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Accounting for management as an expression of eighteenth century rationalism: two case studies

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Accounting for Management as an Expression of Eighteenth Century Rationalism: Two Case Studies

A Thesis submitted in fulfilment of the requirements for the award of the degree:

DOCTOR OF PHILOSOPHY

from the
UNIVERSITY OF WOLLONGONG

By

Robert B Williams B.Com, M.Com(Hons), Dip.Ed.

Department of Accountancy 1995
Abstract

This study is concerned with the use of management accounting in an eighteenth century context through the examination of the accounting systems employed by two firms which operated, in England, in the latter part of that century.

The study begins with a discussion of the movements, both social and intellectual, which originated in the Enlightenment of the seventeenth century. Revised attitudes towards science and the search for knowledge led to the notion of 'useful knowledge' which could be applied for the betterment of mankind. Accountancy was considered to be one source of such useful knowledge.

The eighteenth century was a time of great change, especially in the processes of manufacture, which in a number of industries changed from a domestic based system to a factory based system. This change was influenced by and in turn influenced a number of social changes which are illustrated in the lives of James Watt jnr and Samuel Oldknow as they dealt with the day to day problems of managing their respective businesses. Both men came from different backgrounds yet held a number of similar attitudes, it is suggested that these attitudes led to their use of accounting as an aid to management.

Oldknow was involved in the cotton industry, which developed in Britain towards the end of the eighteenth century, and was for a time the leading manufacturer of muslins. Oldknow's accounting records
reflect the transition from the domestic system to the factory system of manufacture and indicate the changing demand for management information.

On the other hand, Watt jnr was a second generation industrialist, trained for his job and appointed to run the Soho Foundry, an enterprise established to manufacture steam engines. The accounting records of this organisation display the use of sophisticated management accounting techniques and are presented as an example of the use of accounting knowledge in the period of the 'Industrial Revolution'.

The examples of Watt jnr and Oldknow show uses of accounting information that is in accord with current definitions of management accounting and it is suggested that both men saw accounting as providing knowledge that was both useful and important to them in managing the businesses that they each operated.
Dedication

for Ruth

"Many women do noble things but you surpass them all"
Proverbs 31:29
Acknowledgments

It is with sincere appreciation that I acknowledge the patience, understanding and encouragement of my wife Ruth and my family, for without such encouragement this project would never have been completed. I also express my gratitude to my supervisor Michael Gaffikin for his helpfulness and assistance during the course of undertaking this study.

I am grateful also to David and Dell Cook who generously provided accommodation whilst I undertook archival research in England, and to colleagues Warwick Funnell and Janet Moore for their support.
NOTE:

The original spelling, punctuation, grammar and, as far as possible, formatting used by the original authors has been maintained in quotations. As well, the system of weights, measures and money in force in the eighteenth century has also been maintained. Relevant weights and measures include:

LENGTH:

Lineal measure was regulated by the yard. It was divided into 36 inches [1 inch = 25.4 millimetres]. When used for measuring cloth, the yard was divided into 4 quarters, and each quarter further subdivided into 4 nails. The English ell was equal to a yard and a quarter, or 45 inches [Hamilton, 1788].

Cotton was spun into hanks of 840 yards in length, the number of hanks to the pound weight was called the 'count' and was a measure of fineness.

WEIGHT:

The basic measure was the ounce [28.35 grams]. 16 ounces make one pound (lb), 14 pounds equal one stone, two stones or 28lb make one quarter, four quarters or 112lb equal one hundredweight (cwt) and 20 cwt equal one ton or 2240lbs.

MONEY:

All money is recorded in Pounds (£), Shillings (s) and Pence (d).
12 d = 1s or 1/-
20/- = £1
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CHAPTER 1

INTRODUCTION

The factory masters of late eighteenth century Britain had a problem, not only of developing products in a competitive market, but of managing developing businesses at a time when there were no existing models on which to base solutions. For a number of these entrepreneurs accounting provided assistance in the planning and control aspects of their organisations. This study adds to the history of management accounting by elucidating and illuminating a period in its development with suggestions as to some reasons why it was used by the industrialists of the period. The thesis examines the use of management accounting techniques in the late eighteenth century, in England, by Samuel Oldknow, a cotton spinner, and James Watt jnr, a manufacturer of steam engines, as being consistent with their attitudes and philosophies based on scientific materialism.

The history of accounting in its various forms is a very long one and it could be argued that the prime motivation for the keeping of records was to aid the process of management by keeping track of obligations owed to and by the business venture. Pollard [1965] describes three such accounting systems which he argues predate what would be considered as being akin to modern management accounting. These systems include the master/steward or
charge/discharge system which was developed for the administration of large estates; the mercantile system, which arose out of the practices of overseas merchants and bankers; and the accounting developed by manufacturers using the putting-out system. While these three systems held relevance for management accounting, none addressed the peculiar problems that beset the entrepreneurs faced with the development of new technologies of manufacturing. These three practices of accounting were essentially concerned with the regulation of transactions between the manufacturer/estate owner/merchant and the other parties who were external to, yet essential to the conduct of the business. However, these practices do not comply with that which is generally understood by the term management accounting.

Management Accounting

Definitions and Recent Understandings

It would be useful at this point to establish an understanding of what is meant by the use of the term 'management accounting'. A starting point could be the definition of management accounting put forward by Horngren, et al, a standard text on the subject, which describes the use of management accounting in the late twentieth century. They describe management accounting as being focussed on internal customers and measuring and reporting "financial and other information that assists managers in fulfilling goals of the organisation" [1994, p 4].
Similar definitions in other text-books [Hilton, 1994; Garrison & Noreen, 1994; Dyckman, et al, 1994; Emmanuel, et al, 1990; Scapens, 1991] also highlight the internalisation, as it were, of accounting, where accounting records become used in the internal management of a business, rather than solely as a record of external obligations. The definitions are very general in nature, but they all emphasise the notion of the provision of information to assist in the management processes of planning, controlling, organising and decision making [Garrison & Noreen, 1994]. The texts also emphasise that management accounting includes cost accounting, as a system of accumulating cost and other quantitative data, but is wider in its application than the accumulation of costs inasmuch as it provides information for the whole range of managerial activity [Dyckman, et al, 1994]. Cost accounting, then, is encompassed by management accounting, which goes beyond the recording and calculation of cost to incorporate the uses to which cost and other information is put.

Horngren, et al, suggest that management accounting is concerned with three of the four purposes of an accounting system. Those three purposes are:

1. Internal routine reporting to managers for (a) cost planning and cost control of operations and (b) performance evaluation of people and activities.
2. Internal routine reporting to managers on the profitability of products, brand categories, customers, distribution channels and so on. This information is used in making decisions on resource allocation and in some cases decisions on pricing.
[3] Internal nonroutine reporting to managers for strategic and tactical decisions on matters such as formulating overall policies and long-range plans, new product development, investing in equipment, and special orders or special situations.


Again, the stress is on the internal use of accounting data for purposes of management, for the recording of internal transactions as opposed to transactions with external entities.

Management accounting reflects the use of techniques from different disciplines, for the solving of organisational problems, its major focus being the efficient allocation of resources within an organisation [Belkaouï, 1980]. This notion of efficiency of resource allocation is central to the use of accounting information because it highlights the problem of dealing with resources that are always scarce and in demand for a number of alternative applications. The wider role of accounting information has come to prominence since World War II, prior to that the emphasis was on cost and cost control [Scapens, 1991]. Belkaouï [1980] supported the above definition by emphasising its decision support role as well as its use in motivation and the encouragement of efficiency. Belkaouï described management accounting as being "... accounting-based, and individual-, organisation-, and decision-centred" [1980, p 2].

The accounting characteristic of management accounting is related to the accumulation, classification, analysis and adaptation of information. Its organisational dimension is concerned with tailoring a system of internal reports to the organisational structure. The
behavioural aspect is concerned with taking into consideration the cognitive make-up of the recipients of the information as well as motivational factors. Finally the information provided by the system must be relevant for decision making-purposes [Belkaoui, 1980].

Management accounting information is produced to assist managers in carrying out their roles of planning and controlling the function for which they are responsible. Of course, accounting is not the only source of information available to managers, but it does provide a means of quantifying, in common terms, generally money, overall performance. This integrative function of management accounting was referred to by Emmanuel, et al, when they wrote:

... management accounting systems are of major importance because they represent one of the few integrative mechanisms capable of summarising the effect of organisations in quantitative terms.

[1991, p 4]

The integrative function of management accounting becomes paramount as organisations grow in size and complexity. Often accounting is the only source of such information, the aggregation of which makes clear the performance of the organisation as an entity: an aggregation that is essential if the direction of the entity is to be maintained and monitored.

Management accounting assists in the planning function by providing information relevant to product marketing. It aids short-term planning by providing data on past performance and projected future performance. As well, the budgetary process is designed to ensure that the short-term plans from the various parts of the
organisation are in harmony and their assemblage into the master budget provides a financial plan for the organisation as a whole.

The control function of management is helped by the regular production of performance reports that compare actual results with expected results and calculate trends and other significant statistics. Control is assisted by measurements that identify trouble spots and prompt action to be taken. Performance reports are also intended to motivate desirable performance by providing an indication of the effectiveness of goal achievement and a measure of operational efficiency.

The conventional view of the role of management accounting is that it is a provider of information to management. The implication is that this information is objective and free from bias. There is another view, however, that discounts this somewhat idealistic view of management accounting. In the abstract to her paper, Loft writes that management accounting

\[1986, \text{p}\ 137\]

She then goes on, in her paper, to suggest the conventional view might not be the real situation.

Management accounting can be used as a tool of control, in the sense of domination. This view is supported by doubts about the objectivity of information based, so often, on judgements and
interpretations [Miller & O'Leary, 1987; Hopper & Macintosh, 1990; Hopwood, 1987; Neimark & Tinker, 1986; Hoskin & Macve, 1994]. As well, management accounting information tends to flow up the organisational hierarchy, so those occupying a higher status have greater knowledge than those below them in the hierarchy.

Standards and budgets provide prescriptions for behaviour with the system providing information to evaluate and discipline those not complying with the prescription. It is this dual role of management accounting that must be borne in mind when considering the operation of accounting techniques within the context and culture of a particular organisation.

Roberts and Scapens, as a result of their research reported that management accounting did fulfil its traditional role of providing information to help manage but that it also exhibited this dual role of domination. They stated that accounting information

... appeared to be used both as a means of integration and co-ordination and also as an instrument of domination.

[1990, p 107]

This dark side of accounting must be considered when looking at historical uses of accounting where its technology was often instigated as a disciplinary procedure [Walsh & Stewart, 1992] and has been highlighted in studies by Hopper and Armstrong [1991], Miller and O'Leary [1987], Hoskin and Macve [1986, 1992a, 1992b, 1994], and Walsh and Stewart [1992] among others.
The Rise of Management Accounting in Eighteenth Century Britain

Accounting as a management process seems to have become important when the number of internal transactions within an organisation became significant. This implies a change of process and the incorporation of new ways of achieving organisational objectives [Lee, 1975].

The problem then becomes one of where to start to look for the conditions that would require a change in accounting method. For this reason it was decided to concentrate the search on a time when the very nature of the management process was changing, when the nature of how businesses were conducted was going through a process of evolution, for a time when the nature of business activity became such that information supplied by the market became insufficient for the regulation and control of the intermediate transactions in an organisation's production cycle. It has been suggested that management accounting finds its roots in that period known as the Industrial Revolution, that period when the nature of the management process changed with the advent of the factory system [Lee, 1975; Yamey, 1978; Pollard, 1963; Mepham, 1988; McKendrick, 1970; Littleton, 1933; Johnson & Kaplan, 1987; Jones, 1985; Fleischman & Parker, 1990, 1992; Fleischman & Tyson, 1993; Chatfield, 1977; Kaplan, 1984].

The eighteenth century, in Britain, was a time of change in managerial practices. In the course of half a century, manufacturing
changed, in a number of industries, from being cottage and small workshop based to the use of great factories employing many hundreds of people. By the turn of the century, new industries had been established and the Industrial Revolution was well under way. It is to this period, the late eighteenth century, that this thesis looks to discover changes in the role of accounting in its development as an aid to management. It was also decided to limit the research to Britain, because in the eighteenth century Britain was the location of the most consistent and concentrated move to industrialisation [Lee, 1975; Chapman, 1967; Hill, 1967; Mantoux, 1961; Plumb, 1950; Pollard, 1965, 1963; Langford, 1992; Hobsbawm, 1968; Berg & Hudson, 1992].

Interest in the accounting practices of the Industrial Revolution is indicated in recent literature detailing the accounting of a number of firms which operated in the eighteenth and early nineteenth centuries. Edwards and Baber [1979], have written about cost accounting and the Dowlais Iron Company; McKendrick [1970] has written about Wedgewood; Flieschman and Parker [1990, 1992, 1994] have also been concerned with the period, writing about the Carron Company, a preliminary article about James Watt jnr, and other entrepreneurs of the period; Walsh and Stewart [1992] were concerned with Robert Owen and his cotton mill at New Lanark, Scotland; Stone [1973] wrote about the Charlton Mills of Manchester, Beckett [1977] has written a case study of a factory in the 1740s and Jones [1985] has written a book about the use of cost accounting in Wales in the eighteenth century.
This increasing literature is an indication of the interest that is developing in the accounting practices of newly emerging businesses, in the late eighteenth century; it details a time when there were no standards of accounting practice, when each business developed an accounting that suited its needs [Littleton, 1933]. Prompting a further question as to why accounting came to be used as an aid to management. There has been some controversy too as to how these uses of accounting should be interpreted and how accounting practices should be seen in the context of later theories of behaviour [Hoskin & Macve, 1992, 1994].

The question of the very beginning of the use of accounting for management, in Britain, is one that will probably never be answered because time has left only a few records to be analysed. However, those records that do remain, in Britain from the late eighteenth century, indicate the use of accounting in specific instances and it is to those instances that this and the studies referred to above, have turned. This study is based on case studies of businesses operated by Samuel Oldknow and James Watt jnr at the turn of the nineteenth century with a view to examining the use made, by those men, of accounting information in the management of their respective businesses. At a time when there was little separation of the entrepreneur from the business it is necessary to examine as far as possible the views, opinions and the life generally of those in control of the respective business operations. Also, it was a time when there were no established management accounting models, when even notions of cost were somewhat hazy and mainly limited to
prime cost, so each entrepreneur developed an accounting model that suited his circumstances [Littleton, 1933; Lee, 1975].

The Industrial Revolution in Britain

The stories to be presented in later chapters are sited in that period known as the 'Industrial Revolution'. A fairly capricious term, its use was first attributed to Friedrich Engels who used it in 1845 [Mantoux, 1961], but one that requires some sort of definition to set the time period covered by this thesis. A revolution in retrospect, that was far reaching in its consequences, firstly for British society, and then for other countries, its beginning has been put variously in the 1760s [Ashton 1963], in the 1780s [Hobsbawm, 1991], in the last third of the eighteenth century [Mantoux, 1961] and often not defined at all.

In recent times there has been controversy over whether in fact there was an Industrial Revolution. The questioning arose from the attempts by economic historians to quantify various economic indicators pertaining to the second half of the eighteenth and early part of the nineteenth centuries. Fores [1981] even questioned the use of the term 'Industrial Revolution' and suggested that there was no technical revolution before 1850 and that outside the textile industry, iron production and a few other manufacturing processes, there was no widespread introduction of mechanisation and factory production and traditional handicrafts predominated, a point taken up by Berg and Hudson [1992] who countered with the argument
that there had been a continual development in methods of production and organisation in the traditional handicraft activities throughout the latter part of the eighteenth century.

The notion of gradual evolution of the British economy was supported by Crafts, whose work on reconstructing the national accounts for the eighteenth century shows no major discontinuities between 1700 and 1831 [Hoppit, 1990]. Although, Crafts noticed a shift from agriculture to industry and an increasing dependence of manufacturing industry on exports during this period, leading him to suggest that the term 'Industrial Revolution' was still useful even though growth was much slower than hitherto believed [Hoppit, 1990]. According to Hoppit [1990] the conclusion drawn by Crafts and others, emphasise the slow rate of growth of the British economy overall during the period, together with low productivity and investment rates as a witness to the fragility of industrialisation. It was suggested that structural change during the 'Industrial Revolution' came as a result of agriculture decreasing its share of the labour force. Hoppit [1990] questioned the validity of the quantitative data produced by Crafts and points to the not inconsiderable difficulty of quantifying the social and economic structure of Britain before 1831.

Berg and Hudson [1992] also take issue with the gradualist view adopted by Crafts, and others, and point out the views held by those who lived through the last part of the eighteenth century. They quote, for example, Patrick Colquhoun who wrote in his *A Treatise on the Wealth, Power and Resources of the British Empire*, in 1814:
It is impossible to contemplate the progress of manufactures in Great Britain within the last thirty years without wonder and astonishment. Its rapidity, particularly since the commencement of the French revolutionary war, exceeds all credibility. The improvement of steam engines, but above all the facilities afforded to the great branches of the woollen and cotton manufactory by ingenious machinery, invigorated by capital and skill, are beyond all calculation...

[quoted in Berg & Hudson, 1992, p 26]

Robert Owen in his *Report to the County of Lanark* in 1820 supported Colquhoun's assertions when he wrote that

(i)t is well known that, during the last half century in particular, Great Britain, beyond any other nation, has progressively increased its powers of production, by rapid advancements in scientific improvements and arrangements, introduced more or less, into all the departments of productive industry throughout the empire.

[Owen, 1970, p 202]

Berg and Hudson [1992] argue that what was obvious to contemporaries has been obscured by the use of reconstructed national accounts and other aggregated statistics, which they feel is not a good starting point for the analysis of fundamental economic discontinuity. They examined four areas in which they hold a fundamental and unique change occurred during the Industrial Revolution viz. "technical and organisational innovation outside the factory sector, the deployment of female and child labour, regional specialisation, and demographic development" [p 27]. They suggested that radical innovations in the more traditional industries enhanced the success of the cotton industry, as a counter to the
argument that during the period most industrial labour was employed in the more traditional industries. They also suggested, that innovation was spread over the whole range of industries further enhancing productivity, quality and the introduction of new products.

The official statistics of the period, tended to disregard the labour provided by women and children and often wage books record payment to the male head of the household for the labour provided by the family as a whole, so to base productivity calculations on male wages provided a distorted view. Yet the labour provided by women and children was vital to all branches of industry, as Berg and Hudson point out:

... factors both on the supply and on the demand side of the labour market resulted in a labour force structure with high proportions of child and female workers. They were the key elements in the labour intensity, economic differentiation, and low production costs found in late eighteenth century industries. This in turn influenced and was influenced by innovation. New work disciplines, new forms of subcontracting and putting-out networks, new factory organisation, and even new technologies were tried out on women and children.

[Berg & Hudson, 1992, p 36]

The use of female and child labour declined in importance during the course of the nineteenth century as a result of legislation, trade union activity and changing social views on the role of women. The importance of female and child labour can best be completely understood at a disaggregated level and is not necessarily reflected in national accounts [Berg & Hudson, 1992].
Berg and Hudson argue for a move from a macro-accounting framework and suggest that research based on a regional and social level will reintroduce the idea of the dramatic social and economic change represented by the Industrial Revolution and obscured by the movement of aggregate quantitative indicators. This was supported by Hoppit when he wrote:

Commonly, the industrial revolution is seen as a *transition*, involving interconnected changes and continuities, in which the whole tenor, direction and possibilities of economic life were transformed, enabling very dramatic demographic challenges to be defeated over the long term. The industrial revolution did not completely replace one world by another, rather it was the early establishment of the framework by which that was to be achieved ... Such attitudes and perceptions are not to be tested just by counting factories, steam engines or cotton output.

[1990, p 188]

Hoppit suggests that historians must avoid the apparent authority and precision offered by tables of numbers which have a dubious provenance and use them for those parts of the Industrial Revolution that can be counted and those parts only.

The argument put forward by those suggesting gradual change and not 'revolution' ignores the cultural changes that took place during the eighteenth century. Newman refers to the 'literary revolution' which saw the growth of a nationalist literature that "promoted that 'frank' rejection of hand-me-down attitudes which was so vital to the acceptance and implication of new technical ideas" [1987, p151]. McKendrick, et al, [1982] wrote of the commercialisation of the economy that took place during the eighteenth century encouraging
changing attitudes on the part of both the consumer and the producer, requiring changes in the organisation of production to be able to respond to changes in fashion and fashion consciousness among a wider community. It is these changes that are not reflected in aggregate statistics, yet contribute to the new direction taken by the British economy and society during this period, that need to be taken into account when considering that period encompassed by the term 'Industrial Revolution'.

The discussion has come in a circle because the earlier authorities, as well as those authorities quoted above, now seem to agree that the second half of the eighteenth century witnessed a gathering momentum of change [Hamilton, 1953; Ashton, 1963; Mathias, 1969; Berg & Hudson, 1992; Hoppit, 1990]. The change was essentially one of organisation [Musson, 1982; Ashton, 1963]. Building on technical innovation of the earlier part of the eighteenth century in many cases, taking advantage of changes in transport and agriculture, the revolution was in methods of manufacture as the modern factory came into being.

Hobsbawm writes of the Industrial Revolution "breaking out". By this he refers to the ability of society to increase its productive capacity to the point of self-sustained growth. He writes that no

... previous society had been able to break through the ceiling which a pre-industrial social structure, defective science and technology, and consequently periodic breakdown, famine and death imposed on production.

[1991, p 43]
According to Hobsbawm [1991, p 44] the initial momentum for this change can be observed from the middle of the eighteenth century, a phenomena that has led some historians to date the Industrial Revolution as beginning in the 1760s. Investigation of the relevant statistical indices by Hobsbawm and others has indicated that the 1780s are the years in which the economy of Britain showed a sudden turn upwards. A turn which in Hobsbawm's phrase marks the "take-off", although statistics developed by Crafts would tend to deny this assertion and highlight the problems of dealing with imprecise data [Hoppit, 1990; Berg & Hudson, 1992].

The Industrial Revolution was not a revolution in the ordinary sense of the term. It is difficult to find its beginning and according to many it is still in process. For the purposes of this thesis the term Industrial Revolution is concerned with the period beginning around 1780 in Britain. It is concerned essentially with a period of transition, when old ways were giving way to new and new industries, such as the cotton industry, with novel approaches to management, were taking hold. Berg & Hudson [1992] point to the regional nature of industrial change, the development of the cotton industry in Lancashire for example, and the lack of change in other areas. However, this thesis is concerned with two men who were very much caught up in the development of new methods of production and organisation and even though the notion of an 'Industrial Revolution' may be open to conjecture and dispute, for James Watt jnr and Samuel Oldknow the 'Industrial Revolution' was very much part of their lives.
The Role of Biography In Constructing Historical Narrative

The history of human endeavour is made up of the actions and lives of individuals [Butterfield, 1955]. The approach adopted in this thesis is one essentially of biography, as the building block of history. Biography provides a prism of history which allows a focus on a particular period and/or practice not possible with a more general view of the subject [Tuchman, 1982]. For the purposes of this thesis, biography allows an examination of the particular accounting practices used by Watt jnr and Oldknow as well as the influences that were present in their lives that persuaded them to act as they did. Through the prism of their actions it is then possible to gain insight into the actions of industrialists in similar circumstances.

In recent times biography does not seem to be very popular with historians, possibly because, as Porter [1981] suggests, the relationships between individuals and other elements are too complex to be explained by causal determinism. Nevertheless, biography is useful in exploring the development of management accounting because its beginnings depended on the activities of individuals. Biography provides a study in the context of the period in which the subjects lived and worked, as well as providing an insight into the reasons for the subjects' actions.

There are dangers in biography, in bringing to prominence an individual actor, especially one who lived two hundred years ago. The biography can never be complete because we have only
documentary evidence remaining which tells only part of the story and often motives can only be guessed at. As well, secondary characters must remain in the background even though they may in fact be more significant, they can only ever be partially accounted for inasmuch as they interact with the subject [Stewart & Walsh, 1993]. However, biography presents a wealth of detail, and psychological insights into the actor, that is vital in the understanding of the actions.

Other dangers can be present when the actions of the subject, of the biography, are magnified out of proportion to the extent that the accomplishments of the subject are emphasised and praised to the neglect of the conditions that encouraged those accomplishments. This can lead to unreal conclusions about the subject [Stewart & Walsh, 1993]. This thesis takes a more moderate line where the two subjects are seen as interacting with their environment and are very much part of that situation. The subjects are considered as being influenced by and in turn influencing the social and cultural contexts of their lives.

In support of biography as a tool in the exploration of history, Porter had the following to say:

The biographical approach is not "wrong" however, because it allows the historian to substantiate or amend his definitions of elements at the group, institutional or conceptual levels. One understands the eighteenth-century Enlightenment more precisely by looking at its expression in the life of Diderot or of Jefferson, just as one clarifies the meaning of a group by studying the feelings of its members. Care must be taken, of course, that no single individual be represented as the full
expression of any other element in the hierarchy. The individual perceives aspects, not wholes, just as the actual event incorporates only aspects of that individual's experience.

[1981, p 90]

For this reason the lives of Oldknow and Watt jnr are of interest, their reactions and the procedures they adopted to deal with the problems they faced help illuminate the world of industry in the late eighteenth century. The substantial records each left assists in the understanding of the use each made of accounting information, which can be tied in to what is known of general economic conditions of the time.

The individual actor does not live in isolation so in the explanation of that individual's actions it is necessary to also pay attention to his/her relationships with others and the wider context of the society in which that individual lived. It therefore becomes necessary to examine individual experience with reference to the groups to which the individual belonged and the beliefs, knowledge systems, interests and structures that impacted on the individual's life [Porter, 1981; Appleby, et al, 1994; Previtts, et al, 1990b].

Biography is part of the narrative process, albeit at the level of the individual, which seeks to tell of the story of an event and the relationship of that event with other events. Porter refers to an event as

... a temporal process, constituting a definite pattern of relationships with respect to its antecedents. The antecedent world is presented as a set of conditional data, each with a subjective intensity derived from its own formative experience. These data and feelings are
assimilated as elements in the emerging pattern of the novel event. They undergo transformation and integration to a degree consistent with the event's organisational complexity. The final, integrated pattern represents a decision by the event to be what it is and not anything else, a decision implying a range of alternatives that were not realised on this occasion.

[1981, p84]

The event of concern in this thesis is the use of accounting for the purposes of the management of large industrial enterprises.

When explaining the emergence of management accounting, using as a centrepiece the technique of biography, it is important to discuss the antecedent conditions that were involved because the attitudes, the institutions, and the philosophies of the actors all played a part. It was not inevitable that accounting would be adapted to the use of management, but it was, and the process of this transformation provides a key to the constitution of management accounting [Littleton, 1933]. The analysis of an historical period requires that its fundamental principles of order be identified and the ways that these principles are articulated in the events of the period can then be elucidated. The value of this process lies in the extension of experience and its enrichment by reflection [Porter, 1981; Stewart & Walsh, 1993]

Plan of The Thesis

With the intention of examining existent accounting practices for evidence of their use consistent with the present meanings given to
management accounting, this thesis is essentially concerned with two very different businesses; that of Samuel Oldknow, who began his career as a cotton 'manufacturer' in Anderton, Lancashire and ended as a cotton spinner at Mellor in Derbyshire; and the Soho Foundry, a purpose-built factory owned by the partnership Boulton, Watt and Sons which was designed to manufacture steam engines. The two examples of the accounting processes of these enterprises provide an interesting contrast both in their nature and the nature of the men in control, Samuel Oldknow and James Watt jnr; two men, very different in personality and education, yet with many similarities.

Oldknow was selected for this thesis because his business life, beginning in the 1780s and ending in 1828, covers a period of transition from being involved almost completely in the cotton industry from the time it was run as a cottage industry on a putting-out basis to the time it was run on a factory basis when Oldknow employed some 500 people in his mill. Those accounting records that remain, reflect this change of emphasis and transition from one mode of production to the other. Oldknow was involved in several projects, and fortunately a number of records remain to give an indication of the accounting processes he used.

The Soho Foundry, which operated essentially under the guidance of James Watt jnr, was selected because it represents a concerted action to establish, and not adapt, a facility to achieve a specific aim. It was a settled business in the sense that it was built with a purpose in mind and did not go through an evolutionary process as did
Oldknow's business. The Soho Foundry was established with the benefit of the experience of the existing steam engine manufacturing business established by Matthew Boulton and James Watt (sen) in 1775, so that it was not a new experiment. Certainly the procedure of casting and boring metal used in the Soho Foundry were new activities for the partnership, but the process of managing a large enterprise was not. Accounting practices were fairly settled in this organisation and a deal of reliance was placed upon them, the interest for this thesis lies in how this organisation, advanced in its development, used accounting to assist its management processes. The record of the Soho Foundry is well preserved and contains extensive accounting records.

The typical firms of the late eighteenth century were essentially partnerships or owned and run by one person. As a result the interests and personality of the owners are important because of the bearing they had on how the businesses were run [Lee, 1975; Schmoller, 1953]. Hence, emphasis has been placed on the biographies of both Oldknow and Watt jnr. It was their attitudes that determined the course and management of their businesses. The problem of determining these attitudes at a distance of two hundred years is not altogether insurmountable; they were both men very much involved in the social, religious and scientific movements of their times, movements which have been described extensively. They were also well known in the circles in which they moved, so that, as well as there being evidence of attitudes in diaries and other personal papers, there are also comments by third parties.
Plan of the Study

The eighteenth century was a time of innovation, with an emphasis on rational behaviour. It is important to have an insight into the period and its social and philosophical movements to establish a context for the biographies of Watt jnr and Oldknow. To this end Chapters Two and Three give an overview of philosophical and social attitudes that were becoming prevalent from the early part of the eighteenth century; attitudes founded in the Reformation of the previous century and the 'enlightenment' that came from the development of 'science'. Attitudes developed from a growing, changing system of education, from religious views, from technical innovation and from an expanding horizon of potentialities springing from a developing empire. These forces shaped Oldknow and Watt and had a marked influence on their attitudes and, it is suggested in this thesis, played an important role in the use of accounting in the management of their different enterprises.

Chapter Two is concerned with the philosophical ideas that emanated from the late seventeenth century and found its expression in the term 'Enlightenment'. The principle of Enlightenment led to revised attitudes in relation to science and the search for knowledge. This in turn led to the notion of 'useful knowledge'. Knowledge was regarded to be useful when it could be applied with some material benefit accruing to the holder of such knowledge. Accountancy was one source of useful knowledge as was the process of calculation and quantification in general. Quantification and measurement established fact, and fact was considered to be 'useful'. The chapter
discusses the rise to prominence of quantification and more particularly the development of accounting practice as a basis for management accounting. The chapter goes on to discuss the changing nature of manufacture and how it found expression in the development of the cotton industry and also in the development of the steam engine as a commodity in the supply of power.

Chapter Three takes a somewhat wider view of the forces and movements that were present in British society in the second half of the eighteenth century, that had relevance to Watt jnr and Oldknow and the establishment of the factory system in general. The Industrial Revolution was stimulated by a number of factors including economic, societal and cultural changes that had been developing throughout the previous hundred years. These factors also had an influence on the lives and personalities of Oldknow and Watt and were of consequence in their management methods. The chapter discusses changes in the availability and use of labour as one of the factors of production as well as the problems reported by industrialists as they sought to recruit and train their workforce. The chapter also highlights the religious, social and scientific networks that held relevance for both Oldknow and Watt jnr. It also discusses the rise of industrialists as a group with Josiah Wedgewood given as an example.

Chapter Four is concerned with the life and accounting records of Samuel Oldknow. Oldknow had a reputation for producing high quality cotton goods and operated in Lancashire, Cheshire and Derbyshire. Oldknow's business career followed very closely the
development of the cotton trade in Britain and his records reflect the
growth and maturity of this industry. Samuel Oldknow was selected
as a subject for this research because his background was typical of
many who entered the newly developing cotton industry in that he
came from a lower-middle-class family and developed his particular
business from nothing [Crouzet, 1985] to one which had a very high
reputation. His records show how the nature of his various
enterprises changed as the cotton industry evolved.

Chapter Five is concerned with the business career of James Watt
jnr and the Soho Foundry. Established in 1795, the Soho Foundry
employed a sophisticated system of accounting. The chapter
discusses Watt the man as well as the accounting he used to run
that particular enterprise. Unlike Oldknow, Watt jnr was brought up
and trained for a career as an industrialist and entered an
established business with the advantage of readily available capital
and reputation. The example of Watt jnr was chosen because the
business he operated shows evidence of the use of quite
sophisticated accounting techniques.

Chapter Six presents a summary of this project and suggests that
the uses to which Oldknow and Watt jnr put management
accounting information accord with the definition of management
accounting as it is practised in the late twentieth century.

History does not happen but is caused to happen by people going
about their daily lives, often with no plan, yet at the distance of time
it is possible to discern patterns and reasons why they did what they
did. We can observe the spinning statistics accumulated by Oldknow, and the comprehensive cost investigations undertaken by Watt jnr before agreeing to piece rates for his workmen. We can relate these actions to what is known of the characters of the two men. There is a number of examples of their accounting in existence on which to gain a picture of the accounting processes each instigated. That they saw value in these processes is evidenced by the fact that they persevered with them over many years.

This thesis is concerned to show the use, by these two individuals, of accounting techniques to record and manage their businesses rather than some other technology. Neither business was required to submit information to shareholders: the Soho Foundry was a partnership with the partners being very close, while for the most part Oldknow acted on his own. Any accounting processes instituted were solely for the benefit of the proprietors. For them the 'objectivity' of accounting and its ability to clarify and provide a field of view was important. It is suggested that their accounting practices reflected their attitudes as 'rationalists' who perceived their world in terms of concrete facts embodied in measurement. Accounting was conceived as helping them bring order to their environment by its very processes of recording in terms of measurable quantities.

Accounting does have a number of virtues which might appeal to an entrepreneur. It implies a set of rules and an imposed order on business affairs. It can simplify administration by listing defined and desired objectives. It can be used to impose a discipline by the
expectation of performance by employees. It can create a field of view which can expose and record behaviour and performance. It can also provide a basis for legitimation in relationships and negotiations. It is suggested that these attributes of accounting were considered by Watt and Oldknow as they developed their accounting systems, because they fitted well with the personal philosophy of each man as revealed by their associations and interests.
During the Middle Ages the commands of God and the fear of damnation determined individual practical decisions. People believed in a geocentric cosmos, fixed and hierarchic, where supernatural forces could, and regularly did, influence the workings of the natural order. The material severity of life, and vulnerability to the caprices of nature, to famines, epidemics and disease, compounded the repressive quality of the social order. But the new findings and habits of mind resulting from scientific inquiry during the seventeenth century and the eighteenth century Enlightenment, especially in astronomy, physics and biology, marked a major turning point in human history. A new, rational outlook undermined the medieval world view. ... The many scientific breakthroughs of the age convinced most educated people that a decisive break with the past had occurred. New habits of thought liberated humans from superstitious belief in evil forces, in demons and fairies. [Lines, 1992, p 16]

The view of emerging science in the eighteenth century was aimed at mastery of nature, the knowledge acquired to be used for dominion over things. Increasing control over nature allowed greater exploitation of people and those who owned and controlled the technical apparatus responsible for augmenting human productivity.
gained superiority over the general population. Power over nature led to power over fellow humans [Lines, 1992].

The second half of the eighteenth century provided a turning point in the development of organisations and commercial society. That movement of ideas and endeavours, now referred to as the Industrial Revolution, marked a fundamental transformation of human life. It represented an acceleration of growth through and because of both economic and social transformation. The first stirrings of the Industrial Revolution began in Britain and subsequently the British experience served as a model for other countries undergoing their own industrial revolution. However, the British experience was unique in that it was the first and came after some two hundred years of continuous economic and scientific development, that laid a foundation for the changes that were to take place: changes that were far reaching and extended outwards, because Britain was not isolated, but was part of a network of economic relationships which included the rest of Europe and the extensive network of colonies and former colonies that had been established [Hobsbawm, 1969, 1991; Ashton, 1963; Mantoux, 1961; Musson & Robinson, 1969; Hoppit, 1990; Berg & Hudson, 1992; Mathias, 1969].

The Industrial Revolution provided the impetus for change in economic and management practices. Expanded opportunities for trade led to increased demand for products, stimulated by the ability to produce goods more cheaply and in greater quantity through the use of technology, that led to a concern for organisation of the factors of production to ensure more efficiency and hence greater
profits. It is in this period that uses of managerial accounting are found, emerging from the need of managers to have a greater knowledge of the activities they were overseeing. This is not to suggest that people were unaware of the nature of costs, and indeed cost accounting, in the sense of being the debit side of the profit equation, has a much longer history than managerial accounting. However, changing economic relationships increased the need for greater knowledge on the part of the entrepreneurs.

There is a need to look further back into history to seek an awareness of those forces that acted to shape the use of accounting as a provider of managerial information. This chapter is concerned with the intellectual conditions which became current in the early part of the eighteenth century and the uses of accounting that were common at that time, as well as an appreciation of the growth to prominence of the two industrial activities that have major relevance for this thesis, that is the manufacture of steam engines and cotton products.

New Philosophies

The late seventeenth century and early eighteenth century saw the birth of the Enlightenment spirit, in Europe and in particular Britain, which expressed itself in an inquisitive scepticism which probed old myths and took nothing on faith, other than 'reason' that is [Mollenauer, 1965; Stromberg, 1966]. Reason and rationality became the driving force behind many of the innovations that came
about in the succeeding periods. Science and philosophy detached man from nature and turned nature into a machine that could be studied, measured, influenced and changed [Eriksen, 1988]. Stromberg described this process when he wrote that the seventeenth century

... had been an Age of Reason - impossible to deny when one thinks of Galileo and Newton, Descartes and Spinoza, Hobbes and Locke and Leibniz. That is to say, more precisely, its major thinkers had striven to perfect a method of scientific analysis that was careful, rigorous, logical, and naturalistic in that it did not refer directly to supernatural causes. God was assumed to exist as an ultimate guarantee of an orderly universe, but one sought the laws of nature in examination and analysis of the phenomena themselves.

[1966, p 113]

The establishment of reason as the dominant arbiter of scientific endeavour and social relations in the seventeenth and early eighteenth centuries was to prepare the way for the innovations that were to come. 'Reason' became the catch-cry of those who were at the forefront of industrial innovation and development; they observed, measured and evaluated before making decisions. 'Reason' became the rationale and motivation for their actions in both their businesses and personal lives [Seed, 1985].

Europeans came to the realisation that they had power over nature and over themselves. No longer were they at the mercy of a capricious nature and subject to continual cycles of epidemics, famines, wars and early death. They were beginning to feel that they had some control and this control came from the application of human intelligence. No longer were people afraid of change, in fact
the reverse; fear of stagnation became general [Gay, 1969; Hobsbawm, 1991].

Men had become conscious of themselves, not merely as members of society destined to take orders but as free spirits who could sit in judgement and who could demand that the world meet their demands for a full and satisfying life. This was not necessarily an easy process because the grip of vested interests was very strong. There was a move to free individuals from the constraints of the past and to grant them their rights to live as they wished [Rogers, 1932].

There were problems as well, because the yard-stick of reason could provide a severe judgement and did not allow for the flights of fancy of the more creative side of human nature. Rogers wrote of the destructive features of the Enlightenment as being

... a certain lack of imagination, a hatred of vague enthusiasms and of misty ideals and ideas, a determination to apply the test of a severely critical reason to everything and to reject whatever will not stand the test, and the constant reference in all this, as the court of final appeal, to the one undoubted fact - the individual man exercising his rational powers of understanding, and possessed of inalienable rights which society is bound to respect.

[1936, p 352]

Nevertheless, confidence became the "companion of realism rather than a symptom of Utopian imagination" [Gay, 1969, p 3].

The overriding tenor of the period was a greater faith in men's abilities over the environment, a growing hope for life, a greater trust
in effort, a greater commitment to inquiry and criticism, a greater interest in social reform and a growing willingness to take risks [Hobsbawm, 1991]. This new style of thought was to the advantage of the well-born, the articulate and the lucky. The poor remained so, although they gained perhaps indirectly from new innovations and eventually cheaper products. As discussed in the next chapter, agriculture was rationalised by the enclosure movement, leading to an increase in food production but labour was not needed to the same extent and the poor were thrown off the land into the towns [Hobsbawm, 1991; Berg & Hudson, 1992]. In the long run all profited from increased agricultural production but many went hungry during the process. This set the pattern for progress during the eighteenth century, innovation benefited some at the expense of others, yet by the end of the century all classes of society were better off, to some degree, from the changes that had taken place, particularly in the area of public health [Gay, 1969; Hobsbawm, 1991; Ashton, 1964].

Science in the seventeenth century led to a reappraisal of long-held beliefs, resulting in a profound change in the conception of man's place in the universe. No longer was Earth seen as the centre of the Universe, but as a minor planet and the concept of divine purpose, which had been central to science, was now thrust out of the picture. Scientists could disregard this concept in their attempt at explaining the phenomena they observed [Russell, 1989]. While Newton had a clear understanding of the distinction between the universe of God and the discourse of man, those who came after him tried to bring the two together where the system provided the reasoning and the
order, thus leading to an autonomous 'reason' which took the place of God in being the ultimate court of appeal, based not on externalities but on the internal consistency of the system itself. Everything had its place in the divine plan, which would eventually be revealed to perceptive minds [Windsor, 1990; Plumb, 1972; Thomas, 1983].

People began to think of nature as a machine which, like any other machine, could be understood, controlled and improved upon by the application of knowledge. So, over time, the laws of nature and scientific laws became equated with the laws of God. This also applied to the laws which had application to the social and moral sphere [Hill, 1967]. The Enlightenment became an attempt to find a social order which was divorced from questions of religion and the end of man [Windsor, 1990]. The order became the guide and the goal overruled by the system. Reason lay in the system and the system was established by reason. Apparent inconsistencies were dealt with by an appeal to reason. Windsor used the notion of Adam Smith's invisible hand in describing this process of appeal.

And yet, how does it work, this appeal to reason based on system, this system based on reason? By the invisible hand. So on the one hand reason exists as a method of going about things, and on the other hand it is the workings of a system which, whatever the private individual or the social animal tries to do, works out reasonably. Why? Because the private greed becomes the public good; and how? Because the hidden hand ensures that somehow or other the workings of reason, while no longer apparent in the order, are none the less apparent in the system; from which one can say the system becomes the order.

[Windsor, 1990, p 25]
The patterns of thought associated with the Enlightenment movement were not introspective, they provided an attempt to understand the world and society which gave scope to the improvement of society. The improvement of society was a goal which was considered rational yet, in England at any rate, did not threaten the social order [Gay, 1969]. Science was generally applied science. Knowledge which could be used to advance society and benefit humankind was that most sought after. Pragmatism was the overall tenor of the Enlightenment in England, with the results of applying the knowledge being considered far more important than the knowledge itself. The central impulse was to produce the same order and harmony in the social world as had been revealed in the natural world by Newton and his followers, and patterns of conduct which embodied order were sought, with social harmony seen as being anchored in the larger order of nature [Gascoigne, 1994; Porter, 1981].

The view of science was that it should produce 'useful knowledge' and theoretical speculations should be restrained by observation [Rogers, 1981]. Thus the pursuit of knowledge was linked to the notion of utility. The end result was to be bigger and better crops. The ideal of improvement, in the social as well as the technical sphere, was to become the creed for people of all levels of society [Gascoigne, 1994].

The upper class saw the Enlightenment as supporting the social order as it perceived it. It saw in the Enlightenment the support of the traditional values of church and state as well as support of its
own privileged position. The real beneficiaries and the most effective protagonists of the power of critical reasoning were those who were on the fringes of political and social power. The members of what could be termed the lower middle class perceived the acquisition of useful knowledge as a way to the procurement of property and position. These people were well placed to take advantage of and exploit the benefits of the knowledge they were acquiring. Economic benefits led to a strengthening of their attitudes. The profits from innovation created a new wealthy who gained both social and economic status through their pragmatic approach to knowledge [Plumb, 1972; Rogers, 1981; Musson, 1972].

As an example of one imbued with the enlightened spirit, Plumb described Josiah Wedgewood¹ as

... a man of little or no formal education. By the time he reached maturity he had ... absolute ... faith in the efficacy of reason ... Everything, he proclaimed, will yield to experiment, and he possessed an absolute mania for measuring, weighing, observing, recording and experimenting. Nor did he limit his consideration of the rational to his activities as a potter and entrepreneur. He thought both religion and politics should be subject to a like process. This led him to be a unitarian in the former and a radical in the latter...

[1972, p 17]

The Enlightenment movement was not just British, it occurred throughout Western Europe and in America. Philosophers together with articulate businessmen commended ceaseless activity and preached the postponement of immediate gratification for the sake of greater benefits to come. The most zealous advocates for this new

¹ 1730-1795
industriousness came from the merchants, manufacturers, bankers, physicians, shopkeepers and lawyers. In England this movement was largely in the hands of Protestant Dissenters and Scots in search of their fortune. These bearers of the Protestant ethic glorified work and introduced a new set of ideals which are largely still with us [Stromberg, 1966; Russell, 1989].

Gay summed up the impact of this philosophical approach when he wrote that

(t)he same practical philosophy that produced mechanical innovations produced the institutions that made their widespread use feasible and profitable. The factory, the minute division of labour, industrial discipline for workers and managers, improvements in credit and transport were all inventions as deliberate and as rational as the steam engine or flying shuttle.

[1969, p 9]

Such innovations were to come later but the stage was set for people of vision to look to finding new ways of attempting to solve old problems by regarding the future as being full of unrealised possibilities.

The Role of Calculation

The spread of numeracy was allied to the changes of the eighteenth century and contributed to the use of bookkeeping as a way of quantifying and thus objectifying transactions and events. In the early seventeenth century, arithmetic was a subject that concerned
chiefly those involved in a life of commerce. Arabic numerals had only been in use for a short time and as arithmetic slowly diffused, the activities of counting and measuring moved beyond the confines of commerce. In fact measuring became a kind of sport and local mathematics clubs became established. The numbers involved in this pursuit were very small yet they were concerned to attach a numerical certainty to what the majority of people were content to leave to supposition or qualitative description. Prior to this period the basic function of numbers was to simply record transactions, not to calculate. According to Cohen...

... most seventeenth-century capitalists, traders and mercantilists got along quite well without using the quantitative techniques - double entry bookkeeping, geometrical gauging, national account books - that the quantifiers praised. Something more than plain need, then, produced the urge to measure among the handful of quantifying men; clearly, something quite apart from need was at work in their efforts to measure the heights of mountains or the heat of the day. Why did they develop curiosity about the dimensions of some things but not others? One clue may lie in their frequent declarations that numbers brought satisfaction because they signified certainty, quite apart from any practical application. What was measured in the seventeenth century, then, was not only what was thought to be necessary but what most urgently needed to be made certain.

[1982, p 18]

A spate of textbooks was published in the seventeenth and eighteenth centuries which attempted to reduce arithmetic to a set of rules. However, these rules did not aid understanding but made the subject into a set of incoherent bits. Calculation was far from simple in the commercial sphere because of the very complicated system of
weights and measures then in force. Tradesmen were aided by the multiplicity of 'ready reckoners' which assisted with the process of calculation. By the end of the seventeenth century the great mass of people was content with a self-limiting version of commercial arithmetic [Cohen, 1982].

Nevertheless, those members of society who had an appreciation of mathematics applied the process of calculation and measurement to the problems that confronted them. This growing interest in mathematics was in accordance with the changing view of the world that developed from the late seventeenth century. Kline summed up this view in the following way:

Appreciation of the already amazing power of the allies, mathematics and science, imbued thinking men with enthusiasm for a sweeping reorganisation of all knowledge along the following lines. First of all, they exalted human reason as the most effective instrument for the attainment of truths, second, because they regarded mathematical reasoning as the embodiment of the purest, deepest, and the most efficacious form of all thought, the perfect justification of the claims made for the mental faculties of human beings, they urged the use of mathematical methods and mathematics proper for the derivation of knowledge. Third, investigators in each field of inquiry were to search for the relevant natural, mathematical laws. In particular, the concepts and conclusions of philosophy, religion, politics, economics, ethics and aesthetics were to be recast, each in accordance with the natural laws of its field.

[1953, p 274]

This approach to knowledge was based on an unbounded confidence in reason and a belief in the extension of mathematical methods to science and other fields of knowledge [Kline, 1953; Rogers, 1981].
An attitude that was developed further during the eighteenth century and applied to all manner of phenomena, perhaps reaching its culmination, as far as society was concerned, in the work of Bentham and the utilitarians. Mathematics provided a way of instituting order and system which accorded with the rationalist philosophies that were current [Spradlin & Porterfield, 1984].

Quantification, as a way of ordering reality, came from the chaos of the seventeenth century and acquired a reputation for reality and objectivity [Cohen, 1982]. This attitude was carried to later periods when quantification created an objective reality, an accounting that became a truth because it was quantified. Quantification imposed order and to a degree standardisation [Porter, 1992] so it follows that manufacturers with scientific and engineering leanings should use and adapt the process of accounting to assist them in the management of their businesses because of the system and order that accounting imposed [Jones, 1985].

The following sections provide a brief overview of the forms of accounting that were used to record economic activity up to and including the eighteenth century.

**Accounting for Management**

Records of business transactions have been kept in some form or another for centuries, the majority of which were to help the owner in the management of the business [Littleton, 1954; Chatfield, 1977;
Owners were also concerned with costs because costs influenced profits but costs may not have been the prime motivation for record keeping. At such a great distance in time it is difficult to do anything except speculate as to motivations. Nevertheless records do exist and it is instructive to spend some time in considering the nature of the accounting they present.

While it is a generally accepted belief, by some, that cost accounting originated in the nineteenth century and sprung from the development of manufacturing and the factory system [Littleton, 1933], this is only partly true. Examples of industrial accounting can be found in records, dating back to the beginning of the fourteenth century, of the Del Bene Company, importers and finishers of woollen cloth in Florence; also in the records of Francesco Datini a Patese merchant of woollen cloth in the late fourteenth century and the records of the Medici woollen cloth manufacturers of the fifteenth and sixteenth centuries. As well, examples of industrial bookkeeping can be found in German mining records of the sixteenth century. These examples indicate that rudimentary forms of cost accounting were commonly adopted in the textile and mining industries centuries long before the Industrial Revolution [de Roover, 1937].

De Roover [1937, pp 51-55] gives an example of sixteenth century industrial accounting found in the books of Christopher Plantin, an Antwerp printer and publisher, whose records included a double entry ledger and journal, kept in Italian according to the rules laid down by Pacioli. Plantin established his business in Antwerp in
1555 and became the leading printer of Europe. At its peak his business employed 100 men and 22 presses. He adapted printing to the demands of the public by producing high quality, low priced books. The Italian account books relate to the period 1563-1567 when he was involved in partnership. Before and after this period he used single entry records. de Roover notes that:

For each book which Plantin undertook to print, a special account was opened in the ledger ... These accounts were debited for paper used and for wages and other expenses of printing. When the book came off the press, its special account was cancelled and an account named "Books in Stock" (libri in monte) was debited. From this explanation it appears clear that the accounts opened for each book which was printed are the equivalent of a goods-in-progress account, so common in modern industrial accounting. Finally, the account "Books in Stock" is somewhat like our modern finished goods account.

[1937, p 55]

A similar appreciation of the awareness of the value for management of accounting can be found in Lee's [1991] discussion of the accounting methods of the Willoughby family of Nottinghamshire in relation to their colliery in the sixteenth century. While their books were kept on the charge/discharge principle, discussed below, they showed a consideration of cost factors. The accounts were primarily concerned with the way the family's managers discharged their duties in connection with the cash they had under their control, thus they were not designed to provide the information needed for decision making in other than an imprecise way. The accounts do, however, give an indication of the costs of running this enterprise and they also show an awareness of the implications of overhead.
The problems of accounting for industrial enterprises were mentioned in an article by Edwards [1937], where he discusses a book written in 1697 called "The Perfect Method of Merchants Accompts" by John Collins. In the book Collins gives an example of a set of dyer's accounts which show the movement of material from a raw materials account to a process account to which all the costs of dyeing are debited. This is important because "it shows the application of 'double entry' to internal transactions, namely the movement of materials" [Edwards, 1937, p 225].

Another example of cost consciousness was given by Edwards, et al, [1990] when they described the cost accounting at The Mines Royal Company's copper and silver works at Keswick in Cumberland in the period 1598-1615. The authors indicate that the surviving costings relate to the calculation of the cost per kibble\(^2\) of ore mined. Other calculations related to the cost of smelting the ore and the profit to be expected from its sale.

These examples present an awareness of cost which was also present in the 'putting-out' system of manufacture, a practice that was prevalent in the centuries to the time of the Industrial Revolution, and indeed, is still common in the clothing industry in present times.

\(^2\) Weights and measures had not been standardised at the time and often weights depended on local usage and custom. The authors suggest that the kibble was the bucket used for hoisting ore to the surface of the mine and contained somewhere between 1½ and 1¾ cwt (76 to 89 kg.) depending on whether it was heaped or flat on the top [Edwards, et al, 1990].
The putting-out system was a means of organising large-scale manufacture that was very important to the textile industry before the development of capital intensive methods of manufacture.

The Accounting Methods That Were Common During the Eighteenth Century

It is easy to assume from our late twentieth century perspective that the accounting used during the eighteenth century was based on the double entry system. However, this appears to be not necessarily the case. The merchants and merchant manufacturers were primarily concerned with accountability before profit. They were concerned to prevent embezzlement and theft. That is not to say that double-entry bookkeeping was not known, and the early part of the eighteenth century saw an increasing interest in what was known as the 'Italian method'. The accounting system known as the 'charge/discharge system addressed the need to record accountability and the use of this type of accounting can be observed in the accounts of the large estates as well as in the records left by textile manufacturers and similar operations.

Charge/Discharge Accounting

Charge and discharge accounting finds its origins in the accounts of the manor and the large estates. This system developed in England over some five hundred years [Stone, 1993] and was primarily
concerned with accountability. The lord of the manor had to depend on others to do the work of the estate and so they were 'charged' with the responsibility to do a task, which they then 'discharged'. This method of accounting evolved over time and

(charge and discharge accounting, in its final form became a system which, because of its balancing features, had some of the characteristics of a self-contained system such as double entry.

[Stone, 1993, p 4]

The purpose of this accounting was to show that the responsibilities conferred had been performed. There was apparently no attempt to calculate profit or loss, which was not as important as the notion of stewardship and the protection of assets. From the stewards' viewpoint these accounting records provided evidence that their assigned duties had been discharged.

Chatfield described the system as being constructed so that the

... charge and discharge statement was the report of an agent on the assumption and discharge of responsibilities. ... It often contained a money account, with rents and other receipts subdivided by types, and a corn and stock account, with separate categories for grains, cattle and various types of produce. Beginning balances for each item were shown, then the steward was "charged" for manorial and foreign receipts and natural increases in flocks, and "discharged" by deducting cash payments, losses, and other uses of these resources.

[1993, p 1]

The great landed estates of Britain were multifaceted enterprises, not only were they involved in farming but in many other activities
including mining and forestry, as well as the management of the household itself. As such they faced many problems similar to those of the emerging industrial concerns of the period. They were complex organisations, for within each unit there were a number of separate and distinct activities. Such organisations, whatever their purpose, needed a system of reporting and accountability from the very lowest level in the hierarchy to the very highest, if any form of governance was to be effective. The charge/discharge system was structured to measure the honesty and integrity of the functionaries and it was aimed at safeguarding the property of the estate and dealing with dishonesty and fraud [Jones, 1985; Littleton, 1954].

As it operated on the great estates, this type of accounting provided a measurement of performance against predetermined production standards backed by a system of internal check. As such it bears more than a passing resemblance to modern management accounting practice [Most, 1969; Chatfield, 1977]. Accounting acted as a control tool because

[like a corporate executive, the manorial overseer was expected to use accounting data to control operations and plan for the future. His duties included frequent unannounced inspection tours of work areas and reports to the lord of good and bad performance. It was considered sound practice to record every transaction and to separate the functions of record keeping and cash handling. Receipts from sales of wood, meat and hay might be analysed in comparison with expenses. The sowing of various kinds of grains was often recorded in great detail. It was usual to estimate for a year in advance the need for food, fuel, cloth, and other goods and to schedule formally the dates on which cash could be released to stewards according to their anticipated needs.]
Production standards reinforced internal checks. Baker, brewer, and larderer were expected to produce a certain amount of bread, beer, and meat from a given amount of material received. Supply purchases were recorded at the time of delivery, and supplies were locked up when not in use. Frequent physical inventories allowed the stewards to see how closely procurement and issue conformed to the budgeted levels. Clerks in the kitchen, spicery, granary, and other work areas made monthly expense summaries and inventories under supervision of the comptroller's clerks, and the counting house clerks assembled these reports into a total of expenses and a "bill of remainders" showing inventories for the whole estate.

[Chatfield, 1977, p 26]

As it finally emerged in the seventeenth century, the most important book in the charge/discharge system was the memorandum book. Transactions were supported by invoices, payroll lists and receipts. However, no ledger was used and the summary and classificatory functions of the ledger were usually undertaken by the auditor. This system failed to reach the sophistication of the double entry system but for many hundreds of years focussed on accounting for the person in charge of assets [Stone, 1993].

The charge/discharge system was also used in situations where goods were entrusted to another on a commercial basis as witnessed by Robert Hamilton\(^3\) in his textbook on bookkeeping and matters relating to commerce. He described the use of this system as follows:

\[\text{\footnotesize\cite{Mepham, 1988}}\]

\(^3\) Hamilton (1743-1829) was a Professor of Philosophy at Marischal College, Aberdeen (1779-1817), Professor of Mathematics at the Marischal College (1817-1829) and formerly Rector of Perth Academy (1769-1779) [Mepham, 1988].
An ACCOMPT of CHARGE and DISCHARGE is of the same nature as an account current; but differs considerably in form. It contains, on one side, the articles intrusted to the care of the factor, for which he is accountable; on the other side, the manner in which he has rendered accompt for the same; and concludes with the balance which remains in his hands, or which is due to him by his employer.

The student will observe, that instead of charging the several articles at the time they are received, the whole sum which the factor is employed to collect is charged at once; but any part which he is not able to recover before the accompt be settled, is admitted as an article of discharge, unless the factor be bound as cautioner for the payments. If there be any goods instituted to his care, they are charged and discharged in separate columns. And as the design of the accompt is to exhibit the state of the affairs under his management in a concise point of view, the amount of the articles alone is inserted, and the particulars of each are drawn out in separate accounts, to which the general account of charge and discharge refers.

[1788, p 259]

Elements of this charge/discharge system can be seen in operation in the accounts of those who employed the putting-out system. In the case of Griggs, discussed below, it would certainly seem that accountability was uppermost in his mind when making entries in the 'winder's book' and the 'weaver's book'. In both cases the books record the weight of material issued to the workpeople (the charge) and the weight of material returned (the discharge). Similar records can be found in the accounts of Samuel Oldknow, demonstrated and discussed in Chapter Four. Although piece rates are calculated in these accounts the major focus is the reconciling of the material issued with the material returned. The accounts were not balanced, the return of the goods issued was sufficient to discharge the
responsibility and enable the work person to be eligible for payment at the agreed rate.

Haydn Jones [1985], in his account of the development of Welsh industry makes reference to the employment of elements of charge/discharge accounting by the Tredegar Ironworks in the late seventeenth century. The accounts for the Tredegar and Machen forges were kept on a charge/discharge basis, a not uncommon procedure. Many mines were owned by the landed estates so the accounting for the mining activities was an extension of the estate accounts, although, in this instance the ironworks was owned by a partnership.

The use of this type of accounting was not restricted to Britain, Lemarchand [1994] makes reference to its prevalence as the accounting model of mining and metallurgical enterprises in France, at the beginning of the eighteenth century. He suggests the main reason for this to be the fact that much of the capital for these enterprises was provided by the nobility. He further suggests that the dominance of stewardship accounting was not solely due to tradition because it "was founded on the separation between capital ownership and management centred on the notions of responsibility, accountability and control" [Lemarchand, 1994, p.120].

As the eighteenth century progressed and the nature of economic activity changed, the emphasis shifted from the protection of manorial assets to the protection of investors and the determination of profits, and the charge/discharge system increasingly became less
relevant [Chatfield, 1993]. It was around the middle of the eighteenth century, in England, that double entry started to take precedence over charge/discharge and for a time both systems were integrated one with the other [Jones, 1985].

**Mercantile Accounting**

The period from the middle of the fifteenth century to the end of the eighteenth century marks the rise to economic prominence of the merchant class throughout Western Europe [Newman; Deane, 1979; Pollard, 1964; Porter, 1982]. Increased opportunities for trade and better communications enhanced this rise. Merchants were involved in all facets of economic activity including the organisation of manufacture on the putting-out basis alluded to above.

Double-entry accounting developed from the accounting practices of the merchants. However, not all merchants used double-entry accounting but some form of systematic record-keeping was encouraged. Pacioli suggested that merchants would discover that without systematic accounting "it would be impossible to conduct their business, for they would have no rest and their minds would be troubled" [quoted in Yamey, 1949, p 102]. The merchants used accounting to grapple with the problems of large-scale enterprises and the supervision of their business at a distance, and to maintain a record of their credit dealings. The degree of complexity of the accounting procedures used seems to have been extremely variable
indeed it is probable that the vast majority of enterprises used a simple form of record-keeping (which may be called 'single-entry') until well into the nineteenth century...

[Yamey, 1949, p 105]

Accounting was used to cope with businesses that had grown too complex for a single person to control them directly as well as to assist the merchant in maximising gross profit and maintaining solvency [Pollard, 1965; Lee, 1975]. The lack of an established model meant that accounting methods

... were applied where they would serve the needs of the entrepreneur, and not for their own sake. Gross profit was significant, net profit was not ... Accounting ... was ... a set of arithmetical techniques to assist the businessman to conduct his affairs in an orderly, purposeful, and well-informed fashion.

[Lee, 1975, p 11]

In eighteenth century England, accounting was dominated by the requirements of the merchant [Mepham, 1988]. Because text-books on bookkeeping were directed to the needs of merchants, the majority of those working in counting houses would have been trained in these book-keeping methods. This was a circumstance that had implications for those who became manufacturers because the book-keeping system used by the merchants was not entirely suitable for a manufacturing organisation.

Merchants were primarily concerned with the protection of inventory, the prevention of errors and embezzlement and the ability to calculate net worth. They were not particularly concerned with recording capital because the nature of their activities did not include capital transactions. The small amount of fixed capital
employed did not raise questions of overheads either [Chatfield, 1977; Pollard, 1964].

As an existant body of knowledge, the accounting of the merchants provided a basis for the industrialists to develop their own methods and uses of accounting; uses adapted to their particular needs.

**Double Entry Accounting**

During the seventeenth century the centres of economic life began to change from the great estates to the towns and independent manufacturers came into competition with tradesmen belonging to closely regulated guilds. Emphasis shifted from the stewardship of the manorial assets to the protection of investors and questions of income [Chatfield, 1977].

The 'Italian method' of book-keeping became the accounting method of choice for the merchant manufacturers and the large estates, as the century moved on. As people became more interested in profits, double-entry assisted by providing a system of classification backed up by the system of checks provided by the requirement that accounts balance. In this process

(experiences of native investors in the fields of banking, commerce and emergent industry both in Britain and overseas were, at this period, conjoining with those of landlordism and, in all probability by accident of events rather than by design, a system of book-keeping and accountability based on double entry, (not a new system for clearly it had been in use for some time), was
embraced by a few to the maximum advantage of the many. The economic and political environment of the day probably favoured development, for it is from such accidental confluence that great changes often are born. [Jones, 1985 p 60]

The double entry system was seemingly embraced with great enthusiasm by the teachers of mathematics and book-keeping of the time. One such enthusiast was John Watt (1694-1737), the uncle of James Watt. John's father, Thomas, was a teacher of mathematics and John was a surveyor in Scotland [Rolt, 1962]. As part of the work of a surveyor, in the seventeenth and eighteenth centuries, was to collect rents and supervise the tenants of the landed estates, John would have been very familiar with the charge/discharge system of bookkeeping, a fact which makes his enthusiasm for double entry all the more engaging. John wrote an unpublished treatise extolling the virtues of double entry, part of which appears below:

An Introduction to Bookkeeping
Wherein a New Scheme of Recording Business is proposed
By J.W. 1730

An Introduction to Book-keeping

1. Men of business finding a necessity of Recording the transactions thereof, set themselves to find out some convenient form to effect it: The Conveniency of the form is more or less, as by it a man can with more or less ease, discover the true State of any particular, or of the whole of his affairs and consequently, the form will be different, according to the different kinds of business to be Recorded.

4 John Watt was the first person to survey the Clyde river, in Scotland [Rolt, 1962]
A Regular method of recording of Business has been brought in Amongst the Arts, under the name of Book-keeping.

2. Of the many forms that has been, or are yet in use, not one is so universally received, or thought better to answer the end, than the form Commonly called the Italian method of book-keeping; which beautyfully and distinctly, records the whole transactions of business, by the simple contrivance of placing things of the Same kind, & names together. For, Since the recording of the different parts of business successively according to the time of action (which is no more than a Regular minute, or note of business) will not fully answer the design of Book-keeping. Therefore there is a necessity of separating one part, from another, after this manner. In the Book of Accounts (now called a Ledger) let there be ordained different parts thereof for the different things concerned in the mans affairs.

[Watt goes on to describe the use of the ledger and the journal as well as to give examples based on the business of a merchant. He describes the accounting for the owner's equity as appearing in what he terms the 'Stock Account' and also describes the use of the Profit and Loss account. He recommended that in relation to goods, the quantities and qualities of the goods be recorded in the ledger alongside the values. This practice can be observed in the ledgers supervised by his nephew James Watt and his grand-nephew James Watt jnr. He describes the purpose of book-keeping thus:

11. The design of Book-keeping being to show at any time the true state of any particular or the Whole of the merchants business. Nothing can be plainer than that the method of recording business according to this Schem (sic) and was the design for.

[B&W MIV/14/9]
It is this feature that had appeal for the rationalist manufacturers and merchants of the eighteenth century. The system provided a formal record of the flows of cash and goods to and from the business and provided a data base for the proprietors of the business to develop an appreciation of the cost of the various activities they were involved in. The notion of cost, of course, predates the advent of double entry. However, double entry did allow cost to be accounted for on a more formal basis. Double entry also allowed a check to be maintained on employees, thereby maintaining some of the features of the charge/discharge system.

Robert Hamilton, writing his text-book towards the end of the eighteenth century displayed similar enthusiasm for the double entry system when he wrote:

Book-keeping is the art of recording mercantile transactions in a regular and systematic manner [emphasis added]. A merchant's books should contain every particular which relates to the affairs of the owner. They should exhibit the state of all the branches of his business; the connection of different parts; the amount and success of the whole. They should be so full and so well arranged, as to afford a ready information in every point for which they may be consulted. ... The Italian method by double entry, is generally preferred: at least, it is founded upon the most universal principles, and is the most convenient in extensive and complicated business.

[1788, p 265]

Double-entry provided advantages that older book-keeping systems did not offer. As well as maintaining a record of transactions and debts, it provided a framework which enabled the systematic analysis of transactions. Such analysis enabled the calculation of
profit, capital employed and the financial position of the enterprise [Yamey, 1949]. A point well made by John Watt in his explanation of the double-entry system.

As has been noted above, features of the older charge/discharge system lingered for many years, becoming entwined with double entry to produce a somewhat hybridised system, recording only quantities given and returned. The receipts and payments statement, common with non-profit organisations to-day can trace its origins to charge/discharge.

**Manufacturer’s Accounting**

Pollard [1965] points out that the accounting used by industrialists can trace its origins to the accounting of the merchants. That the emerging industrialists drew on the book-keeping systems in use to develop their own ways of accounting for the problems created by manufacture, is illustrated by the way the book-keeping system of the merchants was adapted to include accounts for processing materials. Text-books published during the period can be taken as a guide to the way the adaptation of merchant accounting was envisaged, if not the actual practice. The following examples spanning a century indicate an awareness of the differing accounting needs of industrial enterprises compared to commercial activities.
Edwards [1937] describes a text-book entitled 'The Perfect Method of Merchants Accompts' by John Collins\(^5\), referred to earlier. Published in 1697 it recognised that the needs of a manufacturer were not always the same as those of a merchant and contained an example of industrial accounting in the example of a set of dyer's accounts. Edwards describes this example where Collins

\[\ldots\] produces a raw material account debited with both quantities and values. The incoming material is debited and, when used, it passes from the credit side of the material account to the debit side of the process account, ie. the dye house account to which all the costs of dyeing are debited... The example is important because it shows the application of 'double-entry' to internal transactions, namely the movement of materials.  

[1937, p 225]

According to Mepham [1988] in his survey of eighteenth century accounting text-books, of the three that discussed the special needs of manufacturers, the most comprehensive examples were given by Robert Hamilton, the detail of which suggests that the illustrations were taken from practice. Robert Hamilton [1788] in his book *Introduction to Merchandise* wrote somewhat disapprovingly:

Artificers and manufacturers sometimes keep only a day-book and a ledger; the former, for entering goods sold, or work done on credit; the latter for personal accompts: And perhaps a cash-book and an invoice book.

[1788, p 486]

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\(^5\) John Collins (1625-1683) was a mathematician of note and a Fellow of the Royal Society. His involvement with book-keeping came from seven years spent studying and practising merchant’s accounting while on board a ship hired by the Venetians in their struggle with Turkey [Kats, 1929]
Being aware of the needs of manufacturers and the inadequacy of the records listed above, Hamilton went on to detail the records that a manufacturer should keep [Edwards, 1937; Mepham, 1988] and recommended the following:

A more complete method is necessary for exhibiting the materials used, the work done and the profit acquired. The subsidiary books most useful for these purposes are,

I. A BOOK OF MATERIALS, where quantities purchased and consumed are entered in separate parts, or on opposite pages.

II. A BOOK OF WORK, where the quantities of materials delivered to journeymen, the quantities of wrought goods received in return, the dates of the delivery and return, the value of the materials and wages; and the value of the wrought goods entered in separate columns.

If the business consists in any operation performed on goods belonging to others, this book must contain columns for the quantities received from our employers, the work done, and the delivery of the goods when improved or converted, the charge, and, perhaps, for the payment. By this means, it will be a check upon the ledger, and may sometimes supply the place of one.

Several books of this kind will sometimes be needed. The exact form must be regulated by the nature of the articles.

III. A BOOK OF WAGES, which contains the names of the journeymen and other servants employed at, the number of days, and rate per day, if they be paid by days wages, or the quantities of work done, and rate, when paid by the piece,

[1788, p 486]

The set of records described by Hamilton makes provision for the recording of the cost of manufacture in the Book of Work, this book was in addition to the ledger and summarised the manufacturing process. The Book of Wages was designed to provide a record of labour cost and employees.
Other records that a manufacturer should keep, according to Hamilton include a Journal and a Ledger. The Ledger makes provision for the recording of the different activities or 'branches' of the manufacturer’s business including an account that he describes as a

... general accompt of the trade or manufacture. To the Dr. of this accompt, the balances of the accompts of materials, and other expences, are transferred at the end of the year; on the Cr. the value of goods manufactured each month is entered. The balance shows the gain or loss, allowance being made for the value of goods not yet completely manufactured, and therefore not entered on the Cr.

[1788, p 487]

This description fits a Work-in-Progress account. Hamilton also recommended a finished goods account. Further recommendations for the manufacturer that produces more than one product, were that the books be kept in such a way as to show the profit or loss on each product. Hamilton suggested that profit should be recognised on manufacture of the goods rather than their sale, completed production being valued at selling price. These recommendations were supported, in the second edition of Hamilton's book, by the description of a linen manufacturer's accounting needs [Hamilton, 1788]. According to Mepham [1988] the illustration of manufacturer's accounts is in much greater detail in the first edition of Hamilton's book, with details of a linen manufactory and a shoemaker's accounts. These detailed examples were omitted from the second edition.
The accounting records left by the Soho Foundry under the guidance of James Watt jnr are in accordance with the scheme suggested by Hamilton with accounts established to record the profit on each process. The records left by Oldknow also follow the scheme outlined by Hamilton in his discussion of the linen business. Both sets of records indicate the outcomes from the various 'branches of trade' or departments. These two sets of records are discussed in detail in later chapters.

Forms of accounting were adapted and developed to accommodate changes in methods of undertaking business activity. It is in the changing processes of manufacture that this evolutionary process can be observed. The eighteenth century witnessed a remarkable change in the technical processes of manufacture and the consequent administrative processes necessary to facilitate and accommodate technical change.

**Manufacture**

The first half of the eighteenth century witnessed the beginnings of the transformation that was to come about in the way things were manufactured. The domestic system of manufacture was slowly giving way to more large-scale operation that could take advantage of the division of labour and specialisation [Langford, 1992; Mantoux, 1961; Ashton, 1964]. The domestic system, under which the majority of industries were carried on, was based upon individuals working alone or in small teams, often in their own homes or
workshops [Langford, 1992; Mantoux, 1961]. Even operations involving mining, for example, were conducted using groups of workers contracted to produce an agreed amount of production [Ashton, 1964]. However, by 1735 the pottery industry of Staffordshire exhibited most of the characteristics of a mature industry with the domestic system being largely replaced by large-scale production dependant on the specialisation of labour with a largely urbanised work-force [Langford, 1992].

The textile industry was still largely rural in its operation for the major part of the eighteenth century, but it too was starting to enter a process of change. By the end of the century spinning was conducted on a factory basis and the early part of the nineteenth century saw the incorporation of weaving into the factory. Prior to this the textile industry was conducted on the 'putting-out' or domestic system which was the most common form of manufacturing organisation for this and other industries.

**The Putting-Out System**

The putting-out system worked by merchants contracting with individuals to produce specified articles in their own homes or workshops. The merchants then sold the product to other merchants who in turn contracted with individuals to carry production one stage further. For example, the merchants would supply wool to spinners for spinning into yarn, at an agreed rate. The yarn would be then sold to other merchants who supplied it to
weavers to be woven into cloth at an agreed rate. The merchants were, of course, concerned with cost because that influenced their profit. The cost in this instance was a result of a commercial transaction with the workpeople; labour and material costs were what was paid for a specific piece of work. The putting-out system was employed in a number of industries including textiles, clothing, metal goods, hats and watches [Pollard, 1965; Mathias, 1969; Berg, et al, 1983].

The move of manufacture to the countryside in England and other places in Europe, was associated with the extension of the world market for mass produced goods from the sixteenth century when traditional urban production could not respond, hampered as it was by guild restrictions and high labour costs [Berg, et al, 1983]. Increasing specialisation of areas of production was accompanied by the development of adjacent areas to supply agricultural products. In England, the North and West emerged as prime centres of manufacturing while the South and East were better suited to agriculture [Berg, et al, 1983]. Berg, et al, described the reasons for this move.

The Midlands and the north could not compete in efficiency of cereal production with the south and thus specialised in pastoral farming. In the case of the Midland clay area this entailed a shift from arable to grass in the mid eighteenth century which generated a mass of underemployed and unemployed labour in the countryside. These areas became the major location of many rural industries, including pacemaking, hosiery, and metalwares.

[1983, p21]
Stimulated by increasing demand, as well as radical changes in agriculture, more people became involved in manufacture. The most far-reaching change in agriculture in England was brought about by the enclosure, in the seventeenth and eighteenth centuries, of what were previously open lands. The proponents of enclosure argued that it made each farmer independent and free to introduce whatever crops and improvements he wished. Before, with herds mixing on common lands, improvements in stock breeding had been almost impossible; with enclosure stock improvement was possible [Plumb, 1950, p82]. Enclosure also meant that land was not accessible as readily to small and peasant farmers, who could find work at various times as farm labourers, and thereby provided a ready source of labour for new industries. Describing this situation Hudson [1983] wrote that

(r)ural production in Western Europe by the seventeenth and eighteenth centuries encapsulated a vast variety of organisational forms, some arising directly from technological dictates, others not. At one pole were Kaufsystems of independent artisan households working on their own raw materials and producing a saleable product. Usually a small farm and dual occupation were crucial to the viability of these units. At the other extreme were found putting-out or Verlagsystems, often incorporating sophisticated division of labour between households. Here the catalyst was the merchant who put out work on various processes to an increasingly dependent, often landless, rural proletariat. Between these poles exists a broad spectrum of organisational forms with their associated mix of agriculture and industry and their different household and property structures.

[1983, pp 124-125]
These systems in their various forms often existed side by side. For example, in the West Riding of Yorkshire woollen cloth was manufactured by the traditional system where artisans spun and wove cloth while the worsted system\(^6\), producing a finer cloth (this system was introduced in the eighteenth century), was organised on a putting-out basis where each worker only did part of the process. The putting-out based worsted industry spread very rapidly in Yorkshire, supplanting woollen production in areas of high ground and poor soils to the west of Halifax, Bradford and Keighley. These areas were also characterised by the early enclosure of common lands and the emergence of a large, landless, wage-dependent cottager class. In the more fertile areas the artisanal structure of woollen cloth persisted until well into the nineteenth century. In these areas there were many leasehold and copyhold farms of a size suitable to support the dual economy [Hudson, 1983].

Hudson went on to argue that

... the existence of a landless rural proletariat and a precariously placed clothier group being absorbed from the early eighteenth century by putting-out capitalists is evidenced particularly from the occupations lists in parish registers. The proportion of persons described as clothiers declined, whilst that of weavers, combers and labourers increased. These rural employees were dependent on the market for their basic necessities, and virtually all of the foodstuffs required in the region were supplied from the farms of the east riding. The landless proletariat was divorced from agricultural involvement, as employment in manufacture was usually more easily available and more lucrative.

\(^6\) Worsted cloth was based on a yarn made up of long, straight, parallel fibres resulting in a fine smooth textured cloth.
Thus early enfranchisement and enclosure, together with a decline in manorial controls over the land, encouraged the accumulation of capital in the hands of a few and the growth of wage dependency on the part of others.

[1983, p 130]

The putting-out system was very unwieldy and slow to react to market demands. If merchants wished to increase production they had to contract with more workers, a very costly procedure which involved more travel and greater supervision of an increased number of labourers. Diminished control over quality often resulted as well. Offering domestic workers a higher price for their output often resulted in a drop in production rather than an increase because the artisan tended to work to meet his needs and a higher price meant less work to meet those needs [Johnson, 1983].

The putting-out system was organised essentially on a one-to-one basis with the merchant contracting individually with each worker. Accordingly, it was fraught with many problems. As alluded to above, supervision was a problem, as was lack of flexibility. A very real problem was embezzlement and theft by the workers [Styles, 1983; Pollard, 1965]. Embezzlement under the putting-out system had two features. Firstly the owner of the raw materials was remote from the point of manufacture and had to rely on the worker not to steal or adulterate the material. This reliance on trust led to the second feature where theft by a putting-out worker was seen to have
a different status to theft by other workers and carried a harsher penalty\textsuperscript{7} [Styles, 1983; Ashton, 1964]. Styles commented further:

\begin{quote}
Indeed it has been argued that the key to the shift to centralised production by some employers in the late eighteenth century was not the technical superiority of factory-based technologies, but rather the extent of embezzlement and associated problems of labour discipline under the putting-out system.
\end{quote}

[1983, p173]

Industries organised along such lines provided many opportunities for workers to defraud with a good chance of escaping detection. Workers could appropriate materials and/or produce work of inferior quality. The nature of the processes involved often required adding oil or water or some other substance to the raw material thus aiding concealment of the stolen materials. Production was usually measured by weight and there were problems in accounting for waste, so that manufacturers like Samuel Oldknow required the waste to be returned with the material and the total weight returned to agree with the weight given out. Embezzlement provided an addition to the worker's income and unlike many other factors in his life was directly under his control [Styles, 1983; Ashton, 1964].

K. H. Burley [1958] wrote of the accounting records maintained by Thomas Grigg of Ballingdon, Essex, who, among other things was a clothier employing some 500 people on a piece rate basis about the middle of the eighteenth century. Grigg kept fairly extensive records, 

\textsuperscript{7} Acts of Parliament were passed in 1703, 1740, 1749, and 1777 in an attempt to control embezzlement by the workers with quite dramatic powers of search being given to the employers [Ashton, 1964].
which have survived because they were lodged with the Court of Chancery in connection with a case, and never reclaimed. His textile interests began with the purchase of raw wool and ended with the sale of cloth. The records detail the day-to-day transactions of Griggs' various business interests with little attempt to separate his various interests. However, there exists a large volume of records concerned with the control of materials used in the manufacture of textiles. These records are similar to those kept two hundred years before by the Medici family in Florence, who after all were engaged in an identical business.

Like Griggs, the Medici were entrepreneurs in the textile industry and were faced with identical problems; the organisation of the flow of materials from operative to operative, the supervision of workmanship, the compilation of records on which to base piece-rate wages and the prevention of the embezzlement of materials.

[Burley, 1958, p 54]

Griggs specialised in the manufacture of crepes, worsteds and buntings. Five processes were required: wool sorting and cleaning, combing, spinning, weaving and lastly scouring and dyeing. Sorting, cleaning and combing were carried out on the clothier's premises the rest of the processes were "put-out". The major reason for this was because, for example,

(s)pinning, an unskilled process usually done by women and children, was carried on over a wide area to obtain sufficient labour. The "spinning book", containing the names of 312 spinners, shows that the spinning labour was drawn from as many as 22 different parishes within a radius of about 15 miles of Ballingdon.

[Burley, 1958, p 55]
Griggs did not appear to keep detailed records of the processes carried out on his premises because they were subject to his personal supervision. However, Griggs employed an agent to supervise the spinners. His records show bulk transfers to and from the agent. The agent was left to deal with the individual spinners.

Fewer operatives were employed in the weaving process and it was geographically more concentrated. Griggs supervised the weaving process personally and has left extensive records dealing with both the winding process and weaving. Burley describes the winding process as

... an intermediate stage between spinning and weaving, [where] the warp or longitudinal threads were prepared before being set up on the loom. The "winders" book, octavo in size, has its pages divided vertically into columns. Each column is headed by the name of the winder and is followed by entries showing the weight in pounds and ounces of the warp yarn issued. Each entry is struck through to indicate subsequent return of the yarn. Nothing else is recorded in these accounts; evidently they were maintained purely to control the issue and return of the yarn.

[1958, p 56]

The relationship between Griggs and his weavers was recorded in the 'weaver's book'. The 'weaver's books' had three purposes. They provided a check on the issue of yarn and the return of woven fabric. They were used to record faulty workmanship and they were used to record any fines levied as well as advances made in cash or in kind. An account was kept for each weaver. The format of the 'weaver's book' was so arranged that on
... the left-hand side [of the account], occasionally continuing to the foot of the right-hand side, are recorded the weights of warp and woof yarn issued and the fineness of the woof (piece-rates for weaving being based on the fineness recorded in skeins). Each entry was annotated "rec'd" when the piece of woven fabric was brought in. Against some are noted deficiencies in weight, a corresponding entry on the right debiting the weaver with the fine levied.

[Burley, 1958, p 57]

Fines were a common method of dealing with poor and faulty workmanship.

Griggs used independent contractors for the scouring and dyeing processes and his records show just the issue and return of the fabrics and the claims of the contractors.

According to his records, Griggs made several attempts at cost analyses. These analyses are not comprehensive, failing to give details of individual costs and make no attempt at providing for overhead. However they do provide an illustration of cost consciousness and the records provide an example of the concern that Griggs, and presumably others like him, had for monitoring the activities of those employed by him [Burley, 1958].

The accounting of Griggs and others of his time was concerned with 'things' and the protection of 'things' rather than the discipline of people. Transfers of items to and from the entrepreneur were recorded; if theft, poor quality or some other transgression was expected then a fine in recompense was levied. Essentially the records recorded the flow of things on this individual, one-to-one,
basis. This is evidenced as well when workers were concentrated in the one place, in a manufactory.

Workers scattered around the country-side caused problems of control and direction, Pollard [1965] describes the further refinement of the putting-out system:

One of the main advantages of the putting-out system compared to the former system of handicraft methods was the division of labour and the specialisation and invention that it encouraged. However, this process once begun demanded further concentration, such as in a central manufactory. In such a place experiments could be more easily carried out and improvements adopted on a large scale. Ultimately this process led to the complex machinery and central motive power of the factory.

[1965, p 48]

An example of such a manufactory is to be found in the Haddington New Mills of Scotland which opened in 1681 [Pollard, 1965; Walsh & Stewart, 1992]. The mills were sponsored by the government of the time and had a number of privileges including contracts to supply the army and freedom from import duties. The managers had considerable legal powers over the workmen, who could not resign and remain in the town without the company's consent, yet would be expelled from the town if the company discharged them. The company maintained its own prison and was able to imprison its workers for insubordination or embezzlement of yarn. The workers were not employees in the modern sense but were outworkers. Management took

... great care ... to create order in the warehouse and to develop a foolproof system of book-keeping for the yarn
given out. Labour was not only screened on employment, but watched and kept in discipline by condign punishment, and in good heart by an official piper and an annual 'Way-gouse' at Haddington fair. Despite all these advantages and much thought given to management problems, the minutes show that control over the mills was always difficult and never complete.

[Pollard, 1965, p68]

The experiment was not a success, management was top heavy, skilled workers left the district for richer pickings elsewhere and it was unable to control its staff effectively. Consistent with the putting-out system bookkeeping was concerned with things, not the people who made those things.

Walsh and Stewart [1992] summarised the experiment at New Mills as follows:

Bookkeeping at New Mills was based upon memorialising the exchange of goods or money - an event that occurs at a point and place in time. Materials were modified by servants for cash; these rates of exchange were then adjusted for failure to meet quotas or acceptable levels of waste.

[p 733]

At New Mills, deficiencies arising from waste and embezzlement were indistinguishable, indeed wastage was treated as a natural occurrence at New Mills - allowances were made for 'indrying' and anything beyond this allowance was treated as embezzlement. The enclosed space enabled a degree of control over these two types of deficiency and the erection of a regime of calculation around waste and the nature of production.

[p 735]
The impression left of the firms which existed before the Industrial Revolution is one where the control of labour is based on rigorous sanctions in the form of fines and even prison. The iron works established by Sir Ambrose Crowley in County Durham in 1685 is a particularly good example of an attempt to control the labour-force by extensive and intensive regulation. This venture is best known for its "Book of Laws", which became a sort of constitution for the company, defining duties, compensations and penalties in the minutest detail. Crowley tried to so dominate the lives of his workers that their whole life would "revolve around the task of making the works profitable" [Pollard, 1965, p 72].

In discussing the firms of the pre-Industrial Revolution period Pollard [1965, p 76] concluded that

(a)bove all, they were troubled by the problem of how to achieve effective control over their labour, and the tendency for all of them was to invoke non-economic sanctions, either by legal compulsion or discipline, or by dominating the workers' whole lives inside their townships within the framework of long term 'bindings', a method that goes back to some large Renaissance firms, particularly on the continent, rather than to look forward to the relatively 'free' labour contract of the Industrial Revolution.

Prior to the Industrial Revolution it seems that underemployment was the usual condition of labour both in the towns and countryside, work was irregular and indebtedness the result. The preference for leisure over all other pursuits was almost universal as a result of casual methods of earning and subsequent casual methods of living. There was a great diversity in amount and methods of payment, the
line between established rights and barefaced robbery was difficult to draw [Berg, et al, 1983, Ashton, 1964].

To this time the market place had determined economic relationships. Accounting systems were essentially designed to keep track of what was owing and what was owed. Even in the large accumulations of workers at manufactories such as at New Mills the same held because the market governed economic relations within these institutions. Changes to the use of accounting came with the creation of economic organisations which operated outside the market system and activities were conducted within the firm itself rather than in the market place. The close of the eighteenth century saw the rise of firms akin to the modern concept. Johnson suggests the following reasons for this transition:

Firms arose when individuals perceived opportunities for personal gain greater than those offered through ordinary market exchange. The particular opportunity that probably catalysed the appearance of business firms was an increase, during the early eighteenth century, in market demand for textiles in Western Europe. To meet the increased market demand for textiles, merchants finally understood that they must eradicate the decentralised putting-out, piece-rate contract which allowed each labourer to decide for himself how productive he would be. They replaced that contract with a centralised "factory" wage contract. In other words merchants became employers. They gained control over labour productivity by establishing a centralised firm and administering the tasks of wage earners. Consequently, merchants were in a position to compel individual workers to produce more than they would ever turn out under market conditions in a putting-out system. Now merchants could readily increase supplies of textiles to meet growing demands. [1983, pp 140-141]
These changes, albeit gradual, brought new problems and challenges. Growing demand, increasing capital, and new ways of looking at problems combined to offer solutions that were instituted over the next half century.

Change was not immediate or sudden and to those living in the second half of the eighteenth century it did not seem that the change in tempo of industrial life would have such far-reaching effects on the structure of English society that it did. However, in comparison to the centuries which had gone before the changes in industry in the second half of the eighteenth century were both revolutionary and violent. A very rapid expansion of trade, demand for increased productivity, a shortage of labour coupled to a number of merchants with spare capital to invest, established the conditions for the revolution that was beginning [Deane, 1979; Mathais, 1969].

Changes in hygiene led to a fall in death rates so that after 1740 England experienced a growth in population [Ashton, 1964; Deane, 1979; Porter, 1982]. This population growth had a profound effect on the British economy, demand increased, available labour increased, the population of the towns also increased [Ashton, 1964; Mantoux, 1961]. Another very important effect was the survival of more children of middle and lower middle class parents than hitherto. Many early industrialists came from this class. The Industrial Revolution would not have been possible

... without a rapidly expanding lower middle class with sufficient education and technical background ... This and a growing labour force, adequate capital, and
expanding markets were the prerequisites; they provided the opportunities to which human ingenuity and skill readily responded

[Plumb, 1950, p78]

From small beginnings, the next stage in the development of the processes of manufacture saw the development of the factory system.

**The Establishment of the Factory System of Manufacture**

The establishment of the factory system is perhaps the key development of the Industrial Revolution. Technical innovation had accumulated, providing the means of producing on a large scale, water and then steam provided the force, expanding sources of raw materials and demand for manufactured goods set the scene. The combination of people and capital into large productive units meant that demand could be met at increasingly lower cost and in larger quantities.

The period of the Industrial Revolution offers much scope to observe, with the benefit of some two hundred years distance, the formative processes of modern accountancy. With hindsight, change was rapid, the move from a domestic system of manufacture, in some industries such as cotton, took only a few years while other industries were slow to adopt new ways. The organisation of workers into a factory based method of production gathered momentum as the eighteenth century drew to a close. Initially factory development was slow and the first instance of a factory in the modern sense, in Britain, can be found in the factory established by John Lombe near
Derby in 1717 to spin or throw silk [Edwards, 1989; Mantoux, 1961; Beckett, 1977; Mathias, 1969]. Apparently the size of the works erected by Lombe

... surprised everyone. Five hundred feet long, five or six stories high, pierced by four hundred and sixty windows, it resembled a huge barracks. Once inside, astonishment became still greater. The machines were very tall, cylindrical in shape, and rotated on vertical axes. Several rows of bobbins, set on the circumference, received the threads, and by a rapid rotary movement gave then the necessary twist. At the top the thrown silk was automatically wound on a winder, all ready to be made up into hanks for sale. The vast number of parts which made up the machines, all worked by a single wheel (the motor power for which was provided by the river Derwent).

[Mantoux, 1961, p 194-5]

This establishment is considered to mark the beginning of the modern factory system, in Britain, because it depended on automatic machinery and the operatives being confined to narrow specialised functions [Mantoux, 1961; Edwards, 1989]. While the silk industry became established in a few centres it never achieved the prominence that cotton was to have later in the century. By the end of the eighteenth century cotton yarn was produced in many factories and consideration was being given to the establishment of weaving on a factory basis. Such revolutionary changes in production methods necessitated corresponding changes in the way businesses were managed and labour supervised, and continued research is yielding examples of significant use of accounting in this process of change.

The rise of the cotton industry, discussed below, is a case in point. Springing from very tiny beginnings, it rose to be Britain's most
important export industry in only a few short years. Factory production was not confined to cotton. The pottery industry under the guidance of Josiah Wedgewood developed specialised methods of production. Also, the production of iron was increasingly produced in factories, for example, the Darbys, a Quaker family, of Coalbrookdale in Shropshire, had established their iron works on a factory basis [Trinder, 1991] as had the Dowlais Iron Company in Wales [Edwards & Baber, 1979].

The last part of the century increasingly saw the establishment of purpose-built factories, factories designed and built to achieve the manufacture of one product. The chronology of the development of factories covered a considerable period because

...factory building generally followed the innovation of powered machinery within each industry, although most industries had their early exceptions. On the one hand silk throwing was power driven before 1720 whilst on the other hosiery frames were only beginning to be steam driven in the late 1850s. The iron forge, foundry and furnace were organised on a factory basis by the 1780s whereas nail and chain manufacture were only slowly mechanised ...

[Tann, 1970, p 5]

Ure, in his book "The Philosophy of Manufactures", first published in 1835, defines a factory as designating

... the combined operation of many orders of workpeople, adult and young, in tending with assiduous skill a system of productive machines continuously impelled by a central power.

[p 13]

For Ure the central power source was crucial to the formation of a factory, which he saw as
... a vast automation, composed of various mechanical and intellectual organs, acting in uninterrupted concert for the production of a common object, all of the being subordinated to a self-regulated moving force.

[1835, p 13]

Ure saw three contributors to this agency — labour, science and capital. Directed by science, sustained by capital and moved by labour the factory was designed to serve the needs of the workers, the master and the state. Unfortunately this utopian partnership does not seem to have eventuated. Some masters were concerned for the welfare of their employees, but by no means all were.

Ure's definition of a factory excluded those situations which were not dependant on a source of power such as iron works, potteries, engineering works and so on, yet these industries too went through the process of collecting their labour and resources together in the one establishment, a fundamental characteristic of the factory system being the concentration of the means of production in the one place. This was a basic organisational change that could be applied to any industry [Tann, 1970]. It is the concentration of resources that was revolutionary and indicated new demands on the process of management.

The end of the eighteenth century saw the factory system well established as a means of production that was growing in importance. For the entrepreneur it was a means of large scale production that could be organised more efficiently than could the domestic system, with the probability of greater profits, but at the expense of new and different problems. The problem of raising
capital was major as was the problem of obtaining and disciplining the workforce and simply the problem of keeping track of what was going on [Beckett, 1977].

The factory was a place of experiment. Experiment to discover ways of meeting its demands. The factory required a change in how people viewed time. Factory time ruled lives and set the pace for their daily existence. The schedule became all important because the factory was a rational place. A place of order and symmetry where everyone involved had a recognised and ordered role to play. All activity was directed towards one goal — the goal of achieving a profit. In itself profit was a performance measure, a measure of how well the entrepreneur stood in relation to God and to his fellows. The higher the profit, the higher the standing.

The factory was an experiment, even to its design. New techniques created new problems to be solved. The explosive nature of cotton dust required men to think about fire proofing buildings and ventilation. The collection of large numbers of people in the one place, for such a large part of the day, required the factory masters to think about heating, light and ventilation as well as the basic necessities. The problem of power was tackled in a number of ways. Water-power was cheap but not available everywhere and at all times. Horse wheels were used but feed was expensive. Steam gained in popularity as the transport system improved to allow the transportation of coal at cheaper rates. Each method was tried and experimented with. Samuel Oldknow, for example, used water, horses and steam in Stockport but settled for water at his mill at
Mellor. Owen used water power at New Lanark. Watt jnr used only steam power at the Soho Foundry. As time passed however, steam became the power source of choice because it enabled factories to be sited close to their sources of raw material, labour or markets. A choice aided by the networks of similar minded managers who appear to have communicated with each other a great deal in their search for solutions.

The factory brought a problem of management. No longer were transactions on a personal basis with the workpeople buying and selling material and product. The product passed from process to process which necessitated a different approach to record-keeping. Increasing competition created pressures on prices which in turn created interest in cost and a requirement that cost be known with certainty. It was natural that those trained and imbued with 'rationality' should turn to the numbers provided by accounting to help them in the management process. It is suggested that accounting provided a visibility that the entrepreneurs needed to manage their businesses effectively.

The two industries that are of major interest to this thesis are the cotton industry and the development of heavy engineering specifically the manufacture of steam engines. Their development is related because by the end of the eighteenth century steam engines were becoming the most important source of power for cotton mills, as well as other types of factories. The factory owners sought steam engines as a reliable source of power to serve the machinery they were installing. Cotton cloth was subject to great demand by fashion
conscious consumers who saw numerous advantages in the fabric and attracted large numbers of manufacturers who pressed technology into service [Mckendrick, et al, 1982; Deane, 1979]. The next section briefly considers the development of these two industries.

The Development of the Steam Engine

While the name Watt is synonymous with the steam engine, James Watt was not its inventor but was responsible for considerable and far reaching improvements in its development [Rolt, 1962]. Watt improved a machine, the principles of which have a long history that can be traced back to a description in the first century A.D. by Hero of Alexandria, who described a device to open the doors of a temple using steam to move water to and from a bucket that acted as a counterweight [Law, 1990]. Giovanni Battista della Porta described an experiment in Naples, in 1606, where steam was used to create a vacuum and suck water out of a closed tank [Law, 1990]. Experiments carried out in the seventeenth century by Evangelista Torricelli (1608-1647), leading to the development of the barometer, asserted that the atmosphere had weight, a principle that was put to use by Denis Papin (1647-1712) when in 1690 he used steam to create a vacuum and cause a piston to raise a weight [Law, 1990].

The principles described by della Porta were used by Thomas Savery (1650-1715), an Englishman, when he patented a steam pump in 1698 [Law, 1990]. Savery's pump was not very successful, but it did
work and was used to lift water in a number of private houses and to supply the head race of water wheels in some cotton mills in Manchester [Law, 1990; Mantoux, 1961]. Savery's pump was unable to lift water more than about 7½ metres which severely limited its potential to be used in the coal and tin mines in England where deeper working was encountering problems with drainage.

The first workable steam engine was developed by Thomas Newcomen (1663-1729) along the lines proposed by Papin. Newcomen was born in Dartmouth and worked as a blacksmith until he became interested in the problems of draining water from the tin mines in Cornwall. After a number of years of experimenting Newcomen erected his first engine at a colliery near Dudley Castle, Staffordshire, in 1712 [Law, 1990; Mantoux, 1961]. A very detailed engraving of this engine exists and shows that a

... vertical cylinder open at the top was supplied with steam from a boiler beneath, which resembled a brewer's copper. The piston, packed with leather and sealed with a layer of water on top, was hung by a chain from the arch head of a rocking beam. From the other end of the beam the pump rods were suspended. When steam at slightly above atmospheric pressure was admitted into the cylinder, the piston was drawn up by the weight of the pump rods and any air or water blown out through water sealed non-return valves. After the steam valve was closed, the steam in the cylinder was rapidly
condensed by a jet of cold water. The unbalanced atmospheric pressure drove the piston down raising the pump rods and making the working stroke. The cycle was then repeated, the steam valve and injection cock being opened and closed by a plug rod hung from the beam.

[Law, 1990, p 8]

These engines filled a need and in spite of difficulties with Savery, the holder of the master patent for raising water through the use of fire, a number of engines were installed by 1716 [Law, 1990]. Newcomen engines were installed in greater numbers after the expiry of Savery's patent in 1733 [Law, 1990], primarily as pumping engines for mines with some being used to raise water for water wheels, and after the development of the rotative engine by James Watt in the early 1780s, a number were used to drive machinery directly [Musson & Robinson, 1969; Law, 1990; Mantoux, 1961]. The popularity of these engines was connected to their reliability and ease of erection. The parts, with the exception of the cylinder, were easily made and eventually the cylinders were cast in iron and bored at Coalbrookdale for a small fraction of the cost of the original brass cylinders [Law, 1990]. However, the Newcomen engine consumed a large amount of fuel because the cylinder had to be re-heated after each stroke. High fuel consumption was not a problem for engines used on the coalfields but it did become a major selling point for the much more efficient engine developed by James Watt.
The Steam Engine Developed by James Watt

James Watt (1736-1819), the son of a shipwright and merchant, was born in Greenock, Scotland [Rolt, 1962; Mantoux, 1961; Dickenson, 1935; Smiles, 1865; Muirhead, 1859]. He was working as an instrument maker in a workshop situated at Glasgow University, when he was asked during the winter of 1763-64 to repair a model of the Newcomen engine. His curiosity was aroused when he found it could only make a few strokes before the boiler was exhausted of steam [Dickenson, 1935; Law, 1990]. After a number of experiments Watt determined that the reason for the waste of steam was the alternate heating and cooling of the cylinder. This process not only consumed excessive fuel in the re-heating, but further inefficiencies arose because the cylinder could not be cooled sufficiently in the time available to condense all the steam and gain maximum vacuum. Watt determined that the solution to the problem was to keep the cylinder at the same temperature as the steam entering it and to condense the steam outside of the cylinder. Watt explained his solution to the problem by stating that

\[\text{To avoid useless condensation, the vessel in which the steam acted upon the piston ought always to be as hot as the steam itself... To obtain a proper degree of exhaustion, the steam must be condensed in a separate vessel, which might be cooled to as low as necessary without affecting the cylinder.} \]

[Mantoux, 1961, p 320]

This idea of a separate condenser led to a second improvement which was perhaps more revolutionary than the first, that of using the steam to act on the piston rather than creating a vacuum as in the
Newcomen engine. The engine as Watt envisaged it was described in the specification attached to his patent\(^8\) and to the Act\(^9\), which extended the patent, and was based on the principle that savings would eventuate from keeping the cylinder hot and using the steam to exert force on the piston\(^{10}\).

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\(^8\) Patent 913 'A New Method of Lessening the Consumption of Steam and Fuel in Fire Engines', dated 5 January 1769 with specification dated 29 April 1769 [Mantoux, 1961; Law, 1990]

\(^9\) 15 Geo.III, c. 61 of 1775 [Mantoux, 1961; Robinson & Musson, 1969].

\(^{10}\) The Steam Engine Act (15 Geo. III, c. 61) of 1775 contained the following specification to reduce the consumption of steam which states in part: FIRST, That vessel in which the powers of steam are to be employed to work the engine, which is called the Cylinder in common fire engines, and which I call the Steam Vessel, must during the whole time the engine is at work, be kept as hot as the steam that enters it; first by enclosing it in a case of wood, or any other materials that transmit heat slowly; secondly by surrounding it with steam, or other heated bodies; and thirdly, by suffering neither water or any other substance colder than steam, to enter or touch it during that time.

SECON DLY, In engines that are to be worked wholly or partially by condensation of steam, the steam is to be condensed in vessels distinct from steam vessels or cylinders, although occasionally communicating with them; these vessels I call Condensers; and, whilst the engines are working, these condensers ought at least to be kept as cold as the air in the neighbourhood of the engines, by application of water, or other cold bodies.

THIRDLY, Whatever air or other elastic vapour is not condensed by the cold of the condensor, and may impede the working of the engine is to be drawn out of the steam vessels or condensers by means of pumps, wrought by the engines themselves, or otherwise.

FOURTHLY, I intend in many cases to employ the expansive force of steam to press on the pistons, or whatever may be used instead of them, in the same manner as the pressure of the atmosphere is now employed in common fire engines; in cases where cold water cannot be had in plenty, the engines may be wrought by this force only, by discharging steam into the open air after it has done its office; (which fourth article the said JAMES WATT declares, in a note affixed to the specification of the said engine, should not be understood to extend to any engine where the water to be raised enters the steam vessel itself, or any vessel having an open communication with it).

[Quoted in Clapp, et al, 1976, p 146; Robinson & Musson, 1969, p 77]
Karl Marx pointed out the significance of this development when he wrote that the Watt double-acting engine had become a motor

... able to beget its own force out of the consumption of coal and water; one whose powers were fully under human control; one which could be moved from place to place, and serve as a means of locomotion; one which was urban and not, like the water-wheel, rural, so that production could be concentrated in the towns instead of being scattered over the countryside; one which was universal in its technological applicability, and was, comparatively speaking, little affected by local circumstances in its choice of residence.

[Marx, 1867, pp 398-399]

For Marx, the ability of Watt's engine to be sited anywhere was crucial to the development of industry. Hitherto the steam engine had been used mainly as a pump, the reciprocating engine provided an efficient source of portable power.

Watt continued his experiments by making a number of models in an attempt to determine the most efficient manner of condensing the exhausted steam. Watt was financed in these endeavours by Dr Joseph Black11, Professor of Chemistry at Glasgow and Dr John Roebuck (1718-94), of Birmingham, an industrial chemist engaged in developing coal mines in Stirlingshire and blast furnaces at Carron.

11 Black (1728-99) was trained in medicine but his greatest interest was in chemistry. In a series of experiments carried out in 1759-62 he established the principles of specific heat and latent heat, work that was to have a direct application to Watt's development of the steam engine [Rolt, 1962; Dickenson, 1935].
Roebuck eventually took over Black's loan to Watt and was assigned a two thirds interest in Watt's 1769 patent [Law, 1990; Dickenson, 1935].

Roebuck was declared bankrupt in 1773 and his share in the patent was taken over by one of his creditors; Matthew Boulton (1728-1809) of Birmingham. Watt and Boulton had been acquainted for a number of years and the partnership they formed in 1774 meant that Watt could devote all his time to the development of the engine as well as take advantage of the skilled workmen and facilities of Boulton's Soho Manufactory in Birmingham [Dickenson, 1935; Law, 1990; Smiles, 1865].

Watt's move to Birmingham was the beginning of a very successful partnership between the inventive genius of Watt and Boulton, the far-sighted industrialist. Boulton had the facilities and the capital to turn Watt's ideas into reality at a time when there was an increasing demand for a more efficient and versatile source of power [Rolt, 1962]. Boulton also introduced Watt into his circle of friends that eventually became known as the Lunar Society, described in Chapter Three.
In 1775 Watt's patent was extended for twenty-five years by the Steam Engine Act which guaranteed Watt and his partner Boulton a monopoly on the manufacture of steam engines until 1800.

The first two engines were installed in 1776 and were an immediate success, consuming less than one third of the fuel of the Newcomen engines [Law, 1990]. There were many enquiries, especially from Cornwall where there was a need to pump water from the tin mines, and where coal was very expensive. The engines were erected on a consultancy basis whereby Boulton and Watt supplied drawings and someone qualified to supervise the erection of the engine and the customer arranged and paid for the parts to be made and provided the labour to build the engine. Parts such as valves were supplied from the Soho Manufactory and the partners insisted that the cylinder be obtained from John Wilkinson12 in Shropshire, who had perfected a method of casting and boring cylinders that had no equal [Law, 1990; Dickenson, 1935; Rolt, 1962]. As payment the partners

12 John Wilkinson (1728-1808) was educated at the Kendal Academy [Musson & Robinson, 1969], a Dissenting Academy, he was a friend of Boulton and a leading iron-master. He had blast furnaces and foundries at Bersham and Brimbo, near Wrexham in Wales, at New Willey near Broseley, Shropshire, and at Bradley in Staffordshire. His machine for boring cannon was patented in 1774 and was improved for boring open-ended cylinders such as required by steam engines [Rolt, 1962]. Rolt described this device as consisting of a hollow boring bar 15 ft long, each end of which was supported in bearings. A cutter head revolved with the bar and could be traversed throughout its length by means of a rod which passed through its hollow centre. The cylinder to be bored was mounted rigidly in a cradle between the bar bearings. With this machine it was for the first time possible to produce a cylinder bore that was both truly circular and parallel throughout its length. [1962, p 61]
claimed a yearly premium equal to one third of the saving in fuel costs compared to the old atmospheric or Newcomen engines [Law, 1990].

The engines that were supplied initially were reciprocal engines, that is, they provided an up and down motion suitable for working a pump but not for driving machinery. Machinery needed a power source that provided a rotary motion. Watt had been experimenting with such a motion since 1769 but it was not until 1782 that the first rotative engine was erected at Soho using a sun-and-planet gear patented in that year [Law, 1990].

In the same year as he patented the sun-and-planet gears Watt patented the double-acting engine where the steam acted on both sides of the piston thus giving double the power from the same sized cylinder as hitherto [Law, 1990; Mantoux, 1961]. This innovation required further effort to design a rigid link between the piston and the beam which were connected by a chain. The problem was solved by a parallelogram arrangement which allowed the piston rod to move in a straight line as it pushed the beam up and pulled it down. This device, which Watt called the parallel motion, was patented in 1784 and overcame the problem of sealing the top of the cylinder [Law, 1990; Rolt, 1962; Dickenson, 1935].

The steam engine was under a continual state of development with a number of innovations being introduced to make it a more efficient and reliable machine. Tann [1978] calculates that in the period from 1775 to 1794 there were a total of 256 Boulton and Watt engines in
operation in England and abroad. By the establishment of the Soho Foundry in 1795 the Watt steam engine had reached a state of development where it could be manufactured or sold as a more or less standard commodity.

The Cotton Industry in Britain in the Late Eighteenth Century

The word 'cotton' was used, until the seventeenth Century, in England, to describe a coarse, woollen cloth made in the north of the country. In the sixteenth century Manchester was well known for the manufacture of this type of cloth [Mantoux, 1961]. The fibre we know as cotton\(^\text{13}\) began to make an impact on Northern Europe in general, and England in particular, from the beginning of the seventeenth century. The growth and development of the trade with India saw the public developing a liking for printed cotton fabrics. Indeed it became very fashionable to be dressed in cotton [Mantoux, 1961].

Up to the second part of the eighteenth century finished goods and raw cotton were mainly imported from India and countries around the Mediterranean. According to Mantoux [1961] the first recorded mention of the cotton industry in England was in 1610 in a petition to the Earl of Salisbury and 30 years latter cotton was being spun in Manchester [Mantoux, 1961; Aspin, 1981]. However, at the

\(^{13}\) 'Cotton' refers to the fibres of the plants of the genus Gossypium [Macquarie Dictionary].
beginning of the eighteenth century, most cotton products, including printed cloth, were imported from India [Mantoux, 1961].

The English spinners had tried their hand at spinning cotton but were unable to spin warp that was strong enough to be woven without breaking\(^\text{14}\) so it was necessary to weave a cotton weft with some other fibre, usually linen, as warp producing a cloth called fustian. The weaving of fustians had been introduced to East Anglia, in the late Sixteenth Century, by settlers fleeing oppression in Antwerp. This type of cloth manufacture suited the domestic textile industry and was carried on in Lancashire throughout the seventeenth and eighteenth centuries alongside the traditional woollen industry [Aspin, 1981; Mantoux, 1961].

Concerned by the demand for imported cotton cloth, those involved in the woollen industry managed to have parliament pass an Act\(^\text{15}\), in 1700, prohibiting the import of printed fabric. This Act seems to have had little effect because Mantoux [1961] notes that there were further complaints by woollen manufacturers and even attacks by unemployed weavers on people wearing cotton fabrics. This agitation resulted in even stronger prohibitions on cotton goods\(^\text{16}\). The woollen industry was attempting to stifle competition before it became a

\(^{14}\) The cotton fibre then available was too short in staple to be spun for warp on the spinning wheels then in use [Ashton, 1964; Edwards, 1967]

\(^{15}\) 11 & 12 William III, c. 10 The legislation expressly prohibited the import of printed fabrics from India, Persia and China [Mantoux, 1961; Smelser, 1959].

\(^{16}\) 7 Geo. I, c. 7 passed in 1721 prohibited the use or wear of printed calicoes, even those printed in England [Smelser, 1959; Mantoux, 1961].
problem. Nevertheless the public wanted cotton goods and if they could not have imported goods them they would have the local product. Fustians were not as good as all cotton cloth, being much coarser in texture, but in the eyes of the consumer they had advantages over woollen cloth. One of these advantages was that fustians could be printed [Mantoux, 1961].

During this period cotton growing was flourishing in the Antilles and Brazil. Unlike India and China, which only exported their surplus cotton, most of the American crop was available for export, there being no cotton manufacturing industry in the Americas until the beginning of the nineteenth century. American cotton was imported through the port of Liverpool which was placed very conveniently to the areas of England best suited for cotton spinning and manufacture, principally Lancashire [Mantoux, 1961; Edwards, 1967].

The natural features of Lancashire made it ideal for cotton spinning. Its damp climate and low temperature range aided by helping the fibres to cling together and eventually led to the spinning of very fine threads. However, using traditional methods, the spinners of Lancashire were not as skilled as their Indian counterparts, able only to spin either coarse or weak yarn and not the fine strong warp and weft required for fine cotton fabric. So the manufacture of fustian continued. Because of its ability to be printed the public accepted fustian as a substitute for the Indian cotton it was not able to have.
Despite the best efforts of the woollen industry to defeat this competition, Parliament, on application by the fustian manufacturers, passed an Act in 1735\(^{17}\) allowing printed fustian. This action recognised the demand by the public following the dictates of fashion. The prohibition against printed cotton fabrics was finally lifted in 1774\(^{18}\) [Mantoux, 1961; Smelser, 1959]. Opposition by the traditional textile industry actually contributed to the strong growth of the cotton industry. It allowed the industry to develop unfettered by tradition and able to take advantage of new inventions and practices. The cotton industry came to be Britain's foremost export industry.

In its early years the cotton industry was operated in the same manner as the woollen industry; a cottage industry, carried on by families working in their own premises. The women and the children were responsible for preparing and spinning the yarn and the men carried on the more physically demanding task of weaving the cloth. As well, the nature of the land was such that families could not exist on the products of their land solely and needed to be able to supplement their income. Spinning and weaving provided that supplement.

Around the 1740s a group of men known as the fustian masters began to appear. These people bought the raw materials and

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\(^{17}\) 9 Geo. II, c. 4 of 1735 exempted mixed cotton goods from the prohibitions of the previous Act [Smelser, 1959; Mantoux, 1961].

\(^{18}\) 14 Geo. III, c. 72. This Act was initiated by the petition of Richard Arkwright [Smelser, 1959; Mantoux, 1961].
contracted with the weavers to turn it into cloth. The weavers often subcontracted the spinning to others. The fustian masters then sold the finished cloth to cloth merchants.

By the middle of the Eighteenth Century the cotton industry was still growing but very small compared to the woollen industry. However, the series of inventions which was to revolutionise the industry had begun.

The first of these transforming inventions was the fly shuttle by John Kay in 1733. Equally applicable to all types of cloth this device meant that broader material could be woven than hitherto had been possible. With the old shuttle the width of the cloth was limited to the length of the weaver's arms as he threw the shuttle from one hand to the other. A second advantage was that the weaving process was very much speeded up. Looms incorporating the fly shuttle were in common usage by the 1760s [Mantoux, 1961; Edwards, 1967].

The fact that weaving could proceed more quickly increased the demand for yarn. The spinners could not keep up with this demand and so delays, increased prices and unemployment among the weavers resulted. The textile industry requires a balance between the production of yarn and the weaving of the cloth. The imbalance at this time increased the search for a more efficient way of spinning the yarn. Because cotton fibres are easier to stretch and twist than other fibres the cotton industry was very suitable for experiments into mechanical spinning [Mantoux, 1961; Smelser, 1959].
The need for greater quantities of yarn was answered almost simultaneously by Hargreave's spinning jenny, patented in 1769 and Arkwright's water-frame, patented in 1770. The jenny was derived from the old spinning wheel with the advantage that many threads could be spun simultaneously. Jennies were developed that were able to spin one hundred threads at the same time. Because it was operated by hand it meant that the domestic spinner could expand production enormously with very little capital outlay. The jenny reinforced the domestic system by not requiring any changes in work practices or organisation [Mantoux, 1961; Edwards, 1967; Berg, 1985].

Most organisational upheavals in the cotton industry can be traced to the water-frame developed by Richard Arkwright. Despite the controversy surrounding its invention\(^\text{19}\), the water-frame used rollers to impart the twist to the yarn and resulted in a much stronger thread than could be achieved by a spinning wheel. The machine could be driven by power supplied by water wheels, horse wheels and, later on, steam engines. The water-frame, as developed by Arkwright, was too big for spinners to use in their homes and together with its requirement for

\(^{19}\) Arkwright's patents for this machine were cancelled in 1785 because of doubts about the patent [Mantoux, 1961; Edwards, 1967; Tann, 1973]
a source of power it tended to be established in factories. The water-frame spun a wiry yarn which was ideal for warps and was known as 'twist'. With weft being supplied by the jennies and warp by the water-frame all cotton cloth could be woven. This led to the decline of fustian manufacture and a sharp fall in the price of cotton goods [Mantoux, 1961; Edwards, 1967; Aspin, 1981].

In 1775 Arkwright patented a carding machine which not only carded the cotton fibres but produced rovings\(^{20}\) ready for spinning. The machinery was available to completely mechanise cotton spinning, although it did take a considerable time for the change-over from the domestic system to the capital intensive factory system of spinning to completely take effect.

Crompton's 'mule' introduced after 1779, combined the features of the jenny and the water-frame to produce a thread of extreme fineness and great strength. This machine was invented between 1774 and 1779 but Crompton did not patent it. He made a present of it to the public. The willingness of the manufacturers to pirate

\(^{20}\) The carding process is necessary to prepare the raw cotton for manufacture whereby the fibres are separated and formed into a slender rope of parallel fibres called rovings. Rovings are then spun into yarn.
new inventions tended to make a mockery of the patent process anyway. As it was first devised the mule was manually operated and required considerable strength and stamina to operate and even though power was later used to drive some of its functions it still demanded considerable strength on the part of the operator [Berg, 1985].

The mule completed the mechanisation of the spinning side of the industry. But again the industry was thrown out of balance with the ability to produce more yarn than the weavers could cope with. Balance was not really restored until the development of the power loom [Mantoux, 1961].

It was to the developing cotton industry that Samuel Oldknow and many others like him flocked to make their fortune, and it was this industry that provided a stimulus for further technical advances applicable to other parts of the economy.

**Conclusion**

In the eighteenth century, mathematics was a language of relationships and something more than a tool for quantitating, differentiating and integrating. It provided a format for ordering and appreciating patterns or systems. Numbers were used to modify and reify, making relationships appear more certain, leading to the view that the laws of nature could be translated by standardised measurements [Spradlin & Porterfield, 1984; Porter, 1992]. The
language of mathematics led to a uniformity, an order which accorded well with the rationalist outlook of many. Quantitative conclusions were seen to carry authority because they seemed to be dictated by procedures and rules for the accumulation and processing of numbers [Porter, 1992b]. Herein lay the appeal of book-keeping, its reliance on the language of mathematics provided it with an authority emanating from its perceived objectivity and independence.

Governed by a set of rules, accounting was able to impose order on an apparent multiplicity of transactions [Porter, 1992]. This in turn simplified administration by assisting the determination of whether goals, for example, profit, had been achieved. The supposed objectivity of the numbers provided a basis of legitimisation for price and wage negotiation which transcended opinion and accorded well with rationalist views. Most of all accounting provided a system, a set of rules, and from the system the order which was desired.

Accounting offered the new industrialists a number of features. First of all its rules promised order. Its quantification techniques provided a field of view which set out the state of affairs. It provided a measurement of activity. It provided a data base of past activity which could be utilised in the prediction and formulation of new activity. It also provided a relatively simple means of measuring business performance according to a recognised system. But most of all it provided useful knowledge to assist them in the management of their economic affairs [Edwards, 1989]. Science and technology provided the impetus for the development of the technical processes
of the factory and the quantitative processes of bookkeeping assisted with its management.

The method of book keeping used, accorded with the growing complexity and changing nature of business. The next chapter considers some of the other forces that were shaping the second half of the eighteenth century in England.
CHAPTER 3

A CALCULATING AND INDUSTRIOUS PEOPLE

... the tempo of industrial life was already changing long before 1760, which is conventionally regarded as the beginning of the [industrial] revolution, but to no discerning man of the time did it seem that this change in tempo would affect fundamentally the whole nature and structure of English society.

[Plumb, 1950 p 77]

The attitudes of scientific enquiry and objectivity that developed from the Enlightenment were firmly entrenched by the middle of the eighteenth century. A 'rational' outlook coupled with a stable government, an expanding and vigorous economy, the ready availability of capital and a rising middle class were the hallmarks of the second half of the eighteenth century. It is the purpose of this chapter to examine some of the social and intellectual movements that were present in British society in the eighteenth century and the bearing that they had, and the relevance towards, the processes of accounting described in succeeding chapters, as well as particular reference to Samuel Oldknow and James Watt jnr. The Industrial Revolution was a movement, a changing of direction, that resulted from a number of factors that had been gaining momentum over many years [Hartwell, 1967; Newman, 1987]. The culmination of these forces was to result in far reaching consequences for the whole of British society.
Changes in Agriculture and Their Effect on Labour

During the eighteenth century change took place in agriculture as well as in industry, the one a necessary precursor for the other. The most fundamental change in agriculture was the removal of open fields and their replacement by enclosed fields, thus making the process of agriculture more efficient through greater control by the individual landowner [Ashton, 1964; Hobsbawm, 1968].

In the Middle Ages, the agricultural life was a well ordered one where everyone knew their place in the order of things. The village was a place of custom governed by a system of common fields and overruled by the manor, for agriculture was practiced by the community for its own benefit. However, this life began to change with the labour shortages caused by the Great Plague, the promises of emancipation held out by the growth of the cloth industry and the need on the part of landlords for money rather than labour as payment of rent. By the time of Elizabeth I the English peasants had ceased to be serfs and had become landholders required to pay rent in money. The landlords tended to lease land to those who wanted it [Hammond & Hammond, 1925].

The move to enclose common land began in the sixteenth century and acquired much force in the eighteenth and early nineteenth centuries [Mantoux, 1964; Langford, 1992]. The stimulus to enclosure in the sixteenth century was the market demand created
by the expansion of the cloth industry with subsequent rises in prices for farm produce. Increasing demand for wool saw enterprising landlords evicting tenants and using the land to graze sheep; the return from the wool being much higher than the rent of the land [Plumb, 1950; Berg, et al, 1983].

During the eighteenth century there was a much more vigorous move to enclosure of common land. The landlords had gained much political power and they saw the traditional village way of life as an obstacle to the development of agriculture. It was felt that for agriculture to progress, and be more profitable, the traditional methods had to be done away with, increasing the pace of the move towards enclosure [Hammond & Hammond, 1925; Mantoux, 1964; Hobsbawm, 1968; Deane, 1979; Porter, 1982].

The term 'enclosure' had two different meanings. The first was the appropriation by individuals of land held by the community. The second meaning was the dividing of 'open' fields previously used for co-operative farming for separate husbandry. Each enclosure resulted from individual acts of Parliament, of which Langford [1992] reports that there were some four thousand enclosure acts passed between 1750 and 1810. The final effect of this movement meant that agriculture was better able to respond to changes in demand. Population growth was met by more efficient cereal production as well as better stock management coupled with an increase in the acreage under cultivation [Horn, 1982].
The catchcry of the second half of the eighteenth century was 'improvement', and this meant a range of innovations which transformed the face of the landscape [McKendrick, et al, 1982; Plumb, 1950; Mathias, 1969; Deane, 1979; Porter, 1982; Langford, 1992]. Improvements aided by the enclosure system led to higher productivity and higher profits on the part of the landowners. Some of these landowners then employed their capital in industrial ventures as has been mentioned in Chapter Two. The change in agricultural methods meant that more food could be produced with fewer people. Those people who were employed as agricultural labourers were used only when required, forcing them to look elsewhere to supplement their income. Thus, a pool of labour was available to provide recruits for emerging industries. Production and productivity had increased to feed this rapidly increasing non-agricultural population and new methods of agriculture allowed the accumulation of capital to be used in other ventures [Deane, 1979; Hobsbawm, 1991; Berg & Hudson, 1992].

The changes in agriculture fuelled industry by firstly requiring those not fully employed in agriculture to find additional sources of income, often in the cottage based textile industry. Secondly, those not required at all for agricultural purposes formed a pool of labour available for other activities. Thirdly, agricultural improvements meant that there was sufficient food available to feed those not

1 Enclosure affected the landless and semi-landless workers and the small tenant farmers to a much greater extent than others engaged in agriculture. It is these people who tended to make up the pool of labour [Chambers, 1953].
engaged in agriculture. Fourthly, the profits from agriculture were available to finance ventures in mining and industry as well as infrastructure, such as roads and canals, which benefited the landowners initially but had much wider implications for society generally. These agricultural changes were a necessary precondition to the changes in industrial methods that were in the initial stages of development [Deane, 1979].

Social Changes Prompted By Agrarian Reform

Profound changes in economic life lead to changes in the whole social structure. Enlightened thinkers turned to the problems of society resulting in new attitudes to the problems of poverty, crime and waste. The common responses of the previous age, of satire or self-satisfaction were replaced by analysis and criticism [Plumb, 1950]. There was a growing insistence that human virtue could be measured by its social value, unfortunately such an attitude could be used to justify both reform and repression.

The second half of the eighteenth century is typified by a number of struggles, between rural society and industrial capitalists desiring access to resources; between the new industrialists and the aristocracy who saw their traditional power being eroded; and between the townspeople and those who sought to control them [Plumb, 1950]. All expressed an interest in 'law and order' and the result saw citizens gaining control of towns and improving the facilities and social services for their fellow townspeople [Plumb,
A unity of interests resulted between the new industrialists and the town leaders which intensified the belief in order, efficiency and social discipline. A social conscience developed from which

... everyone gained, the town middle class and the poor as well as the rich. By the end of the century most of the diseases of filth had been checked and diminished, if not destroyed, and in the nineties for the first time the birth rate in London passed the death rate.

[Plumb, 1950, p 86]

As well, a rapidly expanding population provided an unlooked-for resource for the factory owners. The children of the poor had always worked. As soon as they could work, they worked and their work became exceptionally valuable to the factory owners. The children were easy to discipline and could be put to simple repetitive tasks and they were cheap. So the mines and the factories put them2 to work [Hammond & Hammond, 1925; Plumb, 1950; Wilson, 1959; Ashton, 1964]. Children were employed in all manner of industries and processes despite moves to alleviate their suffering.

2 Hammond and Hammond [1925] compare the employment of children from the poorhouses, in the eighteenth century, with the employment of slaves in the West Indies, with the children faring worse, in many cases. The authors point out that when a London parish gave relief it claimed the right to dispose of the children of the person who received the relief. Many children were sent to the cotton mills although it is to be noted that there were a number of employers similar to Oldknow and Robert Owen who took pains to care for the health and well-being of their apprentices. As factories became more entrenched it was the children of the adult workers who were employed in the cotton mills [Ashton, 1964; Hammond & Hammond, 1925; Plumb, 1950].
Regulations\(^3\) were eventually introduced to govern the employment of children, but 'apprentices' were the mainstay of many factories for many years.

The eighteenth century was a time of increasing economic prosperity. British exports were found all over the world \[\text{Porter, 1982; Hobsbawm, 1968; Langford, 1992; McKendrick, et al, 1982}\]. Imports, as well, came from the four corners of the Earth. This expanding trade, both internal and external was supported by an expanding banking system which financed the long credit terms then current. However, interest rates remained low, generally less than three per cent \[\text{Porter, 1982; Ashton, 1964}\], so finance was relatively cheap.

Increasing productivity saw the rise of a new class of men. Those that owned and administered the apparatus of production, both scientific and technical, were in a position to dominate and control the workers to enhance their own position. Their view of the economic world was augmented by writers like Adam Smith who claimed that the laws of the market guided private interests and that these pursuits led to harmony for the whole society. According to

\(^3\) The 'Health and Morals of Apprentices Act' was the first act and it was passed in 1802, it limited the hours of work as well as prescribing minimum standards of hygiene and education \[\text{Ashton, 1964}\]. According to Hammond and Hammond \[1925\] this act had little effect in redressing the situation. Other Acts were passed in 1819, 1831 and 1833. Such acts were difficult to enforce as the magistrates were often cotton mill proprietors.
Smith, the drive of individual self-interest led to competition which led to the provision of the goods that society wanted at the right price and in the right quantities, thereby demonstrating that the interaction of selfish men was to the benefit of society. This provided much comfort to the rising class of factory owners and led to the creation of a new class of people; the working class. The workers were viewed as being in the position of sellers of their labour on an open and competitive market. The problem of unequal bargaining power does not seem to have been given much consideration. As employers of labour the industrialists developed new schemes of managing labour, to enforce a new discipline required by the regularity of the new methods of production [Lines, 1992; Hobsbawm, 1991, 1968].

Sources of Capital in the Industrial Revolution

Capital basically came from two sources. Firstly, increasing agricultural efficiency yielded surpluses on the great estates, these surpluses were turned to developing other resources such as mines and other areas of primary production. It is to be noted that the Duke of Bridgewater (1736-1803) initiated the building of canals in Lancashire to move his coal from the mines at Worsley to Manchester more easily [Ashton, 1964; Mantoux, 1964; Langford, 1992]. The ease of transport along the Bridgewater Canal, opened in 1761, led to the establishment, within a very few years, of a system
of canals that revolutionised the movement of goods throughout England⁴.

The other source of capital was to be found in the emergent middle class. The organisers of the clothing industry, of workshops and shops, accumulated surplus funds to invest in other ventures. The profits of these ventures were re-invested and so more capital was accumulated [Ashton, 1964; Mathias, 1969]. This accumulation and re-investment of capital was different to traditional forms of enterprise, which focussed on accumulating enough to attain goals or supply sufficient food [Giddens in the introduction to Weber, 1989]. Often accompanied by a frugal lifestyle capital, accumulation seems to have been, for many, an end in itself.

Capital accumulation went hand in hand with organisation. The distinguishing feature of the development of business organisation was the organisation and the accumulation of labour to work alongside, and be controlled by the owners of capital, to achieve the aims and ambitions of the capitalists. Without labour being organised as another of the 'factors of production' it is possible that the course of the industrial revolution would have been very different.

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⁴The period from 1761 to 1840 saw the construction of some 6840 kilometres of canals in Britain, the end of this period saw canals suffering increasing competition from the railways [World Book Encyclopaedia].
The Recruitment and Employment of Labour in the Factories

One of the major tasks of the early factory masters was the recruitment and training of their labour force. There were no suitable models on which to base their labour practices and they had to develop methods by trial and error. Problems were dealt with as they arose and so a practice of industrial relations evolved. The foremost problem was one of recruitment. Workers were displaced from the land but to move to the towns or to factory sites was a major dislocation. Pollard discussed this dislocation for the worker and challenge for the factory master when he wrote:

The worker who left the background of his domestic workshop or peasant holding for the factory entered a new culture as well as a new sense of direction. It was not only that the 'new economic order needed ... part humans: soulless, depersonalised, disembodied, who could become members, or little wheels rather, of a complex mechanism'. It was also that men who were non-accumulative, non-acquisitive, accustomed to work for subsistence, not for maximisation of income, had to be made obedient to the cash stimulus, and obedient in such a way as to react precisely to the stimuli provided.

[Pollard, 1965, p 190]

The work was uncongenial and the fact that many of the early factories were modelled on workhouses or prisons did not add to their attractiveness. Factory life meant a loss of the old culture of the cottage industry and seasonal work, and flexible working hours. The new factory culture tied the workers to an alien rhythm of work, which often necessitated new surroundings, new friends and the breaking of old ties with the uncertainties of being cast adrift [Pollard, 1965].
The paradox in the late eighteenth century was that potential workers noted a shortage of jobs while employers complained of a shortage of hands. One of the reasons for this state of affairs was the aversion of the workers to the new discipline and the reluctance of the employers to tolerate the old work habits. There was also a shortage of people with the training to meet the demands of new technologies [Pollard, 1965].

Industrial discipline was a new concept and called for as much innovation as the technical advances. In the early years the methods used to overcome worker management problems could, according to Pollard [1965], be grouped under three headings:

- **The Stick.** Unsatisfactory work was punished by fines, dismissal or beatings. Because of the large number of children employed, beatings were commonplace. The main threats were fines and dismissal, but in times of labour shortage, dismissal did not carry much weight. A common technique was the use of the 'blacklist'; workers who upset one employer were blacklisted and found it almost impossible to get employment with another employer. Combinations of employees were also forbidden by law and meant dismissal.\(^5\)

- **The Carrot.** Various inducements were put forward to encourage productivity. For example, piecework was a common way of

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\(^5\) The Combination Acts (1799-1800) strengthened existing legislation against trade unions [Thompson, 1963; Ashton, 1964].
allowing the workers to earn more and at the same time produce more. Watt jnr's records show a detailed negotiation concerning the establishment of piece rates at the Soho Foundry. Some industrialists were innovative in their attempts at encouraging the employees. Arkwright gave distinguished clothing to his best workers, Owen had his 'silent monitor', Wedgewood appealed to his employees by stressing their common interests, while Oldknow, Dale and Gregg tried to create settled communities.

- A New Ethos. The view of the employers of the time was that workers were their subordinates because they were less well endowed with the essential qualities of industry, ambition, sobriety and thrift. As long as this remained the case then they could not be expected to be influenced by moral persuasion or appeals to their better nature. So there was an attempt to indoctrinate the workers with bourgeois values. This is evidenced by the support given by employers to churches and the Sunday School movement, both to increase the general level of education and to inculcate a moral sense. It is to be noted that Samuel Oldknow was responsible for the building of an Anglican Church at Marple and insisted that his apprentices attend even though he was a member of the Unitarian church. Drinking was, and continued to be, a major problem, so it received major attention in an attempt to reduce it. The attention to developing 'respectability' was an attempt to develop a sober, docile worker in tune with the aims and ambitions of the industrialists.
It was necessary to convince the workers that through a combination of diligence, punctuality, discipline and hard work they could better their lot in life and secure greater wealth and enhanced social position as well as securing a better future for their children. What was needed was to make the workers ambitious [Thompson, 1967].

The employers were also often responsible for the civil law in their communities and dispensed this by sitting on the bench as magistrates. This gave them extra power over the employees enabled them to limit the employees' mobility and activities. That industrial relations were less than ideal has been summed up by Pollard:

> Because of the nature of eighteenth century British society within which modern industrialism arose, because of the bitterly competitive nature of the market facing the typical manufacturer, because of the alienation of work involved in the change, and because, after all, they faced employers as enemies within the distributive system of the capitalist economy, the modern industrial proletariat was introduced to its role not so much by attraction or monetary reward, but by compulsion, force and fear.

[1965, p 243]

As well as learning how to cope with their jobs, working in a confined space under a new discipline the workforce had also to come to terms with a different concept of time.

**A New Concept of Time for the Workers**

During the course of the eighteenth century, the passage of time came to be viewed in a new light and the schedule began to
dominate. No longer was the measurement of time considered to be related to physical phenomena such as the rising and the setting of the sun. The factory bell assumed the place of the movement of the sun. Natural occurrences were not sufficient to regulate the increasingly ordered life that was required by the methods of production being introduced. It was the mechanical clock that had reached a level of development that could provide the synchronisation required by industry. It was the clock that focussed peoples attention on the passage of time and its implications for production and productivity [Landes, 1983; Rifkin, 1987; Hobsbawm, 1991]. A difficulty arose between employers and employees because of the

... contradiction in the eighteenth century between time-free (domestic workers) and time-bound (employers and their agents) [which] gave rise to growing tension as demand increased. There is perhaps nothing that hurts more in business than profits forgone, and the unwillingness of cottage workers to devote themselves unremittingly to their tasks was a growing source of frustration to the merchant-manufacturers who could not fill their orders.

[Landes, 1983, p 228]

The complex, highly centralised technology being installed made it necessary to ensure co-operation amongst a number of people as well as to establish and maintain regular hours of work. Although not in all cases, for instance in the emerging iron and steel industry it was common for the same team to superintend a blast furnace firing which might have run for more than twenty four hours without a break [Hammond & Hammond, 1925]. Most factories required regular hours of work and so became a world of bells governed by the
clock. It was the mechanical clock that changed the perception of time and set the pace for work, as Rifkin pointed out, because ...

(t)o become 'regular as clockwork' became [one of] the highest values of the new industrial age. Without the clock industrial life would not have been possible. The clock conditioned the human mind to perceive time as external, autonomous, continuous, exacting, quantitative, and divisible. In so doing it prepared a way for a production mode that operated by the same set of temporal standards.

[Rifkin, 1987, p 103]

Time was to assume a linear orientation rather than the cyclical orientation it had always had. Science had freed man from the demands and regulation of nature and of God and made the future a secular frontier to be tamed by human ingenuity and determination. A move that was aided by the educational system, such as it was, and the schoolroom became the training ground for the factory. The schedule became important if not more important than reading, writing and arithmetic [Thompson, 1967]. The schedule imposed an order which accorded with the philosophies of the managers. Order and regularity were paramount and

(i)nside the schoolroom, astride the church dais, on the factory floor, the new urban culture was being entrained to a new temporal catechism. The clock and the schedule were being indelibly imprinted into the consciousness of the culture.

[Thompson, 1967, p 112]

In tune with the rationalism of the factory masters this new concept of time became a requirement and punctuality a virtue. From the point of view of the factory managers, how could it be otherwise. Where workers were employed on day rates then a starting and
stopping time had to be assigned, where the workers handed their work on to others then this work flow had to be synchronised. As the employers were paying for time they expected to receive value in return. The cyclical nature of agriculture with its periods of intense activity and inactivity would not do for the factory for time had to be used in the same way as any resource, in the most efficient manner possible.

Common men and women were exposed to time schedules for the first time when they entered the factory. It became a real and intimate part of their lives. They were committed to work for some thirteen to sixteen hours a day for six days a week without let up. Records were kept of their adherence to the schedule. Samuel Oldknow recorded attendance in periods of a quarter of a day, the Crawley iron works kept a daily time sheet for each employee to the minute [Rifkin, 1987]. The schedule ordered every minute of the worker's lives once they had entered the factory gate and it was enforced by a system of penalties and rewards to encourage conformity.

There appears to have been considerable resistance to this time discipline with the institution of 'Saint Monday' persisting in many

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6 In many areas Monday was traditionally regarded as a holiday after attending to religious duties on Sunday. Often Monday was spent at the ale-house, this was not a problem when work was conducted on the putting-out basis because the workers were able to make up the time later in the week [Reid, 1976; Thompson,
places until the middle of the nineteenth century [Reid, 1976; Thompson, 1967]. The lure of the old ways was still very strong, however the schedule eventually won, imposing a time discipline concept that was accepted by future generations.

Religion as an Influence in the Development of Manufacturing

A very significant influence in the development of manufacturing and the people who were involved in its organisation was their religion [Wilson, 1957; Ashton, 1964; Mathias, 1969; Rogers, 1981; Langford, 1992]. The Reformation of the sixteenth century had removed the power of the Roman Catholic Church in a large part of Europe and particularly in England, leading to the subsequent rise of Protestantism.

The reformers were concerned with the direct relationship of the individual to God rather than through the medium of the Church.

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1967]. Thompson [p 78] cites a poem by George Davis written in 1790, in Birmingham and entitled Saint Monday; or, Scenes from Low-Life:

When in due course, SAINT MONDAY wakes the day,
Off to a Purl-house straight they haste away;
Or, at a Gin-shop, ruin's beaten road,
Offer libations to the tippling God:
And, whilst the gen'rous liquor damps their clay,
Form various plans for saunt'ring out the day.

Perhaps at work they transitory peep,
But vice and lathe are soon consigned to sleep:
The shop is left untenanted awhile,
And a cessation is proclaimed from toil.
The central doctrine of Protestantism was that salvation came through faith not through works and so individuals were directly responsible to God for their actions and not to a priestly hierarchy. Because of this Protestantism

...was infinitely more flexible than Catholicism. Catholicism had the iron framework of the hierarchy, headed by the pope. It had the machinery of confession, penance and absolution, and of church courts and excommunication, not to mention the Inquisition, with which to enforce traditional standards of orthodoxy. Protestantism lacked many of these barriers to change of moral attitudes.

[Hill, 1966, p 45]

While some of the institutions and codes of the past were retained in the Anglican church, efforts were made to establish new disciplinary institutions and codes. So we see the rise of a number of Protestant groups dating from the sixteenth century. Protestantism appealed to artisans and small merchants because it helped them to trust the dictates of their own hearts as the standard of their conduct [Hill, 1966]. The old ways no longer gave them any sense of control over the economic world, which was subject to much fluctuation, only self-confidence could give this sense of control and those with this self-confidence felt themselves to be the 'elect of God', and thus unique and different from the rest of society. These

... men felt quite genuinely and strongly that their economic practices, though they might conflict with the traditional law of the old church, were not offensive to God. On the contrary: they glorified God.

[Hill, 1966, p 47]
Martin Luther emphasised this notion when he said that because men served their neighbour through their work they also served God [Hill, 1966]. The Protestants emphasised hard work as being a necessary part of their ethos. They took to heart the verse in the Bible which says

Seest thou a man diligent in his business? he shall stand before kings; he shall not stand before mean men.

[Proverbs, Ch 22, V 29
King James Version]

From this encouragement, it was felt that the earning of money, so long as it was done legally, was the result of and the expression of virtue and proficiency in the pursuit of a business or calling [Weber, 1989]. The emphasis was on the motive of the heart; provided that this was true then all business activity was justified. Usury became a legitimate transaction provided the motives were considered 'pure'. This can be compared to the Roman Catholic casuistry which emphasised the formal and the external and so the release from the sin of usury depended to some extent on accountancy7 [Hill, 1966].

Protestantism found its initial support within the largely educated, urban minorities; those very groups that provided the impetus for

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7 The Canon law of the Middle Ages held that loans were gratuitous contracts and interest was not to be paid. This doctrine was circumvented by a number of devices including concurrent contracts guaranteeing the lender a return on the loan leading to the situation where the lawfulness of interested depended on the drafting of the contracts in the proper form. The Catholic Church dropped its opposition to interest in 1830 [de Roover quoted by Bursk, et al, 1962]
accumulation of capital and its subsequent investment in new enterprises. In describing this situation Hill wrote that there

... was no inherent theological reason for the Protestant emphasis on frugality, hard work, accumulation; but that emphasis was a natural consequence of the religion of the heart in a society where capitalist industry was developing. It was, if we like, a rationalisation; but it flowed naturally from Protestant theology, whose main significance ... is that in any given society it enabled religion to be moulded by those who dominated in that society.

In a society run by Protestants the ungodly must be disciplined; and the duty of performing good works for one's neighbour became a duty to the community. Hence the overwhelming emphasis of later Puritanism on the religious duties of industry, thrift and accumulation. As the bourgeois virtues triumphed, so the society of largely self-employed small producers was transformed into a society of domestic- and wage-workers, who could be profitably employed by those who owned capital. In this society the few who climbed the social ladder did so at the expense of their neighbours. So the thoughts of the fortunate upper ranks came to stress more and more the vices and follies of the poor.

[1966, p 51]

The dogma of the Protestants presented the view that the only way of living in a way acceptable to God was not to avoid the morality of the world by hiding from it but by fulfilling the obligations imposed on the individual by his position in the world. In other words, by his calling. It was the way in which a man fulfilled his calling that was important [Weber, 1989]. The notion of calling was developed further by the evolution of the Protestant movement into a number of different churches.
Perhaps the essence of Protestantism, certainly in the seventeenth century, was encapsulated in that movement known as 'Puritanism'. Taking the bible as its only authority and drawing inspiration from Calvin, the Puritans emphasised the right of private judgement, insisted on knowledge and reason, independence, and uprightness of character and demanded that men spend their time profitably [Kemsley, 1968]. The Puritan outlook favoured the development of enterprise and encouraged a thrifty lifestyle; both qualities exhibited by many of the entrepreneurs of a century later [Gellner, 1992].

The connection between the growth of industry and the rise of groups that dissented from the established church has been observed by a number of authors [Weber, 1989; Ashton, 1964; Wykes, 1990; Hill, 1966; Mathias, 1969; Wilson, 1959; Houston, 1986]. Even though the dissenters were a minority of the population they were well represented in the manufacturing and trade communities in the towns [Wykes, 1990]. A number of reasons have been proposed for the success of these communities in business, Ashton [1964] suggests the most important contributions were concerned with education and the close networks that these groups formed. This view is supported by Wykes [1990] who points out the irrelevance of the Universities of Oxford and Cambridge and their training for the learned professions, for those whose support came from the world of business. The education the nonconformists prescribed for their children was essentially practical in its nature. Wykes [1990] also suggests that few nonconformist parents would have wished to expose their sons to the immorality of the English Universities.
Some of the forms that Protestantism took had a more direct influence on those involved in the changing society of the second half of the eighteenth century than others. The values of dissent were not confined to the chapel, they contributed to people's attitudes and sense of self-worth and impinged directly on their behaviour within society in general [Seed, 1985]. Taking the tenets of Puritanism and moulding them further these Protestant societies produced a number of leaders of the Industrial Revolution.

Quakers

Otherwise known as the 'Society of Friends', the Quakers held a commanding role in the business affairs of the times. They held to the view

... that true religion consists not in certainty but in search, not in old conviction but 'new doubtfulness'. In the end was a 'new certainty' to be discovered, but it was a certainty of a different kind from the old: no longer fixed but hardened into institutions and creeds, but infinitely more powerful because it reached the centre of the human being.

[Loukes, 1965, p 15]

Beginning in the seventeenth century with the teaching of Edward Fox the Quakers worshipped by gathering together in monthly, quarterly and yearly group meetings. These meetings were conducted in silence, a good test of self-discipline. They believed that all life was sacramental and emphasised inner spiritual
experiences rather than a specific creed. Their worship was based on a trust in the Holy Spirit and faith that ordinary people were capable of receiving the Spirit. They became known for their absolute honesty, which was not only a sound moral practice but was good for business too. They were known for their fixed prices and their refusal to haggle [Loukes, 1965].

Unable to send their sons to Oxford and Cambridge the course for the Friends lay in more practical pursuits. In these they did well. Their honesty, their questioning, their humble open mind and their sense of responsibility for others put them in a good position for success in trade. Furthermore

... Friends were sober and earnest, believing that work was better than play. And beneath all this was the digging spirit, looking for the 'truth' of a matter, with the obstinate grasp of essentials that 'clears the mind of its cant'. So they were notable in technical innovation and in building up new structures of human relationships that have left behind an indelible Quaker mark on our industrial system.

[Loukes, 1965, p 74]

The Quakers were very active in building up their businesses, such names as Cadbury, Fry, Rowntree, Bryant and May, Huntly and Palmer, Allen and Hanbury, Darby, Barclay, Gurney and Lloyd figure

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8 Admission to Oxford University required subscription to the Thirty-Nine Articles of the Church of England and the Oath of Supremacy of the monarch. A similar subscription was required at Cambridge University on graduation, so while it was possible for a Quaker or other dissenter to attend Cambridge without graduating few, if any, did so [Wykes, 1990].
very prominently in the history of British business [Mathias, 1969].
In science too, men such as Lister and Dalton made their mark.

Unitarianism

Unitarianism was a movement which is more relevant to this thesis. Samuel Oldknow, whose business is described in the next chapter, was a prominent Unitarian. It would appear that James Watt jnr also had Unitarian connections, although there does not seem to be any direct evidence that he was a member of the sect.

Unitarianism came from English Presbyterianism, as well as from disaffected elements of the Established Church. It had its roots in 'rational dissent' and placed its reliance on a faith which treated the divinity of Christ as a superstitious divergence from defensible theological doctrine [Langford, 1992; Seed, 1985].

The changes wrought on Presbyterianism by the Enlightenment were noted by Mineka when he wrote that

... the predominant influence on Presbyterian thinking from the late seventeenth century through the eighteenth century, like the spirit of the age was rationalistic. The reverence for authority which had marked earlier Presbyterianism was breaking down; the discoveries in science, in medicine and psychology particularly, lead to increased respect for human reason in investigating both sacred and profane truth. The earlier Presbyterian acceptance of the Reformation doctrines of original sin, the total depravity of man, and the atonement became more and more modified, both through the influence of Polish and Dutch theologians
and through English and Scottish philosophers' development of the theory of the natural goodness of man. Increasingly, Presbyterians asserted the right of individuals to employ reason in the interpretation of Scripture and insisted that the Bible, not the opinions of the Fathers, was the basis of the Protestant religion.

[1944, p 14]

The eighteenth century witnessed, for a number of congregations, the transition of Presbyterianism from Calvinism to Unitarianism through a rational process involving the dismantling of much of what orthodox Christianity believed. Beliefs central to Christianity such as the divinity of Christ, the doctrines of original sin and virgin birth and the concepts of the devil and hell were abandoned as irrational superstitions. This process took place on the basis of individual congregations changing their views rather than a concerted, unified movement. However, there were many similarities between these groups or chapels which were essentially urban in location [Seed, 1985].

While many congregations had become Unitarian in outlook the first publicly declared Unitarian chapel was organised in 1774, by Theopilius Lindsey (1723-1808), a former Church of England minister, with the first services being held in London [Seed, 1985; Langford, 1992; Gasgoigne, 1986]. Unitarianism was based in rationalism and appealed to common sense rather than finding its basis in what was called 'the corruptions of Christianity' [Beard, 1861]. Its adherents stood for liberty of conscience, of thought, of speech and of worship. One of the number of congregations that had been established prior to the recognition of Unitarianism as an identity was the Cross Street Chapel in Manchester, a congregation
whose members played a leading role in the development of science and industry in that city and a congregation which will be referred to later.

Unitarianism with its emphasis on rationalism and preference for 'candour' and its distrust of 'enthusiasm' appealed to tradesmen and shopkeepers and other similar groups [Thompson, 1963]. The movement reacted against Calvinistic doctrines that emphasised human sinfulness, as well as the doctrine of the Trinity. They argued that these doctrines were inconsistent with the Bible and contrary to reason.

Perhaps the best known member of the Unitarian movement was Joseph Priestly. His influence gave the movement most of its impetus. A scientist and minister of the church, his theological views imparted a stronger militant tendency to the movement than it had previously possessed. His example encouraged the charge that Unitarianism was cold, unfeeling and related more to the head than the heart [Mineka, 1944]. His writing also furnished Jeremy Bentham with the idea for the greatest happiness principle, later to be the foundation of the Utilitarian movement [Seed, 1985]. As quoted in Seed, Priestley defined virtue as "that disposition of
mind, and that course of conduct arising from it, which is best calculated to promote a man's own happiness and the happiness of others with whom he is connected" [1985, p 312]. A view which no doubt gave encouragement to those hoping to further their own ambition.

The Unitarians rejected creeds as being man-made and as such misleading. They took the Bible as their authority, but they were careful to choose only those Scriptures that would support their position [Mineka, 1944]. While they resented the notion that they were Diests their beliefs bore great similarity to those promulgated by the theory of Deism⁹, that while God created the world and exists He has no further interest in the world. They held the view that God had set in train a series of laws which governed the world and all man needed to do to control the world was to discover these laws through science and through reason. Hence the constant searching and enquiry with no ultimate truth in sight. Yet it was this intellectualism that appealed to its adherents, who were mainly from the educated middle class. What had started as a fringe group at the beginning of the century had grown into an articulate minority with a growing following among professional groups such as scientists, publishers, writers reformers, educators and campaigners, by the end of the century [Porter, 1982]

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⁹ The Deists argued that a few religious truths conformed to the observation of nature and the requirements of reason. God had created the laws of nature and morality, the rest was superstition [Weiss, 1977].
Herein lies the importance of Unitarianism, at its core was a successful elite whose wealth sustained the chapel and its minister and whose views shaped the culture of rational dissent. These people saw their increasing affluence as a reward for their own hard work, calculation and foresight guided by an all encompassing faith in reason. They were supportive of each other in the world of economics, membership of a prestigious congregation being a sign of respectability and credit worthiness. This was important in the era of unlimited liability where the networks of family and chapel provided a system of mutual trust and co-operation [Seed, 1985; Wilson, 1957]. As will be illustrated in the next chapter Samuel Oldknow was a prominent member of a Unitarian chapel and depended on these networks for capital to sustain his business ventures.

**Methodism**

Originating in the established church, Methodism was eventually forced to separate from it. Its founder was John Wesley, who felt that the proper way to reform the evils of society was to transform the individual. He revived the puritan ideal shorn of its political radicalism and advocated thrift, abstinence, hard work and concentration. Wesley, who was a conservative in politics, appealed to the poor with his message of personal salvation [Plumb, 1950; Thompson, 1963].
Early Methodism contained the prejudices of the uneducated; prejudices which became hardened with the movement's success. It had an anti-intellectual, philistine quality which attracted the dispossessed. Typical was its attitude towards education. Wesley considered knowledge of the bible to be sufficient education and did not think that children should play because idle minutes were the greatest danger to a child's soul. He preached that children should be at work. Often this message was preached in areas with growing demand for child labour [Plumb, 1950]. It was no wonder that Methodism was often supported and encouraged among the work people by the factory owners.

The predominant denomination in England was the Church of England. It was the church of the establishment and the majority of the people, but the drive toward economic change came not just from the establishment but disproportionately from the minority groups [Ashton, 1963; Mathias, 1969]. These groups were outside the establishment but not hampered by the establishment. They were forced to find their own way. Excluded from the great universities they established institutions like the Warrington Academy and turned to more practical pursuits. They led for the most part scientific investigation and established trading and industrial houses. They were fired with a zeal not matched by the more mainstream groups, their self denial and quiet ways of living meant that profits could be ploughed back into their businesses. The networks they established provided mutual support and access to
resources and finance\textsuperscript{10}. They viewed their success at business as being in favour with God or as having greater control and knowledge of the natural laws. As Weber wrote:

\begin{quote}
National or religious minorities which are in a position of subordination to a group of rulers are likely, through their voluntary or involuntary exclusion from positions of political influence, to be driven with peculiar force into economic activity. Their ablest members seek to satisfy the desire for recognition of their abilities in this field since there is no opportunity in the service of the state.
\end{quote}

\cite[1989, p 39]{weber}

For the eighteenth century entrepreneur membership of a dissenting chapel was important in three ways, it provided doctrine, connections and credit \cite{chapman}. Membership also provided access to an international community which shared similar values and outlook, a valuable asset when credit terms were for a year or more.

The dynamism of the age depended on individuals being prepared to postpone the pleasure they may feel from their possessions and to use those possessions as capital to earn more profits. Because

\begin{quote}
... it is one of the fundamental characteristics of an individualistic capitalistic economy that it is rationalised on the basis of rigorous calculation directed with foresight and caution toward the economic success which is sought in sharp contrast to the hand-to-mouth
\end{quote}

\textsuperscript{10} These networks did not necessarily reach across sectarian boundaries as there was some conflict between the Quakers and the Unitarians in relation to lifestyle. The Unitarians enjoyed the fruits of their labours while the Quakers expressed forebodings about the consequences of wealth \cite{chapman}. 

existence of the peasant, and to the privileged traditionalism of the guild craftsman and of the adventurer's capitalism, oriented to the exploitation of political opportunities and irrational speculation.  
[Weber, 1989, p 76]

Freemasonry

Another meeting point for the emerging middle-class was provided by the lodges of Freemasonry which were involved in the dissemination of the new natural philosophy and its applications [Hobsbawm, 1991; Money, 1993]. Freemasonry had an influence on the development of industry in the late eighteenth century for this reason together with the networks of relationships of like minded individuals that grew from the movement. Certainly it seems that Samuel Oldknow [Giles, 1984], for example, was a Freemason, as well as a Unitarian. For those who were disillusioned with Christianity freemasonry had the potential to become a new religion based upon belief not in the power of providence but in the power of nature [Jacob, 1981; Money, 1993]. Freemasonry also had the appeal of a club of like-minded men bound together with the hope of finding a degree of commercial stability in this unity [Porter, 1982; McKendrick, et al, 1982]. The widespread acceptance of freemasonry by the aristocratic as well as the middle class is evidence of the desire for a structured universe, even beyond the observable [Colley, 1984; Plumb, 1972; Money, 1993]. Even the most ardent protagonists of reason seemed also to be freemasons [Plumb, 1972].
With ancient beginnings, Freemasonry became organised in the early eighteenth century. Its essential social nature coupled with the trappings of secrecy gave a sense of community to men who were disaffected from the church or chapel. Stressing the virtue of work and being industrious the masons too formed networks of mutual support where

... organised Freemasonry served as a social nexus that promoted specific cultural and ideological goals. Stability under a strong, but constitutional monarchy, social mobility under aristocratic patronage, religious toleration, baconian experimentalism and of course dedication to the new science.

[Jacob, 1981, p 109]

The Masons worshipped the God of the new science whom they called the Grand Architect. The lodges were places "where class distinctions did not count and the ideology of the Enlightenment was propagated with a disinterested zeal" [Hobsbawm, 1991, p 34]. Masonry gave its members credibility, certainly in their own eyes, and this was important at a time of economic transformation, because it provided another network of information, introduction and reliable acquaintance [Mckendrick, et al, 1982; Money, 1993].

**The New Industrialists**

The Industrial Revolution was more a revolution in organisation and attitude than a revolution in technology [Wilson, 1959; Mathias, 1969; Hobsbawm, 1968; Plumb, 1972; Newman, 1987; Langford, 1992]. For example the pottery industry of Staffordshire was
'revolutionised' not because of some decisive invention or the application of mechanical power, but by a series of improvements in the methods of manufacture and its organisation [Hammond & Hammond, 1925]. Men like Josiah Wedgewood were responsible for turning a peasant craft into an industry operating through factories. People were collected together and this collection allowed production to be increased many times over.

Who were these industrialists? What did they have in common that was not common at other times? Certainly the managers and entrepreneurs of the time seemed to have been a very dynamic group. Increasing prosperity had seen the rise of a middle class who had capital to commit to new ventures as well as a taste for the new products that were being developed. A large number of the innovating managers seem to have come from the ranks of the middle-class [Crouzet, 1985] and to have taken advantage of the capital available to them. They were largely of the Protestant persuasion and often dissenters from mainstream Protestantism [Weber, 1989; Ashton, 1964; Mathias, 1969; Chapman, 1992]

The dissenting churches stressed the virtues of thrift and hard work; virtues which were emphasised in the academies that they established as substitutes for the universities that were denied to them. The dissenting academies provided a practical curricula — modern languages, modern history, practical and commercial arithmetic, and bookkeeping as well as the new, experimental sciences. The graduates were well equipped to meet the challenges of the age [Schofield, 1963; Mathias, 1969; Rogers, 1981].
A common trait of entrepreneurial activity in the second half of the eighteenth century was the ability to sense market opportunity as well as the ability to exploit the opportunities that presented [Wilson, 1957; Mathias, 1969; McKendrick, et al, 1982]. They were required to recognise the trends of the marketplace and organise production accordingly. Oldknow remained in continuous touch with his London agents who monitored the dictates of fashion [SOP; Unwin, 1924], and James Watt jnr maintained a copious correspondence with his partners and employees regarding the implications the innovations in other industries might have for the steam engine business [B&W].

A large number of eighteenth century entrepreneurs had little formal training and initially little knowledge of science and technology [Tann, 1973]. However, many of them set about to acquire this knowledge [Tann, 1973; Musson & Robinson, 1969] either by experiment or by first hand observation. Many of the industrialists were also interested in science, following from their desire to understand the laws governing the universe and their 'rational' approach to the world. If the discoveries of their science had practical applications then so much the better. This more than anything else summed up their approach to the activities they were involved in - every problem had a solution, all that was needed was to discover this solution by discovery of the appropriate principles.

They were very practical men [Wilson, 1957]. They often had to deal with situations that had not been problematic hitherto. A major task
being the accumulation and training of a large number of people to work in the new factories. They had to use the tools at hand as well as to develop new ones to mould men and materials to produce the products being demanded. They were aided in this process by their belief in the powers of rational, systematic and detailed investigation.

In his novel *Hard Times*, Charles Dickens [1989] described the manufacturer Thomas Gradgrind as

... (a) man of realities. A man of facts and calculations. A man who proceeds on the principle that two and two are four, and nothing over, and who is not to be talked into allowing for anything over. Thomas Gradgrind, Sir-peremptorily Thomas-Thomas Gradgrind. With a rule and a pair of scales, and the multiplication table always in his pocket, Sir, ready to weigh and measure any parcel of human nature, and tell you exactly what it comes to. It is a mere question of figures, a case of simple arithmetic.

Written in 1854, *Hard Times*, sought to portray an industrial England with the workers very much under the control of men like Gradgrind and others not as altruistic as Gradgrind turned out to be. Yet Gradgrind was a metaphor for the 'rational' industrialists of the time who sought to reorganise society for the benefit of their own class. In Gradgrind we find an attitude which was not uncommon in many who became industrialists and leaders of commerce. The notion of measurement and ascertainment of 'fact' before proceeding to a decision, the notion of awareness of the minutest detail and the notion of logical progression and relationship of these details was of the utmost importance to these people.
Gradgrind represents the archetypal factory master who called upon all the sources of information available to assist in the management of the business. Information that was vital to objectify the business in order to enable rational decisions. The position of accounting in this process is of much interest. It is suggested that accounting techniques were relevant to the style of the Gradgrinds and fitted in very well with the notion of rational decision making.

Josiah Wedgewood

Josiah Wedgewood (1730-1795) is an example of the industrialists that came to prominence in the eighteenth century. Born the thirteenth child of a potter, he started work in the potteries at the age of nine and he eventually rose to become the Queen's Potter [McKendrick, 1959; Thomas, 1936]. Wedgewood became known for his reorganisation of the family pottery business. He was an experimenter with a keen interest in science and the application of science and technology to his business. A dissenter and friend of Joseph Priestley, Wedgewood was also a friend to a number of people who were also involved in science and its application to the problems of industry. McKendrick summed up Wedgewood's contribution to the course of the Industrial Revolution by writing of "his genius for anticipating the techniques of mass production: division of labour, creation of demand through clever salesmanship, constant improvement of the methods of distribution, development of cost accounting, and the application of scientific discoveries to practical problems" [1959, p 89]. As an entrepreneur Wedgewood had the skill
of being able to anticipate the market with the realisation that the growing middle-class would seek to emulate the fashions of the aristocracy and would demand similar products but in far greater numbers.

The pottery of Josiah Wedgewood at Etruria, which served as a model to the pottery industry, can be given as an example of a rational systematic approach to the organisation of production. Wedgewood set up his factory based on the division of labour to produce the new products he had designed. He achieved increases in quality by training his workman in one particular task and then paying them higher wages to stick at that task. In this process of training his workers, Wedgewood had centuries of local tradition to overcome. His potters did not like punctuality, attendance, fixed hours or the scrupulous standards of care and cleanliness required by Wedgewood [McKendrick, 1961]. This presented Wedgewood with a challenge because to...

... change such habits was not easy: nor was it always pleasant. It required exhortation, reward and education to create a factory system. Wesley and the Sunday Schools taught the industrial virtues of diligence, thrift and regularity: Wedgewood's factory discipline - his bell, his embryonic clocking-in-system, his rules and regulations - insisted on them. It is easy to condemn such methods. But it would be ridiculous to deny their results. [McKendrick, 1961, p 55]
McKendrick has written extensively of Wedgewood and the factory that he developed. Wedgewood however does not appear to have had much relish for bookkeeping. Meteyard [1866] notes this dislike and Wedgewood's consciousness of the losses that had resulted from this inattention to the requirements of the books. However, McKendrick [1970] records Wedgewood's awareness of the benefits of accountancy and in particular the benefits of costing. This story is worth repeating if only because it illustrates the rational, investigative approach taken by Wedgewood in most of his activities, this time accountancy provided the tool.

Wedgewood's Etruria works opened in 1769 [McKendrick, 1959, p95]

The article by McKendrick [1970] attempts to evaluate the role of cost accountancy in Wedgewood's business. Wedgewood investigated full-scale costs very occasionally because prices were generally very high, with correspondingly high profits, so he saw no need to be particularly concerned with costs. However, a severe economic depression in 1772 was sufficient to stimulate him to enquire further into the costing process.
In a letter to T. Bentley, his partner, in August 1772 and facing by falling sales and mounting stock Wedgewood wrote that:

it will deserve our serious discussion whether we shd not lower the prices of Pebble & Gilt Vases very considerably, for this I am forming a price book of Workmanship &c which is to include every expence of Vas making as near as possible from the Crude materials, to your counter in London, upon each sort of Vases, of this we will send you a specimen & you will then be able to judge better what we can do in this respect, what will be most prudent is the next question for our consideration.

[McKendrick, 1970, p 49]

In another letter to Bentley on 23 August 1772, he wrote:

I have been puzzling my brains all the last week to find out proper data, and methods of calculating the expence of manufacturing, Sale, loss &c to be laid upon each article of our Manufacture, & a very tedious business it has been, but what is worse I find what I have done is wrong-somewhere, very essentially so, but do not know where or how to amend it though I shall not give up being sensible of the importance of the enquiry, and what I now send you is only to shew what steps I have taken & the grounds I have gone upon, & to desire you will sit down some morning & consider the subject & try to put me in a better way, for it will be of the greatest use to us to establish some such scale as I have now been attempting to examine all our new articles by, that we may not fix the prices so high as to prevent sale, nor so low as to leave no profit upon them.

[McKendrick, 1970, p 49]

These letters show Wedgewood's awareness of the need for an effective system of costing in order to determine a pricing structure.
Even though this attempt ended in failure he obviously intended to take into account all the costs incurred to the time of sale.

Apparently Wedgewood's detailed calculations of costs showed some irregularities in his pricing policy so in some cases he even lowered his prices. He discovered that his prices added 300% to the cost of some of his products, but he was perplexed when he noted that the total cost of manufacture (as calculated) for a year was little more than half the real cost as indicated by his profit.

The exercise of calculating the production costs of his products made Wedgewood aware of the advantages to be gained from economies of scale as a result of large-scale production. He in fact calculated the cost of production of each of the products he produced, making allowance for overheads incurred in their production. The exercise also showed him the profit margins on each product and the potential for price variations.

The products manufactured by Wedgwood offered quality and had fashionable appeal and often the prices were based on what the market was prepared to pay rather than on cost. For the most part he enjoyed a constantly expanding market based on a rising population and expanding overseas markets, but falling demand in 1772 forced a revision in this pricing policy. He simply lowered his prices because his cost calculations had shown that it was feasible to do so. When demand picked up again he raised the prices. The information he gained concerning his profit margins was invaluable but that was not the only benefit because
... the discoveries of his costing operation had two other important, and more lasting, results. Firstly, it made him think out in some detail the implications of his pricing policy and permanently influenced its future development. Secondly, it made him acutely aware of the savings to be achieved through accurate costing, and acutely aware of the permanent role in production costs played by rent and administration.

[McKendrick, 1970, p 54]

While he does not appear to have developed a systematic method for determining cost, Wedgewood seems to have used cost information as a basis for his business decisions. McKendrick notes an entry in Wedgewood's Commonplace book for 29 June 1781 which indicates a costing of new techniques prior to their introduction. He writes that

... in a list of miscellaneous jottings occurs a brief but significant entry. It opens modestly with the words 'Edged some small plates with green in a new way', it goes on to explain the new technique, and comments that it is not only 'much better' in appearance but 'it is done in half the time'. But the important point is that the operation was timed, the length of painting measured, and the price per yard calculated.

[1970, p 56]

This entry provides evidence of investigation before being committed to production. Such investigation could be vital in the face of competition or falling demand when economies of scale and cost consciousness influenced profit margins. Cost investigations also indicated the efficiency of the various workshops in the pottery.

McKendrick [1970] points to other evidence of Wedgewood's awareness of cost accounting when he refers to the 'Cost of Workmanship' book kept by Wedgewood. This book was apparently
kept up-to-date over a number of years with frequent additions and corrections to the cost of the products listed therein. The Commonplace Books show the calculation of the cost of an engine mill, together with the cost of fuel per hour. That Wedgewood was interested in the cost structure of his competitors is evidenced by the detailed calculation of raw materials and carriage at rival factories and their comparison to those at Etruria. The Commonplace Books show the cost per ton of transporting clay and indicate the attempts made to reduce it, as well they indicate the extra expense of new techniques [McKendrick, 1970].

In spite of his aforementioned aversion to bookkeeping Wedgewood gained from his cost investigations and he learnt some very valuable lessons:

He learnt, for instance, that the labour cost of apprentices was only one third of adult workers, and the labour cost of boy and girl assistants not yet apprenticed was even less. In fixing piece-rates for his workers, costing was obviously of great importance and his calculations on this factor are often worked out in very great detail. In 1781 he not only worked out the prices per dozen for enamelling different patterns, but also costed a day's work at the different piece-rates and speeds at which each pattern could be produced. 

[McKendrick, 1970, p 58]

Wedgewood felt some disquiet at not being able to make his calculations reconcile. The discrepancy mentioned in his letter to Bentley was causing this concern. The discrepancy resulted from the comparison of the profit he calculated by multiplying the profit margin on each item sold by the number sold with the profit as
reported by his bookkeepers. He felt that his calculations were correct but could not explain the difference.

His next inquiries revealed why not. For they uncovered a history of embezzlement, blackmail, chicanery, and what Wedgewood called 'extravagance and dissipation'. The discrepancies in Wedgewood's accountancy were not due to his inaccuracies, but to his head clerk's dishonesty, with the help or connivance of his subordinates.

[McKendrick, 1970, p 61]

Even though a considerable part of the profits had been misappropriated this episode does not seem to have led to the introduction of more rigorous internal control.

Wedgwood was highly successful in reorganising the production of pottery. He introduced no new technology initially. However, he did introduce a rational, systematic approach to the organisation of his business. This coupled with his artistic abilities and his ability to judge the market led to his success. A success aided by his use of accounting techniques to aid the decisions that it was necessary to make. The costing techniques used by Wedgewood played an important role in his success because

(n)ot only did it help buttress his firm against the economic threats of falling demand and falling prices, but it also significantly influenced his subsequent production and sales policy even in years of buoyant demand, high prices, and high profits.

The evidence is clear that it was his costing which taught him the advantages of economies of scale, the high level of his profits, and the dishonesty of his clerks. And the evidence is conclusive that in 1772 his cost accountancy was accurate enough to influence the wages he paid and
the prices he charged, and, consequentially, helped to control both his production and sales policy.  
[McKendrick, 1970, p 64-65]

Examples of Jasper ware produced by Wedgwood  
[Wedgwood Company]

Networks

A feature of the late seventeenth and eighteenth centuries was the growth of societies and clubs. Associated with an increasingly urban society these clubs and associations permeated society in general. Libraries and book clubs helped meet the demand for books, mutual benefit funds helped people provide for their futures, the beginnings of trades union as well as all manner of benevolent societies flourished during this period [Langford, 1989; Morris, 1983; Gay, 1969; Musson, 1972].

Describing the establishment of these societies Gay wrote that the...

... age of the Enlightenment was an age of academies - academies of medicine, of agriculture, of literature, each with its prizes, its journals, and its well attended meetings. In the academies and outside them, in factories and workshops and coffee houses, intelligence, liberated from the bonds of tradition, often heedless of ascetic scruples or religious restraints devoted itself to
practical results; it kept in touch with scientists and contributed to technological refinements.  
[1969, p 9]

Such societies were an essential focus of scientific and other pursuits and they became a point of dissemination of new knowledge and theories. The major towns and cities established philosophical and other societies to discuss matters of interest to the members. The Lunar Society of Birmingham, The Derby Philosophical Society, The Manchester Literary and Philosophical Society and The Bath Society were typical of the provincial societies with others being established Norwich, Northampton, Exeter, Bristol, Plymouth and Newcastle [Musson & Robinson, 1969; Robinson, 1967; Morris, 1983; Langford, 1992]. The members of these societies were often those at the forefront of scientific investigation or industrial and agricultural innovation [Langford, 1989; Hobsbawm, 1991]. Interestingly, the various societies often kept in close touch, sharing their new knowledge [Schofield, 1963, 1967].

Morris [1983] suggests that the proliferation of societies for all manner of reasons were part of the creation and recreation of urban elites in a period of relatively rapid social and economic changes and were a basis for the creation of a middle-class identity. The emerging middle-class were, in most cases the driving force behind the development of the Industrial Revolution [Hobsbawm, 1991, 1968; Mantoux, 1961; Langford, 1992].

Wedgewood was a member of this growing network of 'philosophical' societies that were being established in the provincial centres. These
societies, together with the Royal Society, based in London, were forums for new ideas that supported and encouraged areas of new endeavour in the sciences and manufacture. A number of innovations and advances came from the work of these institutions.

Possibly the most important of these regional societies were the Lunar Society of Birmingham and the Manchester Literary and Philosophical Society.

The Lunar Society of Birmingham

Birmingham was a town that was unaffected by various acts of Parliament which restricted trade and movement. Because of this it became a refuge for dissenters, especially those dissenters who wished to establish a trade. By the 1750s the population of Birmingham was characterised by a diverse, liberal, ingenious and industrious group of entrepreneurs [Schofield, 1963]. These people were prepared to take risks on using new techniques and developing new products. As a result of their efforts, Birmingham, with no natural advantages for industry, rose to be a great industrial city.

The economic growth of Birmingham in the eighteenth century resulted from the dynamism and energy of its inhabitants and according to Wise [1967] the reasons underlying this success can be summarised as follows:
1. Improvements in communications, primarily canals, gave access at competitive cost to raw materials and markets for its finished goods.

2. The range of manufactures was extended as a result of innovation, experiment, exchange of information and the adaptation of experience gained elsewhere.

3. The unit cost of production was lowered by the application of new methods of organisation and production.

4. The resources of the district were exploited more fully than in other districts.

5. The size and range of the market for Birmingham's manufactures was extended by the energy of its entrepreneurs.

The members of the Lunar Society were instrumental in much of this expansion.

Because

(m)ore than any other single group, the Lunar Society of Birmingham represented the forces of change in late eighteenth-century England, for the Lunar Society was a brilliant microcosm of that scattered community of provincial manufacturers and professional men who found England a rural society with an agricultural economy and left it urban and industrial.

[Schofield, 1963, p 3]
The Society was originally known as the 'Lunar Circle' and began to meet in 1766 [Blackett, 1967; Schofield, 1963]. The members included among others: Matthew Boulton, Erasmus Darwin, Josiah Wedgewood, James Watt and Joseph Priestly. The Society gained its name from the fact that the members chose to meet in the afternoon of the Monday nearest the full moon, so that they could find their way home easily after the meeting. Most of them lived nearby so that they could, and did, consult daily. Their discussions ranged widely over literature, the arts and, most importantly, science. They were united by a common love of science, or as it was called 'natural philosophy'. Science was considered sufficient cause to bring together people of all views and persuasions. As a group

... they comprised a clearing-house for the ideas which transformed their country materially, socially, and culturally within a generation. They were men of broad interests and their discussions ranged widely, but their major mutual interest was the sciences, pure and applied - particularly as applied to the problems of industry.

[Schofield, 1963, p 3]
The Lunar Society did not act in isolation, it was connected by all sorts of ties, religious, personal, scientific and political, to similar societies in England, Europe and America. Its members were interested in all aspects of their environment and made very positive contributions to aspects of science and education as well as to more practical endeavours.

Central to the group was Joseph Priestly, the Unitarian minister and scientist mentioned above. Priestly embodied the forward looking nature of this group and similar groups. It is to be noted that Priestley was the only member of the Lunar Society who was engaged in pure research with his investigations into oxygen, the others were more involved with the application of science [Blackett, 1967]. Trained, as mentioned earlier, as a dissenting minister, Priestly also taught for a time at Warrington Academy, one of the most famous of the dissenting academies. Having doubts about mainstream dissenting theology he became an important figure in the Unitarian movement. To Priestly human progress was to take place through science, this progress led to perfection and humanity stood at the doorway to a glorious future [Schofield, 1963; Armitage, 1967; Kramnick, 1986].

*James Watt (1736-1819)*

[McKendrick, 1959, p 91]
Armytage includes the following quote from Priestley's *An Essay on the first Principles of Government; and on the Nature of Political, Civil and Religious Liberty* (1771), when describing Priestley's view that the power of humanity would be so enlarged that

... nature, including both its materials, and its laws, will be more at our command; men will make their situation in this world abundantly more easy and comfortable; they will probably prolong their existence in it, and will grow daily more happy, each in himself, and more able (and, I believe, more disposed) to communicate happiness to others. Thus, whatever was the beginning of this world, the end will be glorious and paradisaical, beyond what our imaginations can now conceive. Extravagant as some may suppose these views to be, I think I could show them to be fairly suggested by the true theory of human nature, and to arise from the natural course of human affairs. But, for the present, I waive this subject, the contemplation of which always makes me happy.

[1963, p 66]

Priestly, the chemist, Unitarian and republican, thus summed up the view that the future depended on men like himself discovering the secrets of the universe and applying them for the benefit of mankind. Priestley's support of the French Revolution as well as the American Revolution led to riots against him resulting in the burning of his house and laboratory [*The Times*, 18 July 1791]. In despair at the wanton destruction of his scientific apparatus and the defeat of his purpose, Priestley had the following published as part of a letter in *The Times* on Thursday 21 July 1791:

> You have destroyed the most truly valuable and useful apparatus of philosophical instruments that perhaps any individual, in this or any other country, was ever possessed of; in my use of which I annually spent large sums, with no pecuniary view whatever, but only in the
advancement of science, for the benefit of my country and of mankind.

The members of the Lunar Society rallied to help Priestley and supported him for a time but eventually he moved to America in 1794 [Kramnick, 1986].

The members of the Lunar Society were very concerned with the welfare and happiness of their fellow men, and accordingly they addressed the problems of public health, food, sanitation, social and political problems, as well as education. Also a number of the members of the Lunar Society were actively involved in the reshaping of their society and charting the course of the Industrial Revolution. Factories were supplied with power by steam supplied by Boulton and Watt and the problems of transportation were eased by the establishment of canals and turnpikes, which the members helped to plan and finance. The progress of the Industrial Revolution was assisted by a number of inventions and innovations by members of the group; Whitehurst developed pyrometers, barometers, clocks and balances; Boulton designed and made thermometers; Edgeworth developed an hygrometer and an anemometer; Small, Withering and Darwin were interested in optical instrument design; Wedgewood was interested in matters relating to pottery; and James Watt developed the steam engine to a high stage of refinement; as well, Priestley, Watt, Withering, Kier, and Boulton supported Whitehurst in his attempts to establish an international and absolute system of standard weights and measures [Schofield, 1967]. These people had many other interests in science and technology, especially in those processes that directly affected their own businesses, as well as an interest in the newly developing field of chemistry.
The Lunar Society members were interested in finding practical solutions to the problems of manufacture and society. The solutions they found created more challenges requiring further solutions, a relationship described by Schofield:

These solutions required a commercial system in which credit was available for capital expansion and in which there was a dependable flow of currency; the Galtons organised a country bank, Boulton supported the organisation and operation of others, and Boulton's coining-press supplied coinage that was needed to pay increasing numbers of workers. The increase in capital investment produced demands for greater efficiency of operation which were satisfied (unfortunately, perhaps) by the concentration of machines in large factories which were operated for long hours. The factories were frequently heated by steam and lighted by coal-gas using equipment developed at the Soho works; the workers were disciplined with time-clocks invented by Whitehurst.

[1963, p 438]

The Lunar Society continued to meet into the early nineteenth century, with the addition of Boulton's son Matthew and Watt's sons James and Gregory, but as the founding members died it became less of a force and by 1807 it appears to have ceased meeting [Robinson, 1967].

**The Manchester Literary and Philosophical Society**

A more formally organised society than the Lunar Society, the Manchester Literary and Philosophical Society arose out of a group that began meeting in the home of Dr Thomas Percival in 1781, who
was to be the Society's president for many years [Cole, 1966; Fraser, 1938; Rogers, 1981]. As time passed the Society grew with the great majority of the members being engaged or interested in extending science and art to manufacturing purposes [Musson & Robinson, 1969].

Percival (1740-1804) was educated at the Unitarian Warrington Academy, where Joseph Priestley taught for a time. Percival and Priestley were well known to each other. Unable to study at Oxford University because of the Test Act, Percival went to Edinburgh to study medicine and he commenced practice as a physician in Manchester in 1767 [Fraser, 1938]. Percival was a trustee of the Cross Street Chapel, in Manchester, an important Unitarian congregation [Baker, 1884]. He was also involved in the establishment of the Manchester Academy, in 1785, which was designed to train Unitarian ministers as well as to give a liberal education to those about to enter commercial life [Fraser, 1938; Rogers, 1981].

During his lifetime Percival was an advocate of action to improve public health and to this end he became interested in developing a scheme to keep an accurate check on the statistics for birth and deaths in Manchester. He was also involved in the campaign to better the conditions of children employed in the cotton mills. Percival was the main instigator of the move to demand legislative intervention which led to the Health and Morals of Apprentices Act of 1802 [Fraser, 1938]. Fraser described Percival as
... a true eighteenth-century philosopher in the French sense, a believer in science, civilisation, and progress, out to collect facts and make experiments with a view to furthering the well-being of humanity, a lover of toleration, keenly alive to the dignity and rights of man. [1938, p 39]

Several other leading members of the group, Dr Barnes and Thomas Henry to name two, also had strong links to Warrington Academy and to the Cross Street Chapel. All the members had an interest in natural philosophy and an interest in improving the society in which they lived. There was a free correspondence between the discoveries of science and their application to industry, especially the requirements of the newly emerging cotton industry [Fraser, 1938; Baker, 1884]. Some of the leading manufacturers and businessmen of Manchester were members, men such as John Kennedy, Henry Marsland, John Barrow, John Drinkwater, George Walker and others like Thomas Cooper and Robert Owen, as was James Watt jnr who was for a time its secretary. The result was "that in the Manchester Literary and Philosophical Society there was from the beginning an easy exchange of opinion, and in its rooms a manufacturer could consult with half a dozen Fellows of the Royal Society among the Manchester members without talking the corresponding members into account" [Musson & Robinson, 1969, p 92].

These groups and others like them provided a meeting place for the communication and solution of practical problems arising from the members pursuit of their interests including their business interests. The encouragement given to the pursuit of practical science gave an important boost to the development of industry in Britain.
Conclusion

The course of the eighteenth century in Britain saw profound changes in economic life, which in turn led to changes in the whole social structure. New attitudes to poverty, crime, debt, disorder and waste arose. An expanding middle class reinforced by new industrialists displayed an increasing interest in law and order and the development and betterment of society in general. Communication had been improved as had the banking system which assisted the expansion of industry and the changes in the nature of industry so that by the end of the century industry, aided by the power of the steam engine, tended to be located in urban centres rather than in the countryside where water power was available.

It is these social changes that provide a background for the discussion in the following chapters. The attitudes that developed during the century influenced the attitudes of Oldknow and Watt jnr and helped form their characters. Both men were involved in organisations based on 'rationalist' principles, both were required to deal with workers who were unaccustomed to the demands of the factory and both were required to organise and control large organisations.

The entrepreneurs of the eighteenth century had to face problems for which there were no pre-determined solutions. They were concerned with innovation and the protection of their resources and often had
to make a difficult decision between the two at a time when it was often difficult to distinguish between fact and rumour. That so many survived and made a profit, in often difficult economic circumstances, is a credit to their managerial ability.

The following chapters explore how Oldknow and Watt jnr used the accounting process to create a visibility, an order and a rationality of the internal processes of their respective businesses. These two men, were involved in very different industries, yet they were faced with similar problems in trying to understand the magnitude and vagaries of the businesses that they built. Samuel Oldknow was involved, initially with a business that operated in the old way, employing many people working in their own homes and finally with a business operating as a factory employing in excess of five hundred people. James Watt jnr on the other hand managed an established business with the experience of others to draw upon. Both businesses operated during the same period and both men were known to each other. Their businesses provide both a contrast and similarity in their use of accounting methods to regulate and illuminate their economic progress.
CHAPTER 4

SAMUEL OLDKNOW

Introduction

If any one person can be taken to represent the entrepreneurs of the late eighteenth century then Samuel Oldknow would be a prime candidate for that honour. Largely self-educated, and with many abilities, Oldknow was involved in the cotton industry almost from the time it began its rush to prominence. Looking back over his life and achievements Oldknow seems to have been filled with a sense of destiny, a destiny which led him to be a leading player in the cotton industry as it developed through the last two decades of the eighteenth century.

The aim of this chapter is to discuss the life and accounting records of Samuel Oldknow with a view to illuminating the use made of accounting in the management of his business by a person who was a rationalist and a dissenter, and was very much involved in experimentation with processes and products.
In the affairs of Samuel Oldknow we note a transition. Beginning his business as a fustian manufacturer when the term 'manufacturer' meant a person who contracted with spinners and weavers, who worked on their own premises, as discussed in Chapter Two, and ending his business life as a 'manufacturer' [Fay, 1937] when the term applied to those who organised and ran a factory [Ure, 1835].

The cotton industry served as an incubator for new methods and new ways. An industry of recent origin in the late eighteenth century, cotton manufacture expanded very rapidly as manufacturers strove to compete, as prices fell and demand increased. It was fuelled by cotton grown in the Americas by the subjects of the slave trade and had the effect of devastating the traditional cotton industry of India.

It was an industry that favoured innovation. Not being a traditional industry in Britain but similar to the traditional woollen and silk industries meant that skills could be transferred and equipment adapted to cotton manufacture without the strictures of traditional activities. Inventions such as the spinning jenny, the water frame, the carding engine, the mule and later on the power loom provided an even cheaper product. The introduction of this machinery meant that eventually the traditional home spinners and, later, weavers could not compete in terms of output. Workmen started to combine their resources and establish small spinning and weaving sheds. However, machinery requiring the application of power was beyond the resources of most of these groups and gradually the small operations gave way to the large [Ashton, 1964; Edwards, 1967;
Mantoux, 1961]. So people were collected under the one roof, and factories came into being. Such collections of machinery led to a deskilling of the operators, resulting in less skilled and cheaper labour being employed, with the resulting social consequences [Bythell, 1964; Hobsbawm, 1991, 1968; Thompson, 1963; Unwin, 1924].

It was to this expanding and sometimes profitable industry that Samuel Oldknow turned. At various stages in his career he was involved in most branches of the cotton industry and had a well deserved reputation as the foremost manufacturer of fine cotton, goods for a time [Langford, 1992; Owen, 1857; Unwin, 1924, Oldham, 1990].

The Records of Samuel Oldknow

Any historical research must be based on the records and accounts that remain, often, after many years have elapsed. For so many of the enterprises that blossomed during the second half of the eighteenth century, nothing remains, so it is impossible to gain any impression of the way in which those businesses were conducted. Other enterprises such as the Boulton and Watt organisations left copious records, which are still in a very good condition.

The Oldknow records fall somewhere in the middle ground. The papers and documents are often not continuous and in a very poor condition. Still they give an insight into the management and
conduct of Oldknow's business affairs. Whether his method of conducting his business was typical of the times it is difficult to say, but it does seem reasonable to assume that people in the same industry adopted similar methods, but without records for comparison it is impossible to generalise.

Oldknow's records do indicate that he used a double-entry system to record transactions. However, there are only two final statements showing the calculation of profit. Those records that remain do cover most of the period that he was engaged in business from 1782 until his death in 1828.

The discovery of these records is a story in its own right and it is worth repeating the account given by Unwin [1924] in the Preface to the first edition of his book about Oldknow.

Apparently the records had been placed in a room on the upper floor of a small building attached to the cotton mill built by Oldknow at Mellor, Derbyshire. The mill building was destroyed by fire in 1892, however the building containing the records remained even though its windows were broken. Some children found some of the many weaver's pay tickets stored in the building and distributed them to passers by. One, Arthur Hume, was intrigued and asked permission to explore further. He invited Unwin to join him. Unwin takes up the story:

... and here on January 1st 1921 ... we found a great number of letters, papers, account books, and other business records of every kind and size, covering the
whole floor of a large room and partly hidden from sight by several inches of dust and debris.

[1924, p v]

The records show very much the effects of lying neglected for a century or more and often only fragments remain. They are housed in two different deposits; the bulk is held by the John Rylands University Library in Manchester, U.K., and a smaller collection is to be found in the E.R.A. Seligman Collection in the Columbia University Library, New York City, U.S.A. Other material relating to Oldknow is to be found in the Manchester Central Library and the Stockport County Library, Stockport, Cheshire.

Of the magnificent cotton mill built by Oldknow nothing remains except some tunnels used for conveying water to the water wheel. Of the building that contained the records nothing also remains. Yet much evidence of Oldknow remains in the Marple and Mellor district in the form of the Peak Forest Canal, built on the instigation of Oldknow to transport limestone and the products of his mill [Oldham, 1990; Unwin, 1924; Hodgkins, 1977], various buildings and the mill ponds standing as testimony to this man.

**Samuel Oldknow the Man**

The obituary of Samuel Oldknow published in *Gentleman's Magazine*, November 1828, described him thus:

> Few men who have of late quitted this transitory scene have led a life of greater industry and more active benevolence, or died more universally lamented than this
individual. In the manufacturing, commercial, and agricultural world he has been known for half a century as a man of enterprise and skill coupled with the most unremitting industry and honourable integrity.

In describing his character further the obituary records how

(i)n private life, he had not an equal in the courteous urbanity of his manners. An unvarying, cheerful, and benevolent countenance, with which the heart kept pace, accompanied and supported him through every vicissitude of life. The voice of slander never passed his lips, for he was guided by that great charity which "envieth not", and "thinketh no evil". He was a steady (not a bigoted) friend to the Established Church; regular with his whole establishment, in his attendance in the house which he had built, and exemplary in the performance of every religious duty. To the poor he was charitable in the most extensive sense of the word, and a very "father to the fatherless, and him that had none to help him".

[ p 469]

That Oldknow was held in high esteem is attested to by the three thousand or more people that attended his funeral [Stockport Advertiser, 26/9/1828; Unwin, 1924], and the buildings and canal that he built for his community that still stand today.

From his achievements and accounts of his character [Unwin, 1924; Oldham, 1990; Giles, 1984], Oldknow appears as a genial man who managed to endear himself to everyone. Even though he exhibited a degree of incompetence in his financial affairs his friends were prepared to support him, to the extent of many tens of thousands of pounds in the case of the Arkwrights [Hume, 1969; Fay, 1937; Manchester Weekly Times, 29/4/1892].
It will become obvious in the following discussion of his business affairs that Oldknow was a man of vision with great organising ability. That his vision frequently outpaced his pocket was a problem he had to deal with all his life. His organising ability coupled with his artistic tastes and his impulsive, speculative temperament led him to be the foremost manufacturer of muslins in Britain, with his products being demanded by the leaders of fashion [Unwin, 1924; Owen, 1857; Oldham, 1990; Fay, 1937; Langford, 1992].

Samuel Oldknow was born at Anderton, Lancashire, on 5th October, 1756 [Gentleman's Magazine, Nov. 1828]. Of his education there is little record. However, we do know that he was brought up a Dissenter and his family and he attended Rivington Chapel, near Anderton [Giles, 1984]. This congregation belonged to the group known as English Presbyterians in the middle of the eighteenth century and like other congregations, in the days of Joseph Priestly, it was Unitarian in its outlook (see Chapter Three). In his youth, at Rivington, Oldknow came under a minister trained at Warrington Academy. This, the leading Dissenting school, was a chief training ground for many who became leaders in the worlds of science and political and philosophic liberalism. Priestly had been a tutor at Warrington [Unwin, 1924; Giles, 1984].

Loans received from Henry Norris of Davy Hulme Hall and a member of Rivington Chapel in 1792 indicate that Oldknow continued to maintain links with the people at Rivington, even after he had left the area [Giles, 1984; SOP Box 2]. While his obituary speaks of his attachment to the Established Church, it would appear that
throughout his life he maintained a strong association with the Unitarians and it is possible that the presence of a Unitarian congregation influenced his decision to establish a business in Stockport [Giles, 1984]. The strong allegiance of a number of cotton masters to Unitarianism has been noted by others, this allegiance leading to close commercial ties between centres of the faith [Giles, 1984; Baker, 1884; Smelser, 1959].

Oldknow set up a business in Stockport, Cheshire, in 1784\textsuperscript{1}. At the same time, some of the town's most prominent merchants, tradesmen and manufacturers were among the trustees of the 'New Chapel', a Unitarian congregation meeting in the High Street. Church records show that Oldknow became a part of this group. He is shown as a generous subscriber of funds and is known to have rented a pew there. Even when he had closed his businesses in Stockport he was an active and trusted member in Unitarian circles. He collected money for the Manchester Academy, established by Thomas Percival in 1786, and corresponded with James Touchet, a trustee of the Cross Street Chapel, Manchester, on this and other matters. As late as 1817, he remained a trustee of the Stockport Chapel\textsuperscript{2} [Giles, 1984].

\textsuperscript{1} Lewis's Manchester Directory for 1788 lists Oldknow as a muslin manufacturer from Stockport who stayed at the Bull's Head Inn when visiting Manchester Market.

\textsuperscript{2} Giles [1984, p 49-50] demonstrates that the records of the Unitarian Church, St Petersgate, Stockport indicate that Oldknow and his brother were generous subscribers to the funds of the chapel (known as the 'New Chapel'). In 1794
Many of the people he dealt with were also Unitarians. Peter Ewart, an engineer, often employed by Boulton and Watt, and for a time a partner of Oldknow, was a member of Upper Brook Street Chapel, Manchester. John Bentley, one of his managers was a Unitarian as were the Marsland brothers, cotton spinners of Manchester and Stockport [Giles, 1984; Baker, 1884].

While he maintained religious and business ties with Unitarians, he does not appear to have had any sympathy with the radical politics held by many of them. Oldknow was obviously for 'King and Constitution', a rallying cry for many at the time, because he was appointed first a major, in 1802, then a lieutenant-colonel in the North High Peak Volunteers - a force raised as a counter to the Republican movement of the time [Giles, 1984]. He maintained his Unitarian connection while attending, and even constructing a new church building in Marple for the Anglicans [Giles, 1984; Gentleman's Magazine, November 1828; Oldham, 1990].

His working career began when, like so many others who became important cotton manufacturers, he was apprenticed to a drapery business. In this case the business run by his uncle Thomas, who kept his shop in Nottingham. It is presumed that his 'business' education took place while working in this business. In 1781 at the

Oldknow is shown as occupying 'Pew No 51' at the rent of four guineas per year, he also paid pew rent for his servants. In 1810 Oldknow donated money to help pay off the mortgage of the Chapel.
age of 25, he was taken into partnership [Unwin, 1924]. At that time such businesses usually had direct links with manufacturing, which was still carried on with the domestic system.

Oldknow was interested in other things beside cotton and this is shown by his involvement in agriculture, road and canal building and towards the end of his life, railways [Unwin, 1924, Oldham, 1990]. He was prepared to experiment with cotton manufacture, bleaching, finishing and design [Unwin, 1924; Peel, 1966]. He also established a lime kiln and carried out experiments using lime for agricultural purposes. His obituary refers to him as a great practical and experimental agriculturalist who was not surpassed for the care he took with the selection of his stock or the zeal he showed in improving his land. For this he was appointed President of the Derbyshire Agricultural Society in 1828 [Gentleman's Magazine, November 1828; Stockport Advertiser, 26/9/1828].

Whether by design or default, Oldknow became much involved in improving the communications of the community in which he lived. Improved communications were vital for his mill at Mellor in Derbyshire, because of its isolation at the bottom of a valley. However, the community benefited and benefits still from his foresight in improving roads, bridges and being instrumental in the building of the Peak Forest Canal [Hodgkins, 1977; Misc/94/1-6]. One of his last letters to have survived refers to the superiority of malleable rails over cast iron rails [Unwin, 1924].
Unwin summed up his assessment of Oldknow's character by writing that:

(t)he open countenance, the large expressive eyes, the full and mobile mouth of Oldknow's portrait, reveal unmistakably a sensuous and impressionable temperament, a genial and sympathetic disposition. That he had the defects of these qualities - that he was far from a good man of business, that he often failed to realise his own sanguine expectations and to keep his promises to others - is shown by the frequent and lively remonstrances of his friends, but that he retained their friendship and respect through his worst misfortunes is sufficient evidence of their unshaken confidence in his character ...

[1924, 241]

Oldknow was able to earn a reputation for producing an excellent product, for organising its production and earning a fortune. Unfortunately he was not able to retain the fortune. His character appears as having "a strong element of generous-hearted benevolence reinforced as it was by the Unitarian Ethic" [Giles, 1984, p 79]. When Oldknow died in 1828, having no immediate family, his estates and cotton mill passed to his creditors, the Arkwrights.

**An Overview of Oldknow's Business Activities**

From 1782 until about 1796 Oldknow operated a number of businesses in several different centres eventually concentrating all his efforts at Mellor in Derbyshire, where he remained until his death in 1828. The sections that follow present an overview of Oldknow's business activities.
After learning the business of a draper with his uncle Thomas, Oldknow returned to Anderton, between Bolton and Chorley in Lancashire, in 1782 with the intention to set up in business as a manufacturer of cotton goods, principally muslins\(^3\). It is thought [Unwin, 1924; Oldham, 1990] that his father, who had died many years previously, had also been involved in the cotton business. Muslin was the generic term applied to fine cotton goods and as mentioned previously, these products had been hitherto manufactured only in India.

**The Business at Anderton**

Oldknow was obviously the right man in the right place at the right time, there was an existing demand for muslins which the local industry was unable to address, Crompton's spinning mule had recently been invented, allowing the spinning of very fine yarn and

\(^3\) The greatest demand for cotton fabrics came from women and the general trend of fashion to dresses based on simple classical lines from 1780 well suited to cotton materials led to an increased demand. Muslin, a very fine cloth, was in demand for summer wear, nightclothes and most other items of dress. The other major all cotton cloth, calico, while not as fine as muslin, was popular with the lower and middle classes, it was also popular for men's clothing. Fustians remained popular for most of the decade. As the decade progressed muslins were produced more cheaply and challenged calico and fustian. A major advantage of cotton and cotton mixture cloth was that it could be washed [Edwards, 1967].
experiments in fine spinning were being carried out in nearby Bolton [Oldham, 1990]. Others had tried to produce muslins but the difficulty of obtaining fine yarn cheaply enough had stifled their attempts. Oldknow, of course, did not do this work himself. Firstly he recruited weavers and spent some time with them experimenting, with the result that he started putting goods on the market about September 1782. His records show that he was also buying a considerable quantity of raw cotton which implies that he was employing spinners as well as weavers.

By 1783 he had achieved eminence in the trade, selling primarily to the London market through two agents. Oldknow's pre-eminence in the market was described by a future rival, Robert Owen, writing of his apprenticeship to a Mr McGuffog, a draper, in 1781 when

... there were no other muslins for sale, except those made in the East Indies, and known as East India muslins; but while I was with him Mr. Oldknow began to manufacture a fabric which he called, by way of distinction, British Mull Muslin. It was a new article in the market, less than a yard wide, for which he charged to Mr. McGuffog 9s. or 9s. 6d., and which Mr. McG. resold to his customers at half a guinea per yard. It was eagerly sought for, and rapidly bought up by the nobility at that price, - and Mr. McGuffog could not obtain from Mr. Oldknow a supply equal to his demand.

[1857, p 25]

While McGuffog was based in Stamford, Lincolnshire, Samuel Salte, Oldknow's London agent, friend and adviser had similar complaints [SOP Box 3; Unwin, 1924]. However, Oldknow was unable to expand production to meet demand because he was suffering from what was to be a perennial complaint, that of lack of capital. Insufficient
capital and lack of credit was to hamper him for the rest of his life [Unwin, 1924]. Other problems related to the seasonal nature of the trade and the burst of competition whenever a cargo of Indian muslins came into port. Nevertheless his impulsive and artistic nature urged him to throw himself into the manufacturer of muslins [Unwin, 1924].

At this time he was an employer of outworkers. The spinners and weavers in his employ worked in their own workshops using their own equipment. Oldknow maintained a warehouse at Anderton which was used for giving out cotton to spinners, preparing the warp and giving out warp and weft to the weavers; receiving, examining and storing the finished product [Unwin, 1924; Fay, 1937]. This business was not operated along the traditional lines of the 'putting-out' system. The records indicate that he did not sell the raw material to the workmen and buy back the finished product, but employed these people, paying them for their labour but owning the material. He did apparently employ people in his warehouse. This business was maintained for a number of years employing some 150 or more weavers until about 1792 [Oldham, 1990]. It was not long before his impulsive nature came to the fore and he started looking for ways to expand production, he turned to the town of Stockport in Cheshire, in 1784.
The Establishment of Business at Stockport

Stockport was well established in the textile trade in the 1780s. Previously having a number of establishments involved in silk spinning and weaving, cotton was becoming popular with the manufacturers of the town. A number of water driven cotton spinning mills had been established and there were many weavers in the town and nearby districts. It was also close to the market in Manchester as well as having suitable water for the driving of water wheels.

Stockport had many advantages for an entrepreneur wishing to become established in the textile industry because water power and buildings were available, as well labour trained to work in the silk industry could easily convert to other fibres such as cotton. Other advantages in establishing in a town with a flourishing textile industry came from the presence of people skilled in building and repairing machinery, people with the ability to organise labour and a higher degree of social mobility between the classes [Unwin, 1924].

It was to this environment that Oldknow came in early 1784. Discussions with Arkwright4 in January 1784 led to him advancing Oldknow £3000 at 5% to enable the latter to expand production, and

4 Arkwright(1732-92) had established several spinning mills and supplied twist to Oldknow, he was also a good friend to Oldknow because both Arkwright and his son supported and lent money to Oldknow at various times [Unwin, 1924; Mantoux, 1964; Fay, 1937]
so by the beginning of February Oldknow had some 90 weavers calling at his Stockport warehouse [Unwin, 1924]. He appears to have opened this warehouse immediately on deciding to set up business in Stockport. In July 1784, Oldknow acquired a house and another warehouse in Upper Hillgate⁵, Stockport, which he made into his headquarters [Unwin, 1924; Oldham, 1990].

The business in Stockport continued to expand; by October 1784 he had 100 weavers and by Autumn 1786 he was employing over 300 weavers possessing over 500 looms [Oldham, 1990]. Unlike others in the area, Oldknow followed his practice at Anderton using a variation of the 'putting-out' system. He conducted this business in the same way as the one at Anderton with the weavers being provided with the material to be woven. The records show that the weavers were employed on a piece-work basis with Oldknow supplying careful specifications of the work to be done. They were governed strictly by this specification and were not able to use their initiative as would have been the case under the old system. The reeds and gears, necessary to weave the specified cloth, were supplied by Oldknow. He also supplied the weavers with the looms to make figured muslins, for a rent of 6d. per week [Unwin, 1924; Oldham, 1990].

Oldknow was by this time entering a boom period, so he turned his thoughts to other branches of the business. He employed some 20 people directly in his establishments at Anderton and Stockport.

⁵ SO 773 gives details of the taxes levied on this premises in April 1785 which includes £1-2-6 for window tax.
These people were involved in attending to the spinners and weavers who called for materials or brought back product. It seems that some of these people were employed in preparing the warp and finishing the cloth. Oldknow still depended, however, on other firms for bleaching, printing and dyeing. The profits he was making provided the stimulus to establish a bleaching works at Heaton Mersey, with his brother Thomas as managing partner. These works were run in close co-operation with the Stockport establishment [Unwin, 1924; Oldham, 1990; Peel, 1966].

**Expansion of Business to Heaton Mersey**

Heaton Mersey is situated some two miles from Stockport on the river Mersey. The main requirements for bleaching cloth in those days was access to a plentiful supply of water and a large field where the cloth was pegged out for the sun to bleach. Before the introduction of chlorine bleaching in the 1790s, the bleaching process was long and costly. By November, 1786 experiments were being undertaken by Oldknow in crofting, as the process of bleaching by pegging in the field was called. He mentioned these experiments in a letter to Strutt dated 11th November, 1786 where he wrote about the setting up of the bleaching ground and the application of water to it which he described as "our experimental proceeding in that branch" [letter quoted in Peel, 1966, p 99].

Undated stock lists indicate that printing was also in progress at Heaton Mersey, although it is not known when it commenced [Peel,
1966]. Thomas Oldknow died suddenly in 1791, an event which severely disrupted the way the works were managed. Peter Ewart\(^6\), one of Boulton and Watt's engineers managed these works for a time in 1792. In a letter to James Watt, dated 17 January 1792, before entering this partnership Ewart wrote:

He [Oldknow] has a bleaching and calico printing work in one of the best situations in this part of the country which he and his late brother (who died last spring) carried it on, generally cleared them about £1000 a year and the situation will allow it to be extended to 3 or 4 times as much as it is now; which it is his intention to do but he finds since the death of his brother that owing to the extent of his other concerns, he cannot attend sufficiently to it himself, and that he must either take in an active partner, or give it up.

[B&W 19/5]

Unfortunately these grand plans were not realised. The partnership with Ewart existed for a very short time and in 1793 the works at Heaton Mersey were the first part of the Oldknow empire to be sold [Unwin, 1924].

\(^6\) Peter Ewart (1767-1842) was trained as a millwright and erected steam engines for Boulton and Watt for a number of years, he erected some of the first steam engines in Lancashire spinning mills [Lee, 1972]. Ewart was a Unitarian and a member of the Upper Brook Street Chapel, Manchester [Giles, 1984]. In a letter to W. Wilberforce dated 23 April 1793, Dr. Currie described Ewart as being ...

...not a common character; he was the apprentice of Messrs. Boulton and Watt, and had an extraordinary degree of the most useful knowledge of every kind.

[Quoted by W. Chalnor in the Preface to Unwin, 2ed., p xiv]
Expansion at Stockport

From the records it appears that sometime in early 1787, Oldknow organised, at Stockport, the processes of warping, sizing, and muslin trimming. These operations were central to the support of the weavers and seem to have been organised on a factory basis rather than employing outworkers. The final appearance and saleability of the cloth depended on how it was finished and trimmed, so to ensure consistency of finish this process was initiated in the warehouse and employed 81 women on some 30 finishing and several darning frames [Unwin, 1924].

These were good years for Oldknow, a point recognised by his contemporary Robert Owen when he wrote of Oldknow in his Life of whom

... it was known had not long before made seventeen thousand pounds in each of two successive years.... He made these profits in the manufacture of muslin, while he purchased yarn from the cotton spinners.

[1857, p 40]

Owen, who does not appear to have liked Oldknow, continued and wrote of Oldknow's next venture that he

... thought the spinners were getting great profits, and he was not, like many others, content to do well or very well, as he was doing, — but being ambitious, he desired to become a great cotton-spinner, as well as the greatest muslin manufacturer.

[1857, p 40]
Arkwright's patent for spinning machines using rollers lapsed in 1785, however, Crompton's mules\(^7\), which were not subject to a patent and had been continually improved, were more widespread. Coupled with improvements in the carding machine and the preparation of rovings, great numbers of manually operated mules had been built. It was from spinners operating these machines that Oldknow purchased his fine thread. From about the beginning of 1787 he was obtaining medium counts of warp as well as much of his jenny-spun weft from the numerous small spinners he employed in the Stockport district [Giles, 1984]. Oldknow's next step was to consider building his own spinning mills.

Spurred by the high profits of 1786 and 1787 Oldknow developed his 'grand plan' which would...

... make Stockport the organising centre for the manufacture of muslins and calicoes, finding employment for 1000 weavers in a radius of five to six miles, and another 1000 workers in several factories in the area. The finer counts of yarn would be spun by 50 mule spinners at a new mill being erected on his land at Hillgate in Stockport, which would also be equipped with machines for winding, warping and sizing. Finishing processes would continue to be carried out at the premises at Hazel Grove and Waterside, Disley, and bleaching, dyeing and printing at Heaton Mersey. A mill

\(^7\) Until about 1785 spinning was dominated by the spinning jenny and Arkwright's water-frame but while they had the advantage of being able to produce multiple threads simultaneously neither could spin really fine threads. Crompton's mule had gone through a number of improvements and was able to produce a fine thread on multiple spindles and soon out-numbered the water-frame and jenny in terms of spindles being used [Edwards, 1967].
was to be built at Mellor where the lower counts of yarn would be spun on Arkwright type water-frames or "throstles".

[Oldham, 1990, p 8]

The works at Hazel Grove and Disley in Cheshire, appear to have been very small and not much information remains as to their size and nature.

In late 1787 and 1788 a trade depression\(^8\) had a profound influence on the direction of Oldknow's manufacture. No longer was he able to make only for order. His agents were only able to give him limited orders so he was forced to manufacture for stock to be disposed on the general market. Sales seem to have recovered in 1789.

In 1787 he had purchased land at Mellor in Derbyshire, with the intention of building a cotton spinning mill that would take advantage of the power potential of the river Goyt, which flowed past the site [Unwin, 1924; Oldham, 1990]. The foundations for this factory were not laid until 1790 and it did not start operating until 1793. Meanwhile he was in the process of establishing a spinning

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\(^8\) Smelser [1959, p 112] suggests that this depression may have been due to mass oversupply of product resulting from the activity following the freeing of Arkwright's patents; Hoppit [1986, p 68] agrees with the further suggestion that production of cotton goods was also stimulated by the ending of the American War. The situation was made worse by the East India Company increasing its imports by 60% [Edwards, 1967; Hoppit, 1986]. Hoppit suggests that the major factor contributing to a number of bankruptcies in the industry was the over use of credit.
mill at Stockport. Ambition and the desire to ensure a supply of yarn of the right quality and the right price, led to the building of this mill. His fellow cotton manufacturers in the town were turning to the factory system for yarn production and there was much competition for the available water-power of the two rivers, the Mersey and the Goyt, that passed through Stockport. Oldknow overcame this problem by later installing a steam engine.

Oldknow began spinning operations in Stockport in October 1789 probably in a former silk mill, known as the "Carrs" which he rented [Unwin, 1924; Fay 1937]. It does also seem that he placed ten winding machines in these premises to try and overcome quality problems [SO 786]. Winding was usually done by children and old people, however, his weavers had been complaining of 'lumpy thread' so it seems he decided to exercise greater control by bringing winding under the one roof. That he still employed children to do the work is evidenced by the low wages he paid, from 1/3 to 1/9¾ per week [SO 820; Giles 1984]. The winding machines would have been driven by the steam engine available in these premises [Giles, 1984].

It is only after September 1791 that the spinners worked in Oldknow's own
factory in Hillgate, a building erected for the purpose of being a spinning mill. He originally used a horse wheel to drive the mill, but this proved to be too slow [B&W 19/5/10; Giles, 1984], so he installed an 8 horse power Boulton and Watt steam\(^9\) engine in 1791, for a yearly payment of £40 [B&W 27/23] to drive the machinery. Oldknow was in a hurry to install this engine once he had decided to have one as Peter Ewart\(^10\) wrote in a letter to John Southern at Boulton and Watt dated 14 March 1791 "(h)e is in a great hurry and wants it all done in a week if possible" [B&W 19/5/10].

Oldknow's factory and warehouse in Stockport was eventually put up for auction in 1798, the extent of his establishment was described in the notice of auction as including ...

(a)ll those extensive PREMISES, late in the occupation of Mr. Oldknow, and now occupied by Messrs. Parker, Sykes, and Co., pleasantly situated in the Higher Hillgate, Stockport; consisting of a good House, Stabling, Offices, Garden, and commodious Buildings five stories high, now used for Spinning, and the manufacture of Muslins and other Piece Goods, and has every necessary Convenience for making One Thousand Pieces per Week; the site of which contains about 7640 square yards, part

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\(^9\) The Boulton and Watt Register of Old Engines [Birmingham Central Library] lists this engine as having a 16" diameter with a 4' 0" stroke producing 8 hp, it was 10 ft high and used a sun and planet gear to provide a rotary motion. Oldknow paid for the materials and labour to build and erect the engine as well as being charged a yearly premium.

\(^10\) Ewart was employed in this instance to assess Oldknow's buildings for the alterations needed to install the steam engine. The agreement between Boulton & Watt and Oldknow to install the engine was dated 1 March 1791 [B&W 27/23].
freehold and part leasehold, for long terms of years. Together with an excellent STEAM ENGINE, of Messrs. Boulton and Watts's constructing; and many valuable Fixtures, which will be sold therewith.

[SO 838/5]

Unfortunately for Oldknow the sale did not eventuate and the building continued to be rented for £520 per year to Parker [SOP Box 5]

**Mellor Mill**

The mill at Mellor was to be the jewel in Oldknow's crown. Situated in a valley with the village of Mellor on one side and the town of Marple, Cheshire, on the other, the mill and its associated works transformed the district. Oldham wrote that the

... building of Mellor Mill, along with the complicated system of waterways and millponds, was a colossal undertaking, involving the diversion of the river into a new channel, with a weir, sluice gate and leat to turn the water into the millpond.... From here the water flowed under the road into another millpond in front of the long east side of the mill.... The mill itself was a handsome and impressive brick building, 400 feet long and six storeys high, with the 22 feet diameter by 17½ feet wide "Wellington Wheel" situated in the basement. There was a second wheel of unknown dimensions at the southern end of the building.

... (T)he mill was equipped with Arkwright type water frames of 'throstles', operated mainly by women and young people, carding engines and other machinery for preparing cotton.

[1990, p 9]
Unfortunately this mill was to contribute to the dismantling of the Oldknow empire. Robert Owen described the mill and subsequent events:

He built a large handsome, and very imposing cotton mill, amidst grounds very well laid out, and the mill was beautifully situated, for he possessed general good taste in these matters. In fact he was preparing and had made great advances to become a first rate and leading 'cotton lord'. He had however expended his capital so freely in building this mill, fitting it with machinery, and purchasing land around it, in addition to splendid buildings and arrangements in and near to Stockport for carrying on his extensive muslin manufacture and for its sale, that when the trying time of 1792 arrived, he was too wide in his plans to sustain their expenditure without making great sacrifices.

[1857, p 40]

The trying time of 1792 mentioned by Owen was the shock that came towards the end of the year when it became obvious that war with France was inevitable. War was declared in 1793 and this led to a sudden contraction of trade to Europe [Edwards, 1967]. A greater shock came for Oldknow when his bankers pressed him for repayment of a loan [Shapiro, 1967]. G A Lee, a cotton spinner in Manchester commented on Oldknow's financial predicament when he wrote to James Watt jnr in September 1793 and said that "Oldknow has extended his concerns beyond his
capital in the late commercial storm has reason to feel his error" [quoted in Tann, 1970, p 39].

Oldknow seems to have been in a continual financial crisis. The Mellor Mill was financed largely by credit which he owed in large amounts to Arkwright as well as other creditors. He seemed to always be short of the money required to pay his workers and even depended on the local shopkeepers to supply his workers on credit.

The Mellor Mill completed Oldknow's transition from being a manufacturer with all his workers being outworkers to having his workers employed within the factory. He still had dealings with weavers for some time to come but all the spinners were under his close supervision. His business operations changed from employing skilled workers to employing unskilled women and children [Fay, 1937]. The children he obtained from poorhouses in London.  

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11 Oldknow obtained apprentices from the Rolls Workhouse, Chancery Lane, London, SOP/1 contains a letter [date obscured] from John Blundell, master of the workhouse noting that the magistrates had given consent to nine children being apprenticed. He also obtained children from Clerkenwell [Oldham, 1990]. Oldknow had a reputation for treating these children well [Unwin, 1924, Oldham 1990].
In time, financial pressures forced Oldknow to sell the Heaton Mersey works, to let the Stockport premises and dispose of the Anderton operation. He came to concentrate all his energies in Mellor and Marple, where he is still remembered. By the end of 1798 the bulk of Oldknow's resources were located in Mellor and Marple and most of the rest had been sold. According to an insurance policy dated 25 December 1800, Oldknow still owned the Hillgate premises, which were then untenanted [SOP Box 5]. That his estate development at Mellor took all of his capital is reinforced by a letter to Boulton & Watt, dated 22 December 1798, asking for more time to pay the premium for the engine at Stockport, when he wrote "I assure you what with a world of fixed property and the drains of the Peakforest Canal (none of which can be turned into money just now) ... I crave your indulgence a little longer" [quoted in Tann, 1970, p 39].

The diverse range of businesses that Oldknow was involved in during his career created problems of control and management, especially because the enterprises were conducted in different centres. The records indicate that Oldknow used accounting techniques to assist him in the management process. The next section examines Oldknow's use of accounting techniques and their relation to the development of his various businesses.
OLDKNOW'S ACCOUNTING

Oldknow's business took, in essence, two forms; firstly he employed outworkers ie weavers, spinners, pickers and winders who operated from their own homes. Secondly, he employed workers in his various factories. Because of the differing demands placed on management, the accounting for these two modes of operation have different requirements. In the first instance it is important to ensure that the material given out is returned; in the second instance it is important to ensure that the employees do the work that they are employed to do. With this in mind it is proposed to examine the records in two stages, ie those concerned with outworkers and then those records connected with factory operations. It is unfortunate that no final statements remain. Balance sheets and profit and loss accounts for his main businesses have either been lost or still remain to be discovered. In the next section the accounting processes used by Oldknow to record his relations with his outworkers are discussed.

OUTWORKERS

As mentioned above, there were four classes of outworkers: pickers, spinners, winders and weavers. The accounts which follow show the concern with balancing the flow of material. The material passed to the worker and then back to the warehouse; it did not pass from worker to worker. The accounts show this movement of materials with the emphasis being on the reconciliation of quantities. The accounting method used by Oldknow at this stage of his career was
very similar to that described by Burley [1958] in his account of Thomas Griggs (see Chapter Two).

**Pickers**$^{12}$

The few records relating to the cotton pickers are unclear as to whether the pickers were in-house or worked in their own workshops, collecting the bags of raw cotton and then returning the cleaned cotton and the waste. The records provide an account for each person so employed, sometimes giving an address outside the mill which gives the impression that at least some of the work was done by outworkers. The records take an account form with the debit side showing the gross weight of cotton given to each worker and the credit side showing the picked cotton and the waste. The earliest records available relate to pickers at Stockport in 1790 and only record quantities. An example follows:

<table>
<thead>
<tr>
<th>Martha Singleton</th>
<th>Dr</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gross</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Nov 29</strong></td>
<td>3</td>
</tr>
<tr>
<td><strong>Brazil</strong></td>
<td>6</td>
</tr>
<tr>
<td><strong>Nov 30</strong></td>
<td>3</td>
</tr>
<tr>
<td><strong>Neat</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Dec 2</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Trett</strong></td>
<td>6</td>
</tr>
<tr>
<td><strong>Dec 1</strong></td>
<td>3</td>
</tr>
<tr>
<td><strong>3 - 6</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>3 - 4</strong></td>
<td>6</td>
</tr>
</tbody>
</table>

[SO 764]

$^{12}$ The job of the picker was to prepare the raw cotton for carding by removing the seeds, leaves, stalks and dirt.
The account was ruled off when the material given out was returned. This account is similar to those kept on a charge/discharge basis and shows that on November 29, 1790, Martha Singleton was charged with 3 lb 6 oz of raw cotton from Brazil; this she returned the next day as 3 lb of cotton and 6 oz of waste (trett) thus completing the discharge. The amount payable for the work was recorded elsewhere.

The Pickers' Book for June 1792 contained accounts similar to the above for each employee but with the addition of the rate for the work and the amount payable to the employee. The following account, relating to an employee reporting to the Mellor mill, is typical of the picker's records at this time. Again the material given out is reconciled with the material returned, when it was returned, giving a complete record for each person. It would seem that Sarah Wright was involved in recovering good material from the spinning waste. She was only paid for the useable material she recovered and not the weight of material she processed. She was paid at the rate of 6d per pound.

<table>
<thead>
<tr>
<th>Dr</th>
<th>Sarah Wright</th>
<th>Marple Newhouses</th>
<th>Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1792</td>
<td>(Good) (waste)</td>
<td>(total) (rate) (amt)</td>
<td></td>
</tr>
<tr>
<td>11 June 2 - 8 Spinner's waste</td>
<td>12 1 - 12 ~ 12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 4 - 4 Do</td>
<td>15 3 - 1 - 4</td>
<td>8,6 6d 4/2</td>
<td></td>
</tr>
<tr>
<td>15 5 Do</td>
<td>21 3 - 10 1 - 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>________</td>
<td>____________</td>
<td>________</td>
<td></td>
</tr>
<tr>
<td>25 4 Do</td>
<td>26 2 - 14 1 - 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26 2 Do</td>
<td>27 1 - 10 ~ 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27 1 - 12 Do</td>
<td>28 1 - 4 ~ 8</td>
<td>10,12 6d 5/4½</td>
<td></td>
</tr>
<tr>
<td>29 3 Do</td>
<td>4 July 2 - 2 ~ 14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 July 4 Do</td>
<td>6 2 - 14 1 - 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>________</td>
<td>____________</td>
<td>________</td>
<td></td>
</tr>
</tbody>
</table>

[SO 765]
For a manufacturer concerned with safeguarding his property these records serve to illustrate that a strict accounting was kept as to the quantity of materials given and returned. Quality work was encouraged by only paying for the good material as revealed by inspection on its return.

**Spinning Records**

For a number of years Oldknow employed spinners who were not incorporated into the factory but worked in their own workshops on their own equipment. A document entitled 'Spinning Account' gives the following example of the record of amounts owing to spinners for early 1788.

<table>
<thead>
<tr>
<th>Date</th>
<th>Name</th>
<th>Account No.</th>
<th>(£)</th>
<th>s</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 Janry</td>
<td>Wm Vernon</td>
<td>111</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>S Horsfields</td>
<td>95</td>
<td>2</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Loil Pickford</td>
<td>108</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>16</td>
<td>Letice Beck</td>
<td>42</td>
<td>10</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Joshua Gordon</td>
<td>110</td>
<td>1</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>18</td>
<td>Joseph Gosley</td>
<td>39 2 - 14 @/78</td>
<td>1</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Jno Gosley</td>
<td>44</td>
<td></td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Letice Beech</td>
<td>42</td>
<td>16</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Settled</td>
<td>£ 8 14 5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This document is concerned with the amounts payable for the work done during that period and is a list of account balances.
A document consisting of a sheet of folio folded four times, dated 18th September 1788, and called 'Spinner's Accounts' shows the cotton returned in terms of weight and quality together with the amount owing to the spinner. This document carries more information than the above document. Judging from the check marks and corrections it is probable that this document was used to provide data for entries in the Spinners Ledger. An extract follows, the words in brackets have been added for clarity:

<table>
<thead>
<tr>
<th>18th September 1788</th>
<th>(weight returned)</th>
<th>(quality)</th>
<th>(rate)</th>
<th>(amount)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs ozs</td>
<td>hanks/lb</td>
<td>£ s d</td>
<td></td>
</tr>
<tr>
<td>Rob Seddon</td>
<td>3 - 10</td>
<td>83</td>
<td>9/-</td>
<td>1 12 7½</td>
</tr>
<tr>
<td>Jn Longworth</td>
<td>4 - 5</td>
<td>85</td>
<td>9/6</td>
<td>2 0 11½</td>
</tr>
<tr>
<td>do</td>
<td>2 - 11</td>
<td>90</td>
<td>11/2</td>
<td>1 9 11½</td>
</tr>
<tr>
<td>Wm Morris</td>
<td>4 - 14</td>
<td>83</td>
<td>9/-</td>
<td>2 3 10</td>
</tr>
<tr>
<td>Jn Longworth</td>
<td>1 - 7</td>
<td>99</td>
<td>14/2</td>
<td>1 0 4</td>
</tr>
<tr>
<td>Henry Foster</td>
<td>13</td>
<td>89</td>
<td>10/10</td>
<td>8 9</td>
</tr>
<tr>
<td>Jn Horrocks</td>
<td>2 - 8</td>
<td>66</td>
<td>5/4</td>
<td>13 4</td>
</tr>
<tr>
<td>Henry Stores</td>
<td>4 - 12</td>
<td>75</td>
<td>7/-</td>
<td>1 13 3</td>
</tr>
</tbody>
</table>

Because all of these spinners were outworkers the materials determined the relationship; the above document would have been prepared in the taking-in room where the spinners returned with their product. The rate paid varied with the fineness of the spun yarn, in this instance 14/2 per pound was paid for the finest yarn which was equal to 99 hanks per pound weight.

**Spinners' Ledger**

The cotton wool given out to the spinners and the spun yarn taken back were brought together in the Spinner's Ledger which then
provided a comprehensive record for each spinner employed. The following extract of an account from the Spinner's Ledger comes from a document that is in a very poor condition but, nevertheless, is able to give some indication of the record kept on each spinner working outside the factory. The debit side records the quantity of raw cotton supplied to the spinner and the credit side records the spun cotton returned, the waste, the rate and the amount payable for the work done. The form of the account was in the traditional side by side form; for ease of understanding each side is reproduced separately with comments in brackets. The following extract relates to Thomas Brentnall of Stockport, for early 1788:

**Debit side**

<table>
<thead>
<tr>
<th>1788</th>
<th>7 Jany</th>
<th>1788</th>
<th>7 Jany</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 - 1-23</td>
<td>Gross Cas Cotton</td>
<td>3 9 5</td>
</tr>
<tr>
<td></td>
<td>163</td>
<td>0 (convert cwt, qtrs, lbs to lbs)</td>
<td>9 5</td>
</tr>
<tr>
<td></td>
<td>95</td>
<td>3 brought from page 120</td>
<td>19 8</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>8 Brazil from P120</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4th Febr</th>
<th>96</th>
<th>Brazil</th>
<th>40</th>
<th>Dom° (issues to spinner)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7th</td>
<td></td>
<td>(balance)</td>
<td></td>
<td>12 3 0 4½</td>
</tr>
<tr>
<td>4 March</td>
<td>298</td>
<td>3 Bill</td>
<td>167</td>
<td>5 (amount used)</td>
</tr>
<tr>
<td></td>
<td>130</td>
<td>14 Coarse</td>
<td></td>
<td>£ 15 12 9½</td>
</tr>
</tbody>
</table>

**Credit Side**

<table>
<thead>
<tr>
<th>1788</th>
<th>4th Feb</th>
<th>77-9Braz from 120</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(lbs oz)</td>
<td>(hanks/lb)</td>
</tr>
<tr>
<td></td>
<td>11th</td>
<td>7- 8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1- 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-11</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>2- 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2-10</td>
</tr>
<tr>
<td>28</td>
<td></td>
<td>7- 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2-11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2- 1</td>
</tr>
</tbody>
</table>
The debit side of the account shows that over the period covered by the account Brentnall had been issued with a total of 298 lbs 3 ozs of cotton and on 4 March 1788 he had a balance of 130 lbs 14 ozs in his possession still to be spun. There does appear to be an error in the quantity of cotton issued because the quantities do not add up although there is no notation to the effect that anything is amiss, unfortunately page 120 referred to in the account is missing. The cotton was spun into hanks of 840 yards length and the number of hanks to the pound was a measure of the fineness of the yarn being termed the 'count'. In this instance it is easy to see that the finer the thread, that is, the higher the count, the higher the rate. This spinner was working with cotton from Brazil and Dominica. The account brings together the cotton issued, the cotton spun, the waste and the balance left in the hands of the spinner. This acted as a control tool because it was not unknown for spinners to convert some of their employer's cotton to their own use and to sell the subsequent yarn elsewhere. The account also shows the amount payable to the spinner and how this debt was discharged in the form of a bill of exchange on 4 March.
Winding

After spinning the cotton was in the form of loosely wound hanks which could be dyed. Before the thread could be used by the weavers it had to be wound onto a suitable bobbin or cop. This process was initially carried out by old people or children, usually the relatives of the spinners, in their own homes. The accounting for this process is similar to the recording of the work done by the spinners and weavers.

An illustration of the record made on the return of the wound cotton is given below. This account appears to relate to 1788.

<table>
<thead>
<tr>
<th>Winding Account</th>
<th>(a/c no)</th>
<th>(bunches)</th>
<th>(quality)</th>
<th>(rate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 Oct Racharl Jolly</td>
<td>257</td>
<td>10</td>
<td>20</td>
<td>1/4</td>
</tr>
<tr>
<td>Ann Downs</td>
<td>199</td>
<td>5</td>
<td>60</td>
<td>4/-</td>
</tr>
<tr>
<td>Mary Bennet</td>
<td>236</td>
<td>5</td>
<td>70</td>
<td>6/3</td>
</tr>
<tr>
<td>17</td>
<td>Ann Chandly</td>
<td>165</td>
<td>5</td>
<td>72</td>
</tr>
<tr>
<td>Thos Worsley</td>
<td>238</td>
<td>10</td>
<td>60</td>
<td>8/0</td>
</tr>
<tr>
<td>Nime Chandly</td>
<td>154</td>
<td>10</td>
<td>13</td>
<td>1/1</td>
</tr>
<tr>
<td>Fanny Hudson</td>
<td>190</td>
<td>10</td>
<td>17</td>
<td>1/5</td>
</tr>
<tr>
<td>Martha Woodfin</td>
<td>249</td>
<td>10</td>
<td>12</td>
<td>1/-</td>
</tr>
<tr>
<td>Betty Hewitt</td>
<td>207</td>
<td>10</td>
<td>13</td>
<td>1/1</td>
</tr>
<tr>
<td>Mary Kershaw</td>
<td>222</td>
<td>10</td>
<td>19</td>
<td>1/3</td>
</tr>
<tr>
<td>Mary Bardsly</td>
<td>205</td>
<td>10</td>
<td>18</td>
<td>1/1</td>
</tr>
</tbody>
</table>

There was a set rate for the winding operation which was based on the fineness of the thread being wound. The winders were given a bunch to be wound. Each bunch weighed ten pounds and their pay was determined by the number of bunches wound. Some sample prices from SO 798 "List of Prices - Winding etc", relating to December 1788 are as follows:
The records relating to the winders are very limited. This process was one which lent itself to being mechanised relatively easily and was one of the first processes that Oldknow incorporated into the factory mode of production. There is no indication as to how these prices were calculated.

Weaving Records

Oldknow employed weavers who worked in their own workshops. He supplied them with the warp and weft as well as the reeds appropriate to the cloth they were engaged on weaving. He also supplied them with a very strict specification as to the type of cloth that was to be woven, this was a departure from the traditional putting-out system where the weavers had a considerable influence on what was produced. However, Oldknow kept a very close watch on the market and made sure that the cloth produced by his weavers was what the market required. The following records were used to track the work of the weavers.
Weavers' Taking Book

This book was used to record the cloth returned to the warehouse by the individual weavers returning the week's work. The following extract is an example of the data that was recorded when the weavers returned to the warehouse with the woven cloth and relates to early November 1786.

<table>
<thead>
<tr>
<th>Date</th>
<th>Name</th>
<th>Qty</th>
<th>Desc</th>
<th>Rate</th>
<th>£</th>
<th>s</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Nov</td>
<td>Saml Perry</td>
<td>466</td>
<td>567/8 Romals</td>
<td>8/-</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thos Perry</td>
<td>409</td>
<td>606/4 pm</td>
<td>16/-</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jn Rowbottom</td>
<td>659</td>
<td>606/4 Do</td>
<td>16/-</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Do</td>
<td>494</td>
<td>386/4</td>
<td>9/4</td>
<td>9</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Do</td>
<td>975</td>
<td>6413/8 pm</td>
<td>21/-</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

The book provided a daily list of all weavers calling on that day with a total of the amount payable to the weavers for that day. Detail from this book was used to write up the credit side of the Weavers' Ledger. The weavers listed above returned muslins on that day.

Similar records on loose sheets entitled "Weaving Account" are in evidence for the period relating to 1790-92. An extract follows.

<table>
<thead>
<tr>
<th>(Date)</th>
<th>(Name)</th>
<th>(Cuts)</th>
<th>(Sort)</th>
<th>(Rate)</th>
<th>(Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>22nd Sept 1790</td>
<td>Jn Coupe</td>
<td>224</td>
<td>686/4 Plain</td>
<td>20/2</td>
<td>1 0 2</td>
</tr>
<tr>
<td>25th</td>
<td>Jn Exton</td>
<td>229</td>
<td>645/8 Do</td>
<td>15/1</td>
<td>1 10 2</td>
</tr>
<tr>
<td></td>
<td>Jn Martin</td>
<td>218</td>
<td>686/4 Do</td>
<td>20/10</td>
<td>2 1 8</td>
</tr>
<tr>
<td></td>
<td>Wm Berry</td>
<td>214</td>
<td>724/4 Do</td>
<td>16/-</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Jas. Heywood</td>
<td>231</td>
<td>768/4 Do</td>
<td>23/6</td>
<td>1 3 6</td>
</tr>
<tr>
<td>29th</td>
<td>Jn Preston</td>
<td>40</td>
<td>686/4 Do</td>
<td>20/10</td>
<td>1 10</td>
</tr>
<tr>
<td></td>
<td>Richd Moss</td>
<td>235</td>
<td>684/4 Do</td>
<td>13/5</td>
<td>13 5</td>
</tr>
<tr>
<td></td>
<td>Mrd Taylor</td>
<td>232</td>
<td>64 Do</td>
<td>12/10</td>
<td>12 10</td>
</tr>
</tbody>
</table>

[SO 757]

[SO 763]
In this case the number of pieces (cuts), as well as the amount payable was totaled each day allowing the overall weaving cost per length to be calculated for each day's deliveries. The rate payable for the work was dependant on the nature of the cloth woven indicated in the column labelled 'Desc' or 'sort' which listed the reed\textsuperscript{13} used and the width of the cloth in terms of quarters of a yard, for example, John Coupe returned one length of 'Plain' cloth which required a '68' reed and was $1\frac{1}{2}$ yards wide.

\textit{Weavers Ledger}

As with the spinners the data from the weaver's taking in book was posted to the Weavers Ledger which contained an account for each weaver. The debit side of this account recorded the type of material to be woven, the date it was given out, the weight of the yarn. Often a number was assigned to the warp to allow a check to be maintained in case of questions arising relating to the quality of the weaving. The credit side of the account showed the completed piece of cloth returned as well as the amount payable for the piece. The following example comes from the Weavers Ledger of 1784-85 and relates to a weaver by the name of Mary Barley, it is unusual for a woman to be employed as a weaver because looms were manually operated and involved hard physical labour, it may well have been that Ms Barley employed someone to do the actual work for her:

\textsuperscript{13} The reed was similar to a comb and was used to separate the threads of the warp and force the weft up to the completed web.
### Debit Side

<table>
<thead>
<tr>
<th>Date</th>
<th>N Wp</th>
<th>Sort</th>
<th>Reed</th>
<th>Width</th>
<th>Weft No</th>
<th>Weft C No</th>
<th>Wt Wp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug 6</td>
<td>102</td>
<td>Call°</td>
<td>54</td>
<td>5/4</td>
<td></td>
<td>3-12 27</td>
<td>11-8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7-0  28</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-10 27</td>
<td></td>
</tr>
<tr>
<td>Sept 4</td>
<td>2pr</td>
<td>Call°</td>
<td>54</td>
<td>5/4</td>
<td>4</td>
<td>10-8 27</td>
<td>11-12</td>
</tr>
<tr>
<td>Oct 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-8  26</td>
<td></td>
</tr>
</tbody>
</table>

### Credit Side

<table>
<thead>
<tr>
<th>Date</th>
<th>No ps</th>
<th>Sort</th>
<th>Weft</th>
<th>No</th>
<th>at</th>
<th>£</th>
<th>s</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug 20</td>
<td>1</td>
<td>Call°</td>
<td>3-8</td>
<td>27</td>
<td>8/6</td>
<td>8</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>1</td>
<td>Do</td>
<td>3-8</td>
<td>28</td>
<td>8/6</td>
<td>8</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Sept</td>
<td>1</td>
<td>Do</td>
<td>3-8</td>
<td>28</td>
<td>8/6</td>
<td>8</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>Do</td>
<td>3-8</td>
<td>28</td>
<td>8/6</td>
<td>8</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>2</td>
<td>Do</td>
<td>7-0</td>
<td>27</td>
<td>8/6</td>
<td>8</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Oct 5</td>
<td>1</td>
<td>Do</td>
<td>3-10</td>
<td>27</td>
<td>8/6</td>
<td>8</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>Do</td>
<td>3-8</td>
<td>27</td>
<td>8/6</td>
<td>8</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

The ledger provided no totals and placed no value on the material issued and returned.

Calico was woven in lengths of 21 to 31 yards and in widths of between 3/4 to 6/4 yards. The completed length of cloth was termed a 'cut' and was returned to the warehouse when removed from the loom. The weaver was usually given sufficient length of warp and sufficient weight of weft to complete the assigned task.

The above example, while all the notations are not clear, shows on the debit side the type of cloth to be woven. In this case calico 1¼ yards wide. The credit side shows the completed cloth returned to the warehouse, its weight, the rate for the job and the amount payable. It seems that the main purpose of this record, apart from ascertaining the amount payable to the weaver, was the balancing of
the cotton given out with the product returned. While the record is not complete in that each column is not filled in, it must be remembered that the dealings with the weavers were an interactive process. The weavers reported to the warehouse to receive materials and to return cloth, where the manager had authorisation to make allowances for any poor quality weft or warp [Unwin, 1924].

Manufacturers such as Oldknow, were very concerned that their materials were not stolen by the people they employed. This account brought together issues and receipts to provide a check and it remained a record of the visual examination of the cloth carried out by the manager of the taking-in room. It was more than a simple ledger account detailing financial relationships, it was also a control tool used by the employer to ensure honesty on the part of the employee.

**Weaving Prices**

There appears to have been a standard set of prices for the different types of cloth woven. The "Weaving Prices Books" dated 28 July 1788 has such a list. An example of the prices for 4/4 Plain in varying degrees of fineness is reproduced below. The cloth was one yard wide, the vertical columns represent the reed used and the horizontal columns the fineness of the warp. The amount is per cut or length. The coarser cloth not requiring so much work as the finer cloth. Although the amounts paid to weavers varied with locality
they were relatively well paid compared to other workers in the 1780’s [Smelser, 1959; Bythell, 1964].

<table>
<thead>
<tr>
<th></th>
<th>38</th>
<th>46</th>
<th>50</th>
<th>56</th>
<th>60</th>
<th>64</th>
<th>68</th>
<th>72</th>
<th>76</th>
<th>80</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>2/11</td>
<td>3/4</td>
<td>3/7</td>
<td>4/1</td>
<td>4/6</td>
<td></td>
<td></td>
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<tr>
<td>36-39</td>
<td>4/1</td>
<td>5/2</td>
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<tr>
<td>40-43</td>
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<tr>
<td>44-46</td>
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<td>5/10</td>
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<td>47-49</td>
<td>5/9</td>
<td>6/2</td>
<td>6/7</td>
<td>7/-</td>
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<td>50-52</td>
<td>6/6</td>
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<td>53-55</td>
<td>6/10</td>
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<td>56-58</td>
<td>7/2</td>
<td>7/9</td>
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<td>59-61</td>
<td>8/2</td>
<td>8/9</td>
<td>9/3</td>
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<td>62-64</td>
<td>9/2</td>
<td>9/8</td>
<td>10/3</td>
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<td>65-67</td>
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<td>68-70</td>
<td>10/1</td>
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<td>71-73</td>
<td>10/7</td>
<td>11/1</td>
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<td>12/4</td>
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<tr>
<td>74-76</td>
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<td>12/2</td>
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<tr>
<td>77-79</td>
<td>12/-</td>
<td>12/8</td>
<td>13/4</td>
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<td>80-82</td>
<td>13/2</td>
<td>13/10</td>
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<tr>
<td>83-85</td>
<td>13/8</td>
<td>14/5</td>
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<td>86-88</td>
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<td>89-91</td>
<td>15/5</td>
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</tr>
</tbody>
</table>

[SO 797]
The varieties of cloth that are listed in this book include Towels, Doyleys, Shirting, 4/4 Plain (which could also be had in Cord, Stripes and Checks), 9/8 Plain, 6/4 Plain and Plain Balasores. All of which could be made in varying degrees of fineness. Departures from plain cloth required a premium to be paid to the weaver such as in the example, dated 28 July 1788, which follows:

<table>
<thead>
<tr>
<th>Cords per inch in checks</th>
<th>4/4 Reeds</th>
<th>6/4 Reeds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>34 38 56, 60 64 68, 72</td>
<td>34 38 56, 60 64 68, 72</td>
</tr>
<tr>
<td>Cord stripes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>6d 9d 12d</td>
<td>9d 12d 18d</td>
</tr>
<tr>
<td>10</td>
<td>1/6 2/6 3/6 3/6</td>
<td>2/3 2/9 3/3 4/3</td>
</tr>
<tr>
<td>8</td>
<td>1/3 2/6 3/3 3/3</td>
<td>1/8 2/6 3/3 3/9</td>
</tr>
<tr>
<td>6</td>
<td>1/2 2/3 2/9 2/9</td>
<td>1/6 2/3 2/9 3/6</td>
</tr>
<tr>
<td>4</td>
<td>1/- 1/6 2/2 2/6</td>
<td>1/4 2/- 2/6 3/3</td>
</tr>
<tr>
<td>2</td>
<td>10d 1/3 1/9 2/3</td>
<td>1/2 1/9 2/3 3/</td>
</tr>
<tr>
<td>1</td>
<td>8d 1/- 1/6 2/2</td>
<td>1/- 1/6 2/2 2/9</td>
</tr>
</tbody>
</table>

Charr checks up to 35 Twist 6d pr Cut

36 & 40 9
41 - 50 12
51 - 60 15
61 upwards 18

The table above shows the extra payment to be made for different classes of product because departures from standard cloth required more work and more skill on the part of the weaver. No indication of how these piecework rates were calculated is given, however they appear to apply to all the weavers. A similar price list was calculated in 1791 [SO 792(ii)] covering the same products but showing an increase in piece work rates.

In all the records dealing with outworkers no cost was assigned to the product that was issued to the worker. The cost assigned to the product on receipt was the cost of the labour involved in the conversion of the product.
Dealings with external employees was similar to dealings with any contractor. The problem was one of control. Firstly to ensure that the orders were carried out and secondly to ensure that material was returned. The existing records show the concern with these matters as well as providing information about the state of production. When dealing with outside workers the control of time was not something to be considered because it was up to them when they did the work, this changed however, when the workers were gathered together in the factory. The next section is concerned with the organisation of factory production amongst Oldknow's enterprises.

**FACTORY PRODUCTION**

Once he had embarked on collecting people together to produce on a factory basis Oldknow had new information requirements. Not only was he still concerned with the protection of his property, he became concerned with the guardianship of time, the time he had paid for. Outworkers were paid for their production whereas factory workers were paid for their time. The factory records reflect this concern with value for money. The existing records, essentially take two forms, those concerned with recording the employee and those concerned with the value the employee provided as well as keeping track of the product. It is interesting to note that factory production signals the introduction of performance indicators, a matter that will be discussed later.
The factory records of Samuel Oldknow are fragmented and discontinuous, which creates problems in trying to reconstruct an account of the evolution of his record keeping. However, it is possible to gain an impression of his concerns as he used the process of accounting to keep himself informed of the progress of his various enterprises and those employed to operate them. Unfortunately Oldknow's ledger is not available so it is impossible to see whether the flow of entries he made bears any resemblance to the scheme described by Hamilton [1788] in relation to the linen business [Mepham, 1988]. The records that exist are not in any way complete and consist mainly of loose papers and fragments of books. It is proposed to discuss the recording of the employees and then the other processes Oldknow employed to keep informed.

**Recording Employees**

In common with other manufacturers of his time [Owen, 1857], Oldknow had problems with his employees. He seems to have been held in high regard by them and certainly went out of his way to find employment for the husbands and fathers of the women he employed in the mill at Mellor and he was regarded as one of the more enlightened employers [Unwin, 1924; Fay, 1937; Ashton, 1964; Mathias, 1969; Oldham, 1990]. But, people were not fully conversant with the idea of working, together, under the one roof for six days a week and discipline was often a problem.
Robert Owen discussed the problem of dealing with employees unused to the discipline required by factory working and has made much of his approach to discipline by the use of his 'silent monitor'. In his autobiography Owen describes his method of dealing with what he termed 'inferior behaviour' by the

... contrivance of a silent monitor for each one employed in the establishment. This consisted of a four-sided piece of wood, about two inches long and one broad, each side coloured - one side black, another blue, the third yellow, and the fourth white, tapered at the top, and finished with wire eyes, to hang upon a hook with either side to the front. One of these was suspended in a conspicuous place near to each of the persons employed, and the colour at the front told the conduct of the individual during the preceding day, to four degrees of comparison. Bad, denoted by black and No. 4,-indifferent by blue, and No. 3,-good by yellow, and No. 2,-and excellent by white and No. 1. Then books of character were provided for each department, in which the name of each one employed in it was inserted in the front of succeeding columns, which sufficed to mark by the number the daily conduct, day by day, for two months; and these books were changed six times a year, and were preserved; by which arrangement I had the conduct of each registered to four degrees of comparison during every day of the week, Sundays excepted, for every year they remained in my employment. ... The act of setting down the number in the book of character, never to be blotted out, might be likened to the supposed recording angel marking the good and bad deeds of poor human nature. It was gratifying to observe the new spirit created by these silent monitors.

[1857, p 80-81]

Owen commenced at New Lanark, in Scotland, in 1800, after which the above system was installed. He highlights this method of dealing with the undesirable behaviour of his employees, however, it is to be noted that he does not define the behaviour that corresponds with
each colour. But, it seems that the solution devised by Owen was not unique because some thirteen years earlier Oldknow seems to have had a similar problem of behaviour, which he dealt with by a similar system at Stockport in 1787, when he established a number of women and girls in what he describes as the "Cutting Branch".

**Cutting Frames**

Muslin trimming was one of the first processes to be organised by Oldknow on a factory basis, it is thought that this activity commenced about late 1787. Unwin described the processes of the Cutting Branch wherein

(t)he most important work carried on comprised the trimming of the "float" or figures of the pattern woven, and the cutting of ballasore and romals into handkerchief size. The apparatus of this department was simple, consisting of 30 finishing frames and several darning frames. The staff comprised 81 girls and a foreman or forewoman. The names of the girls suggest that members of one family often worked together.

[1924, p 109]

There are two records of this department still in existence. The first of these, the "Cutting Frames Book", records the work the employees were engaged on, the time they started and the time they finished. The document does not state the year but gives the day and the month. It is thought that it could apply to 1788, shortly after the commencement of this department. An example of a typical page, relating to cutting frame No. 13, follows.
<table>
<thead>
<tr>
<th>No. 13</th>
<th>Shuttleworths 2 Sisters</th>
<th>March 19th 10 Clock</th>
<th>Chains</th>
<th>March 22 9 OC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jane Deraney</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nancy Smith</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shuttleworths 2 Sisters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nancy Moorhouse</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nancy Smith</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nancy Shuttleworth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nancy Smith</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nay Moorehouse</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Same as above</td>
<td>March 29 2 OC</td>
<td>Dice</td>
<td>April 5th 3 OC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6/4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nany Moorehouse</td>
<td></td>
<td>April 5</td>
<td>April 18th 10 OC</td>
</tr>
<tr>
<td></td>
<td>Fany Allen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cooks 2 Sisters</td>
<td></td>
<td>April 18</td>
<td>do 24 2 OC</td>
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<tr>
<td></td>
<td>S Blegdean</td>
<td></td>
<td>10 OC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>L Newton</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Same *******</td>
<td>April 24 2 OC</td>
<td>Great +</td>
<td>May 9th 10 OC</td>
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<tr>
<td></td>
<td>Mary Taylor</td>
<td></td>
<td>May 9th</td>
<td>May 16 10 OC</td>
</tr>
<tr>
<td></td>
<td>Betty Marsey</td>
<td></td>
<td>10 OC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lowes Newton &amp; Sarah Blagdean</td>
<td></td>
<td>hard spades</td>
<td>May 28th 10 OC</td>
</tr>
<tr>
<td></td>
<td>Same do</td>
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<td></td>
<td></td>
<td>May 28 10 OC</td>
<td>Pepper Box</td>
<td>June 15th 9 OC</td>
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<tr>
<td></td>
<td>Same</td>
<td>June 15th 9 OC</td>
<td>Do</td>
<td>July 10 Night</td>
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<tr>
<td></td>
<td></td>
<td>July 11 Morning</td>
<td></td>
<td>July 23 4 OC</td>
</tr>
<tr>
<td></td>
<td>Jane Polpbry</td>
<td></td>
<td></td>
<td>August 2 Night</td>
</tr>
<tr>
<td></td>
<td>Ann Beech</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Mary Sutton</td>
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<tr>
<td></td>
<td>Same</td>
<td>August 3 Breakfast</td>
<td>Double Spades</td>
<td>Do 13 3 OC</td>
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<td></td>
<td>Sept 6 Morning</td>
<td>Opened</td>
<td>Septm 14 10 OC</td>
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<tr>
<td></td>
<td>Same</td>
<td>Sept 14 10 OC</td>
<td></td>
<td>Do 22 4 OC</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hanah Brown &amp; Marget Kerry</td>
<td></td>
<td>Eyes</td>
<td>Oct 8 11 OC</td>
</tr>
<tr>
<td></td>
<td>Same</td>
<td>Sept 22 4 OC</td>
<td></td>
<td>Do 16 10 OC</td>
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<tr>
<td></td>
<td></td>
<td>October 8 11 OC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Betty Davis &amp; Hanah Hyde</td>
<td></td>
<td></td>
<td>Do 26 4 OC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Do 16 10 OC</td>
<td></td>
<td>[SO 759]</td>
</tr>
</tbody>
</table>
This document provides a list of the employees in the department, the work they were engaged on, the time the job was commenced and the time it was finished. This book ties the person to the work and provides a continuous record of the nature of the work being done on this particular frame, as well as the amount of time spent on doing it. The book also provides a check on quality, any complaints could be traced back to the individual worker. A record of the employees' behaviour as they went about their duties was recorded in the 'Report Book'.

**Report Book**

The way these women went about their work was also apparently of concern, because the women listed in the "Cutting Frames Book" also appear in the "Report Book" [SO 815], briefly referred to in Unwin as the "Disgrace Account". The book is in very poor condition and covers some six weeks in 1787. It appears to be a record of the behaviour of the women employed in the cutting frames department. The record on each page covers a two week period, which appears to be the normal practice in Oldknow's accounts. At various places an 'o' appears which Unwin thinks could refer to a mistake. Not all the workers have marks against their name, which tends to support Unwin's view that it records mistakes. Some of the women have a comment as to their behaviour. An example of a number of entries appears below.
Similar to the 'silent monitor' described by Owen, it seems that this record was concerned with employee behaviour while at work. Unfortunately there is no indication of how this record was used or how long the practice continued. However, it does indicate the concern shown towards worker output and performance. Some workers show a much better performance than others inasmuch as they have no marks against their name. Unfortunately there appears to be no account of the effect of this inscription so we are left in doubt as to its use. It is interesting to note that in one of his first attempts at collecting people together in a factory, Oldknow deemed
it important to record and be informed about the behaviour of his employees. The very act of recording behaviour implies a concern with discipline and the process of memorialising breaches of discipline akin to the "recording angel" referred to by Owen [1857, p 81]. This record was consistent with the 'rational' process of measurement and quantification where the record constituted the individual and the event. The record may have also been the result of an experiment to inculcate a more 'acceptable' mode of behaviour or better manners in the young women employed in the work. Oldknow does not seem to have carried on the practice in other parts of his organisation. However it was Oldknow's practice in his early years as a factory master to record work by the person rather than the machine being supervised, this process is further illustrated in the records relating to warping.

**Warping**

Warping began on a factory basis in 1787 and a series of books record the production. The record is by no means complete, however there is enough information to gain an impression of how the work of the warpers was written down. The warpers prepared the warp for the weavers by winding it onto a beam using a machine. This was important work because it determined the pattern to be woven. The weaver then attached the beam to the loom and the warp was unwound in the weaving process.
The existing records constitute a number of bound books, mainly in poor condition, some books appear to relate to an individual machine while others cover a number of machines. The records show that one person was in charge of each warping mill and indicate the work done by each machine and hence each operator. Unwin [1924] states that the warpers were paid 2/- per day, this would explain why the account mentions only quantities. The account for each worker carries a strict specification of the pattern of the cloth to be woven as well as number for each job.

The first book begins in May 1787 and relates to Mill No. 7 [SO 761(ii)], which would have been at Stockport. The book relating to Mill No. 10 begins on May 25, 1787 [SO 761(ii)] and describes the work done by Robert Sutton, setting up the warp for the weaving of night caps.

Thomas Edwards working on Mill No. 1 had more variety to contend with, setting the warp for a variety of muslins. An example follows showing some of the work done on this mill in July and September 1788, more than a year after the warping process had been incorporated into the factory.
This appears to be a record of the person rather than the output of the machine. The machine is not referred to as an entity involved in production, but the operator is. The machine is tied to the man rather than the man being tied to the machine because the output was dependant on the skill of the operator rather than the machine. The record was aimed at ensuring quality by keeping the worker responsible for the work by giving each warp a number [Unwin, 1924], which would allow cross-checking if questions arose. The person responsible for the individual piece of work was made soon aware of any faults in their workmanship by the use of this system, which was important because the quality of the finished product was dependent upon the skill with which the warp was prepared.

By the time operations had shifted to Mellor the records of the warpers had undergone a change. Certainly much less detail was recorded, but then this reflects the changed nature of Oldknow's
business, while still employing some weavers as outworkers, they no longer produced the complicated patterns of earlier times. The cloth produced was usually plain calicoes requiring less skill to prepare the warp. The book entitled "beams Warp'd", starting in August 1804 assigns a warp number and records the weight of warp and the person who wound it. Presumably this was primarily a quality control procedure to enable poor workmanship to be traced back to the worker. At this time too all the workers were women. An example from this record shows:

<table>
<thead>
<tr>
<th>Date</th>
<th>No</th>
<th>By Whom Warped</th>
<th>Weight</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1804</td>
<td></td>
<td>Betty Hudson</td>
<td>lbs</td>
<td>oz</td>
</tr>
<tr>
<td>Aug</td>
<td>11</td>
<td>Do</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Do</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>Do</td>
<td>22  2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>Do</td>
<td>23 13</td>
<td></td>
</tr>
</tbody>
</table>

[SO 772]

From 26 March 1805 the record included the time spent on each job, which was recorded in days and hours. However, no record of the size of the warp yarn was made.

<table>
<thead>
<tr>
<th>Date</th>
<th>No</th>
<th>By Whom Warped</th>
<th>Weight</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1805</td>
<td></td>
<td>H [obscured]</td>
<td>lb ozs</td>
<td>Days Hours</td>
</tr>
<tr>
<td>March</td>
<td>26</td>
<td>Do</td>
<td>19  8</td>
<td>1 1½</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>N Barton</td>
<td>30  13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>H Boswell</td>
<td>23  2</td>
<td>1 10</td>
</tr>
<tr>
<td></td>
<td>510</td>
<td>M Colley</td>
<td>24  4</td>
<td>1 7</td>
</tr>
</tbody>
</table>

[SO 772]

A further refinement occurred when the time was recorded in hours rather than days and hours.

As factory production became more established and more people became involved it was still deemed important to tie production to a
person rather than a machine or a process, where the outcome of that process depended on the skill of the operator. This can also be seen in the accounts of spinning in Stockport.

**Spinner's Accounts - Stockport**

By 1793 Oldknow was heavily involved in spinning in the new Hillgate factory. His new Boulton and Watt steam engine allowed him to operate four rooms of spinning machinery. The spinning records were concerned not only with the output of each machine, but also, with the output of each operator. An example of the production record for the week of April 20 1793 for all the spinning machines shows the emphasis on the output of the operators.

<table>
<thead>
<tr>
<th>April 20 1793 Spinners Weekly Account</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N of Frame</strong></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td>10</td>
</tr>
</tbody>
</table>

First Room

<table>
<thead>
<tr>
<th>April 20 1793 Spinners Weekly Account</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N of Frame</strong></td>
</tr>
<tr>
<td>11</td>
</tr>
<tr>
<td>12</td>
</tr>
<tr>
<td>13</td>
</tr>
<tr>
<td>14</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>16</td>
</tr>
</tbody>
</table>
17  Ric Fleet 144 7, 2 77 548
18  Jno Boveton 144 9, 8 83 787
19  Isaac Fogg 144 8, 1 75 605

Second Room 6097

20  Isaac Stafford 120
21  Thomas Naden 120
22  Charles Bullock 120 6, 1 81 494
23  James Spearpoint 120 5, 14 88 556
24  Isaac Becket 160
25  Joseph Hybert 160
26  Thos Salsbury 160
27
28  Robert Cain 120
29  Geo Sykes 120
30  Geo Burton 160 7, 14 76 447
31  William Salsbury 120
32  Richard Fox 160 10, 10 65 693
33
34
35  Joseph Williamson 120 7, 14 76 447
36  John Edwards 120 10, 10 65 693
37
38  Richard Rogers 120 3, 3 75 240
39  Geo Sykes 120 8, 1 75 600
40  Charles Wilkinson 120 7, 12 67 510
41  Geo Burton 120 3, 12 80 300
42  Thos Salsbury 120 3, 10 79 288

Fourth Room 2758

April 20 1793 Spinners Weekly Account

<table>
<thead>
<tr>
<th>Frame</th>
<th>Spinners Name</th>
<th>N° of Spindles</th>
<th>Weight</th>
<th>Counts</th>
<th>Hanks</th>
</tr>
</thead>
<tbody>
<tr>
<td>43</td>
<td>Robert Cain</td>
<td>120</td>
<td>7, 9</td>
<td>84</td>
<td>635</td>
</tr>
<tr>
<td>44</td>
<td>Thos Rogers</td>
<td>120</td>
<td>3, 3</td>
<td>75</td>
<td>240</td>
</tr>
<tr>
<td>45</td>
<td>Geo Sykes</td>
<td>120</td>
<td>8, 1</td>
<td>75</td>
<td>600</td>
</tr>
<tr>
<td>46</td>
<td>Charles Wilkinson</td>
<td>120</td>
<td>7, 12</td>
<td>67</td>
<td>510</td>
</tr>
<tr>
<td>47</td>
<td>Geo Burton</td>
<td>120</td>
<td>3, 12</td>
<td>80</td>
<td>300</td>
</tr>
<tr>
<td>48</td>
<td>Ric Fivinifire</td>
<td>120</td>
<td>5, 3</td>
<td>76</td>
<td>292</td>
</tr>
<tr>
<td>49</td>
<td>Thos Salsbury</td>
<td>120</td>
<td>3, 10</td>
<td>79</td>
<td>288</td>
</tr>
<tr>
<td>50</td>
<td>Wm Horton</td>
<td>120</td>
<td>6, 8</td>
<td>56</td>
<td>367</td>
</tr>
</tbody>
</table>

Fifth Room 3332
Fourth Room 2758
Fifty three spinning frames with a total of 7740 spindles were available, however, all of this capacity was not used. Earlier in his career as a spinner Oldknow was responsible for counts of above 120 hanks to the pound, these records show that the fineness of the yarn had declined somewhat. As time went by the fineness of the yarn spun continued to decline, this decline can be attributed to the changing nature of the demand for cotton cloth as well as the different technology being employed. In this situation the fineness of the mule spun yarn was not equal to the jenny spun yarn that he used to produce.

The record of spinners for the rest of the year continues along similar lines with a change to fortnightly summaries at the end of June. At a glance Oldknow was made aware of the production of each machine and each machine attendant. A degree of skill in operating these machines was required which could account for the operator’s names being included in the account\textsuperscript{14}. The inclusion of their names

\textsuperscript{14} The operation of mules required more physical stamina than other spinning machinery and the application of power still required the operator to use considerable skill to co-ordinate the movement of the carriage, the winding of the
also provided a means of control whereby the output of the spinners could be compared with each other and with expected output. Later on at Mellor, when different machines were operated by women and children, the practice of recording operator's names seems to have been discontinued. Quality was not so much dependant on the operator but more on the machinery at Mellor, this was because Mellor used different technology, with its spinning being based on the Arhwright water-frame.

Someone has appended the following to the Spinners' Accounts, as if to remind themselves of the classifications of quality.

What constitutes warp is such as will make Good Warp. What constitutes Inferior is bad yarn bad mad(e) cops and small cops.

What constitutes warp is such as will make good warps what constitutes weft is the same as Warp but not so much twisted what constitutes Inferior is bad yarn bad made cops and small cops Inferior is bad weft is for the shuttle warp is for the treadles

[SO 769]

As Oldknow's factories became established the process of recording the time became more formalised and by the time the Mellor mill was established attendance was recorded in a series of time books.

yarn and control the spindles, all the while ensuring that the thread neither broke or went slack [Berg, 1985].
Time Books

The time books consist of fragments of four books used to record the attendance of factory personnel, covering the period 1793 - 1795. Attendance was recorded in quarter day units, with a mark made four times a day\textsuperscript{15}. Employees were paid fortnightly, at a daily rate based on their attendance. These records relate to Mellor and include spinners, apprentices, carders, rovers and drawers, smiths, tilers, plasterers, reeers, makers up, sizers, warpers and winders, and cutters. The following is an example of the attendance of some of the spinners for the fortnight beginning on Saturday 21 December 1793.

<table>
<thead>
<tr>
<th>Decbr 1793 &amp; Jan\textsuperscript{y}</th>
<th>S 21</th>
<th>M 23</th>
<th>T 24</th>
<th>W 25</th>
<th>T 26</th>
<th>F 27</th>
<th>Time Worked</th>
<th>S 28</th>
<th>M 30</th>
<th>T 31</th>
<th>W 1</th>
<th>T 2</th>
<th>F 3</th>
<th>Time Worked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wm Wardle</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>5</td>
<td>XX XX XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>X</td>
<td>XX</td>
<td>XX</td>
<td>9\textfrac{1}{2}</td>
</tr>
<tr>
<td>Thos Hall</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>5</td>
<td>XX XX XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>X</td>
<td>XX</td>
<td>XX</td>
<td>9\textfrac{1}{2}</td>
</tr>
<tr>
<td>Wm Lomas</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>5</td>
<td>XX XX XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>X</td>
<td>XX</td>
<td>XX</td>
<td>9\textfrac{1}{2}</td>
</tr>
<tr>
<td>Josh Clowes</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>5</td>
<td>XX XX XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>X</td>
<td>XX</td>
<td>XX</td>
<td>9\textfrac{1}{2}</td>
</tr>
<tr>
<td>John Cuttler</td>
<td>X</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>3\textfrac{1}{2}</td>
<td>XX XX XX</td>
<td>X</td>
<td>XX</td>
<td>XX</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>John Halden</td>
<td>XX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>XX</td>
<td>XX</td>
<td>2\textfrac{1}{2}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jon\textsuperscript{n}</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>/X XX</td>
<td>4\textfrac{3}{4}</td>
<td>XX XX XX</td>
<td>X</td>
<td>XX</td>
<td>XX</td>
<td>9\textfrac{1}{4}</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Davenport</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alex Lewis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1\textfrac{1}{2}</td>
</tr>
<tr>
<td>Ann Do</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>X/ XX</td>
<td>4\textfrac{3}{4}</td>
<td>XX XX XX</td>
<td>X</td>
<td>XX</td>
<td>XX</td>
<td>9\textfrac{1}{4}</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G Garlick</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX X</td>
<td>4\textfrac{1}{2}</td>
<td>XX XX XX</td>
<td>X</td>
<td>XX</td>
<td>XX</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sarah Brindle</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>5</td>
<td>XX XX XX</td>
<td>X</td>
<td>XX</td>
<td>XX</td>
<td>9\textfrac{1}{2}</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mary Do</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>5</td>
<td>XX XX XX</td>
<td>X</td>
<td>XX</td>
<td>XX</td>
<td>9\textfrac{1}{2}</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Martha Do</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>5</td>
<td>XX XX XX</td>
<td>X</td>
<td>XX</td>
<td>XX</td>
<td>9\textfrac{1}{2}</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>James Do</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>5</td>
<td>XX XX XX</td>
<td>X</td>
<td>XX</td>
<td>XX</td>
<td>9\textfrac{1}{2}</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{15} Norton [1894] recommends a similar system of marks for recording attendance in terms of quarter days. Garcke and Fells [1893] recommend a similar scheme although both of these books were published a century after Oldknow's records were made.
Generously, the employees did not have to report for work on Christmas Day and New Year's Day and they were even allowed to start work late on the second of January, presumably recognising the importance of the previous day's celebrations. They were not paid for this time off though. In 1795 the books list "Night Spinners", implying the working of a night shift.

Unbecoming behaviour seems to have been a problem for some years after the Mellor mill was established as indicated by the following notice that Oldknow caused to be printed, illustrating his continued concern with the training and discipline of his employees, as well as being part of an overall desire for a new ethos among his workpeople (see Chapter Three):

**WHEREAS**

The horrid and impious Vice of profane CURSING and SWEARING,- and the Habits of Losing Time,-and DRUNK-ENNESS,-are become so frequent and notorious; that unless speedily checked, they may justly provoke the Divine Vengeance to increase the Calamities these Nations now labour under.

**NOTICE is hereby given,**

That all the Hands in the Service of **SAMUEL OLDKNOW** working in his Mill, or elsewhere, must be subject to the following RULE:

That when any person, either Man, Woman or Child, is heard to CURSE or SWEAR, the same shall forfeit One Shilling.-And when any Hand is absent from Work, (unless unavoidably detained by Sickness, or Leave being first obtained), the same shall forfeit as many Hours of Work as have been lost; and if by the Job or Piece, after the Rate of 2s. 6d. per Day,-Such Forfeitures
to be put into a Box, and distributed to the Sick and Necessitous, at the discretion of their employer.

MELLOR, 1st December, 1797.

[SOP Box 5]

As the method of organising production became more established and routine Oldknow appears to have become more interested in the overall picture rather than the performance of the individual as indicated by the following documents.

**Wage Payment Papers**

A series of sheets [SO 824], starting in 1804, show the wages payable and the calculation of the currency needed to pay them. By 1811 these sheets of calculations were not only showing the wages payable but were calculating the cost of wages in terms of employees per week and output in relation to the cost of wages per thousand hanks of yarn.

The following example illustrates this relation of wage cost to production.
These statements show the performance of the mill and the above example is indicative of the overview being provided to Oldknow. The areas of interest were the yarn being spun, in this case an average of 36.7 hanks to the pound; the average cost of wages, 7s - 2d.34 per hand per week in this case; and the labour cost of spinning, 14/11.91 per thousand hanks or 6d.61 per pound. These calculations provided a basis for comparisons with preceding and succeeding periods as well as an indication of the cost structure. The problems of aggregation have not been taken into account. The average cost per pound does not take into account the varying degrees of labour required to spin the different qualities of yarn. However, the average price per thousand hanks gives a better
indication because the finer the yarn the more hanks to spread the cost over.

There are other records relating to employment. Oldknow, for example, employed a number of apprentices who were 'recruited' from poorhouses in London and indentured to him until they were twenty one. He seems to have treated them well because a number stayed on after their indentures had been concluded [Unwin, 1924; Oldham, 1990].

Oldknow seems to have been continually short of cash with which to pay his employees [Unwin, 1924, Oldham, 1990]. To overcome this problem he issued them with tickets to obtain payment in kind from the shop he established. This procedure was not unusual at the time, but did have the effect of further tying the workers to the employer. He also provided them with housing, coal and produce from the farms he established, at a cost of course, but there is no reason to believe he took advantage of them16.

---

16 The "truck" system, that was in operation at the time where workers were not paid in cash but in kind, was common in the early nineteenth century industrial villages. One of the reasons for this was the continual shortage of coin with which to pay the employees. While the system was open to much abuse employers such as Owen and Oldknow supplied the shop with goods which were sold at cost or with a small profit margin. In Oldknow's case he operated farms which supplied the shop with produce [Unwin, 1924; Oldham, 1990; Owen, 1967; Porter, 1982; Ashton, 1964].
Recording the Product

In factory production where the product passed from process to process, rather from person to person as in the putting out system, there was a need to record the movement of the product. This was for two reasons; firstly, embezzlement was still a problem and it was necessary to safeguard the goods. Secondly, production had become sufficiently large so that it was impossible to remember the location and progress of the product.

Often Oldknow's records show the movement of quantities but place no values on those quantities. An example of this can be found in the 'Sizing Account Book' [SO 799]. The debit side of the account shows yarn transferred to the sizing department and the credit side shows the yarn being returned, the yarn was identified by weight and size (count), as the following extract shows:

<table>
<thead>
<tr>
<th>Date</th>
<th>Twist Dr on Acct of Sizing</th>
<th>Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(lbs) (count)</td>
<td>(lbs) (count)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>June</td>
<td>26  10  40</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>27  40  46</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>27  40  64</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>27  40  36</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>28  40  27</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>28  10  40</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>28  30  42</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>28  10  43</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>28  40  44</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>28  10  60</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>28  20  41</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>30  70  29</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>30  40  6</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>30  10  6½</td>
<td>10</td>
</tr>
<tr>
<td>July</td>
<td>1   10  14</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>80  26</td>
<td>80</td>
</tr>
</tbody>
</table>

[SO 799]
This is another record kept on a charge/discharge basis where the sizing department acquitted its responsibility for an amount of yarn when it was passed on to the next process. There was no need to balance the account because each batch was recorded as being received and dispatched by the department.

Oldknow kept a close eye on production as the following extract from the "Daily Account of Output", or as it was titled "Sent up Mr Oldknow", shows. This document was a daily account of spinning at Stockport, beginning May 1790 and finishing in October 1791 and referred to the time when Oldknow was using the former silk mill known as the 'Carrs'. Output was shown in terms of quantity, type and value.

**Daily Account of Output or "Sent up Mr Oldknow"**

**Example 1.**

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
<th>Quantity</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1790</td>
<td>To 18 Weft Jn° Rowbottom</td>
<td>4 - 0</td>
<td>91 - 8</td>
</tr>
<tr>
<td></td>
<td>18 Do White</td>
<td>33 - 0</td>
<td>9 - 18 - 3</td>
</tr>
<tr>
<td></td>
<td>16 Weft White</td>
<td>42 - 0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>22 Do Do</td>
<td>12 - 8</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>1 Huckaback Warp</td>
<td>19 - 0</td>
<td>2 - 1 - 0</td>
</tr>
<tr>
<td></td>
<td>12 Weft Jn° Hopwood</td>
<td>12 - 0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12 Do Isac Walken</td>
<td>5 - 0</td>
<td>1 - 2 - 8</td>
</tr>
<tr>
<td></td>
<td>24 Warp Jn° Hampton</td>
<td>5 - 0</td>
<td>1 - 3 - 4</td>
</tr>
<tr>
<td></td>
<td>18 Weft Drab</td>
<td>13 - 12</td>
<td>1 - 4 - 2½</td>
</tr>
<tr>
<td>10</td>
<td>18 Weft Drab</td>
<td>10 - 0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18 Do Do</td>
<td>60 - 0</td>
<td>6 - 8 - 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 Romals Red</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>18 Weft White</td>
<td>43 - 0</td>
<td>4 - 13 - 2</td>
</tr>
</tbody>
</table>

[SO 802]
The use of names for some of the entries implies that some yarn was spun to order while the rest was prepared for Oldknow's weavers and for stock.

Example No 2

| 16 (July 1790) | 12 Warp | 45 - 0 | 97/6 |
| 18 Weft | Wight | 21 - 0 | 45/6 |
| 18 Do | India | 8 - 0 | 14/8 |
| 12 Do | Drab | 50 - 0 | |
| 8 Do | Do | 68 - 0 | 10 - 16 - 4 |
| N3 fine slubing | | 17 - 0 | 1 - 5 - 6 |
| 28 Weft | | 40 - 0 | 5 - 5 - 0 |

Example No 3

| 1790 August |
| 25 7 Doz of 18 Reelt Yn | 26/6 9 - 9 - 6 |
| 2 Do of 10 Do Drab | 16/- 1 - 12 |
| 5½ Do of 22 Do | 29/ 7 - 19 |
| 1½ Do of 26 Do | 32/6 2 - 8 - 9 |
| 1½lb of 18 Blue | 2/3 pd 3 - 5 |
| 5lb of 28 Weft | 2/7½ 13 - 1½ |
| 8¼ of 18 Do White | 2/2 12 - 0½ |
| 4¼ of 14 Do Do | 2/- 8 - 6 |
| 3 of 10 Do Drab | 16½d 3 - 10½ |

Example No 4

| 1790 Oct |
| 29 10 Doz of 18 Reelt Yarn | 13 - 5 - 0 |
| 5 Do of 22 Do Do | 7 - 2 - 6 |
| 43 of N2 Slubing Blue | 2 - 3 - 0 |
Example No 5

1791
January
17  288 of 12 Warps
  25  Warps Warping lb
  75 of 12 Warps
  45 of N3 Weft Lint  11
  23 of 6 Do  13d

                           31 - 4 - 0
                           11 - 6
                           8 - 2 - 6
                           2 - 8 - 9
                           1 - 4 - 11

                         ---------------
                           £43 - 11 - 8

May 27  42 of 18 Weft White
         100 of 10 Weft India & Wast
         24 of 10 Do  Do
         35 of N1 Slubing
  28  11 of 10 Weft India & wast
         5 of 10 Do  Do
         74 of 18 Weft White

                           4 - 11 - 0
                           7 - 15 - 0
                           1 - 15 - 0
                           1 - 0 - 0
                           8 - 0 - 4

[SO 802]

The book was totaled daily thus giving a concise view of the day's production in terms of labour cost. In this way, at this time, Oldknow was kept informed of the progress of production in the spinning mill at least.

Once production became centralised at Mellor, the records become more consistent in nature, with the approach to the maintaining of records and the provision of reports becoming more systematic. Spinning was carried on within the mill but weaving, which was still carried on Oldknow's behalf, was done outside, in the weaver's own workshops. The account recording the transfer of yarn to the weavers shows this movement of materials and was known as the "Manufacture to Spinning Acct". The early part of the book containing this account relates to 1793 and includes quantities only while the latter part includes values as well. The following example was taken from the latter part of the account book. The term 'Manufactory' was used to describe the weaving activities.
The product transferred carries a value made up of material cost and spinner's labour cost. This implies that a costing system was in place at such an early stage in the mill's development. The above account shows a departmentalisation of the accounting for the processes that Oldknow had under his control.

An established base for production seems to have led to a system of regular reporting, both of output and of costs. It was necessary for Oldknow to be kept informed of what was happening in his mill while he was busy with attending to his other affairs. An example of these systematic reports, from the earliest production at Mellor, can be

![Table](image)
found in the "Output Records". Some examples of these reports, complete with original spelling are now illustrated:

**Output Records - Mellor**

**Document 1**

*MF Oldknow Stockport*

From the 19th October to 26th October 1793 Twist Reeled and Made Up in 10 pound Bunches

<table>
<thead>
<tr>
<th>No</th>
<th>Hanks</th>
<th>Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>00720</td>
<td>40</td>
</tr>
<tr>
<td>19</td>
<td>01330</td>
<td>70</td>
</tr>
<tr>
<td>20</td>
<td>20600</td>
<td>1030</td>
</tr>
<tr>
<td>21</td>
<td>14700</td>
<td>700</td>
</tr>
<tr>
<td>22</td>
<td>01320</td>
<td>60</td>
</tr>
<tr>
<td>23</td>
<td>00690</td>
<td>30</td>
</tr>
<tr>
<td>24</td>
<td>00480</td>
<td>20</td>
</tr>
<tr>
<td>25</td>
<td>00250</td>
<td>10</td>
</tr>
<tr>
<td>28</td>
<td>00840</td>
<td>30</td>
</tr>
<tr>
<td>29</td>
<td>00290</td>
<td>10</td>
</tr>
</tbody>
</table>

Total Hanks 41220 Total Pounds wt
200 ten pound Bunches 2000
Reeling Room 26th Oct 1793

[SO 789]

(The No refers to the count, ie hanks to the pound. Hanks X count = pounds; 'Twist' was the name given to the yarn produced by the Arkwright 'water-frames' installed at Mellor and was mainly used for warp.)

**Document 2**

Mellor Reeling room 16th November 1793
From the 9th until the 16th November Lenth and When Reeld and made up in 10 Lb Bunches 35480 Hanks 1800 Lb
Total Reeld 37040 Hanks Wt 1879 Pounds
Hanks Left [in] The makeing up room 1560
Hanks not made up 79 Pounds
Account if Lenth ans Wt Spunn by each over Looker in the Above time -

<table>
<thead>
<tr>
<th>Hanks</th>
<th>lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>10240</td>
<td>528</td>
</tr>
<tr>
<td>13360</td>
<td>676</td>
</tr>
<tr>
<td>13440</td>
<td>675</td>
</tr>
<tr>
<td>-------</td>
<td>-----</td>
</tr>
<tr>
<td>37040</td>
<td>1879 lb</td>
</tr>
</tbody>
</table>

**Document 3**

Mr Oldknow Stockport

Mellor Reelingroom 23 November 1793

From 16th til 23rd Novem Lenth and wt if twist spun and Reeled at Mellor factory

<table>
<thead>
<tr>
<th>Hanks</th>
<th>lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>46000</td>
<td>23001b</td>
</tr>
<tr>
<td>47190</td>
<td>23501b</td>
</tr>
</tbody>
</table>

Lenth and wt spun by each over Lucker in the above time

- Spun by David Shaw in Bottom Room: 11520 Hanks, 577lb
- Spun by Guy Bray: 17560 Hanks, 879lb
- Spun by John Dunn: 16920 Hanks, 844lb

Total Spun and Reeled: 46000 Hanks, 23001b

Thos Conway

[SO 789]

**Document 4**

Mr Oldknow Stockport

From the 23rd until the 30th November 1793

<table>
<thead>
<tr>
<th>Hanks</th>
<th>Pounds wt</th>
</tr>
</thead>
<tbody>
<tr>
<td>47480</td>
<td>2373</td>
</tr>
<tr>
<td>47000</td>
<td>235</td>
</tr>
<tr>
<td>480</td>
<td>23</td>
</tr>
</tbody>
</table>

Lenth and wt spun by Each Overlucker in the above time

- David Shaw: Spun 12800 Hanks, 640 Pounds Wt
- Guy Bray: Spun 18520 Hanks, 932 Pounds Wt
- John Dunn: Spun 16160 Hanks, 801 Pounds Wt

Total Spun and Reeled: 47480 Hanks, 2373 Total Pounds

Mellor Reeling Room November 30th 1793

[SO 789]
**Document 5**

Mellor Reelingroom  December the 7th 1793  
From 30 November til the 7th December Lenth and Wt if Twist spun and 
Reeled at Mellor factory 47200 Hanks 2326 lb  
Made up in 10 lb Bunches 47120 Hanks 235 10lb Bunches

Lenth Spun by Each over Lucker in the above time  
Spun by David Shaw Bottom Room 11920 Hanks 590 lb  
Spun by Guy Brey 18200 Hanks 886 lb  
Spun by John Dunn 17080 Hanks 850 lb  
Total 47200 Hanks 2326 lb  

[SO 789]

**Document 6**

Mr. Oldknow Stockport  
Mellor Reeling Room December the 14th 1793  
From 7th til the 14th December Lenth and wt Twist spun and Reeled at 
Mellor Mill 240 10lb Bunches 48000 Hanks 2400 lb  

Spun by David Shaw 13040 Hanks 660 lb  
Spun by John Dunn 17840 Hanks 901 lb  
Spun by Guy Brey 17120 Hanks 830 lb  
48000 Hanks 2400 lb  

[SO 789]

It is interesting to note that the individual spinners are not referred to as they were at Stockport. It is the overseers or overlookers of the various spinning rooms that are referred to. This could be because spinning was much less a skilled trade, especially in a mill equipped, as this one was, with Arkwright type water frames or "throstles", which could be operated by women and young children [Oldham, 1990; Berg, 1985]. Oldknow, at this stage, still lived in Stockport, so these reports kept him up to date with what was happening at the mill.
By 1797 the output reports had become more formalised with values being quoted for the output. As the next example shows, output was calculated on a daily basis and totaled for the month.

Monthly Output Book

The 'Monthly Output Book' relates to spinning at Mellor and records output on a daily basis, referring to the period May - September 1797.

An example of one day's output shows:

<table>
<thead>
<tr>
<th>Bdl</th>
<th>No</th>
<th>Hanks</th>
<th>Price</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>14</td>
<td>2520</td>
<td>25/-</td>
<td>22 - 10 - 0</td>
</tr>
<tr>
<td>12</td>
<td>15</td>
<td>1800</td>
<td>25/5</td>
<td>15 - 5 - 0</td>
</tr>
<tr>
<td>1</td>
<td>20</td>
<td>200</td>
<td>39/</td>
<td>1 - 19 - 0</td>
</tr>
<tr>
<td>8</td>
<td>22</td>
<td>1760</td>
<td>40/</td>
<td>16 - 0 - 0</td>
</tr>
<tr>
<td>7</td>
<td>24</td>
<td>1680</td>
<td>42/</td>
<td>14 - 14 - 0</td>
</tr>
<tr>
<td>5</td>
<td>26</td>
<td>1300</td>
<td>44/-</td>
<td>11 - 0 - 0</td>
</tr>
<tr>
<td>5</td>
<td>28</td>
<td>1400</td>
<td>46/-</td>
<td>11 - 10 - 0</td>
</tr>
<tr>
<td>10</td>
<td>30</td>
<td>3000</td>
<td>48/</td>
<td>24 - 0 - 0</td>
</tr>
<tr>
<td>3</td>
<td>32</td>
<td>960</td>
<td>50/</td>
<td>7 - 10 - 0</td>
</tr>
<tr>
<td>3</td>
<td>34</td>
<td>1020</td>
<td>54/</td>
<td>8 - 2 - 0</td>
</tr>
<tr>
<td>1</td>
<td>36</td>
<td>360</td>
<td>58/</td>
<td>2 - 18 - 0</td>
</tr>
</tbody>
</table>

73 Bdl 16000 £135 - 8 - 0

['no' refers to the number of hanks to the pound, the hanks were packed in 10lb bundles]

The output of each day was then included in a monthly summary:
Oldknow was obviously concentrating on the spinning of coarser yarn as the 'No' indicates with the counts being spun on this day being between 14 and 36 hanks to the pound. The output in this case was valued in terms of the expected selling price for a bundle (10 lbs) of yarn. It was not uncommon for output to be recorded in terms of selling value rather than cost value.

A summary of the mill's operations can be found in the Miscellaneous Papers [SO 826]. The statement, quoted below, is the only survivor of what could have been a series of monthly reports. A series of similar reports relating to the early 1800s is discussed later.

### Mellor Mill Monthly Statement from Jany 1st to 31st 1797

<table>
<thead>
<tr>
<th>Spindles set up</th>
<th>Total Spindles</th>
<th>Average Spindles Running</th>
<th>Cotton to the cards</th>
<th>Waste to the cards</th>
<th>Hks spun</th>
<th>lbs Spun</th>
<th>Wages Paid</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2608</td>
<td>8464</td>
<td>6000</td>
<td>15842-2</td>
<td>4452</td>
<td>340380</td>
<td>17060</td>
</tr>
<tr>
<td>2</td>
<td>2464</td>
<td>6000</td>
<td>15842-2</td>
<td></td>
<td></td>
<td></td>
<td>405-2-10</td>
</tr>
<tr>
<td>3</td>
<td>2816</td>
<td>576</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>576</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Calculation on the Above Account**

<table>
<thead>
<tr>
<th>Cotton Wool to the Cards</th>
<th>Waste to the Cards</th>
</tr>
</thead>
<tbody>
<tr>
<td>15842 2</td>
<td>4452 0</td>
</tr>
<tr>
<td>at 2/1½</td>
<td>at 1/4</td>
</tr>
<tr>
<td>£1683 1</td>
<td>£296 16</td>
</tr>
</tbody>
</table>

| 20294 2                 |
| 1979 17                 |
This statement presents a summary of the spinning operations for one month and indicates that the mill was not operating to capacity with an average of 6000 spindles out of 8464 in operation for the month. The average count was 20 hanks to the pound which is very low compared to Oldknow’s output at Stockport; the actual cost to spin, in terms of wages paid to the spinners was 5.7 pence per pound. The calculations represent an attempt to determine profitability for the month. The first part of the calculation shows...
the raw materials entering the spinning process and their cost at the beginning of the process. To this is added the cost of spinning estimated at 1 shilling per pound of output. The cost of spinning was calculated in the box at the bottom of the statement where an allowance was made for spinners' wages as well as for items of overhead such as wear and tear, interest on capital investment and other items of overhead. The cost of raw material and spinning was then compared to the value, in terms of selling prices, of the month's output as calculated in the lower part of the statement. It is clear from the statement that only 8450 pounds of output was sold during the month because the selling value is reduced by the expenses of selling (estimated at 10%). The average selling price of the yarn sold was 4/7.2 per pound. The unsold yarn totalling 8610 pounds was valued at 2/3.7 per pound which was below the cost of the raw materials plus the spinning cost. The remaining material was valued at its selling price giving a total value placed on output of £2844-14-2½ for the month. The low valuation of the unsold yarn accounts for the low apparent profit of £11-16-5¼ for the month. This one statement provides a summary of the output and financial condition of the mill for this one month.

The calculation of overheads or 'contingent expences' as Oldknow describes them presented a number of difficulties in calculation. Wages could be calculated relatively easily although in this statement 5½ d. per pound of output was allowed yet the actual cost was 5.7 d. per pound, thus reducing the 'Apparant gain' further. The estimation of the cost of wear and tear is more problematic and was an estimate of depreciation. It was usual at the time to make an
allowance for interest on the capital invested in machinery and in this calculation the amount is reckoned to be 2 d. per pound of output, based on an investment of £16000 at 10%.

The calculation and allocation of overheads created difficulties for manufacturers such as Oldknow, and as indicated in the next chapter for James Watt jnr, as it still does in the present day; there were problems in deciding which expenses to include and in their allocation to production. Oldknow, for example, maintained a relatively large establishment for the accommodation of his apprentices as well as a number of houses let at subsidised rent to his employees yet while these costs could be traced back to spinning output this does not appear to have happened.

Oldknow was obviously concerned with the problem of overhead because he attempted another calculation of contingent expenses on the back of a copy of a letter ordering some printing dated 24th August 1798. The calculation is in Oldknow's writing and is based on an output of 3700 pounds per week (it can be compared with the above statement which was based on an output of 3791 pounds per week for a four and a half week period).

<table>
<thead>
<tr>
<th>Rent of Mellor Mill</th>
<th>£</th>
</tr>
</thead>
<tbody>
<tr>
<td>1600 a year</td>
<td>30</td>
</tr>
<tr>
<td>800 ½ year</td>
<td>17s</td>
</tr>
<tr>
<td>400 ¼ year or 13 weeks</td>
<td></td>
</tr>
<tr>
<td>Rent of a week is 2d</td>
<td></td>
</tr>
<tr>
<td>a pound on 3700 lb</td>
<td>30</td>
</tr>
</tbody>
</table>

\[ \begin{array}{c}
13 \\
30 \\
17s \\
- \\
30.17.0
\end{array} \]
Rent or Interest of Machinery is at 10 Pr C\(^t\) on 16000£

The same as the Rent & on 3700 lb is 2d a pound

Management Clerk
Smiths Joiners &c
Insurance - Carriage
Postage

taken at 2d a pound on 3700 spun Pr week

P\(^f\) Week £ 92 10 0
or 6d a pound on 3700

Wages Pr week
318 Mill hands 74. 0. 0
100 prentices 20

While he arrived at the same rate as in the previous calculation, how he got there was by a different route. This calculation and the previous one, shows the inexactness of Oldknow’s understanding of overhead expenses. The second document included an amount for rent of the mill buildings based on capital cost of £16000 at 10% as well as rent of machinery based on a similar amount. However, in the previous calculation it is likely that the amount for rent of the buildings was contained under the heading ‘Rent Insurance Carriage of Stores Postage &c’ which in total was a lesser amount than is allowed in the second calculation. The second document makes no allowance for wear and tear on machinery which could have been expected to be included with such a large amount of machinery under his control. The allocation rate arrived at of 1/- per pound of output is the same as in the other statement so it might well be that Oldknow made this calculation to confirm the rate that was in use.
Further evidence of systematic reporting can be found in a series of stock sheets which give detailed statistics of production over some three years. Because the stock sheets begin with number 61 it is reasonable to assume that the reporting process began sometime in 1799.

**Stock Sheets**

This record consists of a series of numbered stock sheets [SO 814] beginning with No 61 relating to February 1804 to No 100 relating to Feb 1807. Each sheet covers a four week period and relates to the Mellor mill as well as Oldknow's other interests at Marple. From sheet No 74 of July 1805, monitoring and performance statistics are calculated. All the sheets have details of wages paid and numbers of people employed and calculate the average weight of twist produced during each four week period.

Details from stock sheet No 61 relate to February 1804 and show:

**Wages paid:**

- **Relating to employees:**
  - 208 - 3 - 1
  - 17 - 10
  - 1 - 6 - 6

- **(number)** 429
  - 247 - 0 - 5
  - 44 - 16 - 10
  - 28 - 7 - 8

- **M. Hands**
- **Pickers**
- **Mechanics**

- **2 weeks end 5/3/04**
  - 207 - 11 - 1
  - 37
(number) 432

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stock of twist</td>
<td>23,635 lbs</td>
</tr>
<tr>
<td>Stock of cotton</td>
<td>55,863</td>
</tr>
<tr>
<td>Waste</td>
<td>6.18.4</td>
</tr>
<tr>
<td>Stores</td>
<td>6.15.5</td>
</tr>
<tr>
<td>Garden</td>
<td>20.4.2</td>
</tr>
<tr>
<td>Farm</td>
<td>34.19.6</td>
</tr>
<tr>
<td>Rents</td>
<td>36.18</td>
</tr>
</tbody>
</table>

Average Weight  28.02

Later stock sheets carried much more detail eg

Stock of Waste, Coals, Farm, Garden, Stores, Rents,(values); Cotton, Twist, (weight)
Wages paid to Millhands, Pickers, Mechanics
Weight of cotton produced, value, number of bobbins or cops
Average weight per bobbin
Weight of twist sold and value

Calculations that were made include:

Average Number of Twist (Average Number of Hanks per pound) = the number of hanks of twist produced divided by the weight of twist produced.
Average output per spindle per day = Hanks of twist divided by the number of spindles multiplied by the number of working days (usually 24).

Average (cost) per hand per week = Cost of wages for Millhands divided by the average number employed per week.

Average purchase price of cotton.

Average selling price per pound of twist sold.

Average spinning cost per pound = Cost of wages for Millhands divided by the weight of twist produced.

**Detail from No 87 for 4 weeks ending 1 March 1806**

Relating to cotton:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanks produced</td>
<td>617 325</td>
</tr>
<tr>
<td>Weight</td>
<td>16 214 (lbs)</td>
</tr>
<tr>
<td>Total wages</td>
<td>£590-7-10</td>
</tr>
<tr>
<td>Weight sold (lbs)</td>
<td>22 935</td>
</tr>
<tr>
<td>Value of Sales</td>
<td>£4705</td>
</tr>
</tbody>
</table>

Other matters:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stores</td>
<td>£317-15-7</td>
</tr>
<tr>
<td>Lime &amp; Ashes</td>
<td>£369-9-0</td>
</tr>
</tbody>
</table>

Calculations yielded the following:

Average № of Twist = 38.07 (hanks/lb)
<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per Spindle per day</td>
<td>2.55 (hanks/spindle = 2.55/day)</td>
</tr>
<tr>
<td>Per hand per week</td>
<td>6/0 13/16 (average wages per hand per week)</td>
</tr>
<tr>
<td>Per lb Spinning</td>
<td>6 9/16 (labour cost to spin one lb)</td>
</tr>
<tr>
<td>Per lb Cotton Bot</td>
<td>2/2 1/16 (average purchase price)</td>
</tr>
<tr>
<td>Per lb Twist Sold</td>
<td>4/1 3/16 (average selling price)</td>
</tr>
</tbody>
</table>

(The gross margin per lb for this month was $4/13/16 - (2/21/16 + 69/16) = 1/49/16)

Each fortnight's wages were listed as well as all the sales made, the stock of raw material and finished product on hand.

The information available from the stock sheets has been compiled in Table 4.1 and gives an impression of the magnitude of operations at the Mellor mill from 1804 to 1807.
## TABLE 4.1
### STATISTICS

<table>
<thead>
<tr>
<th>Statement No</th>
<th>61</th>
<th>66</th>
<th>67</th>
<th>68</th>
<th>74</th>
<th>79</th>
<th>81</th>
<th>82</th>
<th>87</th>
<th>88</th>
<th>89</th>
<th>90</th>
<th>91</th>
<th>92</th>
<th>93</th>
<th>94</th>
<th>95</th>
<th>96</th>
<th>97</th>
<th>98</th>
<th>99</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date - 4 week end</td>
<td>3 Mar 1804</td>
<td>21 July 1804</td>
<td>15 Aug 1804</td>
<td>18 Aug 1804</td>
<td>29 Mar 1806</td>
<td>26 April 1806</td>
<td>21 May 1806</td>
<td>1 June 1806</td>
<td>17 July 1806</td>
<td>16 Aug 1806</td>
<td>8 Nov 1806</td>
<td>6 Dec 1807</td>
<td>3 Jan 1807</td>
<td>31 Jan 1807</td>
<td>28 Feb 1807</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Av. hands twist/lb</td>
<td>28.02</td>
<td>29.86</td>
<td>30.59</td>
<td>30.74</td>
<td>30.64</td>
<td>28.29</td>
<td>28.7</td>
<td>28.4</td>
<td>30.67</td>
<td>38.42</td>
<td>38.87</td>
<td>38.21</td>
<td>38.12</td>
<td>37.83</td>
<td>37.67</td>
<td>37.36</td>
<td>37.41</td>
<td>37.29</td>
<td>36.1</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Hands/spindle/day</td>
<td>2.72</td>
<td>2.64</td>
<td>2.64</td>
<td>2.43</td>
<td>2.55</td>
<td>2.58</td>
<td>2.77</td>
<td>2.65</td>
<td>2.18</td>
<td>2.06</td>
<td>2.38</td>
<td>2.61</td>
<td>2.62</td>
<td>2.63</td>
<td>2.77</td>
<td>2.25</td>
<td>2.27</td>
<td>2.45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost/lb cotton purchased</td>
<td>0.25</td>
<td>0.26</td>
<td>0.27</td>
<td>0.26</td>
<td>0.26</td>
<td>0.25</td>
<td>0.26</td>
<td>0.25</td>
<td>0.26</td>
<td>0.24</td>
<td>0.26</td>
<td>0.24</td>
<td>0.26</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price/lb Cotton Sold</td>
<td>3.01</td>
<td>3.01</td>
<td>3.01</td>
<td>3.01</td>
<td>3.01</td>
<td>3.01</td>
<td>3.01</td>
<td>3.01</td>
<td>3.01</td>
<td>3.01</td>
<td>3.01</td>
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<td>3.01</td>
<td>3.01</td>
<td>3.01</td>
<td>3.01</td>
<td>3.01</td>
<td>3.01</td>
<td>3.01</td>
<td>3.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prod. - Hanks</td>
<td>662186</td>
<td>612519</td>
<td>699920</td>
<td>699720</td>
<td>927902</td>
<td>898420</td>
<td>906986</td>
<td>588766</td>
<td>572303</td>
<td>627029</td>
<td>671506</td>
<td>643312</td>
<td>570680</td>
<td>627029</td>
<td>694209</td>
<td>654729</td>
<td>602502</td>
<td>635757</td>
<td>612098</td>
<td>591996</td>
<td>568218</td>
<td></td>
</tr>
<tr>
<td>Prod. - lbs</td>
<td>20841</td>
<td>20541</td>
<td>19772</td>
<td>19837</td>
<td>20915</td>
<td>22613</td>
<td>22300</td>
<td>20796</td>
<td>16214</td>
<td>15257</td>
<td>17274</td>
<td>16636</td>
<td>12850</td>
<td>16392</td>
<td>16600</td>
<td>15976</td>
<td>16840</td>
<td>16253</td>
<td>15953</td>
<td>14740</td>
<td>15736</td>
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</tr>
<tr>
<td>Wares - total</td>
<td>644</td>
<td>583</td>
<td>587</td>
<td>614</td>
<td>609</td>
<td>588</td>
<td>604</td>
<td>597</td>
<td>590</td>
<td>589</td>
<td>584</td>
<td>586</td>
<td>561</td>
<td>552</td>
<td>577</td>
<td>595</td>
<td>629</td>
<td>609</td>
<td>586</td>
<td>594</td>
<td>583</td>
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<tr>
<td>Stock Twist lb</td>
<td>23635</td>
<td>38647</td>
<td>48607</td>
<td>35677</td>
<td>15907</td>
<td>29079</td>
<td>24293</td>
<td>30250</td>
<td>16830</td>
<td>18909</td>
<td>15830</td>
<td>15350</td>
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<td>1350</td>
<td>8236</td>
<td>7849</td>
<td>1400</td>
<td>1859</td>
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<tr>
<td>Cotton lb</td>
<td>56828</td>
<td>38972</td>
<td>43798</td>
<td>32613</td>
<td>101603</td>
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<td>19071</td>
<td>9018</td>
<td>17742</td>
<td>1847</td>
<td>29991</td>
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<tr>
<td>Sales f</td>
<td>3731</td>
<td>3045</td>
<td>3684</td>
<td>3754</td>
<td>4669</td>
<td>3744</td>
<td>2677</td>
<td>1739</td>
<td>4705</td>
<td>4277</td>
<td>2916</td>
<td>4040</td>
<td>3841</td>
<td>2675</td>
<td>3858</td>
<td>3799</td>
<td>3218</td>
<td>1923</td>
<td>2568</td>
<td>4449</td>
<td>2997</td>
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</tr>
<tr>
<td>Sales lbs</td>
<td>56264</td>
<td>17654</td>
<td>31767</td>
<td>29955</td>
<td>24711</td>
<td>14198</td>
<td>13844</td>
<td>8246</td>
<td>22625</td>
<td>21444</td>
<td>20231</td>
<td>14492</td>
<td>19328</td>
<td>29960</td>
<td>19009</td>
<td>12515</td>
<td>9142</td>
<td>13907</td>
<td>29969</td>
<td>15182</td>
<td></td>
<td></td>
</tr>
<tr>
<td>cost/lb Spun</td>
<td>e^0.11</td>
<td>e^0.56</td>
<td>e^0.2</td>
<td>e^0.43</td>
<td>e^0.52</td>
<td>e^0.52</td>
<td>e^0.42</td>
<td>e^0.69</td>
<td>e^0.21</td>
<td>e^0.6</td>
<td>e^0.54</td>
<td>e^0.54</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost/1000 hks</td>
<td>143</td>
<td>165.2</td>
<td>174.8</td>
<td>144.3</td>
<td>140.5</td>
<td>149</td>
<td>149.9</td>
<td>1611</td>
<td>164.8</td>
<td>1811</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Compilation of Statistics and performance indicators from SO 814 Stock

**Sheets relating to Mellor Mill for the period 31 March 1804 to 28 February 1807**
We are not told of the use Oldknow made of these statistics, but they do give an insight into the operating economics of a cotton mill in the early nineteenth century. They show, for example, that the average count had increased over the period, getting as high as 38, whereas the hanks produced per spindle per day showed quite an amount of variation. These statistics provided, for Oldknow, a picture of the mill’s activity summarising on one statement key performance indicators to enable him to monitor the mill’s activities. The stock sheets were prepared consistently over a long period confirming the implication that they were important to the processes of management employed by Oldknow in keeping informed of the mill’s operations.

As the mill became established the performance indicators used became greater in number, with the later statements showing more detail than the earlier ones. The key indicators seem to have been cost per hand per week; cost per pound for spinning; and cost per thousand hanks. Material cost and sales price were also recorded. While these items were not compiled into a table as they have been here, they were reported on a four weekly basis and the sheets on which they were calculated would have been filed together so comparisons would have been easy to make.

In terms of productivity the measures of the weight of cotton produced and the number of hanks produced are complementary because the fineness of the yarn being spun would influence both the number of hanks produced and the weight of cotton processed. The degree of fineness was indicated by the average number of hanks to the pound. The table indicates a trend to an increase in fineness
with the weight of cotton processed declining as the fineness of the finished product increased.

Oldknow kept an eye on efficiency, being concerned with the output for each spindle employed as well as the labour cost of each pound of cotton spun and each hank produced. Cost indications were shown by the cost of the key inputs, monitored in terms of the cost price of raw cotton and the cost of labour in terms of the total and average wages. The marketing of the product was monitored in terms of the total sales value and quantity as well as the average unit selling price. This one document provided a summary of the period's activity in terms of production, sales and efficiency. A far more comprehensive set of measures than profitability, although this too could be readily determined from the data.

Profitability

The format of the information prepared for Oldknow shows a change and by 1812 indicated that profitability was of concern. Compared to the statement of January 1797 a similar account in 1812 shows a better result in terms of expected profit. This document forms part of a series of monthly reports in a standard format dating from 1811 and concerned with the output of the mill at Mellor. An example from the series shows:
### Monthly Acct of Mellor Mill from the 25th January to the 21st February 1812 Both days included

**Dr**

<table>
<thead>
<tr>
<th>Description</th>
<th>lbs</th>
<th>s</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton to the Machines</td>
<td>22729</td>
<td>1633</td>
<td>12</td>
</tr>
<tr>
<td>Pickers Wages</td>
<td></td>
<td>26</td>
<td>19</td>
</tr>
<tr>
<td>18702 lbs Yarn Spun, Contingent expenses at 13ₜₜₜₜ intellectually</td>
<td>1056</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>Balance or apparent Gain</td>
<td>214</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£ 2931</strong></td>
<td><strong>8</strong></td>
<td><strong>9</strong></td>
</tr>
</tbody>
</table>

**Cr**

<table>
<thead>
<tr>
<th>Description</th>
<th>lbs</th>
<th>s</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanks</td>
<td>669559</td>
<td>4562</td>
<td>5</td>
</tr>
<tr>
<td>18702 -Twist No 35,8 48/ₜₜₜₜₜ intellectually</td>
<td>1710</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£ 2851</strong></td>
<td><strong>5</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>£</th>
<th>s</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>681 12 Spiners Waste at 12ₜₜₜₜ intellectually</td>
<td>34</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>190 Pickers ---- at 6ₜₜₜₜ intellectually</td>
<td>4</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>488 6 Dust from Machines at 3ₜₜₜₜ intellectually</td>
<td>6</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>459 0 Rows at 7ₜₜₜₜ intellectually</td>
<td>13</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>800 Fly at 6ₜₜₜₜ intellectually</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 1 Cleaners Waste at 4ₜₜₜₜ intellectually</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19 15 Hand Threads at 1ₜₜₜₜ intellectually</td>
<td>1</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>169 Third Fly at 1ₜₜₜₜ intellectually</td>
<td>14</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>274 Floor Waste at ½ₜₜₜₜ intellectually</td>
<td>11</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>88 12 Sheer Dirt - no value</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£ 2931</strong></td>
<td><strong>8</strong></td>
<td><strong>9</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>£</th>
<th>s</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>21902 14 Appears Short</td>
<td>2851</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>826 2</td>
<td>--</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| lbs                                | 22729 |    |    |

The contingent expenses are Hands in the Mill 6,56
Wear & tear, Interest of Money &c 7

**Total**

<table>
<thead>
<tr>
<th></th>
<th>£</th>
<th>s</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td><strong>£ 0 1 1,56</strong></td>
<td><strong>0 15</strong></td>
<td><strong>3,46</strong></td>
</tr>
</tbody>
</table>

Average Price £ Th. Thousand Hanks

---
From the 25th January 1812 to the 21st Feby Inclusive

<table>
<thead>
<tr>
<th>Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton to the Machines</td>
<td>6052</td>
</tr>
<tr>
<td>taken out of the Bag</td>
<td>5540</td>
</tr>
<tr>
<td></td>
<td>5963</td>
</tr>
<tr>
<td></td>
<td>5174</td>
</tr>
<tr>
<td></td>
<td>------</td>
</tr>
<tr>
<td></td>
<td>22729 lbs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>lbs</th>
<th>ozs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spinners Waste</td>
<td>681</td>
<td>12</td>
</tr>
<tr>
<td>Pickers do</td>
<td>59</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>130</td>
<td>12</td>
</tr>
<tr>
<td>Raws</td>
<td>428</td>
<td>4</td>
</tr>
<tr>
<td>Raw Pickings</td>
<td>30</td>
<td>12</td>
</tr>
<tr>
<td>Fly</td>
<td>800</td>
<td></td>
</tr>
<tr>
<td>Cleaners Waste</td>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td>Hard Threads</td>
<td>19</td>
<td>15</td>
</tr>
<tr>
<td>Third Fly</td>
<td>169</td>
<td></td>
</tr>
<tr>
<td>Floor waste</td>
<td>274</td>
<td></td>
</tr>
<tr>
<td>Sheer Dirt</td>
<td>88</td>
<td>12</td>
</tr>
</tbody>
</table>

These statements show output and anticipate the profit to be earned from the month's operations. They include all the costs of acquiring and spinning the cotton as well as a reconciliation of the quantities of material, although in the above statement there seems to be no attempt at explaining the 826 lb shortfall. This statement is another example of the concise summary Oldknow used, to keep himself informed of the operation of the mill even down to the weight of dirt collected from the cotton. Compared to the earlier statement for 1797 the wages for spinning have risen by 1 d. per pound of cotton spun but Oldknow only allows an extra $\frac{1}{2}$ d. for overhead which indicates that either costs have remained constant or he was not concerned with the recalculation of these amounts. Oldknow continued to maintain his accumulation of the key performance
indicators of average price (cost) per thousand hanks and average price (cost) per hand per week.

The above series of statements were supported by a series of papers detailing the calculations of the various amounts shown on the statement, for example, a paper dated 17 October 1812 shows the following calculations:

1. 18249 lbs of cotton were spun into 670810 hanks yielding an average count of 36.75 hanks to the pound.
2. The wages paid for the period (4 weeks) were £502-18-1 for 633 hands which amounts to a cost of 6d.61 per pound of spun cotton with an average wage per hand per week of 7/2.34.
3. Taken together the average labour cost of spinning each thousand hanks for the period was 14/11.91.

The cost of cotton was based on an average price over periods ranging from one to three months as the following list indicates:

<table>
<thead>
<tr>
<th>Average price for 3 months ending 25 Jan 1811</th>
<th>21½d</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;    &quot;    &quot; 2    &quot;    &quot;    &quot; 22 Mar 1811</td>
<td>19.81</td>
</tr>
<tr>
<td>&quot;    &quot;    &quot; 1    &quot;    &quot;    &quot; 19 Apr 1811</td>
<td>19.76</td>
</tr>
<tr>
<td>&quot;    &quot;    &quot; 2    &quot;    &quot;    &quot; 14 Jun 1811</td>
<td>18.23</td>
</tr>
<tr>
<td>&quot;    &quot;    &quot; 1    &quot;    &quot;    &quot; 12 Jul 1811</td>
<td>17.75</td>
</tr>
<tr>
<td>&quot;    &quot;    &quot; 1    &quot;    &quot;    &quot; 9 Aug 1811</td>
<td>16.76</td>
</tr>
<tr>
<td>&quot;    &quot;    &quot; 1    &quot;    &quot;    &quot; 6 Sep 1811</td>
<td>15.23</td>
</tr>
<tr>
<td>&quot;    &quot;    &quot; 1    &quot;    &quot;    &quot; 4 Oct 1811</td>
<td>14.64</td>
</tr>
<tr>
<td>&quot;    &quot;    &quot; 1    &quot;    &quot;    &quot; 1 Nov 1811</td>
<td>14.53</td>
</tr>
<tr>
<td>&quot;    &quot;    &quot; 3    &quot;    &quot;    &quot; 24 Jan 1811</td>
<td>15.65</td>
</tr>
<tr>
<td>&quot;    &quot;    &quot; 1    &quot;    &quot;    &quot; 21 Feb 1811</td>
<td>17.25</td>
</tr>
<tr>
<td>&quot;    &quot;    &quot; 1    &quot;    &quot;    &quot; 20 Mar 1812</td>
<td>17.26</td>
</tr>
<tr>
<td>&quot;    &quot;    &quot; 2    &quot;    &quot;    &quot; 15 May 1812</td>
<td>17.66</td>
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[SO 824/44-47]
Compared to the earlier prices for cotton (see table) the above prices indicate a general decline in the price for raw product. Statements such as these are a further indication of regular reports of operations. Such systematic reporting does not seem to have been the case with earlier business operations but maybe it is simply that those records have not survived. It is to be noted that the statistics collected by Oldknow focussed his attention on internal operations and not outwards to the industry, enhancing the view that they were designed to assist control rather than assuming a more strategic role.

Other Business at Mellor

Oldknow kept a constant check on the other businesses he had in operation at Mellor. Although, these businesses were subsidiary to the main operation of spinning cotton he still required monthly reports to be made to assist him in their management. The stock sheets [SO 814] referred to above contained details of the outputs and sales of his farm, garden, lime kiln and coal trade. The 'Miscellaneous Papers' [SO 826/5] contain profit and loss accounts for these activities for 1807. The account for the lime kilns conducted at Marple, next to the Peak Forest canal, is given as an example of these records.
Interest on capital was calculated at 5% on the total invested at the end of the year. Whether the accumulated loss was by design or because of circumstances is unclear, Oldknow was involved in several schemes to provide work for the husbands and fathers of his employees to keep the family in the district [Ashton, 1964; Unwin, 1924; Oldham, 1990; Mathias, 1969] and the lime kilns may have been subsidised for this purpose. Oldknow's farm, which was used to provide produce to the shop, also shows an accumulated loss but of half the magnitude of the loss on the lime kilns.

**Summary**

It is unfortunate that Oldknow's diary is not in evidence, because there is no way of knowing how he felt about the progress of his various business. We have to rely on the sparse comments of others as well as the few records that do remain. These records are sufficient to gain the impression that accounting was used extensively in Oldknow's various business undertakings.
That Oldknow's dreams outran his pocket says more about the man than his methods. Insolvent he may have been at various times, but he still managed to put into place most of the dreams he had. In his latter years these dreams encompassed experiments in agriculture and the provision of communications for his community. It must be remembered, too, that for a time Oldknow had a reputation above all others for the quality of his product.

Samuel Oldknow was an organiser. He organised hundreds of people to work to his specification, no mean feat when, in his early years, his workers were spread over a considerable area. Even in his latter years at Mellor his various enterprises employed in excess of five hundred people. The fact that he often created projects that
employed the husbands and fathers of his workers, shows his concern for the community [Ashton, 1964; Unwin, 1924; Oldham, 1990; Mathias, 1969]. Although, it must be pointed out, that the danger of having the head of the household unemployed often meant that the whole family moved on in search for work, obviously there was some self interest in these work creation schemes.

Oldknow broke new ground in his production methods, he was also among the first to set up a factory to produce cotton yarn, as well as being among the first to use steam to operate his machinery. He did not stay with steam though, turning back to water power when he established the mill at Mellor. Presumably this was because water was cheaper, yet he undertook extensive engineering works to change the course of the river Goyt so that the water would be delivered to precisely where he wanted it.

Like other manufacturers of his time, labour seemed to cause a great deal of concern. Improvements in technology meant less skilled labour could be employed. To this end Oldknow employed large numbers of women and children. At the end of the eighteenth century social concern over the employment of children was starting to be raised, yet Oldknow appears to have treated those children he employed as well as or better than other manufacturers. He also went to considerable trouble to ensure that his employees were adequately housed. The apprentices were lodged in a comfortable buildings and he built a number of houses which he let to his employees [Porter, 1982; Pollard, 1964; Unwin, 1924; Oldham, 1990]
The accounting used by Oldknow passes through a process of evolution as the nature of his businesses changed. From the regulation of goods passed out to his workers to providing information on the progress of the mill. Reports produced when the Mellor mill was firmly established indicate a concern for cost information. For the most part Oldknow was acting on his own, he did have partnerships with his brother, Ewart and Arkwright for a time but these partnerships, especially in the last two cases, did not operate for very long. So it is reasonable to assume that the accounting information produced was desired by Oldknow to help him in the process of managing his businesses. The records that do remain do not indicate any use being made of budgets or financial planning. The accounts produced were essentially historical in nature but those reports that are in existence were obviously designed to aid the management process because they were prepared on a regular basis and portrayed key information. Information that was essential for survival in the highly competitive industry that was the cotton industry. The use of performance indicators to summarise the progress of the business and statistics to assist control is evidence of the use of management accounting techniques that is consistent with the philosophy of a man concerned with rationalism and objectivity.
CHAPTER 5

James Watt Jnr

Introduction

The development of the factory system of manufacture created a demand for power to drive the machinery that was being installed. Water, wind and muscle were the traditional forms of power but they were proving to be inadequate for the demands being placed upon them. Wind power was unreliable, muscle power, especially that provided by animals was very expensive and water power was subject to very narrow geographical constraints. Steam provided a means of driving machinery that overcame the drawbacks of the more traditional power sources. Even though manufacturers, such as Samuel Oldknow eventually settled on water power, many other manufacturers did not have that option. Increasing competition for water supplies and labour, required manufacturers to site their factories close to centres of population and seek a power supply that was not dependant on the local topography. Steam filled this need and provided a source of power so versatile that it could be readily adapted to the needs of the factory.

This chapter is concerned with accounting processes that assisted in the management of the Soho Foundry, a factory built in 1795 solely to manufacture the steam engines that provided power to many of
the factories that came into being in England in the late eighteenth and early nineteenth centuries. The chapter is centred around the activities of James Watt jnr, the son of James Watt (1736-1819) the person responsible for the development of the steam engine. James Watt jnr was central to the management of the Soho Foundry and very much involved in its accounting processes.

James Watt jnr was not an innovator in the same way that his father was, but he was able, with the help of his partners, to take his father's innovations and develop a highly profitable enterprise of world renown. To the legacy of his father he added his own special qualities, developing systems and procedures that stood the test of time [Roll, 1930; Robinson, 1954; Gale, 1962]. He applied his engineer's skills to developing solutions to problems of administration and he drew on the information provided by the accounting system to assist in this process.

While there is an extensive literature concerning James Watt snr, there is little, apart from brief, references concerning his son. However, the activities of Watt jnr and the Soho Foundry are starting to attract the interest of researchers [Fleischman, 1993]. The records remaining of matters related to Boulton and Watt are very extensive and are housed in the Birmingham Central Library. These records are very well preserved and include Watt jnr's diaries, letters and other documents as well as a number of accounting records relating to the Foundry.
James Watt jnr was more fortunate than the majority of the manufacturers of his time because he had the advantage of his father's experience as well as a workable and developed product. This did not free him from the day to day problems of managing a large, innovative organisation and dealing with increasing competition, nevertheless he did have the benefit of being a second generation manufacturer. In his approach to management James Watt jnr was a product of the times he lived in, not confined by the constraints of the past and looking forward to a 'rational' future, an attitude that directed his thoughts along paths that were not traditional.
James Watt jnr's Early Life

James Watt senior was not only interested in the problems of engineering, he also had an abiding interest in education. This may be seen in the great care he expended in organising the education of his eldest son, James junior. Each step of young James' education was carefully considered and planned [Robinson, 1954].

James Watt jnr, born in 1769, was destined to be an engineer from the outset. His training, closely supervised by his father, was directed towards the achievement of that role [Robinson, 1954]. However, father James evidently thought some modification was necessary when he wrote to his son on 17 July 1785:

You know my intention has hitherto been to breed you to the business of an Engineer if you should prove fit for it...I have however observed that you do not possess that Ingenuity and attention to mechanical pursuits that I did at your time of life...I therefore wish your Education to be such as may qualify you for a manufacturer as well as an Engineer...

[quoted in Robinson, 1954, p 305]

This change set James junior on a path that was to lead to him ranking amongst the foremost manufacturers of his day.

Such an intense and practical education, as did James jnr receive, well fitted him for the role he was to assume in the building up of the business passed on to him and Matthew Robinson Boulton¹ by their fathers. Although perhaps not displaying the attributes of his father in relation to mechanical pursuits, Watt jnr certainly displayed

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¹ Matthew Robinson Boulton (1770-1842) was the son of Matthew Boulton.
considerable ingenuity in the establishment and the management of the manufacture of steam engines after 1795 at the Soho Foundry [Roll, 1930]. His knowledge of the manufacture of steam engines as well as the experiments he carried out later with steam driven boats indicate that he was an able engineer [B&W Collection].

**Some Early Influences on the Life of James Watt jnr**

Young James was subject to the influence of great men and great ideas almost from the moment he first drew breath. His father was a member of the Lunar Society of Birmingham an informal group which represented the forces of change in late eighteenth century England, as described in Chapter Three. The interests of the members of the group were wide ranging, covering most aspects of scientific endeavour. The group did not exist in isolation but reached out to like minded men and was involved in a network of connections to people of similar scientific and technological leanings. The activities of these people indicates a conscious attempt on their part to shape their world and a deliberate attempt to solve the problems of an industrialising England [Schofield, 1963]. As he grew older Watt jnr was closely involved with many of the Lunar Society members and it is reasonable to assume that these older men, leaders in their field, imbued him with their ideas and attitudes to the world and their place in it.
Education

James Watt jnr's formal education began at a small school run by the Rev. Henry Pickering at Winson Green, near Birmingham and reasonably close to the Soho Manufactory where the business was carried on at that time [Robinson, 1954]. At this school he learnt the basics of writing, arithmetic and Latin. His practical education began in earnest in 1784, when, at the age of fifteen he was sent to John Wilkinson's ironworks at Bersham, in Wales [Robinson, 1954; Fleischman, 1993]. John Wilkinson had a close relationship with the elder Watt at this time and was responsible for the casting and boring of engine cylinders as well as making other parts for the engines that Boulton and Watt were erecting.

At Bersham the plan was for young James to work three hours a day in the carpenter's shop as well as studying, machine drawing, practical book-keeping, geometry and algebra [Robinson, 1954]. James spent a year at Bersham and in that time his father bombarded him with advice and questions as well as continually correcting his style of correspondence. In a letter written on 1 August 1784 his father encouraged him to study merchant's accounts in the afternoon along with arithmetic and algebra [Musson & Robinson, 1969, p 204]. James Watt sen, was particularly watchful of his son's study of mathematics, especially the solution of

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2 Wilkinson supplied cylinders for Newcomen engines as well as Watt engines [Harris, 1967].
mechanical correspondence and sent him problems to be solved [Musson & Robinson, 1969].

Watt snr considered sending his son to university, but on reflection decided to continue his education by sending young James abroad instead. The emphasis still was on an education which would equip the boy in a practical way for the role which his father had mapped out for him [Musson & Robinson, 1969; Robinson, 1954].

The first stage of his European education was to go to Geneva, where under the supervision of J. A. de Luc, a scientist, he attended lectures in natural philosophy. At his residence in Geneva James jnr was required to study geometry and algebra under the guidance of a M. Duvillard [Robinson, 1954]. James Watt snr emphasised this course of study in a letter of 13 March 1785 when he wrote that the "parts of mathematicks that are most essential are Geometry comprehending Conic sections and the doctrine of curves, and Algebra with the whole science of calculation and the application of it to Geometry" [quoted in Musson & Robinson, 1969, p 205].

James Watt snr further stressed the direction of his son's education to equip him for a career as a manufacturer as well as an engineer when he concluded in his letter of 17 July 1785, mentioned above, "I therefore wish your Education to be such as may qualify you for a manufacturer as well as an Engineer so that your dependence may be on yourself and not on the caprices of Judges & Juries in the case of any reverse of fortune" [quoted in Musson & Robinson, 1969, p 207]. This statement was motivated in part by the litigation Watt snr
was involved in at the time over his engine patent³ [Musson & Robinson, 1969; Rolt, 1962].

In August 1785, the young Watt was sent to Herr Reinhard in Saxony primarily to learn German, he was also to concentrate on his mathematical studies as well as merchant's accounts, drawing and dancing [Musson & Robinson, 1969]. All the time the father stressed orderliness of correspondence and note-taking, as he pointed out in a letter dated 13 March 1785 when he wrote:

... let your memorandums be made in clear and orderly method so that by an index you may easily refer to them, and keep your letters, and other loose papers, regularly folded up and docketed.

[quoted in Musson & Robinson, 1969, p 207]

That young James heeded his father's advice is very much in evidence to-day as his letters and other papers have been very carefully, and methodically indexed and preserved.

James Watt jnr, returned to England in 1788, and Matthew Boulton found a place for him in the counting house of Taylor & Maxwell⁴,

³ Boulton and Watt were involved in continual litigation and threatened litigation over infringements of their engine patent. The reason for this was that the terms of the patent were very wide and precluded further development of the steam engine by other engineers. Boulton and Watt were involved in a continual search for what they regarded as 'pirate' engines and when one was found they demanded royalties from its owner, if these were not forthcoming court action was threatened [Rolt, 1962; Tann, 1980].
fustian makers, printers and dyers of Manchester [Dickenson, 1935; Rolt, 1962]. He was apprenticed for three years at a cost of £420 with his father paying his living expenses. In return Taylor and Maxwell agreed to teach young James the "knowledge, art and practice" of their business "to the best of their skill and judgement" [B&W MII/5/14].

The time spent in Manchester was to be of great influence in the life of young Watt.

James Watt jnr in Manchester

In 1788 the city of Manchester was a centre of cotton manufacturing, the boom industry of the last part of the eighteenth century. It was in this city at the impressionable age of nineteen that James Watt jnr was to meet a number of people who were to have a significant influence on his life. From the very beginning ...

(t)he introduction to this firm [Taylor & Maxwell] in 1788 seems to have been made in the first place by Thomas

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4 The entry in Lewis’s Manchester Directory for 1788 reads "Taylor and Maxwell, fustian manufacturers, printers & dyers, Brown street and Cheetwood”. Charles Taylor was a member of the Manchester Literary and Philosophical Society as well as Secretary to the Society for the Encouragement of Arts. Taylor was a pioneer "in the application of scientific methods to dyeing and calico-printing" [Musson & Robinson, p 289, 1969].
Henry\(^5\) [a chemist], who had been corresponding with Watt [senior] about bleaching. In a short while young Watt struck up friendships with Thomas Henry's sons, with Joseph Priestley junior, who was also working in Manchester, with John Ferriar\(^6\), an assistant of Thomas Percival, with Thomas Cooper\(^7\), the bleacher, and with the merchants, Thomas and Richard Walker. By November, 1788 he was attending meetings of the Literary and Philosophical Society...

[Musson & Robinson, 1969, p 96]

The three years in Manchester allowed young Watt to make a wide circle of acquaintances who were all involved in the great expansion of industry that was taking place. These men were involved in the Manchester Literary and Philosophical Society and interestingly too most were involved in the Cross Street Chapel, in Manchester, as discussed in Chapter Three.

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5 Thomas Henry (1734-1816) was trained as an apothecary, he had a keen interest in experimental science and was interested in extending the boundaries of chemical knowledge. In 1771 he patented a method of preparing magnesia, in 1775 he was elected a Fellow of the Royal Society. He lectured on bleaching, dyeing and calico printing to students at the Manchester College of the Arts, he was also a trustee of the Cross Street Chapel [Brindley, 1961; Baker, 1884].

6 John Ferriar was a physician and resided at St James's Square, Manchester [Lewis's Manchester Directory], he was also co-secretary with James Watt jnr of the Manchester Literary and Philosophical Society in 1789 and 1790 [Faraday, 1890].

7 Thomas Cooper (1758-1839) had a law degree from Oxford, he also studied medicine and natural philosophy, he had an interest in chemistry, especially the bleaching process. He was a Unitarian and eventually fled to the United States with Priestley in 1793 [Musson & Robinson, 1969; The Reasoner, 1851].
Cross Street Chapel, a Unitarian congregation, had considerable influence in the intellectual life of the city at that time. Thomas Henry was a trustee, as was Thomas Percival [Baker, 1884]; John Ferriar and Thomas Cooper were members. The Unitarian influence on Watt jnr extends further because Joseph Priestly junior's father was Dr Joseph Priestley the scientist and Unitarian minister as has been mentioned in Chapter Three. McLachlan [1939] suggests that there were two factors which contributed to the formation and direction of the activities of Cross Street men in the life of Manchester. The first came from the pulpit which emphasised the influence of external circumstances on the mind and in turn inspired a doctrine of works, finding expression in a zeal for social and political reform, in scientific experiment as well as in education at all levels, and in a stern sometimes severe morality. The other arose from the great length of time single ministers were in office. It was amongst these men that Watt jnr came to live.

Watt was able to exercise his foreign connections for the benefit of his friends. He introduced foreign scientists to the Society, and was able to introduce foreign publications to his friends, he was also commissioned on occasion to purchase foreign books for his friends like George Lee⁸, a cotton manufacturer and Peter Ewart⁹ [Musson &

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⁸ George A. Lee (1761-1826) was a cotton spinner in Manchester in the partnership of Phillips and Lee. Robert Owen (1857, p 281) described Lee as "one of the most scientific men of his day".
Robinson, 1969]. Watt was elected joint secretary of the Manchester Literary and Philosophical Society in 1789 [Musson & Robinson, 1969].

In 1792, James Watt jnr left Manchester in the company of Thomas Cooper and went to France with the intention of discovering the secret of making chlorine from common salt [Faraday, 1890] a process of vital interest to the cotton industry. This journey to France was to result in very significant consequences for Watt.

James Watt jnr in France

Watt jnr along with Cooper was a member of the Constitutional Society of Manchester, and because they were in Paris they were deputed to present an address to the French Société des Amis de la Constitution on behalf of the Society. This they did on the 13th April 1792 [The Reasoner, 1851; Dickenson, 1935]. James jnr described this event in a letter to his father dated 22 April 1792:

Mr Cooper and I have presented an address to the Club des Jacobins on the part of the Constitutional Society of Manchester soliciting a correspondence with them. It was received with much applause...

[B&W 542]

9 See Chapter Four. Ewart was elected a member of the Manchester Literary and Philosophical Society in 1798 and was one of its vice-presidents from 1812 to 1835 [Musson & Robinson, 1969, p 99].
While they received acclaim from the French their efforts were not appreciated by all of their fellow countrymen with Edmund Burke denouncing them in the House of Commons a week later [Dickenson, 1935; *The Reasoner*, 1851]. However James jnr explained their action in a letter to his father dated 5 May 1792 by writing that they

... had higher objects in view - to promote the general interests of our country to convince the French that though all governments were their enemies, all people were not; and, by laying the foundation of a general alliance amongst the patriotic societies of Europe to fix a barrier against the intrigues of Ministers & Kings, and to establish the peace and happiness of nations upon a broad and durable basis.

[B&W 542]

In his letters to his father, during this period, James jnr at first expresses enthusiasm for the new French Republic, he himself being dedicated to the republican cause in England at the time. In a letter to his father from Paris, dated 19 May 1792, he wrote:

...Everything here is in perfect tranquillity; the laws are executed with force and with vigor, and an absolute prudence of opinion reigns without any person being in any way molested for it. The physical and moral state of the nation is already sensibly improved, for not only the happiness of the great mass off the people is augmented, but the vice and immorality of all ranks is diminished since the absence of the emigrants and the reform of the court. Some troubles have been excited in the Southern provinces but they are the work often ci:devant nobles and often priests who are always the pests of society. If I wanted other proofs that my principles were right than those which experience and seasoning teach me. I should only have to enquire who are the men that profess similar ones? I shall find that they are those who have shown the strongest judgement in other pursuits, and they form nearly the whole of your and my philosophical acquaintance both in England and in their country, having no other interest in circulating these opinions than that of contributing to the happiness of mankind.

[B&W 542]
In August, Watt jnr was responsible for preventing a duel between Danton and Robespierre; this event was recalled by R. Southy\textsuperscript{10}, who learned of the proceedings from Watt jnr, in a letter to A. Alison in 1833, when he wrote that the two had

... quarrelled at one of the political clubs before the 10th August: high words ended in a challenge: they met, and the duel was prevented by the interference of an Englishman, who went out as a second to the one, and represented to them how injurious it would be to the cause of liberty if either of them should fall. That Englishman was the present James Watt [jnr]...

[quoted in Muirhead, 1859, p 478]

By September this mood changed to one of extreme disappointment as in a letter to his father of 4 September 1792 [B&W 542], he wrote of being "filled with involuntary horror" at the atrocities then being committed in the name of the Revolution. His disillusionment with the Revolution led to an unanticipated result when Robespierre at a meeting accused Watt and Cooper of being emissaries of Pitt, the Prime Minister of Britain. Watt in an impassioned speech attacked Robespierre and carried the Assembly with him apparently incurring further wrath because he soon learned that his life was in danger if he remained in Paris, accordingly Watt jnr fled to Italy [Muirhead, 1859; Rolt, 1962].

\textsuperscript{10} Robert Southy (1774-1843) was a poet, historian and miscellaneous author. Southy was converted to Unitarianism by Samuel Taylor Coleridge, he was also a republican and supporter of the French revolution. Later in life he turned to the established church and became a Tory [The Dictionary of National Biography].
In a letter from Italy on 22 November he wrote of being finished with politics [B&W 542]. And, on 3 December 1793 laments the passing of his friends in France, who he describes as "the friends of rational liberty", lost to the guillotine [B&W 542].

These letters from his period in France illustrate the philosophy of James jnr, he was a rationalist, very much part of the Age of Enlightenment when men felt that they had the ability to make the world a better place for all who live in it. He saw the French Revolution removing the old order and establishing a new society very much along the lines of his own philosophy. His letters illustrate his great disappointment that this first attempt to create a society established on rational lines ended in the 'Reign of Terror'.

This appears to have been the only venture into public affairs made by James jnr, because on his return to England he devoted himself to business. Indeed, in a notebook relating to the period when he was in Italy, he remarked that he intended to have nothing to do with politics ever again [B&W M II/6]. His friend, Thomas Cooper eventually fled to America, and James did not return to England until 1794, the British government having been induced to relent and allow him home [Rolt, 1962; Dickenson, 1935].

Home in England

After his adventures in Europe Watt jnr was content to settle to a life as a manufacturer in England. His education had made him well
acquainted with all branches of mathematics, with book-keeping and commercial practice as well as with the state of natural philosophy or science. Describing himself, in his letters, as a rationalist he was very much concerned with finding solutions to the problems which confronted him and the society in which he lived. Coupled with this he had also practical experiences. Both he and Matthew Boulton's son were required, by their fathers, to take a bag of tools wherever they went [Musson & Robinson, 1969; Dickenson, 1935]. He was not adverse to experiment and trial to discover practical answers to practical problems whether they be of a scientific, engineering or commercial nature. His education was primarily as an engineer, with some knowledge of the liberal arts, however his more liberal thoughts and tastes were severely repressed by his father [Musson & Robinson, 1969]. At a time when formal education was concerned mainly with preparation for the Church and the Law, the education designed for James Watt jnr fitted him well for his future role as a manufacturer an advantage not enjoyed by most of the manufacturers of this period. A vitally significant influence on the life of James and indeed Matthew Boulton jnr

... came from the great men with whom they were in constant touch at home and abroad, and as a consequence of that education their outlook was European and not insular. It is hardly surprising that they expanded their fathers' business beyond recognition, and became large-scale manufacturers of the sort that became the pattern of the Industrial Revolution.

[Musson & Robinson, 1969, p. 215]
Watt's Introduction to Business

The education of Matthew Boulton's son and James Watt's son followed a somewhat similar course and they both arrived at 1794 trained, ready for business. Their fathers had decided that they would take them into partnership but first they were to try their wings by taking over, from the older men, the copying-press business and operating it on their own account [Dickenson, 1935; 1936]

James Watt sen, had designed a copying press for copying letters, which he patented in 1780\(^1\). There was a big demand for such a device because letters had to be copied by hand and Watt's invention saved much laborious work. To meet this demand the partnership of James Watt & Co, consisting of James Watt snr, Matthew Boulton and James Keir\(^2\), was formed to manufacture the device along with

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\(^1\) The principle of Watt's invention was to press a sheet of damp, unsized, transparent paper against the original document thus taking a reverse impression of the writing on the document. The copy, often referred to as the 'press copy', was read through the copy paper. Watt's invention was used for more than a century until it was replaced by typewriters and carbon paper [Rolt, 1962; Roll, 1930].

\(^2\) James Keir (1735-1820) was a chemist and a member of the Lunar Society. He was a friend of Matthew Boulton and James Watt sen and managed the Soho Manufactory for a time between 1777 and 1781. Keir developed the first successful process for making synthetic alkali. He welcomed the French Revolution as the "sole triumph of reason, having been the effect of the gradual illumination of the human mind over a whole nation, by philosophy, showing that
its special ink [Rolt, 1962]. As the patent for this invention was due to expire in 1794, young Watt and Boulton took over the manufacture of this device with great enthusiasm. James even designed a self-contained portable press, fitted to hold all the necessary materials for copying and opening out to form a writing desk [Dickenson, 1936]. This business was an introduction for the young men to the tasks they were about to encounter.

The copying business continued for a number of years because the copying machines filled a need, that of being able to produce copies of the many items of correspondence and other documents being produced in the world of commerce. Accounting played an important part in the management of the business, as indicated in a letter by James Watt jnr to Matthew Robinson Boulton dated 8 June 1795 where he wrote, discussing the profit earned:

> Foreman [the bookkeeper] has now struck a balance in our books for the last twelvemonth, from which it appears valuing our stock at prime cost, that we have gained (all deductions made) the immense sum of Three Hundred & Thirty Six Pounds, Six Shillings and Seven Pence, being our Profit upon the Sale of Sixty Three Iron & 19 Brass Machines [there was a choice of roller construction]; and also upon 101 Reams of folio paper, 16 of Quarto, 2 of Foolscap & 153 Dozen of Ink Powders. As far as I have examined the Accts I have little doubt of this being a fair statement & indeed it corresponds pretty nearly with our calculation of profits upon the machines. [emphasis added]

[MBP 353/47]

the true end of government is the happiness of the many' [quoted in Smith & Moilliet, 1976, p 149].
All stock, at the time, was valued at prime cost because of an inability to allocate indirect cost to products. The letter indicates a concern and oversight of accounting matters, Watt jnr, on a number of occasions, recalculated the accounts to check their accuracy.

In all his business affairs James Watt jnr gives the impression of competency and considerable understanding of all aspects of the particular businesses in which he was involved, so the following letter comes as something of a shock. However, it should be remembered that the copying machine business was only a very small part of his diverse business interests and that the clerical work was carried out by people who were often inadequately trained yet trusted and relied upon.

Mr A Weston
London

Dear Sir

Within these few days we have made the unpleasant discovery that one of the Clerks employed by the Copying Company (which now consists of Robinson Boulton & myself under the firm of James Watt & Co) has for some time past been carrying on a systematic plan for defrauding us. This person was employed by us to superintend the Manufactory of the Copying Machines, to keep an account of the mens time, to pay their wages, and occasionally to purchase such small materials as was got from Birmingham and to settle accounts and procure payments there. At the end of every week he delivers to the head clerk or bookkeeper of this department an [account] of all the materials he has paid for during the week, as well as of the mens time and wages and sums to be advanced to them on piecework; the amount of which he then receives in Cash, and is supposed to apply to the payment of the men and the reimbursement of his own advances. The small extent of the concern of James Watt & Co probably

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13 A. Weston was the firm's solicitor.
induced the old Gentlemen in the original establishment of this business to overlook the salutary checks which had been adopted in all their other establishments, of letting the mens notes be made out by a different person from the one that pays them thus rendering it nearly impossible to commit a fraud without three persons being privy to it. The policy on that regulation is now apparent from the abuse which this man has made of the trust reposed upon him. There is every reason to suppose that he has for some time made a practice of charging us with materials which have never been purchased and wages which have neither been earned nor paid and this probably may have been carried on for some time and to no trifling extent.

For two or three years back we have noticed at the annual settlement of the books, a diminution of the profits, which was only partly accounted for by a diminution of the Sales; and having considerable confidence in this man who was brought up under Mr Boulton from his infancy and is nearly related to me of his partner, at whose instigation he was taken into the employ of James Watt & Co we have rather led to the conclusion that the Estimate upon which the selling prices were formulated had been affected by recent alterations in the construction of the Machines and the increased cost of materials & labour [obscured] that any fraud had taken place. And the accounts were undergoing an investigation for the purpose of ascertaining this when other circumstances led to this discovery.

We conceive we shall be able to establish the proof fully, and the Culprit is yet unapprized of the detection of his guilt. Before we adopt any measures whatsoever, we wish to learn from you the law of the case and the mode of legal proceeding. The Man has pecuniary expectations from his relations, and it may be proper to consider whether an action for debt or damages can be sustained, particularly if the punishment the law inflicts upon his offence is trifling - your reply by return of post will much oblige.

Dr Sir

Yours truly
J Watt Junr

The situation was resolved by the man's relatives providing a mortgage and a Bill to cover the amount owing.
The revelation of the lack of internal control is a rather surprising situation given Watt's experience at this stage of his career, however, the letter does provide an explanation for the lack in this instance. The numbers of people employed were never so high that each employee was not known personally to the partners and they did not employ those who they felt they could not trust. That this trust was often misplaced was indicated by this situation and other situations at the Foundry, where according to John Bennett, a clerk at the Foundry convicted of embezzlement in 1827, such behaviour had been common among some of the workers for a number of years [B&W 37/13]. The use of accounting in this and other enterprises does not appear to have been directed at the control of people but more at the defining of and summation of the business. Watt and his partners had many and diverse interests and accountancy was one tool for keeping track of these business affairs.

This introduction to the life of a manufacturer was excellent training for young Watt and Boulton in their next venture, that of managing the manufacture of steam engines.

**The Steam Engine Business**

The original partnership of Boulton and Watt, formed in 1775 was established to act as consulting engineers in the erection of steam engines [Tann, 1981; Dickenson, 1935; Law, 1990; Roll, 1930]. As has been pointed out in Chapter Two, the engine developed by Watt was more efficient and economical than the other engines then
available. As most of the engine parts were made by subcontractors, Boulton and Watt selected appropriate specialists for particular pieces, and because of a concern for the firm's reputation these subcontractors were selected more on the basis of the quality of their work than cost [Tann, 1981]. However as time went by, in order to maintain the high quality of the product, more and more parts were made in Boulton's Soho Manufactory, until by the early 1790's over 50% of the value of the engines was made by the partners [Tann, 1981]. The nature of the business was changing as well, with customers being more interested in purchasing a complete engine rather than being bothered with the close involvement in its construction that had been necessary to this point [Dickenson, 1936]. Other incentives that inclined the partners towards manufacture in their own right included the attraction of a greater share of the profits, hitherto being taken by the sub-contractors. There were problems too with quality control and lack of standardisation, together with the difficulties in coordinating the sub-contractors [Tann, 1981]. Sub-contracting did have some benefits though. The major one being that all the engines were custom built and the sub-contractors bore a large part of the risk.

By late 1794 Boulton and Watt had come to the view that they would have to manufacture complete steam engines and not depend on subcontractors. In October a new partnership under the name of Boulton, Watt & Sons was formed [Dickenson, 1935; Tann, 1981; Roll, 1930]. The partners were Matthew Boulton and his son Matthew Robinson Boulton, James Watt and his sons James Watt
jnr and Gregory Watt\textsuperscript{14}. The purpose of the new partnership was the manufacture of steam engines, thus completing Boulton's promise of 1769 to build a factory for this purpose [Dickenson, 1935; Tann, 1978]. Roll [1930] suggests four reasons for the establishment of the factory, to be known as the Soho Foundry, in 1795:

1. The steam engine patent as extended by the Act of 1775 was due to expire in 1800 and the mounting incidences of piracy of their engine design indicated that there would be intense competition after the monopoly was removed. This impending competition meant that the firm would have to concentrate on efficient methods of production and competitiveness.

2. Success had ensured an adequate supply of capital to finance a new production facility. There was also available a pool of workmen skilled in the production of the various parts of steam engines.

3. Matthew Boulton was 66 years old and James Watt was 58 and both, wishing to pursue other interests, were ready to hand over to their sons.

\textsuperscript{14} Gregory Watt (1777-1804) was a half-brother to James jnr. Always suffering poor health, he died of consumption at the age of 27 [Rolt, 1962].
4. Perhaps the most immediate reason was the disagreement between John Wilkinson and his brother William\textsuperscript{15} resulting in a court order to close the Bersham Ironworks. This meant that the greater supply of castings and especially cylinders would cease. Other foundries\textsuperscript{16} could not match the quality of Wilkinson's work.

There was no formal legal agreement for the establishment of the 1794 partnership so it is not possible to determine how it was intended to operate [Gale, 1962]. It is obvious from the way that the business was conducted that the sons were to be given freedom in their management of this new direction. The elder Watt was not involved apart from advancing finance to buy land and giving advice, he being more concerned with his scientific pursuits [Dickenson, 1935]. Once the new partnership had been formed the first step of note

... was to decide on the building of a completely new works solely for the manufacture of engines and, having decided, to set about the task with a speed and energy which was entirely characteristic of the younger partners. It was a most important decision. Engines had, of course, been built for years, both by Boulton and Watt and latterly by numerous others, but nobody had, so far, put down a factory designed, built and equipped with that one end in view. Here, then, was a new

\textsuperscript{15} Matthew Robinson Boulton married William Wilkinson's daughter. William Wilkinson gave advice on the setting up of Soho Foundry [Roll, 1930; Rolt, 1962; Gale, 1962].

\textsuperscript{16} Cylinders cast and bored by the Coalbrookedale Company were reasonably satisfactory but they were unable to meet the demand and cylinders produced elsewhere were unsatisfactory [Rolt, 1962].
conception. It could reasonably be called the world's first purely engineering works.

[Gale, 1962, p. 76]

Soho Foundry

The name given to the new works was the Soho Foundry and it was intended from the outset to be run as a separate business by Matthew Robinson Boulton, James Watt jnr, and Gregory Watt. The opening of the foundry meant that they would be complete engine manufacturers. Construction began in 1795 and was complete in 1796 [Gale, 1962; Roll, 1930; Tann, 1981; Dickenson, 1935].

The Foundry was sited on 18½ acres in Smethwick, next to the Birmingham and Wolverhampton Canal. The layout of the works received close attention being designed to take advantage of the natural fall in the land. Following the advice of experienced engineers such as Peter Ewart and William Wilkinson the buildings were "extensive and included a foundry with air furnace and core-drying kiln, forging shop, smith's shop, boring mill, turning shop,
fitting shop and carpenter's shop" [Rolt, 1962, p 119]. This establishment was important because it was the first facility ever built for the purpose of building steam engines and offered greater efficiency of production over other manufactories that had been adapted for the purpose. The Soho Foundry was a product of remarkable skill and foresight [Gale, 1962].

![Sketch of the Soho Foundry from South East in 1797 by William Creighton](Original in Museum of Transport, Glasgow)

The buildings were designed to take account of the natural fall in the land which assisted in the removal of the cylinders from the casting pit down a slope to the boring mill "(h)ere was a natural flow-line process, with no unnecessary material movement, in 1795!" [Gale, 1962, p 79]. Similar attention was paid to the siting of the other items of equipment and ancillary buildings, with the aim of achieving efficient production.

The foresight and planning that had gone into the building of the Soho Foundry is evident from a description of the Foundry by Shaw in his *History of Staffordshire* (1798-1801) who observed that

... Messers. Boulton & Watt found it necessary to erect and establish an iron foundery for that purpose [manufacture of steam engines] and they have accordingly in partnership with their sons (to whose activity, genius, and judgement it must be attributed,
that this great work was begun and finished in the course of three winter months) erected at a convenient place and contiguous to the same stream at Smethwick a great and complete manufactory and foundery into which a branch from the Birmingham Canal enters and thereby the coals, pig iron, bricks, sand, &c. are brought and their engines or other heavy goods are transported to every part of the kingdom, their being a wet dock within their walls for four boats to lie.

[quoted in Roll, 1930, p 161]

The Soho Foundry was opened in January 1796, an occasion celebrated by a luncheon for 200 guests [Roll, 1930; Rolt, 1962]. Many former Bersham employees were engaged to work in the new factory including Abraham Storey who was appointed the foundry foreman [Dickenson, 1935; Rolt, 1962]. The new factory did not manufacture all of the engines that the firm sold as the records indicate that Boulton's Soho Manufactory continued to assemble engines and make parts of engines for a number of years even though the Soho Foundry was manufacturing complete engines.

In its first year of operation the Soho Foundry accepted orders for 31 engines and by 1800 had produced 169 engines [Tann, 1981].

Matthew Robinson Boulton seems to have been very much involved in the initial planning for the Foundry while James Watt jnr, judging from the amount of calculations and costings in his handwriting, seems to have been more concerned with the daily organisation and running of the business [Dickenson, 1936]. In a letter to a friend on 14 April 1797, Matthew Robinson Boulton said:

You will (not be a ) little surprised to find that I am a very regular attendant in the counting house & immersed in business. Like a person hesitating on the brink of a cold bath I found that the only means of conquering my aversion was to plunge in; my experiment has so far succeeded. Mr. J.W. junr. & myself with the
occasional advice of the old gentlemen have the entire Management of the Engine business & for the last 12 mos. I have not had respite from it as you will judge from the epitome of our labours.

[Tann, 1981, p 235]

Boulton and Watt rotative beam engine built in 1797 and now in the Science Museum, London, showing the sun and planet gear arrangement.

The Organisation of the Soho Foundry

The Soho Foundry had three main operating departments. The Foundry Department was responsible for the casting of engine parts, the Smithy Department was responsible for the manufacture of parts from wrought iron and the Fitting Department was responsible for machining the parts and fitting the engine together. As mentioned above, engines continued to be built at the Manufactory, with the products of both establishments being sold by the one organisation, however, the records make a distinction between the products of each. The Soho Foundry was operated as an independent entity and was expected to make a profit; as were each of its operating departments which were treated as profit centres.
The Accounting System of the Soho Foundry

The accounting records employed in the Foundry exhibit the same attention to detail and system that is obvious throughout the whole Boulton and Watt organisation. The ledger was set up so that it reflected the work flow through the operating departments. The accounting system was designed to play a central role in keeping the partners informed of the economic progress of the enterprise because the Foundry was only one of several businesses they were interested in. On a number of occasions the partners demonstrated their awareness of accounting issues and their familiarity with the accounting process will be illustrated in the discussion that follows covering the period from the inception of Soho Foundry in 1795 to about 1804 by which time production had settled down into a routine.

The Soho Foundry was part of a wider group of businesses overseen by the Boultons and the Watts and as such it is reasonable to assume a similarity of accounting processes in each of the individual ventures. To this end it is useful to pay some consideration to the instructions given to Mr. Foreman, the accountant/book-keeper for the Engine Manufactory - an enterprise which predated the Foundry but continued to build engines alongside the Foundry. The engines produced by the Manufactory and the Foundry were for all intents and purposes identical, however it was necessary for the Manufactory to obtain some of the parts it needed elsewhere. The existing records indicate that the accounting processes followed a
similar pattern in both organisations. Extracts from these instructions show:

Memorandum for Mr Foreman Nov 5th 1799
Messrs B & W wish Mr Foreman to understand that the Books kept by him were instuted for the purpose of ascertaining the following objects -

1. The collective Profit & Loss of the Engine Manufactory in general

2. The Profit & Loss of the Different branches of the Engine Manufactory viz
   1. of the Smithy department
   2. of the Fitting department
   3. of the Brass foundry
   4. of the Pattern making
   5. of the Boiler acct
   6. of the Pneumatic acct

3. The Amount of raw Materials used
   1. viz of Wrt Iron & Steel +
   2. of Copper & Brass
   3. of Timber +
   4. of Coals +
   5. of Stores +

4. The Amount of Manufactured goods
   1. in Cast Iron
   2. Wrt Iron & Steel
   3. Copper &c

5. The Amount paid for labour
   1. wages paid to workmen in the yard
   2. do to Engine Erectors - & Contra

6. The Amount of Disbursement in Const of Manufactory
   1. Experiments
   2. Repairs
   3. Gen'1 Expences - Int of money, Rents Salaries Decrease in value of Build's & Machinery &c Salaries, Incid' Exps

   4. Carriage, freight &c

7. The amount of goods sold
   in
   1. Cast Iron
   2. Wrt Iron
   3. Copper & Brass
   4. Miscellaneous

The partners were interested in knowing the performance of each operating department, as well as the cost of their product, so the...
ledger was set up to provide this information. The instructions then proceed to detail the accounts required with the procedure to debit and credit those accounts. These rules also provide for the ascertainment of depreciation, referred to as decrease in value of buildings and machinery, which is to be debited to the various operating departments. The arrangement also requires departmental operating expenses to be determined and allocated. As well, quantities are to be recorded where appropriate. Perhaps the most interesting paragraph of these instructions is the last one, which outlines the purpose of keeping the accounts in this way and states that it

... may be proper to repeat that the more explicit & detailed the Accts are kept & the more the wishes of B & W are likely to be fulfilled, their chief aims being to have a distinct view of the total annl accts of each item of disbursement & receipt, & not simply to know the state of the concern generally, the latter point being shown already by Mt Pearson's\textsuperscript{17} books - Where therefore the articles included under one head as stores &c can be distinguished in the entries with\textsuperscript{t} [obscured] complication, it will be very desirable to have it done as B & W will be enabled to collect annually theAmt\textsuperscript{s} of any article with\textsuperscript{t} a troublesome investigation.

[B&W 285/47]

These instructions highlight the general importance placed on accounting by the Boulton & Watt organisation, a view which was held by the junior as well as the elder partners. They had an interest in detail as well as the broad overview. Documents left by Watt jnr illustrate this interest in the detail revealed by the accounts.

\textsuperscript{17} Pearson was the Cashier or accountant, who joined the Boulton & Watt in 1783 and remained with them until his death in 1817 [Roll, 1930].
The Organisation of the Accounting Records at the Soho Foundry

The list of the accounting records kept at the Foundry was extensive. The number of books kept seems high in comparison to the size of the business, but the detail recorded was probably a requirement stemming from the partners involvement in other businesses, as well as the fact that they were often away from Birmingham and had many other interests. It is reasonable to assume that the records that were kept were designed to keep them fully informed of the happenings at the Foundry. A list of the accounting records kept by the Foundry includes:

1. Rough time books and pay notes.
2. General Time Book.
4. Ledger of Personal Accounts.
5. Foundry Men's Ledger.
7. Distribution Register - to record the transfer of goods from one department to another.
8. Ledger of Materials.
10. Engine Books - the cost of each engine was recorded in this book.
11. Fitting Books - used to calculate the cost of fitting the engine.
12. Pattern Books - used to record the cost of patterns used.
15. Sales Book or Day Book.
17. Bill Book.
19. Account Book.
20. Timber Book - cost of timber used.
21. Inventory Book.
22. Cash Book.
24. Ledger.

[B&W 37/2]
The document containing the above list is not dated but from other evidence it would appear to relate to the period after 1811 and before 1816. The document has notations in Watt jnr's handwriting assigning clerks to the responsibility for the keeping of the various records. There were some eight people involved in keeping these books.

The financial year ran from the 1st October to the end of September, in line with the other enterprises of the Boulton and Watt empire.

**The Ledger**

The ledger of Soho Foundry was set up on a double entry basis with a journal for all entries. Information for the journal came from the Day Book\(^\text{18}\) and the Distribution Register. The accounts for the operating departments of the Foundry were set up as profit centres with the profit or loss for the year in these departments being transferred to the general profit and loss account. Transfers between departments took place and were recorded as such with sales being recorded as transfers to Boulton, Watt & Sons. At the end of the year the inventory was determined by inspection, and the existing inventory records indicate the detail of this procedure. There was, however, no separation of the different items of inventory and the inventory recorded for each department included tools and utilities,

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\(^{18}\) Examples of the Journal, Day Book and Ledger can be found in Appendix E, F, G, H, I.
goods and materials as well as finished goods and work in progress. All of these items were taken into account when determining the departmental profit.

The Operating Departments

As has been mentioned, the major operating departments at the Foundry were the Smithy, the Foundry and the Fitting Department. The flow of entries through these accounts was as is shown in the following diagram:

<table>
<thead>
<tr>
<th>Smithy Account</th>
<th>Outputs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs:</td>
<td></td>
</tr>
<tr>
<td>Stock (balance)</td>
<td>Foundry Account</td>
</tr>
<tr>
<td>Cash</td>
<td>Fitting Account</td>
</tr>
<tr>
<td>Stores</td>
<td>Boulton Watt &amp; Sons</td>
</tr>
<tr>
<td>Wages</td>
<td>Machinery &amp; Fixtures</td>
</tr>
<tr>
<td>Boulton Watt &amp; Sons</td>
<td>Buildings</td>
</tr>
<tr>
<td>Sundry Material</td>
<td>(Profit &amp; Loss)</td>
</tr>
<tr>
<td>Rent</td>
<td>Stock</td>
</tr>
<tr>
<td>Reduction in value</td>
<td>RM</td>
</tr>
<tr>
<td>(Buildings</td>
<td>FG</td>
</tr>
<tr>
<td>Machinery &amp; Fixtures</td>
<td>WIP</td>
</tr>
<tr>
<td>General Expenses</td>
<td></td>
</tr>
<tr>
<td>(Profit &amp; Loss)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Foundry Account</th>
<th>Outputs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs:</td>
<td></td>
</tr>
<tr>
<td>Stock (balance)</td>
<td>Fitting Account</td>
</tr>
<tr>
<td>Smithy Account</td>
<td>Machinery &amp; Fixtures</td>
</tr>
<tr>
<td>Stores</td>
<td>Buildings</td>
</tr>
<tr>
<td>Wages</td>
<td>Matthew Boulton - Mint</td>
</tr>
<tr>
<td>Rent</td>
<td>Matthew Boulton Rolling Mill</td>
</tr>
<tr>
<td>General Expenses</td>
<td>Boulton Watt &amp; Sons</td>
</tr>
<tr>
<td>Sundry Materials</td>
<td>(Profit &amp; Loss)</td>
</tr>
<tr>
<td>Cast iron</td>
<td>Stock</td>
</tr>
<tr>
<td>Coal &amp; Coke</td>
<td>RM</td>
</tr>
<tr>
<td>Reduction in value</td>
<td>FG</td>
</tr>
<tr>
<td>(Buildings</td>
<td>WIP</td>
</tr>
<tr>
<td>Machinery &amp; Fixtures</td>
<td></td>
</tr>
<tr>
<td>(Profit &amp; Loss)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fitting Account</th>
<th>Outputs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs:</td>
<td></td>
</tr>
<tr>
<td>Stock (balance)</td>
<td>Boulton Watt &amp; Sons</td>
</tr>
<tr>
<td>Smithy Account</td>
<td>Sundry</td>
</tr>
<tr>
<td>Foundry Account</td>
<td>(Profit &amp; Loss)</td>
</tr>
<tr>
<td>Stores</td>
<td>(Profit &amp; Loss)</td>
</tr>
<tr>
<td>General Expenses</td>
<td></td>
</tr>
<tr>
<td>Rent</td>
<td>Stock</td>
</tr>
<tr>
<td>Reduction in value</td>
<td>FG</td>
</tr>
<tr>
<td>(Buildings</td>
<td>RM</td>
</tr>
<tr>
<td>Machinery &amp; Fixtures</td>
<td>WIP</td>
</tr>
</tbody>
</table>
At the end of each year these departments were debited with an amount equal to 5% of the value of the buildings they used, as well as 8% of the value of machinery at the beginning of the year. General expenses were apportioned between the departments and contained an interest charge for floating capital, calculated as 5%\textsuperscript{19} of the debt owing to Boulton & Watt at the beginning of the year. In the early years rent was debited to these accounts, although this seems to have disappeared by 1799, the rent being a charge for the use of the facilities of the Foundry. This charge was eventually included in the interest charge as the value of machinery and buildings became established. The rent on this fixed capital was equivalent to 5% of the cost of the buildings and machinery [B&W 295].

The debit for machinery and buildings was termed "reduction in value" and is obviously depreciation. Those assets were written down by this amount and there was no attempt to create a provision for depreciation. When the operating departments were involved in building machinery and buildings for use in the Foundry, the cost of these was transferred from the various department accounts to the Building Account and to the Machinery and Fixtures Account.

\textsuperscript{19} The Usury law limited the amount of interest that could be charged on a loan to 5% [Shapiro, 1967]. It was common to allow for interest on capital (see Chapter 4) and in this instance the debt owing represented the capital employed in the business.
Transfers from the Smithy Account to the Foundry Account and Fitting Account, and from the Foundry Account to the Fitting Account, appear from the Day Book to have been made at a price per ton for some items and at an individual price for other items. This was a pre-determined price based on cost. Transfers to Boulton, Watt & Sons, that is, sales were made at the contract or selling price, hence the surplus or deficit on the account. Whether these accounts were used during the year, for management purposes, is not obvious, what is obvious is that they were prepared and the book-keeper was obviously familiar with the principles involved in the concept of a profit centre.

The Profit and Loss Account [MBP 285/27] for 1798, in James Watt jnr's handwriting, shows the inputs and outputs of the Foundry classified according to the nature of the input and sub classified according to operating department (see Appendix A). The document shows an analysis by department, as well as, a reconciliation with the books of account which apparently included a mistake due to the misallocation of interest on capital [B&W 295] (see below). This document was sent, in a letter to Matthew Robinson Boulton, with the further analysis of the income and expenditure of each department [MBP 285/28] that is reproduced below. The statements show Watt's familiarity and high level of accomplishment with the accounting process.

The following statement, in James Watt jnr's handwriting provides a summary of the ledger accounts for the year ended September 30th 1798.
Abstract of the Manufactory or Trade Account at Soho Foundry from Sepfr 30th 1797 to Sepfr 30th 1798.

<table>
<thead>
<tr>
<th></th>
<th>Smithy</th>
<th>Foundry</th>
<th>Fitting</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£</td>
<td>s</td>
<td>d</td>
<td>£</td>
</tr>
<tr>
<td><strong>1797</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct 31st To Inventory viz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buildings</td>
<td>541.6</td>
<td>6</td>
<td>4</td>
<td>3859.19.1½</td>
</tr>
<tr>
<td>Machinery &amp; Fixtures</td>
<td>303.4</td>
<td>11.2</td>
<td>11.2</td>
<td>2701.19.10½</td>
</tr>
<tr>
<td>Tools &amp; Utensils</td>
<td>164.16</td>
<td>6</td>
<td>3.3</td>
<td>381.3. 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1557. 5. 4½</td>
<td>6731.16</td>
<td>8</td>
<td></td>
<td>4345.16. 1¾</td>
</tr>
<tr>
<td><strong>1798</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sepr 30th To Materials bought</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wr Iron &amp; Steel</td>
<td>1160. 7</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pig Iron</td>
<td>2307.10</td>
<td>..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Old cast iron</td>
<td>99.5</td>
<td>10½</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper Tin &amp;C</td>
<td>708. 3</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coals &amp; Coaks</td>
<td>47.15</td>
<td>2</td>
<td></td>
<td>164. 1. 2</td>
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<tr>
<td>Timber</td>
<td>1.12</td>
<td>10</td>
<td></td>
<td>71.11. 6½</td>
</tr>
<tr>
<td>Bricks</td>
<td>13. 3</td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Lime</td>
<td>3. 9</td>
<td></td>
<td></td>
<td>5. 5.10</td>
</tr>
<tr>
<td>Firebricks &amp; clay</td>
<td>151.18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sand</td>
<td>19. 9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stores</td>
<td>19.18</td>
<td>7½</td>
<td></td>
<td>94.16. 7½</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1230.11. 5½</td>
<td>3628.11</td>
<td>1¼</td>
<td></td>
<td>820.12. 5¾</td>
</tr>
<tr>
<td>To Manufactured Goods bt</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>viz Wr Iron &amp; Steel</td>
<td>97.16</td>
<td>7</td>
<td></td>
<td>1455.17. 2½</td>
</tr>
<tr>
<td>Cast Iron (Foundry)</td>
<td>97.16</td>
<td>7</td>
<td></td>
<td>1455.17. 2½</td>
</tr>
<tr>
<td>Sundrys</td>
<td>4.19</td>
<td>4½</td>
<td></td>
<td>418.12. 7½</td>
</tr>
<tr>
<td></td>
<td>4.19</td>
<td>4½</td>
<td></td>
<td>418.12. 7½</td>
</tr>
<tr>
<td>To Wages</td>
<td>662.11</td>
<td>½</td>
<td></td>
<td>955.18. ¼</td>
</tr>
<tr>
<td>To Petty Cash Expenses</td>
<td>18.18</td>
<td>10</td>
<td></td>
<td>26. 11</td>
</tr>
<tr>
<td>To Carriage Freight &amp;c</td>
<td>150.18</td>
<td>8</td>
<td></td>
<td>2. 8.11¾</td>
</tr>
<tr>
<td>To General Expenses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>viz Rent of Build &amp;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machinery</td>
<td>43.14</td>
<td>7</td>
<td></td>
<td>256</td>
</tr>
<tr>
<td>Decreased Value of Builds</td>
<td>27. 1</td>
<td>4</td>
<td></td>
<td>179. 9.11½</td>
</tr>
<tr>
<td>Do - Do Machinery</td>
<td>24. 5</td>
<td>2½</td>
<td></td>
<td>95. 7. 6¾</td>
</tr>
<tr>
<td>Salaries</td>
<td>80</td>
<td></td>
<td></td>
<td>70. 8. 6</td>
</tr>
<tr>
<td>Use of Engine</td>
<td></td>
<td></td>
<td></td>
<td>37. 4</td>
</tr>
<tr>
<td>Repairs &amp; Sundries</td>
<td>19. 2</td>
<td></td>
<td></td>
<td>5. 9.11½</td>
</tr>
<tr>
<td>Portion of Acct of Gen.² Exp.¹</td>
<td>125. 1</td>
<td>½</td>
<td></td>
<td>342.18. 5</td>
</tr>
<tr>
<td></td>
<td>301. 1</td>
<td>3¼</td>
<td></td>
<td>986.18. 4½</td>
</tr>
<tr>
<td></td>
<td>3775. 7</td>
<td>4½</td>
<td></td>
<td>12876.14. 5¼</td>
</tr>
</tbody>
</table>

Note: All amounts are in English pounds, shillings, and pence.
<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>By Transfer of Buildings</td>
<td>541. 6. 4</td>
</tr>
<tr>
<td></td>
<td>303. 4.11</td>
</tr>
<tr>
<td>in the name of Buildings</td>
<td>844.11. 3</td>
</tr>
<tr>
<td>&amp; Machinery</td>
<td>4782. 2. 6</td>
</tr>
<tr>
<td>By Sales</td>
<td>1728.13.11</td>
</tr>
<tr>
<td>By Inventory</td>
<td>245.14. 6</td>
</tr>
<tr>
<td>Good &amp; Materials</td>
<td>863.13. 4½</td>
</tr>
<tr>
<td></td>
<td>1018. 1. 6¾</td>
</tr>
<tr>
<td></td>
<td>2947.19. 2</td>
</tr>
<tr>
<td></td>
<td>1109. 7.10½</td>
</tr>
<tr>
<td></td>
<td>13343.12.3</td>
</tr>
<tr>
<td></td>
<td>13238. 1. 5½</td>
</tr>
<tr>
<td></td>
<td>468.17.10½</td>
</tr>
<tr>
<td></td>
<td>381. 4. 3½</td>
</tr>
<tr>
<td>Gain</td>
<td>92.14. 4¼</td>
</tr>
<tr>
<td>Loss</td>
<td></td>
</tr>
</tbody>
</table>

This schedule is supported by a number of documents [MBP 285/29 -285/33] providing the detailed calculations for the amounts entered in total. The transfers between departments are treated as sales by the transferring department and purchases by the receiving department, the transfers were made at a predetermined price which was above cost. This arrangement allowed each department to make a profit (or loss) and is in line with the scheme suggested by Hamilton [1788] in his *Introduction to Merchandise* (see Chapter Two). The production process was so arranged that the Smithy and Foundry Departments both provided the raw materials for the Fitting Department.

Until 1798 buildings and machinery were included in inventory but it is to be noted in this statement that buildings and machinery were transferred to their own account. However, tools and utensils remains in inventory, the difference in value affecting profit directly.
A note to the above document remarks on the difference between the profit shown in the ledger and the profit shown on the schedule. The difference being due to an error in the allocation of interest to the departments. Interest was charged to the departments, as part of the general expenses, at the rate of 5% on floating capital at the beginning of the year. However, in this particular year interest appears to have been charged twice to the operating departments. The comment in the Journal correcting this mistake bears mentioning:

It must be remarked that the alteration in the balance of General Expences Account affect only the Appart gains or losses of the several Departments & not the result of the general Profit & Loss Account. This account is only affected by real deductions from the property as the Int paid to B&W. Estimated Interests or rent appears on both sides of it & are instituted solely for the purpose of taxing the different Departments with their respective Quotas & shewing their amounts at one view.

[B&W 295]

The profit reported in the schedule is the residual income in each department because the expected return on capital employed (5%) has been removed from profit in the form of interest on floating capital and rent on buildings and machinery and was used, as the above quotation indicates, to show the performance of each department. This was not an uncommon procedure in the eighteenth century, especially in partnerships where capital contribution was unequal [Pollard, 1964; Mepham, 1988; Hamilton, 1788]. The procedure allows a comparison of departments and an indication of their profitability as well as a measure of the opportunity cost of the funds employed.
The treatment of building an engine in the accounting records was more of a job cost situation with the processing departments transferring their finished work back to Boulton & Watt as the selling agency.

**Costing Records**

Considerable attention was paid to cost, one of the reasons being that cost generally formed the basis of prices. In the early years of the Foundry, and indeed at the Manufactory during the same period, the steam engine business became subject to increasing competition with increasing downward pressure on prices. This is borne out by the large amount of correspondence between the partners on the subject of price setting (see below). Increasing sales of not quite standard products also necessitated an efficient cost recording system if the partners hoped to remain in control of their business and to be in a position of being able to determine the profit on individual contracts. The cost of each individual engine made was calculated in the Engine Book.
The engine books\textsuperscript{20} are large books consisting of a printed list of all the parts required by an engine under the headings Cast Iron, Wrought Iron, Brass, Miscellaneous and Fitting. The cast iron was supplied by the Foundry Department, the wrought iron by the Smithy Department and the Fitting Department put it all together. Other materials such as brass work were obtained elsewhere. The list is very detailed and it appears that standard rates were used for the various parts that were standard items for an engine of that size. The following extracts come from the Engine Book for the period 1797 - 1805 and relates to a 14 Horse engine supplied to Peter Drinkwater, a manchester cotton spinner on 22nd October 1799, it is to be noted that weight was recorded as hundredweights, quarters and pounds:

\begin{center}
\begin{tabular}{lcl}
\textbf{No.} & \textbf{Cast Iron} & \\
1 & Cylinder 20\% & 14, 2, 25 \\
   & Bottom & 3, 3, 3 \\
   & Lid & 3, 2, 3 \\
2 & Piston and Core & 3, 3, 6 \\
3 & Air Pump & 6, 3, 13 \\
   & & Lid and Gland 1, 12 \\
   & Bucket & 3, 15 \\
4 & Hot water pump and door & 3, 20 \\
5 & Cold water pump and door & 3, 2, 7 39, 20 30/- 58.15.4½ \\
6 & Cover for the Cylinder Lid & 2, 25 \\
7 & Steam Case in 6 Pieces & 8, 2, 7 \\
8 & Dogs for holding down the Cylinder & 2, 4 \\
9 & Ditto for holding down the Air Pump & 2, 2 \\
10 & False Face & 1, 10 \\
11 & Cover for the Foot Valve & 2, 6 \\
12 & Upper Nozzles & 6 Bonnets 4 Valve Keepers 1, 0, 2 12, 18 18/8 11. 7. - \\
12 & \textit{Under ditto} & 4 Wedges & Plates for Cross Head \\
\end{tabular}
\end{center}

\textsuperscript{20} For an example of the format of the Engine Books see Appendix D-1 and D-2.
## Wrought Iron

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Steady pins in the Top Flanch</td>
<td></td>
<td>6d</td>
</tr>
<tr>
<td>2 Screw Pins, Nuts &amp;c for Stuffing Box</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>7 Screw Pins for Cover of Lid</td>
<td></td>
<td>4d</td>
</tr>
<tr>
<td>2 Screwed Bolts, Nuts &amp;c for holding it down</td>
<td></td>
<td>2, 4</td>
</tr>
<tr>
<td>18 Screw Pins, Nuts &amp;c for Joints</td>
<td></td>
<td>3, 6½</td>
</tr>
<tr>
<td>Steam Case</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Pins, Nuts and Washers</td>
<td></td>
<td>7d</td>
</tr>
<tr>
<td>26 Ditto Ditto for Side Joints</td>
<td></td>
<td>7d</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Governor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron Work</td>
<td></td>
<td>2,18</td>
</tr>
<tr>
<td>Rod for Cistern Valve</td>
<td></td>
<td>7(lb)</td>
</tr>
<tr>
<td>Pins, Nuts, and washers for Joints</td>
<td></td>
<td>26d</td>
</tr>
<tr>
<td>12 Inch ditto ditto</td>
<td></td>
<td>25</td>
</tr>
</tbody>
</table>

```
2,18
7(lb) 10d  5.10
```

## Brass

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Throttle Pipe Brass Collers</td>
<td></td>
<td>1,12</td>
</tr>
<tr>
<td>1 Copper valve for ditto</td>
<td></td>
<td>1, 4 2, 3,13, 6 19d 25. 8.10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injection Cock</td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>Blowing Valve</td>
<td></td>
<td>24d</td>
</tr>
</tbody>
</table>

```
18 24d 1.11. 6
```

## Miscellaneous

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leather for Valves</td>
<td></td>
<td>5 -</td>
</tr>
<tr>
<td>1 Box Pomatum 26lb</td>
<td></td>
<td>1. 6 -</td>
</tr>
<tr>
<td>1½ Boxes Cement</td>
<td></td>
<td>3. 3</td>
</tr>
</tbody>
</table>

```
£ 4.14
```

## Fitting

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder and Parts belonging to it</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder Drilling</td>
<td></td>
<td>10. 6</td>
</tr>
<tr>
<td>Facing ditto</td>
<td></td>
<td>1.</td>
</tr>
<tr>
<td>Boring out the Stuffing Box and Gland</td>
<td></td>
<td>17. 6</td>
</tr>
<tr>
<td>Turning and fitting the Brassses</td>
<td></td>
<td>16. 0</td>
</tr>
<tr>
<td>Fitting Screws to the Gland and Cover to the lid</td>
<td></td>
<td>10. 6</td>
</tr>
<tr>
<td>Ditto steady pins in Top Flanch</td>
<td></td>
<td>5. 9</td>
</tr>
</tbody>
</table>

```
10. 6
```

Abstract

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cast Iron</td>
<td>134, -10</td>
<td>£139.12.5</td>
</tr>
<tr>
<td>Wrought Iron</td>
<td>15, 110</td>
<td>70.6.3</td>
</tr>
<tr>
<td>Copper Brass &amp;c</td>
<td>3, 21,14</td>
<td>33.15.4</td>
</tr>
<tr>
<td>Stores</td>
<td></td>
<td>4.14</td>
</tr>
<tr>
<td>Patterns &amp; Boxes</td>
<td></td>
<td>12.18.6</td>
</tr>
<tr>
<td>Fitting</td>
<td></td>
<td>50.19</td>
</tr>
<tr>
<td>Commissns on Amt of S[oho] F[oundry] Invd @ 2½ pF Cent</td>
<td>312.5.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>301.11.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.16.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>£320.1.7</td>
</tr>
</tbody>
</table>

The above gives an indication of the amount of detail undertaken when working up an engine cost. It also shows the use of standard rates in the calculation of costs. For example, there were a number of castings required to produce the parts for the engine, necessitating several different methods of making the casting. The rates for casting were based on the weight of iron cast even though the actual cost of the individual casting may well have been different. The rates were 30/- per cwt, 18/8 per cwt, 18/- per cwt and 16/- per cwt\(^{21}\). The rates charged were probably based on an estimate selling price taking into consideration the material and labour content as well as the complexity of the casting. The standard rates for castings show an increase in 1800 and then appear to have remained constant for a number of years.

The Smithy used two methods of charging out its work, for most items there was a common charge of 7\(^{d}\) per pound weight, however some items had a fixed charge depending on what it was. The Fitting

\(^{21}\) The 1797 Inventory [B&W 429] values Pig Iron at £6-10-0/ton to £7-9-0/ton.
Department had a series of charges for each operation required to assemble the engine. Again these rates remain constant and are based on direct cost.

All the costs involved in the calculation of total cost were operating department costs and at this stage there was no allowance for general overheads. The commission was payable to the managers of the Foundry as part of their remuneration [Tann, 1981]. This particular engine had a computed cost of $320.1.7, and its actual selling price was £484.0.0 [B&W MII/7/2]. B&W MII/7/2 indicates that each engine was expected to return a profit of 25% based on the engine book cost, this particular engine more than achieved this goal with a gain of £163.18.5. However, not all engines returned 25% of engine book cost as the document illustrates with a listing of all engines shipped during the year showing the difference between the computed return and the profit as calculated by deducting the engine book cost from the selling price.

An entry was made in the engine book for each engine manufactured with a costing of each part that was included in the engine based on standard prices. A more detailed record of actual costs was kept in the Fitting Book.

**The Fitting Book**

The Fitting Book gives a detailed breakdown of the time taken, and thus the cost, in fitting each part. Unlike the Engine Book the
Fitting Book records the actual time and cost instead of the standard rate for the job. Like the Engine Book this book too is pre-printed and is very detailed including a charge calculated for the use of machinery and tools as well as labour. The extract that follows relates to a 14 Horse engine built for Hibbert & Smethurst of Oldham Lancs., completed on 29th January 1801:

<table>
<thead>
<tr>
<th></th>
<th>Days</th>
<th>Charge of mens time</th>
<th>Amount of Mens Time upon each Article</th>
<th>Charge included use of tools and Machinery</th>
<th>Amount with charge for Tools and Machinery upon each Article</th>
<th>Total Amt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder Lid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Centering the Lid</td>
<td>¾</td>
<td>2/4</td>
<td>0. 0. 7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turning ditto</td>
<td>¾</td>
<td>2/4</td>
<td>0. 1. 9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drilling ditto</td>
<td>¾</td>
<td>2/4</td>
<td>0. 0. 7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boring out Stuffing Box</td>
<td>¾</td>
<td>2/8</td>
<td>0. 2. 0</td>
<td>10/-</td>
<td>0. 7. 6</td>
<td></td>
</tr>
<tr>
<td>Boring the Gland</td>
<td>½</td>
<td>2/4</td>
<td>0. 1. 2</td>
<td>10/-</td>
<td>0. 5. 0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2½</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0. 12. 6</td>
</tr>
<tr>
<td>Turning and Fitting the</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brasses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turning and boring</td>
<td>¾</td>
<td>2/8</td>
<td>0. 1. 4</td>
<td>8/-</td>
<td>0. 4. 0</td>
<td></td>
</tr>
<tr>
<td>brass bush for gland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turning and boring</td>
<td>¾</td>
<td>2/8</td>
<td>0. 1. 4</td>
<td>8/-</td>
<td>0. 4. 0</td>
<td></td>
</tr>
<tr>
<td>brass of stuffing box</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turning the Gland itself</td>
<td>1</td>
<td>2/6</td>
<td>0. 2. 6</td>
<td>8/-</td>
<td>0. 8. 0</td>
<td></td>
</tr>
<tr>
<td>Fitting the Bush into</td>
<td>¼</td>
<td>1/10</td>
<td>0. 0. 5½</td>
<td>2/4</td>
<td>0. 0. 7</td>
<td>0. 16. 7</td>
</tr>
<tr>
<td>Gland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2½</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0. 5. 7½</td>
</tr>
<tr>
<td>Fitting Screws to Gland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&amp; Cover to Lid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drilling false cover &amp;c</td>
<td>¾</td>
<td>2/4</td>
<td>0. 0. 7</td>
<td>8/-</td>
<td>0. 2. 0</td>
<td></td>
</tr>
<tr>
<td>Fitting ditto to Lid</td>
<td>1¼</td>
<td>2/4</td>
<td>0. 2. 11</td>
<td>2/10</td>
<td>0. 3. 6½</td>
<td></td>
</tr>
<tr>
<td>Fitting Screws of the</td>
<td>¼</td>
<td>2/4</td>
<td>0. 0. 7</td>
<td>2/10</td>
<td>0. 0. 8½</td>
<td>0. 6. 3</td>
</tr>
<tr>
<td>Gland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1¼</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0. 4. 1</td>
</tr>
<tr>
<td>Fitting Steady Pins in</td>
<td>1</td>
<td>2/8</td>
<td>0. 2. 8</td>
<td>3/2</td>
<td>0. 3. 2</td>
<td>0. 3. 2</td>
</tr>
<tr>
<td>Top Flanch and Drilling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Holes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[B&W 291]
The above shows a small section of the very great detail that the Fitting Books record. The men were paid according to the job that they did with the most common pay rates being 2/4 and 2/8 per day with time being recorded in increments of a quarter of a day. As well as giving an accurate account of the work of the Fitting Department this book provided data for comparison between different engines. There is no indication of the method by which the rate for the Tools and Machinery Charge was determined, nevertheless it shows an appreciation of the need to include these indirect costs.

Actual times and actual costs are shown in the Fitting Book and a comparison with the Engine Book for the same operations and the same engine yields the following:

<table>
<thead>
<tr>
<th></th>
<th>Fitting Book</th>
<th>Engine Book</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder Lid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facing</td>
<td>15.0</td>
<td>15.0</td>
<td>0</td>
</tr>
<tr>
<td>Centering/turning</td>
<td>2.11</td>
<td>3.6</td>
<td>+7</td>
</tr>
<tr>
<td>Boring stuffing box &amp; gland</td>
<td>15.8</td>
<td>17.6</td>
<td>+1.10</td>
</tr>
<tr>
<td>Turning and fitting the brasses 1. 2. 2½</td>
<td>16.</td>
<td>-6.2½</td>
<td></td>
</tr>
<tr>
<td>Fitting screws</td>
<td>10.4</td>
<td>12</td>
<td>+1.8</td>
</tr>
<tr>
<td>Fitting steady pins</td>
<td>5.10</td>
<td>5.9</td>
<td>-1</td>
</tr>
</tbody>
</table>

While there are many differences between the actual amount in the Fitting Book and the rate in the Engine Book there does not seem to be any record of these differences nor any action seem evident to resolve the differences and perhaps alter the rates. This may come
to light with further research or it may well be that the records were kept to provide information only and operated as a check on the work done in the Department.

The costing records kept at the Foundry were supported by a set of subsidiary records [B&W 37/2] which recorded times and costs for all the operations and activities undertaken. The cost records were very detailed and the above extracts are a small example of this detail. As will be discussed later these cost records provided the basis for the prices charged for future engines and provided information for a number of calculations relating to piece rates to be paid to the employees.

The inventory provides a further example of the detailed record keeping at Soho Foundry.

**Inventory**

Inventory was calculated each year by a stock take and the records remaining of inventory are very extensive, the results of each being entered in a large bound book. The location of each item of inventory, its weight, where applicable, and value were recorded with a summary of the inventory of each department at the end. Such a summary for the stock take dated 30th September 1797 can be found in the Inventory Book and shows:
Establishment

Buildings

Machinery & Fixtures

<table>
<thead>
<tr>
<th>Location</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the yard</td>
<td>322.12.0</td>
</tr>
<tr>
<td>In the Carpenters shop</td>
<td>5.16.1</td>
</tr>
<tr>
<td>In the chamber over do.</td>
<td>9.14.3</td>
</tr>
<tr>
<td>In the magazine upper room</td>
<td>58.1 2 ½</td>
</tr>
<tr>
<td>In Do Mr Vivians room</td>
<td>12.8 3</td>
</tr>
<tr>
<td>In Do 2 middle rooms</td>
<td>8.14.5 ½</td>
</tr>
<tr>
<td>In Do West Do</td>
<td>76.15.2 ½</td>
</tr>
<tr>
<td>In the Lodge</td>
<td>8.18.0</td>
</tr>
</tbody>
</table>

$1900.8.10

Tools & Utensils

<table>
<thead>
<tr>
<th>Location</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the yard</td>
<td>47.11 4 ½</td>
</tr>
<tr>
<td>In the Carpenters shop (upper room)</td>
<td>2.3</td>
</tr>
<tr>
<td>In Do (lower room)</td>
<td>7.0 1</td>
</tr>
<tr>
<td>In the magazine upper room</td>
<td>7.3 11 ½</td>
</tr>
<tr>
<td>In Do Mr Vivians room</td>
<td>9.6 10</td>
</tr>
<tr>
<td>In Do 2 middle rooms</td>
<td>2.12.8</td>
</tr>
<tr>
<td>In Do West Do</td>
<td>2.3 3 76.10.5</td>
</tr>
</tbody>
</table>

Miscellaneous

<table>
<thead>
<tr>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>305.4 9 ½</td>
</tr>
</tbody>
</table>

$2785.3.6

Smithy Department

Buildings

Machinery & Fixtures

<table>
<thead>
<tr>
<th>Location</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the upper shop</td>
<td>138.5 4 ½</td>
</tr>
<tr>
<td>In the lower Shop</td>
<td>164.19 6 ½</td>
</tr>
</tbody>
</table>

Tools & Utensils

<table>
<thead>
<tr>
<th>Location</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the upper shop</td>
<td>72.3 10 ½</td>
</tr>
<tr>
<td>In the lower do</td>
<td>92.12 7 ½</td>
</tr>
</tbody>
</table>

Goods & Materials

<table>
<thead>
<tr>
<th>Location</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the upper shop</td>
<td>69.3 10</td>
</tr>
<tr>
<td>In the lower do</td>
<td>119.14.2</td>
</tr>
<tr>
<td>In the Magazine East Room</td>
<td>143.14.1 ½</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Do 2 middle rooms</td>
<td>238.18.9</td>
</tr>
</tbody>
</table>

Deduct Debts owing by this Department

<table>
<thead>
<tr>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>571.10 10 ½</td>
</tr>
<tr>
<td>1580.18 7 ½</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.13.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>£1557.5 4 ½</td>
</tr>
</tbody>
</table>

[B&W 429]

The statement continues in similar detail for the Foundry and Fitting Departments as well as including amounts for stores, bricks, lime,
timber, dwelling houses and an item called farming. The attention paid to the recording of the inventory is indicative of the thoroughness of all the accounting processes as well as the interest of the partners in knowing the value of capital employed and its location.

**Internal Control**

Any system is only as good as the people charged with its keeping and, unfortunately, it seems the Soho Foundry was let down a number of times by the people it employed. In the 1820's there were several embezzlements by clerks who had been employed for a number of years. One, William Bennett, transported to New South Wales for 14 years in 1827, wrote a series of letters [B&W 37/13] just before his departure pointing out deficiencies in the internal control of the organisation. He mentions Bills of Exchange going missing, goods being ordered and never received, bribes being taken to make sure suppliers received orders, secret commissions, and failure to weigh products accurately. While great attention was paid to the records it seems that the attention paid to internal control procedures may have been somewhat lacking.

Some of the above problems may have resulted from a small, underpaid and somewhat overworked office staff. "Two bookkeepers, one cashier, who sometimes acted for the other Soho businesses as well, and a limited number of clerks were employed" [Roll, 1930, p 251], yet the amount of work they did was prodigious,
producing very detailed records and statistics. However, underlying this, the affair of Bennett, who had been employed for a number of years, stands as a testimony to this failure to take account of human nature.

Accounting Information as a Basis for Calculation

The records indicate that accounting information was used extensively by James Watt jnr in relation to two matters - the setting of piece rates for the moulders and the setting of prices for the engines. A discussion of the process of setting the piece rates follows and serves as an example of the degree of investigation and calculation that James Watt jnr carried out before making a commitment to change the procedures of the Soho Foundry.

Piece Rates for the Moulders

The Fitting Department and the Smithy Department had developed piece rates for the employees based on experiences in the Manufactory and in the Foundry. The last department to pay on piece rates was the Foundry Department. In this department the foremen, who led teams of moulders, were paid a premium, in addition to the normal daily rate, to encourage greater efficiency, this premium was not passed on to their teams.
There was a perception on the side of both management and the foremen that it would be advantageous to both if piece rates were introduced to the Foundry Department similar to the Fitting and Smithy Departments. From the point of view of the partners the payment of piece rates meant certainty in the costing of various castings not dependant on the time taken to complete the work.

The Foundry Department was divided into three sections, relating to the casting method employed, namely; loam, dry sand and green sand casting. Within each section there were subdivisions which related to the premiums paid to the foremen. A listing of these classifications is contained in a document dated June 1800, this document gives some idea of the degree of standardisation being introduced:

Classification of Castings for Apportioning Moulders Premiums June 1800

1st Loam & Cylinders made in the Pits
1st Cylinders, Air pumps, Condensors made in sand or Loam in the Pits, Working Barrels. Clack seat Pipes, Plain pipes above 24 Inches Diam² Cylinder Bottoms, Tops, Pistons above 40 Inches diameter or occasionally made in Loam for other reasons at 20/-
The craft of moulding was still a relatively new activity for the partners to come to terms with, so a check was made to see whether the premium was having the desired effect in stimulating production. A document entitled "Table of Castings at Soho Foundry - Serving as a basis to the Table of Premiums" dated July 1 1800, contains the following table.

2nd Dry Sand
Articles
1st Class - Cylinders, Air pumps, Condensers, Working Barrels & Bored goods generally including Hot & Cold water pumps at 20/-
2nd Class-Cylinder Bottoms & Tops, Pistons, Air pump Buckets & Covers, Rotative wheels and others made in Dry sand.
3rd Class-Boiler Steam pipes, Socket pipes, Stop pipes & side pipes or perpendicular Do. Eduction pipes Nozzles and side pipes when in one Piece.
4th Class Nozzles in separate pieces.
5th Class Rotative and other shafts centre Gudgeons out end Do. when in Dry Sand.
6th Class connecting Rods.
3rd Green Sand
Class 1st Steam Cases, Dampers and frames. Covers for Cylinder lids.
Class 2nd Manhole pipes, Feeding mouths, Dead plates and frames, Bonnets false faces. Stop Valves, Throttle pipes, Stuffing Boxes and weights.
Class 3rd - Plummer Blocks and Glands, Saddle plates & Glands, Dogs and weights, Governor Balls, Valve doors, Bottom plates for Air pumps and Condensers & Condenser covers, Cranks & pins for Do.
Class 4th - Air pump & Cylinder Glands, Covers for pistons & Air pumps, Centre & Outer end Gudgeons, Air pump Buckets, Pistons, Rotative & other wheels, Blow pies & sockets.
Class 5th - Fly Wheels.

[B&W 45/18]
Comparison of the Time & Weights, the Time being extracted from the Time Book and the Weights from the above Table

<table>
<thead>
<tr>
<th>Description &amp; Weight of Castings</th>
<th>Days</th>
<th>Cwts</th>
<th>Cwts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loam &amp; Pit Work</td>
<td>398</td>
<td>2</td>
<td>23</td>
</tr>
<tr>
<td>Dry Sand</td>
<td>3443</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Green Sand</td>
<td>2868</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>Open do</td>
<td>1134</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7845</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>2690</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1/4</td>
</tr>
</tbody>
</table>

While the document carries no comments it is obvious that the moulders were not performing to Abraham Storey’s expectations, especially in the Dry and Green Sand castings, and no doubt this calculation helped to provide a sympathetic ear when the moulders applied for a change in their method of payment.

In 1802 there were 54 men and boys employed in the Foundry Department. 34 were divided into 9 teams and employed as moulders in the casting operations. The remaining 20 were known as daymen and employed attending to what should be regarded as the central services of the Foundry, they tended the air furnaces, mixed loam and were involved in smithing and scrap picking [Tann, 1981].

The moulders were divided into teams of a foreman, assistants and apprentices. They were all employed by the firm but the men were
paid by the foreman. This was a variant of the 'butty'\textsuperscript{22} system which was common at the time [Tann, 1981]. In the beginning most employees in the organisation were paid a weekly wage, however, by the late 1790's piece rates applied to those articles that had become reasonably standardised in the other departments.

In order to set the piece rates the partners were very conscious of the rates their competitors were paying to the extent that in 1802 they undertook an investigation of their competitors. No doubt the results of this investigation had other benefits to the firm as well. The investigation yielded the following:

**Piece work Prices at Butterly Furnace 1802**

- Dry sand 20 to 21/- per ton, proposed to raise it to 22/-
- Green sand 7/- to 20/- according to work.

**Low Moor Prices**

- Loam casting under 10 Cwt 3/- per Cwt
- Do. 10 to 20 2/6 "
- Do. above 20 Cwt 2/- "
- Green sand Millwork Wheels &c 7d. per Cwt
- Bath & Stove Work & casting Boxes 1/6 per Do.
- Bars & bearers flashed 4d. per Do.

The Moulders stand to all misfortunes in the running, the Master stands to saleable goods only.

\textsuperscript{22} The butty system was where the workmen formed themselves into groups and made contracts through their leader who was known as the charter-master or butty [Ashton, 1964]. As it operated in 1800 at the Soho Foundry the men were paid a daily wage by Boulton, Watt & Sons through the foreman. The foreman was paid a premium to encourage his team to work hard. In those Departments already paying piece rates the men were still paid on a daily basis and the foreman kept the difference between the wages paid to the men and the piece rate for the particular job [Rolls, 1930].
Prices at Gorsecote

Loam work 50/- per ton
Dry Sand  21/- Do.
Green sand 10/- Do.
The Moulders finding labourers & all assistance.

Prices at Halifax

Loam 2/- per Cwt
Dry sandwork 1/- per Cwt
Pipe Work 1/- per Inch
Wheelwork 7d. per Cwt

[B&W 45/22]

Similar thoroughness was applied to the study of almost every component involved in the manufacture of steam engines before piecework rates were set. Once they were set then output and wage bills were closely monitored for several months [Tann, 1981].

Piecework Determinations

The negotiations with the moulders appear to have been carried out under the auspices of Watt jnr; many of the documents are either in his handwriting or contain his comments. The following series of documents illustrate the thoroughness of James Watt jnr, in this case, in relation to the negotiations for piece rates that took place in 1802. The following are representative of a large amount of calculation in order to derive suitable rates for the moulding of the many parts of the steam engines the firm was building.

Watt consulted with the moulders, asked them for a set of prices and made his own calculations to check the validity of the tenders of the men. The following examples are offered to give an indication of the thoroughness of the process. The examples are typical and those
that are given relate to the negotiations with one of the foremen, Thomas Mousley a Moulder.

The first step was to ask Mousley to indicate the times he estimated his team would take to mould various engine parts.

**Document 1**

Mousleys opinion of the time required for Moulding different kinds of pipes 20 July 1802

Thos Mousley says he

* Would do a 20 Horse Cold Water pump in a day & a 6 Horse in the same time
* Would take about $1\frac{1}{2}$ day to mould a Plain pipe from 10 to 12 Inches
* Would mould a Do of 14 Inches Dr in the little Cylr Box in 2 Days.
* Could make 12 hot water pumps 8 to 20 Horse per week
* It would take him $\frac{1}{2}$ day more to mould those with Jack heads, provided the branch is on the side, if on the top it would take him a full day.
* Jack heads for hot water pumps could be done in a day & half each. If many were made could do one a day
* Could do two clack seats for Cold water pumps per Day
* Could do a Cold Water pump with Jack head in three days
* Could do 9 to 12 Safety pipes 8 to 30" in a week
* Could do 8 Safety pipes of the two large sizes per week - [note in pencil] Isaac Croft thinks he could do 3
* Could do 12 Blowing pipes of all sizes per week & thinks there is little difference in print (sic) of work between them
Could make 6 air pipes for hot water pumps in a week
Could make 9 pipes to join Air Vessels of cold water pipes per week
Could do 3 Stop pipes per week and the same number of Breeches pipes.

[B&W 45/20]
The next document, in Watt jnr's handwriting, draws upon the moulder's estimates, the comments of Abraham Storey, Watt's manager, and Watt's own calculations. The amounts relate to labour cost only, all materials being supplied by the firm.

Document 2

Calculation of the Expence of Moulding Hot Water pumps, Hot Water pumps with Jack heads, Jack heads for hot water pumps Air Vessels for hot water pumps.

20 July 1802

Hot Water Pumps

There are 4 patterns of these from 8 to 20 Horse (the 16H seldom used); the average weight of which is 3qrs, 11lb; the trouble of moulding each being considered nearly the same.

Tho Mousley thinks he could do 12 in a week, which A Storey confirms = 2 pr day

Mousleys Wages per day = 3/2
Chas Betts = 1/4
Wm Mousley = 6
Prem m 2d½ pr cwt but say same as for Cold water pumps 8

---

5/8

2 Pumps = 1cwt 2qrs 22lb at 5/8 = 3/4 per cwt = 2 at

5/8 = 2/10 each

Chipping 4d½ per cwt, getting out & weighing 1d½ = 6d per cwt = 5d each

2/10 + 5d = 3/3 each

[different colour ink] deduct ⅛ of 2/10 leaves 2/5⅓  add

5d = 2/10¾ or say 3/- each

[The ⅛ refers to the premium being paid, Watt removed it for piece work]

Hot Water Pumps with Jack heads

The 20 Horse hot water pump on this construction weighs 1cwt 2qrs - (Marriot & Co) 3½ Drf would take one half more labour than the plain hot water of the same size which as above comes to 3/3

3/3 + 1/7½ = 4/10 or say 5/- each

[different ink] deduct ⅛ of 3/3 = 3d leaves 2/11½ +

1/7½ = 4/7
1 cwt 2 qr at 5/- = 3/4 pr Cwt or deducting 5d per cwt for chipping = 2/11 per cwt
The other patterns are 4½ & 6 Inches Dr and require about equal labour with one another.
A Storey thinks the expense of moulding these will be about one third more than that of the cold.

Cold Water pumps 8 to 20 horse
The Cold water pumps 8 to 20 horse amount by our calculations to 6/9 each

6/9 + 2/3 = 9/- each

[different ink] deduct ⅛ of 8/- leaves 7/- + 1 = 8/-
The average Weight is 3 cwt 1 qr at 9/- = 2/10 per cwt or deducting 4d per cwt chipping & weighing = 2/6 per cwt

Jack heads for Hot Water Pumps

Of these there are two Patterns 4½ & 6 Inches Dr, the Average weight of which may be taken at 1 cwt 2 qr s The trouble of moulding each is supposed the same.

Mousley thinks he could do one in 1½ day or if many were to be made, one per day. A Storey thinks he might very well do one per day.

Mousley & his Mens wages per day = 5/8
1 cwt 2 qr s at 5/8 = 3/9 ¼ per cwt
Chipping 4d per cwt, getting out & weighing 2d = 6d pr cwt = 9d each
5/8 + 9d = 6/5 or say 6/6 each

[different ink] deduct ⅛ of 5/8 leaves 5/- + 9d = 5/9

Air Vessels for Hot Water Pumps

Of these there are two patterns, one 12 Dr & 24 Inches Long weighing 2 cwt 3 qr 10 lb, and the latter 13 & 28 weighing 4 0 7
Average weight 3 cwt 2 qr s Labour in moulding each, nearly the same
Mousley thinks he could do one per day, which A Storey is of the opinion would be the utmost he could manage -

Mousley & his Mens wages = 5/8 pr day
3 cwt 2 qr s at 5/8 = 1/7 ¼ per cwt
Chipping 3d per cwt, getting out & weighing 2d = 5d per cwt = 1/6 each
5/8 + 1/6 = 7/2 each (7/2 + 2/10 = 10/- each)

NB Upon representations from Isaac Croft & Thos Mousley and viewing the Patterns, it appears that the time has been understated and that 1½ day should be allotted for moulding each = 10/- each
[different ink] deduct ⅛ of 8/6 leaves 7/5 ¼ = 1/6 = 8/11 ¼ or say 9/-

[B&W 45/20]
The document gives the impression that Watt did the calculations and then remembered that the rate paid included a \( \frac{1}{8} \) premium so he has gone back with a different colour ink and removed the premium from the calculations. These recalculated rates for the piece are the ones in the agreement with Mousley.

The men were given the opportunity to put their case and the following details Mousley's opinion as to the piece rates applicable to the work he was engaged on.

### Document 3

Thomas Mousleys' Proposals for Moulding Hot & Cold Water pumps, safety pipes, Blowing Pipes, Stop pipes Breeches pipes & c

21 July 1802

<table>
<thead>
<tr>
<th>Item</th>
<th>Each</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold Water pumps to a 20 Horse</td>
<td>£0 10 6</td>
</tr>
<tr>
<td>Do with jack heads</td>
<td>0 15 0</td>
</tr>
<tr>
<td>Plain pipes of Cold Water pumps from 10 to 12 Inches Dr</td>
<td>£10 6</td>
</tr>
<tr>
<td>Do 14 Inches Dr</td>
<td>0 15 0</td>
</tr>
<tr>
<td>Clack Seats for Cold Water pumps from 10 to 12</td>
<td>£0 12 0</td>
</tr>
<tr>
<td>Do 14 Inches</td>
<td>0 15 0</td>
</tr>
<tr>
<td>Hot Water pumps 8 to 20 Horse</td>
<td>£0 3 6</td>
</tr>
<tr>
<td>Do with Jack heads</td>
<td>0 6 0</td>
</tr>
<tr>
<td>Cold water pumps with Jack heads 10 Dr</td>
<td>£15 0</td>
</tr>
<tr>
<td>Do 14 Dr</td>
<td>£1 1</td>
</tr>
<tr>
<td>Safety pipes 8 to 30 Horse</td>
<td>£0 5 0</td>
</tr>
<tr>
<td>Do of larger sizes</td>
<td>0 9 0</td>
</tr>
<tr>
<td>Blowing pipes of all sizes</td>
<td>£0 4 0</td>
</tr>
<tr>
<td>Air Vessels for hot water pumps</td>
<td>0 15 0</td>
</tr>
<tr>
<td>Stop pipes</td>
<td>£14 0</td>
</tr>
<tr>
<td>Do Small pipes</td>
<td>£2 0</td>
</tr>
<tr>
<td>Breeches pipes</td>
<td>£12 0</td>
</tr>
<tr>
<td>Straight Boiler Steam Pipes</td>
<td>£2 6</td>
</tr>
<tr>
<td>Crooked Boiler Do Long &amp; Short Crooks</td>
<td>£0 3 0</td>
</tr>
<tr>
<td>Sockets for boiler steam pipes</td>
<td>£0 3 6</td>
</tr>
<tr>
<td>or 10s each</td>
<td>[B&amp;W 45/20]</td>
</tr>
</tbody>
</table>
This all culminated in the following agreement between the firm and Mousley - all the agreements appear to be identical, the only difference being the prices for work at the end - it will be noted that the prices calculated by Watt are the ones that prevailed and became the set rates. How Mousley felt about this is not recorded, nevertheless he must have agreed to the rates.

Document 4

Conditions upon which Piece Work is let to Thomas Mousley

Boulton & Watt to provide a man to mix up the Loam according to directions given by Thomas Mousley; they are also to provide a Man to heat the Stoves & to work the furnaces, Mousley & his men assisting to charge - Thomas Mousley to find all labour of every other kind necessary for the Moulding, Drying, Casting, taking out of the sand and Foundry, chipping & weighing the goods: Viz to bring the sand into the Foundry; to sift & mix it up, to bring the Boxes into the foundry & remove them to the bank when done with. To ram & finish his own moulds, prepare his own Cores & Cakes (Loam being found him ready mixed up in the Loam house) and to mix up & apply his own Blacking. To give directions to the man who heats the Stoves, when & how to heat them. To work the Crane for his own purposes and to keep it in order as far as he is concerned. To do all the work necessary at the time of Casting (except what relates to the Air furnace). To take the Castings out of the Boxes and the Cores out of the Castings. To remove the Castings to the place alloted for Chipping, to pick out the large Scrap Iron and remove the rubbish to such part of the bank as he may be directed. To keep the part of the Foundry & Stoves which he occupies clean & orderly, & to use his boxes, corebarrels & all other tools & implements in a workmanlike manner. To Chip & weigh his own Castings, & deliver them upon such part of the bank as he may at the time be directed. - To stand to all the Wasters whether apparent at the time of Casting, or Afterwards in the boring or finishing, in case the defect arises from the Casting. To point out to A Storey all such defects as he may himself notice in the Castings and to attempt to conceal none by lead, cement, or any other contrivance.
All Castings the surface of which is uneven from any defects of the mould or improper application of the Blacking to be considered as wasters. To keep exact to such dimensions as are prescribed to him and finish his work in at least as good a manner as has hitherto been done, and endeavouring to improve it so that no Foundry may do better. The chipping to be done to the satisfaction of A Storey and of the Superintendent of Soho & Soho Foundry. To break up his own wasters. Patterns to be carefully used and any damage arising to them from neglect or wilful bad usage to be made good at the expence of Thomas Mousley. The patterns to be delivered to him in the Foundry by the Pattern keeper, and to give him notice to remove them when they are done with.

Alteration of Patterns or Castings not amounting to more or less than one Cwt, not to affect the present Proposals which are to hold good for one twelvemonth.

Soho 24 July 1802

**Piece prices for Thomas Mousley**

<table>
<thead>
<tr>
<th>Item</th>
<th>Inches Dr</th>
<th>Each</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold Water Pumps with Clack Seat in a piece</td>
<td>4½ to 7⁵/₈</td>
<td>6.00</td>
</tr>
<tr>
<td>Working Barrels for Cold Water pumps</td>
<td>9 to 12</td>
<td>9.00</td>
</tr>
<tr>
<td>Do</td>
<td>14</td>
<td>12.00</td>
</tr>
<tr>
<td>Clack seats for</td>
<td>9 to 12</td>
<td>8.00</td>
</tr>
<tr>
<td>Cold Water Pumps with Jack heads</td>
<td>10</td>
<td>12.00</td>
</tr>
<tr>
<td>Do</td>
<td>12</td>
<td>17.00</td>
</tr>
<tr>
<td>Pipes to join [obscured] to Cold water pumps</td>
<td>10 to 13</td>
<td>6.00</td>
</tr>
<tr>
<td>Hot water Pumps</td>
<td>2½ to 4</td>
<td>3.00</td>
</tr>
<tr>
<td>Do with Jack header</td>
<td>3½ to 4</td>
<td>4.00</td>
</tr>
<tr>
<td>Do</td>
<td>4½ to 6</td>
<td>8.00</td>
</tr>
<tr>
<td>Jack heads for hot Water pumps</td>
<td>4½ to 6</td>
<td>5.00</td>
</tr>
<tr>
<td>Air Vessels for hot water pumps 12 to 13 Dr &amp; 24 to 28 Inch long</td>
<td>5¼ to 7</td>
<td>9.00</td>
</tr>
<tr>
<td>Safety Pipes</td>
<td>8 to 12</td>
<td>6.00</td>
</tr>
<tr>
<td>Blowing Pipes of all sizes</td>
<td>2½ to 5</td>
<td>2.75</td>
</tr>
<tr>
<td>Stop pipes</td>
<td>4 to 6</td>
<td>8.00</td>
</tr>
<tr>
<td>Do</td>
<td>7 to 10</td>
<td>11.50</td>
</tr>
<tr>
<td>Breeches pipes</td>
<td>4 to 6</td>
<td>8.30</td>
</tr>
<tr>
<td>Do</td>
<td>7 to 9</td>
<td>9.10</td>
</tr>
<tr>
<td>Sockets for Boiler Steam pipes</td>
<td>4 to 6</td>
<td>4.10</td>
</tr>
<tr>
<td>Do for Do</td>
<td>7 to 9</td>
<td>8.6</td>
</tr>
<tr>
<td>Do for Do</td>
<td>9 to 13</td>
<td>12.00</td>
</tr>
</tbody>
</table>

Plain & Crooked Steam pipes to be taken by the Diameter & length at the understated prices, the Inside Diameter to be taken, & the lengths to be measured down the middle of the pipes.

<table>
<thead>
<tr>
<th>Pipes of 4 Inches</th>
<th>Inside Dr</th>
<th>at 9d per foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do of 4½</td>
<td>Do</td>
<td></td>
</tr>
<tr>
<td>Do of 5</td>
<td>Do</td>
<td></td>
</tr>
</tbody>
</table>
This is a very comprehensive and detailed document of the work that Mousley and his team were expected to undertake together with the rate for each piece he could be asked to cast. All the other foremen went through the same process and complied with a similar agreement which set out their duties and obligations together with the rates to be paid for each item they cast.

Not content with setting the rates, the performance of the moulders was monitored by Watt, in the first few months at any rate, to ensure that the company was benefiting from the new arrangement. The following extracts in Watt's handwriting, comparing production before piece rates were introduced, to production afterwards, illustrate this.

**Document 5**

Statements and Calculation of the work done by the Moulders in different Quarters from July 1800 to 1st July 1802 at Premium work - and from 1 July 1802 to 30 Sep'r 1802 at part Premium & part Piece work.
Extract refers to Thomas Mousley

5 Thomas Mousley

<table>
<thead>
<tr>
<th></th>
<th>Goods</th>
<th>Wasters</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1800 - 1 July to 30 Sep</td>
<td>205</td>
<td>28</td>
<td>233</td>
</tr>
<tr>
<td>1 Oct to 31 Dec</td>
<td>165</td>
<td>20</td>
<td>185</td>
</tr>
<tr>
<td>1801 1 Jan to 30 March</td>
<td>183</td>
<td>16</td>
<td>199</td>
</tr>
<tr>
<td>1 Apr to 30 June</td>
<td>164</td>
<td>-</td>
<td>164</td>
</tr>
<tr>
<td>1 July to 30 Sep</td>
<td>160</td>
<td>22</td>
<td>182</td>
</tr>
<tr>
<td>1802 - 1 Jan to 30 March</td>
<td>158</td>
<td>27</td>
<td>185</td>
</tr>
<tr>
<td>1 Apr to 30 June</td>
<td>150</td>
<td>7</td>
<td>157</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>1185</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>169</td>
<td>1305</td>
<td></td>
</tr>
</tbody>
</table>

Average weight of Pipes of various descriptions made by Mousley per Qtr

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 July to 24 July Premium</td>
<td>50</td>
</tr>
<tr>
<td>24 July to 30 Sep Piecework</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td>230</td>
</tr>
</tbody>
</table>

Observations

Mousley had during the Premium Quarters, the assistance of Chaes Betts the Appce & of his own Son Wm Mousley, with occasional aid from the labourers in the foundry.

At Piecwork he has been assisted by Chaes Betts and Jno Mousley with occasional aid from Wm Mousley, Wm Turton & S. Pritchard. He has done the greatest part of his chipping with his own man, but has had some done by others.

Tho$ Mousley has drawn various sums weekly according to the number of hands employed under him. He says that after he has paid his men & paid for chipping, he has not had more than 14/- per week for himself.

The Ballance coming to him for 9 weeks Piecwork is £1,,16,,8 = 3/- per week which added to 14/- would not make his wages - which are 19/-

His wasters amount to £4,,,-
Although the calculations do not encompass a complete quarter on piece rates alone, Mousley's production certainly increased in the last quarter, nine weeks of which were at piece rates. However increased work rates required more help, who had to be paid. Before the piece rates came into operation Mousley kept 19/- per week for himself; under the new system he only received 17/-. It seems that Mousley did not do very well from piecework because he disappears from the list of moulders by July 1803; Watt, recognising that Mousley was not earning as much as he would on wages does not seem to have done anything about it.

James kept a close eye on the results of the introduction of piecework compared to payment of straight wages with the following extract from a large set of calculations comparing cost/cwt before and after piecework. He appears to have been happy with the results of the experiment because production was up and costs were down.

**Document 6**

Statement of the Amount of Castings & Wages during the first Quarter of Piecework distinguishing what was done at Premium work during the early part of the Quarter

<table>
<thead>
<tr>
<th>Weight of Casting</th>
<th>Wages p(^{d})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ton  Cwt</td>
</tr>
<tr>
<td>1802 Premium work from 1 July to 7(^{th}) August Piecework</td>
<td>60 ,, 17</td>
</tr>
<tr>
<td>17 July to 30(^{th}) Sep(^{r}) Piecework</td>
<td>210 ,, 9</td>
</tr>
<tr>
<td></td>
<td>271 ,, 6</td>
</tr>
</tbody>
</table>

So that the average Cost of Castings during the whole Quarter has been 2/4\(^{1/2}\) p\(^{f}\) Cwt and during the Piecework only 2/2 p\(^{f}\) Cwt.

2/8\(^{3/4}\) Average Cost of Premium Work per Cwt
2/2 Do of Piecework Do
6\(^{1/4}\) saving per cwt by Piecework = nearly 1/5

[B&W 45/22]
Watt regarded the establishment of piece rates as a success as can be seen from his comment at the end of the document when he wrote:

So that it appears that the Foundry since it was put upon Piecework, has been doing at the rate of 314 Tons 14 Cwt per QT which is about ½ more than it did in the three preceding Quarters, which averaged 194 Tons

Piecework was a success from the point of view of the firm because production had increased due to the incentive given to the foremen, while the cost for each part had decreased due to the removal of the premium and greater efficiency in working. Piecework also provided a set or standard rate for each job, that assisted in the calculation of engine cost; a situation that was necessary if reliable and profitable prices were to be set.

Watt jnr did not set labour standards, however, the moulding times incorporated in the piece rate calculations did in fact act as a de facto standard in the sense that if the foreman wished to maintain his income he had to ensure that his team produced the product within the time allowed. The men were still paid on a daily rate and it was up to the foreman to ensure that their time was spent productively because unproductive time affected his pocket directly.
It is to be noted that there is no record of similar calculations of piece rates taking place until 1808.

**Prices**

Originally, the older Watt and Boulton charged a yearly premium for their engines rather than a straightforward price, because they supplied the knowledge to build the engine rather than the individual parts. When first introduced, the premium was based on the savings in coal usage which resulted from the more efficient Boulton and Watt engine compared to the older atmospheric steam engine\(^{23}\). As the organisation supplied more and more engine parts, it charged for those parts supplied plus a yearly premium or royalty. Eventually, when the organisation was supplying the whole engine it became obvious that the pricing system was inadequate.

The price to charge seems to have been a continual problem to James Watt jnr and Matthew Robinson Boulton. Increasing competition, coupled with the fact that the annual premium was

\(^{23}\) Watt snr carried out a number of experiments to determine the relative efficiency of various sizes of engines and developed a calculation to enable him to determine the premium payable on any one engine. To decide the actual premium in any one year it was necessary to determine the amount of work done so he invented a device to count the strokes of the engine [Rolt, 1962; Dickenson, 1935]. Eventually, the premium was calculated by using a formula based on horsepower [Fleischman & Parker, 1994]
never popular with the customers, meant the partners had to pay strict attention to pricing. It was no longer sufficient to trade on quality alone. Also the firm had to be sure that they recovered their costs as they were now supplying complete engines. The change from charging an annual amount to a straightforward price also required a change in methods of calculation. To this end engine cost became the basis for price calculation.

There was a common pricing structure for the engines they built, whether they were built at Soho Foundry or assembled at the Soho Manufactory. Prices were constantly in their minds as can be seen from the considerable correspondence and calculation on the subject. The first word came from the elder James Watt in a letter to Matthew Robinson Boulton.

Soho June 1st 1796

Mr M. R. Boulton

Dear Sir

As your father & myself considering the general subject of premiums it appeared to us that they might with propriety be charged as follows taking Mr Southern's estimate of 12 horse engine for an example

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neat cost materials</td>
<td>£308</td>
</tr>
<tr>
<td>Manufacturing profit 20 pr%</td>
<td>68</td>
</tr>
<tr>
<td>Premium 50 pr Ct on neat cost</td>
<td>154</td>
</tr>
<tr>
<td>Boiler</td>
<td>60</td>
</tr>
<tr>
<td>10 pr% on</td>
<td>Do</td>
</tr>
<tr>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

24 John Southern (1758-1815) joined Boulton and Watt as an assistant draughtsman in 1782 and remained with the firm until his death in 1815. He was a trusted and valued friend and employee, he was admitted as a partner in 1810. Southern is reputed to have invented a device for measuring changing cylinder pressures in 1796 [Rolt, 1962; Roll, 1930; Dickenson, 1935].
or if you think that is too little
materials & 20 pr % 376
premium 50 pr % 188
Boiler + 10 pr cent 66
-----
£630

We think that we have no title to 50 pr % on boilers not being made by ourselves, there is little besides the risk of bad debts - however we wish to leave the whole open till we are all at home, & I think it cannot be satisfactorily settled till there is a view of this years transactions & profit, at present it is better to ask something too much than too little.

Small engines should pay a greater percentage than larger ones, otherwise will be attended with loss, as requiring so much trouble, we should look now to the conclusion of the patent & when all settle prices settle also what we can probably work for when that is required.

I have no news since my last & remain
Dear Sir
Yours affectly
James Watt

[B&W D/1]

While having an appreciation of the direct cost of manufacture the letter indicates an unsureness about indirect costs with the markups of 50% on cost as well as an allowance for manufacturing profit. By this time James Watt snr was acting in an advisory capacity to the others.

The young partners were obviously sensitive to public opinion as the following extract from a letter from Watt jnr at Newcastle to M. R. Boulton on 10th July 1798 where he wrote that the
... opposition we experienced from Murray\textsuperscript{25} at Leeds, that attempted by Hawkes here & the report generally prevalent & generally accredited of the enormity of our profits upon Rotative Engines, make me think seriously that we ought at an early period, perhaps at the close of our books in Sep\textsuperscript{r} to adopt a new Tarif of Prices. If the present premium on Rotatives were reduced to 30 per \%, we might keep it at that rate for a few months & then reduce it farther if judged eligible. It should also be an object of consideration, whether the Londoners should not be put upon the same footing with their neighbours in the Country. Perhaps 25 per \% might be advisable for Colliery Engines, in order still to keep up some distinction between them & others as arising from the very great difference of the value of savings. It will be prudent in us whilst we yet may, to secure the trade in our own hands, by removing in part the incitement to rivalship & bringing matters to that state, in which we can still carry on the business with a reasonable profit after the expiration of the patent.

[B&W E7]

They were concerned with mark up on cost. It must be remembered that at this point in time each engine was built to the requirements of the customer, however there was considerable standardisation of engine components and so a standard price could be set. Whether to charge a different price to customers in London was a question they struggled to answer and was one which was not resolved for some time.

James Watt jnr proposed a differential price structure in a letter to Boulton jnr a couple of months later when he wrote:

---

\textsuperscript{25} Matthew Murray manufactured engines in Leeds, Boulton and Watt had suspicions that Murray had infringed the patent but took no action against him until after 1800 when they opposed his patent application [Tann, 1980].
Above you have a synopsis of the new Estimates. They may reckoned to take place in all Engines sent from hence after the end of the present Month. In framing these, the old estimates have been left quite out of the question & we have proceeded upon what appeared to be the real costs by Foreman’s books. These we have determined by taking out all those of a size that have been made since the prices were raised & the steam cases added; we have then deduced an average cost and added about 5 per % to cover deficiencies & to provide for trifling additions either in the way of improvements or extraordinary size of Rotative Shaft & c. The Boilers have been taken as they stand charged in Foreman’s books (where a profit of 16 per % is already laid on by the Manufactory, which considering the little trouble we have with them is enough on that score) and their average amount has been added to the sum obtained as above for metal materials. This has been assumed as the full cost & to it has been added 33 per % for the country prices & 40 per % for London. An example will make this more clear.

The Average Cost of the MM of a 4 Horse Eng.  

<table>
<thead>
<tr>
<th>Horses</th>
<th>Country</th>
<th>London</th>
<th>Add1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Boiler</td>
</tr>
<tr>
<td>4</td>
<td>£350</td>
<td>£366</td>
<td>£32</td>
</tr>
<tr>
<td>6</td>
<td>£379</td>
<td>398</td>
<td>38</td>
</tr>
<tr>
<td>8</td>
<td>473</td>
<td>497</td>
<td>45</td>
</tr>
<tr>
<td>10</td>
<td>523</td>
<td>548</td>
<td>60</td>
</tr>
<tr>
<td>12</td>
<td>560</td>
<td>588</td>
<td>68</td>
</tr>
<tr>
<td>16</td>
<td>727</td>
<td>763</td>
<td>90</td>
</tr>
<tr>
<td>20</td>
<td>800</td>
<td>840</td>
<td>110</td>
</tr>
<tr>
<td>24</td>
<td>1040</td>
<td>1092</td>
<td>132</td>
</tr>
<tr>
<td>30</td>
<td>1120</td>
<td>1176</td>
<td>160</td>
</tr>
<tr>
<td>32</td>
<td>1156</td>
<td>1214</td>
<td>172</td>
</tr>
</tbody>
</table>

M R Boulton  
Scarborough  

Soho 11 Sep 1798

If the boiler is not to be furnished by us you deduct its cost as stated in the fourth column & we remain in proportion of the percentage charged for Premium. This appeared the simplest mode of proceeding - The London prices have been calculated at 40 per cent. It was thought advisable not to bring them down at once to the country prices, but to lessen the disparity gradually; the one is therefore reduced 17 & the other 23 per % -
Perhaps upon comparing these with the old prices, you may not think we have taken off enough; neither do I. But it may be well to go to work gradually, to try these for half a year & then perhaps to come down to 25 per % on the Country & 33 on the [London]

I have also to add, that Southern otherwise engaged, these estimates have been taken somewhat grossly and will admit of revisions and corrections when we are all together. For the present, they are on the safe side.


[MBP 353/61]

These prices were based on costs in the Manufactory, but as stated above they applied to those engines produced by the Foundry as well. The term MM refers to metal materials, ie. the cost of the various parts and the assembly of the engine (see Appendix B).

The following extract indicates further concern with public opinion as well as the effects of increasing competition. Boulton & Watt engines enjoyed a considerable reputation for quality, but they were expensive and there were a considerable number of other manufacturers in the market, who did not offer a product comparable in quality, but one that nevertheless met most of the customer’s needs at a lower price.

In a letter to James Watt jnr, who was in London dated Soho December 18 1798, Matthew Robinson Boulton wrote that he would

... if possible get an estimate [of brass air pumps] & forwarded by this evening’s coach & shall accompany it with a new list of prices of Engines - we find that considerable embarassment will ensue unless the reduction of our estimates is made very gradually the whole reduction proposed to take place before March 21st 1799 viz from 45 p% to 33 on London & f\text{im} 33 to 25 p% on country we think should be effected by monthly deductions - without this precaution we shall have much difficulty in steearing clear of Disputes upon
this subject & certainly not succeed in accomplishing the alteration with exciting public attention ...

[B&W 38/4]

A second letter to Watt, written later that day, lists the proposed prices with the further proviso that the premium be reduced on a monthly basis and stressing the need for gradual reductions. He wrote:

I send you herewith the prices referred to in my letter of this morning & we propose them for the ensuing month to be stated at one pence % less or at 34 & 28 pence % upon metal Maters & similar reductions to take place monthly till we arrive at the permanent standard - Perhaps it may be judged expedient to make a larger deduction from the London prices in order to bring them sooner to the same standard as the country. From your recent transactions with the Londoners you will be enabled to judge whether this distinction has or is likely to create any dissatisfaction & of course to decide upon the propriety of extinguishing it more rapidly ...

[B&W 38/4]

Watt jnr's reply came from London a few days later when he responded that he could not

... help thinking that the proposed monthly reduction will be troublesome & create some confusion with respect to orders transmitted by Lawson, or any other itinerant agent. The further reduction to be made at 4 pence % in one instance & 10 in the other is so small, that I do not fear its having the effect you apprehend, more especially as the last very considerable reduction was not attended with such consequences & appears indeed to have escaped observation. I should either propose to continue the estimates you now give, for six months, & then take 4 pence % from the Country & 5 pence % from the London price. The remaining 5 might remain upon the London Engines until this time twelvemonths. I presume you have not yet made new Estimates, nor do I think you can, until several Engines have been made with the proposed alterations, which I hope you are now carrying into effect. They will add to the price considerably, unless deductions can be effected in other matters ...

[B&W E/7]
On the eve of the expiry of the engine patent Watt jnr was still concerned with the image of the firm conveyed by the pricing structure as well as with dealing with the opposition. On the 24th April 1799 in a letter to John Southern on the question of prices and quality Watt wrote:

I think the estimates you propose sending to Mr Tewsbury very proper, and I also think it very right that the topics you state should be urged at some length, particularly that our prices now, comprehended nothing but a manufacturing profit & will not be effected by the expiration of our exclusive privilege. That it is not our wish to vie with others in lowness of estimates, but in goodness of workmanship, being well convinced by long experience that the best Engines are the cheapest in the end. ...

[B&W 33/5]

Even though the generally held view was that Boulton and Watt engines were the best available, Watt jnr kept his eye on the market realising that many potential customers were prepared to compromise quality if substantial cost savings were to be made.

In attempts to set a price for the different sizes of engines Watt continually referred to the cost of engines already built as they were listed in the engine book rather than base cost on a 'standard' engine for each capacity. The following examples are taken from a document entitled "Calculations for new Estimates 4th June 1801" and illustrate the calculation of price based on past cost, the document, in Watt jnr's handwriting, includes calculations for eight different size engines.
Example 1

18 Nov 1800

4 Horse

Bryson & son

add Cisterns for feed Apps

& hot water

Additional price of Boiler

2/- pr Cwt on 13 Cwt

------------

270 , 6

67 , 11

£337 , 17

But as a greater proportional profit should be laid on these small Engines to Compensate for the trouble of drawings &c it may stand in the Provisional Ests at £ 350.

[B&W 7/VI/14]

At this time 4 Horse engines were not very common and it was felt that a small engine may create extra cost in its design and assembly.

Example 2

14 Horse

1800

20 Aug Rigby & Chadwick

Deduct for Crank Fly Wheels

£30

do Extra size of B

10

-----

£460. 4

10 Dec Huddart & Co

Deduct for Crank & fly wheels

30

Do for stop pipe

5. 5

35. 5

-----

£454. 11

1801

21 Jan Hibbert & Smethurst

deduct for Dbl Crank Motion

21

Stop pipe & bonnet

5. 4

25. 4

-----

461
The second example shows the calculation of a base cost for these three engines by the removal from the calculation of those parts that make them different and then finding an average cost plus the cost of additional items and then a mark up. The costs for each individual engine manufactured were recorded in the Engine Books and as an example of the origin of the costs used in the price calculations the Engine Book for February 1800 - February 1802 [B&W 232] lists the costs (summary) for the Rigby & Chadwick engine mentioned above as:

<table>
<thead>
<tr>
<th>Item</th>
<th>Cwt</th>
<th>Qrs</th>
<th>Lbs</th>
<th>£</th>
<th>S</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cast Iron</td>
<td>192</td>
<td>2</td>
<td>5</td>
<td>210</td>
<td>17</td>
<td>1½</td>
</tr>
<tr>
<td>Wrought Iron</td>
<td>16</td>
<td>1</td>
<td>11</td>
<td>73</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Copper Brass &amp;c</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>53</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Boiler</td>
<td>35</td>
<td>25</td>
<td></td>
<td>73</td>
<td>19</td>
<td>4½</td>
</tr>
<tr>
<td>Stores</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Patterns</td>
<td></td>
<td></td>
<td></td>
<td>19</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Carriage</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Fitting</td>
<td></td>
<td></td>
<td></td>
<td>59</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>500</td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The price calculations, and there are many still in existence, all show the same attention to detail with succeeding price calculations being based on the average cost of previous engines of the same size.

As time went by, the products the firm offered became more standardised, but reference to past cost was continually made in the calculation of the price of engines. The mark up eventually declined to 25% and then to 20% with no extra premium for London.

As successful businessmen, the partners were concerned to ensure that costs were covered and a profit ensued. Watt jnr monitored costs and prices to ensure that this continued to be the case. For example, a document entitled "List of Engine Materials and Premiums from 30th Septr 1798 to Do 1799" [B&W MII/7/2] compares the price with the cost of all the engines built by both the Foundry and the Manufactory during that period. Differences between the profit and the computed profit based on a percentage applied to cost were calculated and in the majority of cases the actual profit was greater than the expected profit, in some cases considerably more so.

In price calculation no reference seems to have been made to the competition, with all calculations being based on previous cost. Boulton & Watt engines were in a unique situation, having been the first to use a condenser, leading to greater efficiency and cost saving. Because of this uniqueness, the firm traded on its reputation for quality but pursued with equal vigour those firms that pirated their designs and tried to undercut their prices. However, the impending
ending of their patent in 1800 and the subsequent expected expansion in competition forced their attention on the pricing structure.

Price calculations were not limited to the price of whole engines, a comprehensive list of prices for individual spare parts was built up. Generally these prices were based on the standard rates for making that part plus a mark-up of 20 - 25% [B&W 7/IV]. In order to calculate new prices reference was continually made to the cost of parts made previously. The comprehensiveness of this process is illustrated in a document relating to the calculation of the cost of a cast iron beam rather than a wooden beam for a 40 horse engine in 1802. There appears to have been an inquiry as to the extra cost, a cast iron beam having technical advantages over a wooden one.

<table>
<thead>
<tr>
<th>Beam Extra Materials A &amp; G Murray March 1802</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cast Iron Beam</td>
</tr>
<tr>
<td>Turning &amp; fitting Do</td>
</tr>
<tr>
<td>Part expence of pattern</td>
</tr>
<tr>
<td>2 Wrot Iron Cutters for Caps</td>
</tr>
<tr>
<td>16 Steel wedges</td>
</tr>
<tr>
<td>Blacking &amp; weighing</td>
</tr>
</tbody>
</table>

\[ \text{£ } 75. 7. 7\frac{1}{2} \]

Calculation of the difference between a Cast Iron Beam & a Wooden Beam for a 40 Horse

| Materials of Cast Iron Beam as above        | 75. 7. 7\frac{1}{2} |
|---------------------------------------------|
| Main Gudgeon                                | 5. 1. 21          |
| Outer end Do                                | 1. 3. 22          |
| Inner end Do                                | 1. 3. 24 cwt      |
| Caps for Do                                 | 1. 2. 16 say 11 at 20/- 11 |
| Boring & Turning Gudgeons & Caps            | 6. 6              |
| Do Main Gudgeon                             | 17. 6             |
Part Expence of patterns

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wooden Beam - charged at the present prices - 1802</td>
<td>£ 94.14</td>
</tr>
<tr>
<td>Wooden Beam</td>
<td></td>
</tr>
<tr>
<td>Main Gudgeon</td>
<td>4. 0. 10</td>
</tr>
<tr>
<td>Saddle plate &amp; Glands for int(r) extd</td>
<td>1. 3.</td>
</tr>
<tr>
<td>Gland for Centre of Beam</td>
<td>3. 0. 1</td>
</tr>
<tr>
<td>Sad &amp; Plate &amp; Glands for outer end</td>
<td>1. 1. 6</td>
</tr>
<tr>
<td>7 Pins &amp; Nuts inner and back end</td>
<td>151 at 7d</td>
</tr>
<tr>
<td>saddle plates</td>
<td>4. 8. 1</td>
</tr>
<tr>
<td>2 Beam Straps Nuts &amp;c</td>
<td>205 at 7d</td>
</tr>
<tr>
<td>Wrought Iron Gland for back end of motion</td>
<td>22 at 7</td>
</tr>
<tr>
<td>end of beam</td>
<td>176 at 7d</td>
</tr>
<tr>
<td>Turned pin for outer end saddle plate</td>
<td>47</td>
</tr>
<tr>
<td>Turning Centre Gudgeon</td>
<td>12. 6</td>
</tr>
<tr>
<td>Patterns</td>
<td>1. 1.</td>
</tr>
<tr>
<td>Weighing blacking &amp;</td>
<td>10.</td>
</tr>
</tbody>
</table>

Difference of Cost

\[ \text{Difference of Cost} \times 25\% = 79.0 \enspace \text{£} \]

Note that the difference in cost includes the mark up of 25% rounded down to achieve an even value, a common practice; this customer would then have been asked to pay an extra £79 to have a cast iron beam fitted instead of a wooden one. Also, there was no allowance for timber in the calculation of the price of the wooden beam because it was usual for the customer to supply this.

The document continues with the calculation of other parts based on "extracts from the printed Daybook...". The costs of past work were used in many calculations and estimates relating to future work and
the record of past costs formed an important data base to be used in the calculation of all prices.

Cast iron beam fitted to an engine built for Whitbread's Brewery in 1785. The beam replaced the original wooden one. The engine is located at the Powerhouse Museum, Sydney.

Buildings & Equipment

Being at the innovative edge of a new industry required the manufacture of machinery for use within the organisation. Extensive records were kept of this work, the costs involved in construction being transferred to a buildings and a machinery account. James Watt jnr was concerned with the accuracy of calculating the cost of these buildings, machines and other items. The problem was not one of calculating the direct cost, this was a simple process, but rather deciding how to allocate indirect cost. This was not so much of a problem in relation to items that were sold because the mark-up was designed to recover indirect cost. No satisfactory solution appears to have been found, yet it was not a problem confined to this organisation. Many new industries at the time also had to construct their own machinery and had similar problems of calculating its "true" value.
Watt jnr appears to have approached George Lee, a cotton manufacturer and an acquaintance of his Manchester days, for a possible solution. Lee replied in a letter written 11 March 1797:

I wish I could communicate to you any Information respecting the mode of Keeping Manufacturing Books - in the construction of Machinery we never yet could reduce it to a regular piece work or divide the Labour of Making & Repairing it in such a Manner as to determine the distinct cost of each - In the Manufactory I have attain'd rather more accuracy but yet far short of my hopes & wishes - but the Circumstances are so peculiar to it that I conceive it would be impossible to communicate the Mode in such a Manner as to be applicable to any other Business. The System such as it is has been form'd upon observation upon the essential and inferior points class'd in their respective Order of Importance - originally executed with a Minuteness incompatible with Convenience - such as taking Stock every week - but the first Object appears to me to be close personal Inspection for which there is no Substitute & then a moderate Understanding will analyse & arrange with as much Accuracy as is usually necessary - you must therefore descend to the Drudgery & you will in fallibly succeed. ...

[quoted in Tann, 1981, p 241]

It was important to be able to calculate a value for buildings and machinery because it was recognised that machinery and buildings were expended in manufacture and needed to be acknowledged. To this end depreciation, called reduction in value, was calculated and offset against profit each year but being unable to capitalise overhead meant that the amount allowed for depreciation would be insufficient and profit could be overstated and Watt jnr was very concerned with the accuracy of his accounts.
Other Calculations

Many other examples of Watt jnr's calculations and measurements, drawing on accounting information, and relevant to the management of the Soho Foundry are still available. Most of these calculations relate to the various operations carried out on the parts of the steam engine. For example B&W 37/3 "Times & Cost of Boring Nozzles Turning Main & Outer end Gudgeons - 1802" lists the time it takes to bore these parts for each size of engine manufactured, the labour cost per day and the total cost for the procedure. The time for each boring operation has been measured, recorded and costed and was then available to use in determining engine cost or negotiating piece rates with the employees. Along similar lines B&W 37/3/2 is entitled "Time & Calculation of the Costs of Turning Sundry Parts of Engines July 13th 1801" and shows the time taken for turning a number of parts for different size engines together with the labour cost for each operation. Another set of documents in the same bundle [B&W 37/3] show that Watt jnr monitored the piece rates paid to foremen in the Fitting Department in a document entitled "Profit made by men in fitting Nozzles".

Other information kept by Watt jnr includes further details of competing foundry prices [B&W MI/6/10; B&W MI/6/11; B&W MI/6/13]; further calculations of moulding costs [B&W 45/18] and B&W 451 contains "Piecework Prices for Moulders Soho Foundry 1802". This last document consists of a list of all the parts made by the moulders together with the piece price paid for labour to make them, the basis for this list was discussed earlier. The prices were
updated in 1808, 1810, 1812 and 1816. This price list filled the role of providing standard costs when working up an engine cost.

**Summary**

In James Watt jnr we find a man trained as an engineer and businessman, like many of his time, with a wide range of interests. He had many influential friends, who, like himself, were at the forefront of science and industry in the late eighteenth and early nineteenth century. Yet, unlike many of his contemporaries, Watt was not a self-made man. He had been brought up, and trained, with the knowledge that he would succeed his father in the management of the business. He was also given a very extensive education both in England and abroad which allowed him to experience and observe the way others attempted to deal with the problems that confronted them. The education he received emphasised those tools that would be necessary for him to succeed in later life. He received training in mathematics, at a time when mathematics was regarded for tradespeople only. He was trained in engineering including drawing and design. He was also initiated into the mysteries of the counting house, with book-keeping considered to be an essential part of his training. Throughout his life he was involved in experiments in chemistry and engineering, carrying out a number of experiments in adapting steam engines to marine applications and also in agricultural matters.
James Watt jnr was a methodical man, evidenced by his carefully kept notebooks, diaries and correspondence. He was concerned with facts as he saw them, to this end he situated himself within a network of information that he used to negotiate and manage from a position of knowledge. James seems to have taken nothing for granted, rather relying on his own calculations and measurements before making a decision. This is obvious in his dealings with the moulders and with his customers. He accumulated sufficient evidence to back his case or proposition before venturing an opinion.

Watt's training and experiences taught him to be pragmatic when looking for solutions to the problems that presented themselves. He lived at a time of great innovation, when there were no accepted ways of dealing with these new problems. He was involved in a new industry, that of a manufacturing engineer, unlike his father who acted more as a consulting engineer. The other members of the partnership left the day to day running of the Soho Foundry to Watt, who in turn placed great reliance on his managers Abraham Storey and John Southern. As an engineer and scientist he was concerned with facts that could be measured and calculated, so to him the accounting records were much more than lists of dealings with others, they provided a means of measuring and evaluating, a means of calculating and a means of summarisation. It was to accounting that he looked to provide facts about the way the business was operating and it was to accounting that he turned, on occasion for help in managing the business.
The Soho Foundry was a new venture, designed from its inception to build steam engines, consequently the factory was built to ensure smooth and efficient working, a great achievement when it is considered there were no examples to use as a model. The factory that was built and staffed with dedicated, highly skilled and innovative people operated for many years. The Soho Foundry was designed to operate in the same way as its products. As a steam engine was designed to produce power, so too was the factory designed to produce steam engines smoothly and efficiently. As steam engines were designed to be self-governing so too the factory, accounting providing an essential part of this governance.

The accounting system was set up to reflect the organisation of production. It was designed around profit centres and recorded the flow of materials and work from one department to another. Because the Soho Foundry was a pioneering venture it is important not to judge workable solutions found to the problems that arose in the light of present knowledge and practice because of the differing contexts. The accounting processes extant at the Soho Foundry in its early years continued for many years so it is reasonable to assume that they supplied the perceived needs of that time. Certainly the number of documents showing calculations still in existence indicates that the accounting system provided a data base that was used by Watt in the managerial process, yet it does not appear to have been used to produce budgets or other forecasts.

Attention was paid to the profit centres, the Smithy, the Foundry and the Fitting Shop, because these were the main areas of activity in the
organisation. Transfers between the profit centres were recorded and valued with a system of pre-determined costs being used to assign values to the products and materials transferred. The system used cost rates that did not appear to change very much over time. The rates were determined by activity and in the Foundry and Smithy were applied by the weight of product produced and based on the operation performed. Once established, standard rates simplified the processes of working up an engine cost, valuing transfers and the calculation of profit. An inconsistency appears in as much as there seems to have been no attempt to calculate cost variances or even to compare actual cost with the pre-determined rates, yet the Fitting Book\textsuperscript{26} recorded actual times and actual expenses. It could well be that such analysis simply remains to be discovered or that it was not considered to be necessary.

Cost accumulation was an important activity, and was a basis for further activity. Costs were used as a basis for prices and as a check on profitability. Prior costs were referred to when preparing quotations for the supply of engines, and they were referred to when working out prices for non standard engines or parts. The accumulated facts of the past then became a basis for the actions of the future.

The existing records of the Soho Foundry have very little to say about industrial relations. The one exception being the large number of documents pertaining to the question of whether the moulders

\textsuperscript{26} For an example of the format of the Fitting Book see Appendix C-1 and C-2.
should continue to be paid a daily wage or paid by the piece produced. These documents show the thoroughness of Watt in drawing together the available evidence and facts before coming to the decision that it would be more advantageous to pay piece rates. The moulders, who were very experienced in their craft, had the feeling that they would be better off under a piece rate system, however, Watt had to be convinced that such a scheme would be more profitable for the firm than the existing system. He drew together evidence from external sources, evidence from the accounting records and time books, estimates from the moulders themselves, estimates from his manager, and combined these facts in a series of calculations relating to each part produced. The answer pointed the way to piece work so this new system was introduced. Watt's calculations prevailed over the men's estimates, backed by such a powerful calculation how could Watt's conclusions be disputed? However, he monitored the profitability of the new system for the firm and the men and decided that in most cases all were better off than hitherto. These calculations evidence one of the few performance measures that appear to have been used, where Watt calculated the cost of moulding per hundredweight before and after the introduction of piecework. Watt went through the same exercise some years later presumably to ensure that it was still profitable to pay piece rates.

Watt was concerned about the behaviour of his employees as the following extract from a letter to Matthew Robinson Boulton, dated 6 January, 1802, indicates:
I have given their Christmas presents to the Foundry Apprentices. Three have had nothing viz. Charles Betts for frequenting alehouses in company with S. Williams & Meadows and otherwise neglecting his duty; Tho’s Withers for keeping his time badly, giving in a fallacious acct., of it & being impertinent & idle. I have appointed the fathers of these two to come over on Saturday. The other is Baker, who works with W. Harrison and who appears in every respect a waster.

[B&W 2/28/1]

Charles Betts worked with Thomas Mousley as an apprentice moulder, Withers was also an apprentice moulder while Baker was an apprentice working with William Harrison a fitter [B&W 6H, 45]. The letter indicates something of Watt’s dealings with the men but does not give any indication of any further consequences of the offences.

If one of the definitions of management accounting is that it be used to provide information for decision making then management accounting was very much in evidence at the Soho Foundry. The nature of Watt jnr, the overseer was that he was a rationalist who was interested in facts. Accounting numbers helped provide those facts, give shape to the enterprise and confirm decisions. Accounting also provided a data base of information on which to base decisions concerning future actions and future business.

The Soho Foundry was in the business of selling power but all efforts were made to ensure that the sale of power was a profitable one. The Soho Foundry continued to manufacture steam engines for many years. In 1810 a new partnership agreement was made between James Watt jnr and Matthew Robinson Boulton, being the only survivors of the original partnership. Eventually, Watt jnr became the sole proprietor of the Soho Foundry when he bought out Boulton
for £30000 [Gale, 1962, p 83]. In 1841 Watt formed a partnership with three others to carry on the Soho Foundry. After Watt's death in 1848 the Foundry continued under the name of 'James Watt and Company' making steam engines and other products, but it was losing momentum. In 1894 the firm became insolvent and the site was sold to W & T Avery Limited who still remain in possession [Gale, 1962].
CHAPTER 6

CONCLUSION

This thesis has been concerned with the use of accounting as an aid to management in the late eighteenth century. It has concentrated on the activities of two men operating very different businesses yet both exhibiting similarities in their use of accounting information to help define and regulate their respective operations. The plan of the thesis has been to examine the accounting practices of these men, as far as possible, in the context of the society and the times in which they lived. A broad understanding of the term 'management accounting' has been adopted to encompass the contextual differences between the late eighteenth century and the connotations placed on that term in the 1990s. The thesis has been concerned to show a relationship between the use of accounting and other calculative techniques and the rational, materialist outlook of the two men in question. An outlook which equipped them to manage expanding businesses at a time of economic and social change.

Chapter One put forward the view that the purpose of management accounting was to assist the management of an enterprise by providing information to help with the processes of planning, controlling, organising and decision making. Management accounting, it was pointed out, includes but is not limited to, cost
accounting, and emphasises the internalisation of the accounting process. The management accounting practices of eighteenth century Britain employed by Watt jnr and Oldknow bear many similarities with modern practices yet lack the formal procedures that have developed in the intervening period.

The industrialists of the late eighteenth century were without the benefit of established practice so they had to devise their own solutions to problems. Book-keeping, or 'merchants accounts', was well understood and provided a data base of information that was able to be utilised. Often however, the accounting information arising from internal transactions was only partially integrated into the book-keeping system and sometimes not integrated at all. However, integration is not necessarily a prerequisite for the recognition of accounting practices and often developed as the value of cost and management accounting became recognised [Edwards, 1989; Fleischman & Parker, 1990]. The accounting records of the Soho Foundry indicate a partial integration, of what can be termed management accounting, with the financial records. At the time there was no requirement for disclosure so the accounts were produced for the benefit of the proprietor, or proprietors, and were designed to satisfy their information requirements, a factor which influenced the implementation of particular accounting systems.

The close relationship of the proprietor and his accounting practice supports the use of biography as an appropriate tool for the examination and explanation of those practices. The subjects of the two case studies are offered as examples of the way two men dealt
with the accumulation of information and it is not suggested that either one was typical or can be used as a model of common practice. The interest of biography lies in the observation of individual action as a consequence of that individual's background, circumstance and value system. Yet because history is made up of individual stories, biography can serve to further illuminate the past.

The time around the end of the eighteenth century was chosen as the period of interest because it offers much scope to observe, with the benefit of some two hundred years distance, the formative processes of modern management accounting. With the compression of hindsight, change appears to have been rapid and the movement from a domestic system of manufacture in industries such as the cotton industry took only a few years allowing shifts in accounting techniques to be observed in the records of men such as Samuel Oldknow.

Many people in the eighteenth century saw 'reason' established as the basis of scientific endeavour and social relations; this, together with the idea that man had mastery over nature meant that people were released from the constraints of the past and looked to the future with a new confidence. Chapter Two was concerned with this new view of society and its creation of an attitude that looked towards progress and the future. An attitude that all things were possible, especially for the rising middle class, a group of people who looked to their own abilities to advance their material interests.
Underlying these profound changes in attitudes was a reappraisal of long held beliefs, originating with scientific thought in the seventeenth century. The concept of divine purpose giving way to an autonomous 'reason' as the final arbiter based not on externalities but on the internal consistency of the systems being revealed creating a reality based on the observable and the tangible. The laws of nature became equated with the law of God and to have the power of God all that remained was to discover the laws of nature.

The tenor of the Enlightenment, in England, was one of pragmatism where people were more interested in the benefits that came from knowledge rather than the knowledge itself. However, the acquisition of 'useful knowledge' was not a random process but related to knowledge that could be applied for the betterment of society. Often an individual might argue that the betterment of himself resulted in the betterment of society at large, nevertheless despite a large amount of self interest, the eighteenth century saw the rise of a number of movements aimed at improving the conditions of all stratas of society.

One such 'useful knowledge' was calculation and the eighteenth century witnessed an increase in numeracy and an extension of mathematical methods to science and other fields of endeavour. Mathematics was viewed as a way of instituting order and system. Arising from this system of order, quantification imposed an objective reality that lent credibility to rational decisions and actions.
Accounting had been practiced in some form, in Britain, for centuries prior to the Industrial Revolution. However, the methods of accounting in use were not designed to serve the needs of industrialists attempting to experiment with new forms of industrial organisation. Accounting did have merit in its ability to impose order upon business affairs so a knowledge of book-keeping was considered to be useful knowledge. The industrialists were required to adapt the existing accounting practices to provide information suitable for their needs.

Accounting, being based on calculation and mathematical objectivity, provided a system of ordering reality and governing relationships. Relationships that, until the Industrial Revolution, were essentially between people contracting with each other. The principle form of manufacture prior to the establishment of factories was based on the relationship between the manufacturer and individuals working in their own workshops. Accounting was used to record the obligations that existed between the manufacturer and worker and to safeguard the product from theft.

The accounts kept on the large, landed estates recorded the activities involved in managing what, in some cases, were very large enterprises involved in multi-faceted activities. This accounting was designed to ensure that those entrusted with responsibility discharged those responsibilities. With the concentration on the charge/discharge of responsibilities this system was used in some early manufacturing organisations [Jones, 1985] but did not lend
itself very readily because the analysis of results was very cumbersome.

A third strand of accounting came from what was known as the 'Italian method' or double-entry accounting. Used by the merchants to impose order on their often very varied affairs, double-entry provided a system of book-keeping that enabled a systematic analysis of transactions. Double-entry had attractions for manufacturers and could be adapted to their needs as the instructions given by Hamilton [1788] indicate, because it provided a system of rules that resulted in an objectivity which accorded well with the rationalist views held by many manufacturers living in the eighteenth century.

Other conditions prevalent in eighteenth century society influenced the attitudes and consequently the practices of those born into that society. Chapter Three considered some of the influences that helped form the background to the Industrial Revolution and helped shape the personalities of the subjects of the case studies and had a great influence on the uses made of accounting.

During the eighteenth century 'improvements' had transformed the face of the landscape with the enclosure of common lands forcing the landless to move to the towns in search of work. Thus, a pool of labour became available that looked to alternative forms of employment to provide an income. This labour provided new challenges for those who wished to employ them, challenges that were met by the imposition of sometimes very harsh discipline on
those employed within the factory walls. Factory managers were in the position of having to train their employees to operate in an unusual and often, to the workers, a completely foreign environment governed by bells, whistles and the production schedule.

A significant influence on the growing numbers of manufacturers, as the eighteenth century progressed, was their religion. The Protestantism arising from the Reformation in the sixteenth century emphasised the direct relationship of individuals with God and their responsibility for their actions to God. A large number of the industrialists of the eighteenth century were Protestants and a significant number of these were members of congregations which had disassociated themselves from the established church. The members of these minority groups formed networks of support and mutual help which contributed to their success as manufacturers.

Unitarianism was a religious movement that had great relevance for Samuel Oldknow and some influence on James Watt jnr. Described as rational religion, Unitarianism dismissed much of traditional Christian orthodoxy as irrational superstition and appealed to common sense. The adherents of Unitarianism stood for liberty of conscience and thought and freedom of worship. At the core of the Unitarian congregations was a successful elite who saw their affluence as a reward for their own hard work, calculation and foresight guided by their faith in reason. This elite shaped the views of the congregation as well as financially supporting the chapel and its minister.
The eighteenth century was noted for its societies and clubs. Societies and clubs which addressed all levels and aspects of society. Of note were the various scientific and philosophical societies which formed networks of like-minded people who corresponded and co-operated on the solution to various practical problems that faced them. Two famous examples of these societies were the Lunar Society of Birmingham and the Manchester Literary and Philosophical Society. While Oldknow does not appear to have been a member of either of these; Watt jnr had dealings with both. The members of both of these societies were men of broad and diverse interests brought together by an interest in science and its application to the problems of industry. That they were often, dissenters, Unitarians and Whig in politics, emphasises their common interests.

Such was the background to the eighteenth century with its strong emphasis on rationalism and the application of science to the betterment of industry and society in general. Such were the influences that came to bear on Samuel Oldknow, Unitarian, Freemason, member and later president of the Derbyshire Agricultural Society. A man noted for his experiments in agriculture and community building almost as much as the contribution he made to the cotton industry.

While Oldknow's artistic temperament and grand visions appear to have had a deleterious effect on his fortune he did manage to organise hundreds of people to do his bidding. Oldknow's career is interesting because it spans the period during which the cotton
industry changed from being operated on the domestic system to factory production. Oldknow's use of accounting to keep himself informed reflects this change in organisation. Unfortunately Oldknow's remaining records are not sufficient to gain a complete knowledge of his affairs and activities, however, sufficient remains to give a good indication of the system he employed in his various business enterprises. Oldknow was a first generation industrialist in the sense that he, along with a number of others, pioneered the use of factory production in the cotton industry and was required to develop accounting procedures where there were no suitable examples to draw from. On the other hand, James Watt jnr had the experience of his father and Matthew Boulton in established businesses as a point of reference in his business activities.

James Watt jnr was an accomplished engineer, trained by his father to assume the role of a manufacturer. His training encompassed mathematics and book-keeping as well as the problems of manufacture. He was a member of the Lunar Society and the Manchester Literary and Philosophical Society, and was conversant with the then current issues of science. His diaries show him to be a cautious man, not willing to commit himself until he had assessed and measured the possible courses of action. The records that remain of Watt jnr are extensive and allow an appreciation of the accounting of the concerns under his control and show that he placed reliance on accounting data in a number of situations.

The two businesses discussed show a number of similarities. Oldknow's Mellor Mill and the Soho Foundry both represent a
concentration of resources in a single institution with attendant problems of maintaining efficiency in the face of increasing competition. Both men were often away from home attending to matters of business and their other diverse interests, both men were involved in their community, Oldknow in developing Marple and Watt jnr in various activities in Birmingham, being appointed High Sheriff of Warwickshire in 1829 [Fairclough, 1984]. Because they attended to these other interests they needed to be aware of the state of their respective businesses and accounting helped in meeting this need.

How Accounting Assisted in Management

Accounting assisted both men by providing information about the state of their respective organisations which can be restated under the accepted functions of management:

Organising

Watt jnr attached great importance to the Soho Foundry Profit and Loss statement and particularly the Profit and Loss statements for its constituent operating departments with breakdowns of the figures and corrections in Watt's own handwriting. The engine books were used by Watt in many situations to monitor engine cost and calculate prices. The accounting system instituted at the Soho Foundry shows a partial integration of costing records with financial records to assist in the determination of departmental profitability. To this end a system of pre-determined transfer prices was used to
facilitate the transfer of materials between the operating departments. The costing records also show an appreciation of the need to incorporate overhead in the calculation of engine cost and departmental profits.

Oldknow, too, used accounting reports to keep abreast of the course of his business affairs. The prime examples of this process being the series of stock sheets which detail key performance indicators that show production, production cost, wages and sales for four week periods. Oldknow also had prepared monthly profit statements showing the profitability of Mellor Mill. Other statistics, that the Oldknow records show were prepared, were contained in the series of statements entitled 'Sent Up Mr Oldknow' showing the daily production and the cost of spinning. Oldknow's ledgers no longer exist so it is not possible to determine his chart of accounts but it does seem probable, based on the records that do remain, that he kept an eye on the profitability of the various branches of his sometimes extensive empire.

Control

One of the uses to which management accounting is traditionally put is that of assisting management in the control of the organisation. Oldknow's records indicate a number of instances of data being collected for the purposes of control. An example being the 'Report Book' which represented a record of the behaviour of the people involved in working on the cutting frames. The Spinner's Accounts
from Stockport provide an interesting record that could be used for control because the production of each spinning frame is linked to the name of the spinner in charge of that particular frame. Spinning records from Mellor do not tie the spinner to the output, but by the time Mellor became established a different technology was in place and spinning was no longer a skilled trade. Aspects of control were also present in the monthly performance indicators and the accounts that recorded the materials sent to and received from the outworkers employed in spinning and weaving.

The records of the Soho Foundry indicate a concern with measuring the output of various operations carried on within the Foundry. This information does not appear to have been collected on a regular basis but then the operations carried on were very different to the regular routine of a cotton mill. The organisation of the Foundry was such that day to day control was in the hands of managers who were continually on the factory floor. One control mechanism that appeared to work well was the introduction of piece rates for the foremen, the fact that they received the difference between the rate for a piece of work and the amount paid to their team of workers encouraged efficiency. Watt jnr, on a number of occasions, monitored the efficacy of this arrangement. Records such as the Fitting Books maintained a continual monitoring of the time and cost of fitting an engine and the calculation of the profitability of the operating departments could have been used as a control tool.
Decision Making

James Watt jnr drew on the accounting system to assist in his negotiations with the moulders. He needed to be sure that the proposed change in the method of payment would not adversely affect the profit of the Foundry. This assurance was given by the series of calculations both before and after the piecework negotiations. Similar calculations exist for various activities of the Fitting Department.

Prices seemed to occupy much thought especially in the light of the impending increased competition after the cessation of the engine patent in 1800. In all the price calculations the cost of construction has been taken into account. As well, when quoting on modifications to existing engines the tendered price was based on cost as calculated in the costing records.

That the statistics gathered by Oldknow were used for decision support is not immediately obvious, in such a competitive business as the cotton industry the determination of prices was through the operation of the market, however, Oldknow needed to be aware of his costs in order to decide whether to remain in that segment of the market. While Oldknow developed a reputation for being a poor businessman, this largely came from his vision outstripping the resources of his pocket rather than poor management of the operation of those activities he had established. After all the Mellor Mill operated under his control for some thirty six years until his death brought an end to his involvement.
Even though the use made of such information by Oldknow and Watt was often not continuous the existing evidence is sufficient to support the view that management accounting was an important part of their approach to management. The instances that survive serve to illustrate the familiarity of both men with the benefits that can accrue from a system of accounting.

**Accounting as an Expression of Objectivity**

This thesis has indicated that both Samuel Oldknow and James Watt jnr made use of accounting information in the management of their respective enterprises. Both men were faced with organisations that were large and complex, they were both faced with increasing competition in the market, they were both confronted with a need for an objective evaluation of aspects of their respective businesses. Both men had received training in accounting, Oldknow from the time he commenced work in his uncle's drapery business and Watt from his work experience at Bersham and Manchester as well as the instruction he received while in Europe. They both had an appreciation of the advantage that could be gained from accounting.

Accounting had attractions that appealed to the rational, materialist, positivist philosophy that each had adopted because it provided a system of measurement leading to an objectivity that was not otherwise obtained. Also, accounting provided a quantification of performance that accorded well with the pragmatic outlook of both
men and provided an order from the apparent chaos of a multitude of activities which complemented and supported the observations each made.

The management accounting processes used by Watt and Oldknow bear similarities to modern management accounting practice, but there are differences. It is important to evaluate the accounting these men used in the context of the period in which they lived and not to bring modern standards to bear. As has been stated previously there were no models of practice and few people trained in the needs of factory accounting, yet each man developed systems of providing the information he perceived necessary to assist him in management. These systems are recognisable in modern terms as comprising management accounting.
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Appendix B

Soho Foundry

List of Metal Materials for a 36 Inch single 8 Foot Stroke Steam Engine

[B&W 33/6]

A LIST OF THE METAL MATERIALS, for 36 Inch single 8 foot stroke Engine

To be furnished by

BOULTON & WATT,

List of Metal Materials for a 36 Inch single 8 Foot Stroke Steam Engine

1. CYLINDER; Top, its Plate and Screws; Bottoms; Gland, its Brasses and Bolts; and Screws for Top and Bottoms.
2. Bolts, with their Nuts and Washers, for holding down the Cylinder.
3. Casing for the Cylinder; Pipes and Screws.
4. Pifton, Cover, and Screws; Plate and Screws, and Spanner.
5. Nozzles compleat, with Screws, and two Sets of Valves, Racks and Shifters.
6. Pifton Rod, its Cap and Cutters.
7. Perpendicular Steam-Pipe and Eduction-Pipe, and Screws.
8. Condenser-Valve, Socket-Pipe, Blowing-Pipe and Valve, and Screws.
9. Injection Cock, Pipe and Valve, Rod and Screws.
10. Air Pump, Top, Gland, Brasses and Bolts; Bottom; Bucket; and Valves mounted, False Face, Door, and Screws.
13. Rods to hang ditto to Beam.
14. Main Gudgeon, Plummer Blocks, Bolts, Brasses and Glands.
15. Beam Straps and Glands.
16. King Rod, Socket, Round Pins, and Bearing Plates.
17. Arch-Pipes, Arch-Stays, and Bearing Plates.
18. Arch-Plates, Arch-Stays, and Bearing Plates, and Bolts.
20. Great Chains for Inner and Outer End of Beam, and Cross Bars.
22. Air-Pump-Chains, and Arch-Bolts.
23. Martingales, their Bolts and adjusting Screws.
24. Rod and Bracket for Plug, and Screws.
25. Working Gear compleat.
27. Hot Water Pump, compleat.
29. Steam Pipe for One Boiler with Valve in Socket, and Screws.
31. Manhole Pipe, Cover and Screws for One Boiler.
32. Damper and Vanity Gear and Basin Bars, Dead Plate, Fire Door, and Frame for One Boiler.
33. Waste and Return Pipes for inner End, mounted.
34. Barometer Pipe, Cock and Scale.
35. Steam Gage and Scale for One Boiler.
36. Ciltern Valve.
37. Ciltern Body, Plate, and Nuts.
38. Cement and Cement.
### Cylinder

<table>
<thead>
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<th>Operation</th>
<th>Hours</th>
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<tr>
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<tr>
<td>Turning and boring both for Gland</td>
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<tr>
<td>Turning and boring both of Stuffing</td>
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</tr>
<tr>
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</tr>
<tr>
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<tr>
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<tr>
<td>Fitting Plate and Spacers</td>
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<tr>
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<tr>
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</tr>
<tr>
<td>Bush to Gland</td>
<td>1.0</td>
</tr>
<tr>
<td>Fitting Plate and Spacers</td>
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<tr>
<td>Boring out the Cone</td>
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<tr>
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</tr>
<tr>
<td>Fitting Plate and Spacers</td>
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</tr>
<tr>
<td>Boring out the Cone</td>
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</tr>
<tr>
<td>Turning the Cone</td>
<td>1.0</td>
</tr>
<tr>
<td>Drilling the Cone</td>
<td>1.0</td>
</tr>
<tr>
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<tr>
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<td>1.0</td>
</tr>
<tr>
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<tr>
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</tr>
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<td>Fitting Plate and Spacers</td>
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</tr>
<tr>
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<tr>
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<td>1.0</td>
</tr>
<tr>
<td>Fitting Screws, Lockers, and Bush to</td>
<td>1.0</td>
</tr>
<tr>
<td>Bush to Gland</td>
<td>1.0</td>
</tr>
<tr>
<td>Fitting Plate and Spacers</td>
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</tr>
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<td>1.0</td>
</tr>
<tr>
<td>Turning the Cone</td>
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<tr>
<td>Drilling the Cone</td>
<td>1.0</td>
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<tr>
<td>Fitting the Pin</td>
<td>1.0</td>
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<tr>
<td>Fitting Plate and Spacers</td>
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<tr>
<td>Fitting Screws of the Gland</td>
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<tr>
<td>Bush to Gland</td>
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<tr>
<td>Fitting Plate and Spacers</td>
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<tr>
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</table>
### Appendix C-2

**Soho Foundry**

**Fitting and Construction Book**

**Detail Page 1**

[B&W 291]
## Appendix D-1

### Soho Foundry

*Engine Book January 1801*

[(B&W 232)]

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Baulk Collar</td>
</tr>
<tr>
<td>2</td>
<td>Copper Collar</td>
</tr>
<tr>
<td>3</td>
<td>Brass Seat</td>
</tr>
<tr>
<td>4</td>
<td>Brass Guides</td>
</tr>
<tr>
<td>5</td>
<td>Working Gear Baulk</td>
</tr>
<tr>
<td>6</td>
<td>Copper Face on Valve</td>
</tr>
<tr>
<td>7</td>
<td>Baulk in the Lower Parts of Top Valve</td>
</tr>
<tr>
<td>8</td>
<td>Baulk in Bore of Foot Valve</td>
</tr>
<tr>
<td>9</td>
<td>Copper Facing on Baulk Valve</td>
</tr>
<tr>
<td>10</td>
<td>Baulk Facing Powder down</td>
</tr>
<tr>
<td>11</td>
<td>Baulk Blocks for dim</td>
</tr>
<tr>
<td>12</td>
<td>Copper Facing on Falt Face</td>
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### Nobs

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<tr>
<td>1</td>
<td>1.64</td>
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<tr>
<td>2</td>
<td>1.52</td>
</tr>
<tr>
<td>3</td>
<td>1.52</td>
</tr>
<tr>
<td>4</td>
<td>1.03</td>
</tr>
<tr>
<td>5</td>
<td>1.12</td>
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<tr>
<td>6</td>
<td>0.75</td>
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<tr>
<td>7</td>
<td>0.75</td>
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### Copper Pipes

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<tbody>
<tr>
<td>1</td>
<td>Foot of 1/2 Inch Feed Pipes and 6 Fittings</td>
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<tr>
<td>2</td>
<td>1 Inch Gage Pipe</td>
</tr>
<tr>
<td>3</td>
<td>1 Inch Pipe and 5 Flanges to convey Steam to Cylinder</td>
</tr>
<tr>
<td>4</td>
<td>7/8 Inch Gage Pipe and 3 Flanges</td>
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### Miscellaneous

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<td>2</td>
<td>Baulk of 1 Inch, 3/4 Inch, and 1 Inch</td>
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<tr>
<td>3</td>
<td>Baulk Cock for System</td>
</tr>
<tr>
<td>4</td>
<td>Dims for Steam Cist</td>
</tr>
<tr>
<td>5</td>
<td>Baulk of 1 Inch, 3/4 Inch, and 1 Inch</td>
</tr>
<tr>
<td>6</td>
<td>Baulk Cock for System</td>
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*(Page 378)*
**Appendix D-2**

**Soho Foundry**

**Engine Book Detail January 1801**

[B&W 232]

<table>
<thead>
<tr>
<th>Cylinder and Valve belonging to it</th>
<th>Fitting line</th>
<th>Fitting</th>
<th>Fitting Screws to the Gland and Cover to the L.D.</th>
<th>Fitting Screws to the Gland and Cover to the L.D.</th>
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<tbody>
<tr>
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<td></td>
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</table>

<table>
<thead>
<tr>
<th><strong>Steer Case</strong></th>
<th><strong>Draw and fitting it</strong></th>
<th><strong>Fitting</strong></th>
<th><strong>Fitting</strong></th>
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</thead>
<tbody>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Air Purge</strong></th>
<th><strong>Fitting</strong></th>
<th><strong>Fitting</strong></th>
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<table>
<thead>
<tr>
<th><strong>Piston</strong></th>
<th><strong>Fitting Screws to the Center</strong></th>
<th><strong>Fitting the Plunger between</strong></th>
<th><strong>Fitting the Piston and Rod</strong></th>
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</thead>
<tbody>
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<tr>
<th><strong>2 3 4 5 6</strong></th>
<th><strong>8 9 10 11 12</strong></th>
<th><strong>13 14 15 16 17</strong></th>
<th><strong>18 19 20 21 22</strong></th>
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Appendix E

Soho Foundry

Journal entry showing the division of general expenses
30 September 1798
[B&W 295]

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<tr>
<td>General Expenses</td>
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<tr>
<td>Setting</td>
<td>£120</td>
</tr>
<tr>
<td>New Building</td>
<td>£150</td>
</tr>
<tr>
<td>New Machinery</td>
<td>£100</td>
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Total: £650
Soho Foundry
Journal entries showing transfers 30 September 1798
[B&W 295]
Appendix G

Soho Foundry

Engine Day book showing sale of Hibbert & Smethurst Engine

[B&W 256]
Appendix H

Soho Foundry
Foundry Department Account 1798
[B&W 294]
<table>
<thead>
<tr>
<th>Date</th>
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<tbody>
<tr>
<td>1 Jan 1798</td>
<td>Beginning of the account.</td>
</tr>
<tr>
<td>2 Jan 1798</td>
<td>Paid for materials.</td>
</tr>
<tr>
<td>3 Jan 1798</td>
<td>Received materials.</td>
</tr>
<tr>
<td>4 Jan 1798</td>
<td>Worked on project.</td>
</tr>
<tr>
<td>5 Jan 1798</td>
<td>Received payment.</td>
</tr>
<tr>
<td>6 Jan 1798</td>
<td>Continuing work.</td>
</tr>
<tr>
<td>7 Jan 1798</td>
<td>Received labor payment.</td>
</tr>
<tr>
<td>8 Jan 1798</td>
<td>Worked on project.</td>
</tr>
<tr>
<td>9 Jan 1798</td>
<td>Received payment.</td>
</tr>
<tr>
<td>10 Jan 1798</td>
<td>Finished project.</td>
</tr>
</tbody>
</table>

**Appendix I**

Soho Foundry

Smithy Department Account 1798

[B&W 294]
With the top steam valve and bottom exhaust valve open and the upper exhaust valve and lower steam valve closed as shown, the steam pressure above the piston and vacuum below cause it to descend. The valves are then altered by the tappets so that steam is admitted below the piston and the space above is put into communication with the condenser, where the cold water spray is working. Warm water is pumped from the condenser to the boiler. The paths of the piston-rod and plug-tree are kept vertical by the parallel motion.

Boulton & Watt's Rotative Engine, 1788.
DRAWING SHOWING DIAGRAMMATIC SECTIONAL VIEW.
NEG. NO. 306/55

Appendix J

Diagrammatic View of

Boulton & Watt's Rotative Engine, 1788
[Science Museum - London]
To be SOLD by AUCTION,

at the house of

Mr. John Wright, the Navigation Inn, in Marple,

in the parish of Stockport, and county of Chester,

On THURSDAY the 27th day of SEPTEMBER, 1798,

at three o'clock in the afternoon,

Subject to such Conditions as will be then and there produced,

THE ESTATES hereafter-mentioned,

Situate in STOCKPORT, MARPLE, and DISLEY, in the county of Chester, and in MELLOR, in the county of Derby,

In the following Lots;

LOT 1. ALL those extensive PREMISES, late in the occupation of Mr. Oldknow, and now occupied by Messrs. Parker, Sykes, and Co., pleasantly situated in the Higher Hillgate, Stockport; consisting of a good House, Stabling, Offices, Garden, and commodious Buildings five stories high, now used for Spinning, and the Manufacture of Muslins and other Piece Goods, and has every necessary Convenience for making One Thousand Pieces per Week; the site of which contains about 7640 square yards, part freehold and part leasehold, for long terms of years. Together with an excellent STEAM ENGINE, of Messrs. Boulton and Watt's constructing; and many valuable Fixtures, which will be sold therewith.

LOT 2. Five good, substantial BRICK DWELLINGS, with a Picking-Room and Loom-House, standing on lands held for ninety-nine years, under the Rector of Stockport, adjoining the above. The first of these lots is let for £520 a year, and the second for £80; making together a neat rent of £600 a year.

LOT 3. All that ESTATE of INHERITANCE in Fee-Simple, called FURTHER DAN BANK, situate in Marple, in the parish of Stockport aforesaid; consisting of a Messuage or Farm-House, and convenient Outbuildings, and several Closets, Fields, or Parcels of Land, containing 38 acres, 1 rood, and 18 perches, of the Cheshire large measure, or thereabouts, now in the occupation of Mr. Stephen Bellout.

LOT 4. All that COPYHOLD ESTATE of INHERITANCE, called WATERSIDE, in Disley, in the parish of Stockport aforesaid; consisting of a handsome Stone House and Outbuildings, and several Closets, Fields, or Parcels of Land, containing 3 acres, 3 roods, and 2 perches of land, of like measure, situate in White hall, in the county of Derby, now occupied therewith, by the said Thomas Woolley.

LOT 5. One MESSUAGES or DWELLING-HOUSE, with 5 acres and 39 perches, Statute measure, or thereabouts, of Meadow and Pasture Land, known by the name of ROUTING WALLS, in the possession of George Hindley, as tenant at will, situated on the Banks of the Peak Forest Canal, in Marple, eligibly situated for a Boatman working from Whaley to Marple.

LOT 6. A PLOT of LAND, situated on the Banks of the Peak Forest Canal, at the foot of the Northerly Stone Bridge in Marple, over the said Canal, containing 1 rood and 12 perches, Statute measure; very eligible for erecting Lime Kilns upon.

LOT 7. One STONE DWELLING-HOUSE, with 314 yards of Garden Land, and other appurtenances, situate on the road side between Marple Chapel and Marple Lime Kilns, now in the occupation of John Woodall, and his undertenants.

LOT 8. One STONE DWELLING, adjoining to lot 7, with 273 yards of Garden Land, and other appurtenances, now in the occupation of Thomas Conway.

LOT 9. One STONE DWELLING, adjoining to lot 8, with 295 yards of Garden Land, and other appurtenances, now in the occupation of Mrs. Wilson.

LOT 10. One MEADOW, adjoining to lot 9, containing 3793 yards, in the occupation of Richard Grifflins, with the Oak Timber growing in the force thereof.

LOT 11. The INHERITANCE and FEE-SIMPLE of and in the Estate, called DRAKE CARR, situate in Mellor aforesaid; consisting of a Messuage, Outbuildings, and about 17 acres of Land, of the last-mentioned measure, and a quantity of Oak Timber growing thereon, now in the occupation of Messrs. Barton's, Stott, Dodgson's, and Co., or their undertenants.

LOT 12. The INHERITANCE and FEE-SIMPLE of and in the Estate, called TURNER'S, situate in Mellor aforesaid; consisting of a Messuage, Outbuildings, and about 12 acres and 23 perches of Land, of the last-mentioned measure, now in the occupation of William Stotar.

LOT 13. Seven STONE DWELLING-HOUSES, situate on Cobden Edge, in Mellor aforesaid, together with a Field, containing 8 acres, 1 rood, and 21 perches, of the last-mentioned measure, now in the occupation of Matthew Howard.

For particulars apply to Mr. Oldknow, of Medor aforesaid, the owner, or to Mr. Dewhurst, Attorney, in Marple aforesaid, who will direct proper persons to shew the different Estates.

CLARKE, FRINTER, STOCKPORT.

Appendix K

Notice of Auction

[SO 838/5]
Appendix L

Mellor Mill Monthly Statement

[SO 826/17]
Appendix M

Pay Tickets - Mellor Mill

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<th>Item</th>
<th>£</th>
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<td>Rent</td>
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<td>30</td>
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<tr>
<td>Shambles, Meat</td>
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<td></td>
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<tr>
<td>Potatoes 3s.</td>
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<td>10</td>
<td></td>
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<tr>
<td>Coal</td>
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</tr>
<tr>
<td>Laundry articles</td>
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<td>6</td>
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<tr>
<td><strong>Total</strong></td>
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<td>10</td>
<td></td>
</tr>
</tbody>
</table>

Paid to: A. M. J. O. C.

At Sam. & Ichabod's Counting House pay Dr. Randell or Order the Balance of this Act.

At Sam. & Ichabod's Counting House pay B. S. Haughton or Order the Balance of this Act.

Paid to: A. M. J. O. C.

W. Mason, Jr.