Pliable Plastic Production (2010)

To an economist, manufacturing seems like such a simple concept: Buy some equipment (capital), purchase a bunch of raw materials (inputs), hire some workers (labor), and make a product. Refine the process and drive down costs, make enough products and sell them at high enough prices to cover the fixed and marginal costs. Today's manufacturing is more complex—even for relatively small shops. Flexibility is critical to most manufacturers—particularly those who focus on custom products. This company specializes in molding and fabricating plastic items—and many of the things you buy today use plastic components. Entrepreneurs who invent new products typically require many plastic components. All of these have to be designed, custom molds built, and the factory has to schedule inputs and production time on the machines. The goal of this case is to build a database that helps track the main steps of design, purchase, and production.

Design

The first step in creating a new product is to design it. In terms of production of plastic parts, design consists of detailed diagrams of the product along with molds and various extrusion techniques. The type of plastic also needs to be specified because each type has different levels of hardness, flexibility, and strength. For a moment, think about a small plastic box with an attached lid and snap clasp. With the proper equipment, this box can be produced in one piece by extrusion—pushing plastic through a set of molds that shape and contour each element of the box. The key lies in the design and then building a prototype to test and refine the design. In a custom shop, the designs are provided by outside companies who need the product.

Figure 1 shows the basic data needed regarding a design. Typically, designs go through several versions—both during prototyping and once production starts.

Product ID Description Approximate Size: height, width, depth Primary material	Customer Contact Person Phone E-mail Address City, State, Postal Code Country

Version	Date	File	Comments

Input	Quantity per 1000 units	Vendor	Message Commands

Figure 1

Item Order ID Date Vendor Phone Delivery Date Confirmation ID			Customer Job ID Item Quantity	
Item	**Description**	**Quantity**	**Price**	**Value**
Total Price Shipping Cost Total Due				

Figure 2

The basic product information identifies the general product and the customer. Each version has a design file that specifies the details. The database will store the name of the file, but the file is stored separately on the computer system. Typically, the associated file is for the CAD/CAM production system. It contains drawings and exact specifications for the entire product. Engineers generally save the file as a new version when changes are made to the design. Engineering and production notes are stored in the separate file so they can be attached to individual components of the product. The design file also contains information to configure the production machines electronically. When the design file is loaded into the computer-aided manufacturing system, it sends configuration commands to the machines.

Input Purchases

Each product requires the purchase of input items—primarily plastic pellets and color dyes. The quantity needed depends on the size of the product, the number of units to be produced, and the waste percentage. This company maintains inventories of some basic plastics, but generally prefers to place just-in-time orders to have vendors deliver the materials the day they are needed. Ideally, when a production job is scheduled for a specific design, the system would compute the required number of inputs and place the orders electronically with the standard suppliers. To know how much to order, the company engineers need to estimate the various input quantities for each design based on the number of units produced. This data has to be stored along with the design. The bottom section of the Figure 1 shows the basic data needed for the input, the quantity needed per 1,000 units produced, and the standard vendor for that item. The message configuration field contains the information needed to send an electronic order to that vendor. Ultimately, the order would include the exact quantity and delivery date needed. These values could be plugged into the message as parameters.

Figure 2 shows the basic order that is generated when it is placed with a supplier. Most orders contain only a limited number of items, but each product might involve scheduling deliveries from several different vendors. When the job is scheduled, the system transmits this information to the supplier. The vendor's electronic system returns a confirmation number which needs to be stored in case questions arise later. Each order is tied to a specific customer job and product design. Sometimes multiple jobs are scheduled on the same day and use similar

Product Design Version		Customer E-mail	
Machine Operator Quantity Produced Overall Quality Comments/Problems	Start Date/Time End Date/Time Defective Count		
Input	**Quantity**	**Vendor**	**Quality Comments**

Figure 3

inputs. In these situations, a vendor might receive multiple orders. Most vendors simply add up the total amount needed for the similar items and make one shipment. When the shipment arrives, it is checked in against the multiple orders—so even though it is one shipment, it is treated as if multiple items were received. The shipping costs are then split among the multiple orders based on the percentage of product needed.

Production

Many production companies record detailed information about each production step, such as the time, the employees involved, the quantity produced, and quality control measures from the individual machines and the inputs. It is also helpful to record any problems that arise such as broken parts and power outages. For an initial design, it is easier to start with the basic production information. Figure 3 tracks production by steps based on the individual machines. The figure shows basic data for one machine, but a production run can often use multiple machines. Note that a production can use a specific version of a product—which is not necessarily the latest version on file. Sometimes customers want to use earlier versions, so this version needs to be tracked. Each machine is run by an employee operator. The total quantity produced is recorded as well as the number of defective items that are discarded or recycled. An inspector records the overall quality and lists any specific comments or problems that were found.

The firm also needs to track the amount of each input used at each step of production. These values are processed by engineers to refine the design estimates and to track the amount of wastage. When possible, the vendor of the input is recorded to see if some inputs are more efficient than others. Input quality control examines the input resources for obvious defects and records any problems in the comments section. More specific quality control measures and testing processes are conducted separately with that data recorded in a different system. For example, chemists perform tests on samples of the inputs to determine if they meet the desired standards. Because this process is handled outside of the normal production, the results are stored in a different system.

Destination Address City, State, Postal Code Country			Expediter Date shipped		
Item	**Order**	**Production run**	**Quantity**	**Weight**	**Price**
Total Price Date Billed					

Figure 4

Shipping

Once the items are produced, they are boxed and shipped to a location specified by the customer. Often, the destination is overseas so customs forms have to be filed. These steps are handled by an international expediter. The expeditor is also responsible for ensuring delivery and handling any taxes and insurance. Once the items are picked up by the expeditor, our role is over and the customer is billed based on the negotiated prices.

Figure 4 shows the basic information collected for the shipping. Each box shipped is entered as a separate row. A box contains only one type of item. If the boxes are small, the expediter might combine them into larger boxes, but we track them at the detail level. The Order ID represents the specific order placed by the customer. The production run is an identifier that enables the company to track a product back to the day it was produced in case the customer claims there are problems. To assist in quality control tracking, individual boxes contain items only from a single production run. The quantity of items in the box is tracked along with the weight of the entire box. The weight is basically included to assist the expediter and represents the shipping weight including the box.

Exercises

1. Create the feasibility study (initial proposal).
2. Create a list of all of the forms and reports that the company might use.
3. Create a normalized list of tables for each form and report.
4. Create an integrated list of normalized tables for the entire application. Draw the corresponding class diagram.
5. Create the basic tables in a DBMS along with all necessary relationships and integrity constraints. Enter sample data into the tables to test your design.
6. Evaluate the normalized tables and estimate the size of the database—both current size and estimated size in 3 years.
7. List the initial security conditions for the data tables. Create a list of user groups and identify their basic access needs.

8. Design the overall structure of the application. Outline the overall structure and the primary forms. Select a design scheme, including layouts, effects, and colors.
9. Build three initial input forms.
10. Build three initial reports.
11. Improve the forms and reports to make them easier to use.
12. Test your forms and reports with sample users.
13. Build additional forms and reports. Improve all of them. Test all of them.
14. Connect all of the forms and reports into an application. Add help files. Test all the links. Test the forms and reports. Check for consistency.
15. Add security, backup and recovery, and other management features to the application.
16. Move the data tables to a centralized server, leaving the application to run on a client. Build the necessary links and retest the application.
17. Move the entire application to a Web server. Build the forms so that they run on a Web browser.
18. Create an OLAP evaluation query and graphs. Build in a way to create the links so new annual data can be generated automatically. Link the data so that the spreadsheet is updated automatically.