costs of defects, costs of delays, and the cost of the manager's compensation (including applicable bonus)—for defect rates of 1,032; 500; 100; 50; and 32 per million and average delivery times of one to four days. Note the minimum cost.

e. Comment on the optimum delivery times and number of defects necessary to achieve the minimum costs to the firm and the maximum compensation level now that the firm's total costs are considered.

Cases

Case 14–1: Global Oil[13]

In 1995 Global Oil Corporation's Marketing and Refining (M&R) Division was the fifth largest U.S.refiner with 7,700 Global-branded service stations selling about 23 million gallons per day, or 7 percent of the nation's gasoline. All the service stations are company owned. In 1990, M&R ranked last among its peers in profitability and was annually draining $500 million of cash from the corporation.

In 1993, M&R reorganized from a centralized functional organization (Refineries, Transportation, Warehousing, Retail, and Marketing) into 17 geographic business units (sales and distribution) and 14 service companies. The functional organization was slow to react to changing market conditions and the special customer needs that differed across the country. The new decentralized organization was designed to better focus on the customer. New marketing strategies could be better tailored to local markets by giving local managers more decision-making authority.

A new corporate strategy to focus on the less price-sensitive customer who would not only buy Global gas but also shop in its convenience gas-store outlets was implemented simultaneously with the reorganization. Global's new strategy was to redesign its convenience stores so they would become a "destination stop," offering one-stop shopping for gas and snacks.

The old organization used a variety of functional measures: manufacturing cost, sales margins and volumes, and health and safety metrics. After changing its corporate strategy and organizational structure, M&R decided to change its performance metrics and began investigating the balanced scorecard.

Balanced scorecard (BSC) at M&R

M&R formed project teams of managers to design performance metrics for its operations. Thirty-two different metrics were identified. These included Financial (ROA, cash flow, volume growth, etc.), Customer (share of segment, mystery shopper, etc.), Internal (safety incidents, refinery ROA, inventory level, etc.), and Learning (strategic skills accumulation, quality of information system, etc.). The "mystery shopper" is a third-party vendor who purchases gas and snacks at each station monthly. During each visit, the mystery shopper rates the station on 23 items related to external appearance, rest rooms, and so forth. A brochure describing the BSC was prepared and distributed to M&R's 11,000 employees in August of 1994. Extensive meetings with employees explained the new metrics and the BSC concept.

Compensation plans

All salaried employees of M&R received up to a 10 percent bonus if Global ranked first among its seven competitors on ROA and earnings per share (EPS) growth. In addition to this existing plan, a new program was added that awarded bonuses up to 20 percent to managers. The size of the bonus depends on the average performance of three factors:

- Global's competitive ranking on ROA and EPS growth.
- M&R's balanced scorecard metrics.
- Own business unit's balanced scorecard.

[13] This case is based on R Kaplan, "Mobil USM&R(A): Linking the Balanced Scorecard," Harvard Business School Case 9–197–025 (May 7, 1997).

In 1995, M&R generated more income per barrel of oil than the industry average, and its ROA exceeded the industry's average.

Required:

a. Critically evaluate M&R's implementation of the balanced scorecard. Identify any strengths and weaknesses of the program.
b. Was the adoption of the balanced scorecard at M&R responsible for the turnaround in its financial performance?

Case 14–2: Productivity Measures

Background

Economists and managers have long recognized the importance of productivity in determining an organization's success. Productivity is the relation between the firm's output of goods and services and the inputs necessary to produce that output. If a firm is able to produce more output with the same inputs, we say it has improved its productivity. Likewise, if two firms produce the same quantity of goods and services but one firm uses less input, that firm is called more productive. Countries that produce more output per person generate more consumable wealth. Economists keep productivity statistics, and these numbers are reported in the financial press as measuring the competitiveness and well-being of that country.

In the 1970s many of the largest U.S. firms became interested in productivity and better ways to measure and improve their firms' productivity. Largely driven by foreign competition, these American firms were losing market share to Japanese and European rivals. Japanese auto companies were producing cars with fewer employee hours per car than American companies, thus offering lower-priced and often higher-quality cars than U.S. automakers. Foreign steel producers were more productive than their U.S. counterparts. Concerned about their declining relative productivity in 1977, large U.S. firms financed the formation of the American Productivity Center (later the American Productivity and Quality Center). To become more productive, some firms experimented with various productivity measures.

In its most basic form, productivity is defined as:

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

If the firm uses a single input (steel) to produce a single homogeneous product (horseshoes) that never changes over time, then the measure of productivity is the units of output per quantity of input, or the number of horseshoes per pound of steel. If steel waste is reduced, more horseshoes can be produced with the same amount of steel. One measure of productivity is the ratio of horseshoes to steel, in terms of physical volume. Steel is not the only input to making horseshoes. Labor is also an input, and labor is usually the input of most interest to managers. Productivity is usually thought of as the amount of output per unit of labor. Most managers want to know the number of horseshoes produced per person and how this number changes over time and compares to the competition.

Proponents of productivity measurement systems argue that managers should focus on productivity instead of accounting profits. A firm can appear profitable but can be experiencing declining productivity if selling prices are rising faster than input prices. Productivity measures help identify these cases. Managers control the physical aspects of the manufacturing process, such as the amount of steel scrap in making horseshoes, but they cannot control the price of steel or the price of horseshoes. For the most part, managers cannot influence prices but must take them as a given and try to produce more output from a given physical input or the same output using less physical input.

Proponents of productivity measures argue that basing managerial performance on productivity, which does not include uncontrollable price changes, yields a better indicator of the manager's performance. They argue that traditional accounting measures, such as net income, include many factors that managers cannot control and do not focus enough attention on factors that managers can control such as labor productivity. The following example illustrates productivity measurement systems in more detail.

Measuring productivity

If the firm produces several types of outputs (large and small horseshoes) and the mix of output varies over time, then the productivity measure must somehow aggregate the quantities of outputs into a single aggregate quantity. Likewise, several inputs must be aggregated to derive a homogeneous input measure. The measure of productivity (outputs/inputs) must aggregate the multiple inputs and the multiple outputs.

To measure firmwide productivity when multiple inputs and outputs exist, prices are used as the weighting factors. The productivity measure with two outputs and three inputs becomes:

$$\text{Productivity} = \frac{\text{Output}_1 \times \text{Price}_1 + \text{Output}_2 \times \text{Price}_2}{\text{Input}_1 \times \text{Cost}_1 + \text{Input}_2 \times \text{Cost}_2 + \text{Input}_3 \times \text{Cost}_3}$$

Output_i ($i = 1$ or 2) and input_j ($j = 1$, 2, or 3) denote the physical quantities of the ith output and the jth input. Price_i and cost_j are the corresponding output prices and input costs. If one then compares how productivity changes over time, this aggregate measure of productivity will vary with changes in both physical quantities and relative prices. But productivity measures should exclude noncontrollable price and cost changes, thereby focusing managers' attention on physical quantities.

To exclude price and cost changes from the performance measure, yet still have a way to aggregate multiple inputs and outputs, the following scheme is used:

1. Choose a base period year and use that year's prices and costs as the weights for future years. The base year should be one of high production, and a new base year should be chosen about every five years as the structures of production and prices change.
2. Weight the physical quantity of each input and output using the base period cost or price for that input or output.
3. Divide the weighted outputs by weighted inputs to compute the productivity index for the year.
4. Divide this year's productivity index by last year's to get the change in productivity.[14]

A simple example with two inputs (steel and labor) and two outputs (small and large horseshoes) illustrates the mechanics of the computations.[15] Table 1 summarizes operations for the last two years:

TABLE 1 **Physical Quantities**

Inputs/Outputs	*Base Year Prices*	*Last Year*	*This Year*
Outputs:			
Small horseshoes	$2	500	600
Large horseshoes	$3	500	550
Inputs:			
Steel	$1	1,000	1,200
Labor	$4	300	320

[14]J Kendrick and D Creamer, *Measuring Company Productivity,* Conference Board (1969). For an alternative scheme to measure productivity within a more usual standard cost system, see R Banker, S Datar, and R Kaplan, "Productivity Analysis and Management Accounting," *Journal of Accounting, Auditing and Finance,* 1989. Also see E Adam, J Hershauer, and W Ruch, *Productivity and Quality: Measurement as a Basis for Improvement* (Englewood Cliffs, NJ: Prentice-Hall, 1981); and B Gold, *Productivity, Technology, and Capital: Economic Analysis, Managerial Strategies, and Government Policies* (New York: Lexington Books, 1979).

[15]The example and discussion gloss over the thorny issue of including capital as an input. See Kendrick and Creamer (1969) for one possible treatment.

Based on these data, the productivity measures are calculated as:

TABLE 2

Inputs/Outputs	*Last Year*	*This Year*
Outputs:		
Small horseshoes	$1,000	$1,200
Large horseshoes	1,500	1,650
Total outputs	$2,500	$2,850
Inputs:		
Steel	$1,000	$1,200
Labor	1,200	1,280
Total inputs	$2,200	$2,480
	$2,500	$2,850
Productivity	$2,200	$2,480
	= 1.136	= 1.149

Increase in productivity $\frac{1.149 - 1.136}{1.136} = 1.1\%$

Total productivity increased from 1.136 last year to 1.149 this year, or a 1.1 percent increase. Using base period prices, the productivity measure indicates that more output was produced using relatively less input.

In a study of productivity systems in Canada, few firms were found to measure aggregate firm-wide productivity as the ratio of firm outputs to firm inputs.[16] Instead, firms develop a few distinct nonfinancial measures that capture the essential strategic elements of their business. For example, a steel company tracks tons of steel shipped divided by tons of iron purchased and tons of steel shipped divided by number of employees. In an insurance company, the number of policies processed per employee in a particular department is reported. Other companies measure yield rates, defect rates, and production rates. The study concludes (p. 132), "We believe that productivity measures are *operational aids* in the strategic process that helps organization members keep track of what is required for the organization to achieve its long-run goals."

Required:

a. Critically analyze the productivity calculations in Table 2. Did the managers of the firm perform better this year compared with last year, as the productivity measures indicate?

b. Discuss some plausible reasons why comprehensive productivity systems have not been widely adopted by organizations.

c. Consider the situation of Burk Wheels. Burk Wheels manufactures aluminum automobile wheels (onto which rubber tires are mounted). The owner, Gerry Burk, is worried about increased competition from foreign countries (with lower labor costs) and is seeking to increase the productivity of her workers. She decides to implement a bonus system for direct line supervisors and department managers to reward them for improving labor productivity. In particular, supervisors will receive bonuses if they improve their department's

[16] H Armitage and A Atkinson, *The Choice of Productivity Measures in Organizations: A Field Study of Practice in Seven Canadian Firms* (Hamilton, Ontario: Society of Management Accountants of Canada, 1990). A Study of U.S. firms reported that fewer than 15 percent used or planned to use total productivity measures (J Kraus, *How U.S. Firms Measure Productivity* [New York: National Association of Accountants, 1984]).

labor productivity, defined as Output ÷ Labor hours. The casting department is the primary production process whereby molten aluminum is poured into molds, cooled, and then removed to form the wheels. Operating data for the casting department for the last two months prior to announcing the labor productivity incentive program are:

	March	*April*
Wheels cast	1,680	1,710
Direct labor hours	722	701
Aluminum used (pounds)	14,616	15,219
Direct labor wages/hour	$23.10	$23.75
Price of aluminum/pound	$ 0.92	$ 0.91

Calculate the productivity of direct labor for March and April and discuss how labor productivity changed between March and April. Gerry Burk asks your opinion of her proposal to increase productivity by rewarding production supervisors and plant departmental managers for increasing labor productivity. Write Ms. Burk a memo outlining your views of her plan.