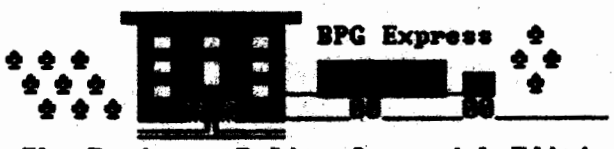

CHAPTER 7

PRODUCTION: PLANNING, SCHEDULING AND COSTS

Your firm's production department should begin the simulation by setting functional-level production goals and objectives and developing production strategy to accomplish these goals. Production goals should support the overall goals developed at the business level and should focus upon what production can contribute to achieving the business-level goals. The following business-level goal was used as an example in Chapter 4:

> Maintain a rate of return on stockholders' end-of-Year 2 investment in your company's stock (goal) of at least 20 (hurdle) percent (index) through Year 7 (time).

Production goals and objectives that support this business-level goal might be:

Goal: Limit inventory storage costs (goal) to one (hurdle) percent (index) of sales (time implicit).

Objective: Maintain an inventory level (goal) at the end of each quarter (time) equal to four weeks (hurdle) of sales (index).

Goal: Maintain sufficient production capacity (goal) to meet the growth (hurdle) in customer demand (index) during management's tenure (time).

Objective: Increase production capacity (goal) by 30 (hurdle) percent (index) during Year 4 (time).

Other goals and objectives may focus upon production costs and capacity utilization.

Production strategy should be designed to enable your production department to attain its goals and objectives. The strategy should plan for the allocation of production resources to gain maximum efficiency while meeting market demand. The strategy for the inventory goal would focus upon production scheduling. The strategy for matching capacity with demand would involve all options for expansion and contraction of capacity. An effective production strategy should include all of the production variables which require resources.

The quarter to quarter tactical decisions which your production management must make are described below. These decisions should be considered in the light of your firm's sales forecast and guided by your production strategy and overall company policy. This chapter will provide suggestions for planning current and future production needs, discuss the scheduling of production for the current quarter and outline the costs associated with various production alternatives. Before we proceed, let's take a little time to discuss the actual production process that takes place within your plant(s). This should give you better insight into the production facilities your firm manages.

The Production Process

Your firm fabricates approximately half of the parts needed to manufacture its product and purchases the remaining parts. Thus, a production line consists of several fabricating machines plus an assembly line. The production line is balanced so that the fabricating machines are able to provide parts at the rate they are needed to meet the demands of the assembly line.

Your firm has contracted with a raw materials supplier and a parts vendor for all of its materials and parts. The contract calls for each supplier to deliver the materials and parts needed for one day's production run to your plant at least an hour prior to the beginning of the first shift each day. This provides sufficient time to ensure that the materials and parts are positioned at their required locations before the line begins to operate. The actual volume of materials and parts can be adjusted on a daily basis to compensate for variations in production due to breakdowns, illness and normal fluctuations in production volumes.

Past experience has shown that your suppliers are very reliable. You can also depend upon your line supervisors to make the needed day-to-day adjustments in materials and parts supplies. Thus, your production team can focus upon providing and scheduling sufficient production capacity to meet market demand. It also is responsible for product development and employee training.

Operations Planning and Scheduling

Existing Capacity

Your firm has six production lines available for use as you assume management responsibilities at the beginning of Year 3. Each of the lines is capable of producing 4,000 units during a forty-hour week. Thus, normal production per line is 52,000 units during a thirteen-week quarter.

With six lines operating at normal capacity, your plant will produce about 312,000 units during each quarter. Actual production, however, may vary from this amount by up to 5 percent in Merica because of factors beyond your control. For example, if production machine down-time is greater than normal, your plant might produce as few as 296,000 units. Conversely, efficiency of your production workers could turn out to be very high in another quarter and the six lines might produce as many as 327,000 units. Experience has shown that production facilities in Sereno tend to have wider variances, with actual output more likely to be less than scheduled output. Variances may be as high as 15 percent.

While your current production capacity is somewhat fixed, you have a number of alternatives for adjusting capacity. A temporary reduction in your firm's production schedule may be arranged if you wish to lay off workers to idle one or more lines for the entire quarter. Workers laid off this quarter are furloughed for one quarter and are recalled on the first day of the next quarter unless you lay them off again. For a layoff lasting more than 13 weeks, it sometimes is more cost effective to deactivate a line. When a line is deactivated, workers are discharged and the machinery is secured, so that reactivation will require one quarter's advance notice to train new workers and prepare the machinery for active use. The costs associated with layoff and deactivation procedures are outlined below.

Production may be expanded by scheduling overtime work, by adding a second shift in your home area plant, by adding additional lines in an existing plant, by constructing additions to a plant, or by construction of new plants in other marketing areas. Overtime costs are described below, under "Production Costs," and the necessary procedures and cash outlays required for other forms of expansion of production facilities are described in Chapter 8.

With these various production alternatives in mind, and considering the costs associated with each alternative, the next step is to determine the strategy that your firm will use to produce sufficient units to meet your sales demand. Suggestions were made in Chapter 6 for completing a sales forecast. This forecast should serve as the basis for the production plans that you will make.

Level Versus Seasonal Production

There are two basic approaches to production planning for a product that has sharp seasonal fluctuations in its sales. One strategy is to plan production during each period of operations that will be approximately equal to the expected sales during that period. Because of higher seasonal demand in the second and fourth quarters, your firm could undertake heavy production schedules during those quarters each year, while idling some lines or otherwise reducing the amount of production during the first and third quarters.

This type of plan has the obvious advantage of enabling your firm to operate with a minimum investment in finished goods inventory. Storage costs could be held at relatively low levels, and the cost of funds necessary to finance inventory accumulations would be minimal. The disadvantage to such a plan is that production costs are likely to be considerably higher. Sharp sea-

sonal fluctuations in production will require adding large numbers of workers to your labor force during the second and fourth quarters of each year and operating your production facilities at or above normal capacity during those quarters. Conversely, during the first and third quarters many of the workers would be temporarily laid off, and a significant portion of your production facilities would be standing idle.

In developing your firm's policies regarding production, you will wish to compare the costs and relative flexibility of seasonal production with a strategy that sometimes is called a level-production plan. A simplified version of the level-production plan would require you to estimate the total volume of expected sales during the coming year and divide that amount by four. Production during each quarter of simulated operation then should be equal to approximately one-fourth of expected annual sales. During the first and third quarters, your firm would produce more goods than are necessary to meet expected sales, and inventories would accumulate to meet the larger demands of the second and fourth quarters.

Obviously, inventory storage costs would be higher than with seasonal production, and more cash would be necessary to finance the inventory buildup. On the other hand, level production would enable you to maintain a stable work force and better utilize your production capacity. A projection of production costs, inventory storage requirements and the cost and availability of funds to finance those inventories will assist you in deciding which type of production plan will best meet the needs of your firm. You may decide to use a combination of both plans that would permit some seasonal variation of production but still involves some inventory buildup for the peak sales quarter.

Inventory Storage Costs

Each production plant (home and non-home area) has room to store 300,000 units of finished product. Thus, your firm begins Year 3 with storage space for 300,000 units in your home-area plant. If additional plants are built, they also will include storage for 300,000 units. It costs 10 cents per unit (or 60 centavos in Sereno) to store unsold goods in your plant(s) for a quarter. If the inventory exceeds the available storage space in a plant, your firm will rent space in a public warehouse in the same area to store the additional units of product. Units will not be shipped to other areas for storage. Public warehouse storage costs amount to 30 cents per unit of product (or Ps 1.80 in Sereno). Units in storage in the public warehouse will be sold prior to the units stored in your plant. All storage costs for a quarter are paid at the beginning of the following quarter.

Production Plan Work Sheets

Work sheets are provided in Appendix D for developing a production plan and estimating production costs. A spreadsheet template of the Production Plan Work Sheet also is available on the disk packaged with this manual in file PRODPLAN.WK1. These work sheets will assist your firm in planning your production requirements, scheduling the necessary production and estimating costs. If your sales forecasts indicate a need for expanding your production facilities, you also will find these work sheets extremely useful in planning the rate at which you should expand and

the type of expansion that you should undertake. Investment alternatives for expansion of your plant are detailed in Chapter 8, along with the costs that are associated with each alternative.

Each work sheet has space for one quarter's operations, with a column for each area and for a consolidation of values. Thus, you may want to use a series of work sheets to forecast production requirements for at least a year. The spreadsheet template file on your disk contains four quarterly work sheets plus a consolidated yearly work sheet. As the competition progresses, the accuracy of your production forecast can be assessed and forecasts of future production requirements can be revised.

An example of the top section of a Production Plan Work Sheet is shown in Figure 7-1. The work sheet will assist you in determining the amount of production that must be scheduled for the quarter as well as the number of units each sales office should order. Our discussion will focus upon the Merica Area 1 column, which we will assume is for the home area, although the other columns will be referenced at times. Suppose that you have forecast sales in Merica Area 1 for the first quarter of Year 3 to be about 103,000 units, as illustrated in Figure 6-1. Your sales estimates should be entered (in thousands of units) on the first line of the Production Plan Work Sheet, as shown in Figure 7-1.

If your management has adopted a seasonal production strategy, you may wish to maintain a relatively small safety stock on hand, say 20 percent of expected sales. Adding this to your sales forecast will yield the total number of units needed for the quarter by area. The minimum number of units needed to meet your expected sales in Merica, Area 1, and still maintain your safety stock will be about 124,000 units:

$$103 + 21 = 124 \text{ units}$$

So enter 124 on the work sheet as Total Units Required.

We find from Appendix C that Merica Area 1 had 29,000 units of inventory on hand at the end of Year 2, Quarter 4, so enter 29 for Beginning Inventory.

Sales offices must place orders to obtain goods to sell in their areas. No orders, no goods! While a sales office has priority in obtaining goods from its local plant, all units produced and not specifically ordered by the sales office may be sold to affiliates. Thus, it is very dangerous for a sales office to rely upon the output of a plant in its area unless the output is committed by a sales office order. The size of the necessary sales office order is determined by subtracting Beginning Inventory from Total Units Required. In our example, the sales office order for Merica 1 would be 95,000 units.

$$124 - 29 = 95$$

Enter 95 under Sales Office Orders on the work sheet.

THE BUSINESS POLICY GAME
PRODUCTION PLAN WORK SHEET

World _1_ Company _1_ Year _3_ Quarter _1_	Consolidated	Merica Area 1	Merica Area 2	Merica Area 3	Sereno
OUTPUT, INVENTORY, AND SALES ANALYSIS (in thousands of units)					
Sales Forecast	318	103	75	75	65
Safety Stock	64	21	15	15	13
Total Units Required	382	124	90	90	78
Beginning Inventory	55	29	10	10	6
Sales Office Orders	327	95	80	80	72
Production Scheduled	328	328	0	0	0
Local Sales Office Purchases	95	95	0	0	0
Local Sales Office Shortage	232	0	80	80	72
Goods Available to Affiliates	233	233	0	0	0
Affiliate Sales Office Purchases	232	0	80	80	72
Sales to Affiliates	232	232	0	0	0
Goods Available for Sale	383	125	90	90	78
Sold to Customers	318	103	75	75	65
Sold to Liquidators					
Ending Inventory	65	22	15	15	13

FIGURE 7-1
Illustration of the Production Plan Work Sheet—Top Section

Production is scheduled in lumps of 52,000 units per line for a normal 40 hour week. If your only sales office was in Merica Area 1, your firm would need to schedule only two lines to meet the demand. The remaining four lines would have to be idled or deactivated. However, we will assume your firm has a sales office in each of the four market areas. If we further assume that Merica Area 2 and Merica Area 3 each requires 80,000 units and Sereno requires 72,000 units (if you believe these are accurate forecasts, I have a piece of the Brooklyn Bridge I would like to sell you), consolidated sales office orders would total 327,000 units or a little more than the normal capacity of six lines, producing 52,000 each for a total of 312,000 units. Thus, the additional 15,000 units will have to be produced using overtime. Six lines running 42 hours per week should produce 327,600 units. Rounding this to thousands of units, 328 is entered on the work sheet for Production Scheduled.

For a producing area, Local Sales Office Purchases from the plant are equal to the Sales Office Order as long as sufficient goods are produced to supply that amount. If production is less

than the amount of the order, the difference should be recorded as a Local Sale Office Shortage. Then, with sufficient production, subtract the Local Sales Office Purchase (95,000) from the Production Scheduled (328,000) to find the Goods Available to Affiliates.

328 - 95 = 233

With 233,000 units available to supply all of the other sales offices, there is enough to fill all of the orders. In our example, the Affiliate Sales Office Purchases for the non-producing areas equal the Sales Office Orders. The Sales to Affiliates equals the Affiliate Sales Office Purchases, or 232,000 units:

80 + 80 + 72 = 232

When more than one plant is in operation, units are Sold to Affiliates according to a long-standing company policy. Goods available for shipment to affiliates are shipped from Sereno first, from domestic non-home areas second (in numerical order) and finally from the home area. The Sold to Affiliates entries would reflect this priority. If goods available for shipment are less than Sales Office Orders, shipments will be pro-rated according to the size of the orders.

In each area, Goods available for sale equals Beginning Inventory plus Production Scheduled plus Affiliate Sales Office Purchases minus Sales to Affiliates. Goods Sold to Customers equals either the sales forecast or Goods Available for Sale if it is less than the sales forecast. The ending inventory is equal to Goods Available for Sale minus Sold to Customers. Note how these values have been entered on the work sheet.

Plan your production requirements now for the rest of Year 3. Then plan an additional quarter as you complete each decision set. This will provide your firm with a running, four-quarter production plan that will allow time to expand your productive capacity when needed.

Scheduling

On each quarterly decision form, **all available production lines in each plant and for each shift must either be scheduled for production, idled or deactivated**. If a line is available for production but is not scheduled to produce, it must be idled (the employees will be laid off for the quarter) or deactivated. Unless all available lines are accounted for on the decision form, the computer program will reject your decision set with an error message requiring you to account for all available lines.

1. Schedule lines. Production lines scheduled for first-shift operation must be entered on the decision form for the market area in which they are located. Enter the number of production lines that are to be producing (not more than the maximum available) and the number of hours that are to be scheduled per week (from 40 to 48). Make sure your entry is for a market area (or

areas) in which you have a plant. If your entry is in the wrong area, the decision values will be rejected by the decision-entry program.

Limits: Lines: 0 to maximum number of lines available
Hours: 0, 40 to 48 (per week)

	Sales Office Orders	Production Schedule	
	(000s)	Lines	Hours
Area 1	# 87	# 6	# 40
Area 2	# 75	#	#
Area 3	# 75	#	#
Sereno	# 75	#	#
2nd Shift		#	#

2. Second shift. Production on a second-shift line is possible only in a firm's home-area plant. Enter the number of second-shift lines that are to be producing (up to the maximum number of lines available) and the number of hours per line that are to be scheduled each week (from 40 to 48). As with the first shift, all available second-shift lines must either be scheduled for production, idled or deactivated.

IMPORTANT NOTE

Second-shift lines are not available and may not be scheduled until production workers have been trained to operate the lines. The training process is described in Chapter 8. Training of new second-shift workers requires one quarter before production may begin. **Advance planning is required, at least one quarter before you intend to begin production.** Thus, if you wish to begin production on one or more second-shift lines in Year 3, Quarter 2, you **must** make an entry for 2nd shift under New Lines for Year 3, Quarter 1.

Limits: Lines: 0 to maximum number of lines available
Hours 0, 40 to 48 (per week)

3. Temporary Layoff. Production lines that are available but not scheduled for production and have not been deactivated should be idled by a temporary layoff. A layoff is for one quarter. The lines are available and the workers may be recalled to resume production in the

following quarter. Enter the number of lines which you plan to leave idle on the decision form under Capacity Adjustment–Layoff. Make sure that all first-shift lines are accounted for and all second-shift lines are accounted for (scheduled, idled or deactivated). If you idle a first-shift line, a corresponding second-shift line must be idled or deactivated unless there remain at least as many active first-shift lines as second-shift lines. A second-shift line may not continue operating unless there is a corresponding line on the first shift. Check to make sure your entry is for the area in which you want to idle lines. Each idled line results in a charge of $52,000 per quarter (or Ps 312,000 in Sereno), subject to inflation. The amount will be reported as Temporary Layoff Costs in the Production Cost Analysis section of the Operating Information Report (Report D).

Limits: 0 to number of lines available

IMPORTANT NOTE

If your firm decides to operate its plant at less than normal capacity, lines that are not used **must** be idled or deactivated. Lines that have been idled are immediately available for production in the following quarter or they may be idled again at that time if you need to maintain reduced production levels.

	Sales Office Orders	Capacity Adjustment		
	(000s)	Layoff	Deac-tivate	Reac-tivate
Area 1	# 87	#	#	#
Area 2	# 75	#	#	#
Area 3	# 75	#	#	#
Sereno	# 75	#	#	#
2nd Shift		#	#	#

4. Deactivate lines. Any line that is available for production (both first and second-shift) may be deactivated and removed from production until such time as you choose to reactivate the line. Enter the number of lines that you desire to deactivate in the appropriate area on the decision form under Capacity Adjustment–Deactivate. Deactivated lines are not available the following quarter and may not be scheduled again for production until they have been reactivated (see paragraph 5 on the next page).

Deactivated lines provide less flexibility because they may not be used for production again until they have been reactivated, which takes a full quarter of preparation. Deactivated lines incur a one-time cost of $100,000 (or Ps 600,000 in Sereno) when they are taken out of production. The deactivation cost of $100,000 for each second-shift and $100,000 for each first-shift

line is charged under Other Expenses on the income statement. Remember, all costs are subject to increases due to inflation.

The only restriction on your ability to idle or deactivate production lines is that the number of second-shift lines may not exceed the number of producing lines on the regular shift. In other words, if first-shift lines are **idled**, any second-shift line utilizing the same equipment must be idled at the same time. If first-shift lines are **deactivated**, corresponding second-shift lines must be deactivated, too.

Limits: 0 to the number of lines available for production

5. Reactivate lines. First and second-shift production lines that have previously been deactivated may be reactivated and made available for production. Reactivation takes one quarter and requires an expenditure of $50,000 per line (or Ps 300,000 in Sereno) for training workers. This charge is reported under Training Expense on your income statement. These costs are subject to the inflation rate of the country. Lines that previously have been deactivated (and are available for reactivation) are reported in the Operating Information Report.

	Area 1	Area 2	Area 3	Sereno
Lines Available for Reactivation	2	0	0	0

Enter the number of lines to be reactivated under the appropriate area on the decision form. Lines may not be scheduled for production until the following quarter.

Limits: 0 to number of lines previously deactivated

Research and Development

At the close of Year 2, each firm in your world was spending approximately $70,000 per quarter on product research and development (R & D). Money spent on R & D funds a research team located at your firm's headquarters which is developing advanced designs of your current product. In commercial R & D applications such as yours, the amount of money spent in product development may have little relation to the results obtained in the short term. Rapidly increasing the budget for a research department probably involves bringing many new research people on line. Each of the new people will require space and time to get acquainted with the project at hand. It may involve significant expenditures in the short run without immediate payoffs (although later returns may turn out to be significant).

Another BPG simulated company with only modest immediate expansion may show similar immediate results, if any, though perhaps not with the same long-run expectations. This has to do with the law of diminishing returns when expenditures are rapidly increased. Much of the expenditure of the rapidly expanding company may have little immediate effect, but with the prospect of later payoffs. While the relationship between the amount of funds spent and the time

required to develop a new product is unlikely to be linear, you can expect substantial continuous funding of Research & Development efforts ultimately to yield a stream of new models. Of course, after a certain point, additional funds will not lead to any appreciable decrease in the time it takes to develop a product.

The personnel working in your R & D department are highly skilled professionals. They are difficult to find and thus cannot easily be replaced once they leave the firm. Dramatic swings in the R & D budget from quarter to quarter will likely have a negative impact upon the morale of the department causing some of your best people to leave. If severe budget cuts are experienced, a new model which is close to release may be scrapped for lack of funds. Later increases in funds may restart the project; however, the time required to complete the project will be much longer than if the project had been carried through to completion originally. The additional time is due to the extra time required to replace personnel who were previously working on the project, as well as the time required to bring existing personnel who were working on the project back up to speed.

An effective research and development program is an essential element of a firm's success. Without such a program, your firm would have no new products to introduce into the marketplace. Your product offering would become obsolete relative to that of your competitors and your sales would be expected to suffer severely.

R&D/Training (home currency)	
R&D	$ 72
Trng	$ 68

Operations and Production Employee Training

Training expenditures for operations and production employees are funded at the corporate headquarters. Your firm spends operating funds on three different types of employee training.

1. People are hired to replace salespeople who quit, retire, die or are promoted. Those new employees must be taught company policies and operating procedures. This type of training can be minimized by following practices that promote a stable work force. Training of salespeople is discussed in Chapter 5.

2. New production employees must be trained to operate expanded production facilities. This type of training is discussed in Chapter 8 under additional production lines.

3. Training that upgrades operations and production employee skills may qualify them for assignment to more complex jobs or for promotions. Training is provided to maintain employee competence levels and to introduce employees to new equipment and production processes. This type of training is discussed below. The amout of this training budget is a decision variable to be entered on the decision form.

The expenses for all three types of training are included in Total Training Expenses on your income statement.

Expenditures for ongoing training of production and operations employees should lead to lower production costs by enhancing employee skills and by improving manufacturing processes. Cost reduction becomes especially important when new products are developed, as new products tend to cost more to produce than do older products. There are significant advantages in being a low-cost producer in terms of profit margins and flexibility during price wars. The more money your firm spends on training, the more it can expect to save on production costs. However, the law of diminishing returns still applies.

Cost reductions from this type of training are reported in the Operating Information Report (page 2, Report E) as a savings level. The higher the savings level, the greater the savings. The amount spent for such training is included in Total Training Expense under Administrative and General Expense, along with other training costs (for new production and sales employees). The reported standard costs per unit include the cost savings which have been realized. These cost savings also are applied to any future models that your firm may decide to produce. Basic labor and material costs reported for new models include the cost savings.

An effective training program is an essential element of your firm's success. Many firms spend between 1 and 5 percent of their budget on training. Without such a program, your production processes are likely to become less efficient relative to your competitors. You almost would be guaranteed the dubious distinction of being the high-cost competitor. Your company would be doomed to failure! We urge you to support a strong, continuous training program.

Production Costs

Basic **standard unit costs** for Model 1, Quality 2 (your current model and quality) at the beginning of Year 3 are as follows:

	Merica	Sereno
Labor	$2.88	Ps 8.90
Materials	1.23	5.72
Maintenance	.25	1.50
Total	$4.36	Ps 16.12

Standard cost levels may be different for each model—usually being higher for a new model than for an existing model. Also, standard costs vary according to quality levels, with labor and materials costs for Quality 1 being 10 percent higher than for Quality 2. Costs for Quality 3 are 10 percent lower.

When a new model is reported in your Operating Information Report, its standard costs and savings level also will be reported. The costs are reported for each area in local currency. These are the costs that your firm would incur if it had a plant in that area. In this way, you can plan the availability of funds required to produce the new model if you should put it into production. For example, the availability of Model 2 with a savings level of 2 might be reported to you, as follows:

STANDARD COSTS PER UNIT
for next quarter

		Merica Area 1 $	Merica Area 2 $	Merica Area 3 $	Sereno Ps
Model 2 Quality 2 Savings Level 2	Labor Cost	2.64	2.64	2.64	8.15
	Material Cost	1.37	1.37	1.37	6.37
Model 1 Quality 2 Savings Level 2	Labor Cost	2.46	2.46	2.46	7.59
	Material Cost	1.23	1.23	1.23	5.72

Note: For Quality 1 add 10%. For Quality 3 subtract 10%.

The costs reported are those for quality level 2. If you should choose, for example, to introduce Model 2 with a higher quality (level 1) then 10 percent should be added to the reported costs for Model 2, Quality 2. If you choose Quality 3, subtract 10 percent from the reported costs for Quality 2.

All production costs are subject to inflation and will escalate at a rate approximately equal to the rate of change in the Consumer Price Index (CPI) for the country. Remember that inflation rates differ by country. The effects of inflation are incorporated in the reported levels of standard costs for all models and these costs are those that will be in effect during the quarter following the report. The material and labor costs of interest to your firm are those in the country or countries in which you have production plants.

Operations and production employee training focuses upon reducing labor and material costs by increasing employee skill levels and maintaining employee identification with and commitment to your firm. Savings realized from training will be available to reduce basic cost

levels below the level that otherwise would occur, **for any model**. For example, suppose that a training program has successfully reduced labor costs by another 20 cents per unit (or Ps 1.20 in Sereno) by achieving savings level 3. The basic standard costs for models number 1 and 2 in Merica would be $2.26 and $2.44, respectively, instead of those reported in the example above.

STANDARD COSTS PER UNIT
for next quarter

		Merica Area 1 $	Merica Area 2 $	Merica Area 3 $	Sereno Ps
Model 2 Quality 2 Savings Level 3	Labor Cost	2.44	2.44	2.44	6.95
	Material Cost	1.37	1.37	1.37	6.37
Model 1 Quality 2 Savings Level 3	Labor Cost	2.26	2.26	2.26	6.39
	Material Cost	1.23	1.23	1.23	5.72

Note: For Quality 1 add 10%. For Quality 3 subtract 10%.

The costs, of course, will rise in subsequent quarters to reflect the impact of inflation as shown by changes in the Consumer Price Index. Suppose that you continue this quarter producing Model 1, even though Model 2 is available. If the labor cost savings of 20 cents per unit were to be realized and the Consumer Price Index in both Merica and Sereno were to rise by another 2 percent (a very unlikely occurrence), the following report would be shown the next quarter in the Operating Information Report.

STANDARD COSTS PER UNIT
for next quarter

		Merica Area 1 $	Merica Area 2 $	Merica Area 3 $	Sereno Ps
Model 2 Quality 2 Savings Level 3	Labor Cost	2.49	2.49	2.49	7.09
	Material Cost	1.40	1.40	1.40	6.50
Model 1 Quality 2 Savings Level 3	Labor Cost	2.31	2.31	2.31	6.52
	Material Cost	1.25	1.25	1.25	5.83

Note: For Quality 1 add 10%. For Quality 3 subtract 10%.

To extend the example a little further, suppose that you then begin production of Model 2, Quality 2. In that quarter your firm develops a new model, model number 3, with labor and materials costs about 10 percent higher than for model number 2, and the Consumer Price Index rises by another 2 percent in Merica and 3 percent in Sereno. The following report would be included in the Operating Information Report for that quarter:

Note that costs for Model 2 are the same as in the previous quarter, except for an inflation adjustment. Model number 3 costs are more than for model number 2 but are lower than they

would have been without the cost savings from training. Cost savings apply to all models that may be available or become available in the future.

STANDARD COSTS PER UNIT
for next quarter

		Merica Area 1 $	Merica Area 2 $	Merica Area 3 $	Sereno Ps
Model 3 Quality 2 Savings Level 3	Labor Cost	2.79	2.79	2.79	8.03
	Material Cost	1.57	1.57	1.57	7.36
Model 2 Quality 2 Savings Level 3	Labor Cost	2.54	2.54	2.54	7.30
	Material Cost	1.43	1.43	1.43	6.70

Note: For Quality 1 add 10%. For Quality 3 subtract 10%.

If subsequent models (numbers 4, 5, etc.) are developed without changing the model number being produced, only the costs of the three most recently developed models will be reported. Following development of model number 3 in the previous illustration, suppose that your management chooses not to introduce it but instead maintained full production of model number 2. Then, a few quarters later, your Research and Development Department reports model number 4 available. A few quarters after that, Model 5 is released while your firm continues to produce Model 2. The following quarter's costs for model numbers 3, 4 and 5 would be reported, but you would have to estimate the costs for model number 2, which would change proportionately to those of model number 3.

IMPORTANT NOTE

Increases in costs for all models will be due to inflation, and decreases would be due to successful training activities resulting in labor or materials cost savings or, perhaps, both.

Standard unit costs are based upon a forty-hour work week with output levels at normal capacity. Normal production is at a rate of 100 units per line per hour. Actual costs are calculated as indicated below and will be reported quarterly in the Operating Information Report. **All costs, except depreciation of existing plant and equipment, are subject to inflation adjustments.** An illustration of production costs is provided in Figure 7-2.

Production Cost Components

Your finance department will need estimates of the amounts of the various components of production cost in order to estimate cash flows and provide sufficient cash to cover these costs, along with other expenditures that will take place during the upcoming quarter. In addition, these estimates will be used in preparation of *pro forma* financial statements for the quarter. The lower section of the Production Plan Work Sheet will be useful in providing these estimates. This part of the Production Plan is illustrated in Figure 7-3.

PRODUCTION COST ANALYSIS

	Consolidated M$000s	Merica Area 1 M$000s	Merica Area 2 M$000s	Merica Area 3 M$000s	Sereno Ps000s
Labor Cost	874	874	0	0	0
Materials Cost	374	374	0	0	0
Maintenance Cost	76	76	0	0	0
Shutdown Cost	0	0	0	0	0
Total Cash Expenditures	1324	1324	0	0	0
Equipment Depreciation	107	107	0	0	0
Plant Depreciation	26	26	0	0	0
Total Production Cost	1457	1457	0	0	0
Total Unit Production Cost	4.67	4.67	0.00	0.00	0

FIGURE 7-2
Reported Costs of Production
Quarterly Operating Information Report

1. Total **labor cost** per hour for straight-time production amounts to 100 times the basic cost level for model number 1 at the beginning of Year 3 for each production line ($288 or Ps 890 in Sereno). The union contract provides for a 10 percent premium for workers on a second-shift operation, or $317 per hour for model number 1 at the beginning of Year 3 (Ps 979 in Sereno). Overtime work (more than 40 hours per week) is paid at one and one-half times the normal rate, or $432 per hour in Merica for model number 1 during Year 3, Quarter 1. To comply with statutory requirements in Sereno, overtime labor costs (more than 40 hours per week) are paid at double time, twice the normal rate, in pesos (Ps 1780 in Year 3, Quarter 1). Contract restrictions make impractical any operations at less than forty hours per week or more than forty-eight hours per week.

An easy way to estimate labor cost is to multiply the cost per unit by the number of units to be produced during the quarter. For straight-time production, this involves using the reported standard labor costs. The cost of units to be produced on overtime or with second-shift operations needs further adjustment to provide for the premium pay on those shifts. Continuing our example using Merica currency, and using the reported costs from Appendix C, if your company is to schedule 6 lines of production at 42 hours per week (about 328,000 units), using the reported labor costs of $2.88 per unit for Model 1, total labor costs for the coming quarter would be estimated as:

Straight time	$2.88 x 312,000 =	$898,560
Overtime	4.32 x 16,000 =	69,120
Total		$967,680

This value should be rounded to $968,000 and entered under Labor Cost, in thousands of dollars.

THE BUSINESS POLICY GAME PRODUCTION PLAN WORK SHEET					
World ___ Company ___ Year ___ Quarter	Consoli-dated	Merica Area 1	Merica Area 2	Merica Area 3	Sereno
TOTAL PRODUCTION COST ANALYSIS (total cost in thousands of dollars or pesos)					
Labor Cost		968			
Materials Cost		403			
Maintenance Cost		82			
Layoff Cost		0			
Total Cash Expenditures		1453			
Equipment Depreciation		107			
Plant Depreciation		26			
Total Production Cost		1586			
UNIT PRODUCTION COST ANALYSIS (cost per unit in dollars or pesos)					
Unit Labor Cost		2.95			
Unit Materials Cost		1.23			
Unit Maintenance Cost		.25			
Unit Layoff Cost		0			
Total Unit Cash Expenditures		4.43			
Unit Equipment Depreciation		.33			
Unit Plant Depreciation		.08			
Total Unit Production Cost		4.84			

FIGURE 7-3
Illustration of the Production Plan Work Sheet—Lower Section

2. **Materials cost** for raw materials used in the manufacturing process is equal to the basic cost level ($1.23 for model number 1 at the beginning of Year 3) for each unit of production. New models generally have higher materials costs. The cost to produce 328,000 units would be $402,948.

$$\$1.23 \times 328{,}000 = \$403{,}440$$

Rounded to thousands of dollars, enter 403 for Materials Cost on the work sheet.

3. **Maintenance cost** averages $25 per hour at the beginning of Year 3 for each production line that is operating, or $0.25 per unit. To produce 328,000 units would require

$$\$0.25 \times 328{,}000 = \$82{,}000$$

Round this to thousands of dollars, and enter 82 on the work sheet for Maintenance Cost.

4. **Layoff cost** is standby cost for lines that have been idled. At the end of Year 2, standby cost for idled lines amounts to $4,000 per line per week. If one line is idled for thirteen weeks, standby cost totals $52,000 and output is reduced by about 52,000 units.

Continuing our example, all six available lines are scheduled for production, so there will be no layoff cost.

5. **Total cash expenditures** is merely the sum of items 1 to 4 above. For our example, add the values and enter the total:

$$968 + 403 + 82 + 0 = 1{,}453$$

Dividing $1,453,000 by the 328,000 units to be produced gives a unit cost cash expenditure of $4.43. The value of the total cash expenditure should be reported to the finance department for inclusion in the Pro Forma Cash Flow Work Sheet for the coming quarter (see Chapter 10).

6. **Equipment is depreciated** on a straight-line basis over 7 years. That is, current-quarter depreciation charges are calculated as 1/28th (3.5714 percent) of the original book value of all equipment in place during the quarter. It should be noted that this is **not** the same as taking 1/28th of the value of net equipment on the balance sheet. Net equipment is the **depreciated** value of equipment in place rather than the original book value.

Six production lines were installed in the original 8-line plant in your home area in Year 1, Quarter 1, at a total cost of $3,000,000. Thus, the current equipment depreciation charges for our example are $107,142.

$$\$3{,}000{,}000 \times .035714 = \$107{,}142$$

Round the value and enter 107 on the work sheet for Equipment Depreciation. The dollar value of equipment depreciation charges will change when you add production lines, but the depreciation rate still will be the same. It should be noted that higher prices for new equipment result from inflation, and price levels will continue to rise in proportion to the change in the Consumer Price Index.

If your firm should decide to install one new line during Year 3, Quarter 2, increase the previously-estimated equipment depreciation charges by 1/28th of the cost of the new equipment for the line next quarter. The full amount of the payment will be capitalized and, therefore, must

3. **Maintenance cost** averages $25 per hour at the beginning of Year 3 for each production line that is operating, or $0.25 per unit. To produce 328,000 units would require

$$\$0.25 \times 328{,}000 = \$82{,}000$$

Round this to thousands of dollars, and enter 82 on the work sheet for Maintenance Cost.

4. **Layoff cost** is standby cost for lines that have been idled. At the end of Year 2, standby cost for idled lines amounts to $4,000 per line per week. If one line is idled for thirteen weeks, standby cost totals $52,000 and output is reduced by about 52,000 units.

Continuing our example, all six available lines are scheduled for production, so there will be no layoff cost.

5. **Total cash expenditures** is merely the sum of items 1 to 4 above. For our example, add the values and enter the total:

$$968 + 403 + 82 + 0 = 1{,}453$$

Dividing $1,453,000 by the 328,000 units to be produced gives a unit cost cash expenditure of $4.43. The value of the total cash expenditure should be reported to the finance department for inclusion in the Pro Forma Cash Flow Work Sheet for the coming quarter (see Chapter 10).

6. **Equipment is depreciated** on a straight-line basis over 7 years. That is, current-quarter depreciation charges are calculated as 1/28th (3.5714 percent) of the original book value of all equipment in place during the quarter. It should be noted that this is **not** the same as taking 1/28th of the value of net equipment on the balance sheet. Net equipment is the **depreciated** value of equipment in place rather than the original book value.

Six production lines were installed in the original 8-line plant in your home area in Year 1, Quarter 1, at a total cost of $3,000,000. Thus, the current equipment depreciation charges for our example are $107,142.

$$\$3{,}000{,}000 \times .035714 = \$107{,}142$$

Round the value and enter 107 on the work sheet for Equipment Depreciation. The dollar value of equipment depreciation charges will change when you add production lines, but the depreciation rate still will be the same. It should be noted that higher prices for new equipment result from inflation, and price levels will continue to rise in proportion to the change in the Consumer Price Index.

If your firm should decide to install one new line during Year 3, Quarter 2, increase the previously-estimated equipment depreciation charges by 1/28th of the cost of the new equipment for the line next quarter. The full amount of the payment will be capitalized and, therefore, must

lso be depreciated. If the inflation factor is a one percent increase from Year 3, Quarter 1, the dditional amount for equipment depreciation for each new line would be about $18,000.

$$.035714 \times \$500,000 \times 1.01 = \$18,036$$

lo new lines are planned for this quarter so our entry is 107.

7. **Plant depreciation** charges are computed and added to the cost of production. Buildings are depreciated on a straight-line basis over a period of 31.5 years in the simulated world, or at a rate of 0.7937 percent of their original book value for each quarter. The original plant in your home area was completed in Year 1, Quarter 1 at a total cost of $3,300,000. It is being depreciated over a 31.5-year period at a rate of 0.7937 percent per quarter. The dollar cost of depreciation thus is $26,192 (rounded to $26,000) per quarter.

If a **new plant** is constructed in another market area (see Chapter 8), the depreciation charges are handled in the following manner: At the end of each quarter of construction, payments made to the contractor are capitalized and depreciation charges are increased by 0.7937 percent of the amount of the payments made. If an eight-line plant is under construction in America, for example, quarterly payments of $1,100,000 (plus inflation) will be capitalized at the end of the quarter and depreciation charges will be increased by about $9,000 per quarter.

$$0.007937 \times \$1,100,000 = \$8,731$$

After three quarters of construction, when the plant is available for use, the total depreciation charges would consist of a little more than $52,000 per quarter—$26,000 on the preexisting plant and about $26,000 (plus inflation) on the new plant. Once the plant has been completed, depreciation charges do not change with inflation because they are based on original cost.

The same procedure is followed for computing depreciation charges on **additions** to existing plants. Two quarterly payments of $450,000 are capitalized and depreciation charges are increased by about $4,000 during each quarter of construction.

$$0.007937 \times \$450,000 = \$3,572$$

The only difference is that construction of new additions is completed in two quarters of simulated operations while new plant facilities require three quarters of construction before completion.

8. **Total Production Cost** is the sum of Total Cash Expenditures plus Equipment and Plant Depreciation. For our example,

$$1,453 + 107 + 26 = 1,586 \text{ (or \$4.84 per unit, see below)}$$

This amount should be reported to the finance department for inclusion in the *pro forma* Income Statement (See Chapter 10). It will form the basis for the estimate of cost of goods sold for next quarter.

These costs can be converted easily to a per unit basis by dividing each cost by the number of units produced during the quarter. For example, total production cost per unit is $4.84:

$$\$1,586,000 \div 328,000 = 4.84$$

Unit cost provides a common denominator which allows for comparison of costs across areas and quarters.

Cost Variance

Actual costs may vary somewhat from those shown above. While production normally is at a rate of 100 units per hour per line, or 4,000 units per week, this rate may not be realized. A seemingly random variation of as much as 5 percent in either direction may occur because of efficiencies or inefficiencies experienced in actual operation. Companies operating production facilities in Sereno have found wider variances in actual volume of production compared to scheduled volume, and hence wider variance in actual costs compared to scheduled costs. Experience has shown that actual production in Sereno is more likely to be less than the scheduled amount, and variances as wide as 15 percent have been noted.

Variations in output may be due to a number of factors. Absenteeism may be higher than normal, down-time of machinery more than expected, or raw material deliveries delayed. All of these factors would cause production levels to be somewhat lower than anticipated. Actual expenditures, therefore, would be slightly lower than those scheduled. Unit costs (total production costs divided by the number of units produced) would be somewhat higher because total labor and maintenance costs will remain at the same level while the number of units produced has declined. Alternatively, absenteeism and machinery down-time may be less than normal resulting in higher than normal levels of production. These variations are beyond the control of your management.

Operations of new plants in other areas will be subject to the same cost functions as those of the existing plant in the home area. A second shift is not possible outside of the home area, however, because of a shortage of supervisory personnel.

Illustration of Overtime Costs

Figure 7-4 illustrates the current quarterly costs of first-shift production at straight time and at various amounts of overtime in your existing home-area plant. The dollar costs are for one line operating for one quarter and are based on the standard unit costs for model number 1 at the beginning of Year 3. Strait-time labor costs are $2.88 per unit. Overtime unit costs are $4.32 per

unit. Plant depreciation is based upon use of six operating lines, with the amount shown being one-sixth of $26,192. Equipment depreciation is one-sixth of $107,142.

	Hours Scheduled				
	40	42	44	46	48
Labor	$149,760	$160,992	$172,224	$183,456	$194,688
Materials	$63,960	$67,158	$70,356	$73,554	$76,752
Maintenance	$13,000	$13,650	$14,300	$14,950	$15,600
Equip't depreciation	$17,857	$17,857	$17,857	$17,857	$17,857
Plant depreciation	$4,365	$4,365	$4,365	$4,365	$4,365
Total cost	$248,942	$264,022	$279,102	$294,182	$309,262
Output (in units)	52,000	54,600	57,200	59,800	62,400
Unit cost	$4.79	$4.84	$4.88	$4.92	$4.96

FIGURE 7-4
First-Shift Production Cost Per Line

It should be noted that total unit production costs increase rapidly as the amount of overtime increases. Labor costs for all additional units produced after 40 hours per week are higher due to the overtime premium. The higher unit labor costs more than offset the fact that the fixed depreciation charges are averaged over the larger number of units produced. If labor costs were proportionately higher than depreciation charges, as they may be for some models, the unit cost differential between straight time and overtime would be even greater.

Summary of Relationships

1. **Basic unit costs**: reported standard costs include inflation-related cost increases as well as savings that may have been realized from successful training programs.

2. **Basic Labor cost, regular shift**, per hour:
   straight-time rate: 100 times basic labor cost
   Merica overtime rate: 150 times basic unit labor cost
   Sereno overtime rate: 200 times basic unit labor cost

3. **Labor cost, second shift**, per hour: same as straight-time rate + 10 percent premium

4. **Material cost per unit**: basic unit material cost as reported

5. **Maintenance cost**, per line:
   $25 per hour, or $0.25 per unit in Merica (subject to inflation)
   Ps 150 per hour, or Ps 1.50 per unit in Sereno

6. **Standby cost for an idle line**:
   $4,000 per line per week (Ps 24,000), or $52,000 per quarter (Ps 312,000)
   Output reduced by about 4,000 units per week, or 52,000 units per quarter

7. **Equipment depreciation charges:** calculated on a straight-line basis over 7 years, or 3.5714 percent of original book value each quarter

8. **Plant depreciation charges**: calculated on a straight-line basis over 31.5 years
   for existing plant: $26,000 per quarter
   for new plant or addition: 0.7937 percent of construction in place each quarter

9. **Deactivation cost**: one-time charge of $100,000 per line, (or Ps 600,000)
   applies both to first-shift lines and second-shift lines separately

10. **Inventory storage cost** amounts to 10 cents (or 60 centavos) per unit for the first 300,000 units, the maximum storage capacity of a plant. Beyond that, public warehouse space is used to store all inventory exceeding the 300,000 limit, at a cost of 30 cents (or Ps 1.80) per unit. A sales office not associated with a manufacturing plant in the same area uses a public warehouse to store all inventory. Quarterly storage costs are paid on the number of units in beginning inventory.