MANAGEMENT, ENGINEERING AND ACCOUNTANCY AS DETERMINANTS OF CHANGE IN MANUFACTURING INDUSTRY; A CASE STUDY OF RAILWAY MECHANICAL ENGINEERING.

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By

David Mark Lawrenson BA hons (East Anglia), Msc (London)
Department of Sociology
University of Leicester

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DAVID MARK LAWRENSON: MANAGEMENT, ENGINEERING AND ACCOUNTANCY AS DETERMINANTS OF CHANGE IN MANUFACTURING INDUSTRY; A CASE STUDY OF RAILWAY MECHANICAL ENGINEERING.

This thesis examines themes from the labour process debate by analysing the history of railway owned mechanical engineering factories in Great Britain.

The general history and background of the industry is described. It is then shown that within the industry there has been a development from methods of simple control toward increasing managerial control over the coordination of the labour process. It is shown that the developments identified in other theories of the transition from simple control, for example, Taylorism in the case of Braverman's theory, are partial effects of this deeper trend toward managerial control over co-ordination. A range of policies are shown to contribute to increasing managerial control over coordination.

Variation within the workshop labour process is shown to be a complex phenomenon that is in part explicable by managerial rivalries. Rivalry is shown to be based on different approaches to the reproduction of the labour process; rivalry between engineering and accountancy is seen as particularly important. It is shown that engineers dominated the management of the workshops but that many of their policies were stimulated by threats to their dominance by the rise of management accountancy, the latter becoming hegemonic in the 1960s.

The role of the workforce is discussed and is shown to have an impact on changes in the labour process but that this influence is heavily determined by the organization of work.

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LIST OF ABBREVIATIONS:

RAILWAY COMPANIES:

BR.....................................BRITISH RAILWAYS
BREL....................BRITISH RAILWAYS ENGINEERING LIMITED
BTC............................BRITISH TRANSPORT COMMISSION
BRMPG.......................BRITISH RAIL MOTIVE POWER GROUP
CR.....................................CALEDONIAN RAILWAY
GER.................................GREAT EASTERN RAILWAY
GNR................................GREAT NORTHERN RAILWAY
GSWR.........................GLASGOW SOUTH WESTERN RAILWAY
GWR.................................GREAT WESTERN RAILWAY
LBSCR.................LONDON BRIGHTON AND SOUTH COAST RAILWAY
LMS.........................LONDON MIDLAND SCOTTISH RAILWAY
LNER..........................LONDON NORTH EASTERN RAILWAY
LNWR..........................LONDON NORTH WESTERN RAILWAY
LSWR..........................LONDON SOUTH WESTERN RAILWAY
MR.......................................MIDLAND RAILWAY
LYR.........................LANCASHIRE AND YORKSHIRE RAILWAY
NBR.................................NORTH BRITISH RAILWAY
NER.................................NORTH EASTERN RAILWAY
SECR.........................SOUTH EAST AND CHATHAM RAILWAY
SR.....................................SOUTHERN RAILWAY

UNIONS:

ASSR...................AMALGAMATED SOCIETY OF RAILWAY SERVANTS
CSEU......CONFEDERATION OF SHIPBUILDING AND ENGINEERING UNIONS
GRWU............................GENERAL RAILWAY WORKERS UNION
NUR...............................NATIONAL UNION OF RAILWAYMEN
TSSA....................TRANSPORT SALARIED STAFFS ASSOCIATION

PROFESSIONAL BODIES:

ILE.........................INSTITUTE OF LOCOMOTIVE ENGINEERS
IME.........................INSTITUTE OF MECHANICAL ENGINEERS

CHAPTER ONE

INTRODUCTION

INTRODUCTION

This thesis investigates aspects of labour process theory by means of a case study of the railway workshop industry. The terms used in this brief definition need further elaboration. The railway workshop industry is that industry responsible for the production and repair of railway rolling stock, as will become clear this is only a working definition which will be elaborated later.[1] The term labour process theory will be more familiar to a sociological audience. The concept of the labour process is derived from the work of Marx, who used it to refer to the production of something useful, by the application of labour to means of production and raw material. It follows therefore that labour process theory refers to sociological generalizations about the nature of production. Current interest in the labour process was stimulated by the publication of Harry Braverman's work 'Labor and Monopoly Capital' in 1974 and this thesis focuses primarily upon the development of labour process theory, from Braverman onwards. This thesis, therefore, brings together a case study of a particular labour process and sociological generalizations about the labour process, with the aim of improving sociological theory and using it to understand facets of the railway workshop industry. In particular, I argue that during the twentieth century the railway engineering industry has been characterised by a growth in management's ability to control the coordination of the labour process, and that there are good reasons to believe this may be true of other labour processes.

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[1]. See particularly chapter two.

This chapter describes how the thesis attempts to substantiate the claim that management's control over coordination has increased. The rest of the introduction is composed of seven sections. Firstly, I describe something of the nature of the industry and the empirical justification for the case study. The second section is a description of the methodology used to generate information about the industry. Thirdly, the literature on the labour process is reviewed, and in the fourth section, I assess the debate. The section following my review and assessment of the labour process suggests some new directions for labour process theory. The sixth section of the introduction summarises the remainder of the thesis and how the chapters contribute to achieving the goal set out above. The seventh and final section is a summary of the introduction as a whole.

SECTION ONE; EMPIRICAL JUSTIFICATIONS FOR THE CASE STUDY

In this part of the introduction, I describe some of the justification for studying the railway workshop industry. A major part of the justification is that the case study examines a number of neglected topics. The thesis addresses neglect in two major areas; firstly, there are few studies of the railway workshop industry [2]

and secondly, a major focus of the thesis is on engineers as managers, a topic which Armstrong argues is in need of investigation (1984, p. 116). In the following section I describe why, even ignoring the theoretical significance of the case study, the industry should have been studied.

The neglect of the industry [3] is to be regretted because the industry is significant for a number of reasons. Historically the industry has been a large employer. During the first quarter of this century railway owned engineering workshops accounted for the employment of a quarter of a million people, the peak figure being 248,555

[2]. To my knowledge there are only two Phd's on the subject (Turton, 1961, Rider, 1987) and none in sociology.There are of course sociological Phd's on railways, for example, Graeme Salaman's study of Occupational Communities among railwaymen and architects (1968).

[3]. The neglect of the railway workshops is explicable in many ways, there is no history of industrial disputes to appeal to those in search of class struggle, only four national stoppages and harmonious local relations, however, the prime reason for neglect is probably the perception of the works as Victorian. In 1929 Engineering Magazine could comment of engineers who mistakenly 'affect to treat questions of locomotive design as beneath consideration'(Engineering, 1929, p. 680). This situation remained to the end, Astrop, an engineering journalist, commented that many outsiders believed the works to be 'closer to the 19th than the 20th century'(Astrop, 1974, p. 293 and 1973a, p. 514).

recorded in 1924, (Census of Production, 1907 and 1924). At this date Swindon with 14,000 staff and Crewe with over 10,000 were among the largest industrial enterprises in Europe. [4] The industry requires study because it has a history of being technically advanced. It was at the forefront of nineteenth century industrial practice, both in Britain, where Gourvish claims the railways were responsible for the development of the mechanical engineering industry (1980), and in America. Taylorism, for example, was based on observing rolling stock component production (Taylor quoted in Sohn-Rethel, 1978, p. 150). In Britain, Reid and Lemon, successive works managers at Derby carriage works, were described as 'the joint fathers of rationalization in this country'(Lemon, 1930, p. 436), and a number of commentators including Seebohm Rowntree and various American manufacturers described Derby carriage works as the most advanced factory in Europe (Lemon, 1930, p. 438 and p.435)[5]. The industry is thus not the technical backwater that it has

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[4].The cotton industry in 1912 accounted for only two and a half times as much employment as railway engineering in 1907 and employment in cotton was falling (Hobsbawm, 1969, p. 208). The car industry at its peak employed slightly less than twice the railway workshop peak (Marsden et al., 1985, p. 64). Both of these industries have received considerably more attention than railway engineering.

[5]. This view was shared in the Engineer magazine which argued, in 1929, that:

> 'in the railway shops was frequently to be found machine tool equipment in advance of that of most manufacturing works. The fact is still more emphasised today, when routing, output programmes and costing systems are worked to.' (Engineering, 1929, p. 680)

Arthur Astrop, another engineering journalist, reasserted this claim in the 1970s. He argued that the facilities were 'amongst the finest in this country if not in Europe as a whole'(Astrop, 1973a, p. 514).

often been assumed to be.

The reason that the workshop industry has been neglected is because social science does not have the resources to investigate all phenomena. This claim is as true of my research as of any other, therefore there are two major areas of neglect within this thesis. Firstly, I have concentrated on the manual processes of production and its control by management, as opposed to white collar productive tasks; [6] secondly, because the sources used provide no information on race and gender, therefore these important issues could not be investigated.

I have no particular desire to become a champion of the works merely to argue that the industry is worthy of study, and it is hoped that in some small way this thesis improves the balance of social science. However, the description of details of a novel industry is not the sole justification for its sociological study and the light that this study can throw on sociological theory is of significance.

[6] One reason for ignoring the white collar production process is that, until 1984, research and design were carried out in organizational separation from the works (Larkin and Larkin, 1988, p. x). Even given the concentration on manual production areas, of activity have been ignored; for example, the discussion of means of production concentrates on cutting machines, as opposed to foundry work, painting processes etc.

SECTION TWO; ANALYSIS AND SOURCES OF INFORMATION

This thesis is the product of the analysis of a large number of sources, principally technical accounts of railway engineering, and the method of analysis adopted is primarily qualitative historical research.[7] In this section I describe the sources of information and the methods used to gather and interpret the data. I turn first to the methods of data gathering and analysis, however, most of this section is devoted to describing the sources of information used.

In the following discussion of methods I discuss firstly the difficulties of access that led to a reliance upon the technical press and then the question of interpretation. Problems of access are standard in the field of industrial sociology (Bryman, 1988) and this was the case with this study. The management of the railway workshop allowed me to make five site visits, conduct interviews with seven managers and they provided some documentary evidence. They showed reluctance when I requested to take a sample of workers, because they felt this would be perceived by the workers as an invasion of privacy and cause industrial relations difficulties. I also had meetings with headquarters staff of the National Union of Railwaymen, the Confederation of Shipbuilding and Engineering Unions and the Transport and

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7. There are a number of counting methods and approaches based on textual exegesis, but they would have been inappropriate. The application of content analysis or other methods of counting would be akin to counting references to the king in Macbeth. Semiotic analysis may have offered something valuable, but the return for time spent would mean a lack of coverage of a neglected industry.

Salaried Staffs Association, and in addition, with two works committees. These interviews were useful in themselves and also yielded further documentary evidence, but the unions were reluctant to release the names and addresses of their members for much the same reasons as management. Thus although there was a certain amount of useful information from unions and management, the major source had to be elsewhere.

Turning to the method used to analyse the technical press it is difficult not to be vague because of the nature of the historical method (Elton, 1967 p. 87 also Marwick, 1970), for example, Elton argues there is really only one 'fundamental principle' in regard to interpreting any source: 'what does it mean?' (Elton, 1967, p. 87). The use of technical accounts as a means of investigating the labour process is nothing new, indeed it is part of Marx's method, and Raphael Samuel used it successfully in an investigation of the late Victorian labour process (1977).

The next part of the discussion of methods explains the nature of the documents used and the justification for their use. The discussion of methods ends by describing how other sources of information, for example, interviews have been used to enhance the technical documents.

The major source of information was technical journals, and these fall into two broad categories, journals published by professional and managerial bodies and journals published for sale to professionals. I describe both of these, concentrating on professional journals, and in doing so attempt to explain the advantages and disadvantages of using these sources.

The most important of these journals are those published by the professional bodies themselves. The reason for this importance is that the papers in the professional journals are written by those in management positions. Particularly important is the journal of railway mechanical engineering's own professional body, the Institute of Locomotive Engineers (ILE), which began in 1911 and merged with the Institute of Mechanical Engineers (IME) in 1970. There are also significant papers published by the IME itself. Other useful papers were published by other professional bodies not catering solely for engineers, for example, the Chartered Institute of Transport or the Great Western Railway Lecture and Debating Society (which catered for white collar railway workers).

The major advantage of papers published in these journals, is that they reflect the authors' knowledge, and cover the subjects in great detail, many of the papers being over fifty pages in length. Because the papers in these journals are written by participants and accepted by organizations connected to the industry, the existence of these papers is a reflection of the concerns of management. Most of the papers presented in professional journals were presented at one or more meetings or conferences, and in all cases the discussions following the presentation of the paper are recorded. The author's conclusions and description were penned in the knowledge that they would be subject to the scrutiny of his peers. This constraint on the author combined with the comments contained in the discussion mean that the papers reveal something of a consensus on a particular issue held by those involved. Thus the presentation of a paper was considered to be an event, and reflected concerns of the particular profession involved. For example, the Institute of Locomotive Engineers, reflecting a concern with management, published several papers on the subject at the end of the First World War (Tonkin, 1921; O'Brien, 1920; Turner, 1921). [8] Thus the publication of papers in professional journals was an event of significance to the profession in terms of both timing and content, and not just a reflection of one author's whims.

The significance of the papers being presented to an audience of fellow engineers is important in assessing the advantages of using this source of information. The basic details of fact should at least be correct because of the engineering professions stress on the importance of science (Glover and Kelly, 1987).[9]

The technical journals published for sale do not have the same quality of being events in the same way as the

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8. This concern is quite considerable given that in the whole of the United States there were only 25 magazine articles published per annum on management during the 1890s and Clawson takes this as an indicator of concern for management matters (Clawson, 1980, p. 167).

9. Indeed the professional bodies saw an important part of their activities as the dissemination of knowledge, for example, one president of the IME stressed that the institutional activities were concerned with the 'important task of the exchange and diffusion of knowledge' (IME, 1954 p. 225) and the first line in the Transport Institute's Memorandum is to 'promote and encourage knowledge of traffic science and of the art of transport in all its branches' (April 1920, p. 1).

papers in professional journals but are subject to many of the same constraints to publish accurately. For example, often articles were written by managers within the railway engineering industry. Many of the journals had the explicit support of railway management and organizational professionals; for example, the launch of the first railway engineering journal, appropriately titled, the Railway Engineer, went ahead with the support and encouragement of railway management.

In summary, in the context of a case study which attempts to describe the historical development of the railway engineering labour process, journals are a useful source of information on the development of the labour process.[10]

There are, of course, problems with the journals. The journals take a great deal of knowledge for granted and thus involve a certain degree of reconstruction of that background knowledge.[11] Also technical journals do not cover all aspects of the labour process and the research has used other sources to supplement their use, and it is to those sources that I now turn. A particular absence within the technical journals is information about the workforce. Through one of the works committees, I made contact with thirteen retired workers, all male and all but one retired from Derby Locomotive Works (the other having worked at

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[10] Also of advantage was the large collection at Leicester University's Transport History Collection, described as one of Britain's most impressive libraries (Independent, 19-5-89, p. 29).

[11]. The researcher has to be aware of uneven development, which in the journals goes largely unnoticed because the stress is upon the novel and reflects the engineers' culture with its stress on technical progress.

Derby Carriage and Wagon works). These men had been mostly union, or other association, activists or had some other contact with those who were. Interviews with these men provided a useful triangulation of this material, particularly as most of the men interviewed were active unionists whose awareness of labour process developments would be greater than their passive colleagues. In these interviews I adopted an open ended qualitative oral history approach in order to gain as much useful information as possible. The number of interviews appears small against large scale surveys but is not small for an oral history approach.[12]

In addition to information from technical journals and interviews, there were a number of other sources used; auto-biographies, official publications (for example, annual reports and accounts), official statistics, proceedings of courts of inquiry, etc. There are also a number of contemporary technical accounts of railway operation in book form and also the publications of a small band of railway historians.

Thus this study is based on the interpretation of technical journals, supplemented by contemporary and oral history interviews and a number of other sources of information. The theoretical aim of this interpretation is the subject of much of the remaining part of this chapter.

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[12] For example, Jeremy White's "Campbell Bunk", one of the most influential pieces of oral history, is based on 12 interviews (White, 1979, p. 44).

SECTION THREE; REVIEW OF THE LABOUR PROCESS LITERATURE

The review of the literature on the labour process is intended to describe what is termed the 'Labour Process Debate'. This debate refers to the large output and theorising about the labour process stimulated by the publication of Braverman's 'Labor and Monopoly Capital' (1974). In what follows I describe Braverman's central claim, which is that: work has been degraded during the twentieth century and the chief mechanism for this degradation has been Taylorism. What is meant by such a claim, and how Braverman came to it, is described. I then give a brief resume of why Braverman's work stimulated such interest.

It is shown in the review that the labour process debate began as criticism of Braverman, whose work has been largely discredited, but that the debate gathered a momentum of its own. I attempt to outline something of the debate by concentrating upon a number of authors and theoretical perspectives widely regarded as significant, the major authors considered are: Edwards, Burawoy, Friedman and Thompson, although the work of other authors is considered if appropriate. The main criticism of Braverman is that he ignores the subjective aspects of work, it is argued that because of this he caricatures the behaviour of workers and management. The work of these major writers and periods within the debate are discussed in the following sequence: firstly, the appeal of Braverman is examined, secondly, the work of Edwards is examined, thirdly, the work of Burawoy and others, fourthly, Andrew Friedman's work, the fifth section is somewhat different in that it examines the growth of contingency theory within the labour process debate, and finally, Paul Thompson's attempt to establish some core theory from the debate is described.

The first author discussed is Edwards, who attempts to show that the development of work is more complicated than Braverman allows, because of the dynamic of class struggle, he argues that both workers and management fight over aspects of the labour process which has led to a number of phases in the development of the capitalist labour process.

The discussion of Edwards is followed by a short exposition of Burawoy, his book 'Manufacturing Consent' (1979) is taken as an example of work which argues that the behaviour of workers is crucial to understanding the way in which the nature of work develops. He particularly argues that, because workers are the source of production, their consent to the plans of management has to be generated. There are a number of writers who make similar points and these are mentioned.

The discussion then turns to the work of Friedman, who also pays attention to the impact of organised workers on the nature of work. Friedman also presents managers as actors. He argues that they are faced with two policy choices, either direct control or responsible autonomy, what these are and what determines their application is described in the text.

Following the discussion of Friedman, I describe a number of other works which attempt to develop the conception of a diversity of management practices. I indicate what the consequences of the application of the criticisms above have been for the state of labour process theory. I argue that contingency theory, the claim that all organizations are different, appears to be dominant.

Then Thompson's work is discussed. This is left until after the assessment of the state of the labour process debate because Thompson's work is an attempt to reject contingency theory in favour of some core theory of the labour process.

My own assessment of Braverman and other contributors to the labour process debate is in the next section of the introduction. The purpose of leaving it until then is that a balanced assessment requires a review of the debate. The purpose of reviewing and assessing the labour process debate is to provide the basis for showing how the explanatory power of labour process theory can be improved. The major aspect of outlining an alternative theory of the labour process is delayed until section five of the introduction but it is possible to give the reader an indication of what is proposed. The general tenor of my argument is that I agree with the major claim that the actions of workers and management have to be considered in any adequate description of the labour process, however, I do not accept the claim that there are no general trends in labour process development to which this often leads. I argue that during this century there has been a growth in managerial control over the coordination of the labour process and that the source of this growth is the existence of management as a separate strata within employing organizations.

BRAVERMAN'S LABOR AND MONOPOLY CAPITAL

Having laid down the structure of this section I now describe the work of Braverman. Braverman's work was intended to place the changing nature of the organization of work as a central feature of the changing nature of the class structure. He limited his investigation to class in itself, that is the objective determinants of class position, rather than the subjective aspects of class for itself or class struggle. The main objective trend that Braverman identifies is that work in the twentieth century has been degraded.

To understand what is meant by degradation it is necessary to describe something of his work. Braverman begins Labor and Monopoly Capital with a discussion of the nature of human labour, which he sees as combining two elements, conception and execution. According to Braverman, humans not only transform material reality (execution) they also think through how they are going to perform these acts of labour prior to actually doing this work. Braverman proceeds to analyse what happens to the relationship between conception and execution under capitalist production, where the labour is performed by nominally free wage labour purchased by capitalists in order to produce a profit.

Braverman argues that under capitalism work for wage labourers has become degraded because of the separation of conception and execution. Braverman argues that the role of conception has become monopolised in the hands of management. It is management that analyses the nature of production and determines how that work shall be done and wage labour is left to carry out the work according to the instructions of management. Braverman sees this as a process that emerges over time with the development of capitalism. In the early stages of the industrial revolution Braverman sees the importance of the sub-division of labour, that is the division of the work necessary to produce any article and the allocation of these tasks to detail workers, as of great importance (Braverman, 1974, p. 78). A more significant step for Braverman was the emergence of the scientific management movement headed by F.W.Taylor at the end of the nineteenth century and brought into being by the monopolistic organization of industry (Braverman, 1974, p. 85). Braverman argues that Taylor's writings made clear that the aim of capitalist management was the monopoly of control over the labour process.

Braverman argues that Taylor was proposing three principles, and that these principles underlie the whole of modern capitalist management. He saw these as:

> 1. The 'dissociation of the labour process from the skills of the workers' (p. 113). The work planned should not rely on craft practices but upon methods worked out and analysed by management.
> 2. The 'separation of conception from execution' (p. 114). Management alone must determine all the work to be done.
> 3. The 'use of this monopoly over knowledge to control each step of the labour process and its mode of execution.'(p. 119). The work carried out is according to management dictates.

As Braverman makes clear, Taylor was not solely a theorist but was also a consultant concerned with putting his principles into practice. The work that he and his followers carried out involved detailed study of the nature of work at particular plants and the devising of various schemes to further the subdivision of labour as a means of increasing production, the time study of work motions being the most famous practice. The impact of Taylorism was, according to Braverman, the destruction of craftsmanship (Braverman, 1974, p. 131). The developments in machinery and their coordination, for example, the assembly line, are seen by Braverman to conform to the logic of the subdivision of labour (Braverman, 1974, p. 230).

Braverman rarely considers the non-marxist theories of work and when he does they are mainly seen as, not very successful, means of habituating workers to work designed on Taylorist principles (Braverman, 1974, p. 145).

In summary Braverman argues that the transition from craft controlled work to Taylorism is the central transition within work and all other changes and workplace policies are peripheral to that central change.

THE APPEAL OF BRAVERMAN

Braverman's work was responsible for stimulating a debate around labour process issues, and it is to the assessment of this appeal that I now turn. Rose argues that the popularity of the labour process was a dual appeal, for some it was the connections with Marxism, for others, it was the triumvirate of labour, means of production and raw material which provided a clear object of study (Rose, 1988). However, the work of Braverman also had a negative appeal in that it was easy to attack. Consequently the labour process debate has primarily consisted of criticising Braverman's analysis (Burrell, 1986, p. 5). The criticisms of Braverman are numerous, but add up to a rejection of the thesis that capitalism leads to a separation of conception from execution via the application of Taylorite logic.

THE CRITIQUES OF BRAVERMAN

In the critiques of Braverman that follow I have attempted to concentrate on the central critique that Braverman ignored subjectivity. In concentrating on this theme a number of other issues have been ignored, for example, the validity of Braverman's claim that nineteenth century production was craft production. In what follows, the sub-sections concentrate on the work of particular authors as a means of elaborating the general lines of the development of the labour process debate.

EDWARDS

The failure to analyse class struggle is seen by many commentators as flawing Braverman's whole analysis, his critics argue that: the objective side of class is a product of the struggle between classes, which he ignores (Rose, 1988, p. 316). This is particularly true of Edwards (1979). Edwards agrees with Braverman (1974) and others [13], that production in the early industrial period was secured by the employment of craftsmen subject to the direct supervision of foremen, but argues that Taylorism was not the means by which craft work was dismantled. Edwards argues that with the growth in organizations, management had difficulty in ensuring that its demands were fulfilled because of the large spans of control. Thus the work carried out was determined by the outcome of relations between foremen and craftsmen. Edwards argues, contrary to Braverman, that Taylorism, along with welfarism,[14] was a failed attempt to overcome this crisis of control and, as such, can be confined to the early phases of modern industry. Edwards argues that the successful transition from simple control was to technical control, epitomised by the conveyor belt which imposed a common speed of working upon the labour force. Thus the worker was left with a choice: either work or not. Given the threat of unemployment the choice often made was to work, even

[13]. Clawson (1980).

[14]. Welfarism would include the type of activities carried out in Britain by the Cadburys, that is, the provision of a number of non-wage benefits and attempts to create consent to work structures by generating workers' identification with the employer.

though this resulted in large levels of staff turnover.[15] Edwards claims, in similar vein to Marx's arguments in the Communist Manifesto about the growth of factories, that Fordism brings workers together into one location and subjects them to the same unacceptable conditions, which provides the motive for and can only be overcome by generating mass unionism. Thus it is argued that the emergence of mass unionism in the USA during the interwar period was due to the emergence of the technical form of control.

Edwards goes further and argues that mass unionism presented a threat to management control over the labour process, what he terms a crisis of control. Management's response was to re-divide the collective nature of the labour process by introducing new divisions (Edwards, 1979, chapters 9 and 10), under a system of bureaucratic control. This involved, among other things, the creation of career ladders, internal labour markets, the departmentalisation of production and the creation of central and peripheral workforces.

The position argued by Edwards is that Braverman failed to take adequate account of the role of class struggle in two senses, firstly, workers struggle effects the policies of management and ,secondly, management has more strategies than Taylorism to rely upon.

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[15]. Beynon records turnover at Ford in 1913 as being around 400% (Beynon, 1973, p. 19).

BURAWOY AND OTHERS

Many authors argue that Braverman is mistaken about the separation of the mental and manual aspects of labour but in this sub-section the major, but not only, focus will be on the work of Burawoy. It is argued that the execution of labour will always have an element of conception, and however much automation and specialisation occurs, the mental aspect of labour cannot be totally extinguished from production (Wood, 1985; Pahl, 1988). The claim being made by such authors, and Burawoy takes a similar view, is that it is impossible for managers to know more about the work that an individual does, than that individual. Management may be able to specify what jobs a machine operator does, but can never know exactly how a particular machine needs to be handled to get the best performance. These are referred to by Wood as tacit skills and will always remain important. For example, Blackburn and Mann noted the pride that unskilled workers took in their monopoly of task specific skills not shared by management (Blackburn and Mann, 1979).

Burawoy (1979) argues that the labour process cannot operate on the basis of control alone. Production cannot proceed solely by the purchase of labour power by employees: the workforce has, ultimately, to consent to the existing organization of work and to carry out tasks. In much the same way as it is argued that all labour activity contains a degree of mental labour, so it is argued that all control must ultimately rest on some form of consent. Burawoy's case study of a machine shop shows how this consent is a product of the structure of work and the workers' own activities, in particular, he shows how workers treat their relationship to the labour process as something of a game in which the aim is to maximise 'welfare' in given constraints: what he terms 'making out'. The aim is to reduce the amount of effort and/or maximise rewards. The acceptance of the game means the acceptance of the set of choices and constraints within the organization of work and thus the capitalist system of organization is consented to (Burawoy, 1979, p. 93).

Burawoy therefore argues that Braverman inadequately described the relations between management and workers at the level of the shop floor.

FRIEDMAN AND MANAGERIAL STRATEGY

The criticisms broadly associated with Friedman have similarities with both the work of Edwards and Burawoy. Friedman's work agrees with Edwards that there is a diversity of management strategy and that union activity influences that strategy. This theory is developed, as with Burawoy, on the acceptance that there can never be a separation between mental and manual labour.

Friedman argues that capital needs to retain workers' flexible skills, and therefore management cannot monopolise mental labour. The reason for this is that it is easier to innovate new techniques with flexible workers than with detail workers of limited skill. That workers are the source of use values is the basis of Friedman's argument that, contrary to Braverman's claim, Taylorism is not the only solution to the control problems of capitalist management.

Friedman was among the first to criticise Braverman's stress on Taylorism as the single method of capitalism (1977). His argument was that the method of control that workers were subjected to depended on their centrality to the labour process. Central workers were those whose skills were central to the use values produced and those whose collective organization could disrupt managerial intentions. These workers were to be given responsible autonomy, that is relatively high wages and relatively high degrees of control over work activities. This is relative to what Friedman terms peripheral workers, that is those not possessing the characteristics of centrality, who still would be subject to direct control methods with affinities to and including Taylorism.

In summary, Friedman argues that management control is either direct or delegated depending on the importance attached to workers' skills and the workers' organization, both of which, it is argued, stem from the subjective side of workers' experience.

THE GROWTH IN CONTINGENCY THEORY

In this sub-section I try and describe something of the present state of labour process theory. It can generally be described as accepting that the form of each labour process is the product of a whole range of factors and is contingent upon circumstances. Contingency theory has for many years been the standard fare of text books on 'organization behaviour' (Handy, 1976, Child, 1984), the central theme being that all organizations are different and the form they take is determined by the myriad factors which influence the management of an organization. Handy, for example, identifies over sixty variables as having an influence on organizational effectiveness (Handy, 1985, p. 14). In this section I describe how this perspective has grown out of the criticisms of labour process theory described above, although rather than examine all proposed sources of variation I focus upon the question of variations in managerial strategy.

Management strategy is presented as leading to indeterminate outcomes. Littler and Salaman, who extend Friedman's arguments about the dual nature of managerial labour processes, argue that strategies that control labour and encourage responsibility among labour co-exist for all labour processes (Littler and Salaman, 1984, p. 115). The logic of this position is that if the subjective element of work cannot be eliminated from any job then it must be encouraged in all workers, at the same time as not relinquishing managerial prerogative. Thus the management of the labour process becomes something of a balancing act varying in strategy with changing circumstances. Salaman argues that the lack of automatic response is partly because management is composed of conflicting sectional groups who pursue their own collective interests within the organization and have their own methods for controlling the productive organization, examples of such groups are, engineers, accountants, personnel etc. (Salaman, 1982, p. 60). On a similar theme Armstrong argues:

> 'The response of capital to its crises (which may not be specifically of control) is mediated...by professions, which are poised to engage on collective mobility projects within the global function of capital in virtue of their possession of techniques which offer responses to those crises.' (Armstrong, 1984, p. 117)

Thus the form that the labour process takes is determined not by factors common to all labour processes but by the way in which management strategy is formulated, and this is the outcome of management conflict.

The view that management strategy is contingent has led to something of a consensus on labour process theory. It seems agreed researchers should abandon 'the fruitless search for the all-embracing descriptive and analytical category' (Thompson, 1986 p. 3 also; Littler and Salaman 1982; Rose, 1988 p. 351; Storey, 1985; Wood, 1982). This conclusion has led many to abandon labour process theory because it is not seen as fruitful for sociology (Salaman, 1986) or Marxism (Cohen, 1987).

THOMPSON'S REACTION TO LABOUR PROCESS THEORY

Thompson has recently attempted to rescue labour process theory from a full scale acceptance of contingency theory. He argues that the re-examination of the labour process theory reveals that, underlying the core texts of the labour process debate, there is a core theory of the labour process which can be utilised in the explanation of changes in actual labour processes. This core, Thompson claims, is the idea of the 'central indeterminacy of labour', by which he means that the capitalist employment of workers does not guarantee production.

Thompson argues that a number of things follow from the indeterminacy of labour. Firstly he argues that relations of exploitation are implied. Secondly, because of competitive relations between capitalist enterprises, the production arrangements need to be constantly revolutionised. Thirdly, and because of the two above, this needs managerial control. And fourthly, because of all the above, this implies structured antagonism (Thompson, 1989, pp. 242-244).

In summary, Thompson argues for a reassessment of the labour process debate as a means of moving beyond a contingent view of organizations. He proposes the central concept of the indeterminacy of labour as a means of understanding the actions of management in capitalist organizations.

Thus in this section as a whole I have described the origins of the labour process debate in Braverman's claim that Taylorism had led to separation of mental and manual labour. The crucial criticism levelled at his work within the debate was that he had ignored the subjectivity of workers and management. In summary, it is argued by critics of Braverman that the nature of the labour process is the outcome of the action of management and workers at several different levels. This stress has led to labour process research and theory being dominated by contingency theory. Contingency theory is criticised by a few theorists, for example, Thompson, who are in search of more general theories. In the next section I attempt to assess the labour process debate as a means of advancing the search for a general theory of the labour process.

SECTION FOUR: AN ASSESSMENT OF THE LABOUR PROCESS DEBATE

In this section I attempt to assess the validity of the points made in the labour process debate. I agree with many of the criticisms of Braverman. In this assessment I attempt to subject the labour process debate to the same treatment given to Braverman. The purpose of this is to lay the basis for my attempt to formulate alternative proposals for labour process theory. I agree with the central criticism of Braverman that he ignores the impact of the actions of management and workers on the nature of work. I disagree with the claim that all organizations are contingent. I propose that the twentieth century has seen a growth in management's control over industry and that this claim can accommodate the criticisms made of Braverman.

In what follows I firstly indicate my agreement with the criticisms of Braverman. This is followed by my criticisms of other writers, particularly Edwards and Thompson. The purpose of examining these authors in particular, is that they go against the grain of labour process theory and attempt, in different ways, to develop a general theory of the labour process. Edwards attempts to develop a developmental sequence of events and Thompson an underlying core theory of the labour process. I will show that these attempts fail. In this section I start to bring in evidence from my case study as a foretaste of the thesis to come.

In discussing Braverman I shall be brief because I accept most of the criticisms levelled at him. He does underestimate the role of the subjective in the labour process.[16] I go further than most critics and argue that Braverman's view of mental labour as the conception that precedes execution is inadequate. Mental labour is also reflexive, it is not only concerned with the transformation of objects but can also be directed at transforming the process of production. In the labour process, labour is as much an object of conception as the object of labour. The labour process requires the exercise of mental labour to enable its reproduction and transformation. The role of mental labour in the reproduction of the labour process can be concentrated in the hands of management, and I would argue that this has occurred during the twentieth century.

Braverman's claim that Taylorism is the basis of all late capitalist management control over production is false. Within the railway workshops Taylorism is shown to have limited application and was only applied on any major scale in the 1970s.[17]. The claim that the workforce have had an impact on the development of the workforce, which Braverman ignored, is supported by my case study which shows that, although the workers within the railway workshops were rather passive, management policy was influenced by shopfloor struggles and attitudes. Not only do I consider Braverman's characterisation of shopfloor struggles to be inadequate, but

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[16]. Although it must be noted that the claim that he argued that a total separation of mental and manual labour was possible, is incorrect. Braverman saw the expulsion of all conception as the ideal to which capital strived but was clear that the displacement of mental labour was only achievable within 'definite limits' (Braverman, 1974, p. 172).

[17]. A full assessment of the role of Taylorism within the railway engineering industry is given in chapter nine.

this is also true of his critics. In attempting to understand the shopfloor culture of the railway workshops I have relied heavily on concepts drawn from the works of Baldamus and Fox. The criticism that Braverman ignored the diversity of management strategy is also supported by my case study, within the railway industry the conflicts between strategy based on engineering and strategy based on accounting is shown to be very important. I do not conclude from this that the development of the labour process is indeterminate but conclude that the diversity of management policy can be brought into a coherent general framework.

The empirical validity of Edwards' description of technical control is questionable. The assembly line has never been the numerically dominant form of production, even within mass production industries where there would be as many or more people off the line as on it (Wood, 1989, p. 29). The case study of the Railway workshop industry supports this criticism because the technical control of the assembly line was very limited. It is difficult to understand why Edwards raised technical control to the importance he does because it is clear he recognises its limitations, for example, when he discusses the coach manufacturers Pullman who had 'little chance to exploit technical possibilities for control', and yet they adopted a 'more sophisticated control structure' (Edwards, 1979, p. 116). The railway workshops used as a case study here also produced coaches and introduced, what I assume are similar, 'sophisticated control structures'. Edwards, in his desire to raise up technical control as 'the' method, ignores these other sophisticated methods. Thus to a large extent, Edwards can be seen as giving 'Fordism', as the method of production by assembly lines is often called, the same kind of universal, if temporally limited, status that Braverman gives to Taylorism. It is clear that the attempt to identify a singular management practice as the method of management, however temporally limited, is difficult and probably impossible given the diversity of work organizations.

Thompson's attempt to explain the diversity of labour processes is by reference to the underlying principle of the 'indeterminacy of labour'. Whilst agreeing with the need to move beyond the diversity proposed by contingency theory I argue that Thompson says little about the nature of the labour process.

The concept of the 'indeterminacy of labour' is to a large extent a restatement of Marx's distinction between labour power and labour, which would seem to imply that we have not got very far. In many ways Thompson merely provides pointers for carrying out labour process analysis and has shelved the idea of saying anything about how the labour process has changed during the twentieth century.[*] I argue that, contrary to Thompson, a core theory of the labour process is achieved by looking at the results of labour process analysis, not at the theoretical starting

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[*] Aside from this criticism there are a number of other problems with Thompson's analysis. Antagonism does not necessarily follow from control or exploitation without some intervening factor, whether this be human nature, (as human nature automatically leads to struggles against exploitation) or some theory of culture or ideology which results in workers being motivated to increase returns for effort.

points of labour process theorists. I attempt to show that the identification by labour process theorists such as Edwards and Braverman of surface policies such as Taylorism or Fordism was at the wrong level of analysis. These policies are the manifestations of a wider tendency, the growth in managerial control over the coordination of production.

In the above I have argued that Braverman's critics are mostly accurate in their criticism that he inadequately understood the subjective element of the labour process. I also showed that Edwards' and Thompson's attempts to develop a general theory failed. This would appear to indicate that such general theories are doomed to failure but I do not think this is so. I would argue that if further criticism of Braverman's conception of the nature of mental labour is taken on board then a general theory is possible. Braverman neglected the role of mental labour in the reproduction of the labour process. The mental labour needed to reproduce the labour process can be monopolised in the hands of management and in the next section I attempt to develop a general theory of labour process developments on this basis.

SECTION FIVE; PROPOSALS FOR AN ALTERNATIVE THEORY OF THE LABOUR PROCESS

In this section I attempt to outline my proposals for an alternative theory of the labour process. This theory proposes that management is a labour process and its object of labour is the labour process of others [19]. I also argue that the coordination and reproduction of the labour process of others can be monopolised by management and that the twentieth century has seen a growth in managerial control in this area.

This section is divided into two sections, firstly, I discuss the conceptual underpinnings of the claim that management control has increased and, secondly, I outline the claim itself and describe those factors that effect the development of managerial control.

I describe two underlying concepts, firstly, I outline my conception of mental labour and, secondly, the concept of managerial control which is derived from it. I then proceed to outline the central theoretical claim of the thesis: that is, that management control has increased during the twentieth

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[19]. In defence of the Marxist approach, Armstrong has recently rejected such a move (1989, p. 310). He argues:

> 'it is not clear how we can separate the management task from managerial social relationships, for the purpose of studying the influence of each upon the other. At the very least, the onus lies upon the proponents of the 'managerial labour process' to show how this can be done' (Armstrong, 1989, p. 312).

The answer to Armstrong's question is that management is that labour process which takes as its object of labour the labour process of others.

century. To support the claim about the development of management it is shown that managers in the railway engineering industry saw the managerial task in the manner I outline: that is, as the ongoing coordination of the labour process. After outlining the proposition that managerial coordination has increased during the twentieth century I outline a number of factors that lead to variation within work organizations. These factors are, firstly, the variable needs for retaining worker flexibility, secondly, workers' struggles, and thirdly, the basis of managerial policy. Within the labour process debate these factors were considered to be important factors that undermined any claim that the labour process is subject to general trends. Therefore in proposing that such a trend exists it is necessary for me to explain how my theory can cope with those objections.

I firstly discuss the role of workforce flexibility and attempt to show that the claim that the varying needs for worker flexibility work against a theory of general trends is misplaced. The essence of this claim is that giving workers greater discretion over their work is not the same as giving workers greater control over the labour process. I then turn to the question of workers' struggles. I indicate that much of the labour process literature is inadequate upon this topic. I argue that the works of Fox and Baldamus and the concepts of wage effort bargain and trust can be used to explain patterns of workplace behaviour. It is shown that the behaviour of workers can influence the strategy of management but it is also shown that they do not undermine managers' claims to have the prerogative to determine the shape of the labour process.

This section then turns to an elaboration of variations in that management strategy. I argue that management strategy can be derived from either market or productive criteria, market criteria meaning policies based on monetary calculation and productive criteria meaning policies based on physical resources. It is also argued that these can be in contradiction and that what is efficient on productive criteria may not be efficient on market criteria etc.[20] This is an important claim of the theory and points away from any indication that the managerial project is simple. Indeed it is a claim of the theory that although both managerial strategies based on market and productive criteria aim at increased coordination, what increases coordination in one sphere can and does resultin lack of coordinationin another. [21] Indeed I will argue that, however far management increases coordination, these two types of polices will conflict because money and material belong to different realms and a stable one to one relationship between monetary amounts and material practice is not achievable. I argue the stress that is given to each strategy is shown to be variable and dependent upon a number of factors, for example, in the case of railway engineering the conflicts between engineers and accountants were particularly important. I also show that the work of

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[20]. There are probably a number of other bases of managerial activity but I consider this division to be the most important.

[21]. This does not mean that there has not been an increase in management coordination of production but that there are limits to how far this coordination can advance and how productive material activity can become under conditions of monetary calculation.

Sohn-Rethel makes similar points.

It is now time to discuss the concepts underlying my claim that management control over the coordination of the labour process has increased. I shall briefly explain my conception of mental labour on which it is based. The claim for the superiority of my conception of the labour process is linked to my criticisms of the labour process debate, because I argue the growth in contingency theory is due to misunderstanding the role of mental labour in the labour process, an irony given that the dismantling of Braverman was based on his neglect of the subjective. The irony goes further because the view of the subjective accepted by the labour process debate has been the same as in Braverman. This view concentrates on the mental aspect of labour as concerned with organising the labour process to produce use values. It was rightly concluded in the labour process debate that this aspect could not be monopolised by management. However, mental labour is not restricted to shaping the labour process in order to produce use values, the labour process also reproduces itself and it is human thought that enables this to occur. The reflexive aspect of mental labour is directed at changing the labour process to enable future changes in the labour process, that is changes in the labour process are not just introduced on a one off basis but are seen to be part of a series of continuing change. Because mental labour is directed at the production and reproduction of the labour process it is therefore directed at the production and reproduction of social relations within production. The meaning of this is that a concern to ensure that change could be continued would be interpreted by management as a continuation of its own prerogative, a continuation best secured by advancing the arena of management control. It follows from this that management control is not restricted to the control of labour, as appears to be the assumption in the labour process debate, but to control of all of the labour process. Management is concerned with the physical utilization of all commodities purchased, labour, means of production and raw materials, and the way they are coordinated and synchronised. As a concluding comment it can be noted that the aspect of mental labour that is concerned with the reproduction of the labour process can in principle, be monopolised by management, as opposed to all mental labour, and I argue that in the railway engineering industry this has occurred.

The second underlying concept of my alternative theory of labour process development concerns the nature of management control. It is clearly necessary to define the meaning of management control because the concept is central to my theory. The meaning of management control can be elaborated by reference to the words of Henry Fowler, one of the most important railway engineers of this century. He argues management is the ability to, 'have what you want, where you want, when you want' (Fowler, 1929, p. 63), that is, it is management's ability to coordinate the production process. The coordination of work is clearly necessary because it refers to the ability to ensure that raw material, labour tasks and the actions of means of production are synchronised so as to reduce waste in both time and resources.

Having defined what I mean by management control and mental labour I shall now proceed to outline my major theoretical claim. I show that in the railway engineering industry the managerial policies identified as central by Marx, Braverman and Edwards, that is, respectively, mechanization, Taylorism and Fordism, are all manifestations of the wider tendency toward a growth in managerial control, particularly control over coordination. The control over coordination is not restricted to physical coordination, it also refers to coordination of activities in terms of cost incurred and value added, management also attempts to ensure that costs that are incurred add value, if an activity does not add value then it will be eliminated, this is the essence of management accounting.

I argue that management's ability to control coordination in both these fields has increased over this century, and that a major reason behind this development toward increased coordination is the need to reproduce the labour process, to change the labour process, management must have control over the way in which the labour process is coordinated. A major concern of management is the ability to change the labour process, therefore the changes that are introduced are in part directed at enabling change to take place, management does not introduce changes that will not allow future transformations to occur.

The idea of the need to reproduce the labour process over time is not solely a process that continues behind the backs of the participants. Managers in the railway engineering industry were aware of the dual nature of management, of managing present day structures of control and changing those structures. Merit, a railway engineer, expressed this clearly:

> 'Management has two kinds of problems. The first is to keep the organization-machine running smoothly and to watch the controls for signs of irregularity. These controls are the various criteria of overall and departmental performance, expressed as the relation of effectiveness to effort. The other kind of problem is to adapt or modify the machine in order to take advantage of new developments or to improve performance at some point.' (Merrit, 1955, p. 21)

Lemon, an important figure in British rationalization during the 1920s and Superintendent of carriages and wagons on the LMSR, agreed, he argued that the changes he had initiated had:

> 'opened up avenues for the scientific study of railway engineering problems by the centralization of administrative control.
>
> We are constantly on the look out for new lines of development and it is confidently anticipated that the new research committee established by the company will lead to further channels of economy and efficiency in manufacture and administration.' (Lemon, 1930, p. 434)

The changes in the labour process were seen as opening up the possibilities for changing the labour process. [22] The workshop management were, not surprisingly, aware of their role in the transformation of the labour process over time, and their role in this long term project should not be underestimated. The most effective means of transforming the labour process over time is to ensure that the changes that are introduced ease future transformations. Something is easy for management to change when it is under

[22]. Once a transformation in the labour process has been established it becomes the norm, for example Hartley, the first head of research and development on any British Railway argued that; 'the new device or process becomes an established part of routine practice'(Hartley, 1932, p. 496 see also Merrit, 1955, p. 21).

their control.

In proposing this new theory of the labour process it is necessary to account for the variability in the nature of methods for controlling the labour process. As was mentioned earlier, the need to take account of workers is considered to be central. Within the labour process debate the nature of the workforce was seen to count against theories proposing a trend of increasing managerial control in two major ways, firstly, managers needed flexible workers to enable the introduction of new techniques, and secondly, workers resisted managers' attempts at increasing control. The theory of increasing control over the coordination of production bypasses these criticisms. The growth in managerial control over coordination is not necessarily at the expense of the working life of the workforce. Management can accept a degree of worker flexibility so long as this does not effect management's ability to exercise control over the synchronisation of the labour process and the reproduction of the labour process. [23]

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[23]. Indeed management may use worker flexibility to increase management's control over coordination of the labour process as a whole. Flexibility of the workforce, as much of the labour process debate has pointed out, enables management to use workers as the means of introducing new products etc. In terms of the theory proposed, flexibility eases management's task of synchronising the elements of the workforce. To argue, as much of the labour process approach has done, that allowing workers to exercise control as a means of ensuring flexibility means that there is no predictable direction of change (Wood, 1982; McLoughlin and Clark, 1988) is mistaken.
It assumes that the natural world is something over which it is possible to continually exercise ever increasing dominion, both in terms of the increasing range of use-values possible and the sophistication needed to transform them. But the natural world is not something that can be increasingly controlled, as gains from control over the material world become increasingly marginal, then

My response to the claim that workers' struggles influences management policy is, again, that this can be accepted without disproving a general trend toward increasing managerial control. I argue that workers' struggles do not appear to reverse the trend toward increased management control over the coordination of production. Labour process theorists do not adequately theorise the nature of workers' struggles and I have found none who assist in the understanding of railway workshops' workers' struggles. The railway workshop workers' struggles had little impact on the form of the labour process. In attempting to understand the industrial relations of the railway engineering industry I have had to draw on the work of two writers from outside the labour process tradition; Baldamus and Fox. The central concept in Baldamus (1961) is the concept of the wage effort bargain, Baldamus argues that workers' struggles concern the amount of wages required for amounts of effort on the part of the workforce, for example, he argues:

> 'Not only strikes but other kinds of instability including absenteeism, excessive labour turnover, and restriction of output have to be defined as symptoms of a fundamental discrepancy in the relation of effort to wages.' (Baldamus, 1961, p. 126)

As I show in my study of the railway engineering industry Baldamus is correct: on very few occasions do workers struggle over anything but the wage/effort relationship. However, Baldamus, mistakenly, shares with much of the labour process debate the view which sees managerial tasks as concentrated on questions of control over labour. He argues that the

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management attention may shift to increasing control over labour as opposed to the transformation of matter.

'organization of industry...revolves on a single process: the administrative process through which the employee's effort is controlled by the employer' (Baldamus, 1961, p. 1). I argue that, contrary to Baldamus's claim that firms primarily seek advantage from increasing effort more than increasing wages (Baldamus, 1961, p. 126), firms aim to work more effectively, in the words of Karel Williams 'working smarter not harder'.[24] Thus although the wage/effort bargain is of prime importance to workers it is not of such great importance to managers, as will be shown, managers in the railway engineering industry conceded wage rises for changes in working practices that enabled them to reorganise the labour process and not necessarily to increase worker effort. Thus although Baldamus's theory appears to be correct about the motives of the workforce, he is wrong about the practices of management.

I do not argue that workers' struggles are without influence and argue that, if Baldamus's arguments are combined with those of Fox in his work 'Beyond contract'(1974), the nature and impact of workers' struggles can be understood. This paragraph is devoted to presenting an outline of Fox's theory. Fox argues that the relationship between workers and management is either high or low trust. These two terms are nearly self explanatory. High trust situations are those in which workers and management take a conciliatory approach to the proposals and activities of each other, workers do not perceive managers' actions to be aimed at increasing

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24. Comment made at Aston/UMIST annual labour process conference, Aston University March 1990 during presentation of my paper; Managers, engineers and accountancy; the railways and the dominance of engineering.

exploitation and managers do not perceive workers as concerned with increasing wages without increases in productivity. Low trust relations are those in which the workers and managers suspect the motives of each other. Fox sees low trust relations as more prevalent than high trust relations. His arguments for this are similar to those of Baldamus. The wage effort bargain leads management and workers to seek advantage over each other by creating a disparity of effort to wages in their own favour. He argues that a vicious cycle leading to a reduction of trust between management and men is often the case, for example, management advantage in the past could lead to a mistrustful and non-cooperative workforce which in turn forces management policies to be implemented without full consultation which further alienates the workforce, and so on.

A view of the workforce which is broadly supportive of Baldamus's view can explain the impact of worker's struggles when allied to Fox's conception of levels of trust. How the workforce reacts to management policies depends on the level of trust, for example, management may wish to introduce a change in working practices to improve their control over the coordination of production, but in a situation of low trust this may be interpreted as an attempt to increase effort. As Baldamus has pointed out management usually wishes to avoid manifest conflicts (Baldamus, 1961, p. 126) and will thus probably shy away from policies that could be misinterpreted. An example from the railway engineering industry may serve to help the understanding of this point. In the period after the First World War the workforce, working under a piece work system, were restricting output because of the previous managerial practice of rate cutting. Management wished to introduce incentive schemes that used a standard rate of output and enabled management to plan work on this basis, the attempt to introduce incentive schemes was never adopted when it was realised that workers would interpret this as another management attempt to cut wages. The use of Fox's conception of trust enables a theory to be constructed of how workers struggles can influence the development of the labour process whilst being occupied with different concerns from management. In a nutshell, management are concerned with control over the whole of the labour process whilst workers are concerned with the wage effort relation.[25] Because the labour process is a more or less integrated whole, disputes over the wage effort bargain have an impact on managerial policy in other areas, a crucial determinant of this being the level of trust within industrial relations.

In discussing managerial strategy so far I have presented it as if it is unitary. As should be clear from the introduction so far, an important part of this thesis is the claim that it is not and that there are disputes within management about what constitutes policy. I argue that different professions take different views on how to manage an organization which draw their inspiration from concentrating on different aspects of capital. In what follows I try to present some of the differences at a very basic level between

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[25]. Although of course to advance the wage effort relation clearly involves workers to struggle in other areas, for example, over negotiating rights or demarcation issues. These do not alter the fundamental point, these types of disputes are usually adjuncts to disputes over the wage/effort relation.

policy based on accounting and policy based on engineering, the purpose behind this choice is that these two policy types are those most central to understanding the development of the railway engineering industry. I first describe the basis of accounting policy and then engineering policy. In this discussion I argue that the policy based on accounting can lead to problems of coordinating physical processes. Then finally I show that Sohn-Rethel makes similar points about divisions within managerial policy.

Accounting, in all its forms, developing from the precepts of exchange, departmentalises the organization and then quantifies the physical activity according to the singular measurement of money. This procedure applies the principles of the market to internal operation of an organization. In the market, the firm is an accounting entity, and the aim of its managers is the maximisation of revenues by making others bear the cost, that is a firm's profitability is due to the creation of externalities.[26] Accounting turns departments and individuals into accounting entities measured in money, with of course similar incentives to create externalities.

Engineering can take a different line, engineers' experience of the nature of physical reality, which does not conform to arbitrary division and measurement but is an integrated whole, subject to unseen deep laws, teaches them that the entity for measurement depends on the

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26. Marxism identifies the worker as the major bearer of externalities in the form of unpaid labour, but there are others; the environment, consumers of monopoly supplies and all other 'market' failures.

process. Material reality does not conform to the social niceties of managerial accountability, the physical entity of any policy change varies with the physical nature of the change. Certainly impacts can be predicted, but not always with certainty as to their nature or location.

The application of 'market' criteria, that is accounting, to the internal workings of an organization encourages effects within departments of an organization, for example, the reduction of costs, by improving the performance of the department, not by the coordination of the whole. Needless to say, departmental performance is increased by the improvement of coordination within that department, but physical reality may mean that this is at the expense of other departments and the whole.

The claim for a split between management policy based on engineering or based on accounting has support in the work of Sohn-Rethel, who argues that there is a conflict between principles derived from the physical labour process, what he terms plant economy, and market derived criteria:

> 'Clearly, industrial plants organised on principles of continuous flow must follow their own rules of development. Strict synchronisation of all part-processes is essential. Any section slower than the others acts as a bottleneck condemning the capital invested in the plant to wasteful utilisation. Further capital must be invested until the plant satisfies the rule of even flow. The result will be the capacity of the plant. This result may or may not be intended nor called for in terms of market demands. If not, the firm stands to lose in the market what it gains by observing the laws of internal plant economy.
>
> Here we notice the gap which opens up, in monopoly capitalism, between market economy and plant economy. For the laws determining the structure and evolution of the production process of monopoly capital are rooted in its intrinsic time economy and relate directly to the labour process of production. But these laws exist, of course, side by side with, and in the framework of, market economy; otherwise the enormous advance in labour productivity and surplus production springing from the new methods would

not transmit themselves into private profits.' (Sohn-Rethel, 1978, p. 162)

An important determinant of the form of labour processes thus becomes the weight given to market or plant criteria by management.[27] As will be seen, the way in which policies based on accounting and engineering (or market and plant criteria) interact and develop is crucially important for understanding the development of managerial control over the labour process within the railway engineering industry. At a theoretical level the manner in which different principles of management deriving from the market or the production process are reconciled is of crucial importance in contributing to the diversity of management policy toward the labour process. I show that managerial policies that were considered to be the crucial method of capitalism can be explained by the inter-relationship of market and plant criteria, for example, the assembly line, seen by Edwards as the method for its time, is shown as a response by engineers to the development of accountancy, or Taylorism is shown to be a particular combination of accounting and engineering. As a further illustration of the impact of the interplay of market and plant criteria, I show that the timing of policies can vary, thus in the railway engineering industry the adoption of mass production was introduced by engineers during the 1920s as a means of isolating accountants, and contrary to what would be considered the normal sequence of events, Taylorism was introduced by engineers during the 1970s as an adjunct to mass

27. Sohn-Rethel perhaps characterises the methods of Fordism and Taylorism in an ahistorical light seeing them as necessary features of production (Thompson, 1989, p. 259).

production in response to the growing demands from senior management for accounting controls. This would seem to be supportive of the conclusion that labour processes vary, that is the railway engineering industry appears different to the 'normal' sequence of Taylorism preceding mass production. I do not agree and instead argue that both these advanced control over coordination and the variation in labour process that they show is due to the variation in the manner in which the contradiction between plant and market criteria is resolved.

In this section I have outlined my proposals for an alternative theory of the labour process. Prior to summarising the contents of the remaining chapters I will conclude this section by reviewing the discussion above. The proposed labour process theory has been developed in two ways; by my research into the railway engineering industry and by a critique of existing labour process theory. The relationship of the theory to the case study is that the theory outlined above is the best means of understanding the development of the railway engineering labour process. I have argued that it is possible for the mental labour required to reproduce a labour process to be monopolised and that on this basis management is a labour process that reproduces the labour process of others. I have argued that the managerial labour process is based on two practices, derived from, respectively, physical and monetary criteria, that are contradictory. I argue that as a consequence of the nature of management the railway engineering industry saw a growth in managerial control over the coordination of the labour process. The nature of management I have proposed is not specific to the railway engineering industry and I can think of no major impediment to the growth in managerial control over coordination in other industries. It is for this reason that I propose it as a general theory of the labour process.

The theory also addresses issues raised in my review of the labour process literature. In that review I had noted that the general conclusion reached in the debate was that there were no general trends in the labour process and that each labour process was a unique product of its environment and history. Although the position that the existence of management has no consequences that can be traced directly to its existence, appears implausible when stated bluntly, it has been strengthened by the failure of attempts to establish a general theory of labour process development, for example, in the works of Braverman, Edwards and Thompson. My theory has attempted to meet head on the very objections that are believed to mitigate against a general trend, that is the need for worker flexibility, workers' struggles and variations in managerial strategy, and has incorporated them.

The theory described above can accommodate the subjective aspect of the labour process considered as the decisive absence within Braverman. The need to retain worker flexibility and the impact of workers' struggles are both considered to lead to variety between labour processes and count against any genéral theory of the labour process. My theory can accommodate such objections because labour control is not central to management, of central concern is labour process control. I argue that workers' struggles are orientated to the wage/effort relation, a conclusion based on my research and the work of Baldamus. Management are willing to accept a standard wage/effort bargain and a standard degree of flexibility because this enables them to plan and synchronise the labour process more effectively. This is not to say that workers' struggles do not effect managerial policy. Workers may interpret managerial policy aimed at advancing control over coordination as an attack on the wage/effort relation [28], and workers' action may result in managers having to drop certain policies. Drawing on the work of Fox, I indicated that a crucial determinant of how workers interpret management action is the level of trust characterising the industrial relations.

Another factor considered to lead to variation in the form of labour processes is the variation in managerial policy. I consider the variation in managerial policy to be an important insight of the labour process debate but argue that it can be adopted into a framework which sees management as a labour process. I argue that the managerial drive toward increasing control over the labour process is contradictory because it is based on principles derived from physical criteria and principles derived from market criteria. Both sets of policies are required by management but they can work against each other and can be the cause of divisions within management, for example, in the railway workshops there was a division between accountants and engineers. These divisions

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[28]. This is not to say that their reaction is illegitimate, policies aimed at advancing managerial control over the coordination of production may indeed impact on the wage/effort relation, for example, this would be true in the case of Taylorism.

within management and the different management policies do cause variety within labour processes but it is a variety which manifests itself as a part of the managerial drive toward control over the labour process.

In summary then I have proposed a general theory of the labour process which sees management as that labour process which controls the labour processes of others. I have argued that this has resulted in an increase in management control over the labour process as management attempts to secure its position and ability to institute change within the labour process. In proposing this theory I have accepted that there is variety caused by workers' struggles and management policy, but have shown that this can be accommodated within and add to the general theory proposed.

SECTION SIX; OUTLINE OF CHAPTERS

In the remaining part of this chapter I outline the subjects discussed in the chapters that follow, and the way in which they relate to the growth in management's ability to control the labour process. Chapters two and three are mainly concerned with providing a basis for describing the changes within the railway engineering labour process that have occurred during this century. They describe the history of the industry until the beginning of this century and describe something of the industry's ownership and product during this and the last century. Chapters four to six describe the management and workers within the industry. This is done in terms of the divisions between these two broad groupings and within each of the groupings. Chapters seven to nine describe the changes in the organization and control of the labour process, examining in turn the developments in work flows, means of production and work measurement.

The contents of chapter two are there to set the scene for the chapters that follow by describing the major parameters of the labour process, the use values produced and the owners who provided the motive to produce those use values. Chapter two is descriptive and charts the patterns of ownership and describes the nature of the product. It is shown that the ownership of main railway workshops has been by the railway companies, placing the works at one remove from the pursuit of profit. An important change in ownership was nationalization in 1948, although later in the thesis this is shown to be mainly of theoretical importance because nationalization had no discernable effects on the labour process.

The nature of the product in railway workshops, the building and overhaul of rolling stock, is shown to have developed slowly. This is important from a methodological point of view as the nature of the product represents a partially controlled variable.

Like chapter two, chapter three provides a basis for understanding the argument that follows, this is done by describing the method of production prior to the take off of managerial control over production during the twentieth century. Chapter three describes how, prior to the 1920s, production was achieved. As will be seen, the prime method used was the foreman system, although paternalism was not uncommon. Toward the end of the period there was a growth in mechanization and therefore the fixed cost element of production. This gave an impetus to attempts to reduce the level of fixed costs.

In chapters four to six the groups who had an influence on the development of the labour process are described. These three chapters describe that subjective element that was considered to be important in the labour process debate. The nature of management and the relations with workers' are described as they provide some of the explanation of the changes that occurred within the labour process, that are described in chapters seven to nine.

Because engineers have been the dominant managerial grouping within the railway engineering labour process I have felt it necessary to describe something of their background as a means of understanding the basis of their policies. Chapter four, therefore, describes the origins of engineering management, indicating that their training was in manual apprenticeships until the 1960s, although these were distinct from the workers' apprenticeships. This is intended to indicate the engineers' connection with physical production which I will later argue laid the basis for much of the engineering policy directed at improving plant economy.

Much of the labour process debate has stressed the importance of workers' struggles, and in chapter five, I examine this theme. It is in this chapter that I present evidence which confirms Baldamus's theory that workers struggles are primarily orientated toward the wage effort bargain. This chapter describes how the system of production that predominated up until the nineteen twenties was seen by engineers to be in crisis. This system was essentially governed by the agenda of getting workers to work harder and was dominated by questions of the wage effort bargain. The industrial relations situation at the beginning of the century, where the engineers opposed the foreman and piecework system , is explained, following Fox, in terms of the low trust it had engendered in the workforce. It is shown that workers influence managerial policy in an oblique way, it is shown that engineers' attempts to revamp the systems of payment by results so as to improve the quality of production control, had to be abandoned because of workers' belief that they were attempting to increase exploitation. The chapter indicates the change in management emphasis from questions of labour control to control over production, by describing the decline in the position of the foreman over the century in both the areas of control over production and control over labour. This decline in the importance of direct control over the workforce is shown to be indicative of advances in managerial control over the coordination of production.

In chapter six, I examine the opposition between engineers and accountants. This examines how costing developed and was applied according to the dictates of engineering. I also indicate how the engineers retained control and a distinctive outlook, only losing the latter from Dr Beeching onwards. This is indicative of the importance of the shifting boundaries between different concepts of utilization of productive resources as determinants within industrial labour processes. This chapter therefore attempts to indicate that management is not a uniform entity and that the divisions relate to different ways of coordinating the labour process and that these divisions are a stimulation to change. This chapter hi-lights the source of instability in management which derives from the contradiction between production and market criteria.

Chapters seven to nine examine the development of the railway engineering labour process. These chapters focus on particular aspects which have been considered important within the labour process debate; chapter seven examines workflows, chapter eight mechanization and chapter nine work measurement. It is shown that the central development is the increasing control over the coordination of production and that developments in all of these areas are special cases of this development, as is clearly shown, control over workflows is most intimately a form of control over coordination. These chapters show that the sequence of these changes does not conform to that presented by some labour process theorists, for example, contrary to both Edwards and Braverman, in railway engineering, assembly lines preceded Taylorism by about fifty years. It is argued that the sequences of management policy can be explained by the struggles between different management groups and previous management decisions. However, it is shown that this variety is explicable in terms of a growth in managerial control over the coordination of production.

Chapter seven examines the strides made in coordinating work flows. Edwards' concentration on the assembly line as the method of transition from simple control is shown to be but a special case of this. This chapter argues that the trend to coordination is universal. It is not claimed that the changes outlined are 'the' method of transformation within the labour process, but that they mark most clearly the process of coordination and the growth in the control over coordination which seem to be central to the development of the labour process in the railway workshops. Chapters eight and nine illustrate this by showing how mechanization and Taylorism are explicable by the proposed theory of the growth in control over the coordination of the labour process.

Chapter eight looks at the development of means of production. Marx considered this to be the central feature in the transformation to the real subordination of labour or managerial control over the labour process. I disagree because it is only the partial achievement of the power to coordinate, the machine coordinates production within its operation, it does not coordinate the operations between machines. The machine provided a useful example to the engineers of a means of increasing output by coordination which not only would increase production, but also would isolate managerial rivals.

Chapter nine brings Braverman back in, by discussing the development of workstudy. It indicates that Taylorism was not a means of transition from simple control, indeed it was not applied on any scale until the 1970s. It is not that it is a failure, but that it is partial and is utilised according to the development of the larger framework of control over coordination.

Chapter ten is the conclusion and summarises the arguments of the preceding chapters and makes a final assessment of the proposed theory of the labour process and its applicability to the railway engineering industry.

SECTION SEVEN; SUMMARY

The introduction has attempted more than is usual in a thesis introduction. I have described the object of the thesis which is to present the case study of the railway engineering industry in terms of a general theory of the labour process. The methodology used to examine the railway engineering industry was described. The literature of the labour process was reviewed and both the widespread acceptance of contingency theory and previous attempts at general theories of the labour process rejected. On the basis of my assessment of labour process theory and my research, I have proposed an alternative theory of the labour process. It was argued that management is that labour process which reproduces the labour process of others and that as a consequence of its position management has advanced its control over the coordination of production. It was shown that this development is affected by the struggles within management and between management and workers and that the control over the labour process can be pursued in many different ways but that these are compatible with a trend toward increasing managerial control.

CHAPTER TWO

THE CONTEXT OF CHANGES IN THE WORKSHOPS

INTRODUCTION

In this chapter, I describe the context of changes in the railway workshops by examining the patterns of workshop ownership, the expansion and closure of workshops, and the changing product of the workshop. A most significant event that occurred in terms of context was the nationalization of the railways, and hence the railway engineering function, in 1948. The significance of this event is in relation to theoretical concerns because from my analysis I cannot detect it having any discernable effect on the development of the labour process. In what follows I define more clearly the nature of my case study, that is, what I mean when I refer to railway workshops, and I then proceed to describe the changes in patterns of ownership and the nature of output and the impact this had on the industry. The impact that ownership and output, which can be characterised as the highest level of control within an industry, has, is discussed according to two dimensions, one is the very simple discussion of the size and location of the industry, the other and more important dimension is the impact ownership has upon managerial policy. Basically ownership of workshops by railways was to produce rolling stock and this has produced a demand that workshops not only produce cheaply but that they do not cause the operating side of railways (those that run trains) to incur unnecessary costs. The aim of reducing costs in production and for operation is something of a balancing act and how it has changed is a major theme of the thesis. Thus this chapter can be seen as providing some basic descriptive background to the nature of the industry, but is primarily aimed at indicating the origin of the concern for costs in both workshops and railway, upon which much of the workshop history revolves.

The British railway workshops were part of a wider railway engineering industry in which three different types of institutions existed:

1. Railway owned sheds for carrying out maintenance to ensure day to day running.

2. Railway owned workshops which made good the wear and tear on rolling stock by major overhauls and new building to replace obsolete stock.

3. Private contractors who built new rolling stock and very occasionally carried out overhauls.

The railway workshop industry dates from about 1839 and is identifiable by two criteria, which have ramifications in policy terms, the work it carries out and railway ownership. It ceased to exist, in Britain, in the summer of 1989 when BREL (British Rail Engineering Limited) was sold to a consortium of Trafalgar House, ASEA and management.

PATTERNS OF OWNERSHIP

Machine locomotion was first used in 1825 on the Stockton and Darlington railway. The completion of the Liverpool to Manchester line in 1830 had more impact on the imagination of the time, and the period to 1875 saw the creation of 75% of the railway networks' maximum route mileage. At the end of the last century 'inland transport was essentially rail transport' (Gourvish, 1980, p. 20). The railway companies developed by a process of amalgamations (Bonavia, 1971, p. 151), and by 1850 there were 15 companies accounting for 75% of the rail revenue. These 15 companies survived and furthered their hold on the industry, until the state sponsored amalgamations into four mainline companies in 1923 (Gourvish, 1980, p. 10). The centrality of railways to the economy has meant that they have continually been subject to state intervention. These state enforced changes in patterns of ownership are set out in Appendix 1 of this chapter, the most important change being railway nationalization in 1948.

The shape of railway organization has always been a political issue. Nationalization made the railway continually subject to government influence via various statutory mechanisms. Since the formation of the Railway Executive during the Second World War, the minister in charge of transport has been responsible for appointing the top management of the railways, who were ultimately responsible for workshop policy. Since nationalization all major investment decisions require ministerial consent, and the borrowing of the railways is controlled by the relevant government department. The annual reports must be submitted to Parliament, the Select Committee on Nationalised Industry can scrutinise BR's activity and the Public Accounts Committee its funding.

The policy of most governments since before nationalization has been pro-road,[1] and since the Second World War this has been enhanced by a vociferous road lobby, and an anti-public transport stance from Conservative governments (Smith, 1983, p. 23; Wistrich, 1983, p. 100; Hamilton and Potter, 1985). Opposition to public transport was manifest in the appointment of Beeching, from ICI, rather than a railway trained manager as chairman of the Board in 1962. Beeching, as is well known, was responsible for something of a "hatchet job" on the railway's route mileage. He also appointed Stuart Mitchell, ex-Royal Ordnance, as Head of a newly formed workshop division to produce a workshop closure and modernisation plan.

Labour's Transport Act of 1968 gave the workshops, for the first time in nearly a century, the freedom to produce for outside parties. In response to CBI pressure the works were also placed in the charge of a separate company to prevent hidden BR subsidies (Bond, 1975, p. 310).

In the run up to privatisation of the workshops, the Serpell report into railway finances, published in Thatcher's first term, recommended the relations between BR and BREL should be based on a more "hands off approach", and

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1. The pro-road stance is true of labour and conservative governments. The Transport and General Workers Union has been a major advocate of road transport and has had more influence of Labour party policy than the railway unions.

therefore subsequently new building and later repair were subject to competitive tendering. The rail and works management used Conservative Party policy as a basis for justifying changes, the white collar union TSSA, noted 'they have already pointed to Serpell and said that if they do not put their own house in order, then it is clear that the Government will give them specific directions' (TSSA, 1983c, p. 3). Included in these policies was the closure of five out of 12 works. At a meeting on the 21st of January 1986 the 'hands off' and closure policies were taken further; BREL was to retain control over only four works and a new grouping, the British Rail Maintenance Group, were to control three ex-works with a very much reduced staff to carry out 'preventative maintenance' (British Transport Officers' Guild, 1986, p. 1) by means of the practice of component exchange, made possible by modular design. This type of repair involves removing and repairing parts individually; enabling locomotives to run and increasing the time between overhauls. This had been practiced at a number of depots successfully for a number of years (TSSA, 1986, p. 2) and there had been 'a growing sense to do as much work at Depot level' for a number of years (BREL, c1980, p. 4). To enable this component exchange policy to occur, a national stores was established at Doncaster with a materials HQ at Derby (British Transport Officers Guild, 1986, p. 2; TSSA, 1986, p. 2 and p. 4). The final four remaining main works were privatised in the Summer of 1989.

THE OPENING OF WORKSHOPS

The early railway rolling stock was supplied by firms of contracting engineers who also performed repair work. The Stockton and Darlington Railway opened a works for day to day maintenance at Shildon in 1826 followed by a further works in 1833. The Liverpool and Manchester Railway likewise opened a works for repair at Edgehill. Early locomotives suffered defects and regular breakdowns (Hill, 1981), for example, on the Grand Junction Railway the crank axles on each of its 55 locomotives broke during a 13 month period (Reed, 1982, p. 7). It was the need for constant heavy repair and a supply of reliable locomotives that led several companies to expand their day to day maintenance facilities to carry out heavy engineering. It has been estimated that 20% of engineering output in the 1830s and 1840s was in the form of railway rolling stock and 'more important', according to Gourvish, 'the railways created a new sector, mechanical engineering'(Gourvish, 1980, p. 25).

The workshops that were to emerge as main works were in the early days almost indistinguishable from engine sheds having small staffs, for example both Derby and Crewe when opened each had 160 staff (Radford, 1971, p. 16; Reed, 1982, p. 16). Many works were placed in the centre of rail networks to reduce the distance locomotives had to go for repair, but this was often in open country away from sources of skilled labour.

By the end of the century, railway companies usually had a small number of works (Table one), differentiated between loco works and carriage and wagon works, the latter category possibly then further differentiated. Of the five companies in table one that did not conform to the norm the LBSCR was in the process of doing so, and at Swindon and Eastleigh, different rolling stock was under different managements in separate locations. These works were, understandably, much larger than the earlier works, in response to the increasing traffic, in each company there was a corresponding growth in the size of workshops. For example, Crewe showed a sixty two fold increase in staff between 1843 and 1918, at Derby there was a 51 fold increase in all railway staff between 1840 and 1912.

TABLE ONE

STAFF AT MAJOR WORKS 1912

COMPANY	LOCATION	WORK DONE	STAFF
GCR	GORTON	L	2,512
GCR	DUKINFIELD	C.W	1,741
GER	STRATFORD	L.C	4,578
GER	TEMPLEMILLS	W	618
GWR	SWINDON	L.C.W	11,760
LYR	HORWICH	L	3,850
LYR	NEWTON HEATH	C.W	1,960
LNWR	CREWE	L	9,000
LNWR	WOLVERTON	C	4,000
LNWR	EARLSTOWN	W	1,800
LBSCR	BRIGHTON	L.C.W	3,600
LBSCR	LANCING	L.C.W	129
MR	DERBY	L	3,988
MR	DERBY	C.W.	4,300
NER	GATESHEAD & DARLINGTON	L	3,953
NER	YORK & HEATON	C	3,932
NER	SHILDON	W	1,161
SECR	ASHFORD	C.W	1,211
SECR	ASHFORD	L	733
CR	GLASGOW ST ROLLAX	L.C.W	2,695
GSWR	KILMARNOCK	L	986
GSWR	BARASSIE	C.W.	269
NBR	GLASGOW COWLAIRS	L.C.W.	2,297.

SOURCE: PRATT 1913.

Some railway companies located several works in one location. For example: Derby, Ashford, Eastleigh, Darlington, Shildon, Swindon Stratford and Inverurie. This was because it enhanced control of senior engineering management relative to subordinate works management, and relative to the directors of the companies.

The opening of new works was used to introduce new methods. For example, Derby Carriage and Wagon Works, opened in 1873, was designed so that raw materials moved in a direct flow and minimum movement from shop to shop to emerge transformed as rolling stock (Radford, 1976; for Eastleigh see Turton, 1961, p. 111). The opening of workshops effectively ceased after the First World War, since when location policy has been one of closure.[1]

[2] 1. Faverdale wagon works Darlington was opened in 1923 by the LNER employing around 500 men. The works was planned by the NER and it is a product of the pre-amalgamation situation. In the 1940s and early 1950s the Ministry of Supply loaned Germiston to the Railway Executive for carriage and wagon work. In the 1950s British Rail opened a wagon works at Townhill employing 80, men but it did not remain a works for overhaul for long, becoming a depot for light repairs.

CLOSURES

The pattern of closure has two facets both related to the operation of the remaining labour processes:

1. Centralization of production at particular locations.

2. Selection, works closure was on criteria of relative efficiency, present and future.

Early works were located either in cramped urban locations which made expansion difficult or in rural areas away from a labour force. Both factors contributed to closures during the last century. The GJR opened Crewe in 1843 as a replacement for works at Liverpool, the GER opened works at Stratford in 1947 and closed works at Romford, and the GNR opened Doncaster in 1853 and closed works at March and Boston. This pattern continued until the First World War, for example, the LSWR opened a Loco works at Eastleigh to replace cramped works at Nine Elms, London.

The major cause of closure was due to overcapacity. As the 15 large companies consolidated their position by amalgamations, they closed subsidiary works taking advantage of economies of scale at workshops by transferring any remaining work (Turton, 1961, p. 114). [3]

Closure continued with the 1923 amalgamations (Railowner, 1936, p. 107; Appendix 3 this chapter). The

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[3] For example the closures at: Greenock (1853), St Helens (1864), Arbroath (1866) and Newport (1875).

cause was not a reduction in rolling stock, because this only shows a reduction during the early thirties and most closures occurred soon after the 1923 amalgamations. The process of closing works with amalgamations continued into the 1930s when smaller remaining railways were taken over.[4] During the 1930s there were works closures that were the product of the recession rather than amalgamation, the largest works to close were at Brighton on the Southern Railway and Gateshead on the LNER. Both of these were to reopen with the onset of World War Two, only to close again in the 1950s. The nationalization of the railways led to the largest amalgamation of the railways the country had seen. Unlike prior amalgamations, closures did not begin straight away but there was a delay of nine years until the first closures.[5] The delay was caused by:

1.The backlog of work built up because of neglect of repair during the war. This appears to be particularly marked in the field of new building and wagon repairs (Railwayman's Yearbook, 1951, p. 9).

2.Regional control from 1953-62 meant works were not under the control of one organization.

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[4] The Somerset and Dorset Joint Railway was taken over by the LMS in 1930 and the Works at Highbridge closed , and the Midland and Great Northern was taken over by the LNER and the works at Melton Constable closed in 1936.

[5] Germiston Carriage and Wagon works was returned to the Ministry of Supply in the early 1950s

3.The 1955 modernization plan introduced new forms of rolling stock, and maintenance of old and new types of rolling stock increased the works capacity needed.

Between 1958 and 1962, the regions closed nine small works with a mean staff of 220 compared to the 2300 staff of the remaining works.[6] The closures reveal the continuing tendency toward centralization. Eight closures were loco works reflecting the facts that the new diesel and electric locomotives required less maintenance than steam, and that private contractors built most of the locomotives and most of the components.

The tendency toward closure was reasserted in the Main Workshop Plan of 1962, formulated by Sir Steuart Mitchell, which closed 12 out of 28 works (Larkin, 1979, p. 138 and p. 140; Cook, 1964). Cook makes it clear that the selection for retention was, not surprisingly, based upon efficiency (Cook, 1964, pp. 53-52).

The works closed were also related to changes in rolling stock. The relative propensity to close loco works is revealed in the Censuses of Production, which show that between 1954 to 1968, employment relative to carriage and wagon works fell from 53% to 36% of the total (Census of Production, 1954 and 1968).

The closures ran concurrently with the development of the other works;'The acceptance in principle of the plan was

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[6] These figures are from 31-12-1957 Johnson and Long pp. 522-525 and partially reflect that the works were being run down.

the signal for the immediate commencement of the detailed examination and planning of the 16 continuing works' (Ridgway, 1967, p. 95; Cook, 1964). There was major investment in new machine tools, the extension of flow line production methods and new methods of production scheduling, for example, network analysis.

The next major round of closures was in the 1980s [7] and this was caused by falling repair requirements (BREL, 1983a). This was particularly marked in wagons because of computerised wagon timetabling. This significantly reduced the running of wagons unloaded, and so meant less repair and less need for new building. The first four closures were all wagon works: Ashford 1981, Templemills 1983, Horwich 1984 and Shildon 1984. The closure of Swindon in 1986, the major location for shunter repair, was also related to the decline in wagon traffic. The transfer of Doncaster, Eastleigh and Wolverton to BR in 1987 and the closure of Glasgow in 1986, were due to the development of modular repair methods.

[7] Small works were closed at Inverurie 1969, Barassie 1974 and Townhill was transferred to the Scottish region.

OBJECT OF LABOUR

The decisions over the location of workshops are based upon some criteria of efficient production. An important element in this is the nature of the object of labour.

All material objects of labour have two facets, they are raw materials transformed into use-values. It is mistaken to identify the object of any labour process as a singular object. On the contrary, a labour process produces many products.

In the railway workshops the object of labour was the fleet of rolling stock and the inputs to maintain this fleet eg:iron, components,etc. The fleet of rolling stock must be considered as a whole, because a prime concern is ensuring the best utilisation of the fleet. The focus on a single object is suspect, having little justification other than commodity fetishism. The object of a labour process can be defined according to the following criteria:

1.The material of the object of labour;

2.Type of use value;

3.Rawness of materials; the usefulness added to a product relative to that added in prior labour processes, ie; the degree of vertical integration;

4.Quantity of objects of labour; and

5.Mix of objects of labour.

TYPE OF USE VALUE

The workshops existed and were owned by the railways to maintain the means of production of the transport labour process. The object of labour of the workshops is not the production of individual articles but the reproduction of a whole fleet of rolling stock. As Bond (Head of Workshop Division in the 1960s) argues, works existed 'to make good steadily, year by year, the wear and tear occasioned by running' (Bond, 1953, p. 176). Rolling stock can be divided into four categories:

1. Locomotives,
2. Rail cars,
3. Coaches, and
4. Wagons.

From the beginning of railways until the 1950s, the overwhelming form of traction was the steam locomotive. It conformed to a uniform design from the earliest days: a frame riding on a number of wheelsets on which a boiler was mounted. Motive power was transmitted from cylinders to some or all of the wheels by means of motion rods. The train was controlled from a cab which also contained the opening for loading coal into the boiler's firebox (Kidner, 1947, p. 1). Steam locomotives were primarily replaced by diesel and electric traction under the 1955 Modernisation Plan, although by nationalization the SR had been running most of its London commuter services using electrically propelled multiple units (EMUs) (Larkin and Larkin, 1988, p. 90).

Multiple units are a combination of coaches and coaches with engines slung underneath.

Coaches and wagons have developed from boxes on wheels to their present form, with a major change being the use of steels and plastics as opposed to wood. The last century saw the application of bogies [8] and the invention of continuous braking (ie brakes on all vehicles in a train), although the adoption of this as standard on wagons is very recent. The end of the last century saw a number of developments in passenger comfort: lighting, toilets, buffets, sleepers etc. This century the developments have mainly been directed at making larger, lighter and faster rolling stock.

Repair of rolling stock is the most important activity in the workshops (Fowler, 1929, p. 59). Bond argued that it was for repairs 'that railway locomotive engineers are largely trained and their subsequent experience principally gained. It is for this purpose, too, that the locomotive workshops are mainly provided' (Bond, 1953, p. 175). Construction was also 'an essential part of the whole problem of maintenance' (Bond, 1953, p. 176), as it made good mileage by replacing worn out rolling stock and adding more efficient vehicles in terms of running and repair requirements (Bond, 1953, p. 176). Repair was the most important expenditure, for all stock, and was double that for construction in 1953, 1974 and 1980 (Riddles, 1953, p. 143; Ridgway, 1974, p. 6; Larkin and Larkin, 1988, p.

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[8] This is a construction of wheels and axles mounted on a frame that horizontally rotates relative to the body of the rolling stock to enable easy passage through curves in the track.

205). The concentration on rolling stock was reinforced by an injunction, taken out by private contractors in the 1880s and lifted in 1970, that restricted works production to the needs of the owning company.

Sending rolling stock for repair is referred to as "shopping". During the inter-war period a system was evolved whereby the depot would examine rolling stock at predetermined periods. In the case of a loco if its general condition had deteriorated, the depot would request a boiler inspection. The boiler examiners' report and the depot's periodical report would be sent to the Central Shopping Bureau. The Bureau would decide whether to shop the loco, or, to continue to run it fixing a date for the next inspection (Ball, 1938; Bond, 1953; Riddles, 1953; Cook, 1947; Garrat, 1963). The system of shopping for other rolling stock and later types of traction was much the same (Simpson, 1957, p. 145). This method of shopping led to a pool of rolling stock running and awaiting repair, which meant less disruption to traffic and allowed the works to choose the rolling stock to best suit production planning (Bond, 1953).

The time between repairs, measured either in miles run or in time, is termed the "periodicity" of repair. [9] The periodicity of repair is clearly open to contention, for example members of the NUR Works Committee expressed concern that the amount of time taken between repairs was increasing to such an extent that safety was being compromised, but

[9] In 1976 Gardiner gives the following periodicities for different types of repair: Light 3.5 years, Intermediate 3.5 -7 years, Heavy 6.75 to 14 years (Gardiner, 1976, p. 109).

generally periodicity determination is seen as a managerial prerogative. Increasing periodicity is a means of substituting capital for labour, the means of transport are so improved, that less labour in the labour process that produces them is necessary. The replacement of obsolete locomotives as a means of fleet maintenance is dependent on their "life span" [10], which is self explanatory.

It is the aim of the operating side of the railway to reduce repair to a minimum. Repair is intended to make vehicles available for service but the process of repair itself reduces availability. It was felt that 'by prolonging the period between any major repair, maintenance costs may be greatly reduced' (Hartley, 1932, p. 499). One conclusion from this, was that there was 'much to be said for performing as much work as possible in running sheds, and reducing visits to a main works to a minimum (Fairburn, 1944, p. 225; see also Bond, 1953, p. 178). Another line of attack was to attempt to increase the life of those things that made shopping necessary by being the first to wear out.[11]

It was said the ideal was 'all components of a locomotive requiring works attention at the same time' and

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[10] Which in the 1960s and 1970s was estimated to be 20-25 years (Gardiner, 1976, p. 109; Oil Engine and Gas Turbine, 1963, p. 33).

[11] For example on coaches it was paint and tyre wear (Hartly, 1931, pp. 501-2), and with locomotives the boiler was the 'governing factor' (Cook, 1947, p. 6; see also Ball, 1939, p. 329), in particular the firebox (Hartly, 1931, p. 502). Also of significance were repairs to wheels and 'to a lesser extent' axles and motion (Fowler, 1929. pp. 60-61). The 'principal factor' for diesel and electric traction was the same as carriage and wagons, that is 'tyre turning' (Simpson, 1957, p. 145), although it may also be transmission repair (Garrat 1963).

the ultimate goal 'the elimination of repairs' (Fairburn, 1944, p. 214). This latter was achievable, in principle, if all components' lives expired at the same time. Modular repair at sheds achieves these gains by reducing time out of service and substituting replacement with repair.

The time under repair was reduced during the inter-war period, by the introduction of repairs that took less time than a total overhaul. During the inter-war period 'great strides were made in repairing and maintaining boilers' (Cook, 1947, p. 6), and this meant that light or service repairs were introduced, where wheels were re-turned and minor repairs carried out, as a means of extending the period between heavy repairs where the boiler was removed (Fowler, 1929, p. 62; see also Cook, 1947, p. 6). This distinction between light, heavy and casual (for accidents and breakdowns), became the standard classification for the shopping of locomotives from that period onwards (Bond, 1953, p. 181). On coaches and multiple units, repairs were on a much wider classification, with up to nine categories of repair (Garret, 1963).

The nature of rolling stock is not only determined by transport requirements. Starkey argues that locomotives have been designed for exercising control over railway workers:

> 'Struggles over the length of the working week led to an...intensification of time use through such innovations as the big engine policy - "bigger, longer, heavier, faster ". If time itself could not be made available in bigger, longer quantities, it could be employed more productively' (Starkey, 1986, p. 13).

This argument could be extended to other types of rolling stock. Nor should it come as a surprise, that rolling stock was designed for ease of manufacture and repair. For example, the class 58 locomotive of the late 1970s and early 1980s was designed on the basis of easy access to components and complete interchangeability.

VERTICAL INTEGRATION

The establishment of workshops by the railways has been categorised by Bonavia (1971) as vertical integration. The larger workshops manufactured almost all of the railways' requirements, the only imported materials being in the raw: iron, steel, brass, etc. An American described the degree of vertical integration in British works to his fellow engineers in surprised tones:

> 'not only locomotives and cars are built, but there everything needed for use by the company, from a wood screw to the machinery of an interlocking switch tower, from a ticket punch to a steel rail, is made up from raw material.' (Railway Engineer, 1888, p. 21)

Crewe was perhaps the extreme in that it had a brickworks manufacturing for railway buildings and bridges. However, many works had gas works, grease works, water works, power generation, etc. During this century the degree of vertical integration has been reducing, most significantly with the introduction of new traction. It was decided that the railways would not manufacture engines, transmission units or their component parts. These were thus bought out which led to major reductions in the amount of smithing, forging, casting, and of course boiler and tender work (Ridgway, 1963, p. 152). The 1955 Modernisation Plan rested heavily upon private industry, out of the 14 diesel locomotive types ordered by BTC in 1955, the railway workshops manufactured the bodies of only three (Tufnell, 1979).

During the final 30 years of the workshops' existence, the amount of foundry work, and other "black trades" was reduced at a quicker rate than the general contraction in the industry. By the late 1970s there was only one iron foundry and one non-ferrous foundry throughout the whole of the industry. By the end, the workshops were primarily a combination of machine shops and assembly shops, with a growing emphasis upon assembly.

EFFECT OF QUANTITY

There was a decline in the output of the works over this century when measured in terms of locos constructed and repairs carried out:

TABLE TWO:

OUTPUT IN 1982 AS A PERCENTAGE OF 1922

New building:

Locos	9
Coaches	37
Wagons	1

Repair:

Locos	5
Coaches	8
Wagons	5

These figures cannot effectively portray changes in output. Firstly there have been changes in rolling stock design, and secondly, they do not indicate the state of inputs. Production is less from the raw than it was in 1922, the amount of wear and tear to be repaired is likely also to be different. Even so, the drop is of such magnitude to indicate that the amount of work has fallen. Part of the explanation is that the amount of mileage needing repair has fallen. Train miles have been falling since Beeching. In 1982 the mileage run was 55% of the total for 1922 (and 1961). The lack of growth in train mileage is due to competition from road transport. The fall in repair work is much more significant than the fall in mileage: repair of locos has fallen twenty fold and train miles by less than half.[12]

There has been a continual expulsion of labour from the labour process. In 1985 the number of manual workers compared with 1922 was 27% and falling, but because of the difficulties in measuring the figures for output it is not possible to devise a measure of the relative expulsion of labour.

[12] The reduction is even more significant as work done in one year is making good the mileage of previous years. The BREL personnel director supplied figures that heavy repairs occur every eight years on average, the average mileage over the eight years to 1982 was 65% of the 1922 figure. This means that compared with earlier repair policy, rolling stock is being run for many more miles between repairs.

THE MIX OF PRODUCTS

The workshops do not face the same form of product decisions as ordinary production, they repair fleets over their lifetime. A change from one type of vehicle to another causes the mix of products to be changed. For example, the decision to use diesel locomotives did not mean that steam locomotives were wiped out overnight. Instead, the works had to repair steam and diesels together for several years. This dilemma occurred every time the rolling stock was changed. In order to reduce diversity, the workshops pursued two related polices:

1. Workshop specialization.
2. Fleet standardisation.

The first developments in specialization were the separation between locomotive and other works, the principle being that this made it easier to fully utilise specialised labour and machinery. Bond argued that:

> 'The ideal to be aimed at, other things being equal, is that all locomotives of a particular class should be maintained by one works only' (Bond, 1953, p. 193).

The policy of specialization was extended beyond types and classes of rolling stock to standardising the location of production of components, for example, BREL's rationalization programme (BREL, 1979).

Standardising the rolling stock fleet by reducing the number of different vehicle types originated from demands to increase the efficiency of the workshops by enabling mass production. Standardisation of rolling stock fleets, like centralization, followed amalgamations:

> 'Standardisation both of complete units and components had, of course, been in progress in the railway industry for many years prior to nationalisation, a notable example of which was the locomotive standardisation carried out by the former LMS railway. This company between 1923 and 1945 reduced its locomotive stock from 10,316 to 8049, at the same time reducing the number of different classes from 400 to 133. Considerable progress in rolling stock standardisation had also been made by the other main line railways.'(Engineer, 1949, p. 27)

The desire to standardise rolling stock as a means of improving production is at odds with the transportation demand for improved rolling stock. The difficulties presented by the Modernisation Plan on works closures have already been noted. Smeddle (CMEE Western Region) makes clear the cost to the workshop of the changes:

> 'Major overhauls in the factory...involve a re-orientation of ideas concerning methods and equipment. Much of the machinery needed for steam locomotive building and repair will become obsolete as the changeover from steam to diesels gathers momentum, and will have to be replaced by new equipment.' (Smeddle, 1959, p. 12-13)

The mix of motive power meant, effectively, that the workshops were repairing two different types of use-value with the same staff and the same facilities. The conflict between works organization and change in motive power is the explanation behind other developments. The SR was the only pre-war company to develop new forms of traction on a mass scale, in this case EMUs, and it was also the only company not to adopt the mass production methods for the repair and production of locomotives (Boocock, 1968, p. 239).[13]

The non adoption of mass production on the SR is due to

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[13] Although carriages had been repaired on mass production lines at the company's works at Lancing since 1923. (Larkin and Larkin, 1988, p. 96).

difficulties of standardising methods because of non-standard stock. This was particularly difficult because multiple units are effectively half locomotive and half carriage and their allocation to works does not readily fit the distinction between loco and carriage and wagon works.

UNDERLYING CONCERNS GOVERNING PRODUCTION

Because the workshops are owned by the railway, this has placed upon them a concern for the cost of production and a concern for the cost of operating a fleet of rolling stock:

> 'during their long history the various main works overhauling the railways in Britain each developed systems for controlling the repair functions with the dual aims of keeping to a minimum cost and time in works '. (Boocock, 1968, p. 188)

In 1920, in line with Boocock's assertion, O'Brien argued that:

> 'Every effort should be directed to reducing the time spent in the erecting shop pits (where rolling stock is repaired) to a minimum '. (O'Brien, 1921, p. 370)

In 1953 Bond stated that 'the number of locomotives under or awaiting repair should always be as low as it can possibly be made, and nothing in the way of shop capacity, equipment or supervision deemed necessary to this end by those responsible must be withheld' (Bond, 1953, p. 188; see also Fowler, 1929, p. 59). The importance of making rolling stock available was stressed into BREL days, thus Hudson argued that the advantage of new computer repair scheduling was 'savings to the railways in general, particularly by reducing the average time that vehicles spend under repair in BREL works'(Hudson, 1974, p. 30).

The emphasis on the availability of rolling stock was because 'time out of traffic is a loss to revenue earning' (Cook, 1947, p. 4), and the directors were kept informed if stock was out of traffic too long, 'the accountants, who no doubt keep that matter very much in mind, begin to wonder what it is doing for its livelihood' (Cook, 1947, p. 12).

As Bond makes clear the speed of repair was not the only criteria, there were also the quality of work and the cost of repair:

> '1.The highest possible standard of mechanical efficiency and reliability of locomotives in service.
> 2.The lowest possible level of expenditure in the workshops' (Bond, 1953, p. 177).

The importance of cost was emphasised by Turner 'there is no branch of management which cannot be regarded as production at a price of some commodity ' (Turner, 1921, p. 135). The engineers have always been interested in cost reduction. In 1920 O'Brien stated that 'the aim of every railway management should be to effect improvement in the cost of repair at a greater rate than capital expansion ' (O'Brien, 1920, p. 370). In relation to the workshops there were two ways of achieving this: increasing the availability of rolling stock or improving the workshops. This dual role led to variations in workshop policy. Cook argued in 1947:

> 'While in recent years, great emphasis has been on maximum availability of locomotives, which in turn demands minimum time in factories, this has not always been the case, and in many periods the searchlight has been laid on the cost of maintaining the stock and, therefore, the operation of the factories in the most economical manner assumes equal importance.' (Cook, 1947, p. 12)

Increasing stock availability increased the cost of repair, as Ridgway argued:

> 'Because of the fluctuations in the maintenance workload and the intermittent nature of new vehicle construction, coupled with the fact that a considerable amount of railway vehicle construction work requires specialist equipment for relatively short production runs, it is inevitable that, from time to time, surplus manufacturing and maintenance capacity occurs in workshops.' (Ridgway, 1974, p. 15)

As Fairburn also noted, the continual attempts to increase rolling stock availability would increase cost on works:

> 'there would come a stage when capital cost could be reduced only at the risk of putting up the repair charges'. (Fairburn, 1944, p. 246)

The origin of the dual demand on the workshops and their resolution is understandable by reference to the balance of forces existing within the railway. Beames argued that there were two different demands on the workshops, and the workshop managers were in the middle and had to balance these demands:

> 'The first was the point of view of the directors and the shareholders. They naturally looked for a reduction in working expenses year by year. Then there was the point of view of the traffic man, who wished to have as small a number of engines as possible out of traffic, and wanted those that were out of traffic to remain in the shops for the shortest possible time. Thirdly there came the man who, like himself, had to try to meet the views of others.' (Fowler, 1929, p. 68)

The manner in which this dual demand on the workshops was reconciled, was by increasing control over the workshops to ensure the satisfaction of both sets of demands. Thus Cook argued that:

> 'work must be programmed and steps taken to ensure the adherence to the programme so that the men may be fully employed and also, that, in order to avoid delays to engines, the reserve of work must be kept to the lowest point ' (Cook, 1947, p. 12)

This position was re-emphasised in BREL, Hudson arguing that the savings in workshop production costs and increased availability of rolling stock made possible by computerisation, required 'closer adherence to the schedules through firmer control of the work involved' (Hudson, 1974, p. 30). Engineers thus believed that the dual demands on the labour process could be satisfied by ensuring managerial control over the labour process.

SUMMARY

This chapter has examined the highest level of control over the railway workshops. They were opened and owned by railway companies to make good wear and tear by means of repair and construction. This led to a dual concern, for fast production combined with effective workshop utilization. How this was resolved depended on the various pressures faced by management, but whatever the balance of forces it was always addressed by increased managerial control. In the next chapter I show how production was achieved in the last century by the direct control of labour, but that by the end of the First World War this method was in crisis.

APPENDICES TO CHAPTER TWO

1. STATE SPONSORED CHANGES IN THE PATTERN OF OWNERSHIP AND CONTROL

1.World War One. The control of the railways bya Railway Executive, composed of company appointees, for the duration of the War and until 1921.

2. 1923. The amalgamation of 15 large and numerous small railway companies into the 'big four' of London Midland Scottish (LMS), London North Eastern Railway (LNER), The Great Western Railway (GWR) and The Southern Railway (SR).

3. 1939 The formation of a Railway Executive for the duration of the War.

4. 1948 The nationalization of the railways under the wider umbrella of the British Transport Commission (BTC). The railways were to be run by a Railway Executive, with the workshops being the direct responsibility of a member of the Executive.

5. 1953 The Transport Act de-centralizes control of the workshops to operating regions.

6. 1962 The Transport Act led to the formation of the British Railways Board (BRB) in 1963, as a separate undertaking, under Dr Beeching. In 1962 in anticipation of the above, a workshops division to centrally control main works was established.

7. 1970 The formation of British Rail Engineering Ltd (BREL), a wholly owned subsidiary of BRB, to control the major works.

8.1986. The creation of a new organization British Rail Maintenance Group to carry out light repair in a number of works separate from the four main works designated for heavy repair and new building, which remained under the control of BREL.

9.1989 The privatisation of BREL.

2. SELECTED WORKS OPENING DATES

1838, Wolverton, Kipps
1839, Glasgow Cook Street, London Nine Elms, Liverpool.
1840, Derby.
1841, Glasgow Cowlairs.
1843, Swindon, Crewe.

3. EXAMPLES OF LOCO WORKS CLOSED POST-1923

WORKS	COMPANY	YEAR
BURNT ISLAND	LNER	1923
BARROW	LMS	1923
HULL	LNER	1920s
MARYPORT	LMS	1923
EDINBURGH St.MARGARETS	LNER	1925
STOKE	LMS	1926
CARDIFF	GWR	1926

Source: Lowe 1975

Notes: other works were closed eg: the loco works at Tilbury and Oswestry and several carriage and wagon works.

4. NUMBERS OF WORKS IN EXISTENCE

YEAR	NO OF WORKS
1948	41
1958	40
1962	31
1966	15
1980	12
1985	9
1988	4

5. GROWTH IN THE SIZE OF SELECTED WORKS DURING THE NINETEENTH CENTURY

CREWE:

YEAR	TOTAL STAFF
1843	161
1848	1600
1850	450
1854	1500
1861	2000
1867	4000
1870	4100
1873	4000
1879	6600
1900	7600
1912	9000
1918	10000

Sources: Reed 1982, Turton 1961, Pratt 1912, McKenna ud.

SWINDON

YEAR	TOTAL STAFF
1843	400
1846	1800
1875	4500
1902	12000
1912	11700
1914	12500

Sources: BREL 1875, Turton 1961, Pratt 1912, Lowe 1979.

DERBY LOCO

YEAR	TOTAL STAFF
1840	160
1850	900
1871	2500
1912	3988

Sources: Radford 1971, Turton 1961, Pratt 1912.

WOLVERTON

YEAR	TOTAL STAFF
1840	400
1851	775
1884	2500
1912	4000
1914	4700
1920	4000

Sources: Turton 1961, Pratt 1912

APPENDIX 6

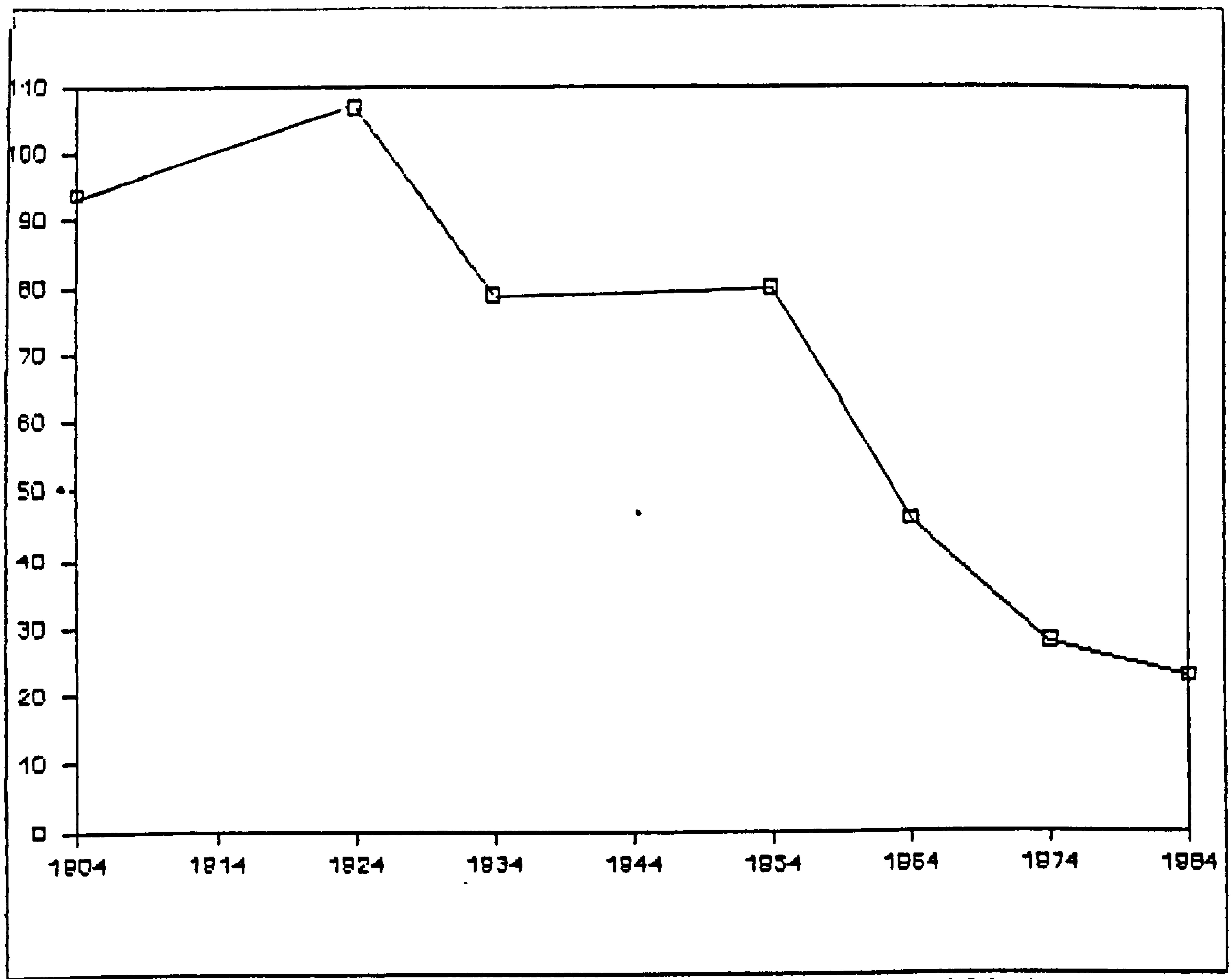

Figure 1 Male Manual Workers In Main Works (000's).

Source: Munby 1978, Railway Staff Returns, BRB report and accounts.

CHAPTER THREE

THE WORKSHOPS PRIOR TO THE FIRST WORLD WAR

INTRODUCTION

The system of control over the labour process prior to the First World War is discussed below in order to provide a base from which the developments during the twentieth century can be understood. I describe how the top levels of management were engineers and how these were responsible for achieving the dual aim of efficient workshops and efficient railway operation that was seen, in chapter one, to spring from railway ownership of the workshops. I then show that this management, which was very few in number, principally exercised control over production by the foreman system,with additional contributions from methods of welfarism aimed at encouraging worker loyalty.

After describing the system of control, I briefly indicate the method of production, the main division being between machine shops and assembly shops, and show that developments in machinery had been marked, and that assembly practices were becoming a bottleneck on production. It is argued that this problem of production, and the predominance of foreman control, had led engineers, who had grown in numbers (see chapter 4) to express a desire to change the labour process. The engineers' opposition is described toward the end of the chapter and is shown as laying part of the basis for the changes that took place in the labour process during the interwar period.

DEVELOPMENT OF PRE WAR MANAGEMENT

During the Victorian period the management of the railway workshops was by those with technical expertise, the mechanical engineers. This is not particularly unusual during this period because, as Armstrong has argued, 'the lack of differentiation of function made it difficult to separate management from technical expertise' (Armstrong, 1984, p. 106). As Pollard has argued in his pioneering, and as yet unsurpassed, study of the emergence of management, those with technical expertise dominated in management at least until the beginning of this century (Pollard, 1968, p. 296). Rose argues that engineers dominated within factory-based industry based on mechanization because 'accountants, the only other significant group in industry, could not adopt these directly co-ordinative functions for the obvious reason that they lacked technological knowledge' (Rose, 1988, p. 51).

In the workshops the managing authority was termed the locomotive superintendent or chief mechanical engineer (CME). This was the managerial link between the operating side and the workshops. Conforming to the normal pattern of the age, he was a person who had been trained by a manual apprenticeship and thus had knowledge of working practices and technical matters. The administrative matters he would be expected to have picked up in lesser managerial posts. On some railways he was responsible for both running locomotives and running main works, although towards the end of the period, the former function was usually under a traffic superintendent (Bonavia, 1971). The CME was responsible for all engineering policy, of which workshop operation was only a part. Other important matters were the design of rolling stock and inspection of purchases and works production. To assist in overseeing his various duties he would have a number of assistants, for example, those dealing with carriage and wagons, and also a chief draughtsman. These positions provided the training ground for future CMEs. The works managers responsible for repair and building of rolling stock were thus responsible to a senior manager with wider responsibilities. Engineers occupied the top positions within the workshops and the CME's central design and technical staff.

Rolt certainly sees the engineers' position of authority as coming from their responsibility in providing rolling stock:

> 'the skill, artistry and pioneer spirit of early Victorian engineers was lost in the second half of the century. To this trend, British Locomotive engineers were a shining exception. They may have erred on the side of conservatism, but the majesty of their handiwork continued to reflect the pride and the craftsmanship of a great tradition. The reason for this exception is clear. Throughout the century the locomotive works of the great railway companies at Crewe, Derby, Swindon, Eastleigh, Darlington or St Rollox were little kingdoms over which successive Locomotive Superintendents (or Chief Mechanical Engineers, to use a later title) ruled with the authority that was almost absolute. Provided the railway company's demand for motive power was adequately met, its directors never interfered... In few other spheres of activity did engineers retain such undisputed sway so long and in this way an ethos from the pioneer days was passed from one engineer to his successor.' (Rolt, 1970, pp. 72-3)

This position of authority was retained by the railway engineers well into the twentieth century and is based on the distance from the process of exchange and the need to provide rolling stock. The engineers were the first management grouping of any size to emerge as a consequence of the growing technical nature of production, both in terms of the product and the means of production, and it would be a fair speculation that the stimulus to their development came from attempts to improve rolling stock performance.

Eversley argues that there were disputes between financial concerns and the engineers.

> 'In these early days, there was continuous friction between these technicians and their masters, the directors in London. After each period of expansion, the slightest sign of a trade recession led to economy measures. (Eversley, 1955, p. 171)

He goes on to argue that 'the technocrats usually won in the long run' (Eversley, 1955, p. 171) and that the ability of the engineers to run Swindon enabled the town to 'flourish' during the depression of 1873-96, when there was 'widespread gloom elsewhere' (Eversley, 1955, p. 168). This was achieved because engineers were not concerned with short term considerations, but with ensuring that machinery and staff were not wasted. This led to a policy of producing an increasing range of components for railway use, and thus setting up contra-cyclical economic forces ie: investments were initiated to mitigate the worst effects of depression. The ability of engineers to retain control was because their policies were 'the demonstration that in the long run a financial saving would result from the step recommended' (Eversley, 1955, p. 188). Cost reductions were central and achievable by engineering policies of utilization of productive capital.

The recruitment of top engineers was from the external labour market, a pool of engineers moving from one company to another. The pool of top engineers was topped up by promotions from within the railway companies.[1]

The promotion path via technical functions was the normal route of management at the end of the period. Bond records that by 1920:

> 'The usual route to works management was, in those days through the drawing office or technical assistants appointments in the works managers office.' (Bond, 1975, p. 28)

Other potential management groups existed. Accountants and bookkeepers had existed on the railways from the beginning (Pollard, 1968, p. 266)- although, in line with the rest of industry, the development of costing systems was principally a product of the twentieth century (Dyos and Aldcroft, 1969, p. 197). The founding text of management accounting (by Garcke and Fells) argued that there was a relative absence of costing in the railway

[1] For example Charles Dick's promotion to works manager at Crewe illustrates both aspects, after serving an apprenticeship in Scotland, he rose from being a chargehand to works' manager via the drawing office, the previous works' manager being appointed CME of the GER (Taylor, 1903, p. 96).

workshops and this was due to being at one step removed from profit making:

> 'There is necessarily greater simplicity in recording expenditure in those cases where production is not for profit, and articles are made or repaired only for the sole and incidental use and benefit of the concern, as, for instance, in arsenals, dockyards, and other national and municipal workshops, railway, gas, tram, and water companies, often accounting under statutory regulations, than in a factory working for profit in competition with other producers. The principles of Factory Accounts explained in this volume are in all such cases applicable .'(Garcke and Fells, 1911, p. 206)[2]

The argument that the lack of accounting was due to a lack of profit incentive is probably correct, when viewed in the context of Great Britain, and confirms the argument that engineering predominance was because workshops produce means of production for use.

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[2]Garcke was an engineer, and Fells described himself as a business organiser (a definition for use by present day industrial sociologists perhaps). The latter coinci-dentally began his career in a railway accounts office, although I have not discovered which railway nor if there was any works connection (Parker and Kitchen, 1980, p. 36-7).

THE FOREMAN SYSTEM

The transformation of labour power into labour in the workshops was achieved by the method of direct foreman control, with a little help from paternalism. The predominance of the former throughout industry is well attested by several authors (Edwards, 1979; Pollard, 1968; Clawson 1980). The shops that constituted the railway factory were under the control of foremen. Management secured production, set the parameters of output and cost, but it was through the direct control of the foreman system that production was secured.

The following table of staff indicates the numbers of foremen and managers:

TABLE THREE

STAFF EMPLOYED IN LOCOMOTIVE DEPARTMENTS IN GREAT BRITAIN AND IRELAND ACCORDING TO BOARD OF TRADE RETURNS 1875

LOCOMOTIVE ENGINEERS	64
DISTRICT ENGINEERS	85
CLERKS	1211
DRAUGHTSMAN	125
FOREMEN	1042
MECHANICS	36693
DRIVERS	9554
FIREMEN	9749
LABOURERS	24331

SOURCE; BOARD OF TRADE RETURNS FEBRUARY 5TH 1875 (The railway diary and officials directory 1876).

Note: The figures may or may not include carriage and wagon works.

Management is confined to 149 engineers, a ratio of management to men (including operating staff) of 1 to 540, presenting something of a problem for direct managerial control. Excluding driving staff, who would not be under foreman control, the ratio of foremen to men is 1 to 59 which points to control being exercised through the foremen.

During the last century, many of the workshops operated a system of internal subcontracting.[3] Under this system a company purchases raw materials and means of production, but not labour; the foreman is given a price for a completed article and is responsible for hiring and paying the staff out of the price negotiated (Littler 1982, Pollard 1968, Clawson 1980). Hudson argues that the system as used in Wolverton meant 'corruption was widespread, with the foremen as central figures', a prime reason being that 'the only record of the transaction remained with the foreman, as subcontractor.' The lack of documentation opened up several opportunities for exploitation in defiance of the Truck Acts:

> 'It was common for the foremen to run shops in Wolverton or Stoney Stratford and to pay the gang partly in vouchers, exchangeable only at their own shops' (Hudson, 1970, p. 49).

The compliance of the workforce was assured, as in the words of one who worked under Wolverton subcontractors 'there was not a lot of jobs outside, so you done as you was told' (Hudson, 1970, p. 49). Williams, a Swindon hammerman, shows that elements of the subcontracting system continued even when management hired labour. The chargeman during the last century was paid all piecework bonus earnings in full, again allowing corrupt practices:

> 'In times past the chargeman used to pay the piecework 'balance' to the men, having received the money in bulk from the company, and he was often guilty of scandalous robbery and cheating. The chargeman could and did pay the gang what amount he pleased and kept several pounds a week extra for himself.' (Williams, 1915, p. 283)

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[3] It was the normal method at Derby at the earliest period (Radford, 1971, p. 25). Works of the GJR and Swindon both used internal subcontracting (Platt, 1987). Wolverton still had the system at the turn of the century in certain shops (Hudson, 1970, p. 49). The GJR never used the system at Crewe, possibly based on previous experiences (Reed, 1982).

By 1915 the chargehand was paid a 'percentage' of 10% of the gang's earnings. At Derby they received a shilling a man. The workers were not the only parties subject to corruption, Radford relates how one internal sub-contracting boiler foreman at Derby managed to receive all the money for boilers made by not hiring any men but using men in company employ (Radford, 1971, p. 25). This was indicative of the lack of managerial knowledge of the shop floor and part of the incentive to increase the same.

The system was not used greatly at the end of the period prior to the First World War, an American visitor to the ILE ascribed the industrial success of the US to the use of internal sub-contracting, and not scientific management (Saunders in Turner, 1921, p. 160). This indicates that the position of foremen in rail shops is not technologically determined and is supportive of Littler's thesis that foremen were incorporated into management on different bases within different cultures (Littler, 1982). The position of foremen in British shops is therefore in need of explanation from particular facts.

The foreman system was the means of ensuring production during the nineteenth century. They were responsible for discipline, dismissals, allocation of tasks, individual rates of pay, piece rate negotiation, methods of work, and, initially, recruitment ie: he acted like a sub-contractor except for paying the workers or reaping the benefits. The appointment of staff was usually on the recommendation of the foremen (Hudson, 1970, p. 49). Williams, a Tory in politics (Williams, 1984), gives the fullest account of the workings of the foreman system in the pre-First World War workshops. He stresses the role of the foreman in recruitment:

> 'Whoever now has a mate he would like to introduce into sheds approaches the foreman. If he is a favourite himself, room will be made for his friend somehow or other' (Williams, 1984, p. 244).

The paternalistic cast of mind of the railway companies also encouraged recruitment on the basis of kinship, a method that had significance to the end. The foremen were responsible for allocating the work to particular men, (Williams, 1984, p. 88) and for any promotions (Williams, 1984, p. 77). Williams considered that it was the gang that performed the work:

> 'Very often it would go on for months just as well without the foremen , and in many cases even better , for it is the chargemen and gangers who have the actual control of operations and who possess the real intimate knowledge of the work.' (Williams, 1915, p. 53)

The foremen were the link between management and worker. They controlled production to ensure that the conversion of labour power into labour yielded a surplus. They were appointed 'to cut and slash the piecework prices... and so better serve the interests of the company' (Williams, 1984, p. 77), and generally to enforce labour discipline. Williams argued:

> 'most foremen are excessively autocratic and severe with their men denying them the slightest privilege of relaxation of the iron laws of the factory'. (Williams, 1984, p. 59)

The position of foreman gave rewards of money, flexibility over work life, status and power, and a number of strategies evolved to secure access to these. At Crewe, foremen ran in family dynasties (Hudson, 1970, p. 60). At Swindon, fitters were the most unionised group within the works (Williams, 1915, p. 35) and used this position to secure promotion to foreman, 'nearly all the foremen of the different sheds are appointed from among the fitters' (Williams, 1915, p. 36). The foremen maintained their status by mixing amongst themselves, usually living in the same streets in railway towns, and various organizations of foremen existed to maintain their separateness. [4]

The foreman was charged with enforcing the rulings of management. At some works these rules were formalised in rule books.[5] The rules depended for their operation on the foremen, and were integrated into the whole system of foremen controlling separate shops. That a person was employed in a particular shop is clear from the Swindon rules:

> 'A workman who goes into a workshop in which he is not usually employed, except by the order of his foreman will be liable to a fine of 2s 6d.' (Hudson, 1970, p. 40)

Rule 10 from Stratford illustrates the extent to which foremen controlled access to the means of production, and the workers' dependence upon them:

> 'When any workman requires a new tool he must apply to his foreman who will supply it if necessary. All new tools must be obtained at the shop stores on a foreman's request .' (Hudson, 1970, p. 53)

The rules were not purely related to questions of swearing, or drinking, or time keeping (which did exist) but also attempted to enforce quality controls. A Swindon

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[4] For example, the Foremen's Association at Swindon (GWR Magazine; 1912. p. 53) and the Foremen's Club at Derby (which existed until the 1940s) (Hudson, 1970, p. 40).

[5] Only three such rule books survive: Shildon 1833, Swindon 1904, Stratford 1909 (Hudson, 1970). Hudson argues that certain works did not have rules eg: Crewe and Derby.

rule stated:

> 'A workman making an article of wrong dimensions , or finishing work in an inferior or unworkmanlike manner , may be called upon to make good such work , and be liable to a fine of 2s.6d or to instant dismissal.' (Hudson, 1970, p. 40)

From a review of the three extant rule books, Hudson clearly believes them to be rooted in the foreman system:

> 'the ill-intentioned and unscrupulous foreman had no difficulty in interpreting the rules in a way that suited him. The rule book was, in effect, tailored to the foreman's requirements. With plenty of unemployment the other side of the perimeter wall , it was safer to play to the foreman than to argue with him.' (Hudson, 1970, p. 60)

PATERNALISM

The location of railway works gave rise to the phenomena of railway towns. A number of works were located where little had previously existed, eg; Crewe, Wolverton, Horwich, Eastleigh, Melton Constable and Inverurie, and others led to population expansion that dwarfed the old settlement, eg: Doncaster, Swindon and Ashford. Yet other towns were altered significantly by the coming of the railways, eg:Darlington, Derby and York. The railways dominated parts of large urban areas, eg: Springburn in Glasgow or Hudson Town in Stratford for GER workers.

The railway provision of housing was a matter of necessity not benevolence:

> 'It was found necessary in each case to recruit suitably skilled workers from the existing engineering districts of north-east England, south Yorkshire, Lancashire and Scotland, and these 'key' workers, drawn together into new rural environments, were housed in settlements provided by the railway companies alongside their workshops.' (Turton, 1961, p. 299)

The companies also provided gas and water supplies, sanitation, libraries, meeting halls, medical funds (usually compulsory), hospitals, GPs etc. [6] Such facilities were provided at smaller railway towns but on a lesser scale.

The cost of dominating the social and economic structure of a town yielded, according to Turton, certain control advantages over other firms, for example he argues:

> "The urban settlements which had developed around the railway works at Crewe, Swindon and Wolverton were dependent upon the railway for essential domestic services as well as employment, and the local administration often contained a majority of railway personnel. Any other industrialist wishing to establish himself in one of these settlements would

[6] For Crewe see Reed 1982; Chaloner 1950; for Swindon see Mountford ud.

therefore have been dependent upon the railway for supplies of water and gas as well as raw materials , and would have had to compete with the expanding railway workshops for labour.' (Turton, 1961, p. 102)

Thus company towns enabled the companies to increase the dependence of the workforce by restricting alternative employment, a power sometimes exercised in a despotic manner. Chaloner outlines what contemporary railway engineers termed 'the reign of terror at Crewe' (Railway Engineer, 1886, p. 317). At Crewe, company officials standing as independents and in league with the Tories, of course, controlled the council in the 1880s, during which period workers of known Liberal and radical persuasion where forced, by foremen, on pain of dismissal, to canvas on behalf of company candidates. Political harassment was widespread but only came to national attention when three local Liberals were dismissed from the works for forming a branch of the GRWU. This incident led to national press coverage of the company's political activities, which resulted in the directors of the railway company condemning Webb, Locomotive Superintendent, and his works management, and ordering their withdrawal from politics. The Liberals gained 20 of the 24 seats at the next election. However, Webb was left with spiritual influence, his brother having been appointed the chief methodist minister some time before.

At Crewe during the 1840s and 1850s, if company houses were unrented, house owning workers had to sell up and move into company housing, again on pain of dismissal. The disincentive to purchase housing increased dependency. Company housing increased dependency, for example, strikers on the Caledonian Railway were evicted from company housing providing something of a disincentive to strike action (Alderman, 1971, p. 132).

In the railway towns, the workers tended to adjust to their dependence by identifying with their railway company.[7] Harloe argues that at Swindon the workers were both 'proletarian and deferential' (Harloe, 1975, p. 23-4), and 'a workforce and indeed a community ... which by and large was prepared to agree "what was good for the company was good for Swindon"' (Harloe, 1975, p. 27).

The desire to create deference and dependence had its most manifest appearance in the process of recruiting from railway families (see chapter five of this thesis). Other methods of creating identification with the workshops were pursued by most companies.[8] Most of the workshops had educational establishments in the form of mechanics institutes. Often these were originally set up by the workers themselves, and then sponsored by the company.[9]

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[7] Newby (1979) similarly sees deference as action rooted in dependence and necessitating certain types of expected behaviour.

[8] 1859 saw the founding of the Railway Benevolent Institute, based in Derby, to which most railways belonged by 1895 (Railway engineer, 1895, p. 164). There was also friendly society provision for example, The United Kingdom Railway Servants Association (Railway engineer, 1880, p. 64). Individual company provision was either through their own funds for example, the LNWR had its own superannuation fund (Railway Magazine, 1902, pp. 145-8), or via donations to existing funds and organizations, for example the MR contributed heavily to the Derby Royal Infirmary (in both money and patients) (Railways, 1908, p. 221), and also had its own superannuation fund (Railways, 1908, p. 356).

[9] For example, Derby workers formed a reading society in 1850 which was given a cottage for its use and in 1894 the MR built a very large building to house what had become the Railway Institute (Railways, 1908, p. 128). The process of worker initiatives being transformed by company funding also occurred at Swindon and Crewe, and probably more generally .

The Railway Magazine, in 1901, was led to comment on railway benevolence:

> 'a great deal is being done by Railway companies to render the unofficial life of their employees both healthy and profitable to themselves. It is almost needless to add that their efforts in this direction have been highly appreciated.' (1901, p. 21)[10]

By the end of the century the locomotive superintendents attempted to secure production by a combination of despotism and welfarism. The identification with the company, which undoubtedly existed, assisted in the transformation of labour into labour power, but the key element was the foreman.

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[10] The article goes on to mention a whole range of clubs and societies etc that flourished under company sponsorship. Of particular importance to this day, was the St Johns Ambulance, which received company sponsorship at most of the railways and held national competitions between teams from the various works (Railways, 1908, pp. 323-324, p. 344, p. 363 and Railway Magazine, 1902, pp. 145-8) .

THE DEVELOPMENT OF PRODUCTION

In the earliest works, all the work was carried out in one shed, although it was usual for there to be a differentiation between locomotive and carriage sheds. As a consequence of the increasing size, mentioned in chapter two, the works saw the development of specialised shops to deal with different processes, the basic division being between assembly (and stripping down) and product forming. Locomotive assembly occurred in erecting shops, and carriage and wagon assembly in body or lifting shops, although I will used the term erecting shop to refer to both. There were three major forming processes: the casting of components in foundries, the shaping of metal by blows or pressure in forges and smithies, and the cutting of metal (and wood) in machine shops. There were also separate shops for various sub-assemblies, for example, boiler shops or wheel shops. The shops were further specialised according to type of product, for example, there were foundries for iron and brass. The shops that existed at each works were all variations on the same theme.

DEVELOPMENTS IN THE MACHINE SHOPS

The first 25 years of workshop history can be seen as being predominantly years of hand construction (Snell, 1971, p. 92; Larkin and Larkin, 1988, p. 149; Reed, 1982, p. 38). The machine tools employed by the end of this quarter century were not particularly well developed, as can be seen from this description of Gorton works in 1851:

> "The fitting and tool shop is 120 feet by 60 feet and contains the whole of the tools, with the exception of the Punching and Shearing Machines, two rows of Fitters Benches down each side are erected near the far end; the Lathes, Drills &c, are placed down each side and have their counter shafts carried by wall plates, built into the side walls, and the Planning Machines are placed in the centre, the whole being driven from two lines of Main Shafting passing longitudinally down the shop, one over the vertical shaft from the Engine, and the other equidistant from the opposite wall." (IME, 1851)

The lack of machine tools evident at Gorton was because the workshops were among the first mechanical engineering establishments. Because of this isolation, part of the burden of the development of machine tooling fell on their own staff.

MACHINE TOOLS

Invention was considered to be part and parcel of the engineer's role. Garret argued that 'it is imperative that we should extend to the utmost the knowledge of our own particular profession, and improve and invent machinery' (Garret, 1881, p. 8). The CME of the LSWR held a patent for wheel lathes as early as the 1840s (Larkin and Larkin, 1988, p. 151). Reed refers to the large 'number of machines devised' by Ramsbottom, the Loco superintendent at Crewe (1857-67) (Reed, 1982, p. 77), and the technical press of the time refers to several of his inventions (Engineer, 1866, pp. 84-5), some of which became industry standard (Larkin and Larkin, 1988, p. 153, p. 155, p. 158). Francis Webb, his successor, held over 'fifty patents for improvements connected with railway plant' (Various, 1893, p. 25). [11] The inventions of the railway engineers had their counterpart in the manufacture of machine tools within the workshops themselves.[12] This type of vertical integration was temporary, because from the start a number of firms developed who had the ability to supply the needs of the workshops, and established a significant foothold in supplying the workshops, and were soon the mainstay of machine tool

[11] Churchward's Swindon locomotive testing plant of the 1920s was considered at the forefront of testing technology and Henry Fowler at Derby Loco helped develop chisel steel that became 'general throughout the world' (Hartley, 1932, p. 497). Inventions are also recorded on the GWR and the SER (Larkin and Larkin, 1988, p. 153, p. 158).

[12] This was the case at Crewe (Engineer, 1866, p. 85), Bow, Swindon, Horwich and Derby (Larkin and Larkin, 1988, p. 52, p. 152, p. 172). Many of the works produced electric motors for machine tools (Larkin and Larkin, 1988, p. 172). Even late on the works produced minor requirements, for example ultrasonic probes (British Journal of Ultrasonic testing, 1983).

provision.

The application of machine tools in this period was seen as due to their 'value in saving labour' more than at other periods (Garret, 1881, p. 13; see also, Engineer, 1866, p. 85). The labour identified for saving was on the basis of cost. For example, the use of steam hammers with dies for stamping out components, meant that 'labour to finish it is trifling', the motive for this being due to smithing being 'a large item in the shop expenditure' (Garret, 1881, p. 12). Direct cost was not the only manner in which the subject of change was identified, Legg argues 'the great improvements in labour saving machinery' in the pattern shops was due to its centrality in the workshops:

> 'There was always a great pressure on the pattern shop, everybody wanting things in a hurry. Time there was such an important object, having regard to the effect of delay on all other departments, that it was of the utmost importance to have the best labour-saving machines.' (Garret, 1881, p. 15)

By the 1880s machine tools were well developed, automatic feeds having been developed (Hulse, 1886, p. 215), and much emphasis was placed on improving on the designs of previous machinery. Garret argued that lathes could be improved in two ways, either making it remove material 'at a rapid rate' or the reducing set up processes, 'complete all the operations without removal of the article' (Garret, 1887, p. 9).[13]

As is the case in later periods, the improvements in machine tooling revealed inefficiencies in the application of labour, and opportunities for improving machine tool output by

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[13] The aim of reducing set ups was stressed in the technical press (Hulse, 1887, p. 214, Engineer, 1866, p. 85).

adopting the specialization of staff, for example, machines being attended at all times and labourers doing the fetching and carrying for the machinist, ' the machine can thus be kept constantly at work' (Garret, 1881, p. 9). At the turn of the century the development of electricity and high speed cutting tools gave further impetus to mechanization. The growth of machine tools and fixed costs gave rise, at the end of the period, to a dissatisfaction with the existing system of coordinating the system of specialized shops.

ERECTING SHOP PRACTICE

In describing the methods of erection, I concentrate upon locomotive work, which went unchanged until the 1920s, because information on carriage and wagons is sparse.

When building a new locomotive the designer's work had to be authorised by the works manager (Stanier, 1907, p. 1), but this was almost the sole managerial intervention, how to produce was decided by the foreman, the foreman would be 'supplied with a schedule of parts, giving drawing numbers and quantities, so that they can at once send to the drawing stores for the drawings they require to get ready the necessary patterns and templates' (Stanier, 1908, p. 1).

When a locomotive was shopped for repair, it was sent in with a report of the repairs necessary (Locomotives and Railways, 1908, p. 101). This would be determined by the driver and shed foreman, and the report went to the foreman in the workshop (Mechanic, 1908, p. 305).

The repair and construction of a single locomotive was allocated to a single group of men. This group of men which might range from a single fitter with a couple of men to a gang of around ten, would be responsible for all the assembling and stripping necessary to that locomotive (Perryman, 1972; Mountford, ud, Railway Magazine, 1944; Mechanic 1908, p. 305; Fowler, 1929, p. 62; Lemon, 1930, p. 421). Cook, works manager at Swindon, summarises the position in the 1920s:

> 'locomotives for repair were allocated to a chargeman with individual gangs who took the locomotive through all its stages of stripping down frame repairs, building up, wheeling, finishing, trial and after trial reports.

Apart from the erecting gangs there were one or two specialist gangs for valve setting and cleading and also of other trades such as boiler makers, copper-smiths, painters. The system was a deeply rooted one which had operated for many years and in many works.'(Cook, 1974, p. 94; see also Cook, 1947, p. 18)

Locomotives were built in one place. Toward the end of the period there were specialist gangs for particularly skilled work, for example, motion fitters and coppersmiths for tubes (Railway Magazine, 1922). Even so, at Crewe as late as the First World War a single fitter and his mates were responsible for not only building the machine, but also taking it out on a test run with the trials driver (Railway Magazine, 1944). In 1930 Lemon, the chief superintendent of coaches of the LMS, described the coach building of earlier times as being in 'the same way as houses are built today ie; in one spot, thus necessitating the congregating of a number of workpeople belonging to various trades in order to carry out their portion of the work on the vehicle' (Lemon, 1930, p. 421). Little change had been made in locomotive erection, Saunders state:

'We are now in the second century of locomotive engineering and can see a vast improvement in the design of engines; but one may safely say that throughout the years the principles of locomotive erecting have not advanced to any great extent.

They have certainly been simplified by the use of modern machine tools etc. but, were the pioneers of locomotive building still alive, they would probably (providing they overcame their astonishment a the size of modern locomotives) commence erecting one as it is done to-day.'(Saunders, 1925, p. 248)

During the nineteenth century mechanization was proceeding steadily in the machine shops but little had changed in the erecting shops.

ENGINEERS VIEW OF MANAGEMENT AT THE BEGINNING OF THE TWENTIETH CENTURY

In 1921 Turner defined management as those who have control over the work of others: 'Management may be defined as the art of directing the energies of others in such a way that the best results are produced at the lowest cost' (Turner, 1921, p. 135). In confirmation of Sohn-Rethel's arguments concerning the crisis of overheads at this period, Turner continued 'the part that interests us most in these days is the latter part' (Turner, 1921, p. 135). O'Brien argued that although foremen exercised control they were there to carry out the policies of management and inspectors and were not part of management (O'Brien, 1920, p. 382). Turner thought that the foreman system was in need of overhaul if production advances were to be made:

> 'the works have passed from the days of generalization into those of specialisation, with its higher efficiency machines, there is not the same specialization or intensity of management. In the average works the usual scheme of devolution is from works manager and assistant works manager to foreman. Although there may be many others with advisory functions, they have, generally no executive authority. In many works the manager and the assistant manager are engaged for the greater part of their time on work, much of which may be of a general business character, most of which keeps them to their rooms. In such circumstances the works are largely run by the foremen. The author submits that it is inconsistent and useless for a railway works yearly to urge its apprentices into long courses of scientific training, unless at the same time it is prepared to make use in a fuller measure of the scientific knowledge the pursuit of which it has been so advocating.' (Turner, 1921, p. 146)

Turner believed the foremen were in charge, and this needed to be rectified by the application of science by engineers. The problem was that a system based on shops led to an uncoordinated whole. Williams notes:

> 'One part of the works is often running at break neck speed, while another is working but three or four days a week and the men are in a half starved condition. In one shed fresh hands are being put on, while from others they are being discharged wholesale. Transfers from one shed to another are seldom made and never from one department to another. One would think the various divisions of the works were owned by separate firms.' (Williams, 1915, p. 43)

The problem of coordination had not gone unnoticed, Stanier, a Swindon engineer of the period, thought it was vital to coordinate the machine shops and the erecting shop, arguing that machine shop foremen 'should be able to keep well ahead of the work in the erecting shop, otherwise the output will suffer, and men will be having idle half hours waiting for fittings'(Stanier, 1907, p. 1). The erecting shop was a brake upon the productivity gains of mechanization in the machine shops, prompting one engineer to comment that locomotive construction was 'as inefficient as anything I know' (Saunders, 1925, p. 267). The cost of mechanization increased a concern to ensure that the throughput of material justified the expense, added to which the replacement of labour increased the relative gains to be made from organizational changes. From the turn of the century, production had been perceived as something more than setting people to work. Stanier defined 'best workmanship' 'I mean not only craftsmanship, but shop organization of the highest order'(Stanier, 1907, p. 1).

In 1921 Turner argued that 'the need for reviewing our methods of management and searching diligently and untiringly for economy was at no time more pressing' (Turner, 1921, p. 135) and that 'this is the day of big schemes for coordinating and increasing production' (Turner, 1921, p. 139). The big schemes referred to are Taylorism and new methods of payment by results, such as the Rowan or Gant systems (Turner, 1921, p. 142, p. 145). As it turns out, Turner was wrong in that the coordination of production proved much more fruitful. Tonkin shows that the impact of management science was part of wider changes in the labour process:

> "For several years past, there has been a constant endeavour to rid our railway workshops of the reproach of innate conservatism, particularly in the organization of the workshops themselves, and in the introduction of improved machinery together with modern mechanical appliances and scientific methods of production.' (Tonkin, 1921, p. 38)

Within the workshops at the end of the period there was a wide concern over the organization of production and the foreman's place within its structure.

SUMMARY

The workshops up until 1920 secured production by a combination of direct control over labour, being exercised by foremen, with a splash of paternalism. The replacement of labour in machine shops had developed at a rapid pace. This growth in mechanization had increased fixed costs, creating a need and opportunity to increase productive throughput. Tonkin speaks of two problems 'that loom large on the horizon of industrial reconstruction - costing and wages systems' (Quoted in Turner, 1921, p. 168), and as we shall see it was towards these areas that engineers at first sought a solution to the productivity problem. The solution finally adopted was in neither area, but in the development of techniques to ensure the coordination of production which achieved large increases in output and marginalized the engineers' managerial rivals, foremen and accountants.

CHAPTER FOUR

THE DEVELOPMENT OF ENGINEERS

INTRODUCTION

I describe below the development of the engineers within railway workshops from around the First World War. It is shown that for most of this century the occupation of engineer has been a product of training in the practical knowledge of production, primarily through privileged apprenticeship schemes. It is proposed that this link with manual work may be the explanation behind the distinctive outlook of the engineer in tackling questions of production. The engineers cannot be seen as ordinary workers but are clearly distinguished by education, in particular the matriculation, and usually paying for apprenticeships. These privileged apprenticeships involved training in more manual tasks than the limited range of tasks carried out by trade apprentices.

Smith argues that in Britain technical workers have their origins in the craft system, he specifically identifies privileged apprenticeships, and not in educational qualifications (Smith, 1987, p. 71). Smith argues that this craft training is part of the affinity that technical workers share with manual workers and partially accounts for their class location in the proletariat. The argument of this chapter is that although craft training of engineers gave them some affinity with manual workers, the nature of this training and the recruitment into engineering was different from that given to tradesmen, the difference being that engineers were recruited predominantly from the educated and wealthy middle classes. Smith's study of the aerospace industry concentrates on the middle and end of this century, when middle class recruitment via the craft system was in decline giving the impression that technical workers shared a common background to workers in the various manual trades. The longer history of the workshops shows that the more open recruitment of working class boys into engineering is a transitionary phase.

On the railway, until the late 1960s, the privileged apprentices in most cases had to have matriculation, and prior to this had to have matriculation and pay a premium amounting to around two years wages. Not surprisingly these two considerations were primarily in the reach of the grammar and public school educated middle classes. After nationalization the payment of a premium was abandoned and more boys of working class origins were recruited - those people identified by Smith - and this was to change with a growth in professionalization of engineering.

Parkin argues that there has been a growth in the use of educational credentials by 'an ever increasing number of white collar occupations to attain the status of professions' (Parkin, 1979, p. 54). It is shown that the railway workshops appear to show a growth in credentialism which would appear to point to a breakdown of the link between engineers and manual work, at least at the highest levels. The growth in importance of educational qualifications and a decrease in manual learning may have had an effect on the manner in which engineers approached production, in particular as the new forms of training stressed managerial and scientific subjects. Of particular importance was the growing emphasis on costing. The claim that engineers have low status in Britain is common place (Glover and Kelly, 1987, p. 23), and it is highly likely that this stress on science and business subjects is seen as a way of contesting this low status, as Armstrong argues (1987).

In what follows I address these themes. It is shown that interwar recruitment rested heavily on recruiting from the middle classes by the privileged apprentice scheme. The nature of this scheme and the numbers recruited is described. The inter-war training is then shown to be based upon a knowledge of manual work supplemented with some theoretical training.

The post-war situation is then described with particular emphasis on the growth in professionalization, with a greater stress on formal training, including accounting and other 'business studies' subjects. It is shown that the similarities of origins between engineers and workers are a product of the transition from recruitment of engineers by privileged apprenticeship to a system of recruiting graduates.

INTERWAR RECRUITMENT

At the time of the First World War there were two major routes to becoming an engineer, either by a privileged apprenticeship or the more prestigious, and rarer, pupillage (Railway Magazine, 1944, p. 282; Larkin, 1979. p. 20). The premium apprentices were seen as trainee managers and engineers, and were excluded from representation by shop committees (Gilbert, 1951a, p. 24).

The output of engineers was not large. During the First World War, at Derby locomotive works there were 400 trade apprentices, 40 privileged apprentices and 4 pupils (Larkin, 1979, p. 21), and Crewe at same time had six pupils (Railway Magazine, 1944, p. 282). Even as late as 1934 the two routes only produced 12 engineers per annum at Derby Loco (Larkin, 1934, p. 242).

Entry into privileged apprenticeship usually required the boy to have matriculated from a grammar or public school, and to pay the company a sum of money for his training, and it is for this reason that this form of apprenticeship is usually referred to as a premium apprenticeship.[1]

The premium system was still in existence in 1951 (Gilbert, 1951a, p. 24), but Parker's 1956 paper on engineering training makes no mention of its existence, and it can be assumed to have been phased out during nationalization (Parker, 1956).

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[1] Pupillage also involved payment at Crewe (Railway Magazine, 1944, p. 282). A premium apprenticeship on the GWR in 1933 cost 100 (Mountford, ud, p. 97), and on the SR in 1928 it cost 60 (Perryman, 1972, p. 13). Mountford noted that the wages for his first two years barely covered the premium. At Crewe, during the First World War, pupils received no pay for most of the two years of pupillage.

The system of recruitment into the railway workshops (money with matriculation) excluded many working class boys from the ranks of the engineers. The majority of engineers were from grammar or public schools well into the 1930s (Larkin, 1934, p. 243). [2]

There was no shortage of takers for the positions, for example, at Crewe there was a long waiting list for pupillage (Railway Magazine, 1944, p. 282), and there was a ready supply of public school boys, as Hobsbawm notes at one large public school, in the 1880s, 75% of pupils wished to follow engineering as a career (Hobsbawm, 1969, p. 186).

It was possible for trade apprentices to become privileged apprentices, at Derby Locomotive Works a route was open for those aged between 16 to 19 years who had performed well; at night school and in practical work and passed a works examination (Larkin, 1979, p. 21). [3]

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[2] Roland Bond the eventual head of the Railway Workshops Division took such a route, doing his apprenticeship at Derby Locomotive Works (Bond, 1975). The sports car manufacturer Bently went from public school to an apprenticeship at the GNR's Doncaster works (Montgomerie, 1989, p.71).

[3] Larkin himself had followed this path, eventually becoming deputy manager of the BR workshop division (Larkin, 1979, p. 21, p. 140) His contemporary, Irvine Forsythe, followed the same path to become Crewe works manager, and later workshop division production manager (Larkin, 1979, p. 25) By 1965 the workshop division must have resembled a Derby Locomotive Workshop privileged apprentice mafia, with the General, Deputy and production managers all having served their time around the First World War.

TRAINING

The premium apprentices and pupils learnt their trade in a similar manner to the trade apprentices, by working with craftsmen (Hardy, 1976). Because these trainees were the future works managers they were given practice in a wider range of skills than normal, for example, at Crewe they 'were called on to cram an intensive course in as many shops as possible' (Railway Magazine, 1944, p. 282), and at Derby Locomotive Works they received a 'wider scope of training' than a craftsman (Larkin, 1979, p. 21). The pupillage lasted two years, being the polish on previous engineering training of some form, and involved working in the more technical blue and white collar trades (Railway Magazine, 1944, Larkin, 1979, p. 21).

At the turn of the century, as part of the wider concern for the effective utilization of mechanized plant, a greater stress was placed upon technical concerns.

Writing in 1906 Saunders, surveying the scene on the GWR and noting the lack of technical training other than a very occasional secondment to UMIST's forerunner (Saunders, 1906, p. 2), argued in tones reminiscent of the whole concern for that era, that scientific training is necessary:

> 'Our old individual self instruction way is no longer sufficient to deal with the complexity of modern problems. All those who are in any way connected with the machinery of the railway- the designer in the draughting office, the man in the shop, and the clerks in the departments - each and every one should have a thorough education based upon a combination of scientific methods with practical experience.' (Saunders, 1906, p. 2)

The emergence of engineers as a large grouping is a product of this era and the concern for science, as is indicated by the emergence of the Institution of Locomotive

Engineers (ILE) in 1911 as a forum for discussion (Maitland, 1911), and the Railway Engineer in 1880 as the first journal. In earlier times engineers appear to be largely distinguished from craftsmen by family connections.[4]

The major technical component of the engineers' training appears to be a short spell in the drawing office.[5] Evening classes appear to have been a common part of the training of premium apprentices and pupils prior to the First World War (Saunders, 1906; Railway Magazine, 1944; Larkin, 1979)

It was about this time that the day release as a form of training was introduced, for example, on the GWR.[6] Sir Henry Fowler, CME of the MR and described as having 'laid the trail for part-time day education' and being

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[4] Platt gives a description of Daniel Gooch's, the first Locomotive superintendent of the GWR, connection with the Stephenson family and various other figures of the early engineering bourgeoisie (Platt 1987). Another example is the appointment of Francis Trevithick, son of the inventor of the Locomotive, as first manager at Crewe. (Reed, 1980)

[5] The period in the drawing office was the distinguishing feature of a premium apprentice on the SR at Brighton (Perryman, 1972, p. 20). Premium apprentices on the GWR were also allocated to the drawing office (Mountford, ud, p. 111) A spell in the drawing office was also a perk at Derby (Larkin, 1979, p. 25). At Crewe, before the First World War, it is doubtful whether the premium apprentices received drawing office experience, although it was seen as a crucial part of the pupils' training (Railway Magazine, 1944, p. 282).

[6] The GWR introduced a very limited three year scheme giving 6 hours day release a week on two afternoons. Fifteen students could take the first year, of which 9 could go on to the second year, and 6 to the final year, and if they particularly 'distinguished themselves' they would be graciously allowed to serve part of their last year in the drawing office and chemical laboratory (Railway Engineer, 1903, p. 307; Saunders, 1906, pp. 2-3). To qualify for the scheme the student had to be between 17 and 18, with a year in the shops and have attended and passed at least one session at an evening technical school which gave preparatory courses (Saunders, 1906, pp. 2-3) It is unclear what happened to the Swindon apprentice on completing his course, as to whether his career developed as an engineer. Lean estimated that by 1924, 60 or 70 apprentices had completed the course (Lean, 1924, p. 14)

'a pioneer in the training of engineers' (Larkin, 1979, p. 21), introduced a number of changes. Recruitment of privileged apprentices or pupils was solely on the basis of qualifications. The apprenticeships were open to those aged between 16 to 18 years with matriculations in five subjects, from grammar or public school, and pupils were honours graduates in mechanical engineering. Under Fowler, the privileged apprentice was given two morning sessions at college, which Larkin notes was truly a privilege because classes started somewhat later than the works' six o'clock norm (Larkin, 1979, p. 22). Added to the day release it was compulsory to attend two evening classes a week (Larkin, 1979, p. 21). All day and evening courses were examined. Another of Fowler's innovations was that pupils received weekly wages of £2 (half the craftsman's rate) (Larkin, 1979, p. 22). The changes in engineering training since this period have reflected the changing nature of the labour process in both its technical and managerial aspects. Larkin, head of training on the LMSR, added a third year for high flying pupils, above and beyond the normal two years of pupillage (Larkin, 1934, p. 243). This supplementary year included training in all subjects with 'which the locomotive engineer is inseparably associated' (Larkin, 1934, p. 244). As reflected the growth in costing, particular emphasis was given to this area by Larkin at the time:

> 'Especially noteworthy is the period spent in the accountant's department. It is an innovation which has everything to commend it. The introduction of individual costing, accelerated by the advent of mechanised equipment, has greatly developed the costs and statistical sections, and by actual contact with those permanently engaged therein a valuable

> insight into the methods used in providing important data, financial and otherwise, and the ultimate practical uses to which such information may be put, is gained.' (Larkin, 1934, p. 244)

The training of engineers was not therefore seen as purely learning practical skills but costing was seen to be inseparably linked to the engineers' function. The growth of technical formalised training, between the Wars, was reflected in the growth of short courses for senior staff, for example, the LMS opened a transport school in Derby during 1938 (Kettle, 1947, p. 452).

POST-WAR ENGINEERING EDUCATION

Nationalization did change some things. By 1956 there were no premiums and 50% of privileged apprentices began as trade apprentices, the others coming from the established sources (Parker, 1956). In 1956 there were three grades of non-craft trainee:

1. Engineering apprentice
2. Engineering apprentice (Diploma).
3. Engineering graduate (Parker, 1956, p. 502).

The engineering apprenticeship was similar to the privileged apprenticeship and lasted two to five years, and terminated at the age of twenty one. This provided few possibilities for advancement unless the individual was seconded to do a diploma in engineering, on block release, a procedure that added a further two years to the length of training. The engineering graduate, as pupils were renamed, remained at two years duration. This was later supplemented in the early sixties by railway sponsorship of graduates which involved a year at the workshops division followed by a full time degree course, followed by a final year at the division.

During the 1970s and 1980s engineers were recruited as graduate trainees and followed a two year programme, run jointly by BRB and BREL, on Chartered Institute lines.[7]

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[7] This course, which included costing, took the following sequence: three months at the training centre in Derby, 10 months works and depot working, 3 months design working at the Railway Technical Centre (RTC), and 8 months training (Hardy, 1976, p. 231).

Hardy argues that this was due to pressure from the Engineering Industry Training Board (EITB) and the Chartered Institutes, although the connection with manual work is not totally broken, as good trade apprentices could still be sent on degrees (Hardy, 1976).

SUMMARY

Apart from a brief respite during the 1950s and early 1960s, engineers have been distinguished from craftsmen by origin and training. The engineers in the past were distinct by being middle class, and possessing a public or grammar school education, they are now distinguished by a degree education, which as often as not reflects a background similar to their forebears. Thus Smith's claim of a common background between manual and technical workers is shown to be a product of transition from one system of training and recruitment, based on privileged apprenticeship, to another based on graduate education. The engineers who exercised authority during the industry's existence were men trained in manual labour, of a wider nature than tradesmen, supplemented by aspects of technical knowledge. At the end, training in manual skills had ceased and recruitment and training were based solely on theoretical knowledge.

CHAPTER FIVE

WORKERS AND SUPERVISORS

INTRODUCTION

In the introduction I noted that one of the major objections to Braverman's thesis is that he ignored class struggle. In this chapter I attempt to show how class struggle can be incorporated into my theory that managerial control over coordination is increasing. Although I do attempt to address the work of labour process theorists within this chapter, particularly the work of Burawoy, the main source of concepts is from authors writing prior to the labour process debate. My major debts are to the work of Baldamus (1961), Fox (1974) and Newby (1977). I agree with Baldamus that the major determinant of workers' actions is the wage/effort bargain. Following Fox, I show that the level of trust in industrial relations between management and workers has a significant impact on management policy. Unlike these authors I do not regard industrial relations per se as the most significant determinant of management policy. I argue that management is concerned with the effective coordination of all elements of the labour process and does not privilege labour effort. From Newby I argue that the concept of deference as the product of powerlessness is a useful concept in understanding the nature of the railway workshop workforce.

It is shown that Baldamus's theory is not adequate on its own but has to be supplemented with a theory of trust.
Although the relationship between effort and wage is very important to the workforce I show that it does not have as much importance for management. I show that the impact of the wage/effort bargain upon management is mediated by the level of trust. Disputes over the wage/effort bargain have an

impact on the level of trust between workers and management. This level of trust affects the ease with which management can implement its policies. These policies are not necessarily related to either the level of worker effort or the level of worker remuneration. Management is not necessarily unified and I show how one section of management can advance its own power because of the lack of trust of another section of management. For example, I show that engineers increased their ability to change the nature of work by exploiting the low level of trust with which workers regarded the foremen.

If Braverman was wrong to ignore the class struggle, it was also clear that to see industrial relations as one continuous process of class struggle would also be misplaced. This is certainly the case within the railway workshops, which saw little industrial disruption. After discussing the problem of piecework at the turn of the century, the chapter examines the development of industrial relations during this century. The work of Baldamus and Burawoy is of major importance. Baldamus's work is important because it shows that workers are primarily concerned with the wage effort bargain. Burawoy's work is important because it shows how workers' actions can be considered whilst explaining consent to management. Burawoy indicated that the experience of work as a form of game is a major contributory factor in producing consent to managerial authority. I agree with Burawoy's analysis and in this chapter I indicate how consent is manufactured.

I see consent as a product of both dependence and the structure of shopfloor relations. The division between labour and labour power is reflected within the consciousness of the workers, a division analogous to the split in the managerial perspective on the labour process. As in the case study of Burawoy, so in the railway workshops. The workers' consent is the product of disputes over the price of labour power, and workers' perceptions remain predominantly at this level. There is little contestation over the growth in management's ability to coordinate production, which is described in later chapters (chapter seven in particular) nor questioning of managerial prerogative. But there is a belief in skill, from which a perspective which looks beyond the use of workers as commodities, could draw strength.

What is also clear is that nationalization, which was once perceived as a means of overcoming capitalist work relations, has achieved little to increase worker control over the labour process. Nor has it changed the manner in which workers perceive work. That state ownership has little effect on workers would appear to support arguments that state industries are what Crompton and Gubbay term state capitals, with little difference between them and capitalist industries, and subject to a tendency to 'separate coordinated labour from control' (Crompton and Gubbay, 1977, p. 110). A full investigation of whether the state railway was the same as a private railway in all important regards bar ownership would need an examination of the role the railways played in the wider economy, although few differences appear to exist at first glance.

The first part of this chapter focuses on how a lack of trust between management and men at the turn of the century led to management innovations in production.

At the end of chapter three, it was shown that at the end of the First World War, the engineers considered that there was a production crisis within the industry. The solution to this problem was either a reduction in expenditure or increasing productivity. As is shown later, the monitoring of expenditure by costing systems, which had the possibility of being carried out by a separate profession of management accountants, was a threat to an engineering management which was trained in manual labour. The first attempts to increase production were by the adoption of various methods of payment by results. The use of piecework in the last century, which was combined with the foreman system of control, had led to price cutting. Because of the central importance that workers attach to the wage effort bargain this had the consequence of contributing to a massive growth in trade union membership after 1905. The emergence of mass trade unions and the failure of payment by results systems left engineers with the task of either uncoupling productivity increases from dependence on piecework and the foreman system, or else seeing an increase in accounting based control systems and the attendant risk of the eclipse of engineering skills. Thus trust becomes an important determinant of management policy because it makes certain actions difficult and raises the possibility of others. For example, low trust had meant that revamping the piecework system was difficult, however, engineers needed to develop some means of increasing productivity, if they did not then management policy may have shifted toward being based on accountancy. Thus class struggle has an impact on management policy but in a complicated and indirect manner.

The emergence of piecework as a problem coincides with the emergence of mass trade unionism, the growth and development of which, throughout this century, is discussed, and in particular the reaction of engineers to unionism. It is shown that much of the productivity problem is blamed, by engineers, upon the foreman system of control described in chapter three. The system of working is described and shows that at the level of the shopfloor, the foreman was still of central importance into the late nineteenth century, and was seen by workers as being the central figure in management. The foremen were gradually reduced in status, although not numbers, throughout the twentieth century as a consequence of the rise of other methods of securing production, particularly the control over coordination described in chapter seven.

The chapter proceeds to examine the workers' experience by describing, in much the same way as for engineers, the recruitment and training, of workers and foremen.[1] It is shown that a system of kinship recruitment has been widespread, giving rise to all working males in some families being employed within the industry, and that this practice was to some extent based upon the previous welfarist practices of the railways. The nature of

[1]. I concentrate on skilled men because my information on others is sparse.

apprenticeship is also discussed primarily by examining the changes that have occurred in its form over the course of this century. The discussion of recruitment and training indicates that socialization into the workplace has a large impact on the generation of consent at work. In particular, it is shown that much of the self image of workshop workers rests upon a commitment to the railways and to the idea of craftsmanship.

It is shown that the changes in the apprentice system, which involved an increase in the central control of apprentice movement from one type of job to another and increased theoretical training, further decreased the role of foremen within the workshops. It is shown that the process of socialization into the role of railway craftsmen and the shop floor negotiations between workers representatives and shop management over the wage effort bargain and other conditions of work, appear to generate the consent to the rules of capitalist production which Burawoy discussed (1979). Even if the rules of the capitalist extraction of the surplus do not change, what is clear is that the way in which this is achieved does (chapters 7-9). I argue that the shopfloor 'game' has changed little, and yet management has initiated considerable changes in the control of work both in terms of coordination and the nature of the means of production, and their ability to reproduce the labour process. I indicate the predominance of workers' struggles are, as Baldamus predicted, directed at the wage effort bargain, by examining the roles of the chargehand, and local disputes. In passing, it is noted that disputes over closure seem to point to a wider consciousness which mourns the wasting of a worker's skills. National industrial relations, which have been largely peaceful, have been concerned with labour power issues, predominantly wage levels, but also questions of negotiating and disciplinary procedure. The quiescence at the national level may be product of the shopfloor, but is more likely a product of a lack of power. I do not describe the shop floor culture or wider social relations, which would be an important element in a full description of worker consciousness.

Much of the information in this chapter is based upon the interviews carried out with retired workers, and as is usual, all the names have been changed. The fact that the contact with these workers was mainly through the union and that they wished to be interviewed affects their responses, the influence being a more oppositional view toward management ameliorated by a pride in having worked for the railway.

THE ENGINEERS' VIEW OF PAYMENT BY RESULTS SYSTEMS AT THE END OF THE FIRST WORLD WAR

The concern over productivity at the beginning of the century led to the proposal of both profit sharing and new wage systems on the railway (Hadley, 1913). Turner, when assessing the growth in various payment by results systems, saw it as matched by the growth in profit sharing systems:

'other methods exist of giving high wages in return for big output, for instance, profit sharing, co-partnership etc. The underlying idea is that each man will feel a shareholder's enthusiasm for the welfare of the concern and will give good work himself and see that others do so too.' (Turner, 1921, p. 145)

Railway management showed a passing interest in co-partnership. This is a method of issuing workers with a return that was in line with the profits of the company and the workers' investment. Co-partnership was practised in large organizations (Livesey, 1908; Hadley, 1913, p. 2), which supports Edwards' (1979) claim that simple control could not promote efficiency in large undertakings, and that they thus sought alternative solutions, although the problem of productivity could have been widespread and large companies could afford co-partnership.

The engineers were dismissive of such schemes, arguing that the workers would only respond to wage incentives, for example, Turner's view was:

> 'that a workman prefers something weekly in his wages, and not something in the future. He does not want to be given a slip of paper with a statement that so many shares have been put to his credit; he wants to handle the money on a Friday night.'(Turner, 1921, p. 165)

Tonkin takes the generalisations about working class culture further by arguing that piecework is more in tune with this psychology than any bonus scheme:

> 'The apparent universality of piecework is due, I would suggest, to the fact that the average working man thinks in terms of money or price, not hours. (Turner, 1921, p. 169)

It was the engineers' view that whatever the problems of the piecework system, the economic attitude of the workers meant that some form of piecework would have to be adopted.

ENGINEERS AND PAYMENT SYSTEMS

By the end of the First World War, most workers were on payment by results (Tonkin, 1921, p. 46; Turner, 1921, p. 169; O'Brien, 1920, p. 381; Industrial Court, 1922). Engineers believed workers were restricting output because they feared rate cuts. The blame was not considered to be the workers' but, argues Turner, firstly, past management practice of rate cutting, which lead to mistrust, and secondly, bad rate fixing which led to rate cutting:

> 'It is generally accepted as a statement of fact that production is being carefully kept by workmen within generally recognised limits. It is worthwhile going into this and examining the reason. If one picks up a book of about twenty years ago on management or wages systems, one generally finds a reference to cutting piecework prices - the reference being of such a form as to give the impression that it was looked upon as perfectly normal and best practice. It has been quite common practice in the past and still prevails in many places, to cut piecework prices when a man earns say time and a third. In some cases immediate economy has undoubtedly resulted from the cutting of the price, but the inefficiency of the man who fixed the price is being visited upon the worker who has to work to it, and long experience of the immediate result of high earnings has taught the latter that it is easier to keep within the recognised limit than to risk having to give more output, for the same earnings. Here then lies much of the cause of the present tendency to limit production. The present position sums itself up as regards piecework prices in this way: the workman has not sufficient confidence in the management to give him maximum output, and the management has not enough confidence in its ability to get prices fixed with sufficient initial accuracy to justify them in saying to the men 'no piecework prices shall be cut.''(Turner, 1921, pp. 139-140)

The engineers, at this time, objected to the previous method of controlling the transformation of labour power into labour. The implication of this position was that rates were not fixed accurately under the system where foremen negotiated prices, for example, Britten argued:

> 'Piecework prices ought not to be cut unless there is some definite development in the shop to warrant the cut. Of course that all leads again to the fixing of the piecework

prices which is a very difficult matter. That in the old days used to be done in a very haphazard manner and I can bear out one speaker's remarks by my own recollection of finishing my work at eight o'clock in the morning, and at other times of working hard all of the day and not being able to earn the money; thus proving that the prices were not fixed properly.' (Turner, 1921, p. 162)

That price cutting had been widespread and led to output restriction was generally accepted, Tonkin argued that relations were now so 'low trust' that it was difficult to introduce any change, piecework's:

> 'fault as emphasised by Mr Turner, has been the accepted role of price cutting, so much so that in the psychology of the working man of today there exists a well rooted objection to reward systems of any form, as from experience of the past years he views such innovation with legitimate suspicion.' (Turner, 1921, p. 169)

The chairman of the discussion following the presentation of Turner's paper, argued that certain of his own works had managed to establish trust by adopting a policy of no rate cutting:

> 'I am old enough to remember when piece prices were always cut when a man got more than it was thought by the management he ought to get. So that the man would work up to his allowance, and it was no good him working any harder...There is a rule which has been in force at Ashford for the past twenty years at least, that piece is never cut, once it is fixed, unless there is some improvement introduced, either in methods or in machinery; and that of course is a very sound rule.' (Turner, 1921, p. 151)

The establishment of trust, to overcome output restriction, was thought achievable by a managerial commitment not to cut rates unless methods changed. This position was reiterated by Britten:

> 'I do not think that when a price has once been made it should be cut. The men should be given to understand that unless some definite circumstances have arisen that make it necessary to cut it, such, for instance, as improvement in machines, which allows the job to be done quicker, the price will remain as originally fixed. Piecework prices ought not be cut unless there is some definite development in the shop to warrant the cut.' (Turner, 1921, p. 162)

Trust, it was felt, could be supported by not cutting rates, although it was thought obviously necessary, according to Turner, that 'when there is change of method of production, there is generally justification in cutting prices'(Turner, 1921, p. 166). Cutting prices on changes in methods was rather difficult to square with the stable rate policy, as revealed in Turner's limp recommendations on approaching change:

> 'if one goes frankly to the men and says 'the price on such and such an old machine is so much, but you can see we have got a different method; you must agree that it is only fair to reduce the price' they will see the justice of it.'(Turner, 1921, p. 166)

The commitment to stable rates appears to create a number of problems. It can be speculated that a policy of rate cutting with changed methods shifted the area of workers' contestation to the question over what constituted new methods, and induced output restriction when changes were being implemented. Turner proposed bonus systems as a solution, hinting at the use of time and motion studies as a means of accurate rate fixing. It was felt the adoption of bonus schemes in the USA accounted for that country's high productivity:

> 'There are several American systems of wage payment that aim at the recognition of this principle (proportionate reward for increased effort) and at unrestricted output, and the author construes that this may account in some measure for what he believes to be the fact that the productivity per man in America is higher than in Britain'. (Turner, 1921, p. 141)

Turner, although an advocate of their usefulness, had reservations about the bonus systems used in Britain:

> 'Efforts have been made to get over the difficulty of accurate rate fixing, and some twenty years or so ago, various systems of wage payment were proposed under the name of premium bonus - the essential feature of which was that the benefit

of increased output was shared between the employer and employee in predetermined proportions. A system which appeared to find much favour was the ' Rowan system ' and this was so designed as to prevent bad ratefixing from resulting in too high wages.

The system found favour for some time as being more or less automatic in its working, but it was not, the author ventures to think, intended to give maximum output, but rather to leave him less satisfied as to fairness of his prices and time allowances than before. This is due to a fundamental error in the system, a study of the result of which will show that as it becomes more and more difficult to increase the rate of output, so the workman's bonus - his reward for the increased rate of output - decreases. In the ideal system precisely the opposite should be the rule - incentive should increase in proportion to the effort required.' (Turner, 1921, p. 141)

Turner thought that the bonus systems attended the problem of excessive costs incurred under piecework, but encouraged the real problem of output restriction. The root of the problem was accurate rate fixing. Clayton agreed with Turner on the nature of existing systems, but argued that his solution of using bonus system would lead to output restrictions and substandard work:

'With regard to premium systems, I wonder myself, that it has ever lived at all. I know of one concern in the railway world which runs a premium system - as it says with success- but how the premium system can be successful without also an elaborate system of supervision I never could understand... As the author pointed out, it is splendid up to a point, and the workman loses all the way down. The result is that I do not think it has ever had a chance, because it necessarily involves this question of supervision. I would say then that if your premium system is a success, then the quality of your work is more than likely not a success' (Turner, 1921, p. 155)

Howell rejected the application of bonus systems because they did not tackle the central problem of accurate rate fixing:

'Mr Turner is commenting on the set piece prices as against the Gantt and Rowan systems of premium bonus. Well doesn't he think it's rather like a man who has gumboils from a decayed tooth, and instead of having the tooth pulled simply lances the gumboils ? He admits in his paper that owing to our inability to fix piece rates correctly it is necessary to have some safeguard on the earnings of the workmen. Well if prices cannot be cut, and they should not be cut - a proper system of estimating piecework prices must be adopted, and it seems to me that there lies the solution to the whole problem.' (Turner, 1921, p. 155)

The problem of piecework, during the first quarter of this century was viewed by the engineers as output restriction caused ultimately by bad rate fixing.

RELATIONS OF TRUST

In this section it is shown that Fox's conception of trust is important in understanding management actions. That, in the early part of this century, there was a mistrust between men and management, which needed to be overcome, was widely felt. The chairman at the presentation of Turner's paper, thought that it was not just fear of price cutting but error on the workers' part:

> 'In regard to premium systems there was a great deal of opposition to them - the good old opposition of the trades unions to high production in any case. It is the old heresy that there is a certain wages fund and if one workman does not get so much money there will be more for someone else and that working slack avoids unemployment. That is one of the things that makes it so absolutely necessary that the author's view of the square deal and the encouragement of conditions of confidence between management and the men should be observed. To my mind the workman is a reasonable person if you get on the right side of him, and the more he is admitted into the business side and the understanding of the management, the more he will see what we are all trying to teach him now, that output is what is wanted, and that if he does more work he won't do his neighbour out of a job, rather the other way. ' (Turner, 1921, p. 151)

We see here the beginnings of a human relations type approach to industrial problems, the stress being on communication as a means of teaching the workforce the error of their ways and creating an environment of trust. The approach to creation of trust was at a very simplistic level, and Howell argued that a notice on the factory wall would solve the problem of the piecework system:

> 'Referring to workmen keeping down to the time and a third or whatever is allowed, it does occur in some places; but if a notice be put up in the shop that prices are guaranteed and that regardless of what the workman makes they will not be cut, I think the bulk of that will disappear.'(Turner, 1921, p. 153)

Turner believed the crisis of the piecework system was somewhat more serious than Howell gave credit, arguing that it had become so discredited, in the workers' eyes, that trust could only be established by abandoning the system:

> 'we are in a condition now when promises as to prices not being cut would be viewed with suspicion, and it struck me that it would be better to have a clean sweep and start with a new system.'(Turner, 1921, p. 164)

The past practice of bad rate fixing meant, for Turner, that the establishment of trust under piecework was impossible. The past methods of management had failed and needed replacing with a more cooperative approach:

> 'One reads much in the American technical papers about the necessity of giving the workmen what in their vivid phraseology is called a 'square deal'. It is an expression that gives one cause to think carefully of the conditions of the past. A square deal given by the management demands a square deal given by the men, but it is for the management side to take the initiative - not as one might make a profitable investment in the hope of receiving something in return, but as a natural duty - the something in return from the other side will not be long wanting when it is realised that the square deal from the management is a permanent institution.'(Turner, 1921, p. 150)

The achievement of trust was seen as important by the engineers and it was their responsibility. Management had to change the way it dealt with the workforce. The difficulty was that there were few mechanisms for improving relations. Turner's suggestions in this direction are primarily irrelevancies, for example,

> 'A system of awards for suggestions made by workmen is to be encouraged. The workman is so very much more in touch with the job than any of the supervisory staff and has so much more opportunity of thinking about it, that it is surprising that suggestions are not more frequently made in works where the practice of considering and making awards for them exists'(Turner, 1921, p. 149).

As with most of the engineers' ideas to increase trust, suggestion schemes appear and clearly were inadequate to the task.

NATIONAL UNIONS

Mass trade unionism is a product of the twentieth century. In the Victorian era the major rail union, the Amalgamated Society of Railway Servants (ASRS), did not recruit shop staff, and the engineering unions were not particularly successful. As Page and Cole noted 'the craft unions have always been weak in the shops'(1917, p. 81). The General Railway Workers Union (GRWU) was formed in 1889 as an industrial union for the railway, in practice its recruitment was limited to those not eligible for the ASRS, which included shopmen but not in large numbers. In 1913, the formation of the National Union of Railwaymen (NUR) from the ASRS and the GRWU and a third union led to a massive growth in recruitment for the NUR (Table four). The craft unions responded by increasing their recruitment and by lobbying the TUC to prevent the NUR's actions (Bagwell, 1963; Page and Cole, 1917). By the end of the First World War the pattern of union organization was fixed, the engineering unions, later all included under the umbrella of the Confederation of Shipbuilding and Engineering Unions (CSEU) dominated the craft heavy locomotive works, and the NUR, the carriage and wagon works. Union membership fell during the depression but rose by 30% during the Second World War (Halverson, 1951, p. 525), to remain at around 100% until the end, a situation assisted by the coming of the closed shop in 1970 (McLeod, 1970; Weighell, 1977, p. 257).

TABLE FOUR

SHOP MEMBERSHIP OF THE GRWU AND NUR.	
1906	800
1907	2500
1909	10,000
1913	30,000
1914	40,000
1916	50,000

SOURCE: Bagwell, 1962, p. 320, p. 360; Halverson, 1951, p. 341; Page and Cole, 1917, p. 74.

By the end of the First World War and a decade before the changes in the labour process that are described in later chapters, mass unionism had established itself within the railway workshop. From this it is clear that Edwards' scheme of technical control leading to mass unionism is thus inapplicable to this industry. This is not surprising, as the causes behind the development of mass unionism were unlikely to be reducible to one causal factor. In the case of the railway workshops, the development of struggles over piecework would certainly have an impact, but the role of the wider industrial relations situation and conscious organization were vitally important. Littler (1982, p. 96) asserts that the emergence of shop stewards within British engineering at the turn of the century was a response to changes in the wage/effort exchanges associated with the application of payment by results systems. It would appear that this factor is also of importance within the development of the railway workshop labour process.

NEGOTIATING MACHINERY

A consequence of union rivalry was delaying the adoption of negotiation procedures until mid-1927 (Halverson 1951; Gilbert, 1951a, p. 24). This system applied to both sheds and main works, and covered wages, hours and conditions (Gilbert, 1951a, p. 24). It was agreed that there would be no withdrawal of labour prior to the results of negotiation (Gilbert, 1951a). The system was headed by the Railway Shopmen's National Council (RSNC) which had equal union and management representation and a predominance of engineering unions. Failure to agree an issue at the RSNC led to it being referred to the Industrial Court, and later ACAS. Each works had a committee and under them were shop committees, a part of the negotiating procedure which became active in 1928 (Gilbert, 1951a; Stamp, 1928, p. 492). The shop committees had a minimum of 2 representatives for each shop over 50 staff, a further representative for every whole or part of 100 staff. Shops under 50 could appoint an informal representative. Works committees had a maximum of ten members elected by and from the shop representatives. At the beginning of 1987 during the run up to privatisation the role of the Railway Shopmen's National Council was replaced, for main works, by a new negotiating machinery for BREL works alone.

In 1922, prior to the development of negotiating procedures, the unions and railway companies covering 75% of the industry agreed to put questions of pay and grading to the Industrial Court. The Court's decision (decision 728) reduced the number of manual grades from 1500 to 225 and fixed basic wages and the minimum piecework earnings at 33.33%. In 1948 a further agreement was reached, outside the standard negotiating procedure, which created 64 grades, 20 pay scales and a minimum piece rate of 27.5% (Railway Executive, 1948; see also Williams, 1959). The final change in the area of grading was that introduced by the Pay and Efficiency agrement which introduced 18 craft grades and 3 non-skilled grades.

NATIONAL DISPUTES

During this century there has been very little industrial action, at the national level there have only been four stoppages. Again contrary to Edwards' thesis, the two most significant stoppages were prior to the developments in mass production. The shopworkers participated in the successful two day general rail strike of 1919 which restored the abolished war bonuses. The longest national stoppage was the solid support for the General Strike.[1]

TABLE FIVE

STRIKING SHOPMEN ON THE GREAT WESTERN.

DATE (MAY)	SHOPMEN ON STRIKE	PERCENTAGE OF TOTAL
5	21,348	95.8
6	21,166	95
7	21,271	95.4
8	21,307	95.6
9	21,306	95.6
10	21,388	96
11	21,362	95.8
12	21,326	95.7
13	21,243	95.3
14	21,282	95.5

SOURCE: The General Strike. GWR p. 53.

There were no further national disputes until a one day stoppage in October 1963 in protest at the announcement of the closure plan without any consultation as to its contents (Wedderburn, 1965, p. 22). The threat to close Derby Locomotive, Swindon and Glasgow also led to a one day stoppage by shop and rail men in August 1984 (Morning Star, 11-8-84). However, the lack of willingness to take industrial action was later confirmed and reestablished when the NUR and the CSEU had to abandon strike ballots to protest against closures in 1985, because local unionists could not

[1] The strike lasted for two days longer on the railways with the aim of securing more reasonable conditions for a return to work (Bagwell, 1963).

guarantee support even at Swindon which was one of the closing works (Swindon Evening Advertiser, 4-9-85).

LACK OF INDUSTRIAL POWER

The railway loyalty of the shopmen, discussed below, may have contributed to the lack of industrial action, but the major reason was that the shopmen did not affect profit and could not stop the trains. Sam, an ex-works' committee secretary and AEU member, summed up the situation:

> 'Say they did get all the BREL works out, it's not going to make much difference, locos will still run and they'll run them longer. If you're talking about guards and the signal men, then of course that's a different kettle of fish, they just stop the system stone dead. You know it, management knows it, there's a lot of apathy. I mean they talk about muscle in the trade union movement, railway workshops virtually haven't got any. I hate to say this but they have ridden on the backs of ASLEF and NUR to a certain degree because that's where the power is and if there's a dispute over pay then there's nothing the railway workshops can do. What happens is that the Board meets ASLEF and NUR on the conciliation side, they give them a percentage rise prior to meeting the railway workshops. Whatever they accept, we are destined to get'

The outcome of the situation of powerlessness led workers to identify with their own works, and not only to a lack of concern for the closure of other works, but to positively welcome their closure. Sam remembers:

> 'when Darlington shut they were halfway through building some type 2 locomotives and Derby got them, and people went round saying 'we'll be alright'. It's dog eat dog and there's no support for anybody from another centre if that centre hasn't got the hatchet, there is no way they're prepared to fight.'

From the turn of the century mass unionism had emerged within the workshops but as was shown it lacked power and was localised, with workers at each works identifying with their particular works. As a consequence very little national industrial activity has occurred within the workshops and the significance of the unions is at the local level.

ENGINEERS AND SHOP STEWARDS

At the end of the First World War, the old methods of control over labour had failed and the new methods of increasing productivity by coordination could not yet be born, to paraphrase someone more famous than myself. The need to increase productivity was still seen in terms of controlling the transformation of labour power. The engineers, as a result of their need to increase trust between management and workers and bypass the system of foreman control, had a positive reaction to both trade unionism and the shop steward movement. The shop stewards emerged during the First World War reflecting the growth in unionism and the shop control system that dominated the works. Turner took a generally favourable view but thought that the lack of trust that existed might prevent the full benefits of management/union relations to emerge:

> 'the altered relationship of men and management as compared with what existed before the War must call for comment. We read much in these days of the aspirations of labour, of the necessity of closer cooperation between labour, management and capital - of Whitley councils. The reason for much of the alteration of relationship lies in the fact that when there was a shortage of men during the War - in the days when everyone was engaged more or less in the big struggle - the workman found himself so much in demand that he became powerful. Realising his power he began to use it - largely for his financial advancement, but also to some extent with the aspirations for better working conditions. The former is more a question of economics than management, but with regard to the latter one, can sympathise to some extent with the aspirations for better working conditions when one thinks of the large proportion of the workman's life which used to be spent either at his work or in going to and from it. Out of aspirations for better working conditions grew the shop steward movement as it now exists - the appointment of a man to each shop to voice any complaints as to conditions of work etc in that shop. This scheme of the selection of a men's representative has distinct advantages, providing that he is a man of considerable experience and with a generous amount of the commonsense of his class and providing that the men of the shop are prepared to accept his leadership. In the latter condition however lies, it

is feared, the chief difficulty. Assuming, however, that one has a men's representative fulfilling these conditions he becomes a very useful link between men and management.' (Turner, 1921, p. 149)

Shop stewards arrived during the First World War as a means of expressing grievances on a shop basis. This was seen as a useful by-passing of the foremen, who by Turner's usage, were not seen as part of management. Ever the pessimist, Turner thought the culture of the shopfloor would hinder the stewards' managerial usefulness:

'My experience is this, as soon as one gets the shop steward to take a lenient view of the management, that is as soon as one begins to educate him, his followers turn him down, and then start again with a new steward. That of course must right itself as education becomes more thorough. (Turner, 1921, p. 165)

A slow process of education would, he claimed, eventually achieve trust between workers and management. The stewards' importance was reiterated, from the chair of the meeting that was discussing Turner's paper:

'Some years ago the men came to me and asked if I was prepared to recognise a shop committee, and I said I would be pleased to do so. We have a committee consisting of four, two on the carriage side and two on the locomotive works - and they have certainly smoothed over many difficulties. They are very reasonable men - as reasonable as anybody may wish to talk to. I think it is an excellent idea. We have not got that fear of shop stewards that they have in some places where the shop steward is looked upon as a revolutionary.' (Turner, 1921, p. 152)

Again unions are seen as a means of management liaising directly with men to iron out industrial relations difficulties. Clayton goes further in his appreciation of shop stewards, seeing them as more useful to management than men:

'I appreciate the shop steward movement very, very much indeed...they are of wonderful use in the shop, and in my opinion are far more useful to the management than they are to the men whom they are elected to serve. At any rate in the company I am concerned with, the management make full use of the shop stewards and find them tremendously useful persons, and just as important as the best piece of up to date machinery we have in the shop.' (Turner, 1921, p. 154)

The need to increase productivity as a response to the rising technical costs of production and the rise in accountancy led to wholesale questioning of the piecework and foreman systems. Productivity was seen as a product of labour effort which could not be coopted because of the low trust relations that existed because of previous attempts to reduce costs by price cutting. That the piecework system existed until 1970 suggests that the problems were solved. They were, not by improving rate fixing, but by engineers taking over another function of the foreman, the determination of production tasks.

THE STRUCTURE OF WORK

As was just noted, piecework was not abandoned and the shopfloor experience of work has remained much the same, structured by a combination of task and reward. The final transformation of labour power into labour, which, as was noted in the introduction, is ultimately based on consent, is achieved in the shops by shop management. The achievement of production is, as Baldamus argued, based upon negotiation around effort and reward between workers and shop management. However much the discretion of shop management may be bounded and its functions narrowed, they are still necessary. It was the shop system that workers experienced. Fred, a machinist who worked from 1916 to 1968, argued that throughout that time:

> 'It was all your direct foreman and chargeman. The chargeman was the important man, he issued your work and the foreman looked after the section, apart from that there was not much else, if the works manager came round he was mostly preoccupied about something, it was probably nothing to do with your section, he was interested in something else, they didn't interfere'

The works social structure can be understood in terms of the dimensions of task coordination, task allocation, supervision and remuneration. All shops would be headed by a chief foreman receiving a flat rate salary. After Beeching they were called superintendents which was 'only a difference in name that's all', according to Frank. These foremen would have a shop office staffed by a number of clerks under their command.

The work was organised under the gang system, and each gang was headed by a chargehand. Chargehands had always existed, sometimes under the name leading hand, and grew to increasing prominence when the number of men in each gang increased. This had the consequence that the experience of being a chargehand consequently decreased. The chargehand was responsible for allocating apprentices to craftsmen and men to particular jobs. The jobs carried out by the gang all had a price. The price of a particular job, in money terms not time, was fixed in the early days by foremen, but later by specialised rate fixers who served under the foreman. The amount of bonus due was determined in the office by the submission of documentation of work completed countersigned by inspectors as being both necessary and satisfactorily. completed. The piece earnings of the gang were combined at the end of the week and a collective bonus rate was determined according to the gang's total output, the chargehand being paid as part of the gang and with something for each man supervised, (a shilling between the wars). Certain workers, like machinists and welders , were paid on an individually timed and paid premium bonus system.

The majority of workers were on piecework with their wages made up of a basic day rate and a piecework bonus. The work needed to make a product had a particular price, and the work done had first to pay for the basic day rate, thus any subsequent amount was paid as piecework bonus, a minimum rate of 33.33% being guaranteed by decision 728.

The price per piece was subject to negotiation at the locomotive works, and although the stewards and individuals did have some role in negotiating prices, the chargehands appear to have a larger role. The shop unions appear to be more involved in applying pressure for a general re-pricing, thus in the diesel shops the unions had a two year battle to get prices re-valued and double the bonus paid to 100%. The prices are negotiated with staff representatives, earlier this was directly with foremen but more generally with rate fixers.

The aim of workers when negotiating prices with a rate fixer was to conceal any quick methods of doing a job so that a reasonable bonus could be earned. The aim of the rate fixer was to negotiate a price that took account of this tendency to find quicker ways and yet preserve the incentive basis of production, but this was not always the case. Nat remembers 'there was jobs that took six or seven hours for a penny, you just didn't bother'. Once a rate had been fixed, according to Nat, the amount of output had to be regulated:

> 'The battle then was to keep your bonus not too high to give the show away, but give a bit more to satisfy the men. You were always constantly doing that.'

The need for vigilance was due to the chance of re-timing. Davy a chargehand erector, remembers that the rate fixers were always on the prowl:

> 'If the rate fixers saw you doing a job quicker they'd send a rate fixer onto the job straight away and have it re-timed again. Cutting all the while.'

The result of this system was in Reg's words that 'they did not let you get too much. You was lucky if you got 55-60%'. The standard rate for the interwar period appears to be of the order of 50%, but after nationalization there was 'piecework drift' and the standard reached around 100% . Piecework drift occurs when inflation is rising but the basis of calculating piecework prices remains the same. The failure to alter the basis of the piecework prices calculation meant that prices calculated decades before were not worth working for, consequently later prices had to compensate for these low prices, resulting in the situation where, according to Sam, an erector, 'some of the times were that good it was ridiculous, but others that bad it was ridiculous the other way'. This diversity between prices was one of the incentives behind pooling earnings in gangs.

THE ROLE OF FOREMAN

The workers' view of what the foreman did varied, from Fred's view that 'the supervisors were quite reasonable chaps, didn't try to push you too far', to Harry's 'they all had their bad points'. The general view is Bob's that 'some were very good and some were wicked.' The workers' view of what supervisors did was primarily seen in terms of discipline. Bob thought there was rather too much:

> 'you needed a shop superintendent, but they'd got all these foremen, they weren't necessary. All they could do was go round the shop and see if any was shirking or perhaps having a drink of tea when they never ought to, if that's a useful function. It weren't really because at the end of the day, you still got to earn your money, it was stupid.'

The monitoring of work by foremen was seen as a hindrance. In the view of Reg, a blacksmith, 'I don't think you get as much out of a chap when there is someone standing over them all the while.' It is widely held that the disciplinary power of foremen declined since the start of nationalization. Stan, a painter, claimed:

> 'When I started there (1946) if the foreman said 'you're sacked', you were sacked, that was the end of it. Not today, if for any disciplinary reason they say to him today 'you're sacked', he immediately goes to works committee and says 'I'd like to appeal against dismissal' and invariably he gets his appeal carried.'

Frank was an example of the sackings that were made by the foreman. When he was shop steward he was dismissed by the erecting shop chief foreman in 1945 for refusing to apologise for being seen washing his hands half an hour before dinner break by an assistant foreman. Frank insists that he had misread the time. The foreman not only had the power to dismiss men, he also had a number of punishment jobs, often for eating or drinking tea in company time, around the First World War a week in the foundry was often used, and after sectionalisation in the erecting shop, a permanent transfer to the stripping section was used which, according to Nat, was 'ten times as dirty' as normal assembly work and paid badly. Len remembers that the maintenance depot was used at Newton Heath because it paid minimum piece-rate and involved outside work. He was sent there for using foul language, in his case the system back-fired because he took to outside work 'it was the best punishment I ever had', and a year later he gave up factory work for good.

The power that foremen had in relation to the ability to place men in punishment jobs meant they were often petty in their dealings with the men. John, a storekeeper, remembers one such instance:

> 'When I started as a lad, we used to have a stove and put a can on it for mashing tea. We had a bloke called Simpson, he was an ex-tradesman, bowler hat type, became stores supervisor. He saw we had a can of tea and he stood over an hour, and that bloody thing dried up and burned a bloody hole in the bloody kettle. That was the system then. The fear was there, at that day and age you couldn't get a job.'

Harry, a labourer with anti-union views, had to join the union in the 1960s because he was being continually harassed by one particular foreman who gave him all the dirty and outside jobs.

The foremen could not only use their power to place people in bad jobs, they could reward their friends, and this occurred well into nationalization, as Stan recalls:

> 'All these foremen have their favourites, the people they like and people that they perhaps don't like so much. You could tell who knew the foreman and who didn't'

When Frank, sacked in 1945, returned to Derby locomotive works in 1966 an assistant foreman, who was an old friend of Frank's, managed to get Frank placed on his own section, confirming the foreman's ability to influence staff allocation well into nationalization.

Foremen were not only responsible for discipline and allocating men to sections, they were also responsible, via rate fixers, for determining piecework prices, and it was over this issue that disputes often arose. Frank remembers in his time the major dispute was caused by a foreman attempting to reduce piecework prices:

> 'We had a new foreman named Mr Coles, and he saw fit to try and top cut the prices on the new engines that were built in the shop. The men kicked over the traces in the new engine department, and of course the whole shop came in and supported them, and Mr Coles promptly withdrew his intentions.'

Davy recollects that disputes in the shop were 'mostly foremen causing some bloody trouble'. Nothing much appears to have changed, because Rider notes that at the turn of the century it was primarily the power of foremen that workers objected to (Rider, 1987, p. 106). Reg argued, and he is typical, that foremen had become more sympathetic to the men and less autocratic over time:

> 'Years ago there was a tendency to be a bit frightened of the foreman, the fear of getting the sack. Over the years the foremen seemed to be more friendly with the men. In the olden days they liked to show they were the authority in the shops.'

Management has little importance in terms of the experience of the shopfloor, much more significant are the chargehands and foremen. The line between management and worker in the shop was between chargehands and foremen. The chargehand is a worker with responsibility for organization, his money and his relations with the foreman depend on a satisfactory organization of his gang over which he had few disciplinary powers. The foreman's role was seen as principally one of rate cutting and discipline. On the whole foremen were viewed unfavourably and, in a situation of payments by results, as superfluous, petty and usually a hindrance.

PROMOTION TO FOREMAN

The route to promotion to foreman was via assistant foremanship, the first step on the ladder being the position of chargehand, either directly leading to assistant foreman, or via a shop staff jobs such as inspector or rate fixer. It was also possible to be appointed directly to certain staff type positions without going through the chargehand post (e.g., progress man), although progress men were paid as fitters. These position also provided routes into management eg: planning engineers and upwards.

Chargehands had a great deal of influence on promotion to lower scale supervisory positions, as they usually went on chargehand recommendation. Frank remembers that he became a chargehand of the gang he was working on due to the recommendation of the departing chargehand, who was promoted to inspector and was eventually made foreman. This system of promotion was not necessarily totally effective. Davy the chargehand, remembers that if a foreman came round asking for someone for progressing or rate fixing 'your best fitter never became foreman or chargehand, you wouldn't let them go'. The result according to Davy was 'prospective foremen, they wasn't that brilliant'. Bob identifies the same process, 'If they came across and wanted a man for progress, the chargehand wouldn't want one of his best men to go.' The reason for not promoting good fitters was that the chargehand's bonuses would be adversely effected.

Another factor perhaps producing bad foremen was the low pay they received, which sometimes involved negative differentials (see next section). Negative differentials were not restricted to foremen, Nat, who had been working as the erecting shop progress man, and would doubtless disagree with what Bob said above about such work, went onto a temporary staff job in the outside department, but he found he was one pound a week worse off. When this was made semi-permanent he complained, and the assistant work's manager told him 'to think of the honour'. He didn't, noting that it wouldn't impress the butcher, and went back to the erecting shed where he was placed in charge of stripping, and as he noted 'he was never offered another promotion'.

DECLINE OF SUPERVISORS

Rose, Marshall, et al. (1987, p. 22) argue for the necessity of supervision under advanced capitalism and argue that 'supervisors under advanced capitalism are neither rendered progressively less powerful nor less authoritive' (1987, p. 20). However,power within organizations has to be conceptualized according to the domain over which it is exercised. Rose et al's study does not examine the discretion that supervisors have to determine the organization of work tasks. In the workshops there has been a decline in the supervisor's role in determining the nature of work, not in the allocation of tasks to particular workers or exercising discipline to ensure task completion. This decline in power over determining the nature of work is a reflection of the engineers' increased role in determining the pattern of work.

The new methods did not decrease the number of foremen, in fact the number of supervisors per worker has increased over time. The definition of what constitute supervisory staff became increasingly catholic, including, in later periods, for example, time and motion men, rate fixers etc.

TABLE SIX

NUMBER OF MANUAL WORKERS TO SUPERVISORY STAFF.

Year	
1875	59
1925	60
1930	59
1935	57
1938	49
1966	15
1970	12
1980	12
1983	14

Source. The Railway Diary and Officials Directory, 1876. Railway Staff Returns. BRB, Report and Accounts. BREL, c1982. TSSA, 24-2-83.

Notes: 1875 applies to the foremen only and the locomotive department only. 1966 and 1970 refer to all BR workshops. 1983, refers only to Shildon Horwich and Temple Mills (all due for closure). Interwar figures refer to foremen and inspectors. Post war figures refer to all supervisory staff.

The wider definition of supervisor reflects the wider nature of post Second World War supervision, for example, during the inter war period there were few official progress men. As an example, in 1961 at York new coach building was carried out by 1768 operatives supervised by 39 foremen and assistant foremen, giving a ratio of 1:45, that is about the same order as during the inter war period. This does not affect the argument, because it is the development of specialization within supervision that lies at the heart of the loss of authority for supervisory staff, the role of supervision being subject to a process of creating a number of detailed supervisors and subject, no doubt, to the Babbage principle.

The declining pay can be seen as a reflection of declining authority. At Swindon, in 1915, the foreman's salary was 70 shillings, and the fitter, the cream of the craftsmen, had a 'day wage' of 34 shillings (Williams, 1984, appendix). Because the meaning of day wage is unclear, the differentials between foremen and craftsmen remain imprecise but are substantial. During the inter war period there was a decline in foremen's earnings relative to wage staff:

TABLE SEVEN

FOREMEN AND INSPECTORS WAGE AS A PERCENTAGE OF FITTER, ERECTOR AND TURNERS WAGES.

YEAR	
1921	145
1923	166
1924	164
1925	162
1926	160
1927	161
1928	157
1929	156
1930	154
1931	156
1932	160
1933	160
1934	155
1935	151
1936	149
1937	142
1938	139

SOURCE: Railway Staff Returns. (The figure for 1923 was calculated on a different basis, being collected from pre-amalgamation companies).

Notes: A regression line of percentage on year gives the following statistics; r=-.87; a=167.35 and b=-1.36. ie: showing a strong correlation for a yearly percentage decrease in foremen's relative earnings of 1.36% a year from 167.35.

Riddles, BR's first CME, remembers the difficulty of getting foremen at Crewe in the 1930s:

> 'They were very difficult to recruit, at least in the twenties and afterwards, because they earned less than some of the men on the shopfloor. Mr R.A.Riddles, who was a premium apprentice at Crewe remembers the manager coming round and asking 'who wants a bowler hat?'[The traditional symbol of authority worn by foremen] Few people did.'(Hudson, 1970, p. 60)

One of my interviewees at Derby had exactly the same experience in the following decade:

> 'I got offered the foreman's job in 1946 - but I would not take it because it was 15 shillings a week less than what the fitter was getting..... that was a lot of money, during the war Fred, my night foreman, was getting less money than

me. Their wages never went up much at all, every time they were right behind '

That the relative remuneration of foremen consistently fell during the inter war period can be taken as reasonable confirmation of their declining importance within the managerial framework.

Supervisors were unionised during the inter war period, the Workshop supervisory staff agreement was signed in 1932 and extended to top foremen in 1947 (Gilbert, 1951a, pp. 47-9; Halverson, 1951). The unionisation of foremen was a product, probably not of proletarianisation, but of promotions to supervisor having to be from a pool of unionised men. The extension of the scheme to higher grade foremen may, again, reflect the age cohort concerned but certainly reflects the greater acceptance given to unions at this period. By the 1950s the relative pay of foremen had further declined, although there was an increase toward the end of the decade. Presented below is a table of the take home earnings of all railway workshop supervisors (i.e., including signal and civil engineering workshops) taken as a relative proportion of the earnings of all main workshop craft workers.

TABLE EIGHT

SUPERVISORY EARNINGS OF ALL WORKSHOP SUPERVISORS AS A PERCENTAGE OF THE AVERAGE CRAFT EARNINGS IN MAIN WORKS 1956-60

GRADE	% of supervisors	year 19-- 56	57	58	59	60
C	2	143	145	155	156	156
B	5	143	142	148	150	148
A	9	133	132	134	137	138
1	20	122	122	123	128	129
2	40	109	106	109	116	116
3	13	106	106	108	114	115
4	8	95	94	96	101	102
Total 4365						

SOURCE: BTC, census of staff.

The classification of supervisors involves a wider definition than foreman: supervisor special class A includes craft foremen, instructors, time and motion men; and supervisor class 1 includes non-craft foremen, technicians, rate-fixers, initial examiners, finished work inspectors, progressmen, and supplies foremen (TSSA, 1965). If these classifications are taken together in the proportions given above, the relative pay rates were:

TABLE NINE

PAY RATES OF FOREMAN GRADES RELATIVE TO AVERAGE CRAFT EARNINGS 1956-60.

YEAR	RELATIVE PAY
1956	125
1957	125
1958	126
1959	130
1960	131

SOURCE: BTC, CENSUS OF STAFF.

There was a significant decrease of differentials relative to the inter war period, the differential being slowly increased toward the end of the decade. These figures underestimate the amount of the overall decline, as they do not include the rates for assistant foremen, which may be included in railway staff returns. There is further evidence of decline in earnings from the late 1960s.

TABLE TEN

SUPERVISORY SALARIES 1966-1970

Year	Take home Earnings all workshop supervisors relative to fitters.
1966	116
1967	115
1968	116
1969	117
1970	118

Source:BRB, reports and accounts.

The evidence shows a reduction in the foremen's differentials from the First World War.[3] The Transport and Salaried Staff Association argued, during the 1960s, that supervisory staff's differentials were not high enough (TSSA, 1965) and in the early 1970s they reported negative differentials for BREL supervisors (TSSA, 1972, para. 173). The decline in differentials relative to workers was matched by a decline in the relative managerial position of foremen. During the mid 1970s there had been a 18% upward drift in managerial grading, that is more chiefs and less indians, however, the chief foreman position was not regraded and remained as 'category d supervisor', and although this does not mean that there were not more chief foremen, it certainly means the position is further down the managerial hierarchy (Modern Railways, 1979, p. 551).

The amount of power exercised by chief foremen, although reduced, was still considerable at the end of the

[3]. Although it has to be acknowledged that within the two sequences for the post-war period (i.e., 1956-1960 and 1966-1970) the relative pay for foremen increases slightly.

pre-Beeching era. Consultants, Urwick, Orr describe the responsibilities of the chief foremen:

> 'The foremen are acting in the capacity of works superintendents or shop managers responsible for the work of sections whose compliments often exceed 200 men...We list below some of the duties for which foremen are partly or wholly responsible:
>
> i.Supervision of workshop and shop staff.
> ii.Production planning and control of associated flow of production documents.
> iii. Material supply and progress control.
> iv.Ratefixing
> v.Estimating and tendering.
> vi.Plant layout.
> vii. Methods, planning and development
> viii.Quality control of raw materials and finished products.' (Urwick, Orr, 1961, p. 8)

The discretion exercised by foremen in these areas had been reduced by the growth of technical staffs and the developments in the coordination of production. What was produced and when, and to a large extent how, was specified by engineers, but within these bounds foremen had a large part to play in the determination of production and the cost of labour.

By the beginning of the 1970s the amount of control over production exercised by chief foremen was further reduced, superintendents, as they were now called, were overwhelmingly concerned with supervision. Their role, which admittedly may not accord with reality, is laid out the BREL management structure as follows:

> (1) Attaining production targets and schedules;
> (2) Controlling expenditure and daily authorisation by his foreman for payment of correctly completed work and the reduction of out of balance and uncontrolled work in the activities under his control;
> (3) Ensuring the work conforms with the specified standards;
> (4) Analysing deficiencies and defective work;
> (5) Ensuring the proper and most economical use of materials;
> (6) Ensuring full and proper utilisation of all tools and equipment;
> (7) Controlling timekeeping and maintaining records;
> (8) Fostering good staff relations by means of

consultation procedure and ensuring good lines of communication within his activities and with other shops and departments with whom he has working contact;
(9) Controlling subordinate foremen and day to day control of shop clerical staff where necessary.' (BREL, 1972, p. 10)

The superintendents are charged with achieving targets primarily by labour supervision, and although there is some role for improving utilisation of materials and machines, the leeway to do this is primarily by labour control. This reduced ability to determine the methods of production clearly indicates a reduction in importance for the foremen. As with manual workers, there are difficulties in interpreting this as de-skilling because the post of supervisor was, during the 1960s, made the start of the managerial career for engineers, thus BRB's annual report records:

'A pattern of management development, designed to provide the works managers for the future, has now become well established. Under the system, young engineers, after preliminary organised training, are appointed as supervisors on the shop floor and then follow a planned career ' (BRB, 1967, p. 38)

Making the post of supervisor the start of managerial progression may not have therefore been interpreted as a decline in status by those engaged in the activity, but it did at the same time further decrease promotion opportunities from the shop floor. The continuing importance of shopfloor relations in the experience of the workforce is thus not matched by a continuing importance of supervision within management. This conclusion supports Littler's thesis. He argued:

'Top management was frequently as much concerned with the attitudes, motivation and power position of the foreman. Senior management wanted to encase the foreman/worker relation in rules, and not simply exercise greater control over manual operatives.' (Littler, 1982, p. 97)

Littler here sees the question of control, in Britain at the turn of the century, as concerned with controlling all the shopfloor. The evidence presented here seems to confirm that this is the case, and possibly goes further because it indicates that supervisors were the main object of enmity among engineers at the turn of the century and that their pay, which is the best indicator of importance in wage labour organizations, has declined significantly relative to skilled workers. The source of this opposition to the foreman is an opposition to previous systems of achieving production, that is craft production with direct supervision. However, it has to be stressed that the fall of the foreman has been a long process, and his eventual extinction is, as Rose etal. (1987) point out, unlikely given the importance of supervision at the point of production under conditions of wage labour.

RECRUITMENT AND TRAINING OF WORKERS

In the next section the thesis examines the impact of recruitment and training upon the experiences of the workforce. It is shown that dependence due to the lack of power in industrial relations terms is accentuated by the practice of kinship recruitment. This combination of dependence and benevolence tends to lead to a loyalty among the workers to the railway, this loyalty can be seen as a partial deference. Newby identifies deference as relationships that involve the exercise of traditional authority (Newby, 1979, p. 416). The relationship of master and men does not seem to exist on the railway, the loyalty to the railway seems difficult to categorise if not seen as deference. Newby argues that deference is primarily shaped by the farmer as a means of legitimating his own interests and that this is based on his economic power over the farm worker, who has few options of alternative employment (Newby, 1979, p. 417). The skills of the railway worker and the ineffectiveness of industrial action, which he shares with the agricultural worker (see Newby on agriculture, 1979, p. 438) have led to a situation in which the railways have been able to create the phenomena of railway loyalty.

Newby noticed that acts of benevolence were common in the relationship between farmers and farm workers, and functioned to overcome occasions of tension between employer and worker and at the same time reinforce the superiority of the employer who granted the gift and raised the expectation that the worker owed gratitude (Newby, 1979, p 430). Within the railways the practices of welfarism, and particularly kinship recruitment during this century, have assisted in the creation of railway loyalty both because of direct gratitude but also in the creation of families that regard themselves as railway families. The situation on the railways is not a direct copy of the situation in agriculture. Railwaymen had more readily available alternative definitions of society, and the place of employer and employee within them. The major source available was the idea of craftsmanship. Craftsmanship gave skilled workers a pride in their ability to transform matter, to create. The skills and beliefs in craftsmanship were learnt during apprenticeship. Although craftsmanship fed an alternative idea of workers as the creators of wealth, it was particularistic and divisive, younger men were considered less skilful and those who did not work on the railway were beyond the pale altogether. Thus the idea of Lockwood that a traditional proletarian viewpoint, which is seen as nourished by skilled work and leading to a stress on the fraternity of the workplace which then spreads further to an identification with a wider class (Lockwood, 1975, p. 17), appears not to follow with the case of the railwaymen. The forces that create deference appear to make for a particularistic craft identity, the railwaymen are proud of their skills and those of their fellow skilled men, but the fraternity only extends to their works first, the railway second and very little further.

KINSHIP RECRUITMENT

The recruitment of personnel during the last century was either the responsibility of the foreman acting as sub-contractor or railway servant, or the works management directly. By the time of the First World War the setting on of staff was under the auspices of the works manager. To become apprenticed to a trade during the early part of this century, in the words of Len ,a coach builder who started his apprenticeship in 1915 aged 14, it was necessary 'to have someone to speak for you'. This was usually family but could include friends of the family in high places (Larkin, 1979, p. 17). In times of labour shortage this offered an advantage to those privileged in this way. The procedure was for somebody to speak to, or write to, the works manager about the potential apprentice, the boy concerned would then write a letter of application to the works manager. If acceptable a letter would be sent to the boy inviting him for an interview and medical. It was often on the latter grounds, including short sight or stature, that family connections were broken. Reversing Gidden's aphorism, kinship was not only a resource, it was also a constraint. Len became apprenticed against his better judgment in order to please his foreman grandfather. Railwaymen became railwaymen not just because of ease of access to desired employment, but also through family expectation. Writing about his experiences as an apprentice at Swindon, Eric Mountford, who came from a long line of coach builders, wrote that when he informed his family he wanted to work as a loco erector 'the whole family tried to dissuade' him and only 'reluctantly gave way'(Mountford, ud, p. 96).

Kin remained important after nationalization, Wedderburn noted that in Gorton and Faverdale 40% had followed their fathers into the works, and 80% had one relation at the works and 50% had two or more (Wedderburn, 1965, pp. 48-51). It was said that in 1982 when the two Derby works had 1000 applicants for 50 posts, preference was given to sons of railwaymen. Kinship operated to include and exclude individuals from trade apprenticeships, if you didn't have somebody 'to speak for you' you could only go labouring. Family ties not only excluded non railway families from craft employment, but at Swindon at least, the sons of engineers were given much greater opportunities than sons of manual workers. Rees speaking in 1921 stated:

> 'For many years in Swindon, if a workman had a trade, whether a coppersmith or boilermaker, his son had the choice of that trade, or perhaps one other. If the boy's father was an engineer, however, then his boy could go where he might' (Pole, 1921, p. 11).

The pattern of recruitment was standard throughout the industry and was seen as yielding benefits in terms of worker loyalty:

> 'Trade apprentices... were the sons of employees and, on entering the works assisted in keeping up the great tradition of family life in the employment of the railway company at Crewe. For it was indeed a valuable tradition, and gave a spirit and coherency to the establishment that resulted in men proud of their jobs, and giving of their best in the building of locomotives. This atmosphere even now is very much a force in railway towns such as Crewe, Wolverton, Swindon etc.' (Railway Magazine, 1944, p. 282)

Family ties should not be overstated, craftsmen employed in a railway workshop were not exclusively trained at that factory. Some had served their apprenticeships at other railway works, after the 1923 amalgamation transfers were not uncommon and when works were closed men were often transferred along with work to the remaining works, for example, when Earlestown closed, 350 men transferred to Horwich (NUR, 1984, p. 1). Works also recruited craftsmen who had served their time in other industries, at Derby it was very common for Rolls-Royce men to be employed by the railway and vice-versa.

APPRENTICESHIP

The core of the apprentice training system remained the same until 1967 when the railways adopted the recommendations of the Engineering Industry Training Board's (EITB) modular system approach. The EITB is a government funded agency charged with standardising and improving the training of engineers throughout the country. Up until the railways accepted EITB standards the apprentice learnt most of his trade working for long periods in one gang and under the jurisdiction of the chargehand. The modular system approach, along with increased desk learning, laid down standard work tasks, and sequenced the occurrence of these tasks, that all apprentices had to experience and this resulted in many more moves between gangs and jobs by railway apprentices than had been the case. This does not mean that there had not been changes in apprentice training prior to this period, of most significance being the declining period of apprenticeship linked to a rising school age and falling age of majority.

The two major changes in apprentice training both occurred at Derby locomotive works, these were:

1.The introduction of the progressive system of apprentice training in 1932 (Larkin, 1979, p. 49; Venables, 1959, p. 55).

2.The opening of a works training school in 1947.

The nature of the relationship between craftsman and apprentice is discussed below in relation to apprentice training. It is shown that this relationship is very important in the transmission of the notion of craftsmanship. It is also shown that this relation was not disrupted greatly by the progressive system of apprentice training, as this along with other changes in the labour process, was directed at reducing the power of supervisors.

THE PROGRESSIVE SYSTEM OF APPRENTICE TRAINING

Larkin, who was responsible for the development of the progressive system of training 'believed the system to be unique'(Larkin, 1934, p. 219). The development of the system was in line with development elsewhere, and he noted at the time of its introduction that 'it is only during recent years that attention has been paid by various authorities to the systematic training of apprentices' (Larkin, 1934, p. 219). The attention given to the training of apprentices is a reflection of the general pattern of development of the labour process, the attention given to one area raises the relative importance of another.

I interviewed eight time-served men from Derby locomotive works and one from the carriage side, of the locomotive men four spent the majority of their time prior to the Larkin changes, thus giving a reasonable before and after analysis of the changes in the system. These interviews are supplemented by four autobiographical accounts of apprenticeships, including Larkin's own (Mountford, ud; Larkin, 1979; Perryman, 1972; Anon, Railway Magazine, 1944-5).

Larkin perceived the modification of apprenticeship as important because it enabled full value to be obtained from an apprentice:

> 'The apprentice is an integral part of the organisation and must accordingly give the required output in addition to acquiring his trade.' (Larkin, 1934, p. 222)

The complaint against the existing system was also related to the fact that it was felt that the foremen dominated training and transfers of apprentices (Larkin, 1934, p. 220). The problem with this was felt to be that the good apprentices were 'often retained for some time ' (Larkin, 1934, p. 219), and on account of this were not receiving a full training. It was also argued that this lack of training was being exacerbated, 'the apprentice of today is not nearly so well qualified as his predecessor ... owing to mechanization and specialization' (Larkin, 1934, p. 219). Worst of all, in Larkin's view, management did not know how apprentices were doing as there was no record of apprentice training (Larkin, 1934, p. 220).

The progressive system applied techniques developed for the control of production, the movement of apprentices around the work echoing the movement of material around the works (chapter nine), and it was argued that this enabled both production and training to be achieved. Larkin termed his system progressive because of 'the apprentice progressing from section to section' (Larkin, 1934, p. 222). The work in different shops had, with the advent of mass production techniques, been allocated to different sections, or gangs, of men who specialised in this one task, day in day out. For a lad to learn all the tasks commonly considered to be part of the trade, he would habe to have experience in all of these dfiffeent sections. Larkin's system merely reorganised the existing system according to a predictable managerial controlled system. It needed only two pieces of information:

1. What are the sections which it is considered necessary for a lad to have experience of in order to be considered a tradesman?

2. How many apprentices are needed on each section?

The number of apprentices needed on a section was divided by the number of apprentices needed in a shop to give the proportion of apprentices employed. The proportions so calculated became the proportion of the total time spent in the shop that the apprentice spent on each section within the shop. Larkin termed this discovering the 'definite relationship between the time spent and the number employed on the section' (Larkin, 1934, p. 222).

The timings of transfers from section to section were drawn up on a schedule board and were initiated by the foreman (Larkin, 1934, p. 229). There was a master schedule of shop transfers which were initiated by the staff office (Larkin, 1934, p. 227). where this was appropriate. The progressive system was deemed to give a full training by ensuring all the elements of the trade were experienced (Larkin, 1934, p. 219). It also gave management a full record of apprentice performance, for deciding if the worker was 'worthy of retention as a craftsman' (Larkin, 1934, p. 232). The records were 'based on a standard code to facilitate comparisons' (Larkin, 1979, p. 49), giving a standardised procedure for assessing performance independent of the personal assessment of supervisors.

The system was extended throughout the LMS and after nationalization it was extended to all apprentices (Parker, 1956).[4]

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[4] With 11,000 engineering apprentices BR was the largest single employer in the country in the 1950s (Parker, 1956, p. 502; Larkin, 1979, p. 51).

IMPACT OF THE PROGRESSIVE SYSTEM

Around the same time as the creation of the progressive training system, they abolished the 'break of service' which was the period when, after completion of apprenticeship at 21, 90% of apprentices were laid off and expected to gain experience elsewhere for a number of years before rejoining railway service (Perryman, 1972, p. 20). Unfortunately by 1930 this often meant a number of years' experience on the dole. It is unclear if the break of service's disappearance was due to the progressive system, or whether the abolition of break of service was due to recruitment difficulties. At Derby, Rolls-Royce were taking on apprentices at break of service 'who didn't come back', Henry Royce was an ex-railway shopman himself. It is highly probable that Rolls-Royce plants were built at Derby and Crewe for poaching staff coming out of rail apprenticeships and it appears common practice for engineering firms to set up in railway towns, for example, Supermarine at Eastleigh or Morris at Swindon.

The progressive system did not seem to have any great effect on the time spent in each gang. The erectors trained prior and after the change, all estimated that they were shifted from fitter to fitter every three to six months, and Frank, who served an erector's apprenticeship remembers reports that went 'to the head office about your ability, your conduct and your attendance and timekeeping' existing in the 1920s, so the reporting system was not as novel as Larkin indicates (Larkin, 1934). The progressive system did not have any impact on the manner in which the trade was learnt. Apprenticeship was learning to use the tools of the trade. A lot of this process was solely by watching, but this had benefits, according to Bob, another fitter:

> 'There was good workmen and bad workmen but there's no better education than that, you see a man keep clacking his hand and then three months' time you're with a man who don't, you think well 'there's a right and wrong way', you quickly learn'

The education was also by using the tools of the trade, a fitter would be expected to have over one hundred different tools even though he was only issued with a hammer and chisel, the rest he usually made himself. The first thing taught to an apprentice fitter was the use of a hammer, as Bob said, 'They'd soon show you how to use a hammer, it was in his own interest'. Indeed it appears that apprentices used to be deliberately allocated to complicated hammering jobs almost straight away, resulting in hand injuries and improved aim (Perryman, 1972, p. 20; Mountford, ud, p. 98). The role of educators was accepted by the craftsmen as part of their identity, for example Frank states the enthusiasm with which his questioning was met:

> 'I worked with a man who was highly skilled and told me everything he knew, he was particularly pleased when I asked questions'

Although there were also strong material incentives to the company and the workers for using craftsmen training for the craftsmen, the apprentice was free labour, as Nat remembers:

> 'If they didn't get one they went barmy 'I'm not working without me apprentice', because he was their labourer. When you got to know the job, it was quite unofficial, he sat back and you did it.

For the company, the craftsmen were free supervision, as

Reg explained, this was achieved by making the apprentice part of the piecework gang:

> 'He kept you at it, if you were one who went round talking and wasting your time, well he was losing money'

THE DERBY TRAINING SCHOOL

The opening of the Derby Loco training school in 1947 was a further development toward managerial control over the apprenticeship process. Venables identifies it as a direct outcome of the progressive training scheme (Venables, 1959, p. 150). This school was to replace the first year usually spent as an office lad with a year of formal training in a school environment. The apprenticeship at this point was five years long, as opposed to the earlier seven and six year periods. The Derby school system was extended by the BTC, the courses were, according to one spokesman, 'considered by those who have studied them to be almost ideal' (Allen, 1950, p. 59; see also Watkins, 1956, p. 14). [5]

As with the progressive system, the schools aimed to satisfy training and production needs. The schools selected the numbers of apprentices for each craft required to fulfil the planned needs of the works from a list given to the school principal (Venables, 1959, p. 151; Parker, 1956, p. 504). The training requirement was seen to be improved by deciding the allocation of apprentices after a probationary period of four or five months (Parker, 1956, p. 504; Venables, 1959, p. 150; Gilbert, 1952, p. 61; Metal Working

[5] Pursuant to this policy, Derby carriage works had a school by 1951 (Radford, 1978, p. 44), Wolverton by 1954 (Railwayman's Yearbook, 1955, p. 150) and at Crewe a school for over 200 students was opened in 1955 (Venables, 1959, p. 150) and was possibly the largest such school in the world at that time (Railwayman's Yearbook, 1956, p. 33) and Horwich's school opened in 1956.(Watkins, 1956, p. 14) By the end of 1955 schools had also been authorised at Earlestown and St Pancras (for Bow)(Railwayman's Yearbook, 1955, p. 41), By the end of the works plan, there were 14 works left, nine with training schools (Metal Working Production 1966, p. 62).

Production, 1962),[6] after which the pupil would be taught a trade, to which he was supposed to be suited, on the basis of 60% craft skills and 40% theory (Larkin, 1979, p. 51). The engineers saw the growth of training as a reflection of the increasingly technical nature of industry throughout the British economy (Parker, 1956). It was viewed as particularly justified on the railways because of the Modernisation Plan (Venables, 1959, p. 158). The training schools were needed because the new forms of traction demanded new skills: 'the methods of training so satisfactory such a short time ago, do not lend themselves to modern techniques of production ' (Osbourne, 1961, p. 7).

This development toward off the job training seems to agree with Charles More's analysis. He argues that there was, in the early 20th century, a move toward skills based on 'knowledge which could only be taught formally or informally' (More, 1982, p. 120). The development of formalised education as a purely reactive process to changes in skills 'needed' must be questioned, a change in the labour process towards skills that depended upon formalised and managerially determined education, cannot be ruled out.

[6] This consists of a number of periods carrying out particular tasks eg:4 weeks fitting, 4 weeks turning, 4 weeks electrical, 2 weeks painting, 2 weeks welding, 2 weeks wood working, and 2 weeks sheet metal working (Metal Working Production, 1966, p. 62)

WORKERS SELF PERCEPTION

The recruitment and training shaped skilled workers' self image, in particular they saw themselves as both skilled craftsmen and railway men. Nat, a chargehand erector, speaks for most shopmen:

> 'Most railwaymen were railwaymen, the railway was sacred, it was your railway. Whilst you got what you could out of it, which every working man should do, there is a point where you didn't go beyond. You was just as keen to see the railways succeed and you do when you retire, I could cry when I look at what's happened. We were never militant, we put up with lots of things that would put others on strike.'

The railways' welfarism appears to pay dividends in terms of worker identification. The paternalistic policies of the railway companies, particularly kinship recruitment, helped to create a loyalty among the workforce which provided fertile ground given its lack of industrial power to influence managerial decision. This loyalty in turn assured that things stayed that way. A major element of the identity of the skilled men was the pride they had in their abilities, which were part of them, as Bill, a boiler maker who had retired 15 years previously said ,'I'm still a craftsmen'. Both Nat and Davy believed that purveyors of their craft of loco erecting 'are born not made'. Braverman may have overstated the extent of craftsmanship, but it is clear that the skilled men saw craftsmanship as he did. Frank, a loco erector:

> 'I used to like to get my teeth into a job and use the file and the feelers and the mike and all the rest of it to bring perfection to that particular job and I felt good once I'd done it and it was passed by inspection.'

The pride in the skilled use of simple tools and craft knowledge is also highlighted in the autobiographical accounts (Perryman, 1972, p. 16; Railway Magazine, 1944). The pride they have in being craftsman has a dual aspect, it is a celebration of their ability to shape material reality with their skill, but it also has an element of arrogance, pointing to those who don't have their skill. In the case of Derby Locomotive works this is directed at two major sources, Rolls-Royce workers and more recent apprentices and workers within the Locomotive works.

Two of the interviewees had direct experience of working at Rolls-Royce, and others had experience of working with Royce's workers who had come to the railway, and the skills of Royce's workers are viewed with complete contempt. This is probably unfair but is the almost inevitable outcome of the dual identity of these men as craftsmen and railwaymen. It appears that the conception of skill often involves such antagonisms. During modernisation, contract fitters from the engine manufacturers Sulzer worked at the locomotive works, and used to call the Derby men 'cowboy fitters' because they were green when it came to diesels. Bob, an erector at the time, recalls 'you could cut the atmosphere with a knife. They were shopping us to the board, anything went wrong with their engines, it was Derby fitters.' After the locomotive men had learnt diesel fitting, the ability to learn a new trade being a source of great pride in that they are convinced others could not achieve such a feat, in Bob's words they 'used to give it these Sulzer blokes then, 'how would you bloody go on if they set you on a steamer.''

It is widely considered that present day loco fitters are incapable of using tools, in Bob's words:

> 'Half them that come out of the training school, they hold the hammer shaft about half way up, they're pushing at it

not slinging it.'

The arrogance of craft generated antagonism within the shop, Harry, a labourer, notes 'Craftsmen always used to let you know that they were craftsmen and that you were inferior to them'. Stan, a semi-skilled painter, related a row caused when a semi-skilled man was promoted to chargehand of the maintenance painting gang including time served painters, the tradesmen objected and the craft dominated works committee decided a semi-skilled man couldn't tell a tradesman what to do.

The antagonisms caused by pride existed across all shades, even within crafts, among boilermakers the 10% who were chosen to be platers as opposed to the 90% trained up as rivetters 'they always treated themselves as being the cream', but argues Bill 'we always contended that our job was as skilful as theirs'. A former pupil at Crewe noted the link made by workers between their status and the work they were doing 'one's feeling of importance grew in proportion to the size of locomotive with which one was associated' (Railway Magazine, 1944, p. 284 and 1945, p. 13). Davy, to this day, believes that anybody working as an erector on construction, as he was, 'had to be very efficient'.

These antagonisms had advantages for management Bill, relates his experience of being shifted on to diesel shunter work, before the modernisation plan, and getting 1 a week less because the rates were so bad, management had encouraged the men to think that they were special:

> 'these blokes because they were on this new technique were as proud as peacocks. They [the managers] bluffed 'em and kidded'em, 'oh you're the blue eyed boys', and on the charge sheets there was even prices out in farthings.'

The recruitment and training methods had produced a workforce proud of being part of the railway and proud of its skills. Harloe's (1975) characterisation of the Swindon workforce as being a combination of traditional proletarian and deferential would seem to be in line with this analysis.

THE CHARGEHAND

In this section I try and indicate how the workers experience of work was chiefly experience through the gang system and price negotiations, a system to which the chargehand was central. The main line of cleavage on the shop floor is between the chargehnad on the one hand and the foreman on the other.

Workers' dealings with foremen were few, as Frank said if a bay foreman wanted to meet his targets 'he wouldn't converse with the men. He would go to his chargehand'. In the words of Nat who worked as a chargehand, 'We weren't managers'. This solidarity with the men was to some extent reciprocated, in Franks view:

> 'On the whole the chargemen were not a bad lot. You got the occasional one who was a little bit more on the management side, he was looking perhaps for elevation'

The chargehands' identification with the men was due to the gang system of working, his position and his wages depended on the gang's output. This moved chargemen toward an identification with workmen in two ways, firstly, because of their dependency on the gang, secondly, because the chargemen bore much of the brunt of the shop supervisory system. Davy remembers his experience:

> 'some foremen used to frighten some of the chargehands to death. I never came into that category because all these foremen that were over me when I ran diesels were all working for me as boys. I knew their capabilities and used to tell them so'

The chargehands were placed in a position of having to defend their gangs' position in two ways, by manipulating the payment system, and ensuring no undue work demands. Frank was demoted from the position of chargehand over the latter issue:

> 'I was relieved of that particular job because I came against a foreman who demanded a particular bogie job that hadn't even started, and he wanted it the following day, and I said he couldn't have it because it was not even on the schedule.'

Being at the sharp end of the shop supervisory system helped push chargehands to identification with the men, but this would be the position of all front line management. The pressure from foremen on chargehands had this effect because it reinforced the chargehand/worker identification produced by the gang payment system. The chargehand was responsible for the flow of documentation that confirmed that a job had been done and confirmed that payment could be made. Most chargehands used to keep a float of job complete tickets, enabling the bonus figure to be manipulated by preventing it appearing too high and for maintaining bonus levels when on bad paying jobs. The ability to manipulate the documents was seen, according to Davy, as a criteria for assessing a chargehand:

> 'You used to say a chargeman was a poor chargeman if he hadn't got a week's wages in his drawer.'

Chargehands, on other occasions, could so organise the work to pay high bonuses, Nat remembers when he was chargehand of labouring and maintenance staff how it was possible to create work for overtime on 'the easy four' (Saturday morning). Mountford noticed the ability of chargehands to make good bonuses by using good organization:

> 'I was put on Jack Maisey's gang, the chargeman who covered the first few pits from the mainline. This was a plum job; Jack's fame at being able to earn piecework money well in advance of other chargemen was well known. Unlike the other chargemen who usually put a fitter, a mate and apprentice on one engine, Jack believed in getting components to the various shops as soon as possible after

> the engine came into the shop. Hence directly one was ready over the pit Jack put a number of his gang on stripping it down, and the speed this was done was unbelievable. Within 24 hours the engine was picked clean as a chicken, the boiler, wheels, motion, axle boxes etc. being away into the respective repair shops, leaving the men to get back to their 'own' engines. By this method, Jack's balance, as the fortnightly piecework payments were known, averaged about 70% compared with about half this on other gangs, for whom 40 per cent was considered good.' (Mountford, ud, p. 103)

The chargehand thus could manipulate the piecework system by firstly ensuring that prices were established for tasks on the basis of long winded ways, secondly, by manipulating the flow of documentation, and thirdly co-ordinating workers to yield benefits from a system intended to price the work of individual fitters. Bonuses could be further enhanced by allocating particular individual workers to individual jobs, eg: slow workers to bad paying jobs.

The chargehand was not always the workers' friend and some were disliked, because some took a managerial line and would attempt to exercise disciplinary powers, eg: reporting people to foremen, and allocating people to bad jobs, to ensure low cost production. Part of this tension was because chargehand was one of the first steps to foreman, and sometimes promotion direct to foreman was possible, and in later years to staff jobs: eg: time and motion men, planning engineers.

Another source of tension was caused by chargehands who were craftsmen exercising authority over non-tradesman. The pride manifested in craftsmen often resulted in a sense of self righteousness in dealing with non-tradesmen. Nat describes his method of dealing with labourers, which was totally different to his methods when he was a trade chargehand:

> 'I got them to think that I'd got eyes in the back of my head. I instilled it into them, you might not see me but I know what you're doing, I've only got to walk down and know what you should have done and what you have done'. I used to walk round two or three times a day and look, sometimes I didn't even know what I was looking at, but made out as I did. More often than not I didn't know where they started and where they finished.'

It appears that there is a greater tendency to identify with management where craft identity is removed. Nat's change in style may also reflect the fact that on the 'shop gang' of labourers and men, they were paid the shop average bonuses and he was not responsible for securing the gang's bonus in any way. The payment of the shop average is universal under the workstudy system.

The position of chargehand is thus contradictory with forces that do pull towards an identification with management, however, on the whole the chargeman identifies with the gang because it is the work they do that pays his bonuses.

In the railway workshops the workers and chargehands experienced work as an attempt to gain the best wage effort bargain out of the piecework system, wider questions of the organization of work were of significantly less importance. Following Burawoy it would seem that the existence of choices within narrower limits, these limits focused workers to struggle over the choices, the best ways of making out, rather than contesting the narrower limits (Burawoy, 1979, p. 94). The concern with getting the best wage/effort bargain was also of prime concern when piecework was finally abolished during the late 1960s and early 1970s to be replaced with premium bonus system. Indeed the transition to workstudy was achieved by management and accepted by workers by playing the rules of negotiating over the price of work.

WORKSTUDY

The workers' approach to workstudy varied, usually according to the perceived effects on money in the pocket. Reg, the smiths' steward, welcomed it. After the signing of the Pay and Efficiency Agreement of 1969 that introduced workstudy Reg went to see the works manager and asked, and got, a commitment that the smithy would be the first on the system. When timings started in two other shops Reg complained. The bemused works manager asked Reg the reason for his support for workstudy, and he replied:

> 'I think we shall get more money, we had a foreman who I wouldn't say kept us right low but he fixed your prices with the rate-fixer where you couldn't get excessive balance. In other words he did his job right by the company.'

Reg argued that his assessment of workstudy was correct and it led to increased wages. This was seen as stemming from the lack of knowledge of workstudy men and the workers' ability to learn quick routes to rapid production. Reg stated:

> 'you got paid for everything you was doing. If you got a new job, nobody could come along, other than your foreman , who had any idea how to start it. If you earnt above standard you kept in hand. With a new job if you found out a quicker way yourself after you'd settled the price, then that's to your advantage'

This ability to manipulate the timings is confirmed by Harry's observations:

> 'The work study people, most of them, did not understand the particular job they were studying. We used to laugh about that many a time. I could never understand, not to this day, why it ever came about, whether it was to find people a job, because in most cases in our shop we were always better off financially than we were before. They had crafty ways of manoeuvring, the tradesmen and semi-skilled.'

This ability to get good money, and the consequent assessment of workstudy, was contingent upon the nature of the shop, and the ability of the foreman or union representatives to fight for sensible times. Stan, a painter, argues that their foreman let the workstudy staff give ridiculous times:

> 'You were given a price for what you'd got to do by people who, well I wouldn't say they didn't know what they were doing, but they weren't painters. Most of this time and motion is done by people who are not painters, they're fitters and all that. What they were trying to do was make out that they knew all about the painting and how long it should take and what it shouldn't do, but they had no idea about doing the job. The shop foreman at that time wasn't powerful enough to say what he should have done.'

The erecting shop was the last shop to accept workstudy but even here there was a divergence of opinion about its uses. Bob, a steward at the time 'was dead against it', he argued that it was operated as a means of increasing the amount of effort relative to the wage. This increased exploitation was achieved by the process of measuring a job and then speeding it up:

> 'When they first went on it I can always remember there was one particular bogie job. They kidded the blokes to go all out all the time. Well nobody could ever achieve a standard. After that they fiddled it to get a standard, it was an embarrassment to management really. It did teach people a lesson. After that you'd go at a reasonable steady pace, to keep a little bit up your sleeve so you know you could get a standard. There's no good going working like a maniac and thinking they'd book it all down, but they cut so much of it , said you weren't working like. Say you were chipping with a chipper, when it wasn't exactly chipping, they said you wasn't working. You have to stop and reposition, a man's not a machine, his hands are bound to move, you have to stop and start again, it's human nature but not according to them, once you stop you weren't working, they'd take them minutes out.'

Sam, works committee representative for the erecting shop, welcomed it and argued that the unions had managed to negotiate its adoption as an aid to worker unity, under the piecework system he felt:

> 'there was perhaps ten or twelve groups in the erecting

shop' the amount that they used to draw on different groups used to vary and used to cause quite a bit of concern, blokes would say 'he's on a cushy number and that'. The shops committee decided that we would have one bonus system in the erecting shop, no matter whether he was skilled, semi-skilled, chargehand, labourer. It wiped that anomaly and a little bit of jealousy completely out of the shop. And I think it was one of the best things that ever happened, where everybody knows at the end of the week that if you'd put the same hours as the bloke next to you you'd get the same bonus.'

Thus workstudy as applied was seen as advantageous because it improved the relationship between effort and reward, and prevented the conflicts that arose from the iniquities of piecework.

The reaction to workstudy, both before and after its implementation, was related to the effect that it had upon the size of the wage packet, individually and collectively.

DISPUTES AT THE LOCAL LEVEL

The workshops from the First World War had high levels of unionisation, but this was not reflected in high levels of industrial unrest. The gains in terms of grievance and consultation procedure, granted largely due to the efforts of the operating side, probably helped ensure the high levels of unionisation. No union representative on a shop committee would represent non-union members, indeed it seems that non-union men were 'sent to Coventry' by union members.

At Derby Locomotive works during the period from 1916 to 1984 only the following local strikes were remembered, a fortnight strike in the boiler shop, a one week strike in the erecting shop and a one day strike in the stores, although the men interviewed spoke of numerous sit-downs and short stoppages usually revolving around piece rate earnings or the behaviour of foremen. But, as one works committee man noted, 'the men never lost any money, they made it up later', that is, it just meant working a bit harder to make up the piecework bonus. The few disputes that did occur reflected the process by which labour power was transformed and conformed to the pattern of acceptance to the rules of the wage/effort bargain which meant an acceptance of management's right to decide the number and coordination of tasks. Disputes intended to avert the closure of workshops point to a questioning of this prerogative.

CLOSURE

The closures of the 1980s were viewed differently to those of the 1960s. In 1962 only 15% of men at Faverdale and Gorton saw management as responsible for closure (Wedderburn, 1965, p. 65), but by the 1980s it was felt management had no commitment to state industry:

> 'Whilst the workforce in the Horwich works have bent over backwards to cooperate with management over the last few years, management have proved incapable and disinterested in the future of BR as a public industry. Senior BR management have been deliberately trying to run the plant down. We have not had a production manager, for example, since January 1982. The workforce in the Horwich plant have, by contrast, displayed a commitment, often in hazardous working conditions, which few in management have.' (Horwich Joint Action Committee, 1982, p. 6)

The local struggles against closure amounted to attempts to affect public opinion (McIlroy, 1984, pp. 113-4), a tactic that met with little success in the climate of the 1980s. These campaigns reveal an approach to costs that shows a similarity with an approach to costs based on the utilization of physical resources. Cost is approached in two ways:

1.Costs are seen as wider than those accruing to a single entity.

2. The abandonment of skills and machinery was seen as relevant and not as sunk costs not entering into calculations.

A number of social audits where carried out by the local unions with the support of local politicians. Social audits determine costs to the community as a whole rather than the individual accounting entity, the firm (Coates, 1981, chapter 6; Coates and Topham, 1974).

Social audits of the cost of closure to the community in Glasgow found this to be 8.3 million (Glasgow evening times, 9-10-85), but over what time period, it is unclear. At Horwich the cost was calculated at 4.8 million pounds per annum (Bolton, 1982, p. 4). Glasgow council wished to take the community intervention further, and develop a feasibility plan for turning the works into a general engineering plant, but BREL's response was 'we have no intention of opening the books' (Glasgow Evening Times, 9-10-85, Glasgow Herald, 9-10-85).

The Shildon social audit listed the types of costs incurred outside of BREL:

1.Costs to industry 'destruction of a relatively efficient manufacturing unit increases the average cost in that industry' (Foster, c1983, p. 16).

2.Extraordinary costs eg:redundancy payments and plant written off.

3.Central government costs eg: benefits paid and lost revenue.

4.Local government costs eg: lost rates and costs of creating new jobs (Foster, c1983, p. 20).

5. Social costs eg: effects on community suffering which later have a knock on effect on the NHS, police, courts etc (Foster, c1983, p. 23).

Ignoring the impact of social costs and costs to industry, short term costs were calculated at 21.2 million pounds and long term costs at £9 million per annum. Had a recovery package been initiated like for steel closures, it was calculated that this would have cost £90 million (Foster, c1983, pp. 21-2).

The Shildon study is not only a social audit, but indicates how unfair accounting had made Shildon 'the victim of unfair competition' (Foster, c1983, p. 16). Many wagons run on the railway are owned by private fleet owners who arrange transport through BR. Private wagon builders, unlike BREL, can lease out fleets of wagons to private rail users, which reduces the costs of a private fleet, guarantees the private builders repair work and enables the private builders to claim capital allowances against tax. Private wagon builders, unlike BREL, were eligible for government subsidies. Foster concludes 'under these conditions even the most inefficient manufacturer could compete with Shildon' (Foster, c1983, p. 14).

The unions' perspective of the decision to close works has to be understood according to a wider criteria of costs, not just the singular accounting entity of the company. This is a view that accords with the engineers' approach to internal company operation, although one doubts if engineers are particular advocates of social audits.

A further similarity between the workers' and engineers' positions on costs is on the issue of utilization, for example, the NUR view on Horwich was:

> 'the cut backs being implemented bring a decrease in efficiency and a lowering of standards which is nothing short of an act of industrial vandalism. We believe in view of the money spent in setting up the coach layouts at Horwich, they should be allowed to repay the money invested. Numerous people in managerial positions have stated the layout to be the best in B.R.E.Ltd. It would be an act of mis-management not to utilise these facilities to the full.' (NUR, 1984, p. 2)

This stress on the importance of utilization is a long way from the accounting maxim 'don't throw good money after bad' which BREL adopted. It does share a certain coincidence with an earlier engineering perspective on the utilization of resources. It is doubtful that earlier engineers would agree to the unions' extension of the principle of utilization to human beings:

> 'the 'Financial Times' (24.6.80) extolled the 'versatile skill base of BREL which allows them to produce a wide range of products, from rolling stock to oilfield patrol boats and litter bins. It is exactly this 'skill base' that BR and the Government are now out to destroy.' (Horwich Joint Action Committee, 1982, p. 4)

The workers fighting closure appealed to a rationality of a wider social and material reality beyond the accounting entity, a perspective that was similar to a number of concerns of engineers. This concern of workers is something that emerges with closure, but it may be linked to an origin in productive labour shared with engineering.

SUMMARY

This chapter has concentrated upon developments on the shopfloor particularly the relationship between workers and supervisors. It has been shown that although certain things have changed much has remained the same and that those changes that have occurred, for example the decline in the status of foremen, have been of a trend-like nature. This degree of constancy casts doubt on the belief that the nationalization of industry alters its capitalist character. As much of the criticism legitimately levelled at Braverman has been at his neglect of workers' struggle, any present day account cannot avoid discussing this without losing credibility. It is clear from the study of the workshops that Braverman's oversight is to some extent understandable. In the workshops, although mass unionism has existed for most of this century, there have been few national or local disputes Most union activity was concerned with the operation of various negotiating and consultation procedures. It has been shown that Baldamus's theory of workers' behaviour is correct. Worker's experience of work is shaped by the impact of direct supervision and negotiations around payment by results and the socialization into railway work.

The lack of union activity appears to have several explanations. It would appear that Burawoy's characterisation of workplace relations having the quality of a game of making out appears to apply to the railway workshops. There are differences, of course, in the workshops, the gang and the chargehand take on more importance in the achievement of a satisfactory wage effort bargain. Burawoy argues that the pursuit of making out tends to lead to acceptance of the rules of capitalist production and it was noticed within the workshops that when workstudy was introduced in the early 1970s its acceptance was negotiated according to the same criteria of getting the best return for effort, rather than the implications of its adoption examined.

The quiescence of workers is not solely explicable by consent to existing work relations, it is also a product of powerlessness and socialization into work. The shut down of the works could not stop the trains, and therefore the unions objectively had very little power. Newby sees powerlessness as one of the necessary features which would encourage a deferential relationship to emerge, and it was noticed that other features of deference could be detected, particularly the welfarist practice of kinship recruitment which created gratitude and railway families. The outcome appeared to be a deferential loyalty to the railway tempered by the pride of craftsmanship. The result of this was fraternal relations with fellow skilled workers, enhanced no doubt by gang working, but a collectivist view restricted to particular works and not extending beyond the railway.

The other side of the shopfloor and negotiations around wage and effort was that of direct shopfloor supervision. It was shown that, although shopfloor management is central to workers' interpretation of work, and crucial to production, it has become significantly reduced in significance during this century. The foreman's role has been reduced from the man who 'hires and fires' and plans to one of supervising labour. This had been achieved partially by the proliferation of other supervisory roles such as rate fixers and latterly time and motion men. This decline in the functions allocated to supervisors has been reflected in declining remuneration. It is also clear that the reduction of the power of the foreman has not been wholly coincidental, the engineers of the end of the First World War saw the problems of production essentially as produced by the foreman system. It was shown that Fox's conception of trust was very important in understanding the industrial relations problems at the turn of the century. The reason the engineers came to such a view is part of the subject of chapter six, and how they managed to replace the foreman system with a control over coordination which engineers themselves exercised is the subject of chapter seven.

CHAPTER SIX

THE ENGINEERS AND ACCOUNTANCY

INTRODUCTION

In the last chapter it was shown that engineers, who constituted the management of railway workshops, believed that the means of increasing productivity by payment by results systems, which was stimulated by the need to match the growth in fixed costs, was made virtually impossible by the existence of foreman dominated production methods. In this chapter, I wish to show that the engineers' views were not only a response aimed at combating rising fixed costs by searching to boost productivity, but also a response to the growing threat of accountancy to their managerial dominance. Rose argues that with the withdrawal of entrepreneurs into the board room, engineers and accountants were the only significant professional groups within industry (Rose, 1988, p. 51), indeed these two groupings are still seen by contemporary observers as offering the most important means of managerial control (Storey, 1983, p. 147).

This chapter shows that this rivalry was not necessarily friendly, and describes the engineers' opposition to accountancy at the end of the First World War. The advent of accountancy is shown to be a stimulant to the search for methods of confronting the rising fixed costs, in ways other than cost control. The engineers' opposition to accounting is shown to continue well into the period of nationalization and has the common theme that accounting cannot adequately map the nature of physical production. It is also shown that after Beeching and as a result of his policies, a change occurred and the engineers came to see accounting and financial criteria as the prime considerations. The accountants' view of engineers is shown to be the reverse, beginning at the turn of the century with a view that accounting was secondary to technical criteria, and ending with a view which held engineers in contempt.

The decline in the position of the foreman was a result of increasing engineering control over the coordination of production, a process charted in the next chapter. This manifested itself in mass production techniques of production which required the coordination of several shops into one large production organization. It is shown that although technical criteria dominated for much of the workshops' history, costing methods were used as a complement in the search for efficiency. It is shown that the accounting used during the interwar period was aimed at monitoring the foreman and aimed further to enhance engineers' control over the shopfloor and to supplement those changes in technical coordination. As the chapter goes on to show, after Beeching, that is under the nationalized regime, costing was further extended and not seen as a means of enhancing technical decisions but was seen as the prime means of ensuring efficiency throughout the workshops. The coordination of the workshops, instead of being dominated by the technical reproduction of the labour process, was seen as being achieved as a balance sheet exercise, and, as is discussed in the conclusion to this chapter, this form of coordination appears, to use a very loaded word, less efficient.

The state sponsored use of accountancy, the capitalist language par excellence, would appear to further undermine the arguments of those who see nationalization as offering any model of socialist development. It is the increased importance of accountancy in the eyes of senior management that led to the change in the perspective of the engineers from a stress on technique to a belief in the leading role of finance, whilst retaining elements of a distrust of costing which came from their training in technical questions. Thus, while the engineers never came to accept totally the claims of accounting, they certainly accepted its hegemonic position, as being the rationale of production. This change in perspective is shown to change the aims of the railway away from a concern for reducing the cost of railway operation and toward a concern solely related to the lowest cost within the workshops, what in accounting parlance would be termed the accounting entity.

This theme of concern for costs within particular boundaries is taken further in the conclusion which casts doubt upon the claims made for the notion of cost centres, that is , individual shops and processes in which management is charged with monitoring their own costs, as aids to efficiency internal to the workshops. Prime concern here is that the lack of concern shown toward the costs passed onto the operating side of the railway may also occur between cost centres within the workshops. It is acknowledged that the monitoring of processes enables some form of coordination between processes to occur, for example, attempting to improve the high cost activities identified by the costing system, but that this may not adequately reflect the physical activities and the need for proper coordination between them.

Therefore this chapter charts the engineers' attempts to meet the challenge of accountancy as a means of reproducing the labour process by adapting it to their own ideas for improving the labour process, which are discussed in greater detail in the next chapter, it is shown that costing was used to enhance the engineers' policies by undermining the position of the foreman. It is shown that the costing of shop activity utilised by engineers, combined with other accounting methods became, during nationalization, of greater significance to senior management, and that, as a consequence, engineers began to see the reproduction of the workshops as an accounting entity as their primary task, whilst retaining certain reservations about ignoring the physical nature of production.

THE ENGINEER'S VIEW OF ACCOUNTING

The growth of fixed costs of production at the turn of the century gave rise to management accountancy. Engineers objected to it, and to accountants, as a threat to their superiority within workshop management. Costing was accepted by engineers as important for a number of reasons, but it was applied on the engineers' terms. The dominance of engineering rather than accounting within management is the reverse of the normal in British industry (Littler, 1982, p. 178; Glover and Kelly, 1987; Armstrong, 1987), and was something that continued until the appointment of Dr. Beeching.

The growth in the importance of fixed costs at the turn of the century gave rise to management accountancy. Methods of costing were seen by engineers as important, firstly, because they addressed the issue of high costs, and secondly, because they could be used to undermine the power of foremen. A converse attitude was taken to accountants who were perceived as threats to the engineers' managerial supremacy. Howell was forthright on the subject:

> 'I think the idea of accountants (they came into prominence during the War) is that the works exist for the benefit of the accountant. I do not know if you have found it so, but I think it is in some places. It should not be. The accountant should be controlled by the engineer; the engineer should tell the accountant what he requires and it should be up to the accountant to supply it'(Turner, 1921, p. 153).

Howell was clear about the order of importance of engineers and accountants, a view emphasised by Britten who linked the need for engineers to control costing and shop systems, the latter being the foreman's prerogative:

> 'There has been a good deal said this afternoon about the

accountant's department and costing and the accountant being viewed with some suspicion by the engineer. I do not know what the practice is in the various railway works, but I think that anybody who leaves the costing and estimating of engineering work, as is done in some places, to an accountant is bound to be disappointed. I think that there should be in the accounts office and the costing department men of engineering and shop experience, and these men should also be continually about the shops, noting any developments that are taking place amongst the machinery, and exploring every avenue that development opens up, so that they will then have a much better chance of getting at a fair estimate'. (Turner, 1921, p. 162)

The objections raised against costing were several, Turner argued costing was too expensive, because management accountants attempted to impose a system that suited accounting and not production:

'The unfortunate tendency of modern costing systems seems rather towards too much concentration - to a desire on the part of the costing man to get a system which is so perfect from an accounting point of view that the cost of running the system is more than the economy derived from it. It should be possible to build up quite efficient costing returns from information obtained from shop clerical staff, if it be insisted that all charges must be shown under specific, as distinct from vague, subheadings.' (Turner, 1921, p. 137)

Turner's proposal to overcome accountancy, like the propositions to increase production, is bounded by an inability to see beyond the existing shop system of production. Clayton argued that expensive costing systems had become the unfortunate reality of industry:

'With regard to 'oversystemization' I think there is a danger ahead of us in the fact that we are apt to make our systems a good deal costlier than the job itself. That has occurred over and over again; and when one sees the amount of paper used in the organization of industry, one cannot wonder that it has been said that we have already passed the stone age and the iron age, now we have come to the age of paper.' (Turner, 1921, p. 155)

The engineers felt that accountancy was becoming too powerful and was not linked to the physical process of production. Tonkin argued that accountancy could be a positive danger to productivity:

> 'the seeming desire of the cost man to weight the works system with all the elaborate detail of accounting checks - so much so that in the effort to attain accounting accuracy the true problem of costing, that of economic production, is missed.' (Turner, 1921, p. 168)

The engineers' opposition to accountancy was not just for the good of the workshops. The engineers were interested in advancing their profession and a number of strategies were discussed as a means of advancing this interest. Turner put forward a threefold strategy, firstly, engineers should learn costing techniques to render the accountant superfluous:

> 'we do not know enough about costing. We have left it in the hands of the accountant. The engineer has to get into the accountants' preserves and get more knowledge of the subject before he will keep the accountant out.' (Turner, 1921, p. 167)

Secondly, there should be greater monitoring of non-accounting statistics:

> 'In the pursuit of economy it is not sufficient to rely on the working of cost returns. It is possible by keeping close watch of analytical returns of the allocation of men to run much nearer to the economic limit in personnel.' (Turner, 1921, p. 137)

Thirdly, there should be closer observation of physical production:

> 'The analytical observation of the actual operations on which costs are incurred also makes it possible to effect many economies which, although individually not great, may yet put up the general standard considerably' (Turner, 1921, p. 138)

In response to the emergence of costing, engineers began to search for alternative means of achieving economy, which belonged solely to the engineering arena, hence the stress upon the physical arena, which had been the preserve of workers and foremen. It was the development of controlling co-ordination that was to yield productivity gains and enable the engineers to retain power, and a distinctive outlook, for a further half-century.

The objection to costing was not something limited to the crisis of the rising technical component of production, railway engineers continued until the 1980s to express doubts about the process of costing. Lemon, a major innovator within the railway industry and responsible for the introduction of costing systems on the LMSR, believed that costing was very useful for management but was deceptive and had to be treated with caution:

> 'cost should be used as a tool of management ... as a means of measurement. There must be some standard of measurement before any progress could be made...Costs were very deceptive, and that fact had always to be remembered when making comparisons.' (Lemon, 1930, p. 440)

Part of the problem of accountancy was that the information produced bore little relationship to the actual physical production, for example, Mountford notes that at Swindon the accountants manipulated figures such that it was possible for the production of one engine to count as the addition of two locomotives to the fleet:

> 'the accountants performed the feat of disposing of two engines for each new (converted) engine added. No 7200 was a conversion from 2-8-0T 5275, but in the accountants' books it also replaced Abedare 2602. So 5275 and 2602 were taken out of book stock, but only one engine, No 7200, added' (Mountford, ud, p. 82).

The consequence of this would be a stable locomotive fleet in accountancy terms but a decrease in physical terms. Mountford also indicates how accountants manipulated the status of locomotives, which also meant a manipulation of mileage records which;

> 'The accountants made some other strange decisions... In 1925/6 a number of constituent engines were sent to private locomotive firms for complete overhaul and, despite returning in much the same external condition, these were nominally condemned, and then put back into stock on their return.

> Their mileage records even started all over again as 'new engines'. On the other hand identical engines which had been overhauled at Swindon, including those completely rebuilt with G.W.Standard boilers, cabs, bunkers etc were neither taken out of stock in the same manner, nor were their mileages affected.' (Mountford, ud, p. 82-3)

This had impacts on repair policy, because the Swindon engineers assessed repair and new build requirements on the basis of potential mileage and age of fleet, and the accounting decisions undermined the usefulness of this assessment. The same policy was followed on accident repairs (Mountford, ud, p. 82-3). Repair policy was affected because the accounting systems' categories did not represent the actual physical processes carried out within a workshop.

The mis-match between costing systems and physical production was more significant after Beeching when investment had to show a particular level of return. The machine tool modernisation plan of the 1960s and 1970s had to be justified in these terms but, as Astrop noted, this meant the reduction in significance of 'less easily calculated benefits from reduced handling, smaller batch sizes at more frequent intervals, and products of higher and more consistent quality' (Astrop, 1976, p. 25). The computerisation of BREL had to be justified in financial criteria, and this was seen as undermining the ability to innovate and improve management:

> 'Intangible benefits are those which are difficult to quantify and express in financial terms. The most important of these...; the improved control of company data, leading to an increase in the reliability, relevance and clarity and timeliness of the information presented to management... Computers also permit tasks to be carried out which were impossible formerly, resulting in a better job being done by the same people. This benefit is a disadvantage when it comes to justifying computer systems. In many cases, when systems are being specified, the users require the system to do very much more than its manual predecessor, resulting in

no apparent saving.' (Hudson, 1974, p. 26)

The use of financial criteria was seen by Hudson as being unable to quantify all the costs and benefits that could accrue from the application of computers. Taylor and Schole, when discussing the application of Computer Aided Design, described the financial assessment that was operated: 'Two exercises were mounted to evaluate the benefits from graphics, one global making broad assumptions and the other looking narrowly at the design process alone', the former was a 'limited' global exercise and looked at savings from the running of rolling stock design and, excluding savings from improved design for manufacture, it was found that the global exercise gave savings of 'four times the annual cost', and the narrow approach which looked at savings in designers' time, overheads etc gave 'a return of 25% on invested capital' (Taylor and Schole, 1975, p. 70) This was a one off exercise. On a routine basis the narrow costings are the sole criteria on which policy is based and are indicative of the enormous mismatch between actual physical cost and measured cost. It was the inability of accounting systems to fully cost the complex physical consequences of any decision that was the major basis of engineering objections. Accountancy had to be adapted to engineering.

The engineers, as we have seen, have always given a high priority to the question of cost. What matters is how it is controlled. In 1929 Sir Henry Fowler, CME of the LMS, argued for the combination of technique and cost under engineering control:

> 'ultimately, physical considerations must merge into the financial. It is essential, therefore, that - as far as practicable - complete financial data should be available for the Chief Mechanical Engineer, both from the point of view of current economical production and maintenance, and as a guide for future policy.' (Fowler, 1929, p. 65)

This concern with the fusing of the physical and the financial was prompted by a concern for fixed cost which, with increasing mechanization, continued to grow during the inter war period. As mass production yielded its benefits, improvements from costing increased in relative importance. The concern for cost was also prompted by financial monitoring of the workshops by the senior management of the railway. Fowler notes of the changes he instituted on the LMS;

> 'there were no snags in the method. If there were, one of the financial assistants of their president would soon find them.' (Fowler, 1929, p. 71)

During the early 1970s a full scale survey of managements' views on the nature of the business and its information requirements was carried out, and the results point to a change from a concern for fusing the physical and the financial toward a leading role of finance and accountancy. The results of the survey showed sixteen activities which were seen as forming a 'business cycle' that 'starts with business planning' (Hudson, 1974, p. 24). Planning was clearly financial, it being assisted by a computerised 'financial model of the business on the basis of which long term plans could be formulated' (Hudson, 1974, p. 22). The outcome was also financial. Accountancy was seen as measuring 'the financial performance against the original plan' and also as the activity which 'concludes the business cycle' (Hudson, 1974, p. 24). Accounting and financial planning were the priorities revealed in the survey:

> 'The production and supplies systems are regarded as 'primary systems' since they generate most of the basic data relating to the physical resources needed to operate the company machines, material and manpower... The accounting systems convert the data generated by the primary systems into the common langauge of money... The flow of operational instruction is of course, in the reverse direction.' (Hudson, 1974, p. 25)

There is not much mention of the provision of rolling stock or the merging of the financial and physical here. Financial criteria 'of course' determine the labour process, in the eyes of BREL, predominantly engineering trained, senior management.

THE ACCOUNTANTS' VIEW OF THE ENGINEERS

The growth in the importance that engineers gave to costing was reflected in the accountants' growing sense of importance. In 1907 the Horwich works' accountant viewed accountancy as important but secondary noting favourably that:

> 'one of the brainiest, and at the same time one of the most successful commercial men I ever met told me that he attributed his success to knowing 'what he was doing, where he was doing it, and what it cost him to do it; and that account keeping was not a money-making but a money-saving operation'.' (Tatlow, 1907, p. 238)

Accountancy was seen as a means of monitoring activities determined according to other, technical criteria, and this view was emphasised by accountants half a century later. Dadge argued that 'accountancy is the servant not the master' (Dadge, 1954, p. 9) and management accounting is not about forcing ' departments to conform to some pattern set by orthodox accounting procedure', on the contrary, Dadge argues that the accountants' aim is 'the service they can render to productive efficiency' (Dadge, 1954, p. 8). When the terms of the subservience are examined it is clear that even if Dadge thinks accountants do not rule, he certainly thinks that monetary calculation does:

> 'Lest it be thought that accounting looms over-large in the control picture, it is necessary to emphasise now that although the terms of measurement are arithmetical and financial, figures are merely the media through which management exercises control. The accountant can provide the means of control; he may point the way and even share in initiating actions needed to correct trends moving in the wrong direction, but he cannot and must not usurp the place of the officers who carry the responsibilities, he must support them.' (Dadge, 1954, p. 5)

Accountancy is seen by accountants as the major means of management exercising control. It is clearly not a large step to advocate that accountants should do the controlling. With the emergence of computerisation, Sargent, a more extrovert Western Region accounting colleague of Dadge, advocated such a move:

> ' The demand on the accountant in this modern world is the production of a vast mass of figures processing and its presentation in a concise and understandable form so that management is given only the vital figures necessary to the determination of the efficiency of the undertaking. Computer techniques are based upon a similar concept. ... It is only right that it should be the accountant who first sees the light in this new world of automation. The accountant of the future will be a combination of production engineer, scientist and mathematician guiding the destinies of the nation.' (Sargent, 1955, p. 10)

He was not wrong. Computerisation was seen as leading accountancy in this direction because it undermined the accountants' bread and butter of book keeping 'Accountancy will be revolutionised, double entry book-keeping so far as detail posting is concerned, will be unnecessary' (Sargent, 1955, p. 10). Added to this it opened up greater possibilities for extending the processes costed:

> 'its speed alone permits rapid processing of basic data, that the production of figures and trends so vital to management today, can be made available within minutes instead of, as before in days. The breakdown of costing into understandable units which at the moment is impossible owing to the vast army of clerks that would be necessary to produce it, has now become an economic possibility from the office point of view.' (Sargent, 1955, p. 10)

Computerisation gave accountants the reason and the ability to extend their activities into the costing control of the labour process. Combined with the priorities of Dr.Beeching, this had a significant impact on the development of costing systems.

By 1970 Somerville, the ex-workshops accountant

(Southern Area), regarded railway engineers with contempt. Certainly he mouthed the view that 'Management accounting is a means to an end' (Somerville, 1970, p. 148) but he argued that management in the workshops had the audacity to ignore it. The works have 'a flow of tolerably accurate accountancy information'(Somerville, 1970, p. 148), which, he argued, was only achieved by appointing an 'outside accountant' as head of finance of the new workshops division, rather than an engineer. The 'major problem' (Somerville, 1970, p. 148), he continued, is not the supply of accounting information but the use of the information. 'It must be doubted if much of the present BR workshops' middle management has either the knowledge or experience to make full use of the financial data now available' (Somerville, 1970, p. 149). He goes on to argue that:

> 'The reason is not hard to find, technical managers are almost exclusively recruited from the staffs of railway CMEE's. While, of course, these men are first-rate railway engineers, they lack the financial awareness which engineering management brought up in a commercial management instinctively acquire; moreover, they are railway engineers not production engineers. The latter point is important to an organization like BR Workshops. For a railway works to function effectively it is necessary to get work - repairs and new construction - in and out in a way that optimises the relationship between time 'on works' and costs. This sort of problem is essentially the province of the production engineer... True production engineers - as distinct from railway engineers holding posts entitled 'production engineer' - are rare men on BR.' (Somerville, 1970, p. 149)

The claimed oversights of the engineers do not have any validity, the concern for balancing works and repair costs has continually exercised railway engineers. The real problem with engineers for Somerville is that they have ignored financial logic.

THE DEVELOPMENT OF COSTING

Management accounting has two facets:

1.The determination of production costs by allocating the costs incurred to the tasks performed, enabling decisions about the nature and quantity of production, a related area is assessment of the benefits from possible investment by estimating future cash flows from present cost knowledge.

2.Accounting for control, the establishment of a standard against which expenditure and revenue of a particular activity and department can be judged. The two major elements are: budgets, which set a standard of expenditure against which actual can be judged, and variance analysis (also called standard costing). This latter method divides costs into controllable and uncontrollable costs for each department, for example, in a machine shop labour costs due to productivity would be identified as controllable, increased labour cost due to wage settlement as uncontrollable.

The costing of items of output was a product of the turn of the century, and control accounts were an achievement of the inter war period (Miller and O'Leary, 1987, p. 242). Miller and O'Leary argued that standard costing was part of and based on the wider movement concerned with overhauling manufacturing activity, particularly scientific management:

> 'The creation of standard costing within the accounting literature, accounting historians have acknowledged, owes a considerable debt to that movement which, originating in the U.S.A., became known as Scientific Management. According to Solomons for example, one cannot read F.W.Taylor's paper of 1903 on Shop Management without noticing that it contains many of the essential elements of what would later become standard costing.' (Miller and O'Leary, 1987, p. 251)

Costing developed, confirming Miller and O'Leary, from a concern with comparing historical costs to a comparison with pre-set standards. Costing and Taylorism, although applied in the workshops, were applied according to the dictates of the engineering framework of control. Costing was applied when it gave engineers control over the shop system and was in accord with the engineers' holistic perspective on production. Costing did not develop to the extent that it intruded upon the engineers' managerial control or expertise.

Accountancy was seen, at the turn of the century, as concerned with the allocation of indirect costs. Tatlow, the Horwich Works Accountant, wrote:

> 'With regard to costs, the only absolutely true figures which we have to begin with are the actual payments made to smiths, strikers in the smithy, mechanics in the fitting shop and erecting shops, machinemen in the machine shop, painters in the paint shop, and yardmen engaged in loading up, and even to the wages of these men, there have to be added all the expenses of the shops in which they are employed, which expenses are more or less common to all the work carried on therein and which are known as general charges, or factory expense ...' (Tatlow, 1907, p. 217)

He then proceeded to list a large range of overhead charges, and the procedure that can be used to allocate them to a manufactured article. That he used a fictional example may be indicative that such costing methods were not actually applied. By the inter war period various costing systems were in existence. On the LMS a system for costing the price of articles produced for stores existed in all works (Fowler, 1929, p. 65, Lemon, 1930, p. 431). The system in use on carriage works only recorded direct production costs ie: wages and materials used in production. The cost office kept a record of the costs of each order, as recorded on material requisition notes and wage cards, on a master cost card, which when the production of the order was complete was used to determine the cost of the components produced (Lemon, 1930, p. 431). The system of costing jobs was extended to the output from the shops. In 1927 the LMS introduced a system of costing the production and repair of different sections of a locomotive, eleven in total (Larkin and Larkin, 1988, p. 203, Fowler, 1929, p. 66). The expenditure on plant and machinery in the individual shops of locomotive works was recorded and passed, every four weeks, to the works manager and shop foreman concerned. By the end of the 1930s the cost accounts covering all expenditure and costs of production, including the allocation of overheads according to some formula for each shop, were included in the regular statements (Beech, 1937, p. 39). For example, the foundry accounts, which were sent to the works manager, recorded expenditure in the following headings:

1. Mixture cost.
2. Incidental expenses. Moulding, Overheads etc
3. Summary of total expenditure.
4. Cost for each order undertaken, broken down as above (Beech, 1937, p. 42).

The whole of the costing system was fed from record keeping; material requisitions, production orders, wage cost cards (Beech, 1937, p. 40-1).

PURPOSE OF COSTING

The purpose of the costing system was to make comparisons. At first this began as an historical exercise but later it developed into a comparison against standards. Tatlow argued that the purpose of management accounting was to enable monitoring over time:

> 'gathering together of factory expenses for each individual shop... offers the advantage of being able to consider the efficiency, output and expenditure of such shops at varying periods' (Tatlow, 1907, p. 217)

He felt that it was by the process of historical comparison that inefficient production could be identified:

> 'a careful analysis of all the items of expenditure in factory operations will often expose leakages of wages and materials, and locate the branch of work which is not being carried on with the economy of other periods or in other districts.' (Tatlow, 1907, p. 238)

The improvements to be gained from accountancy are from a retrospective judgment particularly in relation to the use of indirect costs. The use of historical comparison as a means of identifying inefficiency was still perceived as the aim by Tonkin, an engineer, writing in 1921, who saw costing as having four functions:

1.A check on uneconomical production.

2.Enabling comparison of costs of production between:

a.works

b.different classes of rolling stock

3.Providing for cost reduction

4.Providing estimates.

The setting of standards had not emerged as a role of accountancy, although the use of accountancy for estimating purposes implies that it could be used in this direction. He identified the most important effect of costing as the ability to identify areas where costs needed to be reduced, arguing that 'Management that does not know what repair jobs actually cost is hardly in a position to justify changes in methods or increase workshop equipment to reduce same' (Tonkin, 1921, p. 48). Turner agreed 'efficient costing is one of the first requirements of good management' because 'it is but a natural step from costing to economy; the first shows up the need for and tends to produce the second' (Turner, 1921, p. 137).

The inefficiencies that were being shown up by the application of costing systems were those of the foremen. Turner argues that the advantage of costing systems was the provision of information on indirect costs (Turner, 1921, p. 136). He identifies four main areas of indirect costs, all of which are under the foreman's control:

1.Indirect labour eg:supervisory, clerical, maintenance, transport, sweeping up etc

2.Instructing lads 3.Waiting time eg: waiting for instructions, material etc.

4. Petty stores etc (Turner, 1921, p. 136) .

Tatlow, fifteen years earlier, had listed a whole array of indirect costs, but Turner ignores the cost of management controlled overheads. That the foreman is the subject of comparison is clear when Turner considers overheads:

> 'There are also other overhead charges which, although not coming directly on to the shop, are yet such that the foreman can control them to a certain extent, such as cost of electric light and power' (Turner, 1921, p. 136).

The engineers' enthusiasm for costing was thus related to its ability to yield control over the shop system, and only costs relevant to that aim were brought into consideration. At the beginning of the 1920s foremen were not only compared on a h storical basis, but pre-determined standards had begun to emerge from which to judge their performance, for example, the estimates of material cost were compared with the actual as a means of identifying defective work (Turner, 1921, p. 136).

By the end of the 1920s the use of costing for comparative purposes was used throughout the LMSR, as Lemon commented on the carriage side in 1930,' it is possible to compare every detail from every factory' (Lemon, 1930, p. 431 see also Fowler, 1929, p. 65 on Loco works). The comparison by this time was both historical and against standards. Fowler notes that the foremen received a statements of expenditure 'where necessary explaining any exceptional expenditure' (Fowler, 1929, p. 65). They were thus being compared against some, unspecified, standard.

The system of individually costing locomotives also conformed to enabling comparisons against past records and standards. There was four areas of comparison:

1.Between locomotive classes.

2.Between individual locomotives within a class.

3.Between workshops.

4.Within workshops over time (Fowler, 1929, p. 66).

And, for the first time in the literature he notes that the costing of repairs will enable the 'budgeting of future expenditure'. Beames argued that the advantage of costing individual locomotives was that it forced foremen to change their ways and adopt low paid labour:

> 'in the past the foreman and supervisors were inclined to look upon the man-hour as the correct factor, they were now more inclined to use the pound-hour as a standard. The man-hour could be kept constant, but by putting on a lot of highly paid mechanics the cost of that man-hour might be raised considerably. The people who were responsible for the staff on the pits were now coming to realise, however, that they must have a proportion of lower paid apprentices and people of that sort, so as to keep the pound-hour somewhere about where it was before, or else reduce it.'(Fowler, 1929, p. 68-69)

Working to budgets had become standard on the LMS by end of the 1930s (Ball, 1938, p. 334).[1] For foundry work there were control accounts which enabled the 'comparison of

[1] On the Western Region research facilities were subject to budgetary control in 1951, suggesting their use on its Great Western predecessor (Robbins, 1951, p. 3).

standard expenditure against the actual' in the following processes:

1.Melting and Casting.

2.Moulding.

3.Coremaking.

4.Mixture.

5.Scrap (Beech, 1937, p. 43).

The check with standards was overseen by the works accountants office (Beech, 1937, p. 40). When the cost accounts were sent to the works manager it was the practice for 'their attention to be drawn to any wide variations from standards' (Beech, 1937, p. 43).

By the end of the inter-war period costing was seen as assisting investment decisions, Beech argued that 'the cost accounts form a very valuable basis for the assessment of the effect of these schemes on future expenditure.' The 'full effect of interest...is also taken into consideration' (Beech, 1937, p. 44). By the end of the 1930s costing had emerged as a system for making comparisons, not only with past activities but also against pre-set standards. The costing that was introduced was for monitoring shop and foreman performance, and it will be shown that management accountancy did not become the dominant consideration in production decisions until after Beeching.

THE LIMITED DEVELOPMENT OF ACCOUNTANCY

The productivity increasing innovations of the inter-war period were not stimulated or monitored by the developments in costing. Lemon, speaking of innovations in LMS carriage works, argued that the costing system could not confirm any savings because of the variations in the type of rolling stock produced and costing systems used since amalgamations, but this was not considered an impediment to the assessment of the schemes. 'We are satisfied' he argued ' with the introduction of the progressive system of construction, there has been a reduction in the labour costs and, saving in floor space' (Lemon, 1930, p. 428).

Standard costing (or variance analysis) was not utilised. Dadge, a Western Region accountant, argues that this was because the works did not produce for profit, a common enough refrain, but also that the engineers had developed an alternative based on the overseeing of supervisory performance:

> 'Standard costing is primarily intended for manufacturing concerns whose sole object is to make and sell articles. So far as the manufacture of articles in the railway workshops is concerned, the system has been studied but not so far generally applied. It is of interest in this connection, that our Swindon office has for some years maintained a system of costing which produces similar results. There is a card record for each manufactured article of the standard operations, materials and overheads involved, revised appropriately to current wage rates and material prices; the completed expenditure on each new order is analysed and the departmental cost is compared with the standard, and any appreciable difference disclosed is investigated, consultation being made with technical supervisors in the shop or shops concerned.' (Dadge, 1954, p. 8)

Thus standard costing had not made headway in the workshops. The engineers had devised a system that suited their own purposes.

Swindon dominated the other works on the Western Region. On the other regions, such a close relationship between regions and works did not exist, and costing was even less developed. On the North Eastern Region at the start of the 1960s consultants noted that 'the accountant is not responsible to the works manager' and although the works manager received four weekly statements 'all accounting information remains within the confines of the accountancy function centred in this case on Darlington.' At York a system of budgetary control for new building was abandoned in 1958 (Urwick,Orr, 1961, p. 22). Urwick Orr concluded that 'under present arrangements, there is no effective monitoring of new building costs' (Urwick, Orr, 1961, p. 27) and gave as an example that 'no officially authorised cost figures have been produced on the electric stock orders completed since 1958' (Urwick, Orr, 1961, p. 23). They noted that management thought the costing statements 'did not serve any useful control function' (Urwick, Orr, 1961, p. 23). There was certainly no evidence of standard costing (Urwick,Orr 1961 tables E to H).

For coach repairs, Urwick Orr argued that the fusing of the financial and physical had not occurred, 'the relationship between the technical and financial aspects of coach repair is...somewhat tenuous and attempts to control costs must be of an arbitrary nature' (Urwick, Orr, 1962a, p. 11). They argued that the budgets were of little use because they lacked reference to the physical process, being imprecise and outdated:

> ' In our opinion, the existing system of cost control is ineffective...repair budgets and the financial allocation

are based on a repair classification which is acknowledged to be imprecise. The budgets are also based on cost data derived from what last year's costs were, rather than on what this year's costs should be. No allowance is made for technical changes in the type of repairs required or for non standard work (e.g. Collision damage). The compilation of current costs is not sufficiently detailed to allow for changes in the mix of coaches repaired. (Urwick,Orr, 1962a, p. 10-11)

The four weekly statement was seen by Urwick Orr as of little use as it had 'no detailed breakdown of expenditure by shops or by vehicle type' thus 'accounting statements contribute little to effective control' (Urwick,Orr, 1962a, part two, p. 12).

At Shildon the situation was similarly viewed, budgets bearing little connection to physical processes and very little detailed information:

'Present cost control procedures are unsatisfactory in that:

1.detailed repair costs are not readily available.
2.budget estimates are based on past activity levels not on an assessment of future demand.'(Urwick, Orr, 1962b, p. 2 see also Urwick, Orr, 1962b, part 2, p. 8).

The costing systems as used in outside industry had been applied to a much lesser extent in the railway workshops, the reason being that engineers could secure production by the use of technical methods, costing that was introduced was appropriate to this end. The obvious distaste of Urwick Orr for the lack of accounting methods of control was something that was taken up by senior management when Beeching was appointed head of BTC in 1962.

POST-BEECHING COSTING

Beeching appointed a number of outsiders to control the workshops, D.C.Allan, an accountant from the Ministry of Supply, was appointed to head workshop finance. Somerville argues that 'under his supervision a modern system of integrated financial and cost reporting was set up to replace the rather elementary accounting procedures formerly used in the railway works' (Somerville, 1970, p. 148). Somerville, an accountant himself, notes rather sarcastically that the workshops gained advantages from being a late developer 'In accountancy the workshops organization has been fortunate in its ability to draw upon the vast fund of techniques already built up by the engineering industry'(Somerville, 1970, p. 148).

The BRB 1964 Report noted 'progress has been made in the introduction of uniform accounting and cost control procedure. Each workshop is now a self-accounting unit, being responsible for the preparation of budgets, annual and periodical accounts, product costs and overhead control data' (BRB, 1964, p. 62). And a year later; 'A further advance was made in completing, consolidating and refining the accounting procedures introduced in 1963 and 1964. Budgeting procedures were improved, as was the supply of financial data for management at all levels' (BRB, 1965, p. 58).

The system adopted was described by Sykes as follows:

'The function of cost control was covered in two ways:-
1.Actual production costs were produced on the basis of 4 weekly in arrears.
2. The figures in (1) are compared with the 'planned cost' ... If this exercise reveals a possible overspend, suitable remedial action would be taken' (Sykes, 1970, p. 221).

The changes adopted were toward a much wider emphasis upon budgeting and analysis of variances from standards. Sykes, an engineer, was of the opinion that even though these methods of accounting control existed they were unimportant, 'works organization is such that work is fully planned in detail and accurately costed and consequently adverse financial situations should not arise' (Sykes, 1970, p. 221). The accountant, Somerville took a different line, seeing the accounting information as the basis of control: The structure was 'each works manager is supplied on a four weekly interval basis with the accounting data necessary for the control of his works' (Somerville, 1970, p. 148).

The changes had their impact on management ideology. The BREL standard management structure of 1972 defines part of the role of engineers in terms of financial control, for example, 'the Production Services Manager was charged with 'controlling expenditure within the cost centres designated to the Production Manager' (BREL, 1972, p. 3) and the Production Engineer's (Repair) duties included 'assisting in monitoring and controlling unit costs within the budget towards the targets laid down'.

The range of work costed and over which management monitored performance was, after the changes, quite significant. Ridgway spoke of:

> 'A dramatic improvement in the financial control over all aspects of workshops activities. Each works is measured against pre-determined standard prices for nearly all aspects of the work, the price list for repairs and rolling stock, for example, being made up of no less than 2000 prices for various categories of repairs.' (Ridgway, 1974, p. 7)

BREL, and the engineers, were becoming increasingly concerned with financial control. The amount of work to be done in the workshops was decided according to financial criteria, not the physical criteria of mileage used earlier, during the budgeting stage between BREL and BRB (BREL, c1980, p. 3). The cost of work and the payments due were derived from the costing system, which after Beeching, had been extended to all types of repair. Gardiner the head of BREL describes the system:

> 'There is a Standard Repair Cost for each type of repair and for each type of locomotive, carriage and wagon and there are about 250 different SRCs for the fleet - that is for planned or classified repairs. Each SRC is agreed annually with the CMEE [Chief Mechanical and Electrical Engineer] and is based upon the latter's requirements as described in a series of workshop overhaul schedules. Costs are based upon work content hours derived from work measurement, the materials to be used and the overheads in the shops/works concerned. When a vehicle is shopped there is inevitably some work required which falls outside the schedule. This additional work is costed separately, authorised by the CMEE Resident Inspector and charged as an extra.'(BREL, c1980, p. 3)

Thus the relations of the workshops with the railway moved away from a concern for availability, toward a concern with workshop cost. The development of Standard Repair Cost gave a fillip to the adoption of variance analysis within the workshops, the cause of variance from a standard repair cost standing in for price, making this possible (Larkin and Larkin, 1988, p. 207, Hudson, 1974, p. 25).

Financial concerns were being taken much more seriously, for example, a programme was specifically written to study the performance of a workstudy agreement of 1969 in financial terms (Hudson, 1974, p. 23). Finance techniques were introduced into the design sphere, for example, value analysis, which 'involves questioning the need for any design configuration which inflates manufacturing costs' (Sykes, 1970, p. 209). The decision to invest in new plants was also to be governed by accounting criteria. Gray describes the 1960s machine tool policy as based on 'the selection of the best equipment from a physical and economic standpoint' (Gray, 1970, p. 451). What he means is assessment according to financial criteria. The machine tool modernisation plan was intended to allow for a continual rolling programme of machine tool investment, works managers had to prove to headquarters that proposed investment was justified in financial terms:

> 'Under systematic up-dating procedure, the works manager of each plant is responsible for drawing up his own plans and - most importantly - for justifying them on economic as well as technical grounds. He must be able to convince the company's headquarters at Derby that the new equipment will provide measurable benefits, will show the required financial return (of the order of 16 per cent) and in preparing his justifications he is aware of the fact that an investigation will be made some one to one and a half years after the equipment has been installed to check that his claims are being realized.' (Astrop, 1973, 1, p. 514)

The financial control of working to budgets was applicable to the development of the labour process. By the mid-1980s the return on investment had increased from a 16% to a 20% standard. BREL headquarters had introduced financial criteria on other aspects of machine tool policy thus 'any investment over 100,000 (and many of less) will only be authorised if a double shift workload can be allocated' (IME, 1981, p. 327). By a strange twist of logic the justification of the development of computer systems had to show tangible benefits, by which was meant financial benefits:

> 'It is the intention to justify the introduction of the proposed systems on the basis of the tangible benefits that will result, and the studies to date have indicated that this should be possible. Tangible or direct benefits

are those which can readily be expressed in financial terms.'
(Hudson, 1974, p. 30)

CHANGES IN THE PERCEIVED AIMS OF THE WORKSHOP

The growth in the hegemonic position of accountancy is reflected in a changed view of the purpose of the workshops. With the creation of BREL as a separately accountable firm, the headquarters developed a standard workshop organization with works managers, for the first time, charged with ensuring the 'profitability of the works' (BREL, 1972, p. 1). Although various managing directors still regarded maintenance as 'the prime task' (Ridgway, 1974, p. 6) or their aim (Gardiner, 1976, p. 108), the identification of the workshops as specifically railway engineering had gone, the managing director's view that 'BR is in transport we are in factory based engineering' (Gardiner, 1976, p. 108), is a far cry from Sir Henry Fowler's view that 'there is no other analogous work in the engineering world' (Fowler, 1929, p. 66). The creation of BREL, and earlier changes, had shifted the works away from provision to the railway and increased the concern with sectarian profitability. The accounting measures brought in following Beeching had their impact on the way repair was approached, for example, in the 1960s the technique of critical path analysis (see chapter seven) was used at Crewe, not to increase locomotive availability, as it could have done, but to reduce costs of operation:

> 'A computer analysis of the critical path procedure has been carried out and showed the possibility of reducing the time to ninety four work hours (from 160) with a different deployment of staff, but this would not fit in with the rate of accepting and returning locomotives to traffic which suits operating requirements, or with the repairs budget'. (Engineer, 1967, p. 320)

This approach to repair is alien to that adopted in earlier periods. (Chapter three)

The fluctuations in demand from the railway during BREL days were seen as more of a burden than previously, for example, the managing director's view of the cancellation of an order for 10 High Speed Trains was, despite his protestations, somewhat sour:

> 'BREL at virtually no notice and with no compensation had to respond - I am not complaining for this is our task - but the effect on production planning, material control and labour provision was in factory terms, disastrous' (BREL, 1980, p. 1).

Hudson argued that the moves for greater repair in motive power depots was as a consequence of BREL's profit orientation (Hudson, 1979, p. 550). He claimed BREL had abused their monopoly relation with the railway and instead of showing a concern with the cost of repair, they were busy passing on the costs to the regions by overpricing:

> ' BREL has the power more or less to charge what it likes for the work done, with none of the old loyalty which is usually present among fellow railwaymen - because now their objectives are in conflict, the Regional Chief Mechanical and Electrical Engineers' objective, being primarily to run a reliable railway; BREL's being simply to produce a profit from its workshops' facilities, which are organised to that end.' (Modern Railways, 1979, p. 550)

This profit orientated outlook has led to a lack of sensible repair policies and the passing on of costs to the railway:

> 'to carry out anything but the work for which the vehicle was originally shopped and budgeted. This often results in the absurd situation of vehicles leaving BREL shops unfit for service, and having to be towed to a depot for repairs to be completed. The practice smells of accountancy rather than railway engineering and the objectives seem to be to show a 'paper' output figure which masks the true position'. (Modern Railways, 1979, p. 550)

The managing director disagreed with Hudson's view and in response argued that charges to the railway were strictly controlled 'each activity and cost centre within BREL is separately accounted for and the overheads allocated to a repair activity are and always have been solely to that activity' (Modern Railways, 1979, p. 551). He did not deny the practice of sending out unrepaired locomotives but saw this as a product of forward planning 'designed to achieve a known work load at the most economical price and rate of working' (Modern Railways, 1979, p. 551). It is clear from his reply that a concern for minimising the cost of railway operation vis-a-vis workshop costs had very much taken a back seat.

SUMMARY

The period around the First World War saw a growth in managerial techniques in response to increased fixed overheads. One such development was the emergence of management accounting. The engineers took a cautious approach to costing, seeing it as partially beneficial. The problem for engineers was the emergence of a separate managerial grouping in the shape of accountancy. Engineers advocated that costing needed to be based on an understanding of the physical process of production, because the effective utilization of physical resources did not always conform to the method of measurement that costing entailed.

The development of costing within the workshops was according to the perceived requirements of engineers, one of the most beneficial, in their eyes, being that costing could be used as a measure of the foreman's competence. The repair of rolling stock was governed strictly by technical criteria with costing systems providing additional indicators of comparative performance. A lack of concern for costing was explicable in that the works were not producing directly for sale and a major concern was the effective and cheap operation of the product and not just internal works processes. Belonging to a wider labour process is part of a reality that engineers recognised, and that departmentalised costing does not. After the works modernisation and closure plan this was substantially changed and the creation of a buyer seller relationship between workshops and railways using Standard Repair Cost, combined with other techniques

drawn from British industrial accountancy, moved the workshops toward a management more typical of British Industry.

The discussion of conflicts between accountancy and engineering as methods of organising production presents a difficulty. The opposition of engineers to accountancy, justified in terms of efficiency, is part of a policy to retain power and yet I think it has some validity. This kind of question is something that sits awkwardly with a scientific assessment of developments and I therefore alerted the reader to this influence on the text. Nichols has argued that part of the explanation for low relative productivity within Britain is due to a lack of integration, in my terms coordination, of the means of production (Nichols, 1986, p. 160). He argues as follows:

> 'The degree of integration (of means of production-DL) can vary between different capitalist societies. It can vary both as judged by the degree of centralization and concentration of legally defined production units (atomistic to monopolistic) and in terms of the linkages between them; and it can vary within firms, according to the degree to which production is integrated both as a production process narrowly defined, and with respect to other adjacent functions (e.g. R & D, marketing). To consider MP (means of production-DL) only in terms of 'physical' means of production is to neglect the possible differential effects of such co-ordination. For whereas MP has a physical presence- so many retorts, cooling towers, machines, robots- in actuality these will count for little as far as productivity is concerned, if the operation of such plant and machinery is not planned and co-ordinated; and other things being equal, the better the planning, integration and co-ordination, the higher the productivity will be, even if MP is apparently the same in any two cases in its physical aspect (or of course as judged, less certainly, in price terms).' (Nichols, 1986, p. 142)

Nichols hits the nail on the head, it is coordination that matters in terms of productivity and efficiency. There are a few points with which I disagree. I would argue that it is co-ordination of the labour process that determines productivity rather than merely the coordination of means of production, although I suspect this latter is what he means. He argues that the analysis of British productivity therefore needs to analyse 'how British capitalism is organised' (Nichols, 1986, p. 143). Nichols sees the lack of integration operating at two levels, firstly, the way in which plants and subsidiaries of holding companies are un-coordinated, other authors have attributed a lack of efficiency to British manufacturing on this score (Williams, Williams and Thomas, 1983, p. 88), secondly, internal to the plant. His analysis of the lack of integration at the level of production (narrowly defined) is not extensive and concentrates on the lack of integration between production and other departments (e.g. R & D, design etc). This absence of the technical is something which is true of this thesis and, as Nichols notes most other social scientific writing in the area (Nichols, 1986, p. 157). This is probably because, as Marglin argues, these technical areas are difficult for social scientists to understand (Marglin, 1978, p. 14). Nichols concludes that British managers fail to plan production adequately relative to other nations, and that this is compounded by a lack of R & D. (Nichols, 1986, p. 154, 159). That these are both technical areas and that British management is dominated by accountancy are, I would suggest, not unconnected. Nichols does not make this link, although he does argue that the lack of engineering management and lack of practical skill within those that do exist may be a contributory factor to Britain's productivity problem (Nichols, 1986, p. 108). When describing the origins of ineffective management, Nichols has very little to offer. I would argue that part of the explanation can be found in the dominance of accounting and the subsequent decline in status and transformation of engineering.

What has happened on the railways is clearly a move away from integration at the macro level, that is the separation of operation from workshop, due to the advent of accountancy. I would argue that, at the internal plant level, lack of integration is also a product of the dominance of accountancy. Accountancy views each operation of the labour process like a shop till continually registering cash flow. The transactions within the firm, for example, machine shops producing components for assembly shops, administration providing service backup etc, it is assumed as the basis of the discipline, can all be costed accurately and the cost allocated to the departments. Processes and departments, like firms, have physical externalities which cannot be identified at the level of social transactions within the firm, and drawing on my limited knowledge I can think of several examples of physical changes where the impact of costs is not a simple process of transaction, for example increased component production may be at the expense of quality, which is a cost that the assembly shop or quality control systems have to bear, as another example, the major beneficiary and the major loser when welding is introduced is not the fabrication shop but, in the first instance, the beneficiary is the railway that can operate larger coaches, the major losses are incurred in the foundry's overcapacity.

Finance and physical processes do merge in wage labour organizations but it does not follow, even within the ideological framework of profit, that money is the dominant instance, for example, Alfred P. Sloan, ex-president of General Motors, the largest such organization, states; 'General Motors is an engineering organization. Our operation is to cut metal and in so doing to add value to it' (Sloan, 1986, p. 248). I would therefore argue that the way in which finance and physical processes are merged, both processes being concerned with the reproduction of the organization, is subject to variation and that there is variability in the success with which capital is reproduced, too much concentration on financial criteria is bad for capitalism, that is to say the reproduction of capital is brought back to the reality that it is the product of a labour process. In this thesis the main claim is that there is a tendency for control over coordination to increase over time and I have located this tendency as due to two factors: the importance, noted by Nichols (1986), of coordination as a means of advancing productivity, and the increased ability that it yields to management to reproduce the labour process. The development of coordination is, as Nichols shows, variable across nation states, and by extension, plants. What I have attempted to show is that a major element in this variation is the balance of power between management principles drawn from engineering and accountancy. I use the phrase balance of power between principles rather than referring to professionals because, as was shown for engineers, what constitutes the perspective and practices of the profession moved from a stress on practical work toward a costing led approach.

In the remainder of the thesis the development of control over coordination under the aegis of engineer control is described. It is shown that the engineer's perspective on the labour process as an integrated activity derives from his practical knowledge and, although not perfect, seems to accord with the reality of the labour process. Thus the rest of the thesis is a description of the labour process changes, an elaboration of the engineer's perspective on the labour process and the development of a theoretical explanation of both according to the concept of the growth in control over coordination.

CHAPTER SEVEN

CONTROL OVER COORDINATION

INTRODUCTION

As was discussed in chapter three, production prior to the First World War was secured by the direct supervision of workers, craft and otherwise, by foremen. That system transformed labour power into labour by controlling workers. I have agreed with Rose et al.'s (1987) view that some supervision appears necessary in wage labour organizations, but have argued that this has become increasingly marginalised, which implies that something has become more central. In this chapter, I argue that the control of coordination has become more important in determining the efficiency of production than the performance of supervisors. What is entailed in the notion of control of over coordination is best illustrated by examining Edwards' conception of technical control. In Edwards' study 'Contested Terrain' he similarly argues that the assembly line marginalised the foreman into a position of enforcing 'the requirements and dictates of the technical structure' (Edwards, 1979, p. 120). I see this as supportive of my thesis, but argue that his conception of technical control is one extreme example of the control of coordination. Technical control is said to occur in those situations where 'the entire production process of the plant or large segments of it are based on a technology that paces and directs the labour process' (Edwards, 1979, p. 113). The individual worker is reduced to either working or not working, and the supervisor reduced to seeing if he is working or not working. The pace of work becomes an issue only at plant level. The difficulties of the concept of technical control become apparent when he attempts to distinguish when a firm is using technical control as opposed to earlier forms of simple control. Of particular importance is the significance that he attaches to the range over which control is exercised. He argues that this technical control can be 'distinguished from simple machine pacing' (Edwards, 1979, p. 112). This is where an individual machine or group of machines dictates the pace of work of an individual or group of individuals, when 'the machinery in question utilizes only workers in this particular workplace' (Edwards, 1979, p. 113). It is clear that technical control is not solely machine pacing, but refers to the coordination of the whole of a factory to the dictates of machine pacing. I would argue that the most significant element in Edwards' criteria is the coordination of the whole factory. It was the emergence of what Fowler, the chief mechanical engineer, saw as the aim of management 'what you want, where you want, when you want'. Edwards located the origin of technical control in the continuous flow production of the previous century (Edwards, 1979, p. 113). It is control over workflows to ensure that the activity of workers was balanced with the work of other workers that emerges as the most significant development. The choice of workers to either work or not, still faced workers under conditions where the pace of the flows was decided by management. As we shall see, this is not as stringently under technical control, but that pressure still exists. The benefits of control over coordination go much further than ensuring that workers work to some pre-ordained pace, the ability of management to control the flows of work meant that work was to a common purpose; bottlenecks and idle labour time could be eliminated. But, probably more important, the control over the coordination of work meant that management could change the way in which work was carried out to meet changed circumstances: that is, revolutionise the process of production.

In this chapter I examine how the control over coordination emerged within the railway workshops. This chapter is central to the argument of the thesis that there has been a trend toward control over coordination during this century. The changes discussed were to a large extent carried out under the auspices of engineering management, therefore the changes that have occurred can be seen as indicating something of the nature of the engineering perspective on production. The engineers' policies continued with the same basic direction, increasing the specification of work tasks and the integration of work flows, well after nationalization until the late 1960s and early 1970s when accountancy became the dominant managerial ideology and policy. Thus it seems that state ownership fulfils few expectations in relation to production for need, in the case of the railways the management grouping which it would be assumed were better equipped to satisfy needs, were consciously cajoled into changing practices toward a greater concern for cost.

The major transformations from the situation of simple control occurred during the inter-war period at the end of which one commentator noted that 'During the last few years the system of carrying out repairs has ... been completely revolutionised', by which he meant a move from 'rules of thumb practice' to work on 'scientific lines', the word science being the watch word of the age (Fell, 1939, p. 209). Again re-emphasising that the engineers were concerned with costs, there is the following quote from Lemon, a major figure in changes in workshop practice. He argued for a direct causal link between costs and innovations in production:

> 'Immediately after the war it was realised that the higher costs of both labour and material made it imperative that some quicker and cheaper methods of manufacture should be applied in the construction of rolling stock ' (Lemon, 1930, p. 420).

As has been argued, the end of the First World War was a period when the question of cost raised the question of changing production methods. Before the old system could be abandoned a number of changes had to take place and these are described below. It is shown that under the conditions prevailing at the time, control over coordination meant mass production and this required standardised parts and improved materials examination, which involved more functions being stripped from foremen, as a consequence of standardisation and as a further aid to increasing the speed of production, stocks of components that took a long time to produce and repair were made. As a consequence of these changes in the nature of the product, a number of changes in organization became possible. The inter-war changes began with the specialization of labour, which developed into the progressive movement of tasks between work stations. As is shown, these physical manifestations are distinguishable from the exercise of control over the coordination of the labour process. Bond, later head of the BR workshops, distinguished between a 'progressive system of repairs' and 'time schedules for controlling the progress of repairs'(Bond, 1953, p. 197). It is the control of time that is important, the physical is a manifestation of the increased control of the time of coordinated production, and, as is shown, the control exercised over time yielded significant improvements in production. The chapter continues by showing the effects of the changes on the workers, which contrary to Edwards' arguments show not an increase in collective organization but appear to have led to lateral conflict between workers. The final part of the chapter shows that the concern to improve the coordination of the labour process has continued unabated since the Second World War, and has received a further fillip from computerisation. In chapters eight and nine I further develop the theme of control over coordination by indicating that mechanization and Taylorism are but aspects of the development of control over coordination. The reason for devoting chapters to these two themes is because of the importance they have in the literature. Marx considered the coming of machines to be the fundamental transformation within capitalism, he argues:

> ' In manufacture the transformation of the mode of production takes labour-power as its starting point. In large scale industry, on the other hand, the instruments of labour are the starting point.' (Marx, 1976, p. 492)

For Marx the modern method of ensuring production is through the control of machines. As he says, 'the machine is a means for producing surplus value' (Marx, 1976, p. 492) and under the modern stage of industry the control of the machine and not the control of workers activity is the starting point of production. As we have already seen, Edwards rejects this claim by arguing that machines can still operate within the environment of simple control. That is, workers still have to be made to work them, and the workers' activity is still a prime consideration. It is clear that many Marxists reject mechanization as constituting the fundamental transformation of the labour process under capitalism. Sohn-Rethel argues that there is a 'third stage of capitalist development' (Sohn-Rethel, 1978, p. 142). He argues that, despite appearances to the contrary, there is some evidence that Marx may have anticipated some of the characteristics of this third stage in his discussions of mechanization, but, because flow production and scientific management had not emerged, these could not be fully articulated (Sohn-Rethel, 1978, p. 142). Chapter nine on scientific management clearly relates to Braverman's analysis of Taylorism as the fundamental transformation of capitalist development.

Mechanization, and for that matter the technical control of assembly lines, constitute a particular form of managerial control over the coordination of the labour process; a control where the elements are strictly determined by the managerially inspired design of physical motion. The limitation of mechanization is the limitation of mankind's ingenuity and nature's recalcitrance. As Edwards rightly argues, machines still have to be coordinated into the activities of the plant as a whole, including the activities of their operators. Taylorism is of significance to the discussion of the increasing control of coordination because it is shown to be a tool of increasing coordination rather than a fundamental transformation. The knowledge of production times and their specification only came into existence on the railways when substantial gains had been made in the engineers' ability to control the coordination of the labour process and Taylorism, in its modern guise of time and motion study, could assist in furthering that control and increasing the benefits from that control. This and the following chapters therefore serve a two fold purpose in that they are firstly an examination of the fundamental changes that occurred within the railway workshops labour process, changes that predominantly went unchallenged by the workforce, and they are secondly an illustration of the perceptions of engineers and the consequences of those perceptions.

STANDARDISED COMPONENTS

As has been noted above, the first moves toward the exercise of engineering control over the labour process were directed at instituting the methods of mass production, which required that components were standardised. This was perceived to have two advantages:

1. 'Reduction in the amount of stock'.
2. 'Economy of manufacture' via 'production in the mass'. (Fowler, 1929, p. 60-61)

This principle was adopted for most items. In Lemon's words 'from the standardisation of rolling stock to the standardisation of stationary is only a difference of pounds and pence - the principle is exactly the same'(Lemon, 1930, p. 434). Symes thought that the desire to mass produce was a naturally harboured desire of all in charge of production believing in 'a natural tendency to work on the lines of mass production in carrying out any work of a continuous character' (Symes, 1927, p. 285). Continuing, he argues: 'one generally finds that the works manager and the foremen have a natural desire for production in large quantities' (Symes, 1927, p. 288). Ensuring 'complete interchangeability of components' (Sykes, 1970, p. 191) continued to be of concern throughout the works' history. The first major application of interchangeability to assembly was when the Midland Railway adopted the system of unit construction for coach work in 1919. This system involved dividing 'the construction into several units, such as quarters, ends, roofs, doors.' This meant that all the parts of the coach could be worked simultaneously and because of interchangeability 'parts could be taken indiscriminately and put together without any necessity whatever for hand fitting or any kind of selective assembly'(Lemon, 1930, p. 421). The parts would then be brought together and then assembled, and this process of specialization was extended to all the works and laid the basis of the further development of progressive repairs, examined below:

> 'The method of unit construction originated by the late Midland Company has been developed and extended and has made possible not only the progressive construction of new rolling stock, but the principle has been applied successfully to the repairing of the company's carriages, wagons, and horse drawn vehicles at each of the main factories.' (Lemon, 1930, p. 426)

MATERIALS EXAMINATION

Examination is part of the process of establishing material control over production; it establishes what transformations are required. Inspection is a check to ensure that those transformations have occurred. External inspection of works' suppliers had existed from early in workshop history and was under the control of the CME and not works management (Lemon, 1930, p. 433, Bates, 1949, p. 44, Railway Engineer, 1979, p. 49). This was to ensure that the final product conformed to the specification of the designers and that materials were not the subject of cost cutting (Sykes, 1970, p. 208).

The examination and inspection of internal works manufacture was a product of the inter-war period. Internal examination and inspection were seen as a means of ensuring compliance with managerial standards of accuracy. Ball argued in 1939 that this involved taking control over examination away from the workforce:

> 'Before specialisation reached its present degree of intensity, examination used to be a function of the men actually engaged on repairing the details concerned. Each fitter decided in effect what repairs were to be carried out. Under such conditions it can be imagined that the introduction of any set policy of examination was well nigh impossible.'(Ball, 1938, p. 304)

Examination determined the minimum amount of repairs that would 'enable an engine to be run efficiently for a further period of service' (Ball, 1938, p. 304). It was aimed at the fundamental dilemma of the workshops - that of achieving a 'balance... between costs of repair and operating costs' (Ball, 1938, p. 306). The determination of standardised rules for carrying out repair determined the cost of production. Ball argued:

> 'Fixing standard limits of wear and scrapping sizes is of the utmost importance, as it governs the amount of work to be performed and on it depends to a large extent the efficiency of a repaired engine.'(Ball, 1938, p. 305)

The policy of determining limits of wear and scrapping, in order to fine tune repair costs, required that management maintained control over the gauges used and these were regularly 'checked for accuracy'(Ball, 1938, p. 308). Examination was usually a two stage process. Rolling stock was shopped to workshop examiners who carried out a preliminary examination. This preliminary examination was based on a shopping proposal, and boiler inspectors' report in the case of a locomotive, that were sent in with the rolling stock. The preliminary examination was followed by a main inspection 'interdependent' with stripping carried out by 'a number of examiners ... responsible for a given section' (Ball, 1939 p. 314). The initial examiner's signature of the examination document was the authorization to the chargehand, or similar, for the work to be done and formed the basis of the wage ticket (Ball, 1938, p. 314; Kirkland, 1934, p. 330).

The examiner's reports provided the prime information for monitoring production, as it was examination that determined what did and did not constitute work (Ball, 1938, p. 334). That the work had been carried out according to instruction was determined by a further specialist, the finished work inspector (Ball, 1938, p. 337), whose signature on some form of documentation was confirmation for payment to the gang responsible (Lemon, 1930, p. 431).

The development of examination conforms to the general tendency of stripping away the functions of the foremen. The examiners during the inter-war period were under the control of the foremen (Cook, 1947, p. 14), even to the extent of foremen checking the examiner's conclusions (Kirkland, 1934). During the 1940s, the number of examiners and finished work inspectors increased (Forsythe, 1947) with a growing tendency for them to be directly responsible to the works managers (Bond, 1953; Forsythe, 1947). The role of inspectors as directly answerable to the works manager was firmly established by the end of the 1960s, the 'Works Inspection Assistant is directly responsible to the Works Manager and is thus relieved from any pressures which may be brought to bear due to production commitments' (Sykes, 1970, p. 209; also Railway Engineer, 1979, p. 49).

STOCKS OF FINISHED GOODS

The development of interchangeable components meant the throughput of rolling stock could be increased by keep stocks of those items that took the longest to repair, thu trading off decreased utilisation of objects of labour for increased utilisation/availability of rolling stock. As a general principle, Cook noted:

> 'There are four cardinal items which are so big in the sense of time required to manufacture, that it is essential to ensure that these can be supplied if renewal is required. These are the boiler, frames, cylinders and wheels.' (Cook, 1947, p. 11)

For steam locomotives, boilers took longest to repair and were the first to be considered for standardisation (Owen, 1933, p. 482; see also Bond and Nock, 1975, p. 6). The amount of stock boilers was fixed at 6% of the total (Fowler, 1929, p. 62). The discrepancy of repair times between components was interpreted by management as calling for increased control scheduling, being 'controlled in order to eliminate delay' in waiting for spares (Cook, 1947, p. 11).

SPECIALIZATION OF LABOUR

Specialization was identified by Bristow as the product of growing managerial knowledge of the labour process;

> 'The discoveries of science and the advance of knowledge in railway work have led to a great degree of specialization'. (Bristow, 1933, p. 2)

The tendency to use specialized gang labour for different tasks was the first modification in working arrangements:

> 'Until recently in most erecting shops it was the practice to give a chargehand and a gang of men the job of repairing so many locomotives and these men did all the operations necessary. To-day, however, we split up the erecting of our engines into a number of sections and have special gangs of men who deal with the work of each section and nothing else; thus one gang will deal with the repairs to frames and cylinders, other gangs putting in boilers, motion, axle boxes and so on; one gang following the other in regular progression and specialising on certain work.' (Symes, 1927, p. 289)

Bristow classified the advantages of specialization in the same way as Adam Smith:

1. 'Increased skill and dexterity'

2. 'Economy in time' as a man 'does not have to pass from one operation to another'

3. 'A better distribution of work... according to capacity'.

4. 'Greater use of machinery' (Bristow, 1933, p. 8).

The third criterion, which necessitates control over coordination, was the most important. Fowler argued that, when locomotive repairs are done 'in one position' as was:

'generally adopted in the past when coupled up with a system by which moving gangs of men carry out certain definite work and whilst schedules were arranged for progressing the work...gives fairly good results.'(Fowler, 1929, p. 62-3)

The fairly good results spring from managerial control over progressing the work.

PROGRESSIVE PRODUCTION

Progressive repair, the moving of the work to the man, was the method that followed simple specialization. The aim of this technique is the maximum utilisation of men, machines and raw materials by reducing time spent in transit of all factors of production between worksites. The method of repair adopted was referred to as the progressive system of repairs. Under this system a locomotive, carriage or wagon would enter the shop on a track, the track or line would be divided up into a number of work locations where specific operations were performed. At preordained times the locomotive, carriage or wagon would be moved to the next stage, eventually leaving the erecting shop repaired or built. [1]

The stages varied depending on the size of the shop, but there were often only two or three (Fowler, 1929, p. 62), although Swindon and Caerphilly had four stages (Cook, 1975; Mountford, 1965; Mountford, ud). At Crewe, the system - dubbed the belt system - had eight stages. During the last five stages of this the locomotives were wheeled and connected to the locomotive in front by a steel cable which, at a given time, dragged the line of locos to the next stage (Reed, 1982, p. 164; Fowler, 1929, p. 62). Beames describes it as follows:

> 'The method of processing the repair of locomotives is representative of the principle, now employed throughout the works, of moving the work to the man rather than the man to the work. The locomotive is moved down the shop in the eight successive stages. At each stage the appropriate

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[1] This system was more accurately described, somewhat dismissively by a London underground engineer, who repaired on conveyor lines, as the 'Spot system' (Graham, 1932, p. 4)

> components are added by men expert in their particular work, and the duration of the working time in each shop is regulated to 7 hours 50 minutes. By this means, an engine is stripped and given a heavy repair in 12 days, as compared with 30 to 40 days generally occupied on such work.' (Beames, 1928, p. 254)

In Lemon's words 'the system operates like a relay team in which the performance is a composite result' (Lemon, 1930, p. 428). The shop layouts were designed to 'eliminate transport wherever possible' (Beames, 1928, p. 248). The system of progressively moving raw material to work stations was adopted for both rolling stock and components. It was used on coach repairs first at Newton Heath, and was used at Wolverton, St Rollox, Derby, Earlestown and 'several wagon works'(Lemon, 1930, p. 429). In 1947 they introduced a system of mass production for wagons at Shildon, where the wagons moved from stage to stage by means of an overhead runway and this system produced an output of one wagon every 35 minutes (Engineering, 1947b, p. 436).

At nationalization the policy of the Railway Executive was described, in 1953, by Riddles, the board member responsible for mechanical engineering, as follows: 'Development in the past five years has aimed at extending to all workshops progressive systems of repair with the object of reducing the time taken without sacrifice of quality'(Riddles, 1953, p. 143).

The new types of locomotives were also repaired on the progressive system. For example, the progressive system was used for diesel shunter repairs at Derby by 1947 (Engineer, 1947a, p. 252) and for main line locomotive repairs by 1957 (Simpson, 1957) and was used on the first mainline repairs at Crewe in 1959 (Plant Engineering, 1971), and multiple unit repairs, at Derby, by 1963 (Garrat, 1963). The policy of progressive repairs was further applied during the modernisation plan. It was noted that 'wherever possible vehicle repair shops have been converted to through flow where this arrangement was not already in operation' (Ridgway, 1967, p. 104).[2]

The number of stages in the progressive system with the new rolling stock was greatly reduced; at Derby locomotive works there was a reversion to the earlier system of gang specialization. There were only three stages: the 'rivetters, erectors and electricians move from berth to berth as successive frames enter the berths', the building progressing in 'defined stages' (Simpson, 1957, p. 136). At Crewe the repair of electric locomotives was done in four stages lasting forty hours each (Engineering, 1967, p. 320). At Eastleigh although the carriage repair flow line gave the quickest movement repairs in BREL, they added off stage berths to increase flexibility for dealing with EMU refurbishments (IME, 1981, p. 323). This reduction in the amount of movement is probably related to the decline in its relative importance as a method of control viz-a-viz control over component flows.

The system of progressing raw material through defined stages was applied to components from the inter-war period, 'the processing of the locomotive itself being the final and spectacular result of the system generally' (Beames, 1928, p. 258). The progress system was at first applied to the large components, for example, boilers, and then later to

[2] They were improved at Horwich, Ashford, Inverurie, Glasgow, Doncaster, Templemills, and at York throughput capacity was planned to increase by 20%. (Modern Railways, 1964, p. 415)

almost all processes, for example, painting and scrapping of rolling stock.

MANAGERIAL CONTROL FOR PROGRESSIVE REPAIR

Lemon gives the following 'definite principles' 'to accomplish the work in the shortest possible time':

> (1) The elimination of manhandling of materials as far as possible.
> (2) Allocating definite work to a given position.
> (3) Supply of materials to be anticipated.
> (4)Allocation of men to specific operations.
> (5)The first operation to balance with the last.
> (6)All movements to be regular and at definite intervals.
> (Lemon, 1930, p. 428)

The aim was to minimise the movement of men and allocate them to definite activities according to managerially defined staffing levels.

The ability to organise work on progressive lines required a knowledge of the time taken for production and the component parts of work and the sequence of operations. Bond gives the following as pre-conditions behind the introduction of a progressive system :

> '(1) to assess the man-hours required for all the operations to be undertaken, for each class of locomotive, and to plan the sequence in which they are to be completed.
> (2) to divide the operations into groups or stages, each of which will be undertaken by a separate gang, in such a way that sufficient flexibility will exist in each stage, to allow for the inevitable variations in the amount of work to be done from one engine to another.
> (3) to decide which operations can proceed simultaneously without the men or equipment engaged on each impeding others, and which must, of necessity, be done consecutively, and thereafter,
> (a)to determine the number of days in which repairs should be completed. and
> (b) knowing the output required and how it is divided between class of locomotive and type of repair, to constitute the repair lines as regards number of engines and total time in the shop, in such a way that the required output will be obtained with the minimum number of engines under repair.'
> (Bond, 1953, p. 197)

The effective operation of the progressive system in terms of the reduction of time locomotives were under repair is thus based on managerial knowledge of the labour process and control over the allocation of men to managerially defined tasks.

CONTROL OVER COORDINATION

The most significant change in production was not the progressive system but the method for coordinating the production that accompanied it, so that men, machines and material arrived at the stages when necessary. That is to say, the most important change was not the reduction in movement but the reduction in idle time, in terms of stock, men not working and machines unused. The system of coordinating production that grew up was aimed at ensuring that men, machines and material were brought together at a point to produce at the right time, not too early which would waste that resource. For example, stock arriving late would waste other resources such as the labour and machines waiting to be used. There are two major phases in the development of co-ordination

1. the initial inter-war developments in progressing, which slowly developed until the closures.

2. the intensification of progressing facilities after the closure plan, in particular the adoption of network analysis and computerisation.

Management aimed and achieved control over the coordination of production as a means of unifying all the shops of the factory, Lemon states this position clearly:

> 'In order to ensure successful results from the progressive construction methods, it is essential that there shall be a regular flow of raw material to the unit production shops, and a constant supply of finished components to the erection shop. A shortage in the supply of bolts and split pins is just as disastrous to the system as a shortage in

the supply of larger units.

To meet this necessity an organization somewhat similar to the train control office of the traffic department has been set up at each main factory, and is known as the schedule and progress department. Immediately an order is received for the construction of new rolling stock, a schedule is prepared which gives the actual number of working days required for the construction of the vehicle from the date the drawings and specifications are issued by the head drawing office to the vehicle going into traffic. The schedule gives the number of days allowed the stores department to obtain the necessary raw material, and each shop is allotted a definite number of days for the execution of its portion of the work on each unit....

The progress department issue manufacturing orders to the shops and follow up the material through its different processes from the raw material to the finished state, plotting the progress on a series of charts. Each shop is represented on the charts by a different colour...

By this means a shop holding up a particular component can easily be traced and prompt action taken.' (Lemon, 1930, p. 423-425)

Under the old system the foremen planned the work, here the engineers planned the work. The factory is seen as one large whole. The progress system defined what was to be done and monitored the work flows to ensure that the work was being done as planned.

The increased effectiveness of specialization and progression placed inter-shop coordination at a premium. It was seen as imperative that materials arrived at their appointed place when work was programmed to occur. Fowler sums up this whole philosophy of coordination:

'The strength of a chain is that of its weakest link , and therefore the whole should be of equal strength, so in the case under consideration, the efficiency of supply must be complete in this respect. Every care must be taken to see that there is complete balance between the machine and fitting shops etc and the erecting shops. That this may be so, it is necessary that as much notice as possible shall be given to the several shops as to the actual time that the various articles are required alongside the engine. This can be done by carefully compiling a list of the parts of the locomotive, and the day and time that they will be required after the locomotive has been received, and advising the shops concerned that the engine is in. When this is done properly, in fact, the information that an engine has arrived in the works automatically tells each leading hand when his

> work for that particular locomotive will be required.' (Fowler, 1929, p. 63)

The aim of management was seen as taking control of the coordination of all production to ensure that weak links were reduced to make the factory a machine working at a constant pitch. The ability to achieve this type of coordination required managerial knowledge of the labour process:

> ' Before laying down the progress schedule for the erecting shop, the time taken for various operations with the facilities available must be studied very carefully. ' (Fowler, 1929, p. 76)

After this research the components shops are integrated into the flow of rolling stock through the erecting shops, which is the central focus of the works:

> 'After a careful study of the time when the various parts are required for assembly, a list has been drawn out for the guidance of all shops as to when the various parts are required to be at the engine, counting from the first day when assembly or actual re-erection of the engine begins...
>
> In the shops where repairs are carried out, a progress sheet is drawn up by the shop clerk for each chargehand showing, from the information given, the time when the details dealt with by him are required back in the erecting shop. This ensures that they know exactly what is required of them and can lay out their work accordingly so that under normal circumstances the work is neither delayed nor done unnecessarily early.' (Fowler, 1929, p. 76)

The aim is to integrate the whole of the works to produce and deliver goods at the right time.

This timetabling is made clear to those responsible for supervising the shops by clear documented instructions, the 'data given on it is a progressive list of the various major operations in the order in which they are carried out and at such intervals as are required for the completion of the various stages'(Fell, 1939, p. 161). The instructions issued to component shop foremen were aimed at ensuring that their production was in line with production from the erecting shop:

> 'These schedules are related directly to the belt moves, and thus by reference to the daily minutes each shop foreman is aware of the time when details are due back in the erecting shop.' (Bond, 1953, p. 204)

There was thus a production process in paper which was echoed by the actual process of production:

> ' Progress of the work though the shops should be carefully planned , so as to conform with the programme laid down for the various stages of the work to give the required output. ' (Fell, 1939, p. 161)

The progressing of the works was monitored by establishing planning engineers offices as early as the 1920s (Lemon, 1930, p. 431; Tonkin, 1921), which maintained large progress boards charting the progress of components and repairs through the shops (Bond, 1953, p. 196). During the 1940s the LMS saw the growth of 'modern production planning organization' to deal with material ordering and progress, machine loading, jig and tool design and rate fixing, all of which had been the responsibility of the foreman (Forsythe, 1949, p. 295).

That management should be concerned with the coordination of resources probably is of little surprise, it is for this reason that it is of importance and is clearly central to the managerial programme. Hudson writing in 1970, a graduate engineer later to reach senior level, states its importance as the justification for centralized control:

> 'The problem of ensuring that company resources are efficiently used has long been one of the major problems confronting management. The basic resources of industry are men, machines and materials and the efficiency with which they are used is directly related to the quality of the work schedules employed. The solution to this problem involves the development of more effective Production Planning and Control Methods but this is no easy task for they must ultimately embrace every activity within the factory. These activities are so deeply interdependent that

> the major headache is deciding where to start. However, one of the basic objectives of any Production Planning and Control System is to gear effectively all factory activities to the demands of the main assembly shop, which can justifiably be regarded as the nucleus of the factory. In a Railway Workshop , this is the Main Repair Shop; and the schedules in operation here should be the first to come under close scrutiny when higher productive efficiency is being sought.' (Hudson, 1970, p. 167)

The controlling of flows of material through the works was recognised in the BREL management structure with a separate Progress Engineer 'controlling the movements, in quantity and rate, of all materials required in production activities' and 'supplying a continuous record of material movements with special attention to shortcomings in quantity, quality and rate' (BREL, 1972, p. 4).

PRECONDITIONS FOR COORDINATION CONTROL

Once the times for work had been established there were a number of conditions that are considered necessary for factors of production to be coordinated. The first is to have stocks of materials that cannot be repaired in the time that the rolling stock moves through the erecting shops. As Beames says: 'Obviously it is necessary to have certain spare parts available before such a system can operate' (Beames, 1928, p. 258), chief among which, as has been established, is the boiler.

The other important factor is for management to have control over labour time, Bond argues that the minimum amount of repair is achieved by meeting the following conditions:

1.Sequence of repairs must conform to a strict timetable.
2.Each stage allocated maximum numbers of men for minimum hours.
3.Component repairs must be in line with the main erecting shop.
4.There must be adequate replacement stocks of components.
5.Constant scrutiny to ensure non delays or decreasing standards.' (Bond, 1953, p. 196)

Thus in order to achieve coordination of production, management must take control over the timetable or production, whilst maintaining control over quantity. This process will often entail having stocks of spare components and is thus dependent on interchangeability of components and therefore accurate machining and standards of examination and inspection.

At the erecting shop at Crewe, where the belt system was in place, the time schedules were enforced by the predetermined movements of the belt:

' It should be mentioned that the prearranged times are most strictly worked to, a clock which is altered daily showing the time for the move the next day. A move is made on the blowing of a buzzer in the shop. This time limit is one of the most important features of such a scheme. The knowledge that component parts must be delivered in time to be put in before the next move proves a powerful incentive to every shop in the works.' (Beames, 1928, p. 258)

However, the enforcement of time discipline was in place under all progressive systems:

'A definite number of operations has been allocated to each road, each operation having a time limit which is denoted by clocks placed at the end of each track. Immediately under the track clock is a printed notice detailing the work to be done at each particular stage and no work is allowed to be carried out at any point other than at the stage allocated to it.' (Lemon, 1930, p. 429; also Fowler, 1929, p. 63)

EFFECTIVENESS OF THE INTER-WAR CHANGES IN PRODUCTION

The changes in methods produced the desired effects in terms of the dual aims of the workshops; it increased the utilization of raw materials, manpower, machinery and space used in production and increased the availability of rolling stock. Lemon describes the results as follows:

> 'The system provides for the erection of a maximum number of vehicles with the minimum amount of shop space; expedites the building operations from the start to finish, and creates economies in time and labour. The economies achieved by the introduction of this system have been substantial, for whereas a carriage used to occupy floor space for a period of six weeks from the time of laying down the frame until the roof was put on, today under the unit assembly only six hours are required from the time the carriage underframe is brought into the body construction shop until the fixing of the roof. As a matter of fact in the Derby Works from the completion of the floor to the finishing of putting on the roof is under one hour. ' (Lemon, 1930, p. 426)

The increased rapidity in the production of coaches was echoed in the decreasing number of locomotives out of traffic:

TABLE ELEVEN

PERCENTAGE OF LMS LOCOMOTIVES UNDER OR AWAITING REPAIR

1923	19.02
1924	18.11
1925	13.47
1926	13.24
1927	8.66
1928	6.13

(Fowler, 1929)

The effect of the inter-war changes also increased the availability of components, for example boilers:

> 'Briefly, the net result of this reorganization has been to effect a great saving in the time of repairs with a consequent decrease in boiler stocks coupled with a considerable reduction in piecework prices.' (Kirkland, 1934, p. 336)

The reduction in boiler stocks was the equivalent in internal terms to increasing vehicle availability, conforming to the general stress on utilization.

THE CREATION OF LATERAL CONFLICT BETWEEN WORKERS

The enforcement of time discipline was not too difficult because there appeared to be an unintended consequence of the strict time control, which was the creation of lateral conflict in the manner described by Burawoy and opposite to that expected by Edwards. Edwards argued that the application of technical control created homogenous labour and linked this into a production system. He claimed that 'the combination proved to be exceptionally favourable for building unions'(Edwards, 1979, p. 128). However, there are internal problems with his account. For example, earlier in the same chapter he referred to the effect of mechanization, which he sees as the precursor to technical control, in creating isolation, and this does not appear to be favourable to the building unions (Edwards, 1979, p. 114). Burawoy speaks of the endemic nature of lateral conflict on the shopfloor. He argues that in the piecework shop he discovered the pressure to 'make out', his term for the achievement of bonus payments. He argues that this pressure to 'make out' led to conflicts between machinists and auxiliary workers and co-workers - indeed with anyone who can prevent the machinist from making out. He refers to this process as the 'dispersion of conflict' (Burawoy, 1979, p. 65) and argues that inter-worker conflict had increased whilst management worker conflict had decreased between the time of his study and a study of the same firm carried out by Donald Roy (Roy, 1955). Burawoy's explanation, which appears to rest solely on improved relations of trust between management and men, is not particularly convincing (Burawoy, 1979, p. 70-71). In the railway workshops the tightened coordination that was exercised by management did not result in mass unionism as would appear to follow from Edwards theorising, unionism was well established before the period of mass production. It did, however, result in a growth in lateral conflict between workers, whose ability to 'make out' had come to depend increasingly on the timely performance of work by other gangs. Writing at the time, one Engineer expressed surprise that workers:

> 'even began to criticise things themselves. It certainly was helpful when a charge-hand reached the stage of telling another that he was half a day behind.' (Fowler, 1929, p. 69)

This very same process was commented on by Bond some 25 years later,

> 'the knowledge that each gang's work is dependent on the previous stage has a powerful influence in maintaining the general flow of work, and the standard of workmanship' (Bond, 1953, p. 197).

This process was also noticed by the Consultants Urwick, Orr at York (Urwick,Orr, 1962a, part two, p. 15). It is possible that workers' concern that management properly coordinate production flows, which has its origins in a concern over pay, may lie behind worker acceptance of managerial prerogative. Cook, works manager at Swindon, identified worker concern for work progress as having this origin:

> 'The repairing of locomotives is a complex matter involving many trades, different degrees of work and processes, and subsidiary to this a number of surrounding sections preparing and repairing component parts which have finally to converge for assembly. In order to obtain the best return from the manpower involved, the staff must be kept fully

employed, and the moment one job is completed, the next must be available. This cannot be achieved to this ideal degree so there must be some reserve of work at each stage. All the productive staff are paid by results. Their natural reaction is related to maintaining their earnings and their sub-conscious desire becomes one of seeing a full flow of work and plenty of work around them waiting to be done.' (Cook, 1947, p. 11)

Urwick, Orr argued that workers' restriction of output at York was an accommodation to bad managerial progressing: 'previous experience of the incidence of material and component shortages has led to a pace of work which is consistent with estimates of total work available' (Urwick, Orr, 1961, p. 28). It is certainly the case that unions identified the provision of work as part of the managerial role and one which management accepted (see the discussions of the workers in chapter five and on scientific management in chapter 9).

THE POST-WAR SYSTEM

The effectiveness of increasing managerial control from the 1920s should not be overstated. Urwick, Orr carried out a number of studies of production organization at Shildon and York during 1961 and 1962 which suggested that supervisory staff retained a large measure of control. At York although there was a master schedule for when components were to be produced (Urwick, Orr, 1961, p. 10) and 'production engineers' and 'scheduling staff' dealt with 'routine sequencing' and 'planning' of production (Urwick, Orr, 1961, p. 13). But

> 'there is no detailed pre-planning of the sequence and timing of operations. Each foreman has a number of progress clerks whose duties are primarily to ensure the necessary flow of raw materials into and through their respective departments, to give warning of impending or actual shortages and to 'chase' other departments where necessary. Their activities are co-ordinated at a daily progress meeting and at a weekly new work meeting ' (Urwick, Orr, 1961,p. 12 also p. 18).

At York, although management specified that particular components were needed at particular times, 'there are relatively extensive facilities at York for progressing the flow of coaches through the works' (Urwick, Orr, 1962a, part 2, p. 16).

Management argued that 'with these exceptions, formal scheduling procedures are not in evidence' (Urwick, Orr, 1962a, part 2, p. 15), and the detailed planning of tasks was left on the shopfloor, re-enforcing a point I made earlier that progressive production does not necessarily constitute managerial control. Urwick, Orr argue:

> 'The Production Engineer and Planning Officer play no significant part in the coach repair field. The task of planning and developing repair methods is primarily the concern of individual shop foremen.' (Urwick, Orr, 1962a, part 2 p. 18)

The cause of repair work being 'run of its own volition' was argued to be that 'the scarcity of production control information makes it difficult for the Works Management to exercise effective control' (Urwick, Orr, 1962a, p. 8).

It would appear that the changes in production control had not gone very deep and only dealt with the throughput of major components, leaving an abode within the factory hidden from management:

> 'While there is an established system of monitoring the completion of major items, the planning and controlling of components production is subject to a subterranean process of shop to shop haggling, the results of which are not necessarily related to true priorities.' (Urwick, Orr, 1961, p. 30)

Urwick, Orr argued that the consequence of managerial control being exercised only at the level of large items was lack of utilisation of materials due to lack of integration of resources: 'The volume of work-in-progress is increased by the tendency of each shop to ensure its own regular supply of work' (Urwick, Orr, 1961, p. 31). 'It does not ensure that all repair shops are co-ordinated in the best possible manner' and 'The progress system is not integrated'. All of which meant 'It does not ensure ... that relative priorities are correctly formulated' (Urwick, Orr, 8-3-62, p. 8). The system adopted during the inter-war period was not seen as going far enough in removing production responsibility from foremen or enabling management to coordinate the factors of production in all the shops according to its priorities.

The adoption of diesels exacerbated this situation, increasing foreman control further:

> 'During the lengthy process of BR familiarisation with diesel repair and overhaul, the planning of work has been carried out in individual sections by local foremen, with such co-ordination of planning as could be contrived by works managers through frequent foremen's meetings. (Modern Railways, 1966, p. 365)

FURTHER ADVANCES IN MANAGERIAL CONTROL

The subterranean process of foreman control and its increased significance due to rolling stock changes were the subject of managerial erosion during the works modernisation plan. Flow lines were extended, as noted, but this time with greater flexibility within stages, and, as in the inter-war period, managerial control over production was extended. Of great significance here is the adoption of the technique of network or critical path analysis. As this has a very low profile in the sociological literature it will require explanation. Wild summarises it as 'a method of planning (and controlling) large complex projects of the type found in civil engineering, the aerospace industry, shipbuilding etc (Wild, 1980, p. 97). The new rolling stock introduced under its auspices was more complicated, and therefore it was felt that 'good time schedules are more complicated to calculate' and that networks would 'enable a multitude of known, inter-dependent activities (such as compose a locomotive repair) to be set down in a form revealing most clearly their relationship with one another' (Boocock, 1968, p. 240). To a large extent the method of network analysis is the formalisation of past practices, the process of formalizing leading to a rigour in the application of managerial logic.

The first part of the procedure is the listing of all activities necessary to produce a given use value. Then, for each activity the following two questions were asked:

' a. What must be achieved before this activity can begin and
b. What activity could begin when this activity is completed ? '
(Boocock, 1968, p. 243).

Once this is achieved it is possible to map the activities in some way, originally this was on paper. The mapping process starts with the first activity and ends with the last, with all the activities being placed in logical and temporal sequence, for example, the lifting of the engine from a locomotive was logically after the removal of the locomotive's roof to enable it to happen. It was considered vital that present methods were forgotten, and it was considered that the resulting networks 'portray the true logic of the job and not merely current working methods' (Hudson, 1970, p. 170). Benefits were seen as accruing to management, and it was felt that the questioning of sequences 'will reveal a great number of instances where activities previously thought essential to be taken in sequence can in fact be carried out concurrently and this way can produce much reduced schedule times' (Boocock, 1968, p. 243). In all but the very simplest of processes the map of activities would not show a straight line, as would Adam Smith's pin manufacturing, but would show a network of interrelated sequences of activities that would eventually accumulate in the final completed product, for example, work on repairing the body of a locomotive may not be too dependent on the activities relating to the engine and yet complete repair would entail both.

Once the network has been completed the times that the activities take under normal manning is added, drawn from past experience, piecework times, or workstudy (Boocock, 1968). Once this is done it is possible to identify the 'critical path' which is the sequence of activities under normal manning that govern the minimum time at which a project, repair or construction, can be completed. In the same way that particular components' deterioration governs the repair time, so particular activities govern the completion time. The establishment of the critical path simultaneously identifies non-critical sequences whose late completion would not alter the final completion of the project under normal conditions, and the amount of slack time on these sequences was thus identified.

Networks increased managerial understanding of the nature of production and enabled the dual aims of increasing the utilization of rolling stock and reducing repair cost by identifying and ensuring progress on the critical path and allowing smooth allocation of staff to float activities. Boocock identifies the following as the policies to be pursued once the network has been identified:

> ' a.To maintain continuous progress of the critical path,
> b.to allocate all non-critical activities within their available float time,
> c.to maintain as far as possible a constant level of manning throughout the length of the repair for each of the principle grades, and
> d.to ensure that the men are not scheduled to work in such a concentration in any one area that they get in each other's way.' (Boocock, 1968, p. 247)

Thus, networks enabled the management to ensure that men were being utilised at all times on activities that actually contributed to minimising production times. Networks also gave management further options: a 'time limited schedule' or a 'resource limited schedule' (Hudson, 1970, p. 169); altering manning levels to increase the throughput of rolling stock or reducing the speed of rolling stock throughput to ensure that all activities were carried out with the minimum labour; and so on. It gave information about the effect that extending the critical path would have on total manning levels and it allowed a comparison between utilisation of labour and utilisation of rolling stock. It thus acted as a decision making tool. In Hudson's words: 'logic can be expressed in network form, and analysed with the object of establishing a better balance between overall time and smoothness of manning' (Hudson, 1970, p. 167). There is some dispute over what the main purpose of networks was. Hudson appears to see their benefits in terms of reducing costs, whilst Boocock is more concerned with time reduction (Boocock, 1968, p. 239). The use of network analysis is based on a clear understanding of the nature of production and this meant that knowledge of the new rolling stock, which had to some extent been the preserve of the foremen, had to be increased:

> 'When sufficient experience and knowledge of the work involved had been accumulated, the General Manager Workshops and the Director of Workstudy decided that Network Analysis techniques should be pursued in the planning of diesel locomotive overhauls at Doncaster Works.' (Modern Railways, 1966, p. 365)

These first attempts at Doncaster, in June 1964, proved very successful, and overhauls were cut from 40 to 19 days and further falls were anticipated (The Engineer, 1967, p. 320). By 1965 the method was being used on locomotive maintenance (BRB, 1965, p. 45), and a year later it had 'wider application' on all rolling stock (BRB, 1966, p. 34).

The impetus for network analysis probably came from the workstudy division. The workstudy division staff were 'much impressed with critical path analysis' in the 1950s when one of the earliest visiting speakers to the division's headquarters explained how it was used when building the M1 (Larkin, 1979, p. 130). In 1963 the division was giving courses in the technique, and these courses were given 'increasing emphasis' in 1964 (BRB, 1963, p. 40; BRB, 1964, p. 41). Workstudy men had a high profile in the workshop division, Larkin who had been head of BTC workstudy, becoming the deputy manager in 1962 and a colleague becoming the personnel manager (Larkin, 1979, p. 140). At Eastleigh the workstudy division was acting as consultants and was used in the by now common role of improving human relations by giving talks on the technique, although these were only to supervisors and charge hands (Boocock, 1968, p. 242, 248). It may be possible that works management had some role in initiating the use of networks, the transformation of the shop layouts in the works modernisation plan was based on networks prepared in 'collaboration between the contractors and works managers' (Brookes, 1980, p. 36; see also Ridgway, 1967).

A productivity committee of all works productivity engineers was established to develop universal recommendations. These were:

1. All repairs to be networked.
2. Control centres to be established at all works to:
    a. Monitor adherence to plan.
    b: Coordinate repair and supply shops.
    (Boocock, 1968)

Thus, network analysis continued the themes of earlier changes in production. It enabled the dependency on the foreman to be revealed. Indeed a workstudy division paper gave one of the major advantages as the 'release of foremen from planning activities to man-management'(Quoted in Modern Railways, 1966, p. 365). It made the supervision easier because the network schedule attached to rolling stock enabled 'supervisory staff to ascertain at once the stage to which work has progressed' and compare it with what was scheduled (Engineer, 1967, p. 320; see also Modern Railways, 1966, p. 365).

Another theme which continued was the increase in importance given to ensuring that the component shops were integrated into the flow of work in the erecting shop. The increases in throughput were seen as justifying this integration:

> 'It is essential that smooth flow of materials to and from the erecting shop be obtained to obviate material shortages which would delay the repair of the locomotive.' (The Engineer, 1967, p. 320)

The progress office were responsible for ensuring that component shops complied with the network, a 'transport form' being sent to the erecting shop, supply shop and transport control, giving 'the times at which the materials are due away from the erecting shop and the times due for their return from the repair shop' (Engineer, 1967, p. 320).

As with earlier developments in managerial control, part of ensuring the flow of rolling stock was the provision of spares, it was felt that networks would enable a reduction in spares holding:

> 'Subsequent analysis by networks of the time required to repair spares will show whether in fact spares can or cannot be repaired within the time allowed from their removal from

> the vehicle body to their replacement a critical reassessment of spares holding can be made from this.' (Boocock, 1968, p. 247)

That improvements at Eastleigh were first sought in the erecting shop is a reflection that engineers gave precedence to improving things in the correct order, working from the central process to the peripheral.

Control over the timing of the networks also led to increased demands for increased supervision. Bond, the head of the workshops made this clear:

> 'a principal job of the works management in this sort of repair must be to make it very difficult indeed for the schedules not to be complied with ' (Boocock, 1968, p. 259)

And as with previous changes it advanced managerial understanding of the production process:

> 'The control centres continuous graph provides management with a clearer record than ever before of the manning and progress of locomotive repairs.' (Boocock, 1968, p. 251)

Larkin saw it as a major move away from decisions being based on 'guesstimating' (Larkin, 1979, p. 126), and satisfied the concern for efficiency in terms of the dual aim of the workshops. Robson notes:

> 'It led not only to cost reduction but also an improvement in the availability of locomotives and rolling stock.' (Boocock, 1968, p. 258; see also Modern Railways, 1966, p. 365)

At Eastleigh repair time was reduced from 20 to 12 days, excluding testing (Boocock, 1968, p. 240). The use of networks reveals the significance of coordination as a means of increased output because increases in throughput did not result from any one area working harder : 'Rescheduling does not alter times or method of working' (Boocock, 1968, p. 271). What they resulted from was the ability to identify where men should be allocated to ensure the minimum times and also as a means of reducing costs, which activities had slack times so that they could be timetabled so that as one job finished another could start and men could be transferred from one to another. What this required was flexible staffing (Engineering, 1967, p. 247) and the pay and efficiency agreement of 1969 achieved this, and can be seen as a consequence of managerial desire for flexibility with the advent of network schedules, aiming at 'complete versatility and flexibility within each category' of the three non skilled grades and the reduction of demarcations between and number of craft grades (BRB, 1969, p. 14).

IMPACT OF THE 1960s CHANGES

By 1970 York was organised differently to that revealed by Urwick's reports, and management prerogative was firmly established, 'in order to exercise full management control the build is planned in detail' (Sykes, 1970, p. 181).

The position through which management exercised this control was the Works Production Engineer, whose domain consisted of four sections:

1. Production planning.
2. Work study.
3. Jig and tool design.
4. Technical costing and estimating.

Instead of the foremen determining production methods, it was the Workstudy Division which had to 'determine the most efficient method of manufacture' (Sykes, 1970, p. 181). Unlike the previous situation, it was the Production Engineer's Unit that studied labour and machine requirements and decided upon production dates (Sykes, 1970, p. 183). Again unlike the earlier situation, there was centralized progressing in the Production Planning Office who ensured that 'work which is not moving in accordance with the planned dates is listed and brought to the attention of the producing department concerned' (Sykes, 1970, p. 184). By 1980 the Managing Director of BREL could state that York 'stands comparsion world wide' (BREL, c1980, p. 2), the 1960s changes at Derby Carriage and Wagon were seen to have similar results, in the technical press the factory was declared to be 'the most complete of its type in Europe' (The Welder, 1965).

COMPUTERISATION

The application of network analysis was to a large extent the precursor of the application of computing to manufacturing systems. The first references to computer applications to production were to simulating networks which began in 1967 using the ICL PERT package (Hudson, 1974, p. 23; also Boocock, 1968, p. 257). However, there is no mention of computerisation during the early 1960s even though the computerisation of aspects of works organization were considered from the earliest days of computing on the railways (Hines, 1958, p. 24).

The railways had been pioneers in the use of electric punch card accountancy and statistics machines, using them at Swindon as early as 1911 for mileage statistics (Hines, 1958, 21; Sargent, 1955, p. 1). The computer made most headway in the fields of accountancy and research for the first 15 years or so. Swindon ordered one of the first commercial computers in 1956, for use on payroll and stores (Sargent, 1955, p. 1). Not surprisingly the research department ase also among the first to order a computer (Hines, 1958, p. 26), although a later research computer purchased in 1965 was made available to other departments (Engineer, 1965, p. 888). By the end of the 1950s most of the major works had computers for payroll, cost allocation and stores (Hudson, 1974).

By the late 1960s it was felt that computers should have something to offer production control which was said to be 'the heart of the business', and which until that period had been limited to simulating networks. In August 1970 a five member computer applications team was established to recommend ad-hoc applications and produce systems reports (Hudson, 1974, p. 31).

Shop scheduling and requirements planning systems had become universal by the start of the 1980s, and were to 'sort from date priority requirement and capacity data, the programme of work for a machine or group of machines' (IME, 1981, p. 327) and requirements planning was used to 'decide ordering of raw material and complete components' (IME, 1981, p. 329). There were also developments toward integrating several systems. Hudson felt that in relation to the range of possible computer developments:

> 'to develop each system in isolation would be undesirable and that the development of each should be planned with their ultimate integration clearly in mind.' (Hudson, 1974, p. 25)

The control over component scheduling was an extension of the earlier principles of extending managerial control, it was aimed at 'reductions in the value of work in progress' and the extension of control over non-manual work (Hudson, 1974, p. 30). Computerisation was seen as offering management greater potential for control than before, as it enabled the handling of complexity and flexible responses:

> 'to increase control over component manufacture. The problem is a complex one with thousands of jobs all following different paths through the factory. In addition, the shop floor environment is highly dynamic with changing priorities, urgent jobs, breakdown etc. The need is to be able to re-schedule the factory when required. The volume of data is such that , with the former system of manual load boards, it was most difficult to attain the desired level of control' (Hudson, 1974, p. 27)

Flexibility on the part of management to adapt to changing material requirements was seen by Hudson as requiring, as with control over coordination in the past, greater shop floor obedience to managerial dictate:

> 'Operational problems have been greater than with other systems because a large number of people are involved at management, supervisory and shop floor level. These systems require greater discipline than their manual predecessors, both by the shop floor in working as far as possible to the work-to lists and providing accurate feedback, and by management in ensuring that due dates and priorities are correct.' (Hudson, 1974, p. 27)

The need for greater control with computerisation was re-iterated in the 1980s:

> 'Using such a system requires acceptance of discipline on the shop floor by everyone (machine operators and supervisors), which was not essential with simple machines and and manual systems.' (IME, 1981, p. 329)

The development of computerisation of production is the mere continuation of the pattern of managerial development this century, orientated to the elimination of uncertainty by increasing its control over the coordination of labour, means of production and raw materials.

SUMMARY

This chapter has examined the central process of control over coordination of production. Advances in technical control have been a manifestation of and dependent upon managerial control over coordination: what Sohn-Rethel refers to as 'direct quantification and measurement of labour effected within the labour process of production and in its own terms' (Sohn Rethel, 1976, p. 31). As he makes clear 'it is a measurement of labour not on its own, but of labour in conjunction with and dependent on the technology with which it combines in production and answering the formula of unity of measurement of human and technological functions in their combined productive application' (Sohn-Rethel, 1976, p. 31). The increasing managerial coordination of production is the manner in which labour and material reality are made into one combined and comparable process, all movements of labour and machine and all complexities of products unitised ready for their re-combination in the act of timetabling, the coming together of all factors of production at one point or in Sohn-Rethel's words 'the unity of the synthesis of events in time' (Sohn-Rethel, 1976, p. 31).

The principle, and justification, driving management forward is utilization of machines, space, materials and labour. The production process is a series of activities, which has a central process or series of events around which other processes orbit, and to which they must conform. Added to this, the whole production process is an integrated network of activities which need to be performed in the correct order. As they must be performed in the correct order, so must they be changed in the correct order: from assembly shop to supply shops, from production process to paper process. The correct order and the centre of the process shift: as utilization is enhanced in one area it ceases to be the factor governing the speed of production, and management shifts its attention to another area. Each advance in utilization achieves less and involves more sacrifices.

The underlying theme within the history of the railway workshops has been the development of managerial control over coordination. It has grown by degrees from progressing to networking to computerisation. Utilization by coordination gives management real results not dependent overly on human effort, it is based on its effective direction toward management goals, and each advance requires greater shopfloor discipline.

The origin of the growth in control over coordination is in the crises of productivity at the turn of the century and its related intra-managerial struggles. In the workshops control over coordination has been developed according to the dictates of engineering ideology and policy. The consequence of this has not only been an increase in the utilization of all the elements of the labour process but an increase in the ability of management to respond to changed conditions by coordinating the labour process in some other fashion. This can be achieved because of managerial knowledge of work and the flows that connect them. The discussion of network analysis provided a clear illustration of this ability.

A question that is raised by this discussion is whether a labour process dominated by accountancy would lead to this growth in the control over coordination, given that I have claimed that the engineering perspective appears to offer a more effective method of coordinating production. In this regard I would argue that the application of computerised work programming packages during the period of accounting hegemony would appear to support the claim that control over coordination continues under the auspices of different types of management. I would suggest that the coordination achieved would reproduce certain problems that would contribute to inefficiencies when compared with the non accounting dominated labour process prevalent outside of the UK. Some of these were discussed in the last chapter, but the major difficulties would be that accounting dominated production stresses the centrality of the cost centre, it is in the interest of the manager held responsible for that cost centre to 'make out', to extend Burawoy's concept. A manager can show good savings on his cost centre by effective utilization within the department or process that he is responsible for, but this does not necessarily lead to effective coordination across the plant as a whole. Indeed, it may result in passing externalities onto other shops, thus creating lateral conflict. As a whole, the likely result is the lack of coordination between shops that was seen as typical in the last century (Chapter three). The use of financial criteria is a basis for reproducing the labour process by providing a monitoring mechanism to ensure that costs do not add up to more than can be recouped from some source, whether this be the market or the state. Accounting also enables comparison between different processes to show which seem to be particuarly wasteful. It therefore directs management's gaze to that process and highlights those particuarly cost efficient processes enabling them to be emulated. What accounting cannot yield is a picture of the labour process as the interdependent whole that it is. It can present a picture of the labour process as the addition of a number of cost centres but it cannot assist in making linkages between them - that has to be based on technical knowledge.

This chapter has argued that the reduction of costs under the system of wage labour organizations rests upon effective utilization of the elements of the labour process. Effective utilization depends on the control of coordination, which also increases the ability to reproduce the labour process. In the railway workshops, the increase in management's ability to control the coordination of the labour process has continued throughout the twentieth century and has substantially replaced earlier systems of control based on the direct supervision of labour by foremen. The development of coordination depends on technical knowledge and an over reliance upon accounting methods of control can stunt management's ability to perceive effective solutions to the reproduction of the labour process. The engineers have been the bearers of these technical solutions, and in the next two chapters the development of control of coordination and the related practice and ideology of engineering is related to the process of mechanization and Taylorism.

CHAPTER EIGHT

CONTROL OVER MEANS OF PRODUCTION

INTRODUCTION

As was argued in the last chapter, Marx considered that the development of mechanization constituted the fundamental transformation within capitalist industry. In this chapter it is argued, that as regards the railway workshops, this is not the case. It is argued that the development of machinery is but an aspect of the development of control over coordination.

What is argued below is that the benefits that accrued to management from controlling coordination - that is the ability to increase the utilization of elements of the labour process and the ability to change the manner in which labour raw material and means of production are organized - is evident within machines. It is true that a major advantage of machines is that they have the potential to run faster than is possible under human motive power, but Marx sees the advantage of machinery in the freedom to be able to coordinate raw material and tools more effectively. He argues,

> 'The number of tools that a machine can bring into play simultaneously is from the outset independent of the organic limitations that confine the tools of the handicraftsman'. (Marx, 1976, p. 495)

Indeed, he argues that it is the freedom to introduce many different tools onto a machine rather than the replacement of human power 'which is first seized upon by the industrial revolution' (Marx, 1976, p. 496), and he gives the example of the process of spinning workers who not only had to watch a machine but had to provide the power to operate it. It is clear that the application of inanimate power increases the productivity of the labour process, but machinery yields major benefits by specifying the sequence and number of processes that are to be carried out, the result being to increase utilization of raw material and labour, and Marx gives the example of how one envelope machine was used to replace several detailed workers and their machines (Marx, 1976, p. 500).

The design of a machine is a direct result of knowledge of the labour process and is directed at the effective coordination of material processes, but as a means of transforming the labour process it is only partial. As Edwards pointed out, machines stand alone and need to be related to the whole productive organization (Edwards, 1979, p. 113). Machinery exhibits features of managerial control over coordination, machines ensure that tasks are performed according to managerial criteria and within managerial limits of speed. What it does not do is ensure the coordination between tasks carried out on different machines, although Kaplinsky (1984) has recently concluded that machine design, culminating in modern machine centres, shows a tendency toward integration. That is, the performance of what were previously separate processes carried out on separate machines, are integrated, which points to an increasing correspondence between managerial control over the coordination of production and its manifestation in automated machines. The more that tasks are integrated onto machines, the more important is the stress given to management control over the coordination between them. Marx recognised that this was so when he distinguished between the 'cooperation of a number of machines of one kind from a complex system of machinery' (Marx, 1976, p. 499). That is, the same machines could be just collected together performing the same task and using the same power source, as in a weaving factory where only cloth is produced, or different machines could be linked together in 'a real machine system' (Marx, 1976, p. 501) where:

> 'the object of labour goes through a connected series of graduated processes carried out by a chain of complimentary machines of various kinds' (Marx, 1976, p. 501).

The example that Marx gives is the process of wool spinning (Marx, 1976, p. 501).

In this chapter, I argue that, although mechanization has not led to management being able to dictate the nature of work throughout the labour process, it has provided a model on which management could draw. This model was the notion of coordination. In the railway workshops, management was by engineers with technical skills based on training in manual labour and theoretical engineering, and part of their duties during the last century was seen to be the invention of machinery. The value of the coordination of physical processes was not lost on management with this kind of background, and I would argue that the policy of coordination that was detailed in the last chapter may have its roots in the engineers' knowledge of machines. Gareth Morgan has argued that there are a number of partial metaphors by which management govern organizations, and in line with what I just claimed, he links the idea of the organization as a machine to the requirements of the mechanical age (Morgan, 1986, p. 38).

I would argue that this relationship between coordination and machine is not fixed. The power of machinery for improving the utilization of the elements of the labour process by improving their coordination may have suggested that coordination of the plant as a whole would lead to efficiency. Control over coordination goes further than the advantages of machinery; there have been productivity increases, but the real advantage of control over coordination is that these have been achieved by management having the ability to revolutionise the labour process according to its design. In the past, the single machine did not have this ability. The new flexible manufacturing stations or systems (FMS) discussed by Kaplinsky (1984) may have altered this position but the development of FMS may have been developed from the perceived advantages of managerial control over the coordination of the labour process.

Walker describes FMSs as 'generalized machine tools that can change programmes for different tasks, change their own tools for different tasks, and adjust and change the parts on which the are working' (Walker, 1989, p. 70), they are often found combined with robotics and automated methods of transferring the work. This new machine technology is seen as a central feature of the theory of 'flexible specialization' (Rose, 1988, p. 375; Wood, 1989, p. 3). Rose argues that the theory of 'flexible specialization' claims that the labour process in the western economies is changing to become 'small high-tech units able to switch rapidly from one customized product to another' (Rose, 1988, p. 375).

More generally, new technology - by which is meant that operated according to digital electronic control (Kaplinsky, 1984; Morgan, 1986, p. 38) - has been the subject of recent academic discussion. McLoughlin and Clark (1988), following Wilkinson (1983), categorise explanations of the application of technology into three camps:

1. Innovation theory, this identified as technological determinism. It is argued that the works of Woodward and Blauner, both authors writing prior to the micro chip, fall into this camp. Both are given as examples of authors who see the application of technology as resulting from an inevitable process of improvement and diffusion throughout industry.

2. Labour process theory. It is claimed that labour process theory sees technological developments as a means of increasing control over labour.

3. Strategic choices theory, which portrays the application of technology as the outcome of managerial choices, and the development of technology as reacting through the market to these choices.

It appears that strategic choices theory is becoming the orthodoxy (McLoughlin and Clark, 1988; Jones 1988). Strategic choices theory is a variation of the same contingency type theory that has come to dominate academic debates about the labour process. Under this theory, the employment of technology and its effects are dependent on the organization, and in particular on managerial decisions and struggles around those decisions. I would argue that, while it is true that labour is sometimes given more autonomy after the introduction of technology and that technology is not driven by autonomous product orientated criteria, it does not necessarily mean that labour process theory and innovation theory are wrong in total. Such falsificationism - that is the epistemological point of view that if one theory can be proved to have a contrary case then the theory is wrong - fits a cosy additive model of reality: each is wrong part of the time and, therefore, voluntarism and non-predictability is correct. On the contrary, labour process theory and innovation theory can be combined. Management aims at the totality of control over material nature and the utilization of the labour process. That is, all elements of the labour process are objects of control for management: the object of labour, labour, and the means of labour. Control in each area can be traded off for an overall advance in control.

In the discussion of the labour process debate in the introduction it was noted that this seemed to involve a rejection of Braverman's degradation hypothesis. That is, the range of opportunities to increase the exploitation of matter involves an endless oscillation between increasing labour skills and/or increasing control over matter. For example, Kelly argues that the growth in the demand for a wider range of products in the electrical engineering industry during the 1960s led to a growth in the skills of workers in these industries in order to meet this demand (Kelly, 1985, p. 37-39). This position is also taken up in discussion around new technology, Rose argues that the general tenor of the debate about flexibility is that artisan type labour is needed to meet the new flexible demand (Rose, 1988, p. 374). This view of the labour process is based upon a particular view of nature as something that can yield more and more use values and which can be subject to increasing control. Turner, writing in another context, has expressed this attitude, he argues: 'nature becomes less and less significant for human beings who, through collective and productive labour, push back the boundary of natural restriction' (Turner, 1984, p. 239). I would argue that there is a boundary to mankind's ability to transform nature and, in relation to machine tooling, this could well have been reached. At this point, the object of management may turn from the harnessing of workers' ability to exploit nature toward a search for a uniform method of production for a variety of products.

Given the reservation expressed about the exploitability of nature it is clear that management's desire to utilize both material and labour does contribute to a variation in the amount of control that workers are subject to across the labour process and during different periods. This contributes a major source of the variations and has been correctly identified as such within the labour process debate.

The claim that new technology heralds a new era of flexibility seems implausible. The railway workshops, because of the nature of rolling stock, have always produced in small batches to customised design. It is possible that the flexibility inherent in the control over coordination may have led to machines modelled on the labour process, and that 'flexible specialization' is the working out of themes decided at the turn of the century, rather than constituting a new conjuncture when crucial decisions are being made about the nature of capitalist industry. Piore and Sabel, among the most renowned theorists of 'flexible specialization, argue that the mass production industries of the past were the product of engineers' technical training which, using Morgan's concept and according to Piore and Sabel, was dominated by the machine metaphor (Piore and Sabel, 1984), Morgan also argues that the conception of the organization as a machine has been the dominant view and is only changing because of the emergence of information technology (Morgan, 1986, p. 38). The conception of the labour process as a machine was not so in the case of railway engineers, they understood material production as a flexible process of transformation, and this view has been central to the engineers actions.

In the chapter below I show that the railway workshops indicate that Marx was mistaken in seeing mechanization as the fundamental transformation in the capitalist labour process. It is shown that mechanization occurred within a larger framework of coordination and that the developments within machine technology are only explicable by reference to managements attempts to increase their control over the coordination of the labour process. During certain periods the speed of cutting machines was the important factor, but when speed was increased other factors in the labour process became of greater significance, for example, the transfer of raw material between machines. This description of mechanization as being part of a wider framework of control is done in such a way that casts doubt on the novelty of flexibility because it indicates that mechanization within the railway workshop was developed in a flexible environment. The major thrust of the chapter is thus to indicate that mechanization is part of the wider development toward managerial control over the coordination of the labour process.

This chapter takes only a partial view transformations of the means of production by focus changes in cutting machines, although other changes su in welding and foundry work reveal the same processes. [1] first part of the chapter describes the object of labour the machine shop, that is the components that are machined. A number of constant themes are examined as a means of setting the scene for the discussion of changes in machinery. It is shown that the nature of the object of labour is determined by the demands of the assembly shop and what can be supplied by the foundry, whether the latter be owned by the railway or not. It is shown that the object of labour of the machine shop has been shaped by two factors, an increasing

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[1] The new techniques introduced into the workshops during their history are as follows:

1. The replacement of hand tools by portable power tools, from power hammers to paint sprays.

2. The replacement of most rivetting and smithing by welding.

3. Individually electric driven machine tools to belt driven by first steam then electricity.

4. Increasing accuracy of machine tools, replacing fitting work.

5. Increasing cutting speed and force, replacing pre-forging of components.

6. The adoption of group technology, machines located in one area to reduce transit of raw materials.

7. The development of machining centres, a single machine performing several tasks replacing several setups or several machines.

8. The near complete mechanization of foundries.

9. The automation of welding, painting and cleaning culminating in robotics for welding and painting.

demand for more accurate machining and a relatively constant demand for small batch sizes. The source of the demand for increasing accuracy is shown to be a product of the demands for improved performance in rolling stock and a desire for interchangeable components in the assembly shops. Growing accuracy is shown to have led to methods of standardising measurement. The small batch size and the demand for accuracy are shown to have led to a constant demand for flexible and accurate machines, which was at first was manifested in the widespread use of jigs and fixtures but which increasingly has meant machines capable of being used for several components with accuracy, the FMS being a culmination of this process within industry as a whole.

The discussion about increasing accuracy with flexibility can be seen to a large extent as the product of external demands on the machine shop object of labour. The rest of the chapter is then devoted to what can be considered to be changes 'internal' to the machine shop. As an aside, it should be noted that the application of machine tools has two facets: the replacement of worn out equipment and the introduction of new techniques. Which of these is most important varies. For example, during the works modernisation plan, new technology took priority: whilst the emphasis was on replacement during the Second World War.

In this chapter, I am concerned with new methods, rather than the balance between new methods and replacement machines. The reasons for the introduction of machinery are listed and then these are illustrated by a discussion of the introduction of machinery in the interwar period. Then, given its importance in recent debates, numerically controlled machinery is discussed. The conclusion is that what is considered as the reason for the application of machinery varies, but that, overall, new machines are applied according to what they contribute to the labour process as a whole. That is to say, that the labour process is an interrelated whole and that machinery is applied to strengthen the control exercised over the whole of the labour process and not just as stand alone increases in productivity. The processes of mechanization are thus shown to be a product of management control over the coordination of the labour process and a means of advancing that control.

In this chapter I examine changes in machine tools only, although developments in other areas (for example, welding, foundries, and painting) reveal the same principles. Machine tools can be divided into two broad areas: stationary, usually cutting tools, and portable hand tools. The latter are used for cutting operations eg: grinders, but also include machines, such as riveting hammers, for joining material, for example. Machining exists to produce components for assembly and is affected by and affects developments of other processes, in much the same way as the labour process of the workshops as a whole is affected by material criteria (Chapter 2).

IMPACT OF THE OBJECT OF LABOUR

There have been changes in the type of use value in terms of both the nature of raw material used in machining, (for example, the growing use of plastics) and the replacement of steel for wood in coach construction. However, the machining of metal has predominated. The rawness of the object of labour has also varied. For example, more precision casting has meant less machining. The link between foundry and machine shop is not one way. For example, the introduction of small high speed lathes for engine couplings was to reduce 'costly forging' (Forsythe, 1949), the ability to machine from unshaped lumps of metal has reduced the number of smiths to insignificant numbers.

The impact of output has been more significant than the changes of inputs in the history of workshop machining. Outputs have their impact in two ways: the type of use-value produced and the amount of use-value produced, usually termed batch size. These will be examined, prior to an examination of the development of machine tool policy as a means of changing work practice. This examination has significance for the labour process debate because variations in the nature and size of output are often seen as leading to forces that move away from a general tendency to de-skilling (Wood, 1982; Cressey and MacInnes, 1980). I think this is correct, but it does not preclude all trends. A trend toward increasing control over all aspects of the labour process can exist alongside reductions in the control over particular facets. For example, a reduction in management control over labour may occur if this increases the range of products the organization can produce. Management have pursued policies of attempting to increase material control, by which I mean their ability to determine the shape of products. Control over the ability to shape products enables both Fordist mass production, by controlling the standards of accuracy , and flexible post-Fordist production, due to the ease of performing a range of accurate transformations of matter.

The type of output in the machine shop varies because of changes in either the final product or assembly practices. Although difficult to judge, the major impact is from changes in assembly practices.

CHANGES IN THE TYPE OF PRODUCT

The product of the workshops has remained fairly stable but it has not gone unchanged. From the beginning, machine tools were introduced to increase accuracy over a whole range of products and this is primarily aimed at producing interchangeable components, but it also aimed to improve the performance of rolling stock, for example, by producing accurate piston valves (Stanier, 1907, p. 3). The continual development of rolling stock to faster speeds with lighter rolling stock changed machining requirements. Ridgway argued that the rolling stock modernization plan significantly increased the need for accurate material control:

> 'the need to exercise more stringent control of existing dimensional and surface texture standards, have extended traditional plant and techniques to their limits and, in many cases, it has been necessary to develop new techniques and install new equipment.' (Ridgway, 1974, p. 9)

This material control increased the importance given to scientific study of the property of matter and machines were the object of detailed study in the manner that Taylorism studies labour, for example, wheels were, and probably are, the limiting factor in train speed, wheel lathes therefore became the object of investigation:

> 'a comprehensive detail study was carried out on the design and performance of wheel lathes, the sources and shortcomings identified and this information used in the selection of new equipment in order to minimize future problems.' (Ridgway, 1974, p. 9)

This study was perceived as 'eliminating mystique from the operation' and laying the basis of a managerially controlled improvement in wheels far removed from the previous situation of 'workshop practice'(Wise, 1973, p. 29).

EFFECTS OF CHANGES IN TYPE OF ASSEMBLY PRACTICE

Qualitative changes in assembly shop methods of production had an impact on machining practice, for example, it was Astrop's view that:

> 'The development and increasing use of all welded construction for railway stock has had far reaching effects on production practice. As might be expected, the facilities for profile milling of plates and the subsequent edge preparation for welding, have needed to be improved significantly.' (Astrop, 1973, 2, p. 614)

The development of welded fabrication gave a further impetus to accuracy, the relationship also operated the other way with machines having an impact on welding, for example the use of modern punching machines enabled the use of larger plate, therefore less welding would be required (Astrop, 1978, p. 24).

EFFECTS OF STANDARDISATION OF OUTPUT

Fully interchangeable components mean no cutting of metal in the assembly shop, ie, no fitting. The drive toward interchangeable components, therefore, has two effects: increased accuracy of initial machining and decreasing cutting during assembly. At Derby carriage and wagon works in the 1920s, the design, machining and assembly of coaches was dealt with as a single problem, with the singular aim of reducing coach construction time:

> 'to obtain the maximum number of parts which could be machined at one setting-up, the designs of the various types of carriage stock were examined from the point of view of reducing manufacturing costs ... large batches of standard parts to be put through with only one setting up of the machine. These improved methods necessitated designing of special tools sufficiently accurate to machine timber components to .004 limit.'(Lemon, 1930, p. 421)

STANDARDISED MEASUREMENTS: GAUGES AND JIGS

The drive toward accuracy for interchangeability, or any other reason, is dependent on standardised measurement and gauges.[2] Standard gauges and measures were at first applied to small components, eg, nuts, bolts, screws and basic things like the size of drill holes. Standardised gauges and measurements only became common in the workshops' second quarter century. They were introduced at Derby in 1858 (Radford, 1971, p. 50) and were first in evidence at Crewe in 1857 (Larkin and Larkin, 1988, p. 142). Standardised measurements for holes and pins laid the basis for the expansion of machine tools. Standardisation was seen as a means 'to reduce the cost of work, because articles which have to fit one another if made to gauges, do not require to be taken off the machine to see if they fit, all such taking off being a waste of time and money'(Garret, 1881).

Standardisation was managerially controlled by having centralised tool rooms (tools being the piece of hardened material that comes into contact with the material). Garret recommended the following:

> 'In every shop, if small, and every department if a large one, there should be a well-organised system of making, keeping in repair, and issuing tools ... standard gauges should be first provided. To these all tools such as flat boring bits, rhymers, etc, should be made, and the same gauges would be the standards to which work would be finished ... There should be provided corrective gauges in order to test from

[2] The aim of reducing human inaccuracies in measurement was not limited to establishing interchangeable components but occurred in other areas, for example, the emergence of 'modern optical instruments' for alignment during rolling stock assembly made engineers wonder 'how we managed to build a locomotive in the old days by using pieces of string, squares, straight edges and callipers' (Scott, 1937, p. 672).

time to time the truth of the gauges in daily use.' (Garret, 1881)

The use of machine tooling, as opposed to hand labour, was seen as requiring particular control, because of the need to impose best practice on the basis of scientific, as opposed to craft, knowledge:

> 'Hand tools are everywhere the same, for any departure from a correct shape would be felt by the shoulder of the operator, but tools used in cutting by power are not only different in various shops, but are often not a standard shape in the same shop.' (Garret, 1881)

Standardization of measurements was not firmly established until the beginning of this century, when engineers 'directed their attention to the question of standard tables of limits for the control of accurate dimensions and for the production of parts which were definitely interchangeable,' and began to adopt gauges 'the purpose of which is to eliminate human inaccuracies'(Murray, 1935, p. 418). Standardisation and the elimination of human measuring inaccuracies within machining as a means of increasing interchangeability was stimulated by the First World War, Haigh, writing in 1925 comments in relation to

gauges that;

> 'the manufacture of munitions taught us much, and now it will be found that in many works greater attention is being given to their accuracy in order that machines can be produced with components which are economically interchangeable.' (Haigh, 1925, p. 156)

Standardised gauges and tool shapes were overseen by the expanding number of examiners and centralised tool rooms, a process which continued into the middle of this century (Forsythe, 1949). Tool management developed to such a degree that some machines had their own tool store (for example, one had over 80 different shapes of tool), and this effectively ensured the maintenance of stipulated tool standards (Astrop, 1982, p. 37).

IMPACT OF BATCH SIZE

All machinery is to some extent limited in the transformations it can be used for. The adoption of machinery requires a choice over the amount of generality or specialization required. Where cost is considered to be important, one of the prime criteria for this decision is product batch size. The decision over what machine to employ depended on 'knowing the workload pattern' (BREL, 1985, p. 1), the BREL Production Engineer estimated 85% was known workload and because of the accident repair requirement, 15% was unknown. Large numbers of particular components would enable the purchase of specialised machinery.

Before recent advances in machine tool flexibility, the view of Fowler in relation to the application of machines was: 'the ideal being one machine, one job,' and thus no setting up to be done. But, he continued, 'with a railway company building many different types of vehicle as well as maintaining in good condition those already built the problem is more complicated'(Fowler, 1930, p. 420; see also Owen, 1954). This difficulty was increased because of the small number of orders that were made for new locomotives and rolling stock relative to, for example, cars or washing machines etc. Also, the large range of tasks involved in the production of rolling stock meant, according to Crewe's development engineer that machines at BREL were 'required to perform virtually an engineering feat'. (Tooling, 1978, p. 16) The consequence is that 'the principal object to be aimed at in all production machines...is flexibility'(Fowler, 1930, p. 422; Owen, 1954).

This policy of flexible machinery ' is longstanding, although there were 'one or two specific cases' of products which warranted 'the expense of their production alone'(Fowler, 1930, p. 421). Flexibility was made easier given that lathes were the predominant type of machinery throughout workshop history, accounting for 50% of all machine tools in 1981 (IME, 1981; also Garret, 1881, p. 11). The choice of flexible machinery continued throughout the works history.[3] For example, one article argued:

> 'BREL's facilities have to be flexible enough to suit the multitude of activities carried out and must also be capable of being switched between activities at relatively short notice to ensure the best possible service is provided to our customer, principally BR , consequently it was BREL policy to purchase medium to heavy engineering standard machines rather than specials.' (Quoted in IME, 1981, p. 321)

The batch size of the workshops not only meant that machinery was flexible, but that it was flexible quickly, a BREL official document commented:

> 'There is little point in having a very high production machine which takes many hours to set up when only a small batch of components requires machining. Thus it is the ratio of setting up time to production time which is of

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[3] There was some specialised machinery. Wheel machining is the only area that is technically different from any other engineering work, and to this end a number of machines were employed in this area and were kept 'irrespective of the output of the shop' (Keene, 1938, p. 481), for example, wheel lathes, journal re-turning lathe, lapping machines, tyre borers, wheel presses (Keene, 1938; Wise, 1973, p. 27; Garret, 1881). There were also machines similar to those elsewhere but on a much larger scale, for example, slotting machines which were used for cutting slots in locomotive frames (Garret, 1881). There were also a number of specialised tools whose savings in set up times, and transfer times from one machine to another, overcame any problem of batch size, for example; shearing machine for boiler back plates, drilling machines for firebox casings, portable drilling machines for boilers, copper firebox plate milling machines, portable firebox seating facing machines, automatic copper stay producing machines, cylinder boring machines (Lewis, 1925) and boiler plate seamers (Fells, 1939, p. 176). Specialised machines of this variety continued to be purchased under BREL, for example, a machine for machining the sole plates which strengthen carriage bodies (Marlew, 1976, p. 54).

vital importance, and critical to a general engineering firm such as BREL.' (BREL, c1985, p. 2)

BREL managers believed that the choice between general and special machinery was 'becoming less of a consideration with the evolution of fully automated, unmanned systems' (BREL, c1985, p. 1) and that the costs of set up had reduced so much, that flexible machinery yielded the same benefits as the specialised machinery of before.

JIGS AND FIXTURES AS MEANS TO ACCURACY

The policy of interchangeability had to be achieved within the non-specialised machine tool policy, and this entailed the use of jigs and fixtures. ÷ Jigs and fixtures effectively enforce a predetermined level of measurement and accuracy upon the operator of a machine. Jigs and templates were standard by the 1880s (Railway Engineer, 1888, p. 22), the reason for their application being to 'ensure accuracy and speed of assembly' (Garrat, 1881, p. 566).

By the turn of the century, Stanier could refer to their extensive use enabling 'men to machine castings and forgings without much setting up on the machine, and to ensure interchangeability as well as cheapness of production' (Stanier, 1907, p. 1-2). When Derby carriage works adopted the system of modular construction, the principle of using jigs was extended to the assembly of material, with uniform parts of the coach frame (which had been made interchangeable by accurate jig based machining) being secured in a framework (also called a jig) and assembled. This method ensured that any body part could be used on any coach (Railway Magazine, 1922, p. 434). The use of jigs also increased the safety of rolling stock by conforming to 'the need to build a square frame' (Bates, 1949, p. 50).

During the inter-war period jigs were becoming more 'accurate and standardised'(Bates, 1949, p. 56), and their

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÷ These were either secured to a machine indicating reasonably precisely where a cut had to be made and also preventing cuts being made in the wrong places by masking those areas or acted like a stencil for cutting around (or some other such device).

use was furthered during the Second World War with the introduction of jig and fixture making machines (Forsythe, 1949). Welding, which increased from the 1930s, entailed the use of jigs and fixtures for assembly which became more widespread, jigs not only ensuring standardised production but also preventing the distortion that could occur with welding by firmly holding the structure under fabrication (Bates, 1949, p. 56).

The factor limiting the flexibility to be gained from jigs was described by one works manager in 1970 as 'unnecessary expenditure' (Gray, 1970, p. 451). In order not to lose on the roundabout of time consuming jigging what had been gained on the swings of flexibility, it was argued that 'jigs and fixtures must be of as simple a design as possible in order that the operator may not have to waste valuable time refreshing his memory each time they are brought into use' (Fowler, 1929, p. 422). The principle of flexible means of production was extended to the construction of jigging, the consultants Urwick, Orr noted 'much sound work and ingenuity has been devoted to the provision of jigs and fixtures' (Urwick, Orr, 1961, p. 13), the inventiveness of railway engineers being directed at making each of use on a range of components (Palmer, 1966, p. 418).

FLEXIBLE AND ACCURATE MACHINERY

The desire for interchangeability and flexibility did not go unnoticed by machine tool manufacturers, and by the First World War the range of actions that could be built into a machine had increased (effectively placing the role of jigs into the machine). These were described as 'semi-automatic' machines. These gave more accurate results than jigs and enabled savings in skilled workers' wages, in the same ways as jigging, because, it was argued, 'after being set, repetitious work can be done by unskilled labour'. The type of machines adopted conformed to the limits of the workshop batch size 'the range and adjustability gives scope for a very wide diversity of duties' (Railway Magazine, 1914, p. 347). The substitution of inbuilt machine functions for jigs and templates was limited until a number of recent innovations in the area of measurement control.

An early innovation was the use of continuous digital read outs (DRO) which were attached to large machines in the 1960s and 1970s. Human measurement was reduced to reading the display, meaning that jigs or marking-off could be abandoned as the digital display was acting as a numerical guide to the operator (Astrop, 1973, 1, p. 515; 1973, 2, p. 613). Electronic numerically controlled (NC) machines, which tell the tool exactly what to do, make operator measurement irrelevant. Astrop ascribes the adoption of NC machines to their 'elimination of time consuming marking out and jig manipulation' (Astrop, 1973, 1, p. 515).[5]

[5] Certain machines for repair cannot be pre-programmed, for example, the re-turning of wheels varies depending on the specific wear of each wheel, however, the whole of the machine cycle was fully automated, the machine doing all the measuring and adjusting so that 'all operator measurement and its inherent errors no longer exist'(Larkin and Larkin, 1988, p. 164; also Astrop, 1974, p. 288).

NEW TECHNOLOGY FOR CHANGING WORKSHOP PRACTICE

The remainder of the chapter examines changes in machine shop practice as the reason for changing machine tooling. It is shown how what is emphasised changes, the success in one area increasing the relative significance of concern in another area, but all of which contribute to increasing control over coordination. In the pages that follow I describe the developments in machine tooling, and how the reasons given for their adoption changed. However, it is possible to draw up, directly from the writings of engineers and from engineering journals, a list of all the advantages that engineers attributed to the application of new machines at one time or another. The advantages of new machines were variously seen as below, example references are given in brackets:

1. The replacement or reduction of labour costs, by reducing time and/or skills (Railway Magazine, 1922, p. 12; Astrop, 1974, p. 292).

2. Reducing setting up time to reduce labour costs and saved machine time (Astrop, 1973, p. 614; Railway Magazine, 1914, p. 347; Fowler, 1930, p. 441).

3. Increasing the speed of cutting etc, this reduces the relative amounts necessary of; raw material (work in progress), labour and machinery (Lewis, 1925, p. 291; Keene, 1938, p. 486; Stanier, 1907, p. 7; Machinery, 1966, p. 10; Astrop, 1977, p. 395).

4. The reduction of floor to floor times, reducing the time taken to load the raw material, machine it, and unload the product (Astrop, 1978, p. 24; Fowler, 1930, p. 431).

5. Increasing the number of hours machinery is running, for example, by ensuring a flow of tasks (Keene, 1938, p. 481; Astrop, 1974, p. 286).

6. Opportunities for new products, either novel or more accurate (Ridgway, 1974, p. 9; Stanier, 1907, p. 3)

7. Reduction of wasted raw material (Astrop, 1974, p. 24).

8. Reduction of add-ons eg: jigs and fixtures needed for accuracy (Gray, 1970, p. 451).

9. Improved reliability of machinery (Machinery and Production Engineering, 1977, p. 545).

10. Improved durability of machinery (Garret, 1889,p .11).

Which took precedence varied over time. As an obvious example, the replacement of labour was of more importance in the last century when there was more hand labour to replace. The reasons for changes in the attribution of importance is because advances in utilization by one means, increases the relative lack of utilization of the other at the same time. For example, after years of increasing the speed of cutting, a recent engineering publication was titled ''don't worry about the speeds and feeds' (Astrop, 1984) meaning that greater savings could be made elsewhere, for example in ensuring the machine was running constantly.

THE LEGACY OF THE NINETEENTH CENTURY

During the nineteenth century many tasks previously performed by direct labour were performed by machine and it was stated at the beginning of this century by one commentator that 'the days of unnecessary handwork are past'(Hawthorne in Stanier, 1907, p. 1) It was stated that the developments in machine tools to 'a great extent replace the chisel and the file' which is to say that 'as the machine shop becomes better equipped , so the fitting department is further removed from the old-time laborious hand fitting' (Railway Magazine, 1922, p. 12)[6]

With a reduced significance of handwork it is perhaps not surprising that the two major developments in machine tooling at the turn of the century were orientated to improving machine performance. These were the development of:

1. Electric power. [7]
2. High speed steels and carbide cutting tools (Lewis, 1925, p. 291; Larkin and Larkin, 1988, p. 163).

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[6] This replacement of hand labour from centre stage is not a product of the age but is the product of previous developments, the production of plastic products seventy years later went through the same development from handicraft to mechanisation, glass reinforced plastics had;

> 'traditionally been laid-up in a die by hand, and, on average, one man could produce one such moulding per day. One of a pair of newly-installed hydraulic cold-forming presses, can produce such mouldings at a rate of about 6 to 7/day.' (Astrop, 1974, p. 292)

[7] Railway workshops developed uses for electricity early, for example, from 1893 electricity was being generated by the Midland Railway in Derby (Steam Engineering, 1962) and being used for powering machine tools and internal transport by 1914 (Railway Magazine, 1914, p. 345, p. 318). During the inter-war period electric motive power and individually driven machine tools became the standard (Larkin and Larkin, 1988, p. 162).

THE STRESS ON CUTTING SPEED

The development of high speed steel enabled high speed machines (Lewis, 1925, p. 391), machines which could go even faster from the 1930s following the application of carbide (Forsythe, 1949).[8]

The developments in machine tools led to cutting speed being stressed as a reason for adopting machine tools. Murray argued that 'progress in engineering demands improved materials and better cutting tools to give higher cutting speeds and improved finish on the work'(Murray, 1935, p. 434). Typical of this period is the following description which lays heavy stress on the speed that a tyre borer can cut:

> 'As an indication of the speed at which finishing operations may be effected, mention might be made that the time taken by the finishing tool to travel down a tyre bore of 43/4 length is 3min.55sec. for a bogie tyre of 2ft 9 1/2in dia bore and 8 1/2min. for a tyre of 4ft 9in bore, the resulting finish being round to + - 0.001in with no measurable taper.' (Keene, 1938, p. 486)

This indicates the concern with speed without losing accuracy. Machines were now being used to replace other

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[8] The stimulus that tooling gave to increased machine speed is now over because the latter can now run so fast, that as BREL stated, 'it is tooling which , in recent years, has become the limiting factor in the final outcome of productivity levels from machine tools'(BREL, c1985, p. 2).

machines, and increased cutting speed was one of the major criteria on which progress could be judged, and remained one of the criteria by which tools could be described. [9]

The achievement of faster cutting speeds meant an increase in the utilisation of all aspects of the labour process by decreasing the amount of machine and labour time occupied on individual items and by a relative reduction of the work in progress (the faster the production the less time material is under production). Once high speeds had become commonplace then the relative significance of other methods of utilizing resources was heightened. This change in emphasis is perhaps not surprising, as one later engineer

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[9] Keene describes tyre borers and wheel skimmers in such terms (Keene, 1938, p. 486). The stress on cutting speeds is discernable from the start of the century (Stanier, 1907, p. 7-9). His concern with speed of machining continued through out the 1950s (Also Owen, 1954), and 1960s, for example, Craven slotting machines and wheel lathes (Machinery, 23-1-63, p. 208; 1966, p. 10). Even after the development of numerical control the replacement of machines was still often seen as a question of increased speed, this was less marked in standard cutting tools than in other areas, for example a new universal turner was said to give cycle times '26% of the old' (Astrop, 1977, p. 395), whereas plasma cutting of plate as opposed to oxy-acetylene gave a 500% saving (IME, 1981). Toward the end of the industry speed was part of the reasoning given for adoption of new machines, but was often seen in wider terms than just cutting, for example including set up times and the total floor to floor times. Speed in this wide sense remained the justification, several machines of the 1970s and 1980s were so devised eg: a universal turner is described as giving a total time saving of 30 to 40% (Tooling, 1978, p. 15); a cnc sheet metal machine is described as giving a reduction of throughput by a factor of eight (Astrop, 1978, p. 24); the reduction of set up times is stressed for a horizontal borer (Astrop, 1973, p. 614) and there are similar descriptions of; wheel lathes (Astrop, 1974, p. 288) a sole bar drilling machine (Marklew, 1976, p. 56), guillotines (Rail Engineer International, 1980, p. 28), and punching machines (Astrop, 1978, p. 24; also Machinery and Production Engineering, 1977, p. 546; also Astrop, 1973, 2, p. 614). Pneumatic and electric powered hand tools such as rivetting hammers and grinders, which were gaining increasing application throughout the 1930s and 1940s (Forsythe, 1949), were also described in terms of speed. Tapping machines for stays (these being twisted metal strips for securing fireboxes inside boiler casings) were described in terms that emphasised their revolutions per minute (Kirkland, 1934, p. 334; Engineering, 1944, p. 345).

estimated 'the time that certain milling and drilling machines were cutting metal was about 20%' (Gray, 1970, p. 44). Gray's opinion may reflect the tendency of managers to disparage their predecessors. As an engineer of the era estimated, on the basis of work measurement, that a driller during the 1920s was drilling 46% of the time, what constitutes drilling is open to debate (Fowler, 1930, p. 440). It is probably likely that a figure of 20% is accurate. BREL's Production Engineer estimated that BREL machines, which operated at industry average, were only cutting 5 to 22% of the time in a 168 hour week.

MACHINE ORGANIZATION

The logic of coordination as a means of increasing the utilization of the whole of the labour process was given a relative impetus by improvements in the cutting speed of machines. Owen speaks of 'the urgent necessity of securing the maximum amount of co-ordination, of both processes and plant, throughout the various railway workshops can never be overlooked' (Owen, 1954, p. 346).

The policy of improving coordination was manifested in new approaches to the location of machining tasks:

1. MULTIPLE MACHINING. From the beginning of the century machines existed that carried out several operations at the same time (Stanier, 1907, p. 2), often of the same type, for example, simultaneous drilling (Fowler, 1930, p. 432). The purpose of these machines was to decrease the total 'floor to floor time' that a component was being machined. In line with the importance of material control, it was seen as important that compound machining did not reduce accuracy (Fells, 1939, p. 166).[10]

[10] There are other references to multiple machining in relation to both stationary cutting tools (Lemon, 1930, p. 426; Railway Magazine, 1922, p. 433), and hand tools eg: simultaneous rivetting machines (Kirkland, 1934, p. 334).

2. SIMULTANEOUS LOADING AND MACHINING, for example, drilling machines which allowed 'two components to be drilled while the third was removed' (Fowler, 1930, p. 432).

3. MULTIPLE HAND TOOLING, for example, different types of boiler repair were carried out in distinct locations equipped with an iron framework from which hung special tools organised to ensure as many men could be working on a boiler as possible.[11]

These developments improved utilization in several ways. Work in progress was reduced by the speed of both multiple and specialised machines and the increased time that they were actually cutting rather than being set up or loaded.

Compound machining is no panacea: depending on circumstances other methods were employed. For example, Huffinley notes how two wheel shop tasks are treated in totally different ways, one by a series of specialized tasks and the other by compound machining:

> 'With wheel machinery a number of operations have been coordinated in the one machine thus increasing outputs, the reverse has been obtained with axle machining operations. Operations have been broken down into definite machine cycles with a considerable increase in production and quality.' (Huffinley, 1959, p. 223)

The location of machining operations does not display a uniform physical manifestation but it is the product of the

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[11] For example, stay drilling: 'the structure being so designed that if necessary six men can work on a firebox simultaneously. Two of the machines are specially designed so as to be capable of drilling the upper rows of stays inside the firebox without fouling the box top'(Kirkland, 1934, p. 330; also Fells, 1939, p. 184; Engineering, 1944, p. 345).

attempt to increase the utilization of the labour process.

The grouping of machines' tasks reduced the amount of transporting of materials, men and machines, which not only had a direct effect in terms of utilization but reduced the labour, machines and fuel used in transporting material.

GROUP TECHNOLOGY

The adoption of group technology, the placing of machines necessary to produce a given object together as a means of reducing movement (Salaman and Littler, 1984, p. 86) is a variation on the development of machines to perform compound cutting organization. It was widely adopted. Fowler commented that in carriage and wagon machine shops

> 'delays have been very considerably reduced by the careful grouping of plant. The main object of any plant engaged in quantity production must be to keep details on the move, and fresh appliances are continually being introduced with this object in view.'(Fowler, 1930, p. 431)

Group technology was not just concerned with reducing work in progress, the improvement made in cutting and coordination of machines highlighted further opportunities for reducing labour. Sawmills which carried out 'a dozen operations' were aimed at 'reducing unnecessary labour to an absolute minimum' and involved' no human handling of material' (Fowler, 1930, p. 424). [12]

The policy of grouping machinery is limited, in the manner of specialised machinery, by batch sizes. In 1968 a study of cleaning tasks, being some 3.5% of repair costs, argued against grouping cleaning with related tasks arguing it 'should be concentrated in one self contained shop' in order to prevent 'duplication and underutilization' (Cook and Wood, 1970, p. 78).

[12] The policy of 'minimum handling' was used in other locations eg; wheel shops (Fowler, 1930, p. 428).

REDUCING THE LIMITATIONS OF LABOUR

The faster machines and their improved groupings, both contributing to faster floor to floor times for components, required a new approach to the staffing of machines. The approach to policy took several directions;

1. Correct manning, the engineers directed their attention to ensuring that the manning of machines was adequate to the machines' potential performance, even if this meant a departure from one man one machine. Keene gives an example from the wheel shop:

   > 'One of the most satisfactory and efficient wheel lathes which I have come across is manned by two operators, each taking one rest, fixing the drivers of one face plate etc. This machine gives an output of driving or coupled wheels 40 min, floor to floor, all sizes within its capacity, which is 5ft 6in. The wages cost of the operation is not greater than for the longer time taken by a single operator, and a much greater utilisation of the machine is possible. (Keene, 1938, p. 481)

2. The adoption of automatic machines and jigs enabled the use of unskilled labour, once the machine had been set up, thus reducing labour costs (Railway Magazine, 1914, p. 347; Fowler, 1930, p. 441).

3. Minimisation of delays due to the restrictions placed on machine performance due to the limitations of the human body. Part of this policy was the elimination of the need for brute force, for example, the suspension of boiler hand tools from runways improved machine performance as it permitted 'the use of the machine at any desired angle the operator having no weight whatever to support' (Fell, 1939, p. 184). The fatigue suffered by the human body was also considered a disadvantage, and overcoming this problem was seen as a major advantage of automatic machines over manual machines with attached jigs and fixtures, the latter were seen, by Fowler, to:

> 'have a very serious disadvantage in that the speed with which the machine is run depends entirely upon the operator.
>
> This entails movements on his part which are not necessary with the semi-automatic machine, and which, owing to the time taken in their performance, and the resulting fatigue to the man concerned, tends to reduce the output.' (Fowler, 1930, p. 422)

The slowing down of the machining process due to human movements was also the subject for elimination. In Fowler's view 'the cutting out of time lost through unnecessary movements on the part of the operators appears to be a matter of utmost importance' and often an 'appreciable increase in output' could be achieved by 'a very simple change in some detail of the machine' for example 'delivering the work at the height of the machine table, thus avoiding the necessity of the man bending down to pick articles up from the floor.' In line with the direction of my arguments, this was significant because of improvements in machine operation thus and Fowler states 'this is of paramount importance in the case of a semi-automatic machine, as several strokes of the machine may be lost if the work is not in the operator's hand'(Fowler, 1930, p. 423).

The emphasis upon accommodating machines to human beings was put on a more formalised basis with the general adoption of ergonomics, which was later supplemented by the cybernetics of man-machine interface. (Gray, 1970, p.450). These concerns are part of a post-nationalisation period predilection for fashionable ideas, possibly as part of the wider tendency of engineers to attempt to adopt 'management science' (Armstrong, 1987). The acceptability of these fashions was part of a wider openness of post war management to human science. Human relations, for example, being seen as integral to the success of mechanization 'It is well recognised by all responsible people today that industrial success is most likely to be achieved when up-to-date and efficient plant and machinery is operated under conditions of mutual confidence, understanding and co-operation'(Owen, 1954, p. 346).

Machines did not always reduce the intervention of labour, on other occasions the requirements for material control have led to reskilling, for example, on the production of a particular carriage component jigs proved inaccurate for various reasons, and they therefore let the machinists cut 'free hand' so to speak and it was noted that 'the operator soon obtains an extraordinary degree of accuracy' (Fowler, 1930, p. 431). Of course instances like this are rarely remarked upon but there remained such instances into BREL days, and this was especially true for low batches, and plastic component production, for example:

> 'Contact moulding is an extremely labour intensive procedure with a low production rate, but this is compensated for by low tooling costs and the flexibility of the process.' (Ridgway, 1974, p. 13)

In difficult and low batch situations the use of labour was not perceived as problematic as long as it achieved the required material transformations. Advances in control over material would be traded for a loss of control over labour when deemed appropriate.

Machine tooling is a product of the complicated interactions of different processes, and this results in the constantly shifting profiles of particular policies as increased utilization in one arena raises the gains to be made by attacking a different problem. The emphasis of replacing labour changed to one of increasing cutting speed, which in turn shifted to compound cutting and then on to machine utilization and labour intervention. The situation is more complicated and advances can be made on several fronts, added to which engineers understand the process of production and issues that may become relatively important, can be pre-empted. Writing in 1930, Palmer illustrates this complexity by presenting the gains of compound cutting, cheap labour and rapid throughput of accurate products, from the introduction of just one machine:

> 'Two articles can be put in at a time, and up to 20 holes drilled every minute or minute and a half. A boy operates the machine ... the articles are fed through.

> Every minute or minute and a half a catch is released and the article pushed out on the other side. The articles are all drilled on a jig, and are therefore interchangeable.' (Fowler, 1930, p. 441)

All these gains can be seen as the outcome of an underlying logic to production, the drive to control. This drive has a dual aspect; desire for control over products and the utilization, primarily by coordination, of the labour process, both of these being concerned with establishing managerial control over material reality.

SEQUENTIAL AND NUMERICAL CONTROL

The workshop closure and modernisation plan was intended to involve a large investment in machine tools at the remaining 16 works. Each works' management developed its own investment programme guided by BR workshops HQ (Gray, 1970). Machine tools emerged, the sequences of which were controllable by either pre punched tape (Numerical Control (NC)) or pre-determined sequences built into the electronics of the machine with the cycles selected by placing pins into a connected 'plug board'. (Sequential control (SC)) Gray argues that these machines had influenced the thinking behind the workshops closure and modernization plan:

> 'one of the major considerations within reorganization was the effect which this new concept of machine tools was to have on the equipment of the workshops.' (Gray 1970 p 450)

The modernisation plan was designed to take advantage of improvements in machine tooling, particularly, argues Astrop, in the area of material control as a response to changes in rolling stock:

> ' The modernization programme was not simply a matter of replacing old machines with their modern counterparts. Superimposed on the updating requirements were the problems posed by a general tightening of manufacturing tolerances and upgrading of surface finishes arising from developments in locomotive and rolling stock design, and the introduction of higher running speeds' (Astrop, 1973, 1, p. 514)

The modernisation plan was not limited to allowing for present day improvements, but it was also concerned, asmanagement generally is, to enable future applications to be made easily without massive changes in the layout of machine shops:

> 'It brought the group to the position ... where regular and systematic updating of production facilities could be introduced and the need for large scale upheavals in the future could be avoided.' (Astrop, 1973, p. 514)

The ability to have a rolling programme of replacement technology was BREL policy. The need to update machinery was identified as coming from the dual sources of improvements in products and improvements in process:

> 'Our total manufacturing outlay needs to be continually updated to keep pace with the technological requirements of the railway and to take advantage of developments in machine tools and equipment as they are introduced by manufacturers.' (BREL, c1985, p. 3)

The plan reduced the number of machine tools from 12,000 to 4,500 by 1966 and between 1964 and 1973 705 new machines were purchased 220 being SC or NC (Astrop, 1973, 1, p. 515). The majority of these were SC machines with the order of sequences programmed on the shop floor (Astrop, 1973, 1, p. 514). Derby Locomotive works, which was a works selected to be at the forefront, had only eight NC machines (Astrop, 1973, 2, p. 612). The lack of NC was for two reasons:

1. Difficulties of programming, in particular smooth curves, management thus still preferred to rely on human judgment to achieve the accuracy required.

2. Reliability, as NC machines were used to replace several other machines, reliability was at a premium, if it had been used to replace three machines if one crashed only one third of production was lost and the utilization of the remainder could be increased, this was not an option for NC. In this case management accepted the use of shop floor SC 'programming' for the greater good of meeting product targets.

Machine introductions conformed to the rolling programme envisaged and a number of new machine tools were introduced conforming to a pattern of 'island automation' (Kaplinsky, 1984), that is the machines introduced were large stand alone machines dedicated to a particular operation. [13]

[13] For example, the large machine centre introduced for producing bogies is the most notable (Astrop, 1982, p. 36; Tooling, 1982, p. 7). Derby locomotive works and Crewe were selected to be the site of heavy machinery under a policy of 'rationalization' (Ridgway, 1974, p. 8), and Astrop describes the developments at Crewe (1973, 1) and Derby (1973, 2). The application of plasma cutters in both these locations is described in the proceedings of the IME (1981) the addition of CNC axle lathes and axle box machining centres at Crewe (Astrop, 1977, p. 395 Tooling, 1978, p. 15); Carriage and wagon works also saw the application of large NC machines, Derby is described in Astrop (1973, 3) and York is described in Marklew (1976).

IMPROVEMENTS IN RELIABILITY

By the late 1970s NC machines had become more acceptable and it was not purely large machines being purchased.[14] By 1981 100 NC or CNC machines had been installed and were being introduced at the rate of one a month (Engineering Today, 1981, p. 20). In the depths of the 1980s recession there was an embargo on any investment in new machinery and by the mid-1980s the total had only reached circa 120 out of a total of 5000, although this represented one-sixth in terms of cost. During this period NC machinery was being added to at the reduced rate of one every two months costing 60% of machine tool expenditure (BREL, c1985, p. 3).

Part of the reason for the adoption of NC machines was because of the improvements made possible in programming by the development of computer numerical control (CNC), increasing the precision of programmed instructions, and the computerised production of machine programming (Hudson, 1974). More important was the increase in reliability of the machines, for example, some CNC machine were down only 6 % of the time, such that the impact on production was negligible (Astrop, 1974, p. 286; also Machinery and Production Engineering, 1977, p. 545).

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[14] For example, the purchase of three small NC lathes (Machinery and Production Engineering, 1977).

The reliability of machines was increased in two ways, by increasing the skills on the shop floor and increasing the technical control vested in the machine:

1. Shop floor editing of gross errors in the program made easier by CNC machines (Astrop, 1978, p.25; Astrop, 1977, p. 398).

2. Manual override to prevent waste, for example, to prevent sheet metal flapping and destroying tooling (Astrop, 1977, p. 398).

3. Improved accuracy of measurement. eg; a machining centre that gives the operator a 'detailed dimensional and geometric picture' (Astrop, 1977, p. 398).

4. Inbuilt machine corrections, for example sensors linked to machine shut offs for overspeeding programmed in error (Astrop, 1977, p. 396).

5. Dummy runs, lathes that can trace movements onto a drawing board (Astrop, 1973, p. 616).

Management thus would use whatever means available to increase the reliability of the machines, and thus gain the full benefit of numerical control.

ADVANTAGES OF NUMERICAL CONTROL

Numerical control, not surprisingly, is less concerned with the replacement of hand work or tool speed, but it was adopted for similar reasons to previous machines. The railway workshops have always required flexibility from machines because of the small batch size, which was falling due to with less rolling stock building and repair. In relation to flexibility it was argued that 'NC and CNC have provided particular benefits' (Astrop, 1977, p. 394; also Machinery and Production Engineering, 1977, p. 545). For example, sheet metal punches at York could produce up to 600 different components (Astrop, 1978, p. 25). This range enabled the number of machines to be reduced, even where the policy was for flexible machinery. The particular advantage in this case was the reduction in set up both in terms of jigging and marking up and the times taken setting up the machine for each different product. Setting up had now been replaced by the programme, this enabled the machine to be run more often, and at the same time programming, which was now the set up time, could be carried out concurrently.

The reduction in set up times and the flexibility of machines enabled work in progress to be reduced, the BREL Production Engineer said;

> 'the future manufacturing strategy talked about within the company is that we buy machine tools that give us the ability to produce a just in time philosophy so were not producing thousands and thousands of components that will be lying around the stores and not be required for twelve months...that's part of the remit of the company to reduce stock levels and reduce work in progress which is a very very big saving.

Not only do the new machines reduce material needed for work in progress, they also enable waste to be cut to a minimum, for example, the programming on plasma sheet metal cutters gave a saving of 100,000 per annum by reducing the amount of scrap sheet to 25% from 40%. (IME, 1981)

On the punching machines it was possible to 'nest' components, to be produced such that they were punched out of a sheet in such a way that reduced the amount of scrap and with one set up of the machine, although this depends on having a good idea of forward work load (Astrop, 1978, p. 24).

Computer control enabled much more compound cutting than under mechanical methods, which not only speeded the throughput of material but enabled a significant reduction in transporting material between different operations and enhanced interchangeability by reducing variations caused by material passing though several set ups (Astrop, 1973, 1, p. 516). The case of a large bogie machining centre is described in these terms:

> 'The through put time is about 4 hours which represents a time saving of at least a factor of four, in some cases five, compared with previous multimachine and set up practices. A multitude of operations, from small diameter drilling to face milling and an inversion of the frame to attack the underside are performed. Multi-spindle heads are applied, and the right-angle head is used to work on the sides, end and vertical faces in apertures. By using one (sometimes two) set ups , massive reductions in handling have been achieved, and the distances through which large and unwieldy workpieces have to be transported have been reduced. Minimum set up practice will also have major effects on the accuracy and consistency of machining.' (Astrop, 1982, p. 37)

The large machining centres are the culmination of the tendency toward integration or coordination which is inherent in the policy of utilization of resources by continually eliminating factors unnecessary for the transformation of matter.

IMPLICATIONS OF COMPUTER CONTROL

The increases in utilization of materials, men and machines brought about by new technology, the latter in terms of relative number of machines needed, could only be realised by ensuring that the machines themselves were being utilized. The new machines gave an impetus for management to improve coordination to further this aim, the machine manager at BREL, argued:

> 'you need not worry about saving a few seconds on a piece of carbide or tooling if you're waiting for the tool or waiting for the man or something like that . You're losing valuable cutting time and that is what counts, the improvements in utilisation, the time that the spindle is running is the main objective, must be the main objective. That's the main theme now of any machine tool manufacturer. He'll tell you that now it's the up time and the philosophy now is tool management, ensuring that everything is available for that machine tool. This has been the onus for the last eighteen months and we have tried in a number of works to ensure that we are heading that way.'

Ensuring the utilisation of machinery was seen as management's job and that with computerised scheduling this was being achieved:

> 'the manager should be ensuring that the material , the tape and all this is available, and the improvements in production scheduling, by computer, that have been introduced will assist in that direction and will ensure the machine tool utilisation.'

IMPACT ON LABOUR

Technology has an impact on labour in terms of skill and amount needed. NC machines were seen as a means of increasing labour utilisation in response to the skill shortages of the late 1970s (Astrop, 1977, p. 394; BREL, c1980, p. 2). If this was the case, it was certainly effective as by the mid-1980s the production per man-hour had significantly increased, BREL gave the following ratios, of CNC to manual machines, turning; 4-1 (noting 'setting up times almost eliminated'), drilling, milling and tapping 2 or 3-1, sheet and plate work 10 or 20-1 (BREL, c1985). These output figures were achieved by moving from a situation where there was one man one machine to a situation of having one man looking after three machines (Astrop, 1974, p. 286; IME, 1981) In order to advance machine utilisation all large machines were double shifted (Astrop, 1974, p. 286; Tooling, 1978), and there was increasing pressure to introduce three shifts. The Production Engineer argued:

> 'we are buying expensive machines, and if the competition is running seven days a week, 24 hours a day we have got to run that way.'

He also estimated that the staff saving of all these measures was of the order of four to one, and that excluded the reduction in labouring and progressing work.

The adoption of N.C machines was attributed, by the Production Engineer, not only to their ability to reduce staff but also to the reduction of labour intervention within the labour process:

> 'the initial reason for going for NC machines was that they took some of the arduous tasks away from the operator, and a machine could then work much longer hours without assistance or the exertion from the operator,'

NC machines were identified as having a greater potential for utilization by reducing the interference by labour. Toward the mid-1980s management was seeking a much wider expulsion of labour, to as low as possible, leaving all flexibility in the machines, quoting the Production Engineer again:

> 'The machine tool, you won't improve it dramatically now. From this year's show there's no difference, the difference is unattended operation and a totally unmanned situation, what firms were showing this year was the ability to put two machines together, to have a number of pallets with components on, to be able to load those by some form of automatic guided vehicle, and to have tool stores, and to be fed by a host computer. So that you can schedule all your work load by one main computer which will operate those two machines, and that is the way the Japanese have been going for the last couple of years where it is totally unmanned and it is so flexible that you can get one offs, fifty offs, whatever you want.'

This situation was never achieved under railway auspices but underlay part of the rationale of management as part of its attempt to establish effective and total coordination.

In terms of staff relations most difficulties were said to be presented by 'the task of educating shop committees to the idea that a man had to operate more than one NC machine' (Gray, 1970, p. 452). This principle was probably accepted on the basis of assurances that they would be operated by skilled men, the Production Engineer commented that 'the unions would insist' that this was the case and he said that 'I can't honestly think we have got any category threes (semi-skilled) operating C.N.C machines, category four (craft grade) as far as I am aware is right throughout BREL'.[15]

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[15] There is limited evidence from the late seventies that certain machines were introduced to enable the use of non-skilled labour (Astrop, 1978, p. 23-24; Astrop, 1977, p. 394).

The very fact that skilled men were employed on the operation of NC machines, irrelevant of what tasks they were doing, highlights the problems faced in trying to analyse the movements of skill. It is possible to find managerial support for NC as increasing and decreasing skill. Part of the problem is untangling exactly what is meant by managers when they speak of skill. For example, the BREL Production Engineer believed that NC had 'in a lot of cases improved them. We are producing parts a lot more accurate,' here the final outcome is taken as the measure of skill. The achievement of control over matter is of course an increase in skill, the skill of managing the labour process. It is because of this that managerial assessments of skill are problematic and pose the question of whether they refer to the skill of the process or skill of the workforce. The Production Engineer thought the amount of discretion exercised by machinists was decreased by SC and NC machines; 'You are taking responsibility away from the actual operator onto the machine'. Discretion along with task range was identified as the two main constituent of skill by Littler (Littler, 1982, p. 8). Gray, a former manager of both Derby works, writing in 1970, clearly thought that the NC and SC machines were de-skilling:

> ' Up to this time the procedure was to issue a working drawing to a skilled operator in the machine shop, together with any jigs necessary for the man to perform his particular operation. The sequence of operations would have previously been decided. There were, however, many occasions when a more highly skilled operator would plan his own sequence and jig his own machine ... With sequentially controlled machines the responsibility of the operator changed and his duties could now be shown in four

definite functions:

1. To set up the position and the workpiece as instructed.
2. Insert and position the punched tape and commence the machine cycle.
3. Observe the machinery operations, make tool changes, and carry out checks in accordance with instructions.
4. Unload and reload workpiece.

From this it may be concluded that an NC machine can be operated by unskilled labour... (Gray, 1970, p. 469)

Gray definitely thought that NC deskilled the work if not the man. A problem, not dissimilar and not unrelated to the question of skill as belonging to process or people, is the problem of the location of skill, the Derby locomotive Training Manager thought that NC had 'sent skill up the line' and that the skilled jobs were now performed by the programmers. The Production Engineer argued that the complexity of the machines, necessary for them to take responsibility for production, had meant an increase in the need for, although not the reality of, maintenance skill via the dismantling of craft demarcation;

'There hasn't been an increase in maintenance staff but the skill of maintenance staff needs to be increased , and that is one area where we possibly could do with the integration of the mechanical and electrical staff which we have not got within the company.'

The issue of the distribution of skill is further complicated by the fact that many operators of NC machines became programmers or worked in industrial engineering, meaning that a person's career could progress from deskilled to reskilled job. The question of whether or not skill had been sent up the line was becoming irrelevant as BREL management were realising that with the development of computerised assisted programming it was possible to have cheap shop floor programming, and were proposing to introduce this on lathes, sheet and plate work. These complexities in skill movement reflect the preparedness of management to use labour to achieve control over matter when necessary. It is also clear that the degree of discretion is curtailed. Gray describes the 1960s policy of centralising control;

> 'We are gradually dividing machine shops into two separate functions. One section dealing with a position which covers small batch production and another section dealing with odd jobs repairs. The section dealing with small batch production will be rigidly controlled by the production office, each being provided with a tape or chart and pre-set tooling for a particular job and the operating time strictly controlled on the tape.' (Gray, 1970, p. 471)

In order to achieve this type of control over the machining process, management centralised control, further undermining the discretion of shop management and workforce;

> 'The control of machines in regard to feeds and speeds, setting and sequence of operations has been taken away and been given to the production organization. Consequently, we have set up a new organization to deal with this function in our workshops, and responsible to the works manager are two principal assistants:
> 1.The production engineer.
> 2.The development engineer.'(Gray, 1970, p. 470)

Thus strict centralised control over the labour process was seen as necessary to yield the full benefits of NC machines. Fifteen years later when computerised scheduling for increased machine utilization and just in time production were also seen as increasing the need for control, it was argued that the full benefits of technology;

> 'can only be achieved by relying heavily on the training of Programmers, Operators, the use of computer aids, and, not the least important, carrying out strict disciplines in Workshops at all stages of manufacture.' (BREL, c1985, p. 3)

The interrelated nature of the labour process again pushed the policy in relation to labour in different directions, and increased worker task range but decreased discretion. In this case, it is somewhat fortuitous for management as the amount of discretion has always been the key issue. Management has always tolerated worker skill if those workers submit to managerial dictates directed at improving the utilization of the labour process as a coordinated activity.

The development of numerical control machinery conforms to the development pattern of other machines, and indeed other ways of increasing production. The adoption of numerical control fits well with the concern for flexibility and interchangeability but within this overall framework was directed at increasing utilization of men, machines and materials by reducing throughput times and the physical and human resources to effect transformations.

A major stimulus to the adoption of these types of machines was an attack upon bottle necks caused by human intervention, both in terms of bodily fatigue, set up times and skilled labour which was in short supply. Once adopted, further possibilities were highlighted, for example, just in time production and the total expulsion of labour.

SUMMARY

The examination of the means of production has demonstrated a number of themes. The labour process is a complicated series of interrelations, changes in one activity has ramifications for others. The governing factor behind management action to the interrelated nature of the labour process is the attribution of importance, and this has constantly been concerned with utilization of the different elements of the labour process. It is this that leads to the phenomenon that, if one improvement is made, for example, increased cutting speed, then, relatively speaking, other areas that lead to bottlenecks in the use of cutting speed (e.g., labour fatigue) become more important. All of this contributes to the increased integration of the labour process, which required greater control to be exercised by management over the discretion exercised by workers. The desire of management not only to coordinate the labour process but to exercise dominion over matter is to some extent a countervailing tendency, in that concessions in relation to managerial control over labour are conceded if labour furthers managerial control over product. Once new skills are established they too come under scrutiny for further coordination and control. For example, products can be designed to further managerial control and presumably certain products, by their nature, require less skill. As managerial control over atomised, or more accurately molecular, labour increases, so changes in product can be taken in the managerial stride by reconstituting the elements into a new relationship between

labour and technology, and nature does not provide an endless supply of use values and thus opportunities for labour discretion but is finite.

The implication of this discussion is that Marx was mistaken in viewing mechanization as the fundamental transformation in the organization of the capitalist labour process. At least as far as the railway industry is concerned it is, but it is a facet in the growth of the control over coordination. In describing the development of control over coordination it has also been shown that what may appear as random and contingent reasons for the adoption of new technology, as in the strategic choice theory that appears to predominate, are structured according to managerial demands to increase the utilization of the many facets of the labour process. The decisions over what constitutes the best solution are dependent on prior decisions. The discussion seems to show that the concept of flexible specialisation as the new phase in capitalist development appears to have more feasibility, and the desire to have flexible control over material production seems to appear as a natural development of the control over the labour process, although its newness and the likelihood of flexibility being extended to the workers for anything other than a short time, are in doubt. In the next chapter Taylorism, that other pillar of the mechanical non-flexible age, is examined and in relation to the railway workshops the idea of earlier periods as the age of scientific management is seen as untrue.

CHAPTER NINE

THE IMPACT OF SCIENTIFIC MANAGEMENT

INTRODUCTION

Scientific management was seen, by Braverman (1974) and others who support his position, for example Clawson (1980), as the means and the end of the transition from simple control as the method of controlling the labour process in capitalist economies. As will be shown in this chapter, this is not the case in the railway workshops. The application of scientific management, as with mechanization, discussed in the previous chapter, is shown to be explicable by reference to the growth in the control over coordination exercised by management.

In chapters six and seven it was argued that the concept of the labour process as an interrelated and integrated whole appeared to characterise the engineering perspective. This interpretation brings into question a number of interpretations of the nature of engineering ideology, and in particular the identification of engineering and Taylorism. Stark argues that scientific management was an ideology and a practice developed in the USA, and was intended to advance the autonomy of engineers within the corporations emerging at the turn of this century (Stark, 1980). Littler also identifies Taylorism as the American engineers' contribution to systematic management, although he argues that this connection was not made in Britain where accountants dominated notions of systematic management (Littler, 1982, p. 178). Even given Littler's proviso about the role of engineers within British management, it is clear that he still interprets scientific management as an engineering ideology. I argue that Taylorism may have operated as an engineering ideology in the United States, but that it does not have its origins within engineering training alone. That this is the case is shown by its history within the railway workshops. Even though Taylorism was considered for application in the workshops at the end of the First World War as a possible solution to the problems of productivity that have been outlined previously, Taylorism was not applied until the beginning of the 1970s.

Although this is not the place for a full discussion of the origins of Taylorism, it is clear that it is not the manifestation of the dominance of engineering in management, because this was not the case on the railways. I would locate its origins in the combination of engineering and accounting ideology. In the last chapter, the engineering application of mechanization was discussed. That Taylorism draws on the machine metaphor is generally accepted (Morgan, 1986, chapter 2), but the conclusions that Taylorism draws for the labour process are only partial and ignore the importance of coordination. It could be argued that Taylorism misses the importance of coordination because of the inclusion of costing methods, the latter were often taken as the most important aspects (Littler, 1982 p. 179). Miller and O'Leary have argued that Taylor's system pre-empted many of the major interwar advances in management accounting, such as standard costing (Miller and O'Leary, 1987). As I have argued, capitalist organizations have to be reproduced both as physical and accounting entities and in the USA at the turn of the century

Taylorism performed that function. The origins and mechanistic elements of scientific management enabled engineers, as Littler argues, to monopolise theories of systematic management in the USA.

In the railway workshops the machine metaphor drawn by the engineers was one of combination, and Taylorism was rejected. There are probably two explanations for its rejection: firstly, coordination is more successful than Taylorism, and secondly, management accounting was established as the discipline of a separate professional grouping who posed a threat to engineers dominance. The adoption of Taylorism may have given accounting an opportunity to develop managerial authority and may thus have been excluded.

That Taylorism was excluded from the railway workshops needs explaining. This is especially so given that the workshops were amongst the largest industrial undertakings in the country and on the LMS, the largest employer in the country during the interwar years, the president Sir Josiah Stamp is regarded as a major advocate and practioner of the rationalization of British industry, although this is usually associated with his tenure at Nobel Industries (Hanah, 1983, p. 33, 79). As was noted in the introduction, the railway workshops were regarded as being at the forefront of the development of scientific technique, the techniques in question being the control over flow production rather than Taylorism. The absence of Taylorism from an industry considered at the forefront of industry and headed by captains of industry believed to head the rationalization movement, appears even stranger, given that within the labour process debate Taylorism is often seen as becoming the dominant management system of control during the inter war period. Littler suggests, for example, that via neo-Taylorite systems, particularly Bedaux, scientific management became the dominant method for rationalizing British industry (Littler, 1982, p. 112, 145), and this prognosis is also accepted by Thompson (1989, p. 131). As was shown, the methods introduced by the engineers had results, and clearly this success was enough to maintain the engineers' policy.

Not only was Taylorism excluded from any major role in the workshops during the interwar period, although it was used in machine shops and on welding, it was abandoned totally with nationalization. This abandonment came against the wide scale promotion of workstudy by the BTC and the state generally, and this wide scale promotion is described within the chapter. That a nationalized industry promoted the development of archetypical capitalist methods should come as no surprise at this stage in the thesis. What is surprising, is that workstudy was not applied until the early 1970s, about fifteen years after it was first proposed. As is shown, it is clear that the reason why workstudy was not applied, earlier and why it was eventually applied relates to the interrelated nature of the labour process and the engineers' stress on coordination. It is shown that workstudy is eventually applied when the BTC had moved from a stress on workstudy as a means of increasing worker effort, toward a stress on the use of the information gathered and on techniques of coordinating production, for example, network analysis. Grant argues that workstudy has two aspects, it is a means of managerial planning and can also be used in incentive schemes, the former being of most importance:

> 'Standard times can be used for job planning, delivery dates, costing, budgeting, scheduling work, planning labour and overtime and, perhaps, as the basis of incentive bonus schemes. It is important to see the use of standard times in that order of priority. Incentive schemes are merely a way of stimulating workers to cooperate with management planning and to meet objectives set by management. Where the pace of work is controlled by a machine or a production line, employers may see no need to introduce incentive schemes.' (Grant, 1983, p. 33)

Workstudy is concerned with planning in a situation of non-machine paced work. In the workshops the engineers' interwar innovations resembled production lines, but after further development of these techniques, during the 1960s, it became necessary to know activity times in order to improve the effectiveness of the production lines, particularly the method of network analysis, and hence workstudy was introduced. Consequently workstudy became workshop policy following the Pay and Efficiency Agreement of 1969, an agreement later subjected to a 're-incentive scheme' in 1978 (BREL, 1978).

In summary, the cause of the delayed application of scientific management, was that techniques for the coordinating of production were applied instead. These techniques enabled engineers to preserve their dominance by: increasing productivity, reducing the level of foreman control, circumventing worker suspicion and utilising engineering expertise which, for a period at least, excluded the encroachment of accounting.

SCIENTIFIC MANAGEMENT

AFTER THE FIRST WORLD WAR

The question of correct rate fixing was seen, by engineers, as a problem facing management at the end of the First World War.[1] In 1921 one engineer attending the presentation of Turner's paper thought:

> 'there is a place in certain types of manufacturing for something approaching the detailed motion study as inaugurated, I suppose, by Taylor'. (Quoted in Turner, 1921, p. 156)

Turner agreed, seeing scientific management as a method of overcoming workers' suspicions about piecework:

> 'It is maintained by some that the only proper method of price or rather time rate fixing is by analytical study of the job actually being done before it is timed - a division of the job into its elements and the careful consideration of the best way of doing each element leading up to the settlement of the basic time. A system of motion study is also advocated by some, whereby the various operations of the workmen are split up into their elements and studied, so that the best method of performing each operation is arrived at. At first sight there seems to be something so very drastic in the application of these studies, that they seem irrational and unreasonable from the workman's point of view, but if these aids to the determination of equitable rates are used wisely, and after full and frank discussion with the workmen it can be demonstrated to the latter that a large heart and big mind can accompany a keen desire for efficiency, then they might be rather welcomed than opposed.'(Turner, 1921, p. 145)

Scientific management was seen as a method of overcoming the inadequacy of the foreman controlled, rate fixing system of the time. Turner's criticism of rate fixing is a criticism of the foreman system:

> 'in many works the present system of setting prices is for the foreman to look at the job and assess the price from his own practical experience . It is better to analyse the job into its components , and the system of time and motion study advocated in America, although I

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[1] Scientific management was up for consideration on the railways generally (Farmer, 1921. p. 1-13).

think it goes very much too far, is a very much better system than that I just spoke of '. (Turner, 1921, p. 164)

Turner saw the problem as the fixing of rates by foremen, and the solution as scientific management. At the discussion following Turner's paper, some engineers agreed with all of his analysis (Turner, 1921, p. 156), and although most accepted that the foreman system was the problem, they were suspicious of Taylorism, in the following regards:

1. It ignored the opposition it would generate .
2. The tasks of the railway workshops were too skilled for the application of work study.

Britten's arguments are typical:

'of course I have read the famous book 'Scientific Management' and it struck me that it would never be applicable to railway works. It is all very well when it is a question of loading pig iron, on which a low class of labour would be employed, and the men can be told exactly what to do: but if it were introduced in a railway works, even on mass production, difficulty would be found in overcoming the suspicion of the men'. (Turner, 1921, p. 163)

At the end of the First World War, Taylorism, although regarded with suspicion, was considered as a possible solution to the workshop productivity problem.

WORK STUDY AFTER THE SECOND WORLD WAR

In 1956 the BTC began a centralized initiative to extend workstudy to all areas of transport operation. This initiative had its roots in an earlier haphazard development of workstudy on the railway regions. Workstudy as eventually applied in the workshops had a wider remit than the application of Taylorism, this wider scope being partially the explanation behind the eventual application of workstudy.

DEVELOPMENT OF WORKSTUDY ON BTC

During the 1950s there was an increase of interest in the workstudy, Kenrick, a workstudy consultant summed up this situation, 'the words 'Work Study' seem to have become fashionable recently' (Kenrick, 1956, p. 1), a view expressed by other commentators (Train, 1955, p. 7; Larkin, 1957, p. 44), Kenrick later referred to it as the 'workstudy movement' (Kenrick, 1958, p. 6). During the 1950s workstudy was getting growing institutional support, for example, the government sponsored British Standards Institute set up a committee to study workstudy practices in 1953 (Larkin, 1957, p. 49), and the TUC developed work study training programmes (Larkin, 1957, p. 52). BTC launched its corporate strategy somewhat late in the day.

REGIONAL DEVELOPMENT OF WORKSTUDY

Workstudy was first applied on the railways on a regional basis using industrial consultants. At the forefront was the Southern Region's civil engineers' department whose Exeter concrete works had been using workstudy since 1945, (introduced by the Southern Railway). The department had extended workstudy to all its workshops, and in 1951 to permanent way maintenance (Train 1955 pp. 11-12; Larkin, 1957, p. 49; Kenrick, 1956, pp. 300-301; Kenrick, 1958, p. 8). Most regions followed suit and began to apply workstudy to civil engineering. In 1953 the Western Region was the first to apply it to areas outside of the civil engineering department using to their signal engineering works at Reading (Kenrick, 1956, pp. 300-301). This process was not coordinated from the centre and led to duplication of effort, for example, the Western Region set up a training school at Paddington in 1956 within a couple of miles of a school opened a few months earlier at Victoria by the Southern Region (Larkin, 1957, p. 53).

THE CENTRALISED DEVELOPMENT OF WORKSTUDY

In 1955 BTC established the British Railways Productivity Council, to consider workstudy policy (Kenrick, 1956, p. 291). This was a consultative body with board and union members, and following its recommendation the workstudy division was established in 1956, with Edgar Larkin as Director (Larkin, 1979, p. 127). [2]

A workstudy training centre was established at Watford, courses beginning in 1956 (Larkin, 1979, p. 51). The importance of establishing central control over work study policy by BTC led to the founding of two committees, with union representation:

1. The Work Study Training Centre Advisory Committee, whose function is clear.

2. The Work Study Development Committee, to standardise policy between departments.

Larkin's view was that prior to achieving the application of workstudy, 'senior management had first to be

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[2] The aims of the new division were set out by Larkin as below:

1.To provide a specialist advisory service in work study to the British Railways Regions and other divisions of the Commission.
2.To establish a central pool of experience relating to the application of work study to transport problems.
3.To advise on the co-ordination of relations with the trade unions on this subject.
4.To organise a Work Study Training Centre...
5.To advise the Divisions and Regions on the use of industrial consultants.' (Larkin, 1957, p. 50)

won over' (Larkin, 1979, p. 128), thus it was that Watford was to be devoted to appreciation courses for senior personnel. The overall policy was that 'as far as reasonably practicable the aim should be to assist the various divisions to set up their own work study organizations'(Larkin, 1957, p. 53). To a large extent this was an acceptance of the existing reality of the development of workstudy. The training of work study practioners and appreciation courses for non-senior staff was to be carried out by the six regional schools (Larkin, 1979, p. 128), two of which existed prior to the workstudy division (Larkin, 1957, p. 54).

THE VIEW OF WORK STUDY

Taylor was seen as the founder of workstudy (Train, 1955, p. 11; Larkin, 1957, p. 16) which, at the beginning, was seen to consist, in Larkin's words, of 'two parts, namely method study and work measurement' (Larkin, 1957, p. 48; see also Train, 1955, p. 10). Method study was 'the study of the methods used to execute a particular job' and work measurement' the measurement of the time taken for its completion' (Kenrick, 1956, p. 293). The consequences of method study were perceived in Taylorite fashion as 'the simplification of work'(Train, 1955, p. 10). This identity with Taylorism changed and by 1962 the director of workstudy was referring to 'workstudy in its widest sense' (Larkin, 1979, p. 135), a definition that was to include a range of operational research techniques. However, at first the difference between the BTC approach to workstudy and Taylorism was the former's stress on human relations (Kenrick, 1956, p. 294; Lund, 1960, p. 5; Larkin, 1957, p. 46). Workstudy was defined as: '25 percent techniques and 75 percent communication' (Kenrick, 1958, p. 6; Lund, 1960, p. 5). The human relations element was primarily concerned with gaining workers cooperation when carrying out and implementing studies (Kenrick, 1955, p. 297; Lund, 1960, p. 7). This seems to reinforce Braverman's comments on the role of industrial psychology and sociology as a means of habituating the worker to Taylorism (Braverman, 1974, pp. 139-152).

The adoption of human relations as part of workstudy was seen as necessary due to mistakes made in the application of workstudy in other industries before the Second World War. Train makes this link clear:

> 'It is most unfortunate that some of the techniques devised and called, in the main Time and Motion Study, were used unscrupulously without due regard for human relations during the depressions that followed the First World War, and this abuse of an excellent science which can benefit labour just as much as it can management, did much to retard expansion of workstudy... The abuse of time and motion study after the First War really consisted in ignoring the human element and treating men like robots, or as cogs in a machine. '(Train, 1955, p. 8)

This problem was identified by others, Lund speaks of the 'misuse of such devices as the Bedaux system' (Lund, 1960, p. 3). The problem and its cause are the same as those identified during the discussion of piecework. Bad managerial practice was seen to lead to workers being suspicious of, in managers' consideration, sound systems.

THE REASONS FOR WORKSTUDY IN THE BTC

The 'overall objective of workstudy is higher productive efficiency' (Larkin, 1957, p. 46; see also Train, 1955, p. 10). This is in line with the view of management as being concerned with 'the definition and achievement of the respective objectives in the most economic way' (Lund, 1960, p. 3). The difficulty presented of why this aid to efficiency was not applied earlier, was posed and answered by a member of the BTC:

> 'why are so many administrations agitating about productivity at the moment, when for years we seemed to get along quite satisfactorily ?...full employment...makes it all the more necessary to see we use such administrators and labour as we can get hold of to the maximum advantage.' (Train, 1955, p. 15)

The need to make maximum use of labour in a situation of labour shortage was identified by other engineers (Larkin, 1957, p. 45, 55). This management strategy of using workstudy in times of labour shortage would seem to undermine Friedman's arguments that workers in a strong labour market situation are given autonomy (Friedman, 1977).

The adoption of workstudy on the railways had specific railway factors. workstudy was seen as a means of achieving the aims of the modernization plan:

> 'the more officers and personnel who can be properly trained in workstudy over the next few years, the more certain is the Modernisation Plan likely to succeed.' (Larkin, 1957, p. 55)

Workstudy and the rolling stock changes were part of a dual strategy for achieving a viable railway and transport system (Train, 1955, p. 15; Kenrick, 1958, p. 4; Larkin, 1957, p. 50; Ray, 1962, p. 389).

DIFFERENT APPROACHES TO WORKSTUDY

In this section I wish to draw out two different attitudes to what constitutes efficiency and the nature of workstudy. One approach, in the classical scientific management tradition, sees workstudy as primarily concerned with increasing labour efficiency, the other approach stresses newer techniques concerned with the effective coordination of production.

There are elements of each approach within the writings of all the authors considered, but the wider focus predominated in the workstudy division (if the writings of Larkin its director and his assistant Lund are representative). The perspective of workstudy as Taylorism is represented by Kenrick, one of the leading consultants working on the railway and by Train, an admirer of the work of consultants.

Engineers have historically exercised control over workshop production by means other than directly determining the tasks of labour. Workstudy had its impact when the workstudy division had developed its stress on the contribution of workstudy to the coordination of production, as opposed to a stress on worker effort.

The following quote from Lund indicates the distance that the BTC had moved from Taylorism in 1960:

> 'Individuals work differently and some perform operations or produce more in a certain time than others. It is, however, more important for management to be able to plan accurately the flow of output than to obtain the maximum output from an individual.'(Lund, 1960, p. 3)

Workstudy had become, primarily, a means of controlling production flows, (see also Larkin, 1957, p. 48) which was central because, it was argued, this was where costs were incurred:

> 'high cost is more often due to inefficient management than to low effort on the part of workers. Nor is this the only result of poor management. Even in the transport industry, where labour cost is still a high proportion of the total cost, the very low utilization of capital equipment has at least as great an effect on cost as ineffective use of labour.'(Lund, 1960, p. 3)

Bad management and lack of utilization of equipment were the major causes of high costs, at least in Lund's view, it is therefore not surprising that the major contribution that workstudy could make to efficiency was improving management planning, in particular the coordination of work:

> 'The planning, organizing and co-ordination of the work of large numbers of people to achieve the defined objectives as cheaply as possible makes it essential that managers should know as accurately as possible how long each operation should take: whether it be the movement of parcels from railvan to delivery vehicle, the sale of a ticket or a process in the building of a vehicle. This brings us to the inevitable conclusion that to reduce costs we must manage better. The facets of management in which most scope lies immediately to hand are improved planning of work and obtaining more effective work.' (Lund, 1960, p. 3)

The role of workstudy is to assist in improving efficiency by supplying management with knowledge of the times of activities and enabling them to coordinate the labour process.

The alternative perspective laid stress upon the costs of labour. Kenrick commented that the consultants' schemes would give information to management:

> 'highlighting productivity levels, labour costs per unit of output, and the sources of the excess costs which are being incurred. Finally, it becomes possible to have reliable incentive schemes giving a fair return to management and staff.' (Kenrick, 1956, pp. 298-99)

The focus here is clearly upon workstudy as 'a means of controlling labour'(Train, 1955, p. 14). In 1961 and 1962 the North Eastern Region appointed Urwick, Orr and Partners to examine the applicability of workstudy to their works at York and Shildon. The consultants considered the issue to be the 'labour performance problem' which led to the following advice, 'a complete revision of the system of payment is imperative, rather than any adjustment of present arrangements' (Hambly and Gallon, 1962, part 2, p. 29). From the perspective of those who advocated the work of consultants, workstudy still appeared to be perceived as scientific management.

CONFLICTS BETWEEN CONSULTANTS AND THE WORKSTUDY DIVISION

Consultants were responsible for the first applications of workstudy on the railways. Those employed by the workstudy division took a rather dim view of their achievements, Larkin noted that some 'did a worthwhile job, but others cost a great deal and achieved little. I would normally recommend the use of specially selected and trained personnel from within the organization' (Larkin, 1979, pp. 132-3). This low view of consultants was based on assessment of schemes that concentrated on trying to increase labour output:

> ' In some cases workstudy was used to create a financial bonus scheme for the staff as a substitute for unjustified overtime in the areas of labour shortage ... rough and slipshod time values have sometimes been produced so that the bonus scheme could be introduced quickly ... where method study and work measurement were not carried out thoroughly, and to a sufficient standard of accuracy, the control data are of small value and management will be ultimately faced with establishing more accurate values.
>
> The situation arose, in part, from the calibre and lack of experience of some of the workstudy staff, and the employment of consultants whose objective was to maximize savings in the shortest period of time.' (Lund, 1960, p. 8)

The use of consultants with their concentration on labour has led to data of very little use in management planning. Management needs to establish new values but in sorting out past mistakes leaves itself open to 'the accusation of 'rate cutting' (Lund, 1960, p. 10) and the 'discrediting of workstudy' (Lund, 1960, p. 5), for the second time. The difficulty with workstudy systems based upon increasing labour efficiency, may be the explanation for the shift of the workstudy division's focus toward workstudy as part of a package of work planning and the hostility of its members to consultants. The initial difficulties around workstudy led Larkin to conclude method study 'requires an intimate knowledge of the industry or processes involved' (Larkin, 1957, p. 46). This wider view of what constituted workstudy included the adoption of a number of workstudy techniques, and of particular importance for the workshop was network analysis.

CENTRAL DESIRE TO APPLY WORKSTUDY TO THE WORKSHOPS

The application of workstudy to the workshops did not occur until after 1969, around fifty years after it was first proposed as an aid to productivity, and fourteen years after the formation of a workstudy division. There was a commitment in the division to apply workstudy, the director had an assistant charged with responsibility for the application of workstudies to mechanical engineering. In 1962, seven years after the division's foundation, the director saw the application of workstudy to the shops as an area 'where we can achieve the most rewarding results' (Larkin, 1979, p. 135), this policy was not achieved until seven years later. There was also regional commitment to workstudy, and the regional managers (responsible for the workshops until 1962) also had workstudy assistants with responsibility for main works (Ray, 1962).

The promotion of workstudy had little impact within the workshops (Larkin, 1957, p. 49). Lund summarised the position in 1960 'in mechanical engineering progress has been very slow' (Lund, 1960, p. 11) and Ray in 1962 noted that 'there is as yet not a very noticeable impact of workstudy in the major mechanical workshops' (Ray, 1962, p. 387). Reporting on the works of the North Eastern Region, Urwick Orr's reports confirm this (Urwick, Orr, 1961, 1962a, 1962b).

MATERIAL DIFFICULTIES IN APPLYING WORKSTUDY

Applying workstudy to the railway workshops presents no material difficulties. As one consultant wrote, the workshops present 'the same general potential as one finds in the factories of private industries' (Kenrick, 1955, p. 302). It is clear that he is correct in this assessment. Indeed, Taylor developed his system from the analysis and experience of producing rolling stock components, and it was later applied to rolling stock production in the U.S. (Clawson, 1980, p. 205). In Britain, the regional development of workstudy began in civil engineering workshops, spreading to signals engineering by the early 1950s. In 1957 Springs branch depot at Wigan became the first running shed to go onto workstudy, and by 1960, 55 of these depots, which performed similar work to the large repair shops, were under workstudy schemes covering 3000 men (Lund, 1960, p. 17; Ray, 1962). The small, 500 employee, railway works at Inverurie was the subject of a fully fledged scheme at the end of the 1950s (Lund, 1960, p. 11), and in 1962 consultants had developed a scheme for the much larger Shildon wagon works (Urwick, Orr, 1962d). The fact that workstudy was applied after 1969 is proof enough that there are no major material problems in applying workstudy.

JUSTIFICATION OF THE NON APPLICATION OF WORKSTUDY

Contemporaries argued that the lack of workstudy was due to the existence of piecework (Kenrick, 1955, p. 302; Ray, p. 388; Larkin, 1957, p. 49; Lund, 1960, p. 11). The existence of piecework was used to explain why in certain works method study, but not work measurement, had been applied (Larkin, 1957, p. 49; Ray, 1962, p. 388). This is strange given that scientific management was seen by earlier engineers and Taylor himself as a solution to the inadequacy of the piecework, ie:output restriction and bad rate fixing. During the early nationalization period piecework was considered to be a problem, in straight contradiction to Taylor, because workstudy was unable to give a sufficient increase over existing piecework bonus (Kenrick, 1955, p. 302; Lund, 1960, p. 11), and consequent upon this, the workers and their unions would not accept it:

> ' In Mechanical Engineering progress has been very slow, largely because of the traditional piecework system which has generally resulted in higher 'bonus' earnings than would accrue under the normal workstudy system. Further, the piecework system includes the practice of negotiation and agreement on prices with the staff representatives, whereas the work-measurement time for a job is factual and not subject to any negotiation.' (Lund, 1960, p. 11)

Thus workers and unions were perceived as being committed to workstudy because of high bonuses and staff involvement in the negotiation process (see also Ray, 1962, p. 388). Lund continues to illustrate his theme by explaining that Inverurie was the only workshop to accept workstudy because of 'the low earnings of a 'group piecework scheme' (Lund, 1960, p. 11). The opposition to workstudy, it was argued, did not come from union leaders but from the rank and file:

> 'railway unions have shown commendable foresight in their support of this movement', (Kenrick, 1958, p. 6) but because the top people in a union make a certain policy declaration 'it does not necessarily follow that the union as a whole has the same viewpoint,' (Kenrick, 1958, p. 6)

Piecework was seen as inadequate but, unlike after the First World War, this was not a reason for workstudy but a reason for its absence.

ASSESSMENT OF THE EFFECTS OF THE SYSTEM OF PIECEWORK

Even excluding the intentions of Taylor and early engineers, the explanation of piecework as the reason for the lack of workstudy is not adequate. It is not adequate because the bonuses on piecework were not particularly high, nor did union rank and file vigorously oppose the adoption of workstudy (Chapter five).

The conclusions of the consultants working at Shildon and York was, in line with the older view, that workstudy should replace piecework because 'existing piecework prices are unsatisfactory as a basis for incentive payments, measurements of productive efficiency and planning' (Urwick, Orr, 1962b, p. 9). The failure of piecework is, in contradiction with the view expressed above and worth quoting in full, partially due to an inadequate bonus:

> 'The agreement regulating the setting or piecework prices stipulates that they must permit 27.5% above the base rate being earned. As the base rate contributes only some 35% of the consolidated . rate, this results in a 'gearing' which is below that required to provide an effective incentive.' (Urwick, Orr, 1962b, part 2, p. 10)

To claim that high piecework bonuses were to be made is disingenuous given that they were only calculated on some 35% of day rates. The report goes on to note that there were, what he, and presumably those quoted above, considered to be 'slack rates' (Urwick, Orr, 1962b, part 2, p. 10). Urwick, Orr quoted the average bonus rate at Shildon to be 135% of base rate (Urwick, Orr, 1962b, part 2, p. 10), which amounts to 47% of the day rate. At York, Urwick estimated the bonus to amount to 33% of total day rate, which the consultants regarded as standard for industry (Urwick, Orr 1961). Thus it would appear that the high bonus rates did not reflect high earnings, but the low base rate from which they are calculated. This was the consultants' view:

> ' The progressive rise in bonus earnings ... is in accord with our previous experience of situations involving a two part wage structure, in which the nominally fixed element (ie: additions) is varied, while the variable element (base rate) remains constant. We suspect that these increases in bonus rates reflect the bargaining between foremen and operatives for a mutually acceptable rate of working and take-home pay, rather than progressive improvement in efficiency.' (Urwick, Orr, 1961, p. 28)

The tendency to lax rates because of the negotiation process and lack of work measurement was stressed by colleagues (Urwick, Orr, 1962b, p. 10), but not all foremen would allow for this upward drift of prices, Urwick, Orr reported:

> ' Foremen vary widely in their approach to rate fixing procedures. We encountered, at York, those who took pride in driving hard bargains and those who regarded output as being of greater importance than bonus earnings.' (Urwick, Orr, 1961, p. 29)

The problem of piecework for the consultants was not that because of high bonuses it could not be replaced, but that because of output restriction it needed to be replaced:

> 'We suspect that the most likely reasons why operatives do not increase their effective rate of working are:
> 1. The rate of redundancy would increase.
> 2. They would expect future piece rates to be set more tightly.
> 3. Previous experience on the incidence of material and component shortages has led to a pace of work which is consistent with estimates of total work available.' (Urwick, Orr, 1962, p. 28)

The first two of these are the classic reasons for output restriction , the second was the major concern of the piecework crisis of the post First World War period , but the third focuses upon bad management planning leading to workers fitting their work to the normal cycle of activity. It is the latter which is identified as the major cause of output restriction :

> 'From our discussion with shop representatives, it is evident that it will be difficult to secure the full co-operation of the labour force on the matter of labour performance unless positive steps are taken to eliminate management difficulties (material supply sub-standard equipment, design faults,etc.) which hinder consistent production.' (Urwick, Orr, 1961, p. 28)

The workers saw productivity as a function of the coordination of the labour process, not individual effort mirroring the engineers' holistic perspective and the later concerns of the workstudy division. Urwick, Orr see low productivity as a response to inadequate planning and concluded that the system in operation 'tends to discourage high earnings in return for high productivity' (Urwick, Orr, 1961, p. 29).

Urwick, Orr were given a contract to develop a work study system for Shildon and their experience casts doubt on the claim that workers were committed to piecework. In line with the emphasis on human relations that characterised the revamped workstudy, they began their work by holding a meeting with the shop stewards. Workers showed little hostility to the scheme, the consultants noting that in 'general the reception so far accorded to our work by the workmen is satisfactory' (Urwick, Orr. 1962c, p. 3), although they did note that the 'supervisory staff have shown misgivings' (Urwick, Orr, 1962c, p. 2). The historical decline in the foremen's power and status indicates that their misgivings were probably sound.

The workers' interest went further than acceptance , the union informing the consultants that 'a number of workmen are interested to acquire a better understanding of the principles of workstudy and asked if these men could be given appreciation courses' (Urwick, Orr, 1962c, p. 3).

The perceived commitment of workers to piecework was open to purchase, as had been the case at the conversion of Inverurie to workstudy (Lund, 1960, p. 11). The eventual application of workstudy was open to purchase at a price. The unions had been involved in cooperation over workstudy in the three workstudy consultation committees, but in July 1967 the engineering unions organised by the Confederation of Shipbuilding and Engineering Unions (CSEU) imposed a ban on cooperation with productivity schemes (BRB, 1967, p. 38). The issue was settled in August 1968 after the CSEU 'accepted an interim offer of increased pay for workshop staff parallel to that offered to conciliation', then in the words of the Board they 'resumed normal productivity bargaining'(BRB, 1968, p. 50; McLeod, 1970). The 'Pay and Efficiency Agreement' which instituted workstudy indicates in its title that pay and productivity had to be solved together. Workstudy policy was initiated with a guarantee that pay would not be cut:

> 'When men are transferred from piecework to workstudy schemes, a personal allowance will be paid to maintain their existing earnings within the standard week when working at a standard performance. This personal allowance will progressively be reduced by improvements in standard rates '. (BRB 1969)

The acceptance of existing pay was not an obstacle in 1969 but was seen as something that could be phased out slowly. The option of guaranteed earnings is a standard means of ensuring cooperation with policy changes and was used when the re-incentive scheme changed the basis of work measurement (BREL, 1978, p. 9).

It is clear that the option of guaranteed earnings was the only basis on which workstudy could have been introduced. To present the piecework bonus as the problem behind implementation was a red herring, especially as workstudy was expected to lead to massive increases in productivity and was certainly not portrayed as a means of cutting wage levels. The explanation for the lack of workstudy is not the existence of piecework but something else which can be investigated by examining what had changed to enable the application of workstudy.

CHANGES LEADING TO THE 'APPLICATION OF WORKSTUDY TO THE RAILWAYS

The main change was the Workshops Closure and Investment Plan. The modernisation of the works during the 1960s contained two changes that increased the opportunity for, and importance of, workstudy:

1. Increased planning and control of flows of work.
2. Network analysis for manpower planning.

The first policy involved integrating the activities of all departments into a clear sequence of tasks from raw material to finished rolling stock, ensuring that all men, machines and components necessary to perform a task arrived at the right place and at the right time. This integration was assisted by the use of network analysis which identified the activities that had to be speeded up to increase production (the critical path) and the manpower which could be transferred to do this are identified as that working on sequences with slack time.

These two developments, which have their origin in engineering, increased management's concern to introduce workstudy for two reasons:

1. Increased importance of knowing activity times. Workstudy is about assisting planning not increasing individual effort, information about individual workers' activities was adopted in the workshops when management decided that it would be important. Improved planning increased the importance of discovering critical and slack flows of work, and this meant knowing the times of the activities that made up these sequences.

2. Increased relative importance of labour saving. The improved coordination, following the modernisation plan, increased productivity, raising the relative profile of productivity increases from labour effort.

THE ADOPTION OF WORKSTUDY IN THE WORKSHOPS

The agreement introducing workstudy into shops had two major elements; the introduction of workstudy and the development of flexible labour practices.[3] The aims of the agreement were stated as follows:

> 'The principal features of the agreement are an improved pay and grading structure; development of versatility and flexibility in the utilisation of staff; replacement of piecework by incentive bonus schemes based on work measurement' (BRB, 1969, P. 2).

These features mirror the two attitudes toward productivity as either, a product of coordination, or individual effort. I would argue that even in this agreement, which introduced Taylorism, the emphasis is on productivity as springing from coordination.

The number of grades was reduced from 230 to 18 craft grades, two semi-skilled grades, 1 unskilled grade and 4 store keeper grades. All craftsman would be paid the same rate except for a pattern makers' allowance. The aim of the reduction in grades was to 'improve the utilisation of men, materials and equipment' (BRB, 1969, p. 16). This was to be achieved by increasing manpower flexibility, and in relation to the non-craft grades the agreement was for 'complete versatility and flexibility within each category'(BRB, 1969, p. 14), and the men concerned would be

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[3] Not only did the Pay and Efficiency Agreement guarantee the same earnings as piecework, it also inherited the problem of attempting not to cut rates against a climate of a developing labour process:

> 'Work Content Times will not be altered unless there is a change in methods, materials, tools, equipment or conditions in case of a significant error in the calculations.' (BREL, 1969, p. 12)

given training. Craft trades were not to become interchangeable but certain demarcation lines were to be abandoned:

> 'In cases where the major part of a job is undertaken by one craftsman and a fringe portion by another, in future, the craftsman performing the major part will, subject to his having the necessary skills, perform the complete job' (BRB, 1969, p. 15).

The policy on flexibility and versatility was an attack upon the grading structure which supported the established sequences and practices of activities. In the past, the grading structure reflected the pattern of activities seen as necessary in main works. The extension of flow line procedures, and the analysis of opportunities for staffing transfers from one slack activity to another, demands a grading structure which enables staffing transfers .

Under piecework, the piecework bonus in the workshops was calculated on the output of a piecework group, the size of which varied from a handful of people to several hundred (Urwick, Orr, 1962b, part 2, p. 10). The workstudy system adapted this group payment system, and bonus was paid on the basis of the shop. The workstudy aspect of the agreement was not only concerned with the provision of incentives but also with ensuring the operation of the new working practices, workers had to comply with predetermined schedules and would therefore be issued with:

> ' Work content times, supported by work specifications defining methods, material, tools, equipment and other details relevant to work'. (BRB, 1969, p. 12)

The agreement placed a premium on effective coordination of work. The concern with coordination echoed the workers' demands, and was stated as a principle of effective management by the board:

> 'The management recognise that the resources and techniques available must be efficiently organised so that workshop capacity may be utilised to the best advantage.' (BRB, 1969, p. 5)

The commitment was re-emphasised in the re-incentive scheme; 'Management accept the obligation to supply work to enable a standard performance to be achieved' (BREL, 1978, p. 9).

This scheme aimed at providing 'a greater financial incentive for increased productivity'(BREL, 1978, p. 1). The scheme basically aimed to increase the effort and reward ceiling. The ceiling on the top performance that would receive bonus was raised by 21%, a figure that appears arbitrary. Thus workers could increase production by up to 21% above the old permitted maximum, receiving a pro-rata increase in bonus pay. This indicates that they got their original estimates of the incentive scheme wrong, which may be a reflection of the low priority given to this aspect of the Pay and Efficiency Agreement. I would also speculate that the concerns of the re-incentive scheme were a reflection of a growth in management with accounting based concerns for methods that focused on productivity as due to the effort of individual departments and people.

SUMMARY

This chapter has examined the development of Taylorism and its derivative workstudy within the railway workshops. If Braverman's theory is taken to indicate that Taylorism was the means of separating mental and manual work under monopoly capitalism, and that it marks the fundamental transformation within the labour process, then this is not the case. During the inter-war period the railways were among the largest companies in the country and under immense financial pressure. Yet Taylorism was rejected by these companies, only to be implemented later by a nationalized corporation.

The examination of how workstudy was implemented during nationalization reveals the answer to why it was not implemented earlier, and also throws light on the growth in the control over the coordination of the labour process. Workstudy was applied in the workshops when it conformed to the existing production system. The production system introduced during the inter-war years emphasised the co-ordination of the production flows of the whole workshop and not the maximisation of departmental production or individual worker production. Indeed, the system of production during the nineteenth century which was being abandoned, operated on the basis of concentrating on departmental production. It could be speculated that Taylorism was limited by its reliance on these earlier conceptions of the nature of production.

Workstudy, which was seen as having its origins in Taylorism, was applied when two changes occurred: firstly, when a greater stress was given to techniques for coordinating the labour process and, secondly, when the advances in utilization made by coordinating the labour process could only be furthered by having precise knowledge of activity times. The role of increasing worker effort and reducing worker reward was a secondary aspect of the application of workstudy. Thus, the application of workstudy in the railway workshop is a reflection of the interrelated nature of the labour process. It was shown in the last chapter that machines were introduced according to criteria that varied, as one advance was made in utilization, for example, the introduction of compound cutting as a means of reducing work in progress eventually reduced the relative gains to be made from reducing work in progress, and led to a relative increase in the emphasis on reducing the amount of labour intervening in the machining process. ,That is to say, as one facet of the labour process was improved other facets were relatively problematic. Workstudy as a means of increasing utilization came to be applied when the gains made from controlling the flow of work had increased the relative importance of controlling the coordination of workers who carried out the work, in order to have control over the allocation of workers it was necessary to know how long work took, and of course, as an important extra, whether those times could be shortened.

That workstudy underwent this development is a product not purely of the technical nature of the labour process, but also of the fact that the engineers, a profession more attuned to the nature of material production processes, were in positions of authority and also emphasised the importance of technical criteria for most of this century. Rose has recently criticised Braverman, Noble and Marglin for presenting the engineers as 'infinitely resourceful' (Rose, 1988, p. 374), it should be clear from my account that this is not the case with my discussion. I have presented engineers as being in tune with the coordinated nature of production, but in a crisis management sort of way, that is the labour process changes by developing one aspect of the interrelated whole as it becomes important, and infinitely resourceful manager would develop the whole collectively, although on occasions this does happen and perhaps the development of flexible manufacturing, discussed in the last chapter, is part of a the emergence of the integrated nature of the labour process. Thus the development of Taylorism within the railway workshops conforms to the general pattern of the growth of control over coordination of production within an engineering dominated industry.

CHAPTER TEN

CONCLUSION

INTRODUCTION

The final part of this thesis summarises the preceding descriptions and arguments, and attempts to assess their theoretical importance. Theoretical concerns have been constant throughout the text, although these are most clearly stated in the Introduction. The Conclusion therefore seems an appropriate place to attempt to restate what I consider to be the theoretical significance of my case study of railway workshop history. This restatement is achieved in three parts, firstly, a discussion of the theoretical themes developed and their relation to issues raised in the current academic context, secondly, a chapter by chapter discussion of the argument, and finally an attempt to summarise the argument and processes at work.

THE ARGUMENT OF THE THESIS AND ITS THEORETICAL CONTEXT

The most significant theoretical concerns of the case study are derived from that phase of British sociological history termed 'the labour process debate'.[1] The starting point for this debate was the publication of Harry Braverman's thesis that work had become degraded (workers' activity had become planned and specified by management) and the major moment in this transition was the application of Taylorism.
As is made clear in the Introduction, the labour process debate developed by a combination of subjecting Braverman's thesis to criticism and offering alternative formulations of the nature and development of the labour process. The debate today largely consists of a critique of these latter contributions rather than further critiques of Braverman.

[1] Although I do recognise that this is a transatlantic debate.

The major criticism levelled at Braverman is that he ignored the subjective component of the labour process. He is accused of not identifying the following three subjective factors:

1. workers' struggles as a significant component, shaping the organization of work;

2. all human actions have a subjective component, even degraded work requires tacit skills which cannot be monopolised by management. Following from this, management need to retain the workers ability to respond flexibly and workers must consent, in some way, to the demands of production and management prerogative if production is to take place;

3. management initiatives are the subject of strategy rather than knee jerk responses to system requirements.

By acknowledging these diverse subjective determinants of the labour process and using them to describe changes in particular labour processes many authors have come to the conclusion that the best labour process theory is contingency theory. Contingency theory, which is the dominant mode of thinking in business studies, claims that the shape of any organization is the product of particular circumstances and forces acting upon it rather than any generalized determinants,like, for example, the pursuit of profit.

This thesis has aimed at rejecting the contingency approach to labour process theory, at the same time as accepting that the subjective is a crucial determinant of the labour process. In doing so, I reject Braverman's identification of a general trend as the separation of execution and conception. I also reject Thompson's recent attempt to establish a general theory of the labour process by stressing the 'central indeterminacy of labour' which, besides being a restatement of Marx's theory of exploitation, makes no claims about outcomes. Instead, I wish to argue that the separation of workers from the means of production has led to a tendency for management control over the coordination of production to increase. I have claimed that management's ability to determine what material tasks are carried out, when where, how quickly, and with what means, has increased. This does not imply that work has been degraded, but that management has increased control over the combination of raw materials, means of production and labour tasks. Labour tasks may become more skillful due to the adoption of new techniques.

Effective coordination implies four things:

1. Materials, machines and men come together at the same place at the same time;

2. Coordination in the sense of 1. aims at the effective utilization of the elements of the labour process, for example, the development of multiple cutting ensured full utilization of raw material and machinist labour;

3. Attempts at coordinating one process should be integrated with other processes, for example, machine shops and assembly shops;

4. Changes in the coordination process should not jeopardise but improve the ability to coordinate the labour process in future.

My analysis of the railway workshops has shown the development of managerial control over coordination is a plausible explanation of the changes in the twentieth century labour process. This development has been uneven and a major theme of the previous chapters has been the importance of management rivalries as determinants of the labour process. This does not entail a rejection of general trends but an acceptance that the effects of management rivalries affected the labour process within the wider context of the development of control over coordination.

In the railway workshops the management rivalries have been predominantly between accountants and engineers. I have shown that which tasks constituted accounting and engineering changed over time. Latter day engineering differs from early twentieth century engineering, for example, by giving a greater stress to the importance of financial criteria. As I went on to indicate, the conflicts between accountants and engineers could be understood by referring to the two processes necessary for the reproduction of a labour process, its reproduction as a physical and financial entity. The manner in which the articulation of the financial and physical is managed is seen as particularly important. Sohn-Rethel argues that plant and market economy come into contradiction, I have shown that the contradiction gets resolved according to some criteria. This thesis contributes towards the elaboration of managerial conflicts, both between groups and between criteria for deciding management policy within an overall development of increasing managerial control over coordination.

Because this thesis has been written within the context of British industrial sociology it has been necessary to examine those considered important by the social scientific community, as discussed in the labour process debate. The thesis has alighted on these major concerns and fitted them into a general theoretical scheme of the development of increasing managerial control over the coordination of the labour process. It is to a more detailed recitation of the arguments of the thesis, chapter by chapter, that the next section of the Conclusion turns.

DESCRIPTION OF THE CONTENTS OF THE PRECEDING CHAPTERS

Chapter one sets out the theoretical issues which have been reiterated above. Any discussion of change requires parameters and base lines,. and chapter two, by discussing ownership and product, provides these for the argument that follows. It is to the brief explication of chapter two that I now turn.

This thesis has examined those main workshops owned by railway companies and responsible for new construction and major overhaul. Ownership explains much about the history of the workshops. Ownership by the customer meant production was for use, and this meant that the efficiency of the operating side of the railway was a significant consideration for workshop management. Particularly significant was that works' output of repair and construction be achieved as quickly as possible. The significance of this was that the workshops' employment levels reflected the rise and fall of the railways. Also, the more efficiently the railways used rolling stock, the less works' output was needed, and, somewhat perversely, the more efficient the workshops were, the less workshops were required.[2]

Following chapter two, the thesis followed a format that echoes Marx's distinction between relations and forces of

[2] Also of importance was the fact that the railways were nationalized in 1948, a fact that had little impact upon the forms of work.

production. The development of production during the last century, the topic of chapter three, was divided into three parts:

1. A discussion of the social relations of production,
2. The methods of production, and
3. Management's perspective on the methods and social relations of production at the turn of the century.

Chapter two, by discussing ownership, outlines part of the social relations of production, chapter three examined the social relations involved in setting the workshops to produce. It is shown that because the workshops produced for use, not directly for profit, engineers were entrusted with managerial responsibility. Railway engineers were few in number, during the last century, and were responsible for designing the rolling stock and setting the broad parameters on production levels. Production was mainly achieved, as was common during the last century, by craftsmanship under the control of foremen, and on occasion by subcontractors.

The engineers' mechanical skills derived from their knowledge of locomotives and other rolling stock and was, during the nineteenth century, increasingly applied to the method of production. As a consequence, the workshops were subject to a continual growth in mechanization. The improvements made possible by mechanization were limited in the processes to which they could be applied, for example, they were not widely used in the erecting shops. Even so, the growth in mechanization reinforced the importance of technical skills for management, and increased the numbers of engineers.

As is shown in chapter three, by the end of the First World War the engineers, who had grown in numbers and importance partially as a consequence of the development of the forces of production, began to criticise, and seek alternatives to, the social organization of production, particularly the foreman system. The changes that the engineers were advocating were to be applied in the name of science.

The remaining chapters of the thesis examine and deepen the causes and outcomes of the management 'difficulties' of the early part of this century. This deepening was achieved by each chapter adding further elements to the structure of the whole argument. The social relations of production, by which in this context is meant the development of relations between engineers, supervisors, workers and accountants, are dealt with in chapters four to six. Continuing with Marx's dichotomy, the forces of production were dealt with in chapters seven to nine, these covered, respectively; the coordination of production, mechanization and Taylorism. [3]

At the macro level, the organization of the chapters is intended to reflect the duality, expressed in the introduction to the thesis and this chapter, between the general development of coordination, which is revealed in the chapters on the organization of production and the variability of the social relations of production which determine the speed and efficacy with which coordination develops.

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[3] Technically speaking these deal with issues of the organization of production, as do the earlier chapters on social relations of production.

The dominance of engineers within the management of the workshops, unusual in the British context, was a position that was retained throughout this century, a significant reason being that the workshops produced for use. Because of their centrality their professional and educational development was described in chapter four.

The training of engineers is shown to have changed from one based on manual labour supported with technical training, to one almost solely based on theoretical, often degree, training. The implication of this at the level of sociological theory is that what constitutes an engineer varies over time. This fact is not without consequence because the change in engineering changed the knowledge and resources on which engineers could draw when determining policy. Also, as is shown in chapter six, the internal changes in engineering made railway engineers more susceptible to management as financial management, thus adding further to the point that what knowledge constitutes a profession change over time.

As was emphasised above, the railway engineers wished to transform the social relations of production at the beginning of the 1920s. This meant changing a system where production was achieved by a foreman system of control over works combined with limited mechanization. Chapter five examined the development of worker and supervisor during the course of the twentieth century. A major conclusion of that chapter is pre-empted in this choice of subject matter, and that is that the worker supervisor relationship is central to understanding worker behaviour in the workshops, therefore it made sense to treat the two groups together. Chapter five covers two areas considered important within labour process literature, the subjective role of workers' struggle and consent, and the development of the foreman's role (Littler 1982, Clawson 1980).

The chapter begins with an examination of the engineers' post- First World War opposition to the existing social relations of production. In discussing the engineers' views it is shown that trust, a concept which derives from the work of Fox (1974), has an important impact on the ability of management to adopt certain policies. There were two linked targets of engineers' opposition to the nineteenth century method of production: the foreman and the system of payment by results. The engineers argued that workers working under payment by results were restricting output because of the previous practices of the foremen, poor rate fixing and its consequence of piece rate cutting if the piece rate bonus earned went high. The engineers' concern over the piece rates was not solely stimulated by an awareness of output restriction but was also due to a feeling that there was a lack of trust between workers and those in authority. The engineers, in the immediate post-First World War period, had few ideas of how to overcome the production problems faced, other than some vague commitment to science and openness.

This discussion of output restriction and low trust relations clearly indicates that workers do have an impact upon management perceptions of the labour process. Chapter five goes on to describe the development of mass trade unionism in the railway workshops during the First World War,[4]

[4] High levels of unionisation have existed since that period.

which may have been a major stimulus to the development of the engineers' perception of low trust relations and may have given workers increased confidence to engage in informal struggles, for example, restriction of output.

Mass trade unionism did not, as chapter five shows, translate into mass action, there were few strikes occurring at national level. This was largely due to a lack of power explicable by the fact of railway ownership of the workshops which meant that action had no impact upon sales, because there were none, nor could it stop the trains. Even so, engineers and management enthusiastically welcomed national and local bargaining as a means of negotiating with workers without involving the foremen.

Thus the first part of chapter five established that management perceived the previous century's relations in production as inadequate because of the role of foremen. It also indicated that the emergence of trade unionism may have been the cause of this perception. These matters are clearly complex but the developments in industrial relations described cast doubt on placing too high a significance on the impact of trade unions. The lack of union power and their use for bypassing foremen would suggest that the engineers' concern over production was stimulated, not by the emergence of unions, but by the emergence of accountancy, a matter discussed in chapter six.

In the 'structure of work' section of chapter five it is established that the workers' experience was, as Baldamus (1961) claims, dominated by the wage effort bargain and relations with the foreman. This worker concern is explicable by the continued use of payment by results (piecework was used until 1970), and the use of foreman as the first line of management. It is shown that the lived experience of the workers becomes less and less central to the nature of production. As is shown in the chapters on forces of production, over the course of this century the coordination of production becomes more important than worker effort, and chapter five details the consequent decline in the status of supervisors, in terms of; pay, status and discretion (both in terms of production control and apprentice training).

The continued use of piecework for fifty years after 1920 reveals that the piecework problem was not considered by management as significant, as the method of production and which group had responsibility for its determination. It is argued that the declining significance of worker concerns for the management project underlies much of the consensual nature of railway workshop industrial relations.[5] The marginalization of worker concerns does not mean that workers are irrelevant, as Rose et al. (1987) have argued they still must work and be supervised. As is shown in chapter five, consent to work is further generated by the creation of railway and craft loyalty. The former being a product of the creation of railway families, and following Newby (1979) dependency.

Craft loyalty generated worker consent somewhat differently to dependency, by producing a commitment to work tasks and creating oppositions within the workforce between those with different skills.

Chapter five ends by showing that the disputes that did

[5] And probably those of other industries.

occur revolved around the wage/effort bargain and disruptions to that relationship, for example, with the introduction of workstudy. Indeed, the position of chargehand was shown to provide a mechanism by which disputes over the wage/effort bargain could be accommodated. It is shown that only in the extreme situation of works' closure did workers and unions adopt a rationale free of the wage effort bargain. This change in rationale had little impact, and its importance for this thesis is theoretical. The new rationale stressed the utilization of physical resources as opposed to purely financial criteria. This perspective has similarities with the rationality of early engineers, which was discussed in chapter six, and speculatively, may have its origins in a common experience of productive labour.

The aim of this case study is to elaborate a general trend of labour process development. As Yin (1984) has argued, general laws can be established on the basis of a single case study, providing the mechanisms are adequately specified. Generally speaking, I believe my thesis achieves this. However, in relation to the impact of workers' struggles on the labour process, I do not think this to be the case, and the marginalization of workers' concerns as a mechanism for consent will need further investigation.

Chapter six, which discusses the relations between accountants and engineers, is central to the theory developed in the thesis. To a large extent the gaze of chapter five is directed at groups considered, by the labour process debate, as important opponents of management, that is workers and supervisors. This is not surprising as it was these two together who were responsible for production in the last century, and as was shown, the relationship was identified as in need of change by railway engineers, a change that subsequently happened.

The labour process debate has tended to argue that the groups who are the object of management policy are also the cause of policy. Thus, it is argued that because management marginalised workers and supervisors, the cause of this policy was workers and supervisors' power. The explanation and the specific timing of the nature of the changes is thus also sought within the relations between management and the shop floor. When, on investigation, managerial policy does not appear to be patterned by its struggles with the shopfloor, the natural presumption would be that there is not pattern or trend. This thesis has argued that if conflicts within management are examined, then a pattern does emerge.

The analysis of chapter six, which examines conflicts between engineers and accounting does have some support within the labour process literature, but this is a very limited strand, for example, in the work of Peter Armstrong. It is not such a radical departure when it is remembered that supervisors are part of management, and conflicts with supervisors are more frequently discussed (Littler, 1982; Clawson, 1980; Edwards, 1979). In chapter six the concept of conflict between engineers and foremen has been, metaphorically, rotated to identify any other conflicts involving engineers and other management groups. In this way the explanatory power of conflicts between engineering and accounting is revealed.

Chapter six shows that the engineers' concern for production was stimulated by the emergence of accountants and accounting as a possible alternative means of controlling production. The emergence of accounting around the First World War was related to the rising fixed costs of production associated with mechanization. At this juncture the railway workshops could have developed in two ways; either, the accountants could have emerged as the dominant grouping, with policy decisions being aimed at minimising the expenditure of production processes, or, the engineers could have retained power by instituting policies that utilised physical resources and thus increased productivity. This dilemma restates Sohn-Rethels' notion of contradiction between market and plant economy by seeing it as a contradiction between the reproduction of the labour process by either physical or financial criteria. Both are necessary under capitalism, but I have shown, contrary to Sohn-Rethel, that managerial policy can stress the leading role of one or the other, and overcome contradictions, although for how long is a separate matter.

Chapter six shows that policy determined by the utilization of physical resources became the dominant managerial policy in the railway workshops. This thesis has been at pains to point out that the dichotomy physical resources/monetary resources does not equate directly with the groupings engineers/accountants. The significance of this claim is that the relation of types of management groups to types of policy has to be explained, and not taken as given.

The reader of the first five chapters could be forgiven for thinking that the dominance of engineering produces policies aimed at the utilization of physical resources is itself produced by the railway workshops existing for production for use. Chapter six dispels this illusion by showing that groups and practices are separated and that which practices predominate is the outcome of the activities of the groups involved. This is not to say that organizations are contingent upon struggle because there are boundaries to the form of the labour process set by the requirements of its reproduction as a physical and financial entity, and further that this reproduction process generates and requires a growth in the coordination of the elements of the labour process. The process of coordination is driven forward by the need for efficiency, which itself is explicable in terms of system requirements of profitability and the reproduction of class relations.

The engineers actions are used to illustrate the nature of group struggle. As was mentioned earlier, the engineers' concern for production was stimulated by the emergence of accountancy. The engineers at first responded by attempting to update the established pattern of worker/supervisor relations, but, as was shown in chapter five, low trust relations on the shopfloor meant little success was found in that direction. What engineers did do was to continue the process of mechanization, as is shown in chapter eight, and extended the principles of coordination, which is the core principle of mechanization, to the organization of production. This system of controlling coordination, by progress officers etc., is described in chapter seven, and can be described as control over the speed and direction of work flows. [6]

The engineers' political struggles thus had real outcomes which drew on their theoretical skills and which stressed the reproduction of the labour process according to one half of the physical/financial dichotomy. This does not establish the autonomy of groups and practices, other than to state that the reproduction of the labour process in physical terms involves changes in the technical practices of management, ie, in this case the concept of engineering becomes extended to cover control over production flows. The separation of groups from types of practice also relates to the physical/financial divide. In chapter six it was shown that engineers utilised accounting as a means of monitoring the activities of foremen. Thus engineers were not averse to seeing accounting as part of engineering if it served their interest. The distinctiveness of group from practice is further illustrated in chapter six when it is shown that engineers shifted from a stress upon the reproduction of the physical to a stress on the leading role of the financial.

The causes of the change in engineering to a stress on the financial are outlined in chapter six. The dominance of engineering had been based on senior management's stress on production for use, when following Beeching, the stress was on costs, the balance had shifted from management practice based on technical criteria toward one stressing finance.

Changes in labour process practice were not purely due to senior management dictate. Indeed a major theme of chapter six

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[6] Edward's (1979) description of technical control is somewhat similar but the link he identifies between mechanization and flow lines is machine pacing which is not necessary for control over flows.

is to illustrate that the actions of management professionals were important determinants of their own practices. Thus it was that engineers, confronted by the emergence of accounting, developed means of increasing productivity which diverted senior managements' demands for alternatives.

The description of how engineers came to hold the view of the leading role of finance illustrates further the relationship between senior management and managerial professions. Beeching's stress on cost was responded to by engineers, in the manner of the 1920s, by the institution of methods aimed at increasing production by the technical means of improved coordination. Although these improved productivity they did not divert the new senior management from the application of accounting techniques standard throughout British industry but lacking in the workshops.

As is indicated in chapter six this tenacity of senior management received support from railway workshop accountants. Senior management's decision making was the process which accountants and engineers competed to influence. The engineers of the 1960s were more willing to concede to the claims of finance than their predecessors, and thus it is difficult to determine if the move to finance led management practices was due to the tenacity of senior management, the influence of railway accountants or the change in engineering.

The change in engineers is primarily a change in training and socialization. Engineering training was seen increasingly as a theoretical discipline removed from practical knowledge of manual work and physical production. Thus engineering and accounting (a theoretical white collar discipline) were seen to be more akin than previously. Added to this, management accounting was seen as part of the British engineers' discipline not another occupation. The shrinking railway engineering industry meant that an alternative engineering culture was not sustainable, particularly as an increasing number of engineers were graduates whose initial socialization was into the accounting led world of British industry.

The transformation of railway engineering into a finance led practice secured the continued dominance of engineers within workshops' management. As this was combined with securing supervision as a senior engineering post, the engineers can be seen as being rather successful in extending the area of activities which were considered to be suitable for engineers. Therefore the dominance of finance should not be seen as the defeat of engineering, rather it is the outcome of the engineers' activities and a further illustration of intra-managerial competition and the distinctions between groups and practices.

The final part of chapter six indicates the consequences of the post-Beeching dominance of finance. The major impact is that the aim of workshops came to be seen as concerned with profitability rather than the repair and production of rolling stock at minimum cost, a change, it is argued, which resulted in a lack of coordination between workshops and railway.

The summary of chapter six took the issue of lack of coordination further by discussing the work of Nichols on British productivity (1986), I argue that the dominance of accounting is part of the explanation for the lack of coordination because of its stress on performance springing from the individual department or process rather than the coordination of departments and processes.

Financial reproduction is necessary for capitalist organizations but so to is technical reproduction. Chapter six has indicated that how they are merged varies according to inter-managerial competition and that this has consequences for the output of organizations and understanding national patterns of production.

The remaining chapters from seven to nine continue the theme of coordination. I term these the chapters on the forces of production. In a Marxist sense this may be inaccurate, because only chapter eight is concerned with machinery, chapter seven being concerned with organization and chapter nine with Taylorism. The division was introduced to enable the changes in the nature of the labour process to be illustrated separately from the conflicts within the workshop industry, and related back to these conflicts.

The previous six chapters establish that groups within capitalist organizations compete for the ability to reproduce that organization, and that the reproduction process is structured along financial and material dimensions. It is shown that within the railway workshops the engineers were the dominant management grouping.

The earlier chapters describe how the engineers' technical solutions set against a backdrop of production for use, satisfied senior management's requirements, what is missing is what these policies entailed. Chapter seven redresses this deficiency by describing the technical means by which railway engineers increased productivity. The technical means introduced was what I term the managerial control over coordination, this involved management determining the flows of work through the factories as a means of ensuring the gains of coordination, listed at the beginning of this chapter. Control over coordination is an ongoing process, but it was the inter-war period which marked the beginning of the transfer of control over coordination from the supervisor-worker relationship to management. The development of managerial control over coordination was the chief mechanism behind the declining importance for productivity of the worker-supervisor relationship.[7]

The development of coordination during the inter-war period was achieved by a number of distinct, but connected practices. The first was the adoption of standardised components, enabling mass production, the reduction of hand fitting and complete inter-changeability. These cut down on waste and made the further control of flows possible. Interchangeability relied upon a growth in materials' inspection and control of gauges.[8]

Specialization of labour was furthered during this period, the old practice of men being allocated to a single locomotive etc being replaced by gangs allocated to a particular part of a locomotive etc. At many works this was further developed by moving the work to the men (rather than

[7] Chapter seven indicates that there are a number of similarities between this and Edwards' conception of technical control, but that he underplays the role of coordination and over-emphasises machine pacing.

[8] The growth in materials' examination was also used to reduce repair to a minimum. Interchangeability enabled stocks of finished goods that took longest to repair to be kept and thus significantly reduce repair times.

vice versa), in defined stages.

The most significant development was the method of coordinating these flows of work, to ensure that men, machines and materials were brought together at the same time and place. This process of coordination was achieved by the establishment of production scheduling and progress monitoring overseen by departments under the direct control of management as opposed to foremen. Management was thus increasingly responsible for specifying what work tasks were to be done and monitoring their performance. The success of management's coordination depended, not surprisingly, on a strict adherence to the timetable by the shopfloor.

The inter-war changes described in chapter seven achieved the object of higher productivity.

Edwards (1979) argued that in the USA technical control encouraged union growth. This case study shows that this sequence is not applicable to the railway workshops, where control over coordination, which is similar to Edwards' concept, gave rise to lateral worker conflict.

It is shown that Burawoy's concept of 'making out' appears to be nearer the mark. Burawoy argued that under modern capitalism, the drive to 'make out', ie. achieve piecework bonus, deflects worker management conflict into a consent making process. The inter-dependencies of labour mean that a worker's ability to 'make out' may be foiled by other workers' failure to do their job at an appropriate pace. This process was identified in the railway workshops, and seen as an added contribution to the quiescence of the workshop staff. Unlike Burawoy, I did not give this process an autonomy but firmly located it in the growth of coordination which not only increased inter-dependencies, but also marginalized direct worker effort as a major contribution to productivity enabling the easier bonuses on which making out (as opposed to output restriction) rests.

The development of control of coordination had not, by the time of Beeching totally deprived the foremen of production planning duties. The lull in the development of coordination reflects that it is not a process of constant speed. Just as the inter-war developments in production engineering were stimulated by a financial threat to the engineers' position of dominance so were the next developments. This time the threat was a senior management, under Beeching, concerned for financial control. The workshop engineers' response was to increase further production engineering control by extending flow lines but more importantly utilising the technique of network analysis, an operational research technique for easy, effective coordination. This resulted in significant increases in productivity, but was applied at the same time as the various management accounting techniques imposed from above, which are described in chapter six. The networks were increasingly used to reduce costs rather than the classic task of increasing the speed of vehicle throughput.

The development of coordination is a material practice but it is not purely a product of technically orientated engineers under pressure. The discussion of network analysis indicates that changes in coordination can be used to advance financial control. The final part of chapter seven shows that computerisation, much of which formalised and advanced previous methods of coordination, occurred under a management which, as is shown in chapter six, identified finance as having the leading role.

Chapter seven follows a very similar chronology to chapter six. In the chapter six changes in management perspectives are described and accordingly the end of chapter seven echoes that of chapter six by examining the contribution of financial and technical criteria to coordination. Chapter seven shows that the speed in the development of coordination is related to power struggles within organizations. It also shows that financially orientated management could advance coordination. In the summary it is indicated that the coordination possible was bounded. The concept of accounting entity enables coordination to advance within departments but not between departments. Capitalist organizations have to be reproduced as both financial and material entities, the significance given to financial practices will in part determine the degree and speed of the development of coordination of the material labour process, particularly distorting possible gains from the coordination between departments. It is unlikely that financial practice will reverse the development of control over coordination, which because it yields management benefits in terms of its ability to reproduce the labour process, is set to continue. The analogy could be drawn between this and Cohen's (1978) claim that developments in means of production are unlikely to be disinvented.

Chapter eight examines the theme of means of production.

The discussion indicates that the analogy made between my claim and Cohen's is probably unsurprising given that, as is shown, mechanization is one of the outcomes of the development of coordination. The phenomenon of mechanization has a number of salient points for my thesis. Theoretically it is important because mechanization was seen by Marx as the fundamental transformation of the labour process. It is shown that Marx considered the most significant feature of machinery was the coordination of the operation of many different tools and tasks within the motions of the machine. I speculate that the advantage of coordination, described in chapter seven, which disproved Marx's interpretation of the transition from simple control, were probably stimulated by the evident success of coordination when it is located within machine operation.

The discussion of mechanization is also salient because it relates to recent academic discussions of the application of new technology. Contingency theory appears to have become the dominant theory of technological change. As this thesis rejects this approach to the labour process, it is necessary for the sake of consistency, amongst other reasons, to reject it when applied to technological change.

I argue that the evidence which pointed to contingency theory was essentially negative. This involved evidence contradicting technology being applied as a means of labour control or as a means of material factors, by which is meant product or technical process improvement. I argue that once the concept of control over coordination was adopted then technological change can be seen as either control over either labour or matter, the whole being an advance of total control.

The issue of mechanization therefore not only takes account of important theoretical debates both past, that is Marx, and present, for example, Mcloughlin and Clarke (1988), but also provides evidence on the process of coordination.

Mechanization provides illustrations at two levels, the coordination inherent in individual machines, and the coordination in the process of mechanization. Essentially I argue that control over coordination advances by a process of two steps forward and one step back, for example, control over material, like advancing product design, may involve increasing worker skill, but overall the level of control is advanced. Chapter eight rejects the view that this trade off necessarily implies that labour is not being increasingly controlled. Within a process of increasing managerial control over the whole of the labour process reskilling can only occur ad-infinitum if nature can be infinitely controlled, in terms of both increasing degrees of precision and infinite variety of new products. I claim that much of the literature on flexibility, which is seen as rejecting degradation, is based upon the, probably erroneous, view of nature as infinitely malleable resources under mankind's control.

Chapter eight shows that flexibility is not new but was the basis of workshops production for much of this and the last century. Indeed I claim that the application of the machine metaphor to production may have resulted in the flexible coordination which became applied, as a metaphor, on to the means of production.

Chapter eight illustrates these claims by focusing on the history of machine tools in the workshops. In summary this history is a replacement of hand labour by machinery, machinery which increased in the speed and the range of task that could be performed. This latter became the most crucial factor reaching its culmination in computer control. This brief chronology, of course, hides a much more complex picture.

As with the process of coordination of production, certain conditions for the advance of mechanization were necessary. They both shared the need for control over material specification. The achievement of this control is described, and shown to be an ongoing process, developing from the early gauges to machine based measurement.

Measuring accuracy is not the only parameter required by mechanization. Chapter eight discusses the more social restriction of batch size. Batch size stands in the same relation to machine shops as product quantity does to the factory. In the railway workshops batch size is shown to have been small. This is meant that machine tool policy has tended to stress flexible machining combined with jigging as a means to accuracy, present day NC machines being the integration of jigging onto the machines' operation.

Once the basic parameters of the machine shop has been discussed, chapter eight describes the development of mechanization. It is shown that the application of machines was justified according to ten criteria, for example, replacement of labour, cutting speed etc. Which was important varied over time.

The nature and reason for this variation are discussed. It is shown that the shifts in policy were related to the interconnected nature of the labour process. As one aspect of machine shop practice was improved the relative gains to be made from improvements by other means increased. It is thus that increases in cutting speed at the turn of the century, due to new cutting speed and electric power, gave an impetus to ensure that the organizational context of the machines was improved. The improvement had several facets:

1. Increasing the tasks carried out by machines and reducing the amount of movement of raw materials and labour between machines;

2. Reducing the amount of movement of raw materials and labour between machines; and

3. Improving the degree of machine utilization;

All of which involved increasing utilization of all parts of the labour processes by closer integration. It is shown that the same pattern of development continued with the introduction of numerically controlled machines.

One thing chapter eight does make clear is that the control over coordination advanced by mechanization can advance on several fronts, for example, reducing labour and material control at once. This, it is argued, is particularly so as managers' awareness of and knowledge of the integrated nature of production grows.

The previous chapter, chapter nine, discusses Taylorism in the railway workshops. This is discussed for the same reasons as mechanization, that is, it has been considered theoretically important (by Braverman), but that it can be integrated within a discussion of the growth in coordination.

The chapter opens with a discussion of the relation of Taylorism to engineering. This discussion returns to earlier themes by arguing that Taylorism was a particular combination of financial and physical methods of production control. It is shown that Taylorism, and its later variant workstudy, was not applied within the railway workshops in many major way until 1970, this after first being considered around 1920 and actively promoted by senior management from 1950.

The consideration given to Taylorism in the 1920s is discussed and is shown to have been perceived, by engineers, as a possible solution to the problem of piecework. As is shown in earlier chapters the engineers' solution to the worker/supervisor method of production was not increased speed of work but improved coordination. The improvements in coordination were combined with a particular form of the combination of physical and financial, the financial element being the monitoring of foremen. In simple terms Braverman's thesis is incorrect.

After a discussion of the First World War period chapter nine describes senior management's attempts to promote workstudy. Two possible reasons for the lack of Taylorism are examined; firstly, the nature of the work and ,secondly, the existence of piecework, the latter being the explanation prevalent at the time. These are both seen to be inadequate and the lack of Taylorism is shown to be explicable in terms of the theoretical framework developed in this thesis.

Workstudy was applied for both productive and ideological reasons. Workshops modernisation had increased the importance of worker effort. Just as mechanization turned the spot light on labour movement so did control over work flows, particularly after the application of network analysis. Work study came to be seen as an aid to planning. Improved coordination improves productivity and at the same time increased the relative gains to be made by using workstudy as a means of speeding up labour.

The reason workstudy could provide these gains was because it was increasingly part of a wider system for work place coordination. This combination was appealing to the engineers of the 1960s for a number of reasons, which can be seen as railway engineers and workstudy meeting halfway. The stress on coordination obviously increased its appeal to engineers, but, as was shown, engineers had moved to a more finance orientated outlook and the particular combination of physical and financial had become much more appealing.

Chapter nine finishes with a look at two major agreements which governed the application of workstudy from 1970. It was shown that the major emphasis was indeed upon coordination, particularly flexible manning.

SUMMARY

This final chapter of the thesis has provided a reasonably detailed summary of the preceding argument on a chapter by chapter basis. It is not the intention of the final summary to further distil the argument. My intention in this summary is to state what I consider to be the major theoretical themes.

I have claimed that the railway workshop labour process can be understood according to a few simple themes and principles. The first is that under capitalism, and probably many other systems, the labour process is a series of tasks with monetary causes and consequences. This usually means that the labour process has to be reproduced in physical and financial terms. The second is that this separation between financial and physical gives rise to a number of different groupings. In the earliest period of railway workshop history the division was manifest as the classic division between owners and workers, with the latter under the control of direct supervisors.[9]

The reproduction of the organization rested upon an expertise not possessed by owners, and this gave rise to management and management professionals. In the railway engineering industry the groups of most significance were engineers and accountants, groups which roughly corresponded to the dual nature of the labour process.

Reproduction requires control over those carrying out tasks and this can be achieved by management taking control

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[9] I do not, however, privilege this form of capitalism as theoretically more significant than any other type of capitalism.

over tasks. Thus I have characterised control over tasks as a function of reproducing the organization. I have argued that the material reproduction of the labour process advance by increasing managerial control over physical coordination. This has not been a uniform process but dependent on the weight given to financial reproduction. Accounting reproduces the organization in financial terms by accounting for profit, but when it is applied internally it is both static, it can only measure not create, and leads to a lack of coordination in the organization as a whole. Thus Sohn-Rethel's contradiction between plant economy and market economy is reproduced within the factory.

The railway workshops case study illustrates that how the material and financial are balanced depends on a range of factors, crucially important being the struggles between management groupings. These struggles are judged by the demands of senior management, demands that are influenced by the struggles of management professionals. The outcome of intra-managerial competition is also determined by the competing groups ability to transform the supervisor/worker relation, both in terms of the utilization of resources and the long term ability to transform the labour process. Which group achieves dominance and what practices they use to balance the demands of the physical and financial is the outcome of struggle. Because intra-management struggles take place in a location between worker and senior management the outcomes, in terms of which group predominates and using what methods, are therefore heavily shaped by the nature of the working and ruling classes.

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