI sheet created for the process instructions in Figures 5 and 6 is shown in Figure 7.

Figure 5 shows the process instructions (PI) of TBESIGN1 (User signature to start the PI sheet), PHTEXT (Text description of the phase), and INSTR (Detailed Instruction for the phase). These elements are identified in the PI sheet shown in Figure 7 as items 1, 2, and 3, respectively. Instructions for component consumption are generated for all components assigned to the phase and allow the user to enter the quantity of components. In Figure 7, the consumption quantity is shown for each component assigned to the phase. See item 4.

Process control execution – process message monitoring: A process message is typically data that is recorded in the PI sheet or external process control system...
Figure 6 Process instructions definition for material consumption

Figure 7 A sample PI sheet
that needs to be posted. In Figure 7, the inventory consumption entered on the PI sheet generates a process message when the PI sheet is saved. The process message contains the entered data and, when posted through the process message monitor, calls a function module, in this case (COCI_CONFIRM_MATERIAL_CONS). This function module, in turn, calls the appropriate MM application. Process messages can be configured to call a function module, update user-defined custom tables, send SAP Office mail, or transmit data to external systems via a Remote Function Call (RFC). Usually, process messages are generated for all execution data relating to the manufacture of the product.

**Framework for Matching the Physical Manufacturing Process with the SAP Manufacturing Type**

Typically, the biggest decision on which manufacturing type to use in the SAP system occurs for discrete and process-based manufacturing. Figure 8 provides a framework to help arrive at the optimal SAP manufacturing type.

The first thing to determine when attempting to identify the appropriate manufacturing type is whether you need to have scalable production batch sizes, dynamic raw material quantity calculations, or both. If you need any or all of these, then a master recipe is required and, therefore, there is no option but to set up a process manufacturing model in the SAP system (1).

If there is no need for unique scalability or dynamic raw material calculation, then you must determine whether the manufacturing process is controlled by an external shop floor control system. If so, the next decision is whether there is a need to have all the shop floor process data stored in the SAP system along with the manufacturing order details (such as order number, component consumptions, and batch numbers). If, for example, you intend to use the SAP system for electronic batch history, then you should adopt a process approach (2).
An alternative approach would be to keep shop floor data in the external system and the order information in the SAP system and to combine the two via a front-end reporting tool such as Business Intelligence (BI) in order to show the complete manufacturing data. This approach enables a discrete manufacturing model to be implemented in the system, saving the transaction and master data overhead associated with a process manufacturing model (3).

If there is no shop floor integration, the complexity of process control should be addressed. If the process control has complex requirements, such as a record of procedures or instructions used in manufacturing the batch, signature requirements to sign off that each operation step is completed, and/or integrity checks to make sure operations are completed in order, then a process manufacturing approach should be implemented (4). If the manufacturing data to be captured is simple, a discrete manufacturing approach can be implemented (5).

Case Study

A client involved in the manufacture of medical devices needed the full manufacturing history to be captured in its SAP system. However, there was no external process control system. A decision had to be made between process manufacturing and discrete manufacturing.

After some review, my team determined that the process control data that the client needed to capture as part of the batch record could be recorded using in-process inspection (quality management). The in-process inspection lot could be triggered from a production order. Also, the headcount for the product line was low and already working close to capacity. Introducing master recipe, process instruction data, and the associated transactions associated with process manufacturing would have required additional resources.

Based on these findings, my team determined that the client should implement a discrete manufacturing model. The model leveraged custom reports to combine inspection lot and production order data to provide a full batch record. The standard SAP solution for electronic batch record would have required the implementation of a process manufacturing model. By using a discrete manufacturing model instead, the client was able to conserve resources.

Suhail Jaffari has been involved in SAP consulting and Supply Chain Re-Engineering projects since 1993. Working as a platinum-level consultant, Suhail has and continues to engage with clients worldwide, helping them to realize innovative SAP solutions to support complex supply chain operations. You may contact the editor via email at editor@scmexpertonline.com.