

Controlling the Vertically Integrated Firm: The Du Pont Powder Company to 1914

PRODUCED around 1900 by a great merger wave were mammoth firms whose names have since become household words: International Harvester, Du Pont, General Electric, National Biscuit, American Tobacco, Pittsburgh Plate Glass, U.S. Steel, to name a few. Each firm subsumed within itself several of the activities formerly conducted by individual companies. Manufacturing, purchasing, transportation, and distribution, formerly the isolated activities of independent firms, became integrated in the multi-activity organization.

Integrated firms developed mainly because they provided new opportunities for entrepreneurs to expand profits by combining previously disparate operations. Nineteenth-century entrepreneurs had attained in single-activity firms unprecedented speeds of throughput. Technological developments enabled industries such as steelmaking, petroleum

refining, farm implement manufacture, and food processing to achieve astonishingly vast outputs by the late 1800s. They faced the problem, however, of assuring that their outputs earned the highest possible profit. Manufacturers needed aggressive marketing. They discovered that traditional distributors handling a variety of products supplied by many manufacturers were not interested in promoting any particular manufacturer's line and that it was neither profitable nor effective to offer such incentives as discounts to the distributors. Many mass producers, then, in order to control and streamline the distribution of their products, found it essential to create or acquire their own distribution channels. Some firms also found it necessary to create or acquire sources of raw materials and other inputs, especially where their suppliers enjoyed, but did not pass on in the form of lower prices, scale economies derived from supplying large orders to giant manufacturers. In the multi-activity firms that entrepreneurs conceived, joint ownership and control of resources, information, and rewards gave entrepreneurs the confidence to undertake risky, but potentially lucrative, exchanges that would otherwise go unmet in the market.¹

The complex system of internal exchanges characteristic of the multi-activity firm mitigates the effects of uncertainty in the market. Ironically, this complexity itself poses another source of uncertainty. Because information about its complicated internal processes is difficult to assimilate, an integrated firm can sink in a morass of bureaucratic inefficiency, losing its potential gains. The most successful of the early multi-activity firms tackled this problem by adopting what is known today as the unitary, or centralized, form of organization.² The unitary organization breaks the firm's overall operations into separate departments, each with highly specialized activities (for example, distribution, manufacturing, transportation, finance, and purchasing). The central office coordinates the departments and directs their diverse activities toward common goals.

The centralized unitary structure seemed a natural way to arrange the diverse and interdependent activities of the multi-activity firm. The structure allowed managers within each department to concentrate on efficient and effective performance of their specialized activity. At the same time, it permitted top managers to concentrate on coordinating as a unit the performances of the various departments in the firm.³ Each department was managed by a specialist who used all the techniques of single-activity management, as though the department were a separate, single-activity company. With these techniques, which were highly developed by 1900 and thoroughly publicized by such writers as Frederick W. Taylor,⁴ the department manager achieved cost efficiencies and scale economies. Freed from the task of operating separate departments, top management could apply its energies to attaining peak coordination and to achieving "synergies" inherent in the company's integrated activities. The owners intended, of course, that the profit of the whole company would exceed the profits that could be realized by the separate parts of the company were each part organized either through the market or through another competing firm.

The carefully delineated lines of authority and responsibility in a centralized organization did not by themselves assure that the owners of the multi-activity firm achieved the hoped-for gains. There also had to be mechanisms to ensure that each department's individual performance harmonized with the owners' goals for the firm as a whole. Harmony between the activities of the parts and the desired performance of the whole could not be left to chance. Several mechanisms enable social organizations to achieve the necessary harmony; they include, for example, centrally planned mathematical models, decentralized price systems, and culturally ingrained values.⁵ In America's late nineteenth-century multi-activity firms, a popular mechanism was the management accounting system.

To cope with their firms' many activities, managers of successful integrated firms in early twentieth-century America designed procedures to ensure a flow of reliable and useful information and instructions through their centralized organizations. They might have adopted procedures that trace the consumption of diverse resources to products, similar to those advocated by Alexander Hamilton Church. As we mentioned in chapter 3, they did not do this, presumably because existing information-processing technology made use of such procedures too costly. Instead, we find managers of vertically integrated firms adopting systems already in use in single-activity firms to coordinate internally the multiple processes involved in a single productive activity. But managers of vertically integrated firms modified these systems to assist them in evaluating and controlling several diverse activities.

In these modified information systems, individual departments in an integrated multi-activity firm relied on the accounting measures of performance developed by single-activity firms. In a multi-activity firm, however, it was virtually impossible to relate these disparate measures of efficiency (for example, cost per unit, operating ratio, stock-turn) directly to overall company profit. Moreover, heads of single-activity departments, simply employees in a multi-activity company, were not necessarily as motivated to achieve company-wide profit as were heads of independent single-activity firms. Top managers of multi-activity firms mitigated these problems of control and motivation with two new developments in management accounting. First, they devised budgets to coordinate and balance the internal resource flows from raw material to final customer. Second, they developed a new measure, return on investment, to compare performance in the firm's diverse parts with performance of the whole.

The budgeting and return on investment mechanisms

were designed to harmonize actions in the departments with the overall goals of the firm. The primary goal in many early integrated firms was to achieve higher-than-average returns by distributing to America's mass market the output from mass production technologies. Management accounting in the multi-activity firms directed managers' attention beyond the efficiencies of economic processes at the shop level, and even beyond the synergies gained from linking multiple activities. For the first time ever, the attention of managers was focused on the productivity and performance of capital itself.

Single-activity firms in the nineteenth century had ignored how well capital was being used. We mentioned in earlier chapters that managers of such firms were content to know how efficiently processes were being run once capital was in place. In multi-activity firms, however, top managers—not the market—must allocate capital among activities. The emphasis placed on capital by budgets and return on investment information, while prompted by the desire to evaluate and control specific internal activities, had an unforeseen consequence. The efficient and effective management of capital itself eventually became a driving force in the firm.⁶ Return on investment, initiated as a tool to facilitate the coordination of diverse activities, ultimately became a guiding principle. The full implications of this accounting-driven attention to capital are still being worked out today—as will be discussed subsequently in chapter 8—but the origins of this development can be viewed in the management accounting systems of early American multi-activity firms. We can gain a vivid understanding of this development by observing how one well-known integrated industrial firm, E. I. du Pont de Nemours Powder Company, was influenced by novel management accounting practices designed initially to govern their complex, multi-activity system.

Formation of the Du Pont Powder Company

The records of the Du Pont Powder Company, an explosives firm founded in 1903, provide an excellent example of the early uses of management accounting to evaluate opportunities and to achieve control in an integrated, multi-activity industrial.⁷ The Du Pont Powder Company supplanted the operations of E. I. du Pont de Nemours and Company, an explosives manufacturer in America since 1804.⁸ The Powder Company was founded by three Du Pont cousins, Alfred, Coleman, and Pierre, who, having worked during the 1890s for single-activity manufacturing and transportation firms employing modern management techniques, were certain that advanced administrative methods could be applied profitably to the old family firm. Seizing the opportunity created by a succession crisis in the family firm, the cousins purchased the firm's assets in exchange for bonds in the newly created E. I. du Pont de Nemours Powder Company. By this transaction, known today as a leveraged buy-out, the owners of the old company exchanged their assets for bonds, the interest on which was to equal the expected earnings of the old firm. The cousins thus gained control of the old firm's assets and became owners of a new company whose value would increase only if they could earn more with the old firm's assets than did the previous owners.

In order to evaluate and control the efficiency and profitability of their newly acquired company, the Du Pont cousins immediately began to develop a new administrative structure.⁹ The structure had considerable impact not merely upon the Powder Company, but also upon the organization of the entire explosives industry. Before 1903, the industry comprised several independently managed firms, each of which engaged primarily in manufacturing. Distribution to consumers was handled chiefly by wholesalers and general merchants. The old Du Pont Company and other

major firms in the industry coordinated prices and set output quotas through the Gun Powder Trade Association, a loosely structured, decentralized black blasting powder cartel. After 1903, the cousins rescinded almost all trade agreements in the Gun Powder Trade Association, bought out numerous firms in which the Du Ponts had partial or controlling interest, and consolidated their operations into one centralized, departmentalized enterprise. In short, the Du Pont Powder Company became a centrally managed enterprise coordinating through its own departments most of the manufacturing and distribution activities formerly mediated through the market by scores of specialized firms.

A centralized accounting system facilitated the flow of information through the Du Pont Powder Company's complex departmental structure.¹⁰ The home office requested from the company's mills and branch sales offices, located throughout the United States, daily and weekly data on sales, payroll, and manufacturing costs. The data were then recorded in the basic books of account. The home office accounting department compiled information from the books to rationalize operations and to monitor efficiency. The information assisted top management, the Powder Company's Executive Committee, in formulating plans that would ensure balanced growth among the company's diverse activities. It was also a means of evaluating and controlling the company's ongoing performance in each of the three main operating departments (manufacturing, distribution, and purchasing) and also for the company as a whole. The design of the Du Pont management accounting procedures gave enormous importance to return on investment, a price signal that had been virtually ignored by single-activity industrial firms in earlier times. Du Pont used return on investment as a common measuring rod of performance with which to plan, evaluate, and control for the profits being sought by the owners of the firm's resources.

Information provided by the company's centralized ac-

counting system enabled top management to carry out two capital planning tasks: the allocation of new investment among competing economic activities (including the maintenance of working capital) and the financing of new capital requirements.¹¹ Capital allocation became one of the chief occupations of the newly integrated industrial firms because the multi-activity firm forced managers to consider choices that previously had been left to capital markets. Governing the Powder Company's decisions to allocate investment funds was the principle that there "be no expenditures for additions to the earning equipment if the same amount of money could be applied to some better purpose in another branch of the company's business."¹² Return on investment was the criterion used to evaluate any investment project.

The Powder Company may have been one of the first industrial enterprises to use return on investment in management accounting. Single-activity firms before 1900 assessed net earnings, if at all, in relation to costs of operations and not in relation to the firm's total investment in assets. The typical nineteenth-century entrepreneur, being chiefly concerned with controlling costs and raising efficiency in a single activity, had little reason to measure return on investment. He took his firm's investment (*i.e.*, the scale of operations) for granted and concentrated on managing short-run costs. The Powder Company's executives also recognized the importance of controlling day-to-day operations costs, but they perceived that "a commodity requiring an inexpensive plant might, when sold only ten per cent above its cost, show a higher rate of return on the investment than another commodity sold at double its cost, but manufactured in an expensive plant." They concluded that "the true test of whether the profit is too great or too small is the rate of return on the money invested in the business and not the percent of profit on the cost."¹³

An asset accounting system was the main innovation that permitted return on investment to be used as a tool of

management accounting. Asset accounting in 1900 represented a significant departure from the previous accounting practice that charged off capital expenditures to retained earnings as quickly as possible. Thus, nineteenth-century businesses rarely kept detailed records of investment in plant and equipment. The Powder Company's system of accounting for productive assets was inaugurated in 1903 when the company made a complete inventory of all its plants and equipment and recorded each item in the general ledger account "Permanent Investment." Thereafter, all new construction was charged (and dismantled assets were credited) to this account at cost. The relevant accounting data on construction and dismantling costs were supplied through a comprehensive construction appropriation procedure.¹⁴

The construction appropriation system, in addition to supplying timely and accurate information on new investment, also provided information useful to top management in planning new long-term financing, the second of the two planning tasks mentioned above. Since spending on new plant and equipment was the major factor determining the company's need for new financing, information on appropriations and expenditures for construction was imperative for planning long-term capital requirements. The construction appropriation system, however, supplied only part of the information needed to plan financing. Since the Powder Company's basic policy was to finance expansion out of cash generated by earnings and the proceeds of stock sales (debt financing was eschewed),¹⁵ a forecast of cash flows was required to determine the maximum amount of new construction to which the firm could commit itself. Cash flows were forecast by multiplying the projected quantity of explosives to be sold each month (based on sales department estimates) by the estimated contribution margin per unit for each product (based on accounting department records).¹⁶ In calculating margins, consideration was given to probable future

trends in both product prices and input costs. The figure for operating cash flows was then added to projected nonoperating income (income from land sales, earnings on financial investments) to estimate total cash inflow. When combined with data on construction appropriations, this information on cash flows enabled top management to forecast the company's cash position and thus the anticipated need for new sales of stock.¹⁷ By 1910, the Executive Committee was receiving monthly forecasts of the firm's cash position for a year ahead; both the cash position projections and the cash flow forecasts were reconciled regularly with actual results.¹⁸

The information from the Powder Company's centralized accounting system also served to evaluate and control operations within and among the firm's various internal departments. Similar information was produced in the late nineteenth-century accounting systems of specialized firms connected with the railroad, metal-working, chemical, electrical equipment, and steel industries. But the founders of the Powder Company originated budgets and return on investment statistics that synthesized the disparate signals from departmental accounting systems into information regarding company-wide performance. As a consequence of these accounting refinements, top management did not need to administer daily operations, a task that had occupied the time of managers in single-activity firms before 1900. Top management could now delegate responsibility for operations to departmental supervisors because of the availability of reliable standardized information on operating performance and the use of routine operating criteria and instructions. The sophistication and availability of this accounting information clearly increased the Executive Committee's span of control and prevented the loss of control that otherwise might have accompanied the Powder Company's growth after 1903. All conclusions about the company's management accounting procedures may be better assessed,

however, after the accounting systems used in each of the firm's three main departments are described.

The Du Pont Manufacturing Department

Comprising three separate subdepartments (high explosives, smokeless gunpowder, and black blasting powder), manufacturing was Du Pont's largest and most complex department. Accounting information permitted control and assessment of manufacturing activities in the company's more than forty geographically dispersed mills.¹⁹ The accounting system summarized manufacturing information in two monthly reports, the works cost report and the profit and loss sheet. Data for the two reports came in part from mill production control records such as daily time sheets and daily material usage logs.²⁰ Both sets of reports were distributed to the Executive Committee (on which sat the vice presidents of each manufacturing subdepartment), while only the works cost report went to the mill superintendents. The works cost report contained information pertinent to the mill superintendents' chief area of responsibility, the operating efficiency of production processes.²¹ The additional profit and loss sheet, restricted to the Executive Committee, assisted top management in the execution of its primary responsibility: to maximize overall net earnings and return on investment.

The different purposes served by the two sets of reports can be made apparent by describing their respective contents. The works cost report described both the quantities (not dollars) of raw materials and the dollar costs of all other inputs (except administrative overhead) used by each mill in every production process. Raw material usage was compared both with predetermined standards and with consumption in other mills. The costs of nonmaterial inputs, broken down into labor, power, fuel, and supplies, were

shown for each process in a mill. The information in the works cost report enabled each superintendent to assess his mill's performance over time and in relation to the performances of other mills in the same subdepartment. The profit and loss sheet that was sent only to the Executive Committee contained additional information on all manufacturing costs, operating income, and return on investment.²² The information in this sheet and in supplemental reports enabled top management to assess earnings and return on investment by mill and by product line. A report on "operative income from sales," for instance, showed for each product the total and per unit amounts for gross sales, freight expense, selling expense, mill cost, net operating income, administrative expense, and net income. These data were also aggregated by mill and for the enterprise as a whole.²³ The figure for "mill cost" (*i.e.*, cost of goods manufactured) in the report enabled management to analyze both the cost of each product and the manufacturing costs of each mill in relation to overall net earnings. Mill cost was further analyzed in great detail, in a monthly report that showed its components (ingredients, labor, mill repairs, power, supplies, work accident insurance, and depreciation²⁴) in total and per unit of output for each mill and for each of the company's sixteen products.

The division of information between mill superintendents and top management suggests that the company intended mill superintendents to think and act as if they managed a typical late nineteenth-century single-activity factory. The information given to superintendents emphasized the physical efficiency of production processes within the mill; it said nothing about the mill's financial profitability, nothing about mill earnings, nothing on return on investment. Like Andrew Carnegie running his giant steel works, the superintendent of a Du Pont explosives mill could take for granted its scale of operations; his chief concern was to operate the existing facilities as efficiently as possible.

This concern is evident in minutes from the annual meetings of superintendents of the company's high explosives mills.²⁵ At these meetings the superintendents and manufacturing vice presidents discussed the most recent year's mill operating reports and concentrated almost entirely on comparisons of labor productivity and raw material consumption among the mills. Apparently, the superintendents competed vigorously to be low direct cost producers. There was virtually no talk of profits or return on investment.

Consideration of financial profitability was reserved for the Executive Committee. Thus, the founders of the Du Pont Powder Company did not use their new management accounting information about return on investment as an instrument for delegating decisions about prices, profits, or investment. Decisions about raw material purchases, wage rates, costs of other purchased inputs, and investment in plant and equipment remained highly centralized with top management in the home office. Top management used return on investment information to evaluate alternative uses of capital, not to evaluate the performance of managers in profit or investment centers. The centralization of return on investment information required the Executive Committee to devote more attention to operating details, of course, than would have been the case had the mill superintendents been evaluated as managers of investment centers. But it also relieved top management from the concern, familiar to management accounting theorists today, that mill managers, to enhance their local return on investment, might take actions inimical to the company's best interest.

Surely the Powder Company's top management, who were the owners of the company, were not likely to take actions inimical to the company's long-term profitability simply to enhance short-term return on investment. Modern accounting theorists point out the potential for such "gaming" behavior exists whenever the return on investment figures used to evaluate performance are based on earnings

and investment net of accounting depreciation (*i.e.*, straight line or accelerated). In such cases management can generate a rising return on investment trend, for many years, simply by withholding new investment. But this behavior is not likely when the managers using the return on investment statistics, such as the Powder Company's early Executive Committee, are also the firm's owners. The gaming behavior will more likely occur when the managers are employees of the company, having less self-interest than owners have in the company's long-term profitability. But one can reduce the likelihood of gaming by nonowner managers simply by measuring their earnings and investment without any deductions for depreciation.²⁶ It is interesting, therefore, that the Du Pont Company after 1920, when it adopted a decentralized multidivisional structure, began using gross measures of earnings and investment to measure return on investment in the company's divisions.²⁷

The Powder Company's new management accounting system did not leave the manufacturing department without practical problems to frustrate managers and accountants. Indeed, the company's founders debated two problems that continue to vex accounting theorists to this day. The first was whether to allocate indirect costs to intermediate and final products to facilitate intelligent make-or-buy decisions. The company manufactured many of the intermediate products used to make its finished products. In debating how to allocate indirect costs, Hamilton Barksdale, vice president of the high explosives manufacturing unit, insisted on loading indirect costs onto the finished product, but not onto any of the intermediate products. Barksdale feared that allocations of overhead to intermediate products would be arbitrary and would therefore vitiate analyses of internal mill efficiency. Russell Dunham, chief accountant for the company, opposed this policy. He argued that failure to allocate indirect costs to intermediate output precluded meaningful comparisons of company costs with outside

market prices for the same products.²⁸ The company's early records do not show how they ultimately resolved this debate.

The second accounting issue debated by the founders of the Powder Company was how to price internal transfers of products. On this issue, the accounting department had its way; internal transfers were priced at fully loaded accounting costs. The dissenting view, held by Barksdale and a majority of the company's operating chiefs, was that internal transfers should be priced at relevant market prices. The underlying reason for this difference of opinion, according to Alfred Chandler and Stephen Salsbury, was a conflicting belief about the ultimate purpose of the company's accounting information. Those who favored pricing internal transfers at market "wanted to use accounting data to appraise the performance of the company's departments," whereas those who favored pricing transfers at cost "saw the information only as useful in determining the profit and loss and the return on investment for the company as a whole."²⁹ Interestingly, Pierre du Pont, the chief advocate of the latter view—the view that shaped the early Du Pont Company's transfer pricing policy—subsequently changed his mind and advocated market transfer pricing some years later when he was running the decentralized operations of General Motors.

The Du Pont Sales Department

As in the case of manufacturing, marketing also presented a number of difficult administrative problems to be solved by the Powder Company's centralized accounting system. The major administrative tasks of the sales department included coordinating customer orders with mill production schedules, keeping advised of market trends, evaluating prices, controlling customer accounts, and coordinating and evaluating the performance of the sales staff.³⁰ The sales de-

partment's enormous responsibility for the company's products began when goods were finished in the mills and ended when the goods were sold and delivered to customers. Its task was complicated both by the diversity of the company's products and customers and by the wide geographic dispersion of the company's markets. The sales department managed a large network of branch sales offices scattered across the United States; salaried salesmen working out of the offices sold virtually all the company's products. Most of the branch sales offices (and all the mills) maintained inventories of finished goods. The sales accounting system employed to monitor the complex marketing operation was perhaps the most novel and sophisticated part of the Powder Company's management accounting system.

The primary sales accounting records were sales orders and invoices in the branch sales offices and shipping orders in the mills.³¹ Copies of these widely dispersed primary records were sent daily to the home office accounting department, which kept all the ledgers for finished goods inventories, sales, and customer balances. The company maintained centralized control over its cash balances by advising customers to remit payment directly to the Wilmington, Delaware, home office. Centralized control was also maintained by having the home office audit staff periodically verify the branch office and mill inventories.

The most important information compiled by the home office accounting department from sales accounting records was in the daily sales report, a listing derived from each day's invoices of the quantity and dollar amount of every product sold by each branch office. The reports provided timely information on market trends, usually with a time lag no longer than four or five days, to the vice president of the sales department and each branch office manager. The information in the daily sales report was compiled from invoices in an unusually advanced way.³² Data were entered on punch cards and then sorted using a system introduced

by the U.S. Bureau of the Census around 1890. Because of its exceptional flexibility, the punch card system permitted the home office accounting department to prepare not only the daily sales report, but also the following sales information: a monthly summary of quantities sold and average unit prices by geographic region, by type of product, and by type of customer; a sales cost sheet comparing, among the branch offices, the net prices received and the selling expenses for each type of product sold; and a trial balance of finished goods inventories that was reconciled each month with the general ledger. All these reports provided the vice president and staff of the sales department with comprehensive information to control and coordinate the Powder Company's entire marketing activity.

The sales accounting system contributed to centralized control; but, unlike the manufacturing accounting system, it also encouraged maximum decentralization of decision making. A pricing procedure and an incentive-compensation scheme for salesmen provided the basis for decentralized decision making and lower-echelon profit incentives.

Although pricing had been a major task of top management among firms in the Gun Powder Trade Association before 1903, evaluating product prices in the Powder Company became a routine undertaking that seldom required the attention of top management.³³ A committee of sales department executives, the Sales Board, reviewed minimum prices for each product, usually once a month. The review was intended to ensure that prices were high enough for each product line to earn a target return on investment. To facilitate pricing decisions, the home office accounting department prepared monthly estimates of the profit per keg or per pound needed to earn a given return for the investment in each type of product (15 percent for dynamite and 10 percent for black powder).³⁴ Using data from construction accounting records on the investment in plant and equipment by product line, the home office calculated the desired earn-

ings (for example, 10 percent of the investment in black powder capacity) and divided the expected earnings both by the normal output and the capacity output of the mills. The profit needed per unit of output to earn a desired rate of return (at both normal output and capacity output) could then be added to the unit cost of production to obtain the required minimum product price.

The Du Pont Powder Company set minimum prices on products to preserve existing competition. Convinced that their size and expertise in the industry would always enable them to produce at a lower cost than their competitors, the executives of the Powder Company did not strive ruthlessly to eliminate existing competition. On the contrary, they believed (as did Andrew Carnegie a generation earlier) that it was useful to have smaller, higher cost competitors to provide the industry's excess capacity during market recessions. The presence of these competitors increased the likelihood that Du Pont could run its mills at full capacity in all phases of the business cycle.³⁵ Their cognizance of the value of existing competition partially influenced the Powder Company executives' decision to keep prices close to those of competing firms. Information on competitors' prices was gathered regularly by salesmen and forwarded to branch sales managers and to the home office.

Minimum price figures were sent from the home office to the branch sales managers, who had final responsibility for setting customer prices. A sales manager was allowed to sell above the minimum price, but not below it. His strategy was to set prices as high as he could without risking the entry of a new firm into the industry. While existing competitors were tolerated, new competitors were certainly not sought. For example, in late 1906, the assistant treasurer of the Powder Company, John J. Raskob, noticed that black blasting powder produced and sold by the company in the anthracite region of Pennsylvania was earning 22 percent on investment, whereas the same type of powder produced and

sold by the company in the rest of the country was earning about 2 percent. Since all plants were running at full capacity, he argued that the price of black blasting powder should go up about 5 percent in all districts outside the anthracite region, whereas the price should go down about 8 percent in the anthracite district. "Unless this is done," he said, "the story our Profit and Loss statement tells is that while we are selling powder at lower prices than ever before all over the country with a view to preventing further investment in the business, we are inviting the same competition in the anthracite region by having prices which net us practically four times such income on the capital invested as we net in all other territories."³⁶

The sales accounting system also helped sales managers to control and assess the performance of salesmen through an incentive scheme based on routinely collected financial data. The Powder Company's scheme, as described by the director of sales, was designed "to give greater latitude to our men in the field [with] handling the trade, . . . to place upon our men more responsibility for the results obtained, and to provide so that their compensation will be varied as closely as possible in proportion with the results obtained along the lines we desire."³⁷ Salesmen were paid salaries tied to productivity incentives, rather than more customary commissions. The home office sales department calculated a "normal" volume and a "base" price (not the minimum price) for each product in every branch office. The branch office sales manager allocated his office's "normal" volume among the salesmen assigned to him. If a salesman's actual monthly sales were equal to his "base sales" (the base price times his normal volume), then he received 100 percent of his basic salary. His salary increased proportionately as his actual sales exceeded his basic sales. (It appears, however, that a minimum salary was guaranteed if actual sales were less than base sales.) The procedure encouraged salesmen to weigh both price and volume of their sales. In effect, it en-

couraged them to maximize total revenue for the company (and themselves) within the constraints imposed by the firm's pricing policy. The incentive procedure also allowed the sales department to direct salesmen's efforts with minimal intervention. For example, the home office sales department could provide a direct incentive to a salesman to push one line harder than another simply by adjusting the base price of a certain product.

The sales accounting system offered still another means for reducing the administrative responsibilities of top management. It provided a decentralized check on the performance of branch office managers and induced them to control inventories and costs in their branches.³⁸ The sales department estimated a "normal" ratio of sales costs to gross sales for each branch office. Sales costs included general office expenses plus 5 percent each of the average accounts receivable and average inventory balances. When the ratio of actual sales costs to gross sales was less than the normal ratio, 7.5 percent of the savings was added to the branch manager's salary. The manager was given discretion to distribute an additional 5 percent of the savings to his staff. The Executive Committee received a monthly sales cost sheet that compared gross sales and sales costs by branch office. By creating incentive and establishing control, the Powder Company's sales accounting system helped to coordinate the sales department's performance with the organization's overall earnings goal.

The Du Pont Purchasing Department

The Powder Company's founders perceived that great savings could be achieved if the buying of raw materials were carried out by one purchasing department located in the home office rather than separately at individual mills.

The purchasing accounting system helped to control expenditures on raw materials, to assess alternative sources of supply, and to coordinate purchasing with production. Unlike the manufacturing and sales department systems, however, the purchasing department system was not designed to coordinate and appraise the performance of line operatives.

The purchasing accounting system centralized control over the ordering, receiving, and expensing of all purchases by relying upon the well-known accounts payable voucher system used in the home office accounting department.³⁹ The voucher system, first used by railroad accountants during the mid-nineteenth century,⁴⁰ offers convenient control over balances due on account as well as assurance that purchases are charged to the proper accounts in the proper accounting periods. The purchasing department, which initiated all orders for materials with outside suppliers until about 1908 (when the company began to integrate backward into ownership of supply sources), placed all orders on the basis of market price information. The accounts payable division of the home office accounting department entered each order in a voucher register, issued checks for payment, and provided a monthly summary of all expenses for materials. The summary, derived from the voucher register, provided the basis from which ledgers were posted and cost statements were prepared. Each month the audit staff reviewed all voucher entries and payments.

Having centralized the control over purchase transactions, the purchasing department next concentrated upon achieving the lowest possible prices for raw materials. Until 1908, management had purchased most raw materials from outside agents whose terms could easily be compared with market prices. Consequently, very little internal accounting information had been necessary. Indeed, one of the few times that internal accounting information was required took place after 1905 when the Powder Company, which had customarily purchased nitrates through American commission

merchants, established its own agent in Chile to buy nitrates.⁴¹ The internal reporting required by the venture was minimal. Regular account was kept of the added cost of the Chilean office, shipping services, and working capital; these costs per ton of nitrate were compared regularly with prices charged by outside agents such as W. R. Grace and Co.⁴²

The 1907 recession revealed a major problem with the decentralized purchasing accounting system. In their careful assessment of the effects of the recession upon the policies of the Powder Company, Chandler and Salsbury point out that the purchasing department's efforts to buy raw materials at minimum price caused a working capital crisis during 1907.⁴³ As prices fell during the business cycle downturn, the vice president of purchasing accumulated vast supplies of essential raw materials; the payments required for these purchases fell due, however, just as declining orders for explosives reduced working capital. After narrowly escaping the crisis, management revised its purchasing policy to permit the purchasing department to buy at the lowest possible prices only up to a prescribed stock level, a level that varied with each month's sales projections.

While the maximum stock levels imposed by this new policy reduced the risk of a working capital crisis, they introduced the possibility of supply shortages in the event of an emergency, such as disruption to shipping in wartime. Intent on reducing its dependence on outside suppliers, the company began to acquire ownership of many supply sources, although it never achieved full ownership of supplies of all its basic raw materials.⁴⁴ The earliest steps toward backward integration involved controlling the production of such critical materials as charcoal, blasting caps, and packing crates. Each of these inputs accounted for only a small percentage of total purchases. The Powder Company's major raw material purchases were for nitrate of soda and crude glycerine. Of these, the company chose to integrate backward only into nitrates production.

Although many factors, both strategic and economic, impinged on its decisions to integrate backward, the basic criterion used by the Powder Company to evaluate these steps was return on investment. Basically, an investment in outside supply sources was approved only if it was judged likely to earn at least 15 percent per annum, the return the company normally earned in dynamite making, its most profitable production activity. The purchasing department used two procedures to estimate return on investment in integrated supply operations.⁴⁵ One procedure was followed when the company proposed to manufacture its own supplies of certain inputs (for example, dynamite packing crates or blasting caps). The estimated return, or "profit," on such a manufacturing process was calculated by deducting the estimated unit cost of production from current market price. This estimated "profit" was then divided by the estimated net investment that would be required to build or buy the necessary production facilities.

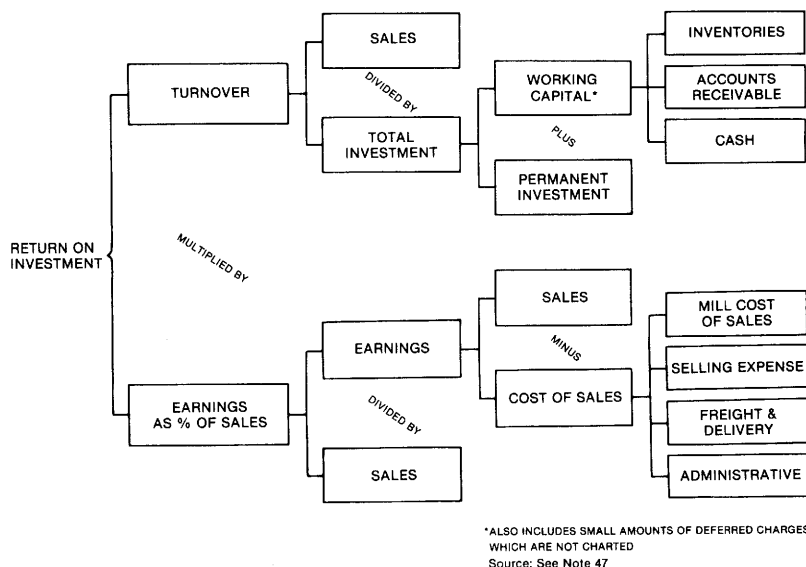
The second procedure was followed when the company proposed to control, but not to own, the source of supply of an essential raw material. It entailed first estimating the savings that would result from buying direct rather than buying through a commission agent. In order to determine these savings, the estimated unit cost of direct purchases was deducted from the market price charged by outside suppliers. Next, the purchasing department computed the return on investment by dividing these savings by the additional investment in inventories that direct buying would require. Although the two procedures have been criticized because they did not take into consideration the effect of the Powder Company's projected demand on market prices, it appears that the company did use conservative estimates of market price in order to make these return on investment calculations.⁴⁶ On the whole, therefore, these procedures provided useful guidelines for the allocation of Powder Company resources.

The Ascendancy of Return on Investment

The management accounting systems in each department of the Powder Company provided a powerful arsenal of statistical tools with which to plan, control, and motivate people in the company's diverse activities. The information from these systems on the efficiency of processes within each specialized department would have been familiar to managers of many nineteenth-century single-activity firms. But the information on the internal efficiency of capital across the three functional departments was unheard of before the coming of the multi-activity enterprise. The imaginative use of return on investment information enabled the Powder Company's top managers to effectively supplant capital markets in deciding how to allocate resources within the American explosives industry.

Indeed, their intense desire to assess every aspect of the company's activities in terms of the price of capital led the founders of the Du Pont Powder Company to devise an ingenious return on investment formula that continues to serve accountants and financial analysts to this day. The formula, shown pictorially in Figure 4-1,⁴⁷ factors return on investment into the product of the sales turnover ratio (sales divided by investment) and the operating ratio (net earnings divided by sales). The formula, as depicted in Figure 4-1, shows how return on investment is affected by a change in any element of either the income statement (via the operating ratio) or the balance sheet (via the turnover ratio). Viewed from that perspective, the Du Pont return on investment formula is an ideal tool for controlling, with accounting numbers, any vertically integrated company's operations. And that was the purpose to which the Powder Company's founders applied the formula. Between about 1915 and 1918 the company established a unique system for reporting the information in Figure 4-1 for each product line and each mill; the information was presented to top man-

Figure 4-1. The Du Pont Return on Investment Formula
Relationship of Factors Affecting Return on Investment



agement in a series of wall-sized charts—over 350 in fact—that were updated each month and maintained for easy viewing in a special Chart Room at the home office in Wilmington.⁴⁸

It would be a mistake, however, to conclude from their extensive use of formulae and charts that the founders of the Powder Company “ran the company by the numbers.” The return on investment reports went only to top management who used the information for planning and company-wide control. Subordinate managers were not compelled to achieve return on investment targets; rather, they strove to achieve economies and efficiencies within their respective specialized activities. Top management alone assumed responsibility for the investment and allocation decisions that ultimately determined how effectively the company’s integrated activities used capital. There was little chance, there-

fore, that Powder Company operating managers would try to achieve return on investment targets either by under-investing in capital or by curtailing expenses that would raise short-run earnings but diminish the firm's long-run value.

Indeed, it is probable that the Powder Company's founders saw their return on investment formula in terms of its unique historical significance for the multi-activity enterprise. As we have noted, by combining the operations of two or more single-activity firms into one integrated enterprise, the multi-activity firm intends to achieve results superior to those of a collection of single-activity firms acting independently. For a multi-activity firm the logic of combining the operating ratio and the turnover ratio into one index of company-wide performance is impeccable. The Du Pont return on investment formula combines, in effect, the two accounting measures of performance that single-activity firms engaged in manufacturing and distribution had developed separately during the nineteenth century. But the Du Pont formula combined the two distinct measures of performance (the operating ratio and the turnover ratio) in a way that permitted the multi-activity firm to perform as a mini-capital market.

The idea for the Du Pont return on investment formula (and for the Chart Room as well) originated, as far as we know, with F. Donaldson Brown, a college-trained electrical engineer and one-time electrical equipment salesman who joined the Powder Company's sales department in 1909 and became assistant treasurer of the company in 1914.⁴⁹ None of Brown's surviving records indicates how he hit upon the idea for his return on investment formula.⁵⁰ Interestingly, Brown had no formal training or experience in accounting. His expertise in electrical engineering (at the age of 17 he received the B.S.E.E. degree from Virginia Polytechnic Institute) suggests that he was proficient at mathematics and adept at interpreting relationships among the diverse parts

of a complex system. His experience in selling no doubt gave him an appreciation for the effect of turnover and distribution costs on a company's profits. Evidently, his mathematical, engineering, and marketing skills gave Brown a unique perspective on the determinants of company performance that was not understood by most contemporary accountants. Brown's ideas about financial planning and control had a profound impact on the Du Pont organization and later on General Motors. Yet his ideas did not become widely known among professional accountants until the 1950s, when a new generation of management accounting textbooks introduced them into the standard MBA curriculum.

Summary

The need for a uniform financial measuring rod compelled managers of integrated multi-activity firms to push management accounting beyond the cost management systems developed by single-activity enterprises in the nineteenth century. The Du Pont Powder Company discovered one such measuring rod in return on investment, an accounting ratio that helped management determine the price of capital used within the company. The Powder Company's return-on-investment reporting system compared every aspect of the company's diverse internal operations with alternative uses for capital, while preserving the best of single-activity cost management information about each of the company's specialized activities. With no obvious precedent to follow, the Du Pont organization between about 1903 and 1915 created a management accounting system whose essential features remain to this day a model for complex business organizations.

The Du Pont Powder Company's management accounting system mitigated many bureaucratic problems that otherwise might afflict a centrally managed, complex inte-

grated business firm. Left unsolved, these problems would ultimately have limited the size of a vertically integrated enterprise by the cost of coordinating diverse internal activities. The cost increases as a firm grows in size primarily because communication of instructions and information throughout the organization becomes more difficult with larger numbers of people. Communication difficulties that lower the quality of information about opportunities for gain within the firm are analogous to conditions that make prices (*i.e.*, measures of alternative opportunities) less than perfect in product and capital markets. Because of the costs of discovering opportunities for gain both in markets and within firms, we observe economic exchange occurring in both places, and not all in markets or all in firms. To paraphrase the famous theorem that Ronald Coase enunciated over fifty years ago, a firm will grow until the marginal cost of discovering opportunities for gain within the firm exceeds the marginal cost of discovering opportunities for gain in the market.⁵¹ By lowering the cost of discovering opportunities within the firm, management accounting systems such as the one developed by the founders of the Du Pont Powder Company have undoubtedly increased the potential size of complex business organizations.

Notes

1. A discussion of the points summarized in the previous paragraphs is in Alfred D. Chandler, Jr., *The Visible Hand: The Managerial Revolution in American Business* (Cambridge, Mass.: Harvard University Press, 1977), chapters 9–11.

2. Oliver E. Williamson, *Corporate Control and Business Behavior; An Inquiry into the Effects of Organization Form on Enterprise Behavior* (Englewood Cliffs, N.J.: Prentice-Hall, 1970), chapter 2; Alfred D. Chandler, Jr., *Strategy and Structure: Chapters in the History of the American Industrial Enterprise* (Garden City, N.Y.: Anchor Books, 1966; reprint of 1962 ed.), 43–50.

3. Oliver E. Williamson, *Markets and Hierarchies: Analysis and Antitrust Implications* (New York: Free Press, 1975), 133.

4. Joseph A. Litterer, "Systematic Management: Design for Organizational Recoupling in American Manufacturing Firms," *Business History Review* (Winter 1963), 369–391.

5. See H. Thomas Johnson, "Accounting, Organizations and Rules: Toward a Sociology of Price," *Accounting, Organizations and Society* volume 11, No. 4/5 (1986), 341–343.

6. A similar development occurred with the use of conversion cost information in single-activity firms during the nineteenth century. An accounting number such as cost per labor hour also assumed a life of its own by driving the search for labor-saving efficiencies, say, from improved machinery. In the twentieth-century vertically integrated firm, return on investment numbers drove a similar search, this time for more productive opportunities to use capital in general.

7. The records referred to here are described in 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), 185, n. 6. The records are cited hereafter as "Hall of Records" with the appropriate box or shelf number.

8. The following account of the Powder Company's early history is drawn from Alfred D. Chandler, Jr., and Stephen Salsbury, *Pierre S. duPont and the Making of the Modern Corporation* (New York: Harper & Row, 1971), 47–120.

9. *Ibid.*, 77–120.

10. *Ibid.*, 144–147. Two papers give a concise description of all facets of the Powder Company's centralized accounting system: R. H. Dunham, "Object of Accounting," paper for the High Explosives Operating Department Superintendents' Meeting No. 33 (New York, April 20–26, 1911), and William G. Ramsay, "Construction Appropriations," paper for the H.E.O.D. Superintendents' Meeting No. 32 (New York, April 12–16, 1910). The papers, on file at the Eleutherian Mills Historical Library, Greenville, Delaware, are reprinted in H. Thomas Johnson, ed., *System and Profits: Early Management Accounting at Du Pont and General Motors* (New York: Arno press, 1980).

11. Chandler and Salsbury, *Pierre S. du Pont*, 158–168, 201–217.

12. Ramsay, "Construction Appropriation," 2.

13. Dunham, "Object of Accounting," 17. The basic figure used by the company for return on investment was net earnings (after deducting depreciation and before deduction of interest on long-term debt) divided by net assests (total assets minus goodwill and other intangibles, current liabilities, and reserves for depreciation).

14. In accordance with this procedure, all proposed investment in plant and equipment was described on standard appropriation forms calling for estimates of expenditure, estimates of the savings in cost or other benefits anticipated from the proposed investment, and evidence of proper authorization. Once an appropriation was approved, a report was presented on the final actual expenditure on the new asset. Proper authorities were then expected to account for any unreasonable variance from the original estimate. See Ramsay, "Construction Appropriation," *passim*.

15. Chandler and Salsbury, *Pierre S. du Pont*, 210–213, 251–254.
16. Examples of the earnings forecasts are found in Hall of Records, boxes 184736–184740, item 43 (about 1907), and shelf area 182701–182712, items 161 and 161A–161D (1910).
17. Chandler and Salsbury, *Pierre S. du Pont*, 251–252.
18. Examples of these monthly cash forecasts (ca. 1910) are in Hall of Records, shelf area 182701–182712, item 173. Reconciliations of cash forecasts to actual cash flows are at item 186. Reconciliations of earnings forecasts to actual earnings are in boxes 184736–184740, item 43.
19. Each mill produced only one type of explosive (smokeless gunpowder, high explosives, or black blasting powder), usually in several varieties, and it also produced many of the intermediate materials (e.g., acids) that were used to make the final products.
20. The company centralized all purchasing and payroll records in the home office accounting department. The mills kept only those records needed to ascertain the quantities of inputs (material and labor) and the quantities of output for each of their processes. Dunham, “Object of Accounting,” 7–19.
21. Examples of the reports are in the Minutes of the High Explosives Operating Department Superintendents’ Meetings on file at the Eleutherian Mills Historical Library.
22. Chandler and Salsbury, *Pierre S. du Pont*, 146–147. Examples of work-sheets used to prepare these reports are in Hall of Records, box 133859.
23. Hall of Records, box 133859.
24. A brief description of the company’s depreciation policy is in order. Because the company invested regularly in cost-saving technical improvements, most plant and equipment were replaced long before wearing out. Consequently, the amount charged to depreciation each period was “obsolescence insurance, as it [covered] the replacement or rearrangement of plants or parts of plants, because out of date, or badly laid out according to more recent ideas, or illogically located on account of change in trade conditions, or, in fact, almost any reason other than that the plant is worn out or damaged by accident.” (Dunham, “Object of Accounting,” 17.) The company also charged an additional amount each period to anticipate the costs of plant and equipment destroyed by fire and explosion (referred to as “work accident insurance”). The monthly rates for depreciation were .5 percent for plant and 1.25 percent for furniture and fixtures; for work accident insurance, 2 cents per keg for powder and 1 cent per pound for dynamite on every unit of explosive manufactured. Current operating expense was therefore regularly charged for all repairs and maintenance to permanent plant and equipment, for the estimated amount of depreciation due to technical obsolescence, and for the estimated loss that would arise from fire and explosions.
25. Minutes of the High Explosives Operating Department Superintendents’ Meetings on file at the Eleutherian Mills Historical Library.
26. Theorists will point out that the ideal solution to this problem is to use annuity (or present-value) depreciation in calculating return on investment. For more on the pitfalls of evaluating managers with return on invest-

ment statistics see Robert S. Kaplan, *Advanced Management Accounting* (Englewood Cliffs, N.J.: Prentice-Hall, 1982), 526–534.

27. For more on Du Pont's present-day practice of ignoring depreciation in internal evaluations of return on investment, see David Solomons, *Divisional Performance: Measurement and Control* (Homewood, Ill.: Richard D. Irwin, 1965), 134–135.

28. Dunham, "Object of Accounting," 10–11 and "Discussion," 1–2.

29. Chandler and Salsbury, *Pierre S. du Pont*, 153.

30. *Ibid.*, 140–141.

31. The company's sales accounting records are described in great detail in Dunham, "Object of Accounting," 4–7.

32. *Ibid.*, 5, 19.

33. Chandler and Salsbury, *Pierre S. du Pont*, 163, 141, 155–157. The method described in this paragraph, which the company used to determine minimum product prices, is not discussed by Chandler and Salsbury; it is inferred from worksheets and correspondence in Hall of Records, boxes 184736–184740, items 27 (B. Blasting Powder) and 39 (Dynamite).

34. Company records do not give reasons for the different returns desired on dynamite and black powder. One can surmise that dynamite required a higher return because it was then a relatively new product with riskier market potential.

35. Chandler and Salsbury, *Pierre S. du Pont*, 93, 156.

36. Letter from J. J. Raskob to P. S. du Pont (Wilmington, July 27, 1906), Hall of Records, boxes 184736–184740, item 29. The constraints imposed on sales managers' pricing activities are outlined in the letter from the director of sales cited in note 37.

37. Letter from director of sales dated April 2, 1906, reprinted in Johnson, *System and Profits*.

38. *Ibid.*

39. Dunham, "Object of Accounting," 2–4, 7–13.

40. J. H. Bridge, *Inside History of Carnegie Steel Company* (New York: The Aldine Book Company, 1903), 84; George W. Wood, *The Voucher System of Book-keeping* (Pittsburgh: G. W. Wood, 1895).

41. Chandler and Salsbury, *Pierre S. du Pont*, 185–186.

42. Hall of Records, shelf area 182701–182712, item 139.

43. Chandler and Salsbury, *Pierre S. du Pont*, 220–228.

44. *Ibid.*, 187, 204, 228.

45. Hall of Records, shelf area 182701–182712, items 116, 137, 138, 139, 145.

46. Chandler and Salsbury, *Pierre S. du Pont*, 245.

47. From T. C. Davis, "How the Du Pont Organization Appraises its Performance," in *AMA Financial Management Series No. 94* (American Management Association: New York, 1950), 7. Reprinted in Johnson, *System and Profits*.

48. *Ibid.* See also F. Donaldson Brown, *Some Reminiscences of an Industrialist* (Easton, Pa.: Hive Publishing, 1977, reprint of 1958 ed.), 27.

49. Brown, *Some Reminiscences*, chapters 1–3 and introduction (by Ernest Dale). For additional interesting background on Brown, see Peter F. Drucker, *Adventures of a Bystander* (New York: Harper & Row, 1978), 263–266.

50. Brown may have read Alfred Marshall's discussion of the relationship between earnings, turnover, and return on capital. See Alfred Marshall, *Principles of Economics* (London: Macmillan, 8th ed., 1920; reprinted in 1969), 260, 511–513.

51. Ronald Coase, "The Nature of the Firm," *Economics*, Vol. IV (1937), 386–405. Reprinted in K. Boulding and G. Stigler, eds., *Readings in Price Theory* (Homewood, Ill.: Richard D. Irwin, 1952), 331–351. An extremely interesting commentary on Coase's article, including a note on its evolution, is in Stephen N. S. Cheung, "The Contractual Nature of the Firm," *Journal of Law and Economics* (April 1983), 1–21.