

Coals from Newcastle: an evaluation of alternative frameworks for interpreting the development of cost and management accounting in Northeast coal mining during the British Industrial Revolution

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Abstract—How have the power and organisational effects of modern accounting systems developed? What is the appropriate theoretical framework for interpreting that development? Researchers in the ‘Neoclassical’ tradition of ‘economic rationalism’ focus on tracing how efficiently developments in accounting techniques, from the British Industrial Revolution (BIR) to the present, have been engineered to match the demands for new forms of rational economic management of emergent big business, while those adopting a ‘Foucauldian’ approach emphasise how it was that the emergence of new practices and knowledge-based discourses for calculating human performance, and for establishing new forms of human accountability, engendered the creation of the modern kind of business organisations through ‘disciplinary power’. To evaluate the relative merits of these two frameworks, we re-examine the primary archival evidence about managerial practices in the Northeast BIR coal mines. We focus on two unique features—the cadre of professional managers/consultants (the ‘viewers’) and the form of direct labour contract—since comparable features have been held to be significant in the rational economic development of sophisticated cost and management accounting techniques in other industries. We find that, while the records include sophisticated valuations of mines and calculations of technological efficiency, surprisingly absent, as compared with ‘modern’ accounting and managerialism, is any detailed measurement of human performance for setting piece rates and controlling production. Although our particular findings here could be explained within both the ‘Neoclassical’ and ‘Foucauldian’ theoretical frameworks, their consistency with the evidence being obtained from other historical sites further questions the adequacy of ‘economic rationalism’ to explain fully the genesis of modern management and the development of accounting’s modern power.

Keywords: British Industrial Revolution; coal mining; economic rationalism; Foucault; management accounting history

1. Introduction

In attempting to add to our understanding of the power and organisational centrality of modern cost and management accounting, especially in large-scale, increasingly global businesses, at a juncture when accounting's future role is currently being subjected to fundamental questioning, it is necessary to understand the path of its historical development. Accounting historians have recently been debating the relative sophistication and significance of a variety of cost accounting developments in the UK and US during the late 18th and early 19th centuries. The aim of this paper is to contribute to the resolution of the ongoing debate between the 'Neoclassical' (or 'economic rationalist') view and the 'Foucauldian' (or 'disciplinary') view¹ of the nature and significance of these developments, through examining and interpreting the original archives of the coal-mining industry of northeast England, an industry in the vanguard of the British Industrial Revolution (BIR).²

Historians representing the Neoclassical school have, through their archival research, pointed to what they see as growing evidence of the use of accounting for management decision making and for co-ordination of increasingly large-scale industrial enterprises to be found, not only in US private enterprise from the early 19th century (e.g., at the Waltham-Lawrence mills [Tyson, 1998]), but also in major industrial enterprises in Britain from the late 18th century onwards (Boyns and Edwards, 1996, 1997b; Fleischman and Parker, 1997).

They have seen these developments in accounting as rational economic responses to the new

¹ The labelling is Loft's (1995). For further elaboration of the role of the Foucauldian approach in modern management accounting theory, see Bhimani (1999). We do not directly address in this paper the third major theoretical framework of recent accounting history which is grounded in 'labour-process' theory and sees the cost of developments in cost and management accounting in the 19th century as being borne by capitalists solely because of the increased extraction of 'surplus value' from labour effected by ever more systematic labour control. As currently articulated (e.g., Hopper and Armstrong, 1991), the labour-process thesis has focussed primarily on later 19th century US accounting developments. Given that the evidence to be presented in this paper supports the view of other recent work (e.g., Boyns and Edwards, 1996) that a focus on labour control was not a primary characteristic of BIR accounting, we consider that it is more appropriate to evaluate the limitations of the labour-process thesis in papers that primarily address the 19th century US context (e.g., Fleischman and Tyson, 1996; Hoskin and Macve, 2000).

² We embrace a wider chronological perspective than most for the BIR, 1760-1850. However, since early UK coal mining was in the vanguard of contemporary accounting and business practice even before the BIR (Hatcher, 1993: 305), we have drawn additionally on available information from before 1760.

management demands of what was to become big business and as early examples of key advances towards what has become current management accounting practice. Given the general recognition that Britain was the cradle of industrialisation, this line of research has largely developed as a refutation of Pollard's oft-quoted conclusion (1965: 248) that 'the practice of using accounts as direct aids to management was not one of the achievements of the British Industrial Revolution' and also as a recognition of a role for UK accounting in the 'management revolution'.

On the other side, among authors who have adopted what has been labelled a 'Foucauldian' approach, are accounting researchers who have reinforced Chandler's (1977) thesis that the 'management revolution' was primarily a US phenomenon, while reinterpreting the nature and causes of that revolution. In particular, they have identified the conditions for the genesis of modern managerialism with 'disciplinary' developments at the US Armory at Springfield in the 1830s and 1840s, and subsequently on the US railroads (Hoskin and Macve, 1988, 1994; Ezzamel *et al.*, 1990) and have begun to trace how these developments, in turn, were disseminated to other industrial concerns and enabled the growth of US 'big business' (Hoskin and Macve, 2000). The influence of engineers who were educated under a new 'disciplinary'³ regime of writing, examining, and grading—at the US Military Academy at West Point from 1817 onwards—has been seen as the catalyst for an accounting and management revolution characterised by new practices and new knowledge-based discourses for calculating *human* performance and for establishing new forms of *human* accountability, which were later transmitted to the UK, Europe, and beyond. These accounting changes themselves made possible the creation of new kinds of business organisations through their 'disciplinary power' (Hoskin and Macve, 1988), while the indigenous UK developments of this period (and those in other US sites before the new disciplinarity was disseminated there)

are seen as historically interesting mainly for their technical aspects rather than for their significance in creating the modern managerial business corporation.

In an attempt to resolve this Neoclassical/Foucauldian debate, researchers from each of the contending schools have revisited the archives collaboratively. Fleischman *et al.* (1995) studied Boulton & Watt (B&W) and argued that the historical crux, in identifying the discontinuity between early attempts at costings for accountability, decision-making, and control purposes in the new manufacturing industries and what may be seen as the modern managerial approach to accounting, lies in tracing where ‘labour standards’ were first articulated and systematically implemented—when the focus shifted from machines to men. Such standards introduce new practices and a discourse that extends beyond the engineering standards that assess materials and machine efficiency to the establishment of equivalent norms of human performance for modern managerial control.⁴ It is the first crucial step to inventing the modern, increasingly internalised, *human* accountability, not just of labour but also of all organisational participants, including all ranks of management, in a ‘hierarchy of mutual surveillance’ that extends throughout the organisation (Ezzamel *et al.*, 1990).⁵

However, Fleischman *et al.* (1995) found that, although B&W was an engineering firm in the vanguard of BIR accounting practice, the transition from highly sophisticated

³ Disciplinary in this context refers both to the way in which practices (and, in particular, ‘writing, examining, and grading’) constitute the control environment and to their being embedded in an expertise in new forms of knowledge (discourses). For further elaboration, see e.g., Hoskin and Macve (1986, 2000).

⁴ Reference to ‘labour standards’ does not imply the full panoply of labour standard costs and variance analysis that developed as part of the Taylorist efficiency movement of the late 19th/early 20th century (Fleischman *et al.*, 1995: 166-167). Tyson (1998) here missed the point at issue, as discussed in Hoskin and Macve (2000).

⁵ None of this suggests that accounting was not significant before. It clearly was, but nothing like as significant as nowadays in framing the whole discourse of business performance evaluation and therefore action. Neither is it suggested that individuals were not judged before through their accounts. But these were traditionally prominent people, already identified as significant individuals before the accounts were prepared. Such ‘stewardship accounting’ dates from ancient practice, through medieval estate accounting, to modern times. The *new* (19th century) human performance measurement *created* ‘calculable persons’ *within* mass populations (Hoskin and Macve, 1986; Miller and O’Leary, 1987).

It is also not suggested here that researchers in the Neoclassical tradition have not been interested in evidence of accounting for human performance and, in particular, accounting techniques for labour control in manufacturing industry (e.g., Boyns and Edwards, 1997b; Boyns *et al.*, 1997). However, no positive findings have yet emerged for our period, even in large-scale works environments where tasks were repetitive and in some respects more measurable in nature, such as the mid-19th century UK iron and steel industry in South Wales (see, for example, Boyns and Edwards, 1996).

engineering standards for the material components of constructed steam engines to comparable standards of economic performance and labour efficiency was not achieved there despite an initial, impressive attempt around 1802. The famous piece-rate regime for which the firm has become renowned was found to be an isolated episode that did not presage the birth of modern managerialism.⁶ The historical discontinuity, the crux, which introduced systems of control discipline of the kind that, through internalisation of performance norms, nowadays ‘quietly order us about’ (Foucault, quoted in Megill, 1979: 493) was still to occur. Consistent with the other archival evidence from the UK in the early 19th century, which illustrates a growing array of cost and management accounting practices being developed during the BIR which are still utilised today, there generally remained an absence of those practices focussed on calculating human performance, a key characteristic of the discourse of modern management action and control routinely embedded in modern organisational structure and strategy.

In response, Boyns and Edwards (1996, 1997a) have in turn criticised this disciplinary view as being too narrow and as ignoring both the range of objectives and achievements of 19th century British accounting, as well as the important differences in the paths of historical development that were followed in the US, the UK, and elsewhere in Europe. They, as well as others (e.g., Tyson, 1998), have argued that the prime focus of research into the management accounting history of this period should continue to be on investigating the variety of ways in which accounting practices were developed to meet the demands of a range of organisational objectives under varying conditions—practices which are still part of the management accountant’s toolkit today.

As yet, these various lines of research on 19th century archives have left open whether the most significant developments occurred in the UK or the US. And did the changes in human accountability that Fleischman *et al.* (1995) regarded as crucial only emerge

⁶ See Williams (1999) for further discussion of B&W’s use of costs in pricing.

essentially in the late 19th /early 20th century US industrial environment, articulated as part of the emerging discourse of Taylorism (Miller and O’Leary, 1987; cf. Shenhav, 1999; Fleischman, 2000), or can they indeed be identified in earlier US practices, such as those introduced at the Springfield Armory (Ezzamel *et al.*, 1990)?

Both Fleischman *et al.* (1995) and Boyns and Edwards (1996) have called for confirming evidence to support the findings about B&W in a wider application. Boyns and Edwards’ own work on the huge ironworks at Dowlais in South Wales (1996, 1997a) has demonstrated that accounting control over labour was not one of the features of the increasingly sophisticated accounting system there in the mid-19th century. Our research here now applies the approach of Fleischman *et al.* (1995) to examining original archival evidence about mining practices in the Northeast coal mines.

Accounting researchers have recently identified the extractive industries of the late 18th and early 19th centuries, in particular the coal-mining industry in Northeast England, centred on Newcastle upon Tyne, as a hitherto largely neglected source of rich evidence on costing and managerial practices (Oldroyd, 1996, 1999; Fleischman and Parker, 1997; McLean, 1997; Brackenborough *et al.*, 2001). Given the early development of increasingly capital-intensive mining, coupled with coal’s own crucial economic significance in providing the raw energy source for rapid expansion of both industry and transportation during the later stages of the BIR, while the mines retained their historical linkage to the ‘old order’ of the landed estates, it may be tentatively argued that their practices left an enduring cultural legacy which continued strongly to influence the pattern of development of management and accounting practices, not only in the later coal industry but possibly in UK industry more generally (Boyns and Wale, 1996; cf. Napier, 1991).

The mine owners/lessees had continuing traditional requirements for accurate financial accounting of sales output (the vend*)⁷ for the contractual purposes not only of calculating rentals under lease agreements but also of operating their regional cartel. But particular features of the Northeast mines during the BIR, which might suggest the opportunity for the development of cost and management accounting for purposes of labour control, include the role of a newly emergent professional, managerial cadre of mining engineers (the viewers*). The viewers, acting both in direct management capacities and as consulting engineers, made sophisticated geological, engineering, and financial assessments of the profitability of alternative decisions about mine sinkings and operations, based both on their direct underground inspections ('views') of mines and on detailed accounting and statistical records. Moreover, the mines in the Northeast had an almost unique set of labour practices, whereby employment and piece rates for the skilled miners, who were generally directly employed rather than hired by internal subcontractors as in other coal fields, were for a long period set, and guaranteed, at the annual bindings*. These aspects of managerial control and labour relations are comparable to those in other industries that have been argued by economic rationalists (e.g., Johnson and Kaplan, 1987) to be significant economic factors in the rational early development of more sophisticated cost and management accounting systems, focussed on managing labour cost. The Northeast mines in the BIR period therefore provide a particularly interesting test bed for alternative explanations of the factors that have driven, and the consequences that have resulted from, cost and management accounting changes.⁸

This paper interprets the findings of our own review of the Northeast mining archive in a further effort to evaluate the explanatory power of the Neoclassical and Foucauldian frameworks with regard to developments in BIR cost accounting and their linkages to modern

⁷ Coal-mining terminology indicated by an asterisk at first mention is defined in the glossary that appears as Appendix A to this paper.

accounting practices and to modern management in large business organisations. Our examination of the original records shows that detailed accounts were indeed kept of the output and the efficiency of inputs of materials and the use of equipment (horses and engines), and that these data were used for management decision making and control. In this regard, our findings reinforce the growing evidence of the sophistication of BIR cost accounting back to its origins in the early 18th century. But, while labour was clearly seen by the mine owners and their managers as the major element of cost,⁹ to be minimised as far as possible, surprisingly absent (at least to the modern mind¹⁰) is any correspondingly detailed examination of human performance to provide a scientific determination of what should be a ‘fair-day’s pay for a fair-day’s work’ as a basis for setting piece rates, a practice that *has* been identified in particular US contexts, such as the Springfield Armory in the first half of the 19th century (Hoskin and Macve, 1994).

Explanations of the relative lack of sophistication in the accounting for and control of labour productivity, as compared with that for machines and material, can be offered both from a Neoclassical perspective (the economic benefits of greater sophistication at this time and in the circumstances of the mining industry would not have justified the extra costs and the risks of resistance from, often scarce, skilled labour) and from a Foucauldian perspective (the conditions for establishing the necessary practices and engendering the necessary discourse that could observe human productivity as equivalent to and directly comparable with that of machines had not yet arisen). However, given the presence of the particular characteristics of the mines in the Northeast, which are comparable to those that have been

⁸ While the scale of operations was often large, with work forces in the hundreds and even thousands, operating conditions and work practices were, however, not those of factory routines. The weight to be attached to these historical differences is discussed further below.

⁹ Church (1986: 501 ff.) estimated that labour cost was of the order of 50% to 75% of total working cost for much of the 19th century.

¹⁰ We accept, of course, that many such accounting and management concepts are part of a modern mentality which cannot be literally translated to earlier times (e.g., Miller and Napier, 1993). However, the interesting historical question is *how far* and *in what respects* did the practices and discourses of earlier times overlap with our own.

held to be significant in the rational economic development of sophisticated cost and management accounting techniques in other industries (especially the managerial role of the viewers and the form of labour contract coupled with the absence of internal contracting), we suggest that an economic rationalist might have expected *prima facie* to see more development here in accounting for human performance and control of labour than we have in fact been able to find.¹¹

How significant is such a negative finding? While it is unlikely that there can ever be wholly conclusive historical evidence for either the Neoclassical or the Foucauldian view, this evidence from the Northeast mines in the BIR, when taken with similar negative evidence from B&W and Dowlais in the UK, and sites such as the textiles mills in the US, adds another piece to the jigsaw from which is gradually emerging a picture that suggests that there must have been some unique factor, complementary with but going beyond economic rationalism, that was necessary for the crucial developments in human accountability to occur in certain key early industrial sites in the US that more completely explains the genesis of modern management accounting. It is just such a disciplinary factor for which the Foucauldian view offers a theoretical and historical understanding (Hoskin and Macve, 2000).¹²

Further research in both the UK and elsewhere is therefore still needed since each further negative result adds critically to our historical understanding, while it would only take the discovery of one positive result to throw into question the Foucauldians' current hypothesis that the key sites were in the US. Further examination of any such positive case, if found, would of course be needed in order fully to understand its historical context and to establish whether it was merely a 'one-off'—such as the B&W case appears to have been—

¹¹ It would be wholly circular, perhaps tautological *ex post* rationalisation, for economic rationalists to argue that the absence of accounting development *must* of itself signify the absence of sufficient overall economic benefit to induce such development.

¹² Even without adopting the Foucauldian explanation, Chandler (1977) has recognised that the managerial changes introduced on the early US railroads went far beyond what was necessary for purely economic efficiency.

with no linkage to the wider, more general development of modern management.¹³

Nevertheless, if it was established that the case was more likely to be typical of, and related to, other significant developments (as has been argued for the case of the Springfield Armory in the US [Hoskin and Macve, 2000]), such a discovery would then require wholesale revision of the Foucauldians' current disciplinary theorisation of accounting's historical development and of the genesis and nature of accounting's power in modern organisational management.

Clearly it is impossible to examine every extant archive—and one is, in any event, faced with the loss of so many archives already—but an efficient research strategy will focus, as we have done in the B&W case and here, on cases that provide prominent historical examples of industrial, technological, and economic conditions that might otherwise be expected *a priori* to have favoured the development of the relevant significant advances in accounting and other managerial techniques. Each such 'negative' result will thereby further build confidence in the overall picture through 'replication' of individual 'trials' (e.g., Otley and Pollanen, 2000).¹⁴

We develop the remainder of the paper as follows. The next section provides a brief introduction to the historical background of the BIR coal-mining environment. In section 3, we analyse the archival evidence from the Northeast coal mines to identify the major purposes for which accounting data were recorded and how they were used (and equally significantly, *not* used). We also suggest how this evidence, and the possible reasons for the relative sophistication of the differing accounting techniques and analyses, may be interpreted both from a Neoclassical and, alternatively, from a Foucauldian perspective. In section 4, we discuss the contribution of our evidence and our interpretations of that evidence to the

¹³ Another interesting example of developments that did not lead to a more general and widespread adoption is that of the accounting and management innovations in Spanish factories in the second half of the 18th century. These innovations appear to have come to a halt when the companies collapsed following the French Revolution, which had led the Spanish royal family to adopt a siege mentality that isolated Spain from further connection to modernising influences in the rest of Europe (Carmona *et al.*, 1997; Gutiérrez Hidalgo *et al.*, 2001).

¹⁴ The underlying principle of this approach to the significance of *negative* as much as of *positive* evidence is firmly in keeping with the Popperian tradition of 'falsification' that underlies most formal scientific and empirical research. This paper focusses primarily on the evidential issues. For further elaboration of the theoretical arguments for the Foucauldian position, see Hoskin and Macve (2000).

historical debate over modern cost and management accounting systems, while identifying continuing priorities for further research.

2. The coal-mining environment in the BIR

On Tyneside, coal reigned supreme during the BIR. Output there more than doubled between 1775 and 1830, from nearly 3 million to nearly 7 million tons (Flinn, 1984: 26). The number of operatives employed in the Northeast's coal industry is a speculative guess at best although Flinn (1984: 363) estimated 13,600 of all grades for the period 1807-1809. Benson (1980: 9) suggested that one-third of all British miners were employed in the Tyneside region. Mining operations there were also on a larger scale than elsewhere. At a time when most mines elsewhere had fewer than 50 operatives, 12 in Northumberland and Durham had more than 200 (Benson, 1980: 11). Some could number a total work force in excess of 2,000.¹⁵

2.1. Managerial organisation

A distinctive feature of the Tyneside coal industry was the degree of organisation among the colliery owners. Of three owners' organisations that spanned the BIR, the most prominent was the Grand Allies, founded in 1726, which has been described by Oldroyd (1996). Various types of accounting records were generated by these cartel-like consortia, which attempted to use monopoly power to maximise profits. Flinn (1984: 262) has suggested that the means of attempting to achieve this end were threefold—the restriction of output, the elimination of price competition, and the control of labour costs.

In terms of output restriction, the participating collieries divided the market in relation to 'the basis', a 'predetermined assumed vend' (Flinn, 1984: 262). Each colliery would be allocated a share based upon its actual production in the previous year, but this could be adjusted for improved methods of working, the opening up of new seams, etc.¹⁶ Overall, it

¹⁵ In Johnson's view book, it is reported for Hetton Colliery in 1827 'that they have bound Hewers 560 and Putters etc. in proportion' (DF/WF/28.1: 431). Flinn (1984: 363) estimated as a rule of thumb that hewers would constitute approximately a quarter of the total colliery work force in the early 19th century.

¹⁶ Such arrangements provided both incentives and opportunities for owners to overstate the productive potential of their pits in order to gain a larger allocation. One of the viewers' roles was to act as referees in disputes

would seem that the cartel was ineffective as a device to control output, but that its greater purpose was to provide a united front for price determination and labour-cost control. The Tyneside masters' organisations amassed a substantial collection of business records that have survived in the archive and document the importance of detailed accounting for output to facilitate the operation of the contractual requirements of the cartel.

Another distinctive feature of the management of the Northeast collieries was the role of the 'viewers'. These professional mining engineers variously combined the roles of managers, engineers, surveyors, accountants, and agents, and dealt with all stages of mining from initial exploration to the sale of coal to ships bound for London. They could either be resident with a single enterprise or act as consultants to many mines. While the landowners, or the lessees of the mining rights, provided most of the initial capital, the viewers provided the management expertise. They served as arbiters in wage disputes, as valuers of mining interests, and as referees in rental disputes and in the determination of the allocation of the vend (Flinn, 1984: 57-68; Church, 1986: 409-415, 454-456). One of the most valuable features of the archive is the survival of 'view books' in which are set out, *inter alia*, viewers' computations of the profitability of prospective mine sinkings and operations, as well as analyses of materials and equipment (particularly horses and engines) with respect to their productive capacity and efficiency of utilisation. The viewers' crucial role in management makes the investigation of how far they developed sophisticated accounting practices a question of particular historical significance.¹⁷

2.2. Labour management: direct employment vs. internal contracting

between owners as to the fair distribution of the vend, requiring them to conduct inspections of the relevant mines in order to audit the claims being made as to their productive capacity (DF/WF/28.1: 427, 431-433, 520; DF/WF/28.3: 28). Owners would still not hesitate to write letters to the referees pointing out post-audit additions and improvements to workings which ought to be taken into account in determining their share (DF/WF/28.1: 426).

¹⁷ Their view books provide the all-important interpretations of how they were *using* the accounting numbers and other statistics that they compiled or that were furnished to them (Hoskin and Macve, 2000; Brackenborough *et al.*, 2001).

It appears that the processes that determined contractual arrangements varied considerably between mining districts across Britain and were the product of local custom. A major geological difference between the Northeastern coal fields and elsewhere may have had potential significance for the development of differing labour management systems. In Wales, the Midlands, Lancashire, and Yorkshire, the ‘longwall’ system of extraction meant that the hewers* collectively confronted the same coal face, while in the Northeast’s ‘bord and pillar’ method, the hewer worked alone in a far more constricted area (Benson, 1980: 54; Flinn, 1984: 55). Whether or not differences in ore extraction were a pivotal factor,¹⁸ the fact remains that labour management was distinctive in the Northeast. Here the individual workers were employed directly by the owners or lessees of the mine and were paid piece rates for output (the hewers) or by the shift/day (many ancillary workers) (Flinn, 1984: 374-375). Elsewhere, by contrast, the labour management function was subcontracted to a charter-master* or butty, who contracted to supply coal at an agreed price. It was left to the butty to divide his receipts between remuneration for himself and the individual workmen. While such contracting was experimented with in the Durham/Newcastle area, it did not survive the 1810s. Owners found it ‘troublesome, expensive, and . . . unproductive’ (Flinn, 1984: 57).

Benson (1980: 69) observed that under the butty system in the Black Country, the hewers were paid for an amount of time, contracted with the butty, based on what would be required to hew a given volume of coal. In Scotland, the ‘darg’ was a daily output expectation multiplied by a rate per ton. Welbourne (1923: 16) wrote of a less formalised arrangement in Tyneside where hewers, directly employed and paid for output not time, ‘came away when they were satisfied with their day’s work’, a satisfaction not measured by time but by forward progress. Mine owners and lessees were particularly concerned that required daily output levels should be achieved by the hewers so as to ensure the productive daily work of the army

¹⁸ Church (1986: 274-275) argued that ‘the crucial difference in work organization came only with longwall *machine* mining’, which was only gradually introduced in the late 19th century.

of other mining labourers. The owners/lessees attempted to counteract the hewers' traditional flexibility and freedom with respect to daily attendance and hours worked (Flinn, 1984: 367-369; Hatcher, 1993: 386 ff.) through the inducement of piece rates and the establishment of output quotas, together with fines for absenteeism. But these attempts at work discipline were often of limited success.¹⁹

Ashton and Sykes (1929: 163-165) concluded that, generally, hewers' total remuneration was determined on the basis of their achieving a customary output for a normal day's work, known in Northumberland and Durham as the 'stint'. In 1765, the stint required a total of six to seven hours per day, but this lengthened to eight to ten hours in the 1820s. The stint was raised or lowered many times during the first half of the 19th century as wages and prices rose and fell (Church, 1986: 557). However, while the underlying concept is simple, it is far from clear how it was operationalised. The detailed calculations, by which determination was made of the current normal day's output and how it should be calibrated to the differing geological and other working conditions in different mines, and thereby to the piece rates to be fixed for hewing in each location, remain a mystifying absence in the surviving archive (as we discuss further below).²⁰

The form of organisation of labour has generally been regarded by business historians as a crucial feature in the development of early cost accounting. Johnson and Kaplan (1987: 23, 47-51) argued that direct managerial determination of labour productivity for setting piece rates and labour control only become important in manufacturing industry after the demise of internal subcontracting late in the 19th century in the US. Littler (1982: 67) has argued that 'systems of internal contract acted as a substitute for accounting'. Similarly in the UK, Boyns and Edwards (1996) offered, as an explanation of the lack of any development of accounting

¹⁹ Absenteeism (for example, the long tradition of regular celebration of 'St. Monday') was a particular problem in mining as in other industries (Flinn, 1984: 370-374; Hatcher, 1993: 396).

²⁰ The concept of the stint appears to have degenerated by the 1840s to 'a nominal unit of account for piecework' (Mitchell, 1984: 131).

control over labour at Dowlais in the mid-19th century, the argument that this was a rational evaluation that the costs would outweigh the benefits given, *inter alia*, the system of internal subcontracting.

However, Fleischman and Tyson (1996) have questioned—in the context of the US-based Waltham Watch Company—whether there is a simple linkage between the abandonment of internal contracting and the intensification of cost accounting both to establish labour piece rates directly and to measure and control labour output. In the UK, the 1802 piece-rate exercise at B&W is another example of an (albeit temporary) intensified managerial focus on labour costs being used to determine fair prices, not for directly employed workers but to be offered to the internal contractors (Fleischman *et al.*, 1995).

Nevertheless, it is still the case that there is general agreement among economic and business historians that in the *absence* of internal contracting there is clearly a strong economic pressure, at least in factory environments, for the development of cost accounting as a tool for the measurement and control of labour cost and labour performance. The hierarchical nature of pit labour in the Northeast around 1800, with the hewers' special position reinforced by long apprenticeship and kinship ties, did not constitute the conditions for the introduction of a factory-style organisation of labour (Benson, 1980: 54). Nevertheless, the unique arrangement in the Northeast mines of direct employment of the work force (with the hewers, putters* and certain other underground workers on piece rates, and other workers on day rates [Flinn, 1984: 374-375]) does make this region of particular interest when investigating how far there was any emergence of managerial control over labour productivity through accounting.²¹

²¹ Compare the Springfield Armory at the beginning of the 19th century which, right from the beginning, had its own managed work force, even though inside contracting was normal for the industry and was used at Harper's Ferry Armory. At Springfield detailed labour control *was* introduced by West Point alumni engineers (Ezzamel *et al.*, 1990).

While the mine owners/lessees in the Northeast could generally be confident of the skill of their key workers (given, *inter alia*, the widespread handing down of hewing jobs from father to son), their prime concern was to overcome the miners' natural temptation to reduce the extreme physical demands of their work by working at less than full effort. Paying piece rates for output attempted to minimise this possibility.²² Both sides were, of course, also concerned not to be cheated, whether by the miners sending inferior material or underweight corves* to the surface or by the owners' representatives either under-recording the amounts sent up or unfairly rejecting output of good quality.²³

2.3. Binding

The annual binding of miners was a distinctive aspect of the Northeast's coal-mining environment, reflecting its unique practice of direct employment rather than leaving organisation of labour to internal contractors as was done through the *butty* system in other coal fields. Binding was, in the first instance, the attempt of mine owners to guarantee a supply of (often scarce) skilled labour, but the price in terms of the binding bounty granted on signing the bond was frequently high. In the second half of the 18th century, 6d or 1s was the usual sum paid for the annual indenture, but in boom times and when labour was scarce, as during the frequent wars of the period, the amount of binding money fluctuated greatly and at its highest represented half the normal annual wage of the miners (Flinn, 1984: 353-356). In

²² Only extremely limited direct supervision of hewers was possible given the physical working environment (Mitchell, 1984: 101-102). However, piece-rate systems carried the disadvantage of allowing workers to exercise their own labour/leisure trade-off, giving rise to uneven patterns of work during each pay (e.g., Flinn, 1984: 370 ff.; Church, 1986: 242-243). It was necessary to find ways of keeping up effort. Thus, for example, in a report on the production potential of Thornley Colliery in 1842 for the purposes of the allocation of the *vend*, the viewer George Johnson noted that, while previous production records had been very considerably lower, 'A considerable quantity of Coal has lately been worked in the pillars of the 5/4 seam & Mr. Heckles considers at as cheap a rate as in the Whole Mine, hewing price in pillars 6/- per score. Mr. H. says, *if exertion is used*, they can work from the 5/4 Coal 265 scores daily, viz. A. Pit 90, B. Pit 100 and D. Pit 75 scores and from the Harvey Seam 80 scores may be drawn daily.... Work the Harvey Seam with Davy Lamps, & the men *not allowed to use Gunpowder*' (DF/WF/28.3: 649, emphases added).

²³ The role of the 'kekers' or checkers was particularly contentious as they could impose fines as well as deprive hewers of piece rates (Flinn, 1984: 379). It was not unknown for the miners to attempt to cheat each other by bribing or intimidating the boy putters to 'chalk' other hewers' corves as theirs or by exchanging other hewers' identifying tokens for their own (Benson, 1980: 70-71).

spite of the effort to control labour movement, a high level of migration was evident, both within a particular coal field and between districts, since miners were permitted by law to migrate between bindings (Flinn, 1984: 342).²⁴

The demise of binding in the Northeast coal field began with a new (or reorganised) combination of owners, established in 1805 in response to what they saw as the intolerable ‘panic’ levels of binding money and associated inducements that had been paid in 1804, following the resumption of war. Limitation came to be placed on binding money as the owners required a greater control over the stability and predictability of their labour costs (Taylor, 1960: 229). However, the practice held on in Northumberland until the 1840s and in parts of County Durham for three decades beyond (Ashton and Sykes, 1929: 98; Church, 1986: 236-237, 260-261). During the period when binding was prevalent in the Northeast, there was clearly an added incentive for mine owners/lessees to exploit as far as possible the productive potential of the labour they were reciprocally bound to employ.

2.4. Accounting practices

In the economic environment of BIR coal mining in the Northeast, as outlined above, what management solutions and related accounting practices were required? It was a setting in which the landowners who let out their mining rights needed to assess how much rent they could charge (while guarding against excessive overworking of their mineral rights), while lessees needed to know how much they could afford. The prevailing form of lease in the Northeast combined a minimum fixed rent with a royalty (or ‘tentale rent’) on output (Fordyce, 1860; Flinn, 1984: 46), so lessors needed to monitor output to avoid being cheated of rent due through under-recording. Mine owners/lessees also needed to concentrate attention upon the ever-expanding capital requirements for the extraction of coal from deeper and deeper seams and to evaluate the costs and benefits of changes in technology (e.g., from horse-driven to steam-driven water pumps).

While technological changes in coal-face working (the major element of working cost) were minor until the advent of coal-cutting machinery in the late 19th century, there were some choices to be made. If gunpowder was used, a greater quantity of coal could be brought

²⁴ Although the particulars of binding gave rise to some labour disputes, the miners enjoyed many advantages from the process. The typical one-year indenture period established settlement under the Poor Laws for migrant labourers, although in some districts employers fixed the binding period at 11 months, 15 days to deprive these workers of settlement (Webb, 1921: 8). Binding also provided miners immunity from military service and protection from discharge during slack periods (Ashton and Sykes, 1929: 84-85). In the early 19th century, the

down more quickly, but the trade-off, in addition to the safety problems, was that the coals would be smaller and therefore of less value (Flinn, 1984: 92; Mitchell, 1984:75-76; Church, 1986: 340).²⁵ There were different ways of working the coal face (Church, 1986: 328 ff.). The owners/lessees relied for expert advice and for operational management on the new professional class of viewers. The unique form of labour contract, the bond, was designed to provide 'sticks and carrots' for the colliers, particularly the hewers. While the illegality of unions until 1825 and the long tradition of a unified owners' association in the region presented major hurdles to organised labour movements, the custom of the annual binding is nevertheless generally held to have engendered an expertise in collective bargaining which provided 'a valuable education for both employers and workers in the decades running up to the creation of formal trade unions' (Flinn, 1984: 357).

While labour practices in the Northeast coal fields were largely unique over most of the BIR period—and it is notoriously difficult to establish general patterns and causes of adoption of particular employment practices even today (Marsden, 1986, cf. 1999), let alone historically (Boyns and Edwards, 1996: 52-54)—it may be argued that mine owners and lessees increasingly had similar concerns to other BIR entrepreneurs. They were increasingly faced with the problem of how to ensure the most efficient exploitation of fixed resources that had required a massive outlay of capital expenditure. Boyns and Edwards (1996: 52-53) have quoted the frustration of the managers at Dowlais in South Wales at the difficulty of securing continuous, regular working of their furnaces and mines when faced with an ill-disciplined and often drunken work force.²⁶ While the capital sums expended in mining did not yet reach the scale of later industrial enterprises and certainly not that of the early US railroads

binding process afforded miners the opportunity to bargain collectively for wages and conditions of employment at a time when the Combination Acts prohibited other groups of workers from union activity (Flinn, 1984: 357).

²⁵ Mitchell (1984: 137) also commented that once the use of gunpowder became widespread in the 1840s, a greater organisation of hewing labour into shifts, with an overall reduction of hewers' hours, was developed in the Northeast.

(Schmitz, 1993: 12-16), the costs of winning pits and of purchasing the steam engines, whose pumping capacity in turn enabled ever deeper and more costly sinkings to be undertaken, were escalating rapidly.²⁷ As the archive shows, how to improve speed and efficiency of movement of hewn coal from the coal face to the pithead through replacing horses with engines, or engines with more sophisticated engines, was a major preoccupation of the viewers' financial calculations, based on accounting records and statistics. But increasing disciplinary control over labour performance through accounting did not yet enter the equation. Labour was certainly seen as a very significant cost in the accounts, to be minimised as far as possible, while labour activity was to be maximised by whatever means might be available. However, labour efficiency was not yet a scientific input to be optimised through objective calculation.

We now turn to the archive in order to investigate in closer detail how far these particular conditions, each of which required forms of accounting, may be seen to have engendered innovative accounting developments of a recognisably modern, managerial kind.

3. Analysis of the archival evidence

The surviving business records of the Tyneside coal industry during the BIR are, for several reasons, more plentiful than for corresponding coal enterprises elsewhere in the UK. First, the mining concerns spanned a wider geographic region than most other leading coal districts.

Second, coal mining was the dominant economic activity whereas elsewhere it was secondary

²⁶ Similar labour problems were faced in the US armories (Hoskin and Macve, 1994) and in the US textile mills (Hoskin and Macve, 1996). Indeed, the labour history of the BIR, as in other countries, was almost universally one of attempting to impose factory discipline on a recalcitrant work force (Pollard, 1965: 206-208).

²⁷ As with other increasingly capital-intensive industries, the capitalists' desire to maximise their return, given their sunk fixed investment, brought the dangers of 'ruinous competition' through price cutting (Best, 1990: 18-19, 49-50), which were countered by the formation of the mine-owners' cartels to attempt to regulate both output (the vend) and labour costs (through standardising binding practices). Individual owners faced the need to balance effort devoted to productivity improvements against the restrictions on increasing their output imposed by the allocation of the vend. Owners also had to weigh the collective advantages of the cartel arrangements against their individual advantage from maximising their share within the overall limits set or from opportunistically circumventing the system.

to iron (e.g., South Wales and the Black Country) or cotton textiles (Lancashire). Third, coal-mining operations were more substantial on Tyneside, thus requiring more record keeping and making accounting more affordable. Finally, the high degree of collaboration among mine owners resulted in record keeping and data collection for purposes of controlling the regional coal and labour markets.²⁸

In order to facilitate our analysis of the evidence and to point up the Foucauldian/Neoclassical interpretations, we have organised the selection that we have made from the extensive archival material that we have examined into two sections. First, we will consider the accounting techniques that were not directly related to labour; data of particular interest to the economic rationalist insofar as they are seen to demonstrate a purposeful or sophisticated accounting that informed business decision making as mining technology advanced. Second, we will examine evidence related to labour cost and control in order to evaluate whether a discontinuity between the pre-modern and modern occurred in this environment, such as has been claimed for the Springfield Armory in the US (Hoskin and Macve, 1988, 1994, 2000) but not for B&W or for Dowlais in the UK (Fleischman *et al.*, 1995; Boyns and Edwards, 1996). Foucauldian scholars particularly privilege labour control as a particular instance of an increasingly general control over all organisational participants, including management, and as contributing significantly to the development of that human calculability which, it is argued, constitutes the genesis of modern managerialism and the distinctive power of modern accounting.²⁹

3.1. Accounting techniques (not specifically related to labour)

²⁸ The archives of Tyneside and Wearside coal-mining enterprises are housed in the Durham, Northumberland, and Tyne and Wear repositories. An extensive and detailed description of the contents of the surviving business records is provided in Fleischman and Parker (1997), and so is not repeated here. Additionally, the authors thank David Oldroyd of Newcastle University for pointing out a new archive for the Wylam Colliery held at the Northumberland Record Office at North Gosforth, still in the cataloguing process. A first look has not revealed any costing practices markedly different from those described below.

²⁹ To the Neoclassicist, however, labour control would be but a single facet, not particularly privileged, of the more general question of whether or not the developments in accounting were appropriate to the purposes of

The aim of this section is to present materials that contribute to the project of Neoclassical accounting historians in recent years,³⁰ which seeks to rehabilitate BIR cost accounting and to demonstrate that it exhibited advances in methods that were previously generally thought not to have occurred until the end of the 19th century and the early 20th century with the age of Taylor and scientific management.³¹

From early BIR records, it is apparent that mining entrepreneurs in the Tyneside region used accounting numbers to gauge and improve the profitability of their ventures. Surviving records illustrate a variety of approaches including expense analysis, comparative extraction and operational profitability calculations, mine valuations, return-on-capital analysis for new investment, revenue forecasting, and monitoring of the 'vend'.

Expenses were typically tracked on fortnightly production reports known as pit bills* and pay bills*. These expense records appear to have been kept more carefully in the Durham vicinity than elsewhere. There survives, for example, a continuous series of pit and pay bills for the Ouston Colliery from 1816 through the 1840s (NCB 12/1). In these documents, the

economically rational entrepreneurs.

³⁰ From the Foucauldian viewpoint, by contrast, this evidence is of secondary interest as, while these technological developments were impressive and may have been economically significant, they did not yet contribute to the development of human calculability. However, the evidence here as to the wide range of advances in accounting methods does serve to highlight the absence of an equivalent advance in accounting control over labour productivity.

³¹ There is, however, a major theoretical difficulty with this Neoclassical approach, given that it starts from a premise that the array of modern accounting practices represents a set of useful tools that assist management decision making and control. It sees the historical research question to be the need to investigate when economic and industrial developments reached a stage where these various practices were introduced as a rational response to a business need. But it has often been argued that many of these practices even today have no obvious inherent economic value; indeed, some of them have been frequently criticised as being detrimental to rational economic management (e.g., Coase, 1938; Johnson and Kaplan, 1987). From this perspective, the historical question is how the emergence of these practices, initially perhaps for quite different reasons, changed the discourse of management so that they became an integral part of modern management knowledge and power structures and, indeed, were inherent in the formation of those structures. Such an approach characterises the Foucauldian viewpoint. How did these practices, within a new discourse that objectified human performance and engendered a disciplinary power, become part of the new range of calculative practices that formed the essential glue of modern organisational design and communication and of management control? Here is the crucial significance of developments in the disciplinary process of accounting for labour in manufacturing industries (cf. Shenhav, 1999). For further debate of the paradoxes that Foucauldians see within the economic rationalist approach to explaining developments in cost and management accounting, see Hoskin and Macve (2000) and contrast the responses thereto by Boyns and Edwards (2000) and Tyson (2000).

cost of each extractive process is provided for each of the 26 pay periods yearly and an annual cost per score* computed for each process.

At the Tyne and Wear archives, there are two large compendia of viewers' records that span nearly three-quarters of a century. One is a volume titled 'Correspondence, Valuations, Reports, etc', dated 1776-1839 (DX 198/1); the other a view book of George Johnson in two volumes plus indices which covers 1828-1848 (DF/WF/28.1-4). These collections include a substantial quantity of expense estimates and production reports, estimates for winning* and working, and expenses of leading* the ore from the mines to the staiths*. They provide an extensive record of costs, including spreading winning costs over production. Once a mine began operations, there remained a continuous need to open new workings and shafts for access and ventilation as the mining proceeded underground, what Flinn (1984: 195-197) has called 'running investment'. At the Murton Colliery in 1803, a 2d per chaldron* cost, 'Undertakers to sink a New Pit during the Term', reflected an awareness of these future common-cost allocations in calculating estimates of production costs. It was also typical for these costings to include a line item for 'damage(d) ground', as landowners commonly charged a separate element of rent for such land (DX 198.1: 72; DF/WF/28.1: 332-334).³²

Comparative costings were a prominent feature in the coal-mining archives from the earliest days. The Grand Allies' minute book contains a pre-BIR entry (circa 1727) of a comparative costing per ten* for the raising and leading of one thousand tens as between 'the partnership' undertaking it or by paying 'Mr Pitts', the latter's total cost per ten of £6/5/2d being cheaper. The computation includes a 4/6d allocation for interest at 10% on the capital infrastructure cost of £2,500 and an averaged 4s per ten charge for 'Stock in Trade (besides all hazards) £4,000' (presumably computed at 5%) (NRO 3410/GA/2: 14-15). The minute book

³² Presumably the rental charged reflected loss of agricultural earnings from such land and/or an estimate of the cost of its reinstatement at the termination of the lease. We cannot tell if the lessees may have been making an ongoing provision for any further reinstatement liability that would be finally adjusted or eliminated when a realistic estimate of the restoration cost had been reached.

also contains a number of comparative costings from the 1730s, including the cost ‘per tenn’ of working Heaton (£6/12/4d) and Long Benton (£6/19/4d) in 1735 (p. 98). A computation of the relative profit margins per ten at Long Benton, Gateshead Park, and Salt Meadows (pp. 48-49) shows that working the latter two sites would yield a total of £261,253/2/6d, against £163,800 expected from working Long Benton alone.

While there is a substantial volume of comparative costing of alternative methods for different processes, such as drawing* and leading (e.g., DX 198/1: 104-105, 688-691), there seems to be a lack of corresponding attention to internal comparisons of actual operations.³³ However, an estimate of costs at various pits belonging to the Mount Moor Colliery (DX 198/1: 641-645) in the period 1790-1795 appears to indicate that cost comparisons could serve a useful business purpose. Here 33 expense categories were costed to the farthing. This analysis reflected a substantial variation in mining costs as between Swan Pit (seam 1 = 7/1³/₄d per chaldron, seam 2 = 7/9d), Bounder Pit (7/0d), Gate Pit (6/6¹/₄d), and Way Pit (6/7¹/₂d). (A final cost for Spring Pit [4/9d] is much lower as it excludes any costs for leading ‘from the Pits to the Staith’ or for ‘interest on the Stock for Horses, Hay, Corn’, ending instead with ‘Setting on at the Shaft... 1¹/₂d’.) At the other end of our period, a yield comparison was made at Stella Coal in the 1840s to test the percentage of good coals extracted from the Towneley (42.647%) and Stella (40.260%) seams respectively (NCB 1/SC 478: 56-57).

In addition to the costing and profitability calculations already noted, concern with the basic physical and geological conditions of mine winnings and workings permeate the extant records, gradually supplemented with increasingly sophisticated engineering calculations of mechanical efficiency. While there survives an ‘accounting of boring’ for 1768 at the Urpeth Colliery, a purely physical account in which the type of rock encountered at various depths is

recorded in fathoms, yards, feet, and inches (WAT 1/5/15),³⁴ there is an impressively detailed 1752 estimate of the ‘expense of cribbing* and planking made upon 2 fathoms or a 12 foot length of tubb* of 7 Feet diameter’ (WAT 1/5/7). The Grand Allies appeared more concerned with the ‘expense of boreing’ than the physical properties as a 1738 minute-book entry sets the cost at 5s per fathom for the first ten fathoms, then an additional 5s for each five fathoms (NRO 3410/GA/2:46).

A relatively sophisticated view of incremental costs is revealed in an 1802 estimate of the cost of a new winning at Angerton, which would require installing an engine to lift water 10 fathoms ‘after the Pit is sunk’. It was noted that the engine would be used ‘to work 1 pair of Grey Stones for grinding corn’ in the meantime (DX 198.1: 144-5).

Typical of an emphasis upon productive potential given existing technology is the analysis for the Hetton Colliery in 1827, given in the Johnson view book in the context of determining maximum output for the purpose of the vend allocation (DF/WF/28.1:441):

‘To the bottom of this Inclined Plane, the Coals are brought by Horses; the Engine drags 8 Rollys up at a time, each Rolly carrying 3 Corves, and takes them from the foot, to the Head of the Plane in 7 minutes; but allowing for time of Changing, and casual Stoppages, suppose 12 minutes to be reckoned for each set of Rollies; and at this rate the performance will be 6 Scores an Hour’.

Newcastle-area mining records contain a number of colliery valuations undertaken by viewers. While these analyses were on occasion restricted to estimated mineral reserves, they were more typically a total valuation of the colliery. Here one frequent feature, not in evidence in Fleischman and Parker’s (1992) study of the coaling operations of iron companies, was the use of risk-adjusted rates of return on capital investment. In the examples we have examined, these rates ranged from 6% to 15%.³⁵ There is included for Hetton Colliery in 1823 an interesting ‘what-if’ calculation which gives alternative values depending upon whether a new pit had to be sunk after ten or twenty years, adjusted for the differing present values of the future outlays (DX 198.1: 568-573).

³³ An 1827 costing for two seams of the High Main Coal (the Hutton seam cost 7/3d per chaldron and the Maudlin seam 8/1³/₄d) (DX 198/1: 529) was not intended for comparative purposes as overleaf the two totals were simply combined before the common costs for the whole mine were added.

³⁴ A similar survival a half-century later for the Jesmond account (DF/WF/30/12) likewise documents the physical properties of new borings without mention of the attendant costs.

³⁵ For a fuller discussion of the viewers’ use of discount rates, see now Brackenborough *et al.* (2001).

In respect of the Ashington Coal Company (NCB/A5/4), there is an 1843 report from Turner estimating the cost of winning and probable profit at Black Close, a property of the Duke of Portland. While the report is written clearly in an elegant hand, the numbers are badly rounded and the arithmetic is shocking. However, a winning cost totalling £13,000 and then an annual bottom-line profit of £2,302 were reckoned for sales of 20,000 chaldrons (the costs developed from ‘a careful estimate and comparison with the neighbouring collieries’), representing a 17¾% return on capital. Then a sensitivity analysis was done of the effect of a new railway link to the Tyne, which indicated that sales could now be 30,000 chaldrons at no extra initial capital cost. Annual sales value and costs would now both be higher, with overall annual profit of £3,429 and return on capital ‘20½% nearly’ (*sic*—should be 26½%). We cannot tell how far the decision usefulness of this innovative ‘what-if’ analysis was handicapped by its lazy costing and poor numeracy.

In the Durham area, the Stella Coal Company’s management in the 1830s and 1840s was extremely concerned about the costs of capital improvements. An intricate differential cost analysis associated with the sinking of the Emma Pit is described in detail in Fleischman and Parker (1997: 119-121). The company solicited multiple estimates for improvements related to engines and transport. Costings were undertaken to compare transport options and motive power sources (machines or horses). Tender offers were required for capital investment opportunities, such as matériel provisioning, engine upgrades, and construction. The Stella archive is sufficiently complete to allow the researcher to establish linkages between the *ex ante* estimates and the business decisions based upon those estimates and tender offers. This dominant concern with capital expenditure control and major operational decisions on expansion or contraction stands in marked contrast to the company’s relative inattention to labour and its cost control (other than in terms of broad categories of direct and indirect costs) as discussed further below.

As already noted, a distinctive feature of Northeast coal mining, not in evidence elsewhere in the UK, was the organized attempt of the owners in the region to control the sales market through collective action. The earliest collusive effort, that of the Grand Allies, saw the accumulation of a significant volume of statistical data to administer the division of the wholesale coal market, mainly comprising distribution by sea to London. There are a number of agreements in evidence from the 1730s reflecting this distribution. The format typically included the agreed-upon vend of different coal varieties for a particular year, followed by additional columns charting actual sales and the negotiated quota for the succeeding year. In one such marketing arrangement, 22 collieries participated. Nineteen of these failed to sell their allotted volume, while three exceeded their quotas (NRO 3410/GA/2:80). The allocations changed from year to year, and the view books contain extensive workings, returns from questionnaires, notes on mine visits, and reports submitted to the owners' association in respect of the settlement of disputes over how the vend should be allocated between collieries (DF/WF/28.1: 398-520). The minute books of the 'Committee of Coal Owners for the Rivers Tyne & Wear' from 1805-1826 (NRO 263) provide further evidence of this communal control. There appear yearly statistics on chaldrons vended and monthly selling prices.

There is also evidence of how the mine owners exercised control in the labour market concomitant with their control over output and the division of sales. In the next section we look more closely at accounting's role in the control of labour cost, but the significant observation that we carry forward from this review of the other aspects of colliery costings and business statistics is that the BIR Northeast coal mines exhibit a range of advances in accounting methods appropriate to the changing economic and technological conditions they faced. Since advances of this kind are consistent with both Neoclassical and Foucauldian interpretations of accounting developments, it is therefore all the more necessary to explain

why there does not seem to have been an equivalent advance in *human* accountability and, in particular, in accounting control over labour productivity. Here the interpretations will differ.

3.2. Accounting and the control of labour cost

By contrast with the sophisticated estimating and accounting for geological and engineering costs, what is most noticeable about the treatment of labour costs in the mining records is the relative lack of attention to and sophistication in assessing labour productivity. However, there are several examples of archival evidence reflecting a concern with controlling labour costs.

Monthly expenses at the Birtley Mine of George Humble & Co. for the late 1760s and early 1770s (NCB 2/4) included various mining functions charged at a going piece rate. These charges were annually amended, as might be expected in coal mining since the bindings were an annual event that would naturally occasion changes in piece rates. Nevertheless, they provide a marked contrast with the inflexibility evident in the system at B&W 40 years later (where rates remained unchanged for several years [Fleischman *et al.*, 1995]). The rate for hewing, for example, fluctuated from 1/10d per score in December 1763, to 2/6d in October 1766, and 2/4d in February 1771. Meanwhile, the cost for drawing reflected a related but distinct pattern—8d per score in December 1763, 1/6d in December 1765, 1/8d in December 1769, and 4/6d per shift (a change from an output-based to a time-based measure)³⁶ in February 1771. It is relevant to note that while the fluctuations for these two activities moved up and down in approximate tandem, amendments did not occur at precisely the same point in time. Thus, hewing rates changed most typically in October, the binding date, while variations in drawing piece rates were presumably more influenced by differences in seam conditions and depths.

Some 1783 colliers' bonds for the Walker Colliery (NRO 3410/WAT/1/3) give the binding date as October and the binding pay a modest 1s. The various stipulated piece rates made some allowance for seam quality and the narrowness of the work area. There was also

provision for headway pay. There was a 1s per day fine for not showing up for work and a 6d per corve abatement for poor coals. A procedure was defined for resolving disputes over the measuring of corves: seven days' notice was required and inspection was to be done by hewers chosen by the employees and approved by the viewers. Finally, pay for day workers was based upon a 'reasonable Dayswork', as defined by the employers. Similarly, bonds for Newbottle Bourn Moor Mine in County Durham, drawn up by the administrators of the estate of John Nesham in the years around 1804 to 1808, provide that the drivers 'shall and will drive such Quantities of Corfes of Coals & at such distances as shall be thought a reasonable days Work by the said Admors. or their Agents' (TWAS 65/2077/box 4823 [1292]).

Pencil notes on documents written in ink are sometimes used to amend accounting data to reflect additional information. Some Stella pay sheets for 1839 (NCB 1/SC 264) exist which record the days worked by employees, almost always in whole days. However, notations in pencil indicate days and partial days not worked, sometimes measured in quarter days. On the reverse of the sheet, the pay was originally calculated on the basis of expected full days, subsequently reduced for the missed days to arrive at total pay. Another pencil and ink exercise for South Hetton Colliery in 1834 saw estimates of production levels in chaldrons by its viewer, Thomas Hall, entered into the memorandum book in ink. Noted in pencil were variances in the subsequent actual volume of output. It appears that notice was taken of differences between estimates and actuals, although no explanations (e.g., labour inefficiencies) are provided for production shortfalls (NCB 1/TH/15: 172).

Owners were naturally concerned to reduce labour costs wherever possible. The Stella archive contains a proposal from the 1840s for ten redundancies at Towneley Colliery. An estimated saving of £6/1/10d per week was projected (NCB 1/SC 465, 478). Accounting numbers were also deployed at Stella Coal for abandonment decisions. In 1844, Robert Simpson, Stella's owner/manager, recommended the closing of the Towneley Colliery.

³⁶ This datum, and the rate for hewing at the same date, may relate to a price paid for a particular project.

Although labour was cheaper there than at any other installation, the costs associated with its non-central location were deemed prohibitive. It was observed that the work force could be moved to Star Gate. To obtain the same amount of coal as before the proposed abandonment, Simpson suggested opening a new seam at Stella Freehold and increasing the number of days worked beyond the then current nine per fortnight. His forecast was for an annual saving of £865/9/0d, including a 1/9d per score reduction in costs of raising, a relocation of five horses, a reduction in rents and royalties, a diminished use of sundry items (ropes, oil, and grease), the redundancy of a wagonway* wright, and reduced poor rates (NCB 1/SC 515). In 1849, Simpson did a similar analysis to determine at which pit work should be curtailed, occasioned by the slow sales the firm was facing (NCB 1/SC 516).

The accounting at Cowpen Colliery (ZRI/35/15) included a redundancy recommendation as part of a comparison of costs of raising for 1832 and 1833. It was calculated that the 29,375 chaldrons raised in 1832 cost on average 11/1½d, while the next year's production was significantly reduced (17,548 chaldrons) but with unit costs significantly higher at 13/9½d per chaldron. The accountant had two observations to make on these data. First, £1,105 could have been saved in 1833 had 13 pit workers been discharged, a course of action indicated by the lower volume of production. This saving included their £45 yearly salary, plus savings on materials they consumed. Had these redundancies been made, the 1833 cost per chaldron would have been reduced to 12/6½d. Second, it was concluded on the basis of these statistics that production should never be allowed to dip below 20,000 chaldrons annually, thus exhibiting a good appreciation of the differing impacts of variable and fixed costs.

Certain documents in the Watson archives are reflective of a greater attention to labour-based statistics than we have seen elsewhere in the extractive industry. In WAT 1/5/88 (1830-1831), for example, the average weekly wages of hewers at Cowpen Colliery are segregated

into three operative categories, at 19/7³/₄d, 17/5¹/₂d, and 11/10¹/₂d respectively. Unfortunately, there is no information regarding the method by which miners were assigned in this classification scheme.

As previously discussed, the owners also sought to exercise communal control over the labour market. An immense spreadsheet survives, dated 1805, on which are logged the numbers of hewers bound to and from each colliery on the Tyne and Blyth (WAT 1/5/31a). There also appears in this record the formula used in 1805 to determine the number of pitmen that could be bound to each colliery that year. Each was entitled to 95% of its average, actual labour force for the preceding three years in order 'to supply the new collieries of the number then remaining' (WAT/1/5/31g). WAT 1/5/32 contains the colliery owners' agreement as to the maximum binding money to be paid at the binding in October 1805, differentiating payments on geographical location and marital status. The document also set out 'no poaching' agreements and provided that there should be no hiring of men who refused to be bound. In WAT 1/5/41a, there is a similar record for 1806. Here again there is evidence of the owners' association's efforts to establish maximum wage rates.

In the minute book of the Tyne and Wear owners' committee (NRO 263), there is a return for 1812 for each colliery of the wage rates paid for various categories of labourers. The owners were particularly concerned with binding arrangements, both the numbers of miners employed and the wage maxima. The minute book contains statements from mine agents who had apparently violated the rules established by the association.

The binding agreements at Stella in the 1840s raise many questions about the relationship between accounting and labour relations. By this relatively late date in the BIR, standard contractual clauses were now in printed form with much space provided for handwritten specifications as to a particular colliery's working. Included among these standard clauses in 1841 was a guarantee of sufficient work for hewers to earn 28s per fortnight over at least eight days, except for the month surrounding Christmas. However, the more substantive phraseology from the perspective of labour control was the provision that the individual hewer (NCB 1/SC 540):

'...shall, when required (except when prevented by sickness or other sufficient unavoidable cause) do and perform a full day's work on each and every working day, or such quantity of work as shall be fairly deemed equal to a day's work, (not exceeding eight hours) and shall not leave their work until such day's work or quantity of work is fully performed or finished to the extent of each man's ability, and in default...pay...two shillings and sixpence'.

By the time of the 1843 annual binding, the owners had colluded to change the conditions of employment 'in consequence of the present depressed state of the Trade' (NCB 1/SC 558).

Their circular stated that the guarantee of 28s per fortnight should be reduced to 26s and was to be averaged over the four preceding pays. The eight-day guarantee was left to the discretion of each individual colliery. The 'Standard price of Hewing' was reduced from 4s to 3/8d for eight hours. The wages of other workmen were similarly reduced.

Consistent with the owners' agreement, the 1843 Stella bonds were significantly changed. While the printed standard clause about the hewers' obligations (reproduced above) remained, in the section left blank for handwritten specifications the hewing piece rates were now set within a range of 4s to 5/6d per score, depending upon the miner's location in the mine. It is particularly interesting to note that the owners' association defined wages at day rates, while Stella's binding agreements specified piece rates adjusted for the geological and other conditions in each seam that would affect productivity. The standard printed clause guaranteeing sufficient work for hewers to earn a minimum amount had been crossed through. In its place was substituted a handwritten clause that allowed that hewers could be required to do shift labour (any work other than hewing) at the rate of 2/9d per nine-hour day. This stipulation reflected the degree to which the hewers were the aristocrats of mine labour. Not only was their normal pay much higher than other operative classifications, their normal hours were shorter.

Another standard printed clause crossed out in 1843 was the provision that in the event of a mine closing due to accident, hewers were entitled to 2/6d per day if alternative work could be found for them, 1/6d if not. Instead, it was stipulated in hand that (NCB 1/SC 545):

'the said Owners shall be empowered to lay off the said Collieries as usual at Christmas without any payment whatsoever being made; and in case the said

Collieries should be prevented from working for more than Two Callendar Months by any cause whatever then this agreement to cease and determine’.

By 1863 (somewhat beyond our main period), bonds at Penshaw Colliery (NRO 3410/WAT/1/3) had changed in some further respects. The binding date was April and there was no signing bonus. There appeared to be a greater attention to the collier’s productive potential as a function of the quality of his location in the mine. A day’s work was now specified as eight hours.

From the accounting perspective, what is striking in these labour arrangements is the failure of management to depart from what was traditional and customary in defining a ‘fair day’s work’. Language such as ‘the extent of each man’s ability’ does not approximate the precision that cost accounting can bring to bear in disciplining labour. Even where piece rates introduced a greater specificity to wages as a labour-control technique, the Stella archive is silent as to how these rates were determined. Were they based on observations, negotiations, or whim? How were piece rates amended? At least in the case of B&W, the process for setting rates is known, even if the exercise was a one-off in that subsequent attention was never focussed upon revision (Fleischman *et al.*, 1995). Here, by contrast, we have no direct clues and no evidence of attention to calculating the efficiency of labour as a means of control.

The level of accounting detail about overall profitability, about machines, and even about horses, is not in evidence for charting workers’ activities or potentialities. For example, in the Johnson view book, as already noted, there are various reports on the productive potential for pits, suggesting output could be increased or had been higher in the past.³⁷ The conclusion about the Pensher Colliery in 1826 was ‘present quantity 38 [scores] a day, but may be advanced to 45’ (DF/WF/28.1: 507), and regarding Harraton, ‘present quantity 27

³⁷ Clearly, owners had an incentive to claim the highest credible level in order to maximise their share of the allocation of the vend.

[scores] a day, but 37 [scores] have been got and can be got again' (DF/WF/28.1: 508). The technical focus was clearly on how to get more out of machines and horses. There are detailed calculations of how much engines can draw, strokes per minute, etc. (e.g., DF/WF/28.1: 90, in a valuation report). While there is comment on the state of the seams and the quality of the coal, nothing seems to be said as to how these factors relate to productivity and/or working rates of miners. As an example, a viewer's opinion is given that a wage rate of '3/9d per score, with a 16 peck corf' is 'sufficient' for hewing to get merchantable coals from the Hutton seam of Shieldrow Colliery in 1799 (DX 198/1: 101). But there is no justification given for this reckoning and, again, what is absent is any *calculation* of what constitutes a fair day's pay for a fair day's work.

In the mid-1830s, in the context of a dispute over the allocation of the vend, George Johnson, one of the leading viewers, clocked the time occupied in 'drawing, striking, and putting into the shaft each iron 60 peck* tub' as 1 minute, 15 seconds. This speed would allow for 7 scores per hour, 84 per day, according to Johnson's reckoning (DF/WF/28.3: 5). However, this precise timing exercise was again more focussed on the capability of an engine than of the miners. Immediately subsequent, the report goes on to say that the owners had now ordered 80-peck tubs, expected in a fortnight, which the machine 'will draw in the same time which will give [nine and one-third scores] per hour or 112 [scores] per day of 12 hours'. In an 1839 analysis of the Thornley Colliery, Johnson estimated that 'on an average of narrow and wide work' each of 360 active hewers (28 were reckoned to be off per day through sickness or 'other causes') could produce 10 corves of 20 pecks per day (DF/WF/28.3: 26-27). However, no details were provided to support this estimate of productivity.³⁸ Similarly, it was observed for Cragwood Colliery, 'a man will average in the Main Coal about 17 tubs of 22 pecks—the score 23 tubs' (DF/WF/28.3: 33). At least these estimates were made in the context of views of the particular conditions in individual mines. In 1813, another leading

viewer, John Buddle, simply asserted that a hewer would produce 28 corves (1.4 score) per day on average (Flinn, 1984: 390).

During the 1830s, a standard list of 18 questions was devised for drawing up viewers' reports on individual mine operations in the context of the negotiations over the allocation of the vend. Extracting numerical data from just one of many such reports (DF/WF/28.3: 95-98), questions 14 and 15 asked for the number of engines (3) and machines (13) available for drawing coals. However, no information was provided for the size and condition of the labour force. Question 16, requesting the greatest quantity of coal that could be drawn daily from the workable pits by the present machinery, was answered by a calculation of the number of scores (of 20-peck corves) that each of the 13 machines could draw per day (60), giving a total of '780 scores per day by single shift'. Question 17 asked the same information relative to the current establishment of men, but did not include a detailed calculation, just totals for each pit's output and a grand total of 400 scores for the three pits. The final question asked for the greatest amount ever drawn in two successive fortnights and the pertinent dates. Question 18 seems more likely to have been answered with actual data, whereas the responses to 16 and 17 appear theoretical. In the given case, the answer was 11,736 scores (of 20-peck corves of 21 corves to the score) for the three pits over 22 working days. This total daily average (533) was more than the men were theoretically capable of doing, but less than machine capacity.³⁹ This concentration upon maximum production levels appears again and again throughout Newcastle-area archives. However, its intent was clearly not to establish workers' responsibility for achieving certain levels of output, but rather to provide the basis for the division of the seasale coal market (the vend).

³⁸ See fn. 22 above for Johnson's remarks about the same colliery in 1842.

³⁹ A similar relationship is reported for later responses from various collieries in 1842 (DF/WF/28.3: 314, 359 ff.). The standard questions asked (p. 276) remain essentially unchanged. Although some of the answers might include figures for the number of men employed, there was still no detailed productivity calculation to justify the output capabilities asserted, while, presumably through an increasing laxness bred by familiarity, the engine capabilities were also no longer supported by as much detail.

How were productivity and pay rates linked? One of the more incomprehensible features of the Tyneside archives is the fact that the binding agreements fixed specific piece rates for hewers' output while the owners' cartel established maximum rates for hewers' pay per day. Somewhere, in order to reconcile these different approaches, there must have been knowledge as to what a fair day's output would be given the condition of each pit or seam. As discussed in section 2.2., this relationship was expressed in the notion of the 'stint'. But we have not been able to find any documented evidence as to how this customary productivity was actually measured or negotiated. None of the standard histories of British coal mining (e.g., Flinn, 1984; Mitchell, 1984; Church, 1986; Hatcher, 1993) have attempted to explain it at that level of practical, operational detail. The negotiation of rates would appear to have had more to do with the collective bargaining arrangements for the annual bindings than with the results of any attempt at a more scientific observation of productivity.

The perplexing inconsistency in an accounting methodology that tracked capital improvement costs so carefully while manifesting inattention to labour control may be examined from the viewpoint of both the historic-theoretical frameworks being considered here. From the economic-rationalist perspective, there may have been a greater cost/benefit in analysing and influencing the productive potential of machines, but not so the performance of labouring men. Machines such as steam engines could extend the depth to which pits could be dug and could substitute for horses in hauling coal to the surface. More efficient machines could substitute for less efficient machines. Moreover, from that perspective, the need for additional labour control might have been obviated by the annual binding procedures that defined the collier's obligation and restricted his mobility; by the tradition of training through long apprenticeship and the passing of the hewer's privileged function from father to son; by the piece-rate payment system; by the conditions of working at the coal face; and by the tacit knowledge of owners, labourers, and viewers as to what could normally be expected given the

traditions of the industry. Nevertheless, substitutions could be made in methods of coal-face working and, increasingly from the 1840s, between the explosive power of gunpowder and the human power of hewing. Decisions must have been made here too, but there is no evidence that the relevant *calculations* were undertaken (or, at least, have survived) (cf. Mitchell, 1984: 76).

Meanwhile, the Foucauldian approach would be to enquire whether the discontinuity had yet occurred that would signal the genesis of modern management. A necessary breakthrough would be for managers to evaluate workers in the same way that they gauged the productivity of machines. In the absence of a conceptualisation that men's work could be measured as the work of machines, a commitment to *accounting* control of labour would be problematic. But, once management rationalises men as objects of efficiency like machines, an awareness of the measuring calculus can be communicated to them. Worker resistance may make this communication ineffective initially, but when, eventually, the work force internalises the discipline and becomes 'governable persons' (Miller and O'Leary, 1987), the resulting payoff can be that the workers' own well-being and that of the organisation are jointly advanced. It would appear that the conditions of possibility for this managerial advance to occur, the interweaving of new accounting practices and emerging managerial discourses, were not yet to be found in the Northeast coal fields, although accounting did serve a variety of other economic functions.

In summary then, it would appear that accounting was not used in the Northeast coal industry in the BIR for surveillance of the kind that characterises modern systems of control, not only of labour but of managers as well. Disciplinary systems of the kind that, through internalisation of performance norms, 'quietly order us about' (Foucault, cited in Megill, 1979: 493) were still absent.

4. Conclusion

The archival evidence from the coal mines of Northeast England around the turn of the 19th century demonstrates the utilisation of an array of cost and management accounting practices that still form part of the accountant's portfolio of techniques today. Accounting was a vital ingredient in stipulating contractual arrangements between mine lessees and owners, in organising and monitoring the division of the vend within the owners' cartel, and in informing the viewers' concerns with expenditure control, with evaluation of technical efficiency improvements through increased mechanisation, and with major operational expansion/contraction decisions. Its variety of contractual and managerial roles reinforces the evidence from other significant BIR industries, such as B&W's Soho Foundry and the Dowlais mining/ironworks complex.

Differing contingent organisational demands for accounting developments in different countries and industries and at different times may be offered as economic rationalist explanations of the diversity of practices evident in the various archives of this period that have been examined and continue to be examined in the UK, the US, Europe, and elsewhere. Researchers such as Boyns and Edwards (1996), Boyns *et al.* (1997), and Tyson (1998) have argued that the prime focus of research into the management accounting history of this period should be on investigating this variety of ways in which modern accounting practices developed to meet the demands of a range of organisational objectives under varying conditions. These objectives included contractual (and other) relationships between firms and their suppliers of capital, their lessors, their competitors, their equipment suppliers, their customers, and, where relevant, state agencies. We have seen examples of several of these in relation to the Northeast mines. But accounting also contributed ever more extensively, in the increasingly capital intensive and multi-activity business enterprises that emerged from the Industrial Revolution, to the internal management co-ordination of such large-scale

undertakings, to strategic decision making, and to operational planning and control (Fleischman and Parker, 1991).

Given the achievements we have documented in the accounting in BIR Northeast coal-mining, Neoclassical (economic rationalist) historians would not accept the ‘Foucauldian’ position that the absence of certain labour-control practices signals an environment discontinuous from modern practice. A wealth of evidence has been introduced here to illustrate the attention mine owners/lessees paid to cost control. As labour was a major expense item, this cost factor became a major focus. That the mine managers did not, however, deploy or develop accounting data to measure and control the productivity of their work forces may well have been rational economic behaviour within the context of the BIR. The anticipated disbenefits from labour resistance to a disciplinary regime may well have been perceived to outstrip the benefits of greater labour efficiency. Scarcity of skilled labour was perhaps a decisive factor, as Fleischman and Oldroyd (2001) have hypothesized for Nova Scotian coal mining. Moreover, at a fundamental level, Neoclassicists would question the Foucauldians’ privileging of labour control as *the* prerequisite to modern management (Boyns and Edwards, 1996, 1997a; cf. Hoskin and Macve, 2000).

From the Foucauldians’ perspective, this contingent, demand-led approach offers only limited explanations of differing developments. For example, Johnson and Kaplan (1987) emphasised the importance of the demise of internal contracting in engendering close management attention to labour productivity and standard costs. While rational economic explanations of differing labour practices are often hard to identify (Marsden, 1986; cf. 1999), we have noted that a particular feature of the Northeast coal fields in the 19th century, unlike those in other parts of Britain, was that they did have direct employment, not internal subcontracting. Nevertheless, detailed accounting control of labour was still absent.

It has not been our purpose to deny the sophistication of the accounting practices developed in the Northeast coal mines in the BIR; indeed, they offer some of the earliest exemplars of the range of accounting practices to be found in BIR enterprises, as well as in early industrial enterprises in the US and elsewhere. But the extension of such modern accounting techniques does not in itself explain the fullness of modern accounting's power. In addressing 'the extent to which "successful" accounting methods transform the entities and practices of which they provide a calculative knowledge' (Miller and Napier, 1993: 632), it is argued that one of the key distinguishing features of modern accounting, that which gives it its particular power and status, is its objectification, classification, and surveillance of human performance.⁴⁰

This is why we see a crucial historical question as being how the discourse that could conceptualise and observe humans as equivalent to machines, and thereby engender the management revolution that characterises modern industrial organisation, was itself engendered. It has been argued elsewhere (Hoskin and Macve, 1994) that the conditions for this discursive leap and the relevant transformation of practices are to be found in the US in the early 19th century, concentrated in a group of engineers who had 'learned how to learn' in a new way at West Point from 1817 onwards. The history of how their influence spread through both manufacturing industries and the early railroads—the first large-scale, divisionalised US business organisations—has begun to be traced (Hoskin and Macve, 2000). The corresponding crux in the archival evidence for BIR firms is the identification of whether (and, if so, of where, when, and how) 'human control through accounting' was initiated in the UK too, control which could then develop from the initial direct control of productive labour

⁴⁰ 'Far from being neutral devices for mirroring the social world, the calculative technologies of accountancy are complex machines for representing and intervening in social and economic life. Along with allied expertises, the creation of calculating selves and calculable spaces enables a normalization of individual lives that is cast in financial terms. The visibility conferred on the calculating self who occupies a specific locale within a loosely assembled network of calculable spaces is intrinsically linked to norms of financial performance. Ways of organizing and ways of calculating have developed hand in hand' (Miller, 1992: 78-79).

through to generalised, internalised control of all organisational participants through the ‘writing, examining, and grading’ of the accounting eye.⁴¹

This paper has argued that the evidence from Northeast coal mining further reinforces the view so far obtained from the archives of other early BIR organisations. Despite a variety of conditions, no evidence of the crucial developments in human calculability has yet been found in the UK at a time when such developments have been argued to be observable in certain key organisations in the US.⁴²

As in the cases of B&W, Dowlais, and other BIR firms examined to date, this negative archival evidence on labour accounting practices does not of itself enable us to resolve the debate between the Neoclassical and Foucauldian perceptions of the processes by which modern accounting and modern management evolved. But an accumulation of such evidence will enable us to piece together more of the jigsaw of our theoretical understanding of how such developments occurred. Our own examination here of the Northeast mines in the BIR reinforces the need for further detailed historical research into accounting developments in the late 18th and early 19th centuries, elsewhere in the UK, in the US, and in other industrialising countries, to seek to identify where, when, and how the key transformations occurred and whether they are more adequately explained by the Neoclassical or Foucauldian perceptions of the processes by which modern management has evolved and developed.

As we have already noted, such research should not, and could not, examine every extant archive. Indeed, that would be pointless, not least because of the loss of so many

⁴¹ For further discussion of how UK and US accounting and management practice developed in different ways in the 19th and early 20th century, and of the gradually increasing interchange between them, see Hoskin and Macve (2000).

⁴² Indeed, in the case of British mining companies, Boyns and Wale (1996: 75) found that, even after the turn of the 20th century and up to nationalisation in 1947, while mining company top managements were receiving greater volumes of disaggregated information on productivity, costs, and profits, nevertheless, ‘there is virtually no evidence of moves towards the use of standard costing and budgeting, two of the most significant developments generally associated with the advent of scientific management during the early twentieth century’ (in which Britain and Europe generally lagged behind the US—cf. Fleischman, 2000). By this late date, however, one also needs to take account of the role of labour unions in the negotiation of pay and conditions. As

archives already. The further research needs to focus in particular—as we have done here and in the B&W case—on those ‘key sites’ that may be judged to have been significant in industrial and management development, and that have features that might be expected *a priori* to have favoured the relevant crucial advances in accounting and other managerial techniques (just as here it is the particular characteristics of the managerial and labour organization of the Northeast mines that make them of special historical interest). Many such sites are likely to have been examined before by other historians, albeit through different interpretative lenses. But ‘replication’ studies, even where they continue to provide only negative results, also provide a vital research contribution (e.g. Otley and Pollanen, 2000).

We therefore conclude by re-echoing the calls in Fleischman *et al.* (1995) and Boyns and Edwards (1996) for continuing investigation on both sides of the Atlantic, as well as in continental Europe and beyond (e.g., Boyns *et al.*, 1997; Carmona *et al.*, 1997; Bhimani, 1998), to trace the conditions of emergence of the key defining characteristics of modern accounting’s power. In this way we can hope to sharpen, even if not resolve, the continuing current debates that, on the one hand, see the outputs of routine accounting systems emerging historically as valuable inputs to rational economic decision making⁴³ and, on the other hand, despite scepticism about these alleged economic rationales, nevertheless see the processes of the same routine accounting systems as enforcing a discipline that is an essential constituent of modern business organisation. Deciding which of these interpretations is historically more convincing may in turn be of value in illuminating aspects of the topical debate over what characteristics of present-day accounting, if any, will retain their power in the future organisational management, control, and governance of the redesigned, increasingly ‘virtual’,

explained in fn. 1 we leave for a separate paper a critique of the ‘labour-process’ framework of historical analysis.

⁴³ See Hoskin and Macve (2000) for further discussion of the theoretical implications of economic rationalism in relation to accounting numbers, in particular analysing the distinction between optimal information (Coase, 1938; Wells, 1978) and the advantages that may accrue from suboptimal information production under uncertainty (Casson, 1997; Feltham and Xie, 1994; Lamoreaux *et al.*, 1997; Tyson, 1998).

organisations that are emerging in the new era of internet-based, globalised business (e.g., Pasternak and Viscio, 1998; Otley and Fakiolas, 2000; cf. Jones, 2001).

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NRO:	Northumberland Record Office, County Hall, Morpeth, Northumberland and Melton Park, North Gosforth, Newcastle upon Tyne
TWAS:	Tyne & Wear Archives Service, Blandford House, Blandford Square, Newcastle upon Tyne
WAT:	Northumberland Record Office, Melton Park, North Gosforth, Newcastle upon Tyne
ZRI:	Northumberland Record Office, Melton Park, North Gosforth, Newcastle upon Tyne

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APPENDIX A

GLOSSARY

binding:	annual contracting of individual miners to specific mines
chaldron:	a variable weight, 53 cwt. in Newcastle
charter-master:	a subcontractor who supplied the labour necessary to extract coal and raise it to the surface
corve:	a measure of capacity, varying between 16 and 20 pecks
cribbing:	a temporary wooden lining to a shaft, subsequently replaced by tubbing
drawing:	carrying coal from the mine face to the surface
hewer:	a miner who cuts coal from the face
leading:	carriage by horse-drawn cart or wain
pay:	fortnightly pay periods
pay bill:	fortnightly computations of all expenses related to coal extraction
peck:	unit of dry measure, $\frac{1}{4}$ bushel or eight quarts
pit bill:	fortnightly computations of individual miners' output and pay
putter:	an underground hauler of coal by any form of transport
score:	twenty corves
staith:	a quay for transferring coal from a wagonway to a keel, generally with coal storage facilities
ten:	a variable measure of coal, typically 50 tons approximately
tubb:	shaft lining made with wood, bricks, stone, or cast iron
vend:	quantity of coal marketed either by individual collieries or by all
viewer:	a mine manager or consultant engineer
wagonway:	a railway for horse-drawn wagons using rectangular wooden (later iron) rails
winning:	to prepare a shaft for the extraction of coal

Source: These definitions are taken in part from Flinn (1984: 458-462).