CHAPTER 3

Efficiency, Profit, and Scientific Management: 1880–1910

In the last quarter of the nineteenth century, a demand arose for new management information that was not provided by the conversion cost systems described in the previous chapter. The demand originated in firms that mass produced complex machine-made metal goods such as reapers, sewing machines, locks, scales, pumps, typewriters, and the machines used to make such goods. The complex manufacturing processes made it difficult for managers of these firms to gather precise and accurate information about the efficiency of workers engaged in specialized tasks. The search for this information inspired a systematic analysis of factory productivity in late nineteenth-century machine-making firms that came to be known as "scientific management." Furthermore, diverse (often custom-made) product lines also prompted managers to seek information about the

sources of a firm's profitability. The quest triggered a flood of research—primarily by mechanical engineers who also worked on scientific management problems—into methods for compiling accurate information about product costs. Between 1880 and 1910, engineer-managers in American metal-working firms developed a host of new cost measurement techniques both to analyze task productivity and to link profits to products. The techniques had a profound impact on twentieth-century accounting practice, although the engineers and managers who developed them had no intrinsic interest in accounting as such.

Scientific Management and Efficiency

The scientific quest for knowledge about efficiency originated in metal-working firms whose owners desired closer control over increasingly complex and specialized manufacturing tasks.[1] Until the 1880s manufacturers had concentrated attention on improving high-speed machine technology used in their factories; day-to-day supervision of work in the factory was delegated to semi-autonomous department foremen who acted as, and frequently were, inside contractors. In a study of inside contracting at the Winchester Repeating Arms Company, historian John Buttrick describes the system as follows:

> Under the system of inside contracting, the management of a firm provided floor space and machinery, supplied raw material and working capital, and arranged for the sale of the finished product. The gap between raw material and finished product, however, was filled not by paid employees arranged in the descending hierarchy so dear to the hearts of personnel experts but by contractors, to whom the production job was delegated. They hired their own employees, supervised the work process, and received a piece rate from the company for completed goods. The income of a contractor consisted of the difference between his wage bill and his

sales to the company, plus the day pay he earned as an employee himself. The company's largest single expense was the amount paid to the contractors for finished goods.[2]

In short, contract foremen hired, fired, and paid their own work force and were responsible for the economic performance of their departments, keeping anything left over as their own profit.

While the system reduced the cost to owners of supervising and controlling a diverse and often highly skilled work force, it meant that owners knew very little about costs and efficiencies in factory departments. Moreover, the immediate beneficiaries of improved efficiency were the contract foremen and their workers, not the firm's owners who supplied the basic machine technology. Goaded by excess capacity during the depressed 1870s, many manufacturers in metal-working industries began to dismantle the inside contracting system. Sharing ideas at annual meetings of the American Society of Mechanical Engineers, they designed recordkeeping systems to track the flow of material and labor costs going into complex machine-made products. To encourage proper reporting, they established plans for workers to share in the gains of improved efficiencies, and they created clerical staffs to collect and record information about shop-floor activities.[3] By the 1880s managers of many complex metal-working firms had information about material and labor costs similar to the conversion cost information that already existed in textile factories and steel mills.

The engineering-minded managers in some of the metal-working firms then went a step further than their peers in other industries. Instead of designing systems merely to accumulate actual material and labor costs, the chief object of manufacturing cost systems up to that time, these "scientific managers" focused their attention on predetermining "standard" rates at which material and labor should be consumed in manufacturing tasks. The methods they devised to determine standards for material and labor inputs included en-

gineering design of bills of material and time-and-motion study.

Engineers and accountants used information about standards for three very different purposes in the two decades preceding World War I. As we have already mentioned, some scientific management engineers developed information about standards in order to gauge the potential efficiency of tasks or processes. Frederick W. Taylor's search for the "one best way" to use labor and material resources typifies this use of standard performance information. For Taylor, standards provided information for planning the flow of work so that waste of material and time was kept to a minimum. Taylor's manufacturing cost systems were designed to monitor physical labor and material efficiencies, not to monitor financial costs.[4] Consequently, Taylor did not view standards as a tool to control financial costs. But management experts who did not share Taylor's indifference to financial outcomes had no aversion to using the standards for cost control. For instance, Percy Longmuir, an American engineer who wrote about foundry cost management around 1900, devised a novel way of using information about material and labor standards to control *actual* costs.[5] According to David Solomons,

> [Longmuir] proposes that the labour costs of each class of work undertaken in the foundry should be ascertained, each type of labour, e.g., moulders, labourers, etc., being kept separate. These labour costs are then related to the weight per cwt. "Experience," he says, "will readily give standard factors for each class of work and these standards may be plotted on a chart as a fair curve (straight line), the departure from which of the actual weekly cost line will instantly show the degrees of good or bad working."[6]

It was only a short step from Longmuir's chart to the development of detailed systems for analyzing variances between standard and actual performance. There is ample evidence that manufacturers around 1900 used information on variances between actual and standard costs to control their

operations.[7] Credit for writing the first published descriptions of modern systems for analyzing standard cost variances goes to two management consultants, Harrington Emerson and G. Charter Harrison.[8] Harrison followed Emerson and in 1918 became the first person to publish a set of equations for the analysis of cost variances.[9] Emerson was perhaps the first writer, however, to stress that information about standards permits managers to differentiate between variances that are due to controllable conditions and variances that are caused by conditions beyond managements' control,[10] an idea that management accountants many years later would associate with flexible budgeting.

Accountants, not engineers, developed a third purpose for standard cost information, one that differed greatly from the purposes intended by writers such as Taylor, Longmuir, Emerson, and Harrison. Some financial accountants in the early 1900s recognized that standard costs could greatly simplify the task of inventory valuation. Accountants generally did not accept the idea of entering standard cost information into the financial accounting ledgers, however, until after World War II. We will discuss the impact of twentieth-century financial reporting upon cost accounting at greater length in chapter 6. But it is important to note at this point that financial accountants who discussed standard costing during the interwar decades rarely, if ever, considered how managers could use variances between actual and standard costs to control manufacturing operations. Instead, their main concern was how to properly classify variances—in particular, how to dispose of them—in published financial reports.

Strategic Product Costing for Profitability Analysis

Scientific management experts such as Taylor and Emerson devised new cost accounting procedures primarily

to assess and control the financial and physical efficiency of processes and tasks in complex machine-making firms. For Taylor and Emerson, the main purpose of collecting cost information was the same as it had always been for managers of nineteenth-century textile and steel firms:[11] to evaluate the efficiency of processes, not to assess the performance of an entire organization. Taylor and his peers simply extended the use of such information to monitor the efficiency of complex machining processes in firms that customarily relied on inside contracting.

Engineers and management experts in similar firms subsequently developed a new goal for cost accounting: to evaluate the overall profitability of the entire enterprise. Alexander Hamilton Church, a contemporary of Taylor's, was particularly interested in developing management methods to ensure that efficient parts added up to a profitable whole. He expressed this concern by contrasting two approaches to management, analytic (*i.e.*, Taylor's) and synthetic.

> The main distinction between synthesis and analysis in this connection is that synthesis is concerned with fashioning means to effect large ends, and analysis is concerned with the correct local use of given means. . . . The view taken by analysis . . . is a narrow and limited one; it concerns itself with the infinitely small. Its task is to say "how to use certain means to the best advantage." . . . But the synthetical side of management demands that every effort of analysis, like every other effort made in the plant, shall have some proportion, some definite economic relation to the purpose for which the business is being run.[12]

One of Church's principal devices for linking "every effort of analysis . . . to the purpose for which the business is being run" was product costing. He advocated using product cost information to trace a firm's overall profitability to the profits earned on individual products.

> . . . if a perfect system of distributing all the . . . charges incurred in production were in use, and a list were to be prepared of all delivered orders showing:—
>
> 1. their prime cost . . . wages and materials.

2. the indirect shop charges.
3. a due proportion of general and selling expense, then the aggregate of these items for all orders completed and delivered, when set against the sale prices, would show a difference or balance exactly corresponding to the net profit shown by the profit and loss account.[13]

Church justified this "ideal" product costing system on the principle that "the organization of no works can be considered complete until it is able not merely to connect its costs of all classes with its jobs, but also to check its financial position by aggregating its profits on sales item by item."[14]

Calculations of full product costs for the purpose that Church had in mind required methods to link overheads to products. Nineteenth-century manufacturers had virtually ignored the allocation of overhead to products. The issue was first addressed by mechanical engineers in the 1880s. Many historians mistakenly associate the overhead allocation methods of these early mechanical engineers with the overhead application procedures used by twentieth-century financial accountants.[15] But, the engineers and the accountants applied overhead to products for very different reasons. As we show in chapter 6, modern financial accountants required cost accounting to value inventory for financial reporting. Overall profit measurement and inventory valuation did not require accurate information about the cost of individual products; aggregated information about average costs would do. Church understood that aggregated average cost information would do even for management purposes as long as the factory manufactured only a few products and those products used all the factory's resources at about the same rate. But Church railed against using the "commercial accountants'" overhead allocation procedures in situations where a diverse line of products used factory resources at widely varying rates. His insightful evaluation of crude averaging procedures is worth quoting at length.

No one has ever suggested that prime costs should be averaged. No one ever argues that if $200 has been spent on 20 articles, then

the cost of each can be safely considered at $10, unless indeed the product is absolutely uniform. Such a suggestion would be treated with ridicule, because obviously the only use of detailed costs is to reveal the *relative* amounts of wages and material that the different orders have absorbed. The incidence of labour-cost and material-cost on orders is too obviously individual and unequal for us to think of averaging prime costs.

When, however, we come to the second [indirect shop] and third [selling and general] elements of cost . . . an entirely different plan is commonly pursued. Notwithstanding that the expenditure under this head frequently equals and sometimes surpassses in value the item of wages which are generally so carefully traced and allocated to individual orders, it is a very usual practice to average this large class of expense, and to express its incidence by a simple percentage either upon wages or upon time.

That this plan is entirely misleading there can be very little doubt, because few of the expenses in the profit and loss account have any relation either to each other or to wages or to time. To rely upon an arbitrary established percentage which may actually be either much over, or much under, the real incidence of a number of varied factors on a particular order, may be a good way of getting rid of figures and giving an air of finality to cost accounts, but it is very little else. As a guide to actual profitableness of particular classes of work it is valueless and even dangerous.[16]

Church gives an example of the absurdity that can result when indirect costs are averaged over products that use factory resources at widely varying rates.

We find that as against $100 direct wages on order, we have an indirect expenditure of $59, or in other terms, our shop establishment charges are 59 percent of direct wages in that shop for the period in question. This is, of course, very simple. It is also as usually worked very inexact. It is true that as regards the output of the shop as a whole a fair idea is obtained of the general cost of the work. . . . And in the case of a shop with machines all of a size and kind, performing practically identical operations by means of a fairly average wages rate, it is not alarmingly incorrect.

If, however, we apply this method to a shop in which large and small machines, highly paid and cheap labour, heavy castings and small parts, are all in operation together, then the result,

unless measures are taken to supplement it, is no longer trustworthy.[17]

Church believed that information about a product's cost should reveal the real resources used to make the product. Consequently, a key to commercial success in manufacturing is "a thoroughly comprehensive method of recording shop work, *including the connection of expenditure of all classes with the items of output on which they are incident.*"[18] (Italics added.) It is relatively easy to connect overhead expenditures with the output "on which they are incident" when dealing with simple processes and few products. "The difficulty of dealing adequately with [overheads] in their relation to [causes] is usually in proportion to the heterogeneity of the business carried on."[19] Church argued that overhead, ideally, was the cost of countless factors of production, each of which should be traced separately to products. For practical purposes, however, he advocated dividing the factory into a series of "production centers" through which overheads should be loaded onto products.

Church believed that indirect costs should consist only of an irreducible element of costs that cannot be traced to individual products. He suggested that the distinction between direct and indirect expenses *of a product* ought to be abandoned in order that accountants and managers focus attention on "the *real* incidence [of expense] on particular jobs"—the differences in rates at which products consume resources.[20] Church argued that cost accountants should give separate consideration to factory and selling expenses because widely different conditions affected their real incidence among individual products, not because factory costs "attach" to products and selling costs to periods. Even though he considered selling and general costs separately from factory costs, Church nevertheless included them all when he computed product costs so that overall company profits could be traced to the profitability of individual products.

Engineers in many metal-working firms developed an

interest in product costing around 1900, although none seems to have developed as sophisticated a view of costing as Church. The engineers demanded information about product costs because their firms' commercial success depended on accurately and rationally quoting prices for complex custom-made machine products. Like Church, virtually all of the engineer "cost accountants" viewed product cost as consisting of a portion of *all* costs incurred in the firm, not just shop costs. Product cost included selling, general and administrative costs and, in many authorities' view, an allocation for imputed interest on equity. Implicitly, then, these engineers sought product cost estimates that would link product profitability with a company's overall profits.

An English textile company executive, G. P. Norton, described in 1889 another procedure for linking the overall profits of a manufacturing firm with the efficiency of its parts.[21] Norton's system did not rely on product costing, but it did make an intriguing use of standard cost information. Norton presents an accounting method for comparing an integrated multiprocess textile company's performance with the profit that would have been earned if the firm's internally managed processes were coordinated through market exchange. David Solomons provides a succinct description of Norton's system.

> The cost records, which were kept quite separate from the commercial accounts, were designed to allocate costs to departments and processes in such a way that the costs could be compared with the prices that would have been charged by outside specialists, *i.e.*, the trade or "country" prices, as they were called. The results of the undertaking are summarized in a Manufacturing Account, the first part of which compares the actual sales with the work done valued at the trade prices, the difference after stock adjustments being the amount of profit that should have been made if the work had been carried out at the trade rates. In the second section of the account the "actual" costs (*i.e.*, the cost arrived at after allocations of overhead) of each of the processes, spinning,

weaving, dyeing and finishing, are compared with the work valued at trade prices, the difference showing the "profit" or "loss" on each department. The sum of these profits and losses plus the profit from the first section of the Manufacturing Account show the net profit of the business subject to deduction of certain expenses not allocated between the processes.[22]

Two additional features of Norton's system deserve mention. When the disappearance of "country workers" after 1900 made it impossible to secure external market rates for piecework, Norton in later editions of his book recommended the use of standard costs instead of trade prices; also, Norton valued product inventories for balance sheet and income determination purposes at market prices—his cost system was not designed to serve financial reporting purposes. It is indeed unfortunate that modern accounting historians have discussed Norton's ideas in terms of the financial reporting purposes that shape modern product costing instead of the purposes Norton had in mind. To A. C. Littleton, for instance, Norton's system of accounts, while "ingenious," is less than a "modern reader" might hope for because it fails "to show the calculation of the cost of goods manufactured and to furnish the basis for unit cost prices to be used in computing inventory valuation."[23]

Neither Norton's standard cost system nor Church's product costing system has any precedent in the process-oriented conversion cost systems that we discussed in chapter 2. The earlier systems gathered information to help managers evaluate and control the efficiency of internal processes, not to link performance in each process with a firm's overall profitability. With relatively homogeneous lines of products and few processes, achieving efficiency in the processes was probably enough to insure overall profitability. But heterogeneous product lines and complex processes in metal-working firms—the situation encountered by Church—made it important to know the cost differences among products that used underlying processes at widely

different rates. In such firms cost information used to monitor efficiency may also be used to evaluate profitability if it is traced carefully to products.

The use of accounting information to assess overall profitability soon becomes the chief object of management accounting systems in complex industrial enterprises that integrate two or more activities. The next chapter describes the development of these systems in vertically integrated industrial firms. Like Norton and Church, the giant integrated industrials were concerned with a company's system-wide performance, a significant departure from the management accounting systems of nineteenth-century single-activity firms. But vertically integrated firms after 1900 did not use either Church's product costing or Norton's standard costing procedures to link information about the company's overall performance to information about the performance of each separate process. Instead, they developed systems to track the performance of the company and its decentralized units by one common denominator: return on investment. The systems required that companies now give attention to the amount of capital invested in the enterprise, a consideration ignored in all management accounting systems that we have observed before 1900.

Notes

1. Alfred D. Chandler, Jr., *The Visible Hand: The Managerial Revolution in American Business* (Cambridge, Mass.: Harvard University Press, 1977), 271–279; Mariann Jelinek, "Toward Systematic Management: Alexander Hamilton Church," *Business History Review* (Spring 1980), 63–79; Joseph A. Litterer, "Systematic Management: The Search for Order and Integration," *Business History Review* (Winter 1961), 461–476.

2. John Buttrick, "The Inside Contract System," *Journal of Economic History* (Summer 1952), 205–206.

3. The major contributors to this literature up to World War I included Henry R. Towne, Harrington Emerson, Percy Longmuir, John Whitmore, Al-

exander H. Church, Frederick W. Taylor, Henry Gantt, Frederick Halsey, G. Charter Harrison, and Frank Gilbreth.

4. A former associate of Taylor's said that for Taylor "[financial] costs, though of course important, are secondary to productive efficiency." See C. B. Thompson, *The Theory and Practice of Scientific Management* (Boston: Houghton Mifflin, 1917), 71.

5. Percy Longmuir, "Recording and Interpreting Foundry Costs," *Engineering Magazine* (September 1902), 887.

6. David Solomons, "The Historical Development of Costing," in David Solomons, ed., *Studies in Cost Analysis* (Homewood, Ill.: Richard D. Irwin, 1968), 3–49. The text quotation is from page 38.

7. See references to John Whitmore in Solomons, "Costing," 37–40.

8. *Ibid.*, 40–42 (on Emerson), 46–47 (on Harrison).

9. *Ibid.*, 47.

10. *Ibid.*, 40.

11. H. Thomas Johnson, "Management Accounting in an Early Integrated Industrial: E. I. du Pont de Nemours Powder Company, 1903–1912," *Business History Review* (Summer 1975), 193–194; Daniel A. Wren, *The Evolution of Management Thought* (New York: John Wiley, 1979), 131–135.

12. Alexander Hamilton Church, *The Science and Practice of Management* (New York: The Engineering Magazine Co., 1914), 24–25, as quoted in Jelinek, "Toward Systematic Management," 73. We are indebted to Richard Vangermeersch for sharing many fascinating insights from his extensive research in the writings of Alexander Church. For a useful compilation of previously unpublished Church manuscripts, see Vangermeersch, *The Contributions of Alexander Hamilton Church to Accounting and Management* (New York: Garland Publishing, 1986).

13. A. Hamilton Church, "Organisation by Production Factors," *Engineering Magazine* (April 1910), 79–80.

14. A. Hamilton Church, *The Proper Distribution of Expense Burden* (New York: The Engineering Magazine Co., 1908), 24.

15. This point is a major theme developed by M. C. Wells in his *Allocating Common Costs* (Urbana, Ill.: Center for International Education and Research in Accounting, 1978).

16. Church, "Organisation by Production Factors," 80–81.

17. Church, *The Proper Distribution*, 28–29.

18. *Ibid.*, 13.

19. *Ibid.*, 11.

20. Church, "Organisation by Production Factors," 80.

21. George P. Norton, *Textile-Manufacturers' Bookkeeping for the Counting House, Mill and Warehouse* (London: Simpkin, Marshall, Hamilton, Kent, 1889).

22. Solomons, "Costing," 36–37.

23. A. C. Littleton, *Accounting Evolution to 1900* (New York: American Institute Publishing Co., 1933), 344.