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Abstract: This paper uses the archival records of three entities successively carrying on coal and ironmaking activities at Staveley between 1838-1900, together with the findings from earlier research, to explore the costing information generated over the period 1690-1900. We find a system of cost accounting, broadly defined, in operation throughout the period, a large measure of continuity concerning its basic features, and innovations made from time to time presumably designed to improve its usefulness. The paper uses the results of this and earlier research to explore the nature of accounting change and draws attention to possible differences in the path of development between countries. Further, we assess the significance of our findings for present ideas concerning the development of cost accounting systems in Britain and the U.S., and argue for a broader view to be taken by researchers into the nature of management accounting's development.

A previous article [Edwards and Boyns, 1992] examined the accounting records of two vertically-integrated charcoal ironmaking enterprizes operating as partnerships in the Sheffield area between 1690-1783.[1] The main findings were that their accounting systems, each based on double entry bookkeeping, involved complete integration of the cost and financial records, the identification of unit costs for raw material inputs, the use of accounting prices to record the movement of goods between locations in order to measure departmental results, and the calculation of input-output yield statistics for raw materials and intermediary products.

[1] These were The Duke of Norfolk's Works in south Yorkshire and the Derbyshire and Nottingham Company located around Staveley, north Derbyshire.

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The present paper uses the findings from this earlier research together with the archival records of three entities[2] (two sole traders and a quoted public company) subsequently carrying on coal and ironmaking activities at Staveley, in succession, during the period 1838-1900 for the following purposes:

* to contrast the nature of cost accounting developments in Britain and the U.S.;
* to argue for a broader view to be taken of the development of managerial accounting than is implicit in the debate concerning the significance of events at the Springfield Armory;
* to outline and analyze the costing system in use at Staveley between 1838-1900; and
* to assess the likely relevance of the data generated for the purposes of planning, measurement and control.

INDUSTRIAL ACCOUNTING DEVELOPMENTS IN THE U.S. AND BRITAIN

There is a growing literature on the development of cost accounting and a keen interest in the extent to which failure to respond to changing circumstances during the twentieth century has caused it to lose its relevance [Johnson and Kaplan, 1987]. A feature of this literature is the debate concerning the way in which our knowledge of earlier developments can help to explain the nature and purpose of cost accounting and the process of evolution into its present day form.

Much of the literature used as the basis for generalizing earlier developments in English-speaking countries, post-1800, deals with the activities of nineteenth century U.S. companies [Johnson, 1972; Chandler, 1977, 1990; Johnson and Kaplan, 1987; Hoskin and Macve, 1988, 1994; Tyson, 1990, 1992, 1993]. Particular importance is ascribed to events at the Springfield Armory. According to Chandler [1977, p. 72], "before the mid-1830s the only industrial enterprises in the United States to have an internal sub-division as extensive as that of Adam Smith's famous pin factory were a small number of gun making establishments." Features of the most successful of these, the Springfield Armory, were that it had a workforce of 250 men and was, for decades, the largest metal working establishment in the country. Chandler therefore sees it as perfectly natural for "tech-

[2] The records for these companies are housed at the Derbyshire Record Office, Matlock, Derbyshire and the Sheffield City Library, archives department.

niques of modern factory management" to appear first in this "important prototype of the modern factory" [Ibid., pp. 72-3].

If we accept Chandler's view that the scope and scale of business activity is likely to have implications for the design and development of the management information system, we might *expect* to find differences between the U.S. and British experiences. Of particular relevance is the fact that factory development had begun somewhat earlier in Britain. Proto-industrialization during the seventeenth and early eighteenth centuries had seen the emergence of the proto-factory,[3] involving a significant investment in tools and implements and a labor force assembled to perform specialist functions under supervision [Flinn, 1962; Marshall, 1980, chapter 6; Mepham, 1988, pp. 57-8].

The pace of industrialization picked up in Britain during the second half of the eighteenth century with the textile, especially cotton but also woolen, and iron industries coming to the fore. By 1812, in the neighborhood of Birmingham alone, there were 10 iron works, each of which cost over £50,000 to establish and typically engaged between 300-500 workmen apart from the colliers [Ashton, quoted in Edwards, 1937, p. 193]. An example of an organization growing rapidly during the first half of the nineteenth century, under the leadership of Sir John Guest, was the Dowlais Iron Company which employed 5,192 people in 1842. In the same year, it was described as "the first [iron works] in the world,"[4] but it is not necessary to go beyond the locality of south Wales for other examples of substantial British Companies at this early date.[5]

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[3] The first factory proper is generally considered to be John Lombe's silk-throwing mill near Derby in 1717. It was 500 feet long and, with five or six stories resembled "a huge barracks . . . with its automatic tools, its continuous and unlimited production and the narrowly specialised functions of its [300] operatives" [Mantoux, 1928, p. 199].

[4] Letter from S. W. Roberts of Philadelphia to Thomas Evans, the overseas agent of Dowlais. Glamorgan Record Office, Dowlais main series letter book 1842 (2) f. 368.

[5] The Plymouth Iron Company employed 3,900, Tredegar 2,757, Rhymney 2,494, Penydarren 2,071 and Blaenavon 1,971, while Cyfarthfa employed 2,000 at the forges alone [Royal Commission on Childrens' Employment in Mines and Manufactories, 1842, Report of Rhys William Jones, Appendix, Part 2, p. 594]. The Report of the Commissioners for the State of the Population in the Mining Districts, 1846, puts employment at Dowlais at c. 6,000 and at Rhymney c. 4,000, of which 1,600 were employed in the mines. It is also stated that 1,700 were employed at Dowlais in the mines, but it is not clear whether this is part of the 6,000.

Given Chandler's [1977, 1990] assessment of the impact of the large-scale business enterprize on cost accounting developments, it would be surprising if progress in this direction had not been made early on by companies at the forefront of Britain's Industrial Revolution. Indeed, research has been undertaken which suggests that important costing developments did in fact occur in Britain both prior to and during the Industrial Revolution [McKendrick, 1970; Stone, 1973; Jones, 1985; Fleischman and Parker, 1990, 1991, 1992; Fleischman, Parker and Vamplew, 1991; Edwards and Newell, 1991; Edwards and Boyns, 1992]. Moreover, refinements of accounting technique, of fundamental importance in terms of departmental profit and performance measurement occurred in relatively small iron making establishments [Edwards and Boyns, 1992].

This paper will present further evidence both explicit and suggestive of the fact that this material was used for management purposes [see also Boyns and Edwards, 1995].

DEVELOPMENT OF MANAGEMENT ACCOUNTING — SOME SUGGESTIONS

It has been persuasively argued that Johnson and Kaplan's analysis of the development of management accounting in *Relevance Lost* [1987] has "placed accounting history centre-stage not only in the research agenda, but also for practical business management" [p. 36]. The result has been an upsurge of publications in this area and an intense and sometimes heated debate [Tyson, 1992; Fleischman, Kalbers and Parker, 1992; Miller and Napier, 1993; Hoskin and Macve, 1994; Tyson, 1995] between Foucauldians, Marxists and economic rationalists concerning the respective merits of different approaches to accounting history [Napier, 1989; Miller, Hopper and Laughlin 1991]. Calls have been made for recognition of possible merit in more than one approach towards analysing accounting's past [Fleischman, Kalbers and Parker, 1992], and the late eighteenth century accounting practices of Boulton & Watt have been the subject of re-interpretation as the result of collaborative research between Foucauldians and an economic rationalist [Fleischman, Hoskin and Macve, 1995].

Recent years have also seen an interesting debate in the accounting history literature concerning the "genesis of managerialism" [Hoskin and Macve, 1994]. According to Chandler, the necessary administrative co-ordination of emerging large-scale companies during the nineteenth century was facilitated

by the adoption of bookkeeping procedures based on "standard double-entry accounts" [Chandler, 1977, pp. 73-4]. The Springfield Armory case is cited as an exemplar, with events during the stewardship of Colonel Roswell Lee (1815-33) seen to have been of crucial importance.

Historians of a Foucauldian persuasion [Hoskin and Macve, 1988] have challenged Chandler's "demand - response" explanation for the development of managerialism during the 1830s and 1840s. They agree that events at the U.S. Springfield Armory in the first half of the nineteenth century saw accounting play a full part in the development of "managerialism," but see a disciplinary power-knowledge framework as responsible for observed changes. In the opinion of Hoskin and Macve, identified events, which include the "West Point connection," conspired to produce "crucial discontinuities from previous accounting and management practices" [Hoskin and Macve, 1988, p. 38]. The major step forward comprised a new accountability based on "a full accounting for labour productivity" [Hoskin and Macve, 1988, p. 38; see also Chandler, 1977, pp. 72-5]. In a later paper, Hoskin and Macve [1994] have demonstrated conclusively the fact that Springfield's accounting system under Lee was based on the stewardship-oriented charge/discharge accounting rather than, as Chandler believed, the potentially more commercially-oriented double entry bookkeeping [1994, pp. 18-22], and have further argued that it was "a revolutionary time-and-motion study undertaken in 1831 which exposed the previously-hidden problem of slack, and thus made it possible to engineer the subsequent cost and productivity transformations" [1994, p. 6]. The time and motion study is thought to have been the "brainchild" of Lieutenant Daniel Tyler, a West point graduate who joined Springfield in 1831.

The Hoskin and Macve thesis has been challenged by Tyson [1990, 1992, 1993]. Tyson re-examined the Springfield archive and concluded that there was, potentially, a managerial accounting system in place prior to Tyler joining the Armory, and that subsequent changes in the *use* of this accounting system can better be explained in terms of a range of identified economic and social factors. Tyson's findings have been stoutly resisted by Hoskin and Macve [1994] who re-assert their earlier conclusions.

This debate is of relevance to our study for reasons which include assertions made by Foucauldians concerning the nature and purpose of costing systems uncovered by other academic

researchers. Earlier costing developments in U.S. textile mills are down-played due to their perceived inability to establish effective accountability in respect of workers and production [Hoskin and Macve, 1988, pp. 70-1]. More importantly, for our purposes, while Foucaudians have noted the introduction of cost accounting techniques *in British companies* before and during the Industrial Revolution [McKendrick, 1970; Jones, 1985; Edwards, 1989; Edwards and Newell, 1991; Fleischman and Parker, 1990, 1991], the significance of these findings[6] has been questioned [Hoskin and Macve, 1988, 1992] on the grounds that they provide evidence of cost *finding* but not cost *control*.

We use the findings from recent research into the Staveley archives together with our investigation of its predecessor companies [Edwards and Boyns, 1992] to question this conclusion. We think that progress in management accounting history research needs to pay more attention to two factors, of which the second is given particular emphasis in this paper. First, there is a need to consider the possible significance of differences in environmental circumstances between countries. For example, it is plausible to argue that a country with a long industrial history and steady rate of economic development in circumstances where labor was relatively plentiful (e.g., Britain between the seventeenth and nineteenth centuries) is likely to exhibit significant differences in the development of its technologies, including accounting, compared with a country which started much later but then industrialized more rapidly against a background of labor shortages (e.g., the U.S.).

Second, while we share with Hoskin, Macve and Tyson a concern with the development of accounting as a tool for management, we argue that it is a mistake to focus overmuch on "using accounting information *to exert human accountability*, e.g., by eradicating slack and increasing work efficiency" [Hoskin and Macve, 1994, p. 7, emphasis added]. The material presented and commented on in the remainder of this paper contains little or no evidence of an accounting system being used principally as a means of surveillance of the workforce. However, we argue that a broader view needs to be taken of the possible nature and role of accounting systems both within and between countries. That is, we suggest that management was concerned to make the best use of available resources within certain constraints, of which one may have been a recognition

[6] Also, in the U.S. context, Porter, 1980.

of the need to maintain harmonious management/worker relations in a period when the "governable person" [Miller and O'Leary, 1987] had not yet been created, at least in the private sector. We therefore take the view that it is unduly restrictive to equate the development of managerial accounting with the growth of scientific management, which is seen to have its origins at West Point and to have been popularized by Frederick Taylor in the late nineteenth century. Rather, we take as a reference point the definition of management accounting which appeared in the report prepared by the team which visited the U.S.A. in 1950 under the auspices of the then recently established Anglo-American Council on Productivity. It is the first such definition of which we are aware that has appeared in the British accounting literature.

> Management accountancy is the presentation of accounting information in such a way as to assist management in the creation of policy and in the day-to-day operation of an undertaking (1950, p. viii).

We recognize that we focus on a term "management accounting" which was not even used in the nineteenth century, but we do not see this as a problem.[7] Our sole purpose is to discover whether the system we have researched meets the basic criterion subsequently articulated as justifying that designation.[8]

In the next two sections, we present our analysis of the system of accounting used at Staveley between 1838-1900. In the final section, we emphasize the gradual evolution, over two centuries, of an accounting system which (our investigations of archives elsewhere suggest[9]) had many features in common with that in widespread use among iron, steel and coal companies in the late nineteenth century. Also, we make a tentative assessment, based on the limited explicit evidence available, of the extent to which this system can be regarded as serving manage-

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[7] See Miller and Napier [1993] for a different view

[8] In this context, we note a broad similarity between the 1950 definition and those used by today's management accounting textbooks.

[9] Bolckow, Vaughan and Company Ltd, Cleveland (British Steel, North Eastern Regional Records Centre); Consett Iron Company Ltd, Durham (British Steel, North Eastern Regional Records Centre); Dowlais Iron Company, Glamorgan (Glamorgan Record Office); Pearson and Knowles Coal and Iron Company Ltd, Lancashire (British Steel, North Western Regional Records Centre); Shelton Iron, Steel and Coal Company Ltd, Staffordshire (British Steel, North Western Regional Records Centre); and South Durham Steel and Iron Company Ltd, Durham (British Steel, North Eastern Regional Records Centre).

ment's informational requirements. We acknowledge the lack of surviving evidence to demonstrate the precise use made of this accounting information and refer to the contemporary literature for illumination on this matter. In the final section we also comment further on the process of accounting change in different countries and argue for a broad view of management accounting to be taken by researchers into its history.

THE INTEGRATED ACCOUNTING SYSTEM

1838-41: Staveley Works — George Barrow, Sole Proprietor

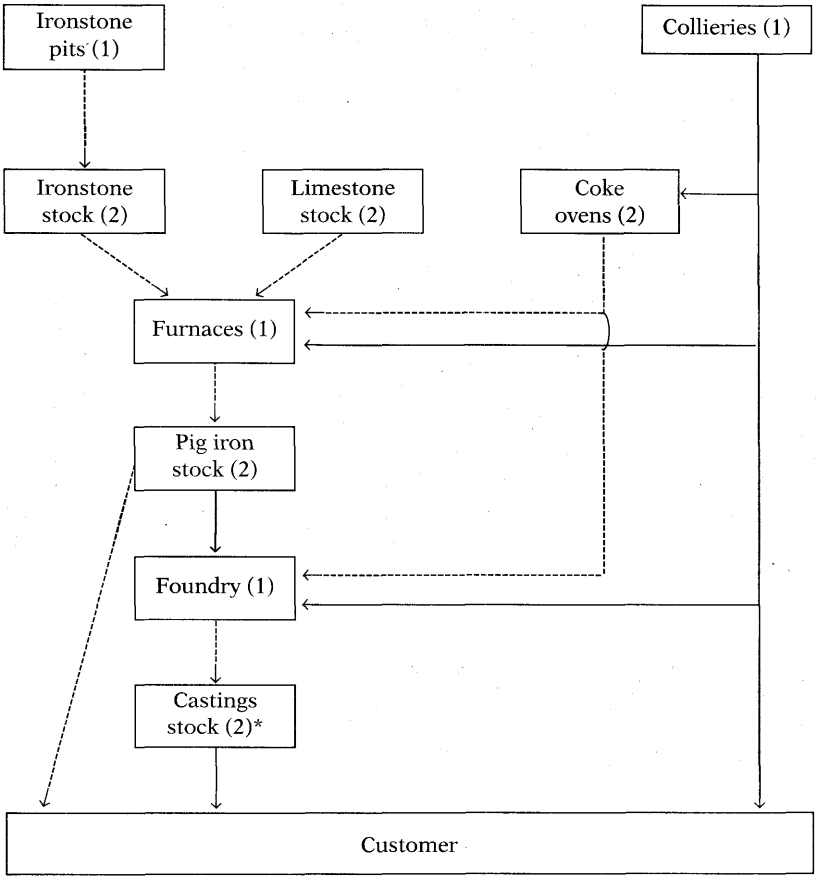
In 1783, at the end of a 21-year lease, the tenancy of Joseph Clay (managing clerk of The Duke of Norfolk's Works and the Derbyshire and Nottingham Company) was not renewed and the two partnerships were dissolved. Staveley was then leased to Walter Mather who belonged to a group of capitalists that also controlled foundries and mills in south Derbyshire. In the endeavor to improve profitability, the furnace was re-built to enable the use of coke instead of charcoal as its main fuel [Hopkinson, 1957, p. 117]. Following Mather's death in 1796, Staveley was bequeathed to his sons-in-law, William Ward and Edward Richard Lowe, though the latter died in 1800 and his widow continued in partnership with Ward.

In 1805, Lowe's widow married George H. Barrow, a Southwell solicitor, who initially took little interest in Staveley. Bad management and a run of losses from *circa* 1810 encouraged Barrow to become more involved and, in 1815, he took over the ground leases and assumed sole responsibility for the works. George continued to run the business until 1841, by which time backward integration had secured supplies of ironstone and coal from local pits and collieries.

The single accounting record which appears to have survived from George's proprietorship is the double entry-based private ledger for 1838-41 [D3808]. Nevertheless, the wealth of physical and financial information it contains enables us to construct a fairly clear picture of the nature of business operations at this time, the flow of goods between operating departments and stock, and the way in which costs and profits were measured [Figure 1].

FIGURE 1

Staveley Works, departments and cost/revenue flows, 1838-41



* Small amounts of castings were supplied and recharged to other departments in the form of items such as rails, wagon wheels, punches, plates, pram wheels, point plates, pipes, pulley wheels, washers, drum wheels and doors.

----------→ Transfers at cost

——————→ Transfers at an accounting price

(1) Separate columns in these ledger accounts list physical quantities transferred to the next stage of operations.
(2) Separate columns in these ledger accounts list physical quantities for both inflows and outflows.

Source: Private ledger of Staveley Works, 1838-41.

The main operating departments (each of which was allocated a separate ledger account) consisted of three collieries, an unspecified number of ironstone pits and coke ovens, two furnaces and a foundry. There were also separate ledger accounts for stocks of limestone (purchased externally and subsequently transferred to the furnaces), ironstone (obtained from the pits and used in the furnaces), pig iron (produced by the furnaces and transferred to the foundry or sold) and castings (produced in the foundry for subsequent sale). Coal was transferred from the collieries to the coke ovens, furnaces, foundry and customers.

The unbroken arrows in Figure 1 indicate transfers to customers at selling price and to other operating departments at accounting prices, subject to periodic adjustment, which were usually below market price. The outcome was an accounting system which produced profit or loss measures for each of the operating departments which interfaced either partly (collieries producing coal and furnaces producing pig iron) or wholly (foundry producing castings) with the market. The costs incurred by the ironstone pits were re-charged monthly to the ironstone stock account, while the cost of coal transferred to the coke ovens was, in turn, re-charged monthly to the furnaces accounts and the foundry account based on their respective usage. The ironstone stock and limestone stock were each recharged to the furnaces at accounting prices, again subject to periodic adjustment. In these cases, however, it seems that the transfer prices were designed to recover the cost with any under or over-recovery, so far as we can judge, affecting the valuation of closing stock which was inserted as the balancing figure.

Each of the ledger accounts contains figures for physical inputs [Figure 1, notes 1 and 2], while each of the stock accounts also contains figures for physical outputs [Figure 1, note 2]. The reconciliation of physical quantities helped to prove the completeness of the record,[10] identified deficiencies which could be judged acceptable or otherwise, and provided the data which

[10] The exception is in the case of the coke ovens where the actual coke produced weighed substantially less than the coal consumed. For example, the charge to the furnaces for November 1848 shows that 549 tons 19 cwts of coal produced 329 tons 19 cwts 1 quarter of coke. These figures are closely in line with the expected input-output ratio of 60% [Gibson, 1922, p. 77], and we speculate that the numbers generated by the accounting system were compared with this kind of yardstick.

we imagine were used to calculate yields.[11] The continuity in the accounting system over time is worth noting. Between 1690-1783, the outputs of operating departments which interfaced partly with the market were also valued at accounting prices (at that time closer to market price than seems to have been the case between 1838-41), while other transfers, such as ironstone (purchased) and charcoal (produced), were made at cost [Edwards and Boyns, 1992, pp. 160-3]. Table 1[12] lists departmental results achieved at the main profit centers, together with those of the farm, brickyard, lime kiln, and on the meat account.

TABLE 1

Balances of profit and (loss) extracted from private ledger 1838-41.

	April1838/ March 1839	April 1839/ March 1840	April 1840/ March 1841	April 1841/ December 1841
	£	£	£	£
Pig iron	4,893. 9. 8	3,669.15. 5	3,888. 5. 9	643.11. 2
Castings	3,368. 7.10	2,676. 9. 1	454.16. 8	(50. 5. 8)
Collieries				
Hollingwood	1,676. 1. 8	1,577.19. 1	836. 5. 1	62.17. 3
Norbriggs	10.10.10	(206. 2. 4)	*	*
Staveley	751.13. 4	550.12. 5	(121. 8.11)	(139. 3. 1)
Norbriggs New		(146. 1. 5)	(173.19.11)	196. 18. 6
Other				
Farm	(138.19. 4)	(131. 4. 6)	(181. 5. 4)	*
Meat account	122. 4. 3	(10. 8. 3)	*	*
Brickyard	**	20.19. 0	*	*
Lime kiln	**	43.12. 0	*	*

* Ledger accounts not written up for these years.
** Ledger accounts not balanced this year

Source: Private ledger, 1838-41 [D3808].

[11] We have evidence to show that they were made in earlier times at Staveley [Edwards and Boyns, 1992, pp. 166-7] and also later (see below).

[12] The contents of Table 1 reflect the fact that not all the ledger accounts were written up and/or balanced between 1838-41, with the situation worsening towards the end of George's proprietorship. Elsewhere in the ledger we find material amounts of expenditure on fixed assets recorded in accounts which were not balanced until the ledger was closed. For example, there is a Staveley New Colliery Account and a New Furnace Account which, respectively, show accumulated debit balances of £1,729. 17. 7 and £1,068. 16. 8. [D3808, Private Ledger, 1838-41]. These omissions are suggestive of the fact that neither a trial balance was extracted nor final accounts prepared for the years 1838-41.

We can therefore conclude that the ledger provided a *fully* integrated[13] record of financial and costing information. At Staveley, the recognition of differential roles for cost and financial records was yet to arrive. The system of double entry bookkeeping had been modified and extended to meet changing business requirements, and we can conclude that the ledger remained the center-piece of the accounting system that could be directly consulted for both the financial and physical data required to inform assessments of the firm's profits, performance and financial position.

1841-63: Staveley Works — Richard Barrow, Sole Proprietor

Following a successful re-negotiation of the lease[14] in 1841, George transferred control of the Staveley Works to his younger brother, Richard, who had been a "successful merchant in the China trade [and] who made a second career in coal and iron, using his mercantile fortune to exploit the potential of railway development" [Chapman, 1985, p. 123].

For this period the series of private ledgers are supported by journals and cash books. There is also a Capital Account Book, 1841-65 and a Balance Sheet Book, 1841-63 [D3808] which contain final accounts and related working papers. The system of double entry bookkeeping appears to have been the same as before; certainly the private ledgers were maintained on broadly the same basis. However, modifications and improvements were made from time to time in the system of record keeping. Also, for this period, there has survived data generated outside the ledger suitable for the purpose of assessing performance.

1841 innovations: Following the change in ownership, certain alterations were immediately made to the system of record keeping, principal among which was that limestone stock[15] and the ironstone pits each became profit centers [D3808, Private Led-

[13] Much of the discussion of the integration of cost and financial accounting systems, beginning in the 1890s [e.g., Mann, 1891, pp. 631-2], focuses on the need to reconcile, periodically, separate systems, or to ensure their correspondence through the use of control accounts. The Staveley archive draws our attention to the possibility that, in certain industries at least, a single set of books was initially used to meet differential information requirements.

[14] The property belonged to the Duke of Devonshire.

[15] It is possible that the balancing amounts (credit and debit) were under or over-recoveries of cost rather than profits or losses, but this seems unlikely in view of the magnitudes of the amounts involved.

ger, 1841-47]. A further refinement to departmental profit measurement resulted from the decision to re-charge the furnace and credit the foundry "for blast," with the amount put at £100 for 1844.

The survival of journals for the period post-1841 enables us to examine more carefully the transfer prices used at Staveley.[16] For example:

* Coal: Journal entries for November 1848 [D3808, Journal, 1847-49, fo. 121] show that credit sales and "ready money" sales of *hard coal* were each made at 6s. for larger quantities and 7s. for smaller quantities. This type of coal was re-charged to the "railway sales account" (a new profit center[17]) and the furnaces at 5s. *Soft coal* was charged to the railway sales account and the foundry at 4s., and this amount also obtained for cash and credit sales, although 5s. was received for one small quantity of credit sales. Cobbles were charged at 4s. to the new furnace and the railway sales account, but produced 5s. from cash and credit sales. Slack was charged at 1s. to the new and old furnaces, but realized 2s. in cash and credit sales.
* Pig iron stock: Journal entries for January 1848 [D3808, Journal, 1847-49, fo. 36] show pig iron stock charged to the foundry at £4 per ton while fetching £5. 15. 0 per ton in the market. In April 1849 [fos. 166 & 171], the transfer price was £3. 10. 0 at a time when the Barrow could get £5. 10. 0 for sales to customers.

We can therefore see that the transfer prices for coal and iron were, at this stage, significantly below market price. It therefore remains a matter of conjecture whether this discount was designed to reflect the fact that a company (buying in bulk) could purchase coal and iron at much less than it could sell them, or whether management made a conscious decision to

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[16] An examination of the accounting records of ten coal, iron and steel producers in the late nineteenth century has shown them all to employ systems of transfer pricing though with considerable variety in the methods used to make the calculations. It does not seem to have been a matter which received much attention in the early literature, and the first publication we are aware of which deals specifically with this topic is Brady [1930].

[17] We surmise that this term describes coal transferred to customers by rail rather than used at the works or sold locally. This profit center was discontinued in the 1860s when the entire coal profits came to be reported under the names of the separate collieries.

subsidize furnace production (where coal was the major input), foundry production (coal and pig iron) and railway sales (coal).

1847 innovations: The first set of *final* accounts for the new firm was made up to June 30, 1847 [D3808, Balance Sheet Book, 1841-63] six years after the commencement of Richard Barrow's stewardship. The accounts comprise a balance sheet setting out the financial position at that date and a "Statement of Profit and Loss" covering *each* of the six years since formation. The first balance sheet shows Richard Barrow's capital investment at £116,297. The profit and loss account was produced in what was at this time a familiar format in the iron industry. It lists profits or losses arising at each profit center which included, for 1847, five collieries, several ironstone pits, several coke ovens, two foundries; two furnaces, the farm, a brickyard and railway coal sales. The final accounts did not reveal the calculation (costs and revenues) of departmental profits and losses and it was therefore necessary to refer to the ledger for this information.

An interesting feature of these accounts is the computation of charges for depreciation and imputed interest on the capital invested in fixed assets used by each profit center.[18] These were then deducted from the balances for each profit center (profit or loss) extracted from the ledger, and the outcome was a series of departmental results which take account of both the decline in value of fixed assets and the opportunity cost to Barrow of investing in the Staveley enterprize.[19] The depreciation rates range from 5%-10% on individual assets, which is probably explicable in terms of differential estimates of useful life. The imputed rates of interest varied from 3.5%-5%. These were roughly in line with central government interest rates[20] though we are unable to explain why different rates were used for different assets.[21]

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[18] The detailed calculations were set out in the working papers under the heading "Statement of Capital, Interest and Depreciation Accounts" [D3808, Balance Sheet Book, 1841-63].

[19] The inclusion of an interest charge when appraising capital investment proposals was quite common at this time but the imputation of interest in post-fact accounts was rare [Edwards, 1989, p. 312].

[20] The yield on government consolidated stock was 3.4% in 1847 and the bank rate 5% at the end of the year.

[21] The credit entries for accumulated profit, accumulated depreciation and interest charged to date were, in the balance sheet, added to the figure for Barrow's original capital investment. Also noteworthy is the use of the term "realised" profit for the purpose of describing the figure for profit transferred

1856 innovations: The business was expanded to a significant extent during the 1850s as a result of opening up the Speedwell and Springwell Collieries. The surviving records show that a number of important changes were made at this stage to the accounting system.

Using the accounts for 1860 for illustration purposes [D3808, Balance Sheet Book, 1841-63], we find that the main profit centers consisted of two ironstone pits, three collieries, the pig iron department, the castings department, and the railway coal sales [Table 2]. The entire output of the two ironstone pits, 26,745 tons, was consumed in the production of pig iron. The total output of the three collieries amounted to 298,816 tons, of which 29,763 tons was consumed in pig iron production and 4,089 tons by the castings department. The balance was available for sale. The entire output of the pig iron department, 12,118 tons, was transferred to the castings department.

TABLE 2

Output, costs, revenues and profits, year to June 30 1860

Operating Departments	Output	<——Per Ton Statistics——				>
		Cost	Receipts	Profit	Establishment	Net Profit
Coal	**tons**	**s. d**	**s. d**	**s. d**	**d**	**s. d**
Victoria	119,708	4s. 5¼	5s.11½	1s.6¼	8¼	10
Speedwell	68,391	5s. 7¼	5s. 5¾	(1½)	8¼	(9¾)
Springwell	110,717	3s.10¼	5s. 5¼	1s.7	8¼	10¾
	298,816					
Ironstone						
Staveley	15,778	13s.4¼				
Hady	10,967	15s.9½				
	26,745					
Pig Iron	12,118	64s.7¼	62s			2s.7¼
Castings	16,118	99s.5¾	123s.11½	24s.5¾	4s.0	20s.5¾
Railway Coal Sales	337,140					8½

Notes: 'Profit' figure is equivalent to contribution.
For 'railway coal sales', only figures for total output and net profit per ton are given.

Source: Balance Sheet Book, 1841-63 [D3808].

annually to the balance sheet, while a memorandum entry at the foot of the general profit and loss account *adds back* the charges for interest and depreciation to "realised" profit to give a figure captioned "total" profit.

In 1860, the accounting prices used to track transfers of goods between departments were as follows: the pig iron department was charged at the rate of 6s per ton for hard coal and 5s per ton for cobbles, while the castings department was charged at 5s per ton for coal, presumably of a different type from that used in the iron department. The entire output of the pig iron department was priced at 62s per ton, which we know was the prevailing market price as the castings account shows that an additional 5,120 tons of iron were purchased from outside at this figure. The figure for revenue in the colliery accounts is described as "sales and consumption," indicating the dual destination of the coal for use within the company and transfer to the "railway coal sales" account. Coke was charged to the castings department at 21s per ton, which may have been the average cost of production in view of the very small balances transferred from the coke account to the general profit and loss account at the end of the accounting period.

TABLE 3:

Apportionment of Establishment Charges 1860

Establishment charge	Proportion for collieries			Proportion for castings			Proportion for rail coal a/c			Total		
	£	s	d	£	s	d	£	s	d	£	s	d
Railway wagon repairs				671	2	2	3,020	4	3	3,691	6	5
Salaries	3,090	9	0	687	19	6				3,778	8	6
Railway repairs	1,545	4	6	340	4	1				1,885	8	7
Loco. repairs	2,683	1	5	591	15	8				3,274	17	1
Rates and taxes	1,348	11	2	301	19	8				1,650	10	10
Books, stationery stamps etc	224	15	3	41	16	7				266	11	10
Manufactory	814	15	1	176	14	9				991	9	10
Gas Works	365	4	8	87	3	8				452	8	4
Law expenses	618	15	1	179	1	8				797	16	9
Schools	126	8	4	31	4	1				157	12	5
Donations	168	11	4	30	16	8				199	8	0
Cart Roads	14	0	11	4	4	10				18	5	9
Water Works	421	8	4	92	18	0				514	6	4
	£11,421	5	1	3,237	1	4	3,020	4	3	17,678	10	8

Source: Balance Sheet Book, 1841-63 [D3808].

The post-1856 accounting system so far described was much the same as its predecessor except that the transfer prices were closer to market than had been the case between 1838-47. It also contains four important innovations. The first concerns the treatment of joint costs. A number of entries for overheads, which had previously been debited to the general profit and loss account for the entire business and not traced to individual profit centers, were now entered on a separate schedule headed "Establishment Charges."[22] Table 3 shows that the establishment charges (which cover some overheads of a general character as well as those clearly associated with production) were then allocated between the "proportion for collieries" and "proportion for castings" (foundries); i. e., nothing was charged to the ironstone pits whose entire output, at this time, was transferred to the pig iron department (furnaces) or to the pig iron department whose entire output was transferred to the castings department (foundries) [see Table 2]. The method of apportionment between collieries and castings is not clear and varies from 3.5:1 to 5.6:1 for individual items.

[22] Interestingly, some of these entries *previously* appeared in the profit and loss account as credit as well as debit entries, indicating that at least some of the activities measured were treated as profit centers themselves, with production profit centers re-charged for the services they received.

TABLE 4

Cost of getting coal

	Half year ending June 1856							
	Staveley		**Hollingwood**		**Victoria**		**Springwell**	
	tons 44846		**tons 31586**		**tons 9918**		**tons 26973**	
Wages, viz								
Bank								
Carpenters, smiths etc	1½		1¼		2¼		2¼	
Carters, labourers	½		1¼		¾		2¾	
Enginemen, firemen	½		¾		2¼		¾	
Hanging on, bank & weighing	3¼		3½		4		3	
Leading & stacking	2½	8¼	5½	1/0¼	7	1/4¼	8½	1/5¼
Underground								
Getting, including head in stalls	2/1		2/5½		3/-		2/0¼	
Putting	-		-		-		5¼	
Heading	1		4¾		-		7¾	
Horsekeepers & horse drivers	1¼		1¼		2½		3¼	
Engine plane	2		3¼		-		-	
Switchkeepers & incline	1¼		2½		5		1¼	
Ventilators, airways furnace etc	1		2¾		4½		2¾	
New roads, airways	1		8¾		-		6	
Road repairs, road & nightmen	1¾		3½		8¼		6½	
Overmen, foremen & deputies	½	2/10¾	1	4/9¼	1	4/9¼	1¾	4/11¼
Total wages		3/7		5/9½		6/1½		6/4½
Materials & Wages, viz								
Pit waggons & repairs	2¼		2¼		2¼		2¼	
Pit timber	1½		2½		8¼		5	
Metal punchions	¼		2¼		-		1¾	
Stat. eng: & pump repairs: & pumps	2		2		2		2	
Stores, oil, ropes nails, candles etc	2½		7		4½		5½	
Pit horses & horsekeeping	2¼		5¼		8¾		6½	
Pit rails	¼		3½		¾		2½	
Wrought up iron	¼		1½		1		1½	
Castings	¼		½		½		¾	
Carting	-		-		-		-	
Rent of land & surface damages	¼		¼		¼		¼	
N.Marriott's men, stone, bricks etc	¼	1/-	4¼	2/7¼	1¼	2/5½	4	2/8

TABLE 4

Cost of getting coal (Continued)

Proportion of Establishment Charges								
Railway Wagon Repairs	2¼		2¼		2¼		2¼	
Supers' & clerk's salaries	2½		2½		2½		2½	
Railway repairs	1¾		1¾		1¾		1¾	
Locomotive department	2		2		2		2	
Rates & taxes	¾		¾		¾		¾	
Team Labour & horse-keeping	½		½		½		½	
Books stationery, stamps etc	½		½		½		½	
Manufactory repairs of machinery etc	½		½		½		½	
Gas Works, coal & wages	¼		¼		¼		¼	
Law expenses	½		½		½		½	
Stores, undivided balance of account	¼		¼		¼		¼	
Hollingwood boat level	¼		¼		¼		¼	
Donations	-		-		-		-	
Schools	-	1/-	-	1/-	-	1/-	-	1/-
Royalty		5		2¼		3¾		2¼
Current Cost		6/-		9/7		9/10¾		10/2¾
Interest on capital				9½		1/8½		7
Depreciation of capital		2		1/7		3/5¼		½
Total Cost including interest and depreciation		6/2		11/11½		15/0½		11/11¾

Source: Foundry Statements and Returns Book, 1856-79 [D3808]

Second, the journal and the ledger henceforth contain much less detail than was previously the case [D3808, Private Ledger, 1856-63; Journal, 1856-59]. The ledger accounts contain no physical quantities and, in the main, transfers between departments were made just once a year.[23] Therefore, whereas prior to 1856 it was possible to find out a great deal about business operations from a perusal of the ledger, the informational content is much reduced thereafter.

[23] For example, in 1860 there was a single transfer from foundries to castings on June 30 of £25,317. 12. 11 [D3808, Private Ledger, 1856-63].

The third important change was the introduction of the Foundry Statements and Returns Book [D3808] which ran through from 1856 to 1879. This document contains the physical data previously available in the ledger, and also a significant amount of new material including comparative statements, for similar activities and/or consecutive time periods, usually prepared on a half-yearly basis. The tabular presentation used is illustrated in Table 4 which sets out the cost of getting coal at four of the company's mines in the first half of 1856. It provides cost per ton statistics for each item of input together with subtotals for "Bank Wages," "Underground Wages," "Materials & Wages," and the "Proportion of Establishment Charges". This tabular format was also used for the purpose of summarizing the overall results of individual departments [see Table 2]. From 1856, the annual accounts also contain, for each department, full details of costs and revenues. It seems likely that average unit cost figures for production inputs contained in the Foundry Statements and Returns Book were prepared by dividing the total cost of each item appearing in the ledger and dividing them by separately recorded totals for physical output. The emphasis on physical as well as financial measures is implicit in the range of additional statements[24] generated at Staveley on a routine six-monthly basis.[25]

The Foundry Statements and Returns Book, together with the analyzed final accounts, therefore provide a clear picture of both the nature of business operations and the financial interpretation of these activities suitable for the purpose of identifying waste and inefficiency (by comparing performance over time), assessing the comparative performance of different departments producing similar products, and measuring the contribution of each department to overall profit.

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[24] These were: the get, sales and consumption of coal; cost of getting ironstone; cost of calcining ironstone; loss of weight on calcining ironstone; sales and consumption of coke; cost of making coke; cost of making pig iron; average cost of all descriptions of castings.

[25] Examples of *ad hoc* statements prepared to keep management informed of financial developments include: "Cost of the Construction of Lady View Engine" [fo. 23]; "Cost of Making Brasses for Railway Wagons, Engine uses [1856-64]" [fo. 193]; "Cost of Horsekeeping and Cart Repairs [1856-64]" [fo. 194]; "Summary of Expenditure on New Works from July 1st 1863 to June 30th 1876" [fos. 149-50]; "Statement of Capital [expenditure] and Depreciation to 30th June 1876 [1869-1876]" [fo. 151]; "Statement of Amounts set aside Yearly for Depreciation [1869-76]" [fo. 152].

The fourth and final change involved the removal of depreciation and interest charges from the final accounts. However, these items continued to be included in the calculations of cost contained in the Foundry Statements and Returns Book [Table 4]. Table 4 shows that the term "Current cost" was used to describe the aggregate of the following costs, using coal for illustration purposes — wages, materials, establishment charges and royalty. The term "Total Cost" was used to describe current cost plus depreciation and imputed interest on capital employed. We can therefore see that information was made available which would have enabled Barrow to assess whether the total cost of individual operations was covered by selling price.

1863-1900: The Staveley Coal & Iron Company, Ltd

Richard Barrow, having significantly extended the coal and iron making operations, in old age with no heirs, sold the business to a group of Manchester businessmen headed by Henry Davis Pochin. The Staveley Coal & Iron Company Ltd was incorporated to acquire the assets of Barrow's firm with effect from July 1, 1863.[26] The well-known Victorian accountants David Chadwick [Cottrell, 1984] and James Edward Coleman [Jones, 1988, p. 214] were involved in the promotion of the company and in entering the originating transactions in the books of account. The firm, Chadwick, Collier & Co., was appointed auditor and Richard Barrow stayed on as chairman of the new company until his death in 1865.

The company was reasonably profitable during the first nine years of operations, very profitable between 1872-75, but profits then declined and were poor for a long period extending from 1878 to 1889. The early 1890s were again highly profitable, the mid-1890s a period of depression, followed by recovery which led to high profits by the turn of the century.

There was a considerable expansion of activities in the years

[26] The purchase price was fixed at £491,824, satisfied by the issue of share capital amounting to £100,000 and the balance by installments, including interest, over the next six years. In line with the usual practice in Britain, during the late nineteenth century, industrial capital (in this case £285,000) was raised locally, mainly from the cities of Sheffield and Manchester. The new company was quoted on the Sheffield Stock Exchange from 1873, later also on the Manchester and Liverpool exchanges, and from 1899 on the London Stock Exchange.

up to the end of the century,[27] but the broad organization of business operations and the way these were reflected in the accounting system remained unchanged. Indeed, certain books, including the Foundry Statements and Returns Book 1856-1879, were in use for the period spanning incorporation.[28] The company's cost accounting practices continued to exhibit strong evidence of continuity, with changes periodically made presumably in an endeavor to ensure that the system matched perceived business needs.

One important modification was the re-introduction of a depreciation charge to the annual accounts which were now also prepared for external use, with the maintenance of capital being a major preoccupation of the directors throughout the remaining period covered by this paper [Edwards and Boyns, 1994, pp. 1163-67]. However, the practice of making notional charges for interest and depreciation at *cost and profit center level* was discontinued. The analysis of the establishment charges between departments interfacing wholly or partly with the market continued to be carefully carried out, with the basis of cost apportionment now clearer.

In 1870, for example [D3808, Balance Sheet Book, 1863-93], most establishment charges (salaries, books, stationery and stamps, law expenses, incidental expenses — save for a small amount charged directly to North Staveley Colliery — and travelling expenses) were apportioned between Staveley Collieries, North Staveley Colliery, and the Castings department on a per ton basis.[29] The tonnages were calculated as follows: for the

[27] Between 1860 (figures in parenthesis) and 1900, production (tons, round thousand) increased as follows: limestone 43,000 (7,000); coal 1,800,000 (299,000), pig iron 132,000 (12,000); and castings 69,000 (16,000) [Staveley Works balance sheet books 1841/2-1862/3; Staveley Coal & Iron Company Ltd.: detailed balance sheets 1893/4-1922/23].

[28] A minor change was to allocate the "establishment charges" to profit centers within the ledger so that the balance in the ledger for, say, Hollingwood and New Hollingwood collieries was after deducting establishment charges which were, for example, £12,144. 16. 5 in 1870.

[29] This basis was also used for railway repairs, schools, donations, water works, and workmen's hall, although in these cases the apportionment was only among the Staveley Collieries and the Castings department, implying that the North Staveley Colliery did not benefit from any of these expenditures. Rates and taxes for the North Staveley Collieries, which were presumably in a geographically separate location, were separately identified, whereas the amount for the Staveley Collieries and castings was again apportioned between each pit on a per ton basis. The costs of the manufactory and gasworks were apportioned

collieries — their output; for castings, — the amount of ironstone, limestone and sand used to produce pig iron and castings, plus the output of the pig iron and castings departments. The logic underlying these apportionments is that establishment costs were a function of throughput and that inputs and outputs should be counted in only one department, so that all coal output was counted only in the collieries.

The approach remained broadly the same at the next decenniel date (1880) but there were some significant modifications. The total amount allocated to the castings and pig iron departments, on the basis of their combined throughput, was then split between those two departments in the ratio 2:1.[30] This change was consistent with a desire to measure the profitability of departments which interfaced at least partly with the market. The decision was made in the early 1870s to expand pig iron production by the construction of additional furnaces (see below) and, whereas pig iron production was insufficient to meet the foundries' requirements in 1870, ten years later nearly half of the pig iron output of 61,526 tons was available for sale.[31] The allocation of the total castings charge between the two foundries and the allocation of the total collieries charge between the ten collieries and two coke ovens was then made on a per ton basis.[32]

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between the Staveley Collieries and the Castings department, respectively, in the ratios 1:2 and 1:1. Because the term "Staveley Collieries" covered six separate pits, the total allocation was then shared among them on a per ton basis.

[30] Working papers show that the tonnage figure for castings, for the purpose of the above allocation, was built up as follows: pig iron department — quantity of ironstone and limestone used plus pig iron sold; castings department — pig iron and sand used and castings made. This continues the logic of charging flows to only one department, with pig iron used to produce castings counted only in the latter department. Why these figures were then combined and the allocation instead made between castings and pig iron on a 2:1 basis is not clear, but it certainly affected the allocation as ironstone used was comfortably the largest of the relevant throughputs.

[31] Other changes in the apportionment of establishment charges were as follows: rates and taxes were identified with each major center of activity; the cost of the manufactury was charged entirely to castings, save what appear to be notional charges of £200 and £50 respectively to collieries and pig iron; one half of the gas works expense was charged to castings — the basis for allocating the other half between collieries and pig iron is impossible to discern as is the method of splitting law expenses among all three departments.

[32] It is interesting to note that, despite the emphasis on producing costing data, there does not seem to have been quite so much concern with its reliability. An apparent weakness was the inclusion in the department accounts of large

It is difficult to find any rational explanation for the allocation of establishment costs only to departments interfacing with the market. In circumstances where transfers were made at a figure designed to reflect market price, one would expect cost to be allocated between all operating activities in order to discover whether total departmental cost was covered by departmental revenue. It might be argued that establishment costs were not charged to departments transferring all their output internally on the grounds that such costs were unavoidable, and the essential question was whether production made a contribution to overall company profits. A problem with this line of argument, however, is that not all fixed costs were included under the heading of establishment charges. It might also be pointed out that the method adopted would have had greater logic if all transfers were made at cost; in such circumstances there would be little point in allocating to departments expenditure which would then be transferred, in total, to the next department down the line.

The method used to value interdepartmental transfers became the subject of the board's attention at a meeting held on November 22, 1875 [D3808, Minute Book, 1871-75]. A question arose as to the price charged for ironstone to the furnaces, and the secretary confirmed that it was charged at cost price. Following a discussion of which the details were not minuted, "it was resolved that, in future, the furnace should be debited at the market price so as to show if there was a gain or loss by the undertaking." At the next monthly board meeting, held on December 20, 1875, it was further resolved *"that* the system of book-keeping laid down by the board at its last meeting in respect of the Frodingham Glebe ironstone be applied to lime, sand, bricks, and all other materials supplied from one department of the company to another department as far as practicable."[33]

We might assume that the outcome was the production of more relevant data for assessment and decision making pur-

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write-off's of capital expenditure from 1885 to 1900 amounting in total to £246,380. However, a record was maintained of such amounts written off, and it would presumably have been possible to interpret the calculations of departmental profit and unit cost in the light of this knowledge.

[33] We saw, above, that the lime kiln and the brickyard had previoulsy been treated as separate profit centers in the period 1838-41.

poses. And we might surmise that the downturn in profitability, in 1875, following four very good years focused the minds of management more sharply on the need for meaningful accounting information. The report made by the directors to the shareholders at the end of the year contains the following passage of relevance in this context:

> the extraordinary inflation of the Coal and Iron trades must inevitably lead to very great competition in the future, and there is not the slightest doubt that the development of the iron and coal trades is now far in excess of the requirements of the trade of the country.[34]

The analysis considered so far cover periods of six months or a year. Evidence survives for the late-nineteenth century of attempts also made to monitor performance on a weekly or monthly basis.[35] Weekly Cost Books detailing operations of individual furnaces cover discontinuous time periods between 1885-1933; the first was for the period November 21, 1885 to January 3, 1891 [D1185]. There is a weekly sheet for each of the three furnaces then in blast which contains unit cost data broadly similar to that appearing in the Foundry Statements and Returns Book.[36] In addition, the weekly sheet shows yield data for individual inputs and a column for "remarks" which provided a record of events to help explain increases/decreases in cost/profit. For example, the entry for March 27, 1886 reads: "No 2 furnace stood 124 hours for repairs and alterations to throat. Blast off 5 am Monday March 22nd. Blast on 9 am Saturday March 27th."

Also relevant for the purpose of monitoring performance was the analysis book [Sheffield City Library, SIR31] kept by the company's accountant, Robinson. It contains a miscellaneous range of calculations, records and analyzes for 1879 onwards, including the following items:

* Calculations of the comparative make of pig iron taking four months of 1879 and five months for each of the following two

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[34] Shareholders were also warned that "profits obtained during the past year are due, in a great measure, to the very favourable contracts which remained unexecuted at the commencement of the financial year."

[35] It is of course a possibility that financial statements covering shorter periods than six months were prepared before 1879, but that they have not survived.

[36] One difference was the inclusion of a single round sum for establishment charges which began at £90 per week and was increased to £140 in June 1886 when the number of furnaces in blast was reduced from three to two.

years. In the first year there were five furnaces in operation, in 1880 six furnaces, and in the following two years seven furnaces. Calculations were made of the average make per furnace per month and per day, presumably to enable valid comparisons to be made and conclusions drawn.

* A comparison, based on a month in 1883, of the cost of coke used to smelt a ton of pig iron. The results were Ireland coke, 2s 6.91d; Wells and Company's coke, 2s 1.53d and Springwell coke, 1s 11.61d. The conclusion reached was that Wells was 19¾% better than Ireland, Springwell 25¾% better than Ireland and 7⅓% better than Wells.
* An analysis of activity at the new foundry where pipes and castings were manufactured. Statements were prepared for four or five-week periods, commencing the four weeks ending April 25, 1896 and continuing until 1900. They show the tonnage of pipes and castings manufactured, and cost per ton in respect of the following expenses: coal and iron, establishment charges, haulage, wages, fuel, land and manure, carbon, timber, repair, sundries, stores, wrought iron, steel and brass. There then follows a statement which shows for various employees, the tonnage manufactured, total cost and cost per ton. At the bottom of the sheet total and unit cost was compared with sales figures to give a profit figure. There is a similar analysis for the old foundry.

ACCOUNTING DATA AND STRATEGIC DECISION MAKING — 1863-1900

During the period 1863-1900, there is much evidence of the use of *ad hoc* accounting reports to help tackle pressing business problems. It is instructional to refer to some of these reports, as they provide an indication of the topics considered deserving of top management attention, of the use made of accounting data, and of strategic decisions reached which influenced the long-term developments at Staveley.

Soon after the Staveley Coal & Iron Company Ltd was incorporated, its board of directors realized that expenditure was needed both to improve the infrastructure of the company and to ensure its longer-term viability and position in the industry. Planning was difficult in the nineteenth century iron and coal industries, with demand fluctuating considerably in response to changing business conditions. It was therefore important to structure the business so as to achieve maximum production flexibility while, at the same time, balancing the needs and capa-

bilities of the various departments. In this context, there was a need to operate a sufficient number of furnaces to be able to match those in blast with current requirements, and to have available a guaranteed supply of essential materials — coal, ironstone and coke.

The second directors' report, for the year to June 30, 1865, indicates that the developmental process was already underway with the purchase of the North Staveley Collieries at Aston for £25,353, an acquisition which proved of inestimable value to the company. A report from Markham to the board, dated December 16, 1867, contained an estimate of the additional cost that would be required to increase the production of coal by 25% from the present level of 800,000 tons per annum. As the existing collieries were working at or near full capacity, Markham advocated three initiatives designed to achieve the desired objective: the sinking of an additional pit at Hollingwood; increased production at North Staveley; and a new sinking at Waterloo to be worked in connection with the Springwell Colliery. Markham then turned to an examination of the resource implications of any decision to expand production. The analysis identifies, in detail, the cost of sinking the new pit and further essential, related expenditure on colliers' cottages (it being increasingly difficult to get colliers to travel from urban centers where jobs were becoming more readily available) and railway wagons. The estimated financial requirements were £100,000, made up of 200 cottages at £90, 600 railway wagons at £70, and the new sinking at £40,000 [Report, December 16, 1867, p. 7].

A further important strategic decision, reported by the directors in 1870, was to build two additional furnaces, making six in all (further increased to eight by 1874) in order to reduce the amount of pig iron which, as noted above, needed to be purchased from outside at this time. We can infer the use of routinely generated internal costings to help reach this decision from the directors' observation that the company "can manufacture pig iron as cheap as other firms . . . [and] . . . are of opinion that an increased production of pig iron will be attended with profitable results" [Directors' Report, 1870]. Markham's knowledge of relative costs is also demonstrated by his claim that, in 1874, the company could make pig iron as cheaply as its north of England competitors [Chapman, 1981, p. 78]. Later, in 1885, Markham maintained that "nearly all Derbyshire furnaces were smelting at a loss and that Staveley was one of the few that could show any kind of profit margin" [Ibid., p. 79].

It is interesting to speculate on the extent to which cost and profit data for individual companies were readily available. It is difficult to believe that firms were comfortable with the idea of such information being made available to competitors. But iron and coal were close-knit industries at this time, with the same people on the boards of competing concerns (and probably holding significant shareholdings in each of them) and companies using the same business advizers (the services of William Armstrong[37] and Chadwick, for example, were widely sought after). It is therefore likely to have proved difficult to prevent information drift, even when determined efforts were made to prevent this happening. For example, on February 2, 1895 [D3808, Minute Book, 1888-95], the board "resolved that none of the costs of the company to be communicated by any of the officials to anyone without the previous consent of the board."

Capital expenditures, once made, were then carefully monitored. A report from Markham to the board, dated January 20, 1868, re-examines an estimate of £73,000 made on August 27, 1866 to cover a range of expenditure including new pumping engines for the Speedwell and Seymour pits, the development of the North Staveley Collieries, and the Waterloo sinking. The remaining work outstanding, together with revised estimates, indicated further necessary expenditure totaling £60,800 [p. 16]. Markham believed that, although the company had sufficient money to finance operating activities, it would be necessary to provide separately for the above expenditure "which cannot be postponed with advantage" [p. 16]. The directors' minutes for October 19, 1868 [D3808, Minute Book 1866-71] show that expenditure was carefully monitored, with Markham explaining that his January estimate would not be significantly exceeded.[38] There are a number of other references to monitoring the cost of new projects, and the process was formalized by a board minute of November 24, 1891 [D3808, Minute Book 1888-95] by which

[37] Armstrong, an engineering consultant based in Ferry Hill, Durham, was engaged by companies in the north east of England for a variety of business purposes. At Staveley, he was engaged to value the collieries and ironworks at the date of incorporation and to advise, subsequently, on the company's depreciation policy. At Bolckow Vaughan, Armstrong was consulted on a wider range of matters, including cost levels. The arrangement with Armstrong entered into in 1869 is detailed at the directors' meeting held on 21 April [directors' minute book number 2].

[38] The then current position was that £17,170 had been spent and he estimated that £46,250 was required to complete the work.

"The secretary was instructed to keep a book for presentation to the board of all authorised expenditures, the estimated cost and the actual expenditure."

In addition to estimates of the cost of new investments, there is evidence of formal attempts made to evaluate the impact of a *new scheme* on the company's financial position. In his report dated December 16, 1867, for example, Markham informed the board that a new blowing engine was being constructed. His preoccupation with financial stability may be inferred from the use of the payback method of capital investment appraisal to evaluate the financial implications of this project: "Even in the present depressed state of trade I believe the additional furnace that has been put up will save the Company [in] the first year of its working one half of the present outlay of capital that has been incurred" [p. 9]. It appears that the rapid recovery of the investment was possible because the company was able to manufacture iron at a price 10s less than they could buy it outside [Ibid.].

A board minute dated September 21, 1868 [D3808, Minute Book 1866-71] focuses on the financial implications of a proposal to change operating procedures. Under the heading "Blast furnaces gas, reduction in production of iron," Markham reported that workers "have taken gas from two of the furnaces and are burning it under the stoves and three boilers." Further, that results

> so far appear to establish the fact that the production of iron from the furnaces is materially reduced, and that the quantity of coal used in the furnaces has increased. A statement has been prepared showing that the make of the furnaces monthly since number three furnace was blown in, and a note made when the gas was taken off from each of the furnaces and the results appear to be unsatisfactory. The make-up of iron for the past month has been at the rate of £2. 12. 11¼ per ton. The coal and ironstone have both been charged at reduced rates as compared with the corresponding period of last year, consequently the cost compared with the other period has materially increased.
>
> The value of the small coals to the boilers is comparatively small, and the fact that we have made our iron at about 48s per ton with a considerable portion of our own stone, renders it essential that the whole of the question, should be examined with great care.

A further illustration of the use of accounting data for strategic decision making is implicit in the following entry in the directors' minutes under the heading "Blast furnaces." Markham reported on and "referred to the stock of pig iron on hand: owing to the unremunerative prices to be obtained and the decreased demand in the present state of the trade, he considered it advisable to blow some of the furnaces out in preference to increasing the stock, which was chiefly 'forge', as he did not think it would be sold for some time to come owing to the change going on in the trade" [D3808, Minute Book 1866-71, June 23, 1879].

REVIEW OF THE EVIDENCE

The Role of Accounting

Questions which we attempt to explore further here are, who used cost accounting data for decision making, for what purpose, and was it relevant? The dominant personality at Staveley between 1863 and his death in 1888 was Charles Markham. He was recruited by Pochin from the Midland Railway Company where he was one of its senior engineers. As was common in the iron and coal industry, the Managing Director (more often carrying the title General Manager at this time) produced a monthly report for the board. No copies of those prepared at Staveley have survived, and we can only speculate as to their accounting content based on the few references made to Markham's reports in the board minutes.

Of most interest in the present context is that, in response to a request made on February 17, 1868 [D3808, Minute Book 1866-71], Markham presented the board [March 16, 1868] with a statement showing the comparative cost of getting coal, and of the sales and profit for each of the four years ending June 1867. We do not know whether this was a regular occurrence, but lack of board comment on such matters suggests that it was not. We therefore conclude that at Staveley the day-to-day management of the works was the responsibility of Markham and his deputies who headed individual departments.

Turning to decisions of a strategic character, which usually involved financial outlay, we find the board members more heavily involved, although it is doubtful whether they did much more than agree with Markham's conclusions. The archives suggest that cash flow was the principal concern when making strategic decisions, with management possibly convinced that a new

investment would prove profitable provided the current level of efficiency could be maintained for an expanded output. Having negotiated long-term leases at the time of incorporation, there was a determination to make the investment work and, provided financial stability could be maintained, management remained confident that the company could outperform its rivals. The fact that the company was incorporated at what proved to be a low capitalization [Edwards and Boyns, 1994, p.1156] no doubt helped in this direction.

Concerning the nature and purpose of the routinely prepared reports, we find at Staveley between 1838-1900, in common with the position between 1690-1783, the complete integration of the cost and financial records; the use of transfer prices to measure departmental profits; and the use of unit costs, analyzed in detail, for comparative purposes both between activities and over time.[39] This type of information may be compared and contrasted with that found by Johnson [1972] at the Lyman Mills textile company for the 1850s where an integrated cost and financial accounting system was in use, but where it was principally concerned with building up figures for the cost of production. Johnson [1972, p. 474] concluded that such calculations were clearly being prepared for management looking "inwards on the shop, and not outwards on the industry." The basic aim was to control internal plant operations; for example, to gauge the physical productivity of the mill operatives, to assess the impact on operations of changes in plant layout and to control the receipt and use of raw cotton. That is, the emphasis was on cost identification and control.

The cost accounting data at Staveley were adequate to provide an input for these kinds of decisions, but also others. In particular, departmental profit data provided management with the information required to assess the relative profitability of different collieries, furnaces, foundries and ironstone pits; to enable management to discover whether, and the extent to which, total business costs were covered by revenues; to reach closure decisions; and to identify the financial advantage to be gained by squeezing out the middle man.[40] It should also be noted that the detail appearing in the Foundry Statements and

[39] Although there were these broad similarities, the amount of costing data generated increased significantly over time.

[40] The inclusion of depreciation and imputed interest, from time to time, is further evidence of an awareness of the need to cover total costs in the long run.

Returns Book 1856-1879 would have allowed management to examine movements in individual costs. In other words, *total cost per unit* was calculated, but there is no evidence to suggest that management was preoccupied with this single measure as the basis for performance assessment or decision making. Elements of direct cost per ton could be used to monitor efficiency, while the careful observation of movements in fixed establishment costs per ton would presumably underline the advantages of working at full capacity.

The lack of surviving evidence of the use made of routinely prepared costing data is disappointing but, perhaps, unsurprising. The questions which such evidence would have been expected to illuminate; e.g., the degree of waste and inefficiency, were matters principally for the consideration of managers lower down the managerial hierarchy. We might expect that, in circumstances free from any constitutional obligation to retain a formal record of what was said (such as the obligation to record the meetings of boards of directors in robust minute books), communication of information was often by word of mouth or in a written form less likely to have stood the test of time. Nevertheless, we can see from evidence occasionally recorded in the minute books that Markham was fully familiar with the cost of operations both at Staveley and elsewhere.

We are perhaps able to gain further insight into the purpose of Staveley's accounting system from contemporary assessments made by two distinguished scholars. According to Robert Hamilton (1788), Professor of Philosophy in the Marischal College, Aberdeen, "When a person is engaged in several branches of manufacturer, whether on different materials, or on the same materials through several successive stages, he should keep his books in such a manner as to exhibit the gain or loss on each" [quoted in Solomons, 1952, p.6]. While, according to Charles Babbage [1832, p. 203], Lucasian Professor of Mathematics at the University of Cambridge from 1828 to 1839:

> The great competition introduced by machinery, and the application of the principle of the sub-division of labour, render it necessary for each producer to be continually on the watch, to discover improved methods by which the cost of the article he manufacturers may be reduced; and, with this view, it is of great importance to know the precise expense of every process, as well as of the wear and tear of machinery which is due to it . . . One of the first advantages which suggests itself as

> likely to arise from a correct analysis of the expense of the several processes of any manufacture, is the indication which it would furnish of the course in which improvement should be directed.

It is clear that the system at Staveley was capable of satisfying these kinds of priorities fairly well.

The Process of Accounting Innovation

In *The Visible Hand* [1977], Chandler's survey of the extant literature led him to conclude that, Springfield Armory and the railways aside, U.S. accounting systems were little concerned with costing matters until the 1850s when, as noted above, managers at the Lyman Mills pioneered important new developments. We have seen that Hoskin and Macve have since re-examined the significance of developments at the Springfield Armory in the light of "the West Point connection" and concluded that they paved the way for revolutionizing accountability based on the measurement of the productivity of the workforce.

By the 1880s, considerable cost accounting progress had undoubtedly been made in the U.S., and cost sheets prepared for the Carnegie steel company were found to be far more detailed and accurate than the system of cost controls in the leading textile companies and elsewhere [Chandler, 1977, p. 268]. Of relevance for the Hoskin and Macve thesis is the observation made by a contemporary worker at Carnegie that "The men felt and often remarked that the eyes of the company were always on them through the books" [quoted Ibid., p. 268]. But there were other, and wider, applications for the accounting system which, Chandler [Ibid.] judged, included "the evaluation of the performance of departmental managers, foremen, and men"; "to check the quality and mix of raw materials"; "to evaluate improvements in process and in product"; "to make decisions on developing by-products"; to price "nonstandardized items"; and to help decide whether or not to "accept a contract". Our study of the accounting system operated at Staveley shows that, in Britain, costing developments started far earlier and in certain important respects went beyond those revealed by Johnson's [1972] examination of the Lyman Mills records even if, by 1880, they had not achieved the sophistication of data generated at Carnegie. Nevertheless, while the system operated at Staveley from 1690 to 1900 exhibits substantial continuity, it also exhib-

its changes made in response to new business and organizational circumstances.

These findings also require us to modify the interpretation placed on what Solomons [1952, p. 17] has termed "The Costing Renaissance." The starting date of the Staveley records, 1690, predates the first known text on double entry bookkeeping which gives consideration to tracking internal flows of goods [Collins, 1697]. This pioneering text was followed by just a handful of publications [cited in Solomons, 1952, pp. 4-17; Edwards, 1989, pp. 313-14] over a period of almost 200 years which considered the implications of adapting techniques developed for a mercantile economy to industrial needs. Nevertheless, industrial concerns such as Staveley were using costing techniques and developing them as the need arose. Thus Solomons' suggestion that "to a great extent they [the authors cited] were only rediscovering ideas that *were becoming of practical importance for the first time*, but which could certainly have been found, though perhaps in an undeveloped state, in earlier works" [1952, p. 17, emphasis added] needs to be elaborted, since it is becoming increasingly clear that the rediscovery suggested by Solomons was, in fact, *confined to the literature*.

The evolution of Staveley's cost accounting system, commencing seven years before the publication of Collins' text, can be seen as a perfectly natural process which may have been replicated elsewhere in Britain as well as in other countries of the world. In such cases there was a need for neither a "rediscovery" nor a "renaissance" in cost accounting; the managers were convinced of the value of costing information throughout. This demand/response explanation for accounting development is recognized as a driving force also in the U.S., where railway managers were aware of the need for a constant flow of information as a prerequisite for efficient railroad operation. This

> brought a revolution in accounting; more precisely, it contributed substantially to the emergence of accounting out of bookkeeping. The techniques of Italian double-entry bookkeeping generated the data needed, but these data, required in far larger quantities and in more systematic form, were then subjected to types of analysis that were new. In sum, to meet the needs of managing the first modern business enterprise, managers of large American railroads during the 1850's and 1860's invented nearly all the basic techniques of modern accounting [Chandler, 1977, p. 109].

We do not claim that Staveley's system met all the managers' financial information requirements,[41] nor even that it was as good as it should have been. For example, we find no explicit evidence of the employment of standards or "norms". Neither have we been able to tie down the method of overhead apportionment in all cases. However, we do find evidence of an endeavor to establish causal relationships (what are referred to today as "cost drivers"), while the use of "norms" based on trial runs has been discovered elsewhere in far earlier times [Edwards, Hammersley and Newell, 1990], and we might speculate that similar experiments provided yardsticks at Staveley. In other words, the detailed cost and yield calculations may have benefitted from comparisons with norms as well as between time and activity.

The findings from this research go beyond the question of the type of the calculations made and their usefulness for the purpose of decision making. They also suggest the need to re-examine the nature of the development of cost accounting and to incorporate in that re-examination a recognition of the fact that similar explanations may well not apply to developments in both Britain and the United States due, for example, to the differential circumstances of industrial development, particularly the fact that industrialization occurred earlier and at a steadier rate in Britain, and that the labor market possibly exhibited different characteristics in the two countries.

Attention must also be paid to changes in business conditions, and their impact assessed. The circumstances at Staveley over a period in excess of 300 years demonstrate important similarities and dissimilarities. The works comprised an integrated business operation throughout, with ironstone pits, furnaces

[41] The problems that growing industrialization produced for industry were listed by Edwards (1937), including the following which, one imagines, would have worried management at Staveley — the need to control, supervise and pay large numbers of employees; the need for cost and output details relating to various processes as a check on waste and inefficiency; the need to know prime costs so that decisions about price-cutting could be made when demand was slack. Edwards also commented on the importance of interest as an element of total fixed cost with it being estimated that, by about 1833, interest accounted for about one quarter of a cost of bar iron. We might add that management would also have been interested in total costs to assess the extent to which these were covered by prices and to judge the company's ability to survive and prosper in the long run. (This matter did not receive emphasis from Edwards who was a determined advocate of marginal cost and a severe critic of the arbitrary apportionment of overheads.)

and foundries' common features. Important changes occurred over time, however, which included the following: charcoal purchased from outside producers was replaced as a source of fuel by coal supplied from collieries owned by the company; the production of pots and pans for domestic use was replaced by cast iron pipes for a business and municipal market; and the slitting mill used in earlier times to convert bar-iron into nails was closed down. The scale of operations, of course, increased enormously with pig-iron production rising from approximately 500 tons in the 1750s to 132,000 tons in 1900, while coal production increased from zero to 1.8m tons per annum, the bulk of which was sold to contribute the major proportion of the company's reported profit at the later date. Judged against this latter criterion, we can conclude that the accounting system at Staveley displayed a high degree of continuity and, with little evident difficulty, was adapted to meet perceived management requirements in an evolving organizational structure which produced massive growth in the scale and scope of operations and numbers employed.

The Need for Further Research

What is the significance of this study for the present debate concerning the nature of management accounting development? On the whole, we see it as providing greater support for economic rationalist rather than Foucauldian-based explanations. This does not mean that we disagree with conclusions reached concerning the importance of events at West Point and the Springfield Armory for the development of managerialism, nor that "the development of cost and management accounting [in the U.S.A.] might be traced to the influence of the engineering graduates of the military academy at West Point" [Hoskin and Macve, 1988, pp. 37-8].[42] However, we do question whether the case made by Hoskin and Macve is in certain respects overstated, and whether they have underestimated the significance of events elsewhere for the development of management accounting. For example, is there sufficiently strong evidence to justify their claim that the "birth of accounting out of bookkeeping" in terms of the disciplinary effect on workers [1988, p.68] is sustainable? The uses to which accounting information

[42] We have noted in this paper that Britain looked to the U.S.A in 1950 for leadership in the development of management accounting systems.

is put are many and various, including pricing, preparing estimates, measuring the profitability of departments and products, calculating the yield from material inputs, identifying waste and pilferage, assessing labor efficiency and helping management make investment decisions. These seem to go far beyond concerns with "human accountability" [1988, p.37] which is the essence of the Hoskin and Macve thesis.

We have shown that costing information capable of illuminating many of the above management problems was produced at Staveley and, in a few cases, we have been able to cite clear evidence of the way in which it was used in relation thereto. We therefore conclude that Staveley's accounting function, despite the lack of explicit attention to human accountability, comprised a system of management accounting within the definition of that term laid down in the 1950 Productivity Report.[43] Nevertheless, we would agree that the reasons for the apparent failure to impose labor norms and measure deviations therefrom is a matter which requires further investigation since it may possibly be a factor which helps explain Britain's relative economic decline after 1870.[44] Whereas systems of scientific management were adopted rapidly in the United States under the influence of Frederick Taylor and others, it is not until the 1920s that we find evidence of them being introduced in Britain [Littler, 1982] or of any attention being devoted to standard costing in the British literature [Stelling, 1924; Renold, 1927].[45] The existing evidence suggests that, during the period covered by this paper, British management preferred to rely on some combination of subcontracting, piece rates and direct supervision to achieve adequate labor efficiency, and the question of whether British management either considered it desirable or practical to impose disciplinary control through norms is a topic worthy of investigation. At Staveley, concern with waste and efficiency, to the extent that this extended to the performance of labor, appears to have relied on observations of changes in the wages of different categories of labor per unit of output. The extent to which this served as a

[43] Comparable wordings can be found in modern management accounting texts.

[44] Current knowledge on this issue in the British context remains limited. Certainly, it does not seem sufficient to justify Locke's [1979a; 1979b] conclusion that inferior accounting technology was a significant factor explaining Britain's poor relative performance.

[45] Progress was even slower in France with standard costing not receiving widespread adoption until the 1960s.

spur to action is largely hidden from researchers into this archive and must await the discovery of more revealing primary data.

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